THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

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EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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THE

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On the Foraminifera of America and of the Canary Islands.

Alcide d'Orbigny, celebrated for his travels in South America, has lately published three long essays on the imperfectly known class of the Foraminifera. One appeared in the *Histoire Physique, Politique, et Naturelle, de l'Ile de Cuba, par M. Ramon de la Sagra*; a second in the *Histoire Naturelle des Iles Canaries, par MM. P. Barker-Webb et Sabin Berthelot*; and the third in the *Voyage dans l'Amérique Méridionale, par M. Alcide d'Orbigny.* As these memoirs, so highly important for this class of animals, are contained in very expensive works, and are therefore the less accessible to the public, some extracts from them may not be without interest for our readers.

Every thing in nature which escapes the naked eye, not only remains unknown to the great mass of the people, but even unnoticed for centuries by those who anxiously endeavour to investigate the beauties of creation. How many myriads of beings are still unknown to us! How many years must yet elapse ere we acquire an adequate idea of the extent of zoology!

If the enormous size of the largest animals of our globe lead us to contemplate the omnipotence of the Creator,—if the regularity of their forms, the adaptation and perfection of their organs, the richness of their whole structure, prove to us their wonderful completeness,—so, our understanding is not the less astonished when we descend to those hardly noticeable beings, whose number counterbalances their infinite minuteness, so that by their multiplicity they perform without our being aware of it, one of the most important parts in nature. Can it indeed fail to strike with wonder every one who reflects that the sand of all sea-coasts is so filled with these microscopic animals termed Foraminifera, that it is often composed of them to the extent of no less than a half? Plancus* counted 6000 in an ounce of sand from the Adriatic Sea; we ourselves have reckoned 3,840,000 in an ounce of sand from the Antilles. If we calculate larger quantities, as for example a cubic yard, the amount surpasses all human conception, and we have difficulty in expressing the resulting numbers in figures. And yet how insignificant is all this when we regard in the same point of view the whole enormous mass of the sea-coasts of the Earth? We thence deduce the certainty that no other series of beings can, in regard to number, be compared to the group we are now considering, not even the myriads of minute crustacea which colour large spaces on the surface of the sea,† and which afford nourishment to the largest animals, viz. the whales, and not even the infusory animals of fresh water, whose shields partly compose Tripoli;‡ for these are limited in their distribution, whereas the Foraminifera occur on all coasts.

If we inquire what part is performed by the minute animals now under consideration, and many of which do not attain a half, a fourth, or a sixth of a millimetre in size, we shall find no less reason for astonishment. The author has examined the sand of all parts of the earth, and found that it is the remains of the Foraminifera which constitute, in a great measure, banks that interrupt navigation, which stop up bays and straits of the sea, which fill up harbours, and which, together with corals, produce those islands that rise up in the warm portions of the Pacific Ocean. When we regard the influence of the Foraminifera on the strata of the crust of the globe, we be-

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* *Ariminensis de conchis minus notis.*

† Near Brazil we have seen the sea coloured a deep red for nearly a degree, and this was caused by a species of the genus *Cetochylus*, which, according to the testimony of the whale fishers, forms almost exclusively the food of whales.—See *Voyage dans l'Amérique Méridionale, part. hist.* t. 1. p. 17.

‡ Academy of Sciences of Berlin, 29th July 1837.—*Annales des Sciences Nat.* vol. viii. p. 374; also Edinburgh New Philosophical Journal, vol. xxii. p. 84.

come so much the more convinced of what we have said as to the living species, and it is easy to adduce facts to shew that they contribute much to the formation of whole deposits. Beginning with the newer epochs, the tertiary formations, we have, above all, a striking case in the environs of Paris. The *Calcaire grossier* of that extensive basin is, in certain places, so filled with Foraminifera, that a cubic inch from the quarries of Gentilly afforded 58,000, and that in beds of great thickness and of vast extent. This gives an average of about 3,000,000,000 for the cubic metre; a number so great as to preclude further calculation. We can hence, without exaggeration, conclude that the capital of France, as well as the towns and villages of the neighbouring departments, are almost entirely built of Foraminifera. This group of animals is not less abundant in the tertiary formations extending from Champagne to the sea, and its numbers are prodigious in the basins of the Gironde, of Austria, of Italy, &c. The cretaceous beds likewise contain myriads, as is proved by the nummulitic limestone of which the greatest of the Egyptian pyramids is built, and by the vast number of these bodies of which the white chalk from Champagne in France across to England is composed.* We find also Foraminifera down to the lowest beds of the Jura formation. Thus have these shells, which are hardly perceptible to the naked eye, altered not only the depths of the actual ocean as it now exists, but also, previously to our epoch, formed mountains and filled up basins of great extent.

These very abundant beings remained, nevertheless, unnoticed for centuries. The first were observed in the sand of the Adriatic sea by Beccarius in the year 1731. It was for a long time believed that that sea alone contained Foraminifera; and, with the exception of some living ones observed in England by Walker and Boys, and some fossil species noticed by Lamarck as occurring near Paris, nothing was known of the presence of Foraminifera in the other parts of the earth until the year 1825, when the author made known his first work on the subject.

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* *Foraminifères de la Craie blanche du bassin de Paris. Mém. de la Société Géologique de France.*

We must ascribe the obscurity in which the Foraminifera have remained to the difficulty of their observation and to the comparatively trifling results generally obtained from the investigation of microscopic bodies; and yet there are few branches of study more accessible to every one, and which afford more important consequences. Should an observer be resident on any coast whatever of the various quarters of the globe, or on any tertiary, chalk, or oolite formation of a continent, he will find everywhere under his feet an immense multitude of Foraminifera, for whose examination a simple lens is sufficient. In regard to the importance of the study, it ought to possess equal interest for geologists as for zoologists; for the first, because it enables them to determine the temperature of the regions in which the fossil animals lived, by means of a comparison with those which still live in our seas, and also, because it gives them information respecting the formation of certain strata, questions of the highest importance for the history of our planet; and, for the last, from the elegance of the forms of these animals, from their peculiarity of organization, and finally, because they constitute one of the most numerous classes of animals, and, notwithstanding their minuteness, play an important part in nature.

The facts relating to the geographical distribution of the Foraminifera are extremely interesting. The author has brought together eighty-one species from the coasts of the two sides of South America, a number which already affords data for certain conclusions, but which will doubtless be afterwards increased.

The configuration of the coasts, their greater or less depth of water, their particular nature, and more especially the direction of the great currents, have the greatest influence on the distribution and the number of species of marine animals. The configuration of South America is well known; every one is aware that the narrow point stretching towards the pole forms the most distinctly marked boundary between the Atlantic and the Pacific Oceans; but no one knows that there the direction of the currents contributes not less than the configuration of the land to disunite the two oceans. The great currents from the south-west polar regions which flow towards the extremity of South America, there in fact separate into two different branches. The one proceeds eastward past Cape Horn, follows in the Atlantic Ocean the coast of the Continent from south to north, and stretches along Patagonia and the Pampas from Buenos Ayres to Brazil; the other, on the other hand, strikes against the extremity of America, remains in the Pacific Ocean, follows the shore from south to north, and proceeding along the coasts of Chili, Bolivia, and Peru, extends beyond the equator. The polar water which is divided at Cape Horn, and which follows the coasts on both sides, prevents the animals passing from one ocean into the other, for, to do so, it would be necessary for them to move against the current and against the prevailing winds, which is impossible. The form of the continent and the direction of the currents would therefore, *a priori*, render it probable that the two seas should possess entirely distinct Faunas, and that the only possible point of contact of the two should be at Cape Horn, where the separation begins. The distribution of the Foraminifera confirms this view.

Opposite Cape Horn, at a depth of about 160 metres, the bottom of the sea was examined by means of a sounding lead having a diameter of only a few centimetres, and yet this small surface yielded a considerable number of Foraminifera and Polypi. This is a fact of great importance, because it proves that these animals can live in great depths of the sea, and gives us an idea of the innumerable multitudes of these beings in such cold regions. The bottom of the sea must, in the strict sense of the word, be covered with them, in order to be able to furnish more than forty individuals to so small an object as the sounding lead. Among these forty individuals there were five species: *Rotalina Alvarezii*, *Rotalina Patagonica*, *Truncatulina vermiculata*, *Cassidulina crassa*, and *Bulimina elegantissima*. Of these five species, the four first occur only on the coasts of Patagonia and of the Malvinas, and therefore belong to the Fauna of the Atlantic Ocean; while the fifth lives in Chili and all Peru, and hence belongs to the Fauna of the Pacific Ocean. This result shews distinctly that Cape Horn is the point of departure of both the Faunas peculiar to the two different seas, and that a larger number of species belong to the Atlantic than to the Pacific. This also is to be explained by the direction of the currents; for, as these come from the south-west, they must carry the water more easily to the east from Cape Horn than to the west, and hence must impart more of their peculiar species to the Atlantic than to the Pacific. This agrees extremely well with the distribution of the five species of Foraminifera.

Of the eighty-one species observed on the coasts of South America, fifty-two occur in the Atlantic Ocean without even one of them presenting itself in the Pacific, and thirty are peculiar to the Pacific, without a single individual of them being found in the Atlantic Ocean. The only species common to the two seas (*Globigerina bulloides*), lives not only on both coasts of America, but also in the Canary Islands, in the Mediterranean Sea, and even in India. As it occurs everywhere, it does not alter the well-grounded results. The following list of the species will exhibit more clearly what I have said:—

Species.	Of the Atlantic.	Of the Pacific.
Oolina compressa	Malvinas.	...
lævigata	Do.	...
Vilardeboana	Do.	...
caudata	Do.	...
Isabelleana	Do.	...
melo	Do.	...
raricosta	Do.	...
striata	Do.	...
inornata	Do.	...
striaticollis	Do.	...
Dentalina acutissima	Do.	...
Marginulina Webbiana	Do.	...
Robulina subcultrata	Do.	...
Nonionina cultrata	Do.	...
subcarinata	Do.	...
pelagica	...	in the open sea.
Polystomella Lessonii	Malvinas; Patagonia.	...
Owenii	Patagonia.	...
articulata	Malvinas; Patagonia.	...
Alvarezii	Do.	...
Peneroplis pulchellus	Do.	...
carinatus	Patagonia.	...
Rotalina Alvarezii	Cape Horn; Malvinas; Patagonia.	...

Species.	Of the Atlantic.		Of the Pacific.
Rotalina patagonica	Cape Horn; Patagonia.		
peruviana	...	...	Valparaiso; Cobija; Callao; Payta.
Globigerina bulloides	Malvinas.		Valparaiso.
Truncatulina dispar	Do.		...
vermiculata	Cape Horn; Malvinas.		
depressa	...	...	Valparaiso.
ornata	...	...	Do.
Rosalina peruviana	...	...	Cobija; Arica; Payta.
Saulcyi	...	...	Arica.
araucana	...	...	Valparaiso.
cora	...	...	Callao.
inca	...	...	Do.
consobrina	...	...	Do.
rugosa	Patagonia.		...
ornata	Do.		...
Isabelleana	Malvinas.		...
Vilardeboana	Do.		...
Valvulina pileolus	...	...	Arica.
auris	...	...	Chili; Cobija; Arica; Callao; Payta.
inflata	...	...	Valparaiso.
inæqualis	...	...	Payta.
Bulimina pulchella	...	...	Valparaiso; Callao; Payta.
ovula	...	...	Valparaiso; Callao.
elegantissima	...	...	Cape Horn; Valparaiso; Callao.
patagonica	Patagonia.		...
Uvigirina raricosta	Malvinas.		...
striata	Do.		...
bifurcata	Do.		...
Asterigina monticula	Patagonia.		...
Cassidulina crassa	...	...	Cape Horn; Valparaiso; Callao.
pupa	Malvinas.		...
pulchella	..	...	Payta.
Guttulina Plancii	Patagonia.		...
Globulina australis	Do.		...
Bolivina plicata	...	...	Valparaiso.
costata	...	...	Cobija.
punctata	...	...	Valparaiso.
Biloculina peruviana	...	...	Payta.
patagonica	Patagonia.		...
sphaera	Malvinas.		...
Isabelleana	Do.		...
irregularis	Do.		...
Bougainvillii	Do.		...

Species.	Of the Atlantic.		Of the Pacific.
Triloculina rosea	Patagonia.		...
cryptella	Malvinas.		...
lutea	Do.		...
boliviana	...	...	Cobija.
globulus	...	...	Payta.
Cruciloculina triangularis	Malvinas.		...
Quinqueloculina meridionalis	Patagonia.		...
patagonica	Do.		...
Isabelleana	Do.		...
magellanica	Malvinas.		...
peruviana	...	...	Arica.
flexuosa	...	...	Do.
inca	...	...	Do.
araucana	...	...	Valparaiso.
cora	...	...	Payta.

Of the five Foraminifera of Cape Horn, four are peculiar to the Fauna of the Atlantic Ocean. Of these four, two are frequent in the Malvinas, without extending to the northern coasts of Patagonia; one occurs on the coast of Patagonia, without presenting itself in the Malvinas; and one is common to both localities. We thus see that the Foraminifera of Cape Horn are distributed through the Atlantic Ocean, because they follow the direction of the currents.

In the Malvinas there are thirty-eight species, a high number when we take into consideration the southern position and the low temperature of these islands; and this is a proof that the Foraminifera can live and multiply in all parts of the earth, and in all temperatures, if the locality be favourable. Of these thirty-eight species, only five are found on the coast of Patagonia, near the Rio Negro. This might appear singular, did we not know that the currents which proceed from Cape Horn diverge not a little towards the southern portion of America, so that one of the two branches follows the coasts of the continent, while the other traverses the Malvinas, and in this way the water which washes these islands does not again come in contact with the coasts of the continent. Hence it follows that the Malvinas and Patagonia can have in common only the species distributed over all coasts, while the Malvinas can possess their peculiar species, which are distinct from those of the continent. This is actually the fact, inasmuch as they afford no less than thirty-three peculiar species.

On the north coast of Patagonia, from the Bay of San Blas to the peninsula of San Josef, that is, from 20° to 23° S. L., the author discovered eighteen species of Foraminifera, of which five occur also in the Malvinas; there thus remain thirteen species which are peculiar to this part of America.

In order to follow up this comparison, let us now direct our attention to the opposite side of America. Multiplied observations shew, that near Valparaiso, in Lat. 34° S., the number of species varies in an extraordinary degree, according to the localities. In the sand of the Bay of Valparaiso, where the weakness of the current would lead us to suppose that light bodies must be accumulated in large quantity, two species only of Foraminifera were found; but, on the other hand, on the opposite side of the point Cormillera, where the current is very perceptible, investigations made at a depth of 12 to 20 yards, on a bottom covered with corals, yielded a large number of Foraminifera. Hence it results, that the Foraminifera are more numerous where the current is powerful than in still bays. It is also ascertained that this difference depends more on the natural constitution of the bottom than on the currents, inasmuch as sandy and muddy coasts are less favourable for the Foraminifera, whereas the localities rich in corals are well calculated to give development to great masses of these animals. In Chili twelve species of Foraminifera were collected, of which eight are peculiar to that region. The other four not only extend to the coasts of Bolivia, but are also met with in the Equatorial regions. We may assume that certain species are confined to certain limits of temperature, while others, less dependent on temperature, are transported by currents to all the shores of South America.

When we unite together the species of Arica and of Callao, the harbour of Lima, that is, from L. 12° to 15° S., in order to compare them with those of 34°, we have fourteen, of which four occur also at Valparaiso, and four which extend northwards as far as Payta, and to the Equator. Thus there are only eight peculiar species; a proof that the Foraminifera of the Peruvian coast agree partly with those of the temperate regions of Chili, and partly with those of the warm regions of the Equator, but also offer some distinct species.

We have still to speak of the Foraminifera of the equatorial regions, partly of those at Payta, in Peru, and partly of those at the mouth of the Guayaquil. There are nine species, of which four belong at the same time to the localities already enumerated, while the other five are peculiar to these places.

It is proved by the comparison of species, that the two coasts of South America present, as regards the Foraminifera, two entirely distinct and yet contemporaneous faunas. If we compare the species of the south coasts of the Atlantic ocean with those of the Antilles, or with the equatorial fauna, which includes one hundred and eighteen species, we find that among the latter there are none of the species of the south coasts, and although both series are in the same ocean, yet they are totally distinct. This result may be applied directly to the geology of the Tertiary period, and proves, that at inconsiderable distances on the same continent, entirely different and yet contemporaneous Faunas may exist. Different basins, therefore, which contain different species, may thus belong to the same epoch.

Having given this numerical comparison of the species, let us now glance at the distribution of genera in the two Faunas of South America. In the order *Monostega*, we find that the genus *Oolina*, so common and so rich in species in the Malvinas, is not represented by a single species on the coasts of the Pacific. The order *Stichostega* affords the same result on the east coast; for, the genera *Dentalina* and *Marginulina* occur there, while we have no species in the Pacific. The more numerous members of the order *Helicostega* are more uniformly distributed, but yet each sea has its particular genera. *Robulina*, *Polystomella*, *Peneropolis*, and *Uvigerina*, occur on the east coasts in the Malvinas and in Patagonia; *Valvulina* alone occurs only on the west coasts in Chili, Bolivia, and Peru; *Nonionina*, *Rotalina*, *Globigerina*, *Truncatulina*, *Rosalina*, and *Bulimina*, are common to both oceans. Of the *Entomostega*, *Asterigerina* is met with only on the east coasts; *Cassidulina* on both sides. The *Enallostega* have the genera *Guttulina* and *Globulina* in the Atlantic alone; while *Bolivina* is exclusively found in the Pacific. Among the *Agathistega* we find the genus *Cruciloculina* in the east; while *Biloculina Triloculina*, and *Quinqueloculina* are inhabitants of the east as well as the west.

Combining these data, we find, that of the twenty-four genera of South America, there are ten common to the two sides, two are peculiar to the Pacific, and twelve to the Atlantic; or, what is the same thing, twenty-two genera live on the shores of the Atlantic, and only twelve on those of the Pacific. If we ask the cause of this great difference in the number of species, and especially of the genera, between the two coasts of South America, we shall perhaps find a satisfactory explanation in the peculiar configuration of the two shores. Owing to the proximity of the Andes, the coasts of the Pacific are so steep, and the descent so abrupt, that no soundings can be obtained at a very short distance from land, viz. at little more than half an English mile; thus a narrow stripe only remains for the Foraminifera, and sometimes they cannot live at all. On the shores of the Atlantic, on the other hand, the gentle slope of the land from the Andes to the sea is continued in the bottom of the sea, so that at a distance of more than two degrees from the coasts there is still a depth of water suited to the Foraminifera. There is, therefore, on this side of America, a broad zone on which the Foraminifera are propagated, whose surface is at least ten times as large as the other. This double fact affords an explanation of a very important question—that as to the undoubted influence of the configuration of the surface on the composition of the series of beings which inhabit it, and also one of the most interesting applications to geology in the elucidation it offers as to the differences of species of fossil coverings of animals in contemporaneous formations.

The rich materials of Cuba, Haiti, St Thomas, Jamaica, Martinique, and Guadaloupe, afforded the result that Cuba, owing to its wide extent, and to its favourable position as to winds and to the currents from all other islands, possesses on its coasts all the species of Foraminifera which are met with on the shores of the Antilles; while the Cuba species are not distributed in proportion in the other parts of the Archipelago, Another result is that in regard to the multiplicity of species met with in Cuba. No other place, with exception of the Adriatic Sea, can be compared to it. Cuba has no less than one hundred and eighteen species, or a tenth part of the total amount known to the author.

The Foraminifera of the Canary Islands, forty-three in number, having been investigated from too limited materials, we may suppose that a much larger number will yet be discovered. In regard to their geographical distribution, the following conclusions have been deduced: The Foraminifera of the Canary Islands, which are common also to France, are seven, and form nearly the sixth part of all the species. They may be divided into three series according to their mode of occurrence, viz., 1. On the coasts of the ocean alone; 2. on the coasts of the Mediterranean; and, 3. on the coasts of the ocean and of the Mediterranean. Of the first section we have no species; of the second six; *Orbulina universa*, *Globigerina bulloides*, *Planorbulina vulgaris*, *Truncatulina variabilis*, and *Textularia sagittula*; of the third only one, *Truncatulina lobata.*

Hence it appears, that, with the exception of the *Truncatulina lobata*, which is less dependent on temperature, as it occurs towards the North Pole, all belong to the Mediterranean Sea. We may, therefore, conclude that the Foraminifera found in the Canary Islands and on the coasts of France, live in dependence on the zone adapted to them, as the Mediterranean is warmer than belongs to its latitude, owing to its being sheltered from the northern currents.

The species belonging to the Canary Islands which occur in other places are four, *Orbulina universa*, *Lingulina carinata*, *Planorbulina vulgaris*, and *Rosalina valvulata*. These live also in the Antilles, and hence appear to be peculiar to tropical regions, or they are transported by winds or vessels to the American coasts.

There is another division of the species of the Canaries, viz., those which occur likewise in a fossil state. These are six in number, of which five, *Orbulina universa*, *Lingulina carinata*, *Globigerina bulloides*, *Truncatulina lobata*, and *Textularia sagittula*, occur in the subapennine tertiary strata of Italy, and the three last also in the tertiary formation of Austria near Nussdorf and Buitur. This number of identical species increases the approximation of the Canary Foraminifera to those of the Mediterranean; for the greater part of the species still living in this sea also occur in a fossil state in the tertiary series of Italy and Austria. There still remains the sixth species, *Quinqueloculina lævigata*, which is found in the tertiary basin of Paris.

There are likewise thirty-three species which are peculiar to the Canary Islands. Taken together, these, though specifically distinct, possess the habit of those belonging to the Mediterranean.

We subjoin M. d'Orbigny's definition of the group :— "The Foraminifera are very small, microscopic, non-aggregated animals, which invariably possess a separate individual existence. They have a coloured jelly-like body, which is either entire and rounded, or separated into sections, which lie in simple or alternating lines, are spirally rolled up, or wound round an axis. This body is contained in a chalky, rarely cartilaginous covering, which is formed according to the segments of the body, and completely corresponds to the shape of the latter. From one or more openings or pores of the last segment of the covering, there project contractile, colourless, very long, thin, subdivided and branched threads, which serve as organs of motion."*

Observations on Jerusalem. I. *General Topography.* II. *Climate.*†

1. *General Topography.*

Jerusalem, now called by the Arabs *el-Kuds*, "the Holy," and also by Arabian writers *Beit el-Mŭkdis*, or Beit el-Mukaddas, "the Sanctuary,"‡ lies near the summit of a broad

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* Dr Troschel in Wiegmann's Archiv für Naturgeschichte, 1840.

† From Dr Robinson's excellent Biblical Researches in Palestine, Mount Sinai, and Arabia-Petræa; in three volumes octavo, with original maps. Published by Murray, London, 1841.

‡ Abulfed. Syr. ed. Köhler, p. 9. Edrîsi ed. Jaubert, i. p. 341. Freytag Lex. Arab. iii. p. 408. Edrîsi also once gives it the name *Aurashalim*, which is said to be sometimes used by the native Christians, l. c. p. 345.

mountain ridge. This ridge or mountainous tract extends, without interruption, from the plain of Esdraelon to a line drawn between the south end of the Dead Sea and the SE. corner of the Mediterranean; or more properly, perhaps, it may be regarded as extending as far south as to Jebel' Arâif in the desert, where it sinks down at once to the level of the great western plateau. This tract, which is everywhere not less than from twenty to twenty-five geographical miles in breadth, is in fact high uneven table land. It everywhere forms the precipitous western wall of the great valley of the Jordan and the Dead Sea, while towards the west it sinks down by an off-set into a range of lower hills which lie between it and the great plain along the coast of the Mediterranean. The surface of this upper region is everywhere rocky, uneven, and mountainous, and is, moreover, cut up by deep valleys which run east or west on either side towards the Jordan or the Mediterranean. The line of division or water-shed between the waters of these valleys—a term which here applies almost exclusively to the waters of the rainy season—follows for the most part the height of land along the ridge, yet not so but that the heads of the valleys which run off in different directions often interlap for a considerable distance. Thus, for example, a valley which descends to the Jordan often has its head a mile or two westward of the commencement of other valleys which run to the western sea.

From the great plain of Esdraelon onwards towards the south, the mountainous country rises gradually, forming the tract anciently known as the mountains of Ephraim and Judah, until, in the vicinity of Hebron, it attains an elevation of nearly 3000 Paris feet above the level of the Mediterranean Sea. Further north, on a line drawn from the north end of the Dead Sea towards the true west, the ridge has an elevation of only about 2500 Paris feet; and here, close upon the water shed, lies the city of Jerusalem.* Its mean geographical posi-

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* According to Schubert's measurements, the town of Hebron has an elevation of 2664 feet. Russegger gives the same at 2842 feet. The adjacent hills are two or three hundred feet higher. The height of the Mount of Olives, according to Schubert, is 2555 Paris feet; and, according to Russegger, Jerusalem is 2479 Paris feet above the sea.

tion is in lat. 31° 46′ 43″ N., and long. 35° 13′ E. from Greenwich.*

Six or seven miles N. and NW. of the city, is spread out the open plain or basin round about el-Jîb (Gibeon), extending also towards el-Bîreh (Beeroth); the waters of which flow off at its SE. part, through the deep valley here called by the Arabs Wady Beit Hanîna; but to which the monks and travellers have usually given the name of the Valley of Turpentine, or of the Terebinth, on the mistaken supposition that it is the ancient Valley of Elah.† This great valley passes along in a SW. direction, an hour or more west of Jerusalem; and finally opens out from the mountains into the western plain, at the distance of six or eight hours SW. from the city, under the name of Wady es-Sŭrâr. The traveller, on his way from Ramleh to Jerusalem, descends into and crosses this deep valley at the village of Kŭlônieh, on its western side, an hour and a half from the latter city. On again reaching the high ground on its eastern side, he enters upon an open tract sloping gradually downwards towards the east; and sees before him, at the distance of about two miles, the walls and domes of the Holy City, and beyond them the higher ridge or summit of the Mount of Olives.

The traveller now descends gradually towards the city, along a broad swell of ground, having at some distance on his left the shallow northern part of the Valley of Jehoshaphat; and close at hand on his right, the basin which forms the begin-

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* The latitude here given is the mean of four observations, viz.:—
Niebuhr, ———31° 46′ 34″ Reisebeschr. Ed. iii. Anh. s. 116.
Seetzen, ———31 47 47 Zach's Monatl. Cor. xviii. s. 542.
Captain Corry, —31 46 46 Comm. by Sec. of R. Geogr. Soc. Lond.
Moore and Beke, 31 45 45 Journ. of R. Geogr. Soc. Lond. vol. vii. 1837, p. 456
Mean, 31° 46′ 43″ differing only 3″ from Corry, and 9″ from Niebuhr.

The longitude is that found by Capt. Corry from a lunar observation in 1818, kindly communicated by the Sec. of the R. Geogr. Soc. of London. This is the only tolerable observation yet made for the longitude. Seetzen, indeed, observed imperfectly at three different times; but his results vary more than a degree from each other. The middle one is 32° 46′ E. from Paris, or 35° 6′ 24″ E. from Greenwich. See Zach's Monatl. Corr. xviii. s. 544. Berghaus has 32° 53′ 09″ E. Paris = 35° 13′ 33″ E. Greenwich, a casual approximation deduced from a comparison by Itineraries from Yâfa. Memoir zu seiner Karte von Syrien, pp. 26, 29.

† 1 Sam. xvii. 2, 19.

ning of the Valley of Hinnom. Further down, both these valleys become deep, narrow, and precipitous; that of Hinnom bends south, and again east, nearly at right angles, and unites with the other, which then continues its course to the Dead Sea. Upon the broad and elevated promontory, within the fork of these two valleys, lies the Holy City. All around are higher hills: on the east the Mount of Olives; on the south the Hill of Evil Counsel, so called, rising directly from the vale of Hinnom; on the west the ground rises gently, as above described, to the borders of the great Wady; while on the north a bend of the ridge connected with the Mount of Olives bounds the prospect at the distance of more than a mile. Towards the south-west the view is somewhat more open, for here lies the plain of Rephaim, already described, commencing just at the southern brink of the Valley of Hinnom, and stretching off south-west, where it runs to the western sea. In the north-west, too, the eye reaches up along the upper part of the Valley of Jehoshaphat; and, from many points, can discern the mosque of Neby-Samwîl, situated on a lofty ridge beyond the great Wady, at the distance of two hours.

The surface of the elevated promontory itself, on which the city stands, slopes somewhat steeply towards the east, terminating on the brink of the Valley of Jehoshaphat. From the northern part, near the present Damascus Gate, a depression or shallow Wady runs in a southern direction, having on the west the ancient hills of Akra and Zion, and on the east the lower ones of Bezetha and Moriah. Between the hills of Akra and Zion another depression or shallow Wady (still easy to be traced) comes down from near the Jaffa Gate, and joins the former. It then continues obliquely down to the slope, but with a deeper bed, in a southern direction quite to the Pool of Siloam and the Valley of Jehoshaphat. This is the ancient Tyropœon. West of its lower part Zion rises loftily, lying mostly without the modern city; while on the east of the Tyropœon and the valley first mentioned lie Bezetha, Moriah, and Ophel, the last a long and comparatively narrow ridge also outside of the modern city, and terminating in a rocky point over the Pool of Siloam. These three last hills may strictly be taken as only parts of one and the same ridge. The whole site of Jerusalem, from the brow of the valley of

Hinnom, near the Yâfa Gate, to the brink of the Valley of Jehoshaphat, is about 1020 yards, or nearly half a geographical mile; of which distance 318 yards are occupied by the area of the great mosque El-Haramesh-Sherîf. North of the Yâfa Gate the city wall sweeps round more to the west, and increases the breadth of the city in that part.

The country around Jerusalem is all of limestone formation, and not particularly fertile.* The rocks everywhere come out above the surface, which, in many parts, is also thickly strewed with loose stones; and the aspect of the whole region is barren and dreary. Yet the olive thrives here abundantly, and fields of grain are seen in the valleys and level places; but they are less productive than in the region of Hebron and Nâbulus. Neither vineyards nor fig-trees flourish on the high ground around the city, though the latter are found in the gardens below Siloam, and are very plentiful in the vicinity of Bethlehem.

2. *Climate.*

The climate of the mountains on which Jerusalem is situated differs from that of the temperate parts of Europe and America, more in the alternations of wet and dry seasons, than in the degrees of temperature. The variations of rain and sunshine, which in the west exist throughout the whole year, are in Palestine confined chiefly to the latter part of the autumn and the winter, while the remaining months enjoy almost uninterruptedly a cloudless sky.

The autumnal rains, the "early rains" of Scripture, usually commence in the latter half of October or beginning of November, not suddenly, but by degrees, which gives opportunity for the husbandman to sow his fields of wheat and barley. The rains come mostly from the west or south-west,† continuing

* The limestone of the neighbourhood of Jerusalem appears, from the observations of Russegger and others, to belong to the Jura formation, with occasional patches of superimposed chalk strata.—Edit.

† Luke xii. 54.—"When ye see a cloud rise out of the west, straightway ye say, There cometh a shower; and so it is." These words were spoken by our Lord at Jerusalem.

for two or three days at a time, and falling especially during the nights. Then the wind chops round to the north or east, and several days of fine weather succeed. During the months of November and December the rains continue to fall heavily; afterwards they return only at longer intervals, and are less heavy; but at no period during the winter do they entirely cease to occur. Snow often falls in Jerusalem in January and February to the depth of a foot or more, but does not usually lie long.* The ground never freezes; but Mr Whiting had seen the pool, at the back of his house (Hezekiah's), covered with thin ice for one or two days.

Rain continues to fall more or less through the month of March, but is rare after that period. During the present season there had been little or none in March; and, indeed, the whole quantity of rain had been less than usual. Nor are there at the present day any particular periods of rain, or succession of showers, which might be regarded as distinct rainy seasons. The whole period from October to March now constitutes only one continued season of rain, without any regularly intervening term of prolonged fair weather. Unless, therefore, there has been some change in the climate since the times of the New Testament, the early and the latter rains, for which the husbandman waited with longing, seem rather to have implied the first showers of autumn, which revived the parched and thirsty earth, and prepared it for the seed; and the later showers of spring, which continued to refresh and forward both the ripening and the vernal products of the field.†

During the whole winter the roads, or rather tracks, in Palestine, are muddy, deep, and slippery, so that the traveller at this season is subjected to the utmost discomfort and inconvenience. When the rains cease, the mud soon disappears, and the roads become hard, though never smooth. Whoever therefore wishes to profit most by a journey in Palestine, will take care not to arrive at Jerusalem earlier than the latter part of March. During the months of April and May the sky is

* So Shaw in 1722. Brown, near the close of the century, found here very deep snow for several days.—Comp. Scholz., p. 138. The information in the text is derived from our resident friends.

† James v. 7; Prov. xvi. 15.

usually serene, the air mild and balmy, and the face of nature, after seasons of ordinary rain, still green and pleasant to the eye. Showers occur occasionally, but they are mild and refreshing. On the 1st of May we experienced showers in the city; and at the evening there was thunder and lightning (which are frequent in winter), with pleasant and reviving rain. The 6th of May was also remarkable for thunder, and for several showers, some of which were quite heavy. The rains of both these days extended far to the north, and overtook our missionary friends who were returning from Jerusalem to Beirût; but the occurrence of rain so late in the season was regarded as a very unusual circumstance. Morning mists, however, are occasionally seen at a later period.

In ordinary seasons, from the cessation of the showers in spring until their commencement in October or November, rain never falls, and the sky is usually serene. If during the winter there has been a sufficiency of rain, the husbandman is certain of his crop; and is also perfectly sure of fine weather for the ingathering of the harvest.* The high elevation of Jerusalem secures it the privilege of a pure atmosphere; nor does the heat of summer ever become oppressive, except during the occasional prevalence of the south wind, or Sirocco.† During our sojourn from April 14. to May 6., the thermometer ranged at sunrise from 44° to 64° F., and at two P.M. from 60° to 79° F. This last degree of heat was felt during a Sirocco, April 30. From the 10th to the 13th of June at Jerusalem, we had at sunrise a range from 56° to 74°; and at two P. M. once 86°, with a strong NW. wind. Yet the air was fine, and the heat not burdensome. The nights are uniformly cool, often with a heavy dew; and our friends had never had occasion to dispense with a coverlet upon their beds during summer. Yet the total absence of rain soon destroys the verdure of the fields; and gives to the whole landscape the as-

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* "Snow in summer and rain in harvest" were things incomprehensible to a Hebrew; Prov. xxvi. 1. Rain in wheat harvest occurred only by a miracle; 1. Sam. xii. 17; compare Amos, iv. 7, and Jerome's Commentary upon the passage.

† Luke, xii. 55. "And when ye see the south wind blow ye say, There will be heat; and it cometh to pass."

pect of drought and barrenness. The only green thing which remains is the foliage of the scattered fruit-trees, and occasional vineyards and fields of millet. The deep green of the broad fig-leaves and of the millet, is delightful to the eye in the midst of the general aridness; while the foliage of the olive, with its dull greyish hue, scarcely deserves the name of verdure.

The harvest upon the mountains ripens of course later than in the plains of the Jordan and the sea-coast. The barley harvest precedes the wheat harvest by a week or fortnight. On the 4th and 5th of June the people of Hebron were just beginning to gather their wheat; on the 11th and 12th the thrashing-floors on the Mount of Olives were in full operation. We had already seen the harvest in the same stage of progress on the plains of Gaza on the 19th of May; while at Jericho, on the 12th of May, the thrashing-floors had nearly completed their work. The first grapes ripen in July; and from that time until November, Jerusalem is abundantly supplied with this delicious fruit. The general vintage takes place in September. We found ripe apricots at Gaza in May; and they are probably brought to Jerusalem, though I do not recollect to have seen any there. The fine oranges of Yafa were found in abundance both at Jerusalem and Hebron. In autumn the whole land has become dry and parched; the cisterns are nearly empty; the few streams and fountains fail; and all nature, physical and animal, looks forward with longing to the return of the rainy season. Mists and clouds begin to make their appearance, and showers occasionally to fall; the husbandman sows his seed; and the thirsty earth is soon drenched with an abundance of rain.

On the Apples of Sodom that grow on the shores of the Dead Sea I. Mr Lambert's Account. II. Dr Robinson's Account.

I. *Some account of the Apples of Sodom, or the Galls found on a species of Oak from the shores of the Dead Sea.* By Aylmer Bourke Lambert, Esq., F.R.S., V.P.L.S., &c.

Some time ago I had the honour to submit to the Society (Linnæan Society) the branch of a shrub from Monte Video, bearing galls containing a new insect, brought by Mr Earle, who accompanied Captain Fitzroy in the Beagle. I have now the pleasure to exhibit specimens and a drawing of the far-famed apples, *Mala insana*, from the mountains east of the Dead Sea, and which now prove to be a gall on a species of oak, containing an insect. These galls were brought home by the Hon. Robert Curzon, who has lately returned from the Holy Land. They are the first that have been seen in England, and will enable us to clear up the many great mistakes that have been made by travellers about them. Mr Curzon tells me the tree that produces them grows in abundance on the mountains in the neighbourhood of the Dead Sea, and is about the size of our apple-tree. It is perhaps the *Quercus foliis dentato-aculeatis* mentioned by Hasselquist as growing on Mount Tabor (Trav. p. 281.) There appear to be two or three different plants for whose fruit these galls have been mistaken, viz. *Solanum sodomeum*, which appears to have been confounded with *Solanum Melongena*, and *Calotropis gigantea*, &c. I shall refer to what Hasselquist says (p. 287) of the *Mala insana*, and likewise the account given of it in that useful work, the Modern Traveller, by Mr Conder, who seems to have brought together all that has been said or written on this most interesting subject; and, what is very extraordinary, and greatly to the praise of that gentleman, having probably never seen the production itself, he rightly guessed its real nature. Mr Curzon informs me these galls, when on the tree, are of a rich purple, and varnished over with a soft substance of the consistence of honey, shining with a most brilliant lustre in the sun, which makes the galls appear like a most delicious and tempting fruit. Having had the curiosity to taste a small quantity of the interior of one, I found it the strongest of bitters, and that it may truly be said of it, "as bitter as gall." The gall is pear-shaped, with a circle of small sharp-pointed protuberances on the upper part of it, which appear to be formed by the insect for air or defence, or some other purpose. In each of the galls there is an aperture through which the insect escapes, and in the centre there is a small round hole or nidus, where it has lodged.

Since writing the above, I find the leaves of the oak to be those of *Quercus infectoria*, which is accurately figured in Olivier's Travels in the Levant, and that the galls are identical with those of commerce. The tree grows abundantly throughout Syria. The insect has been named by Olivier *Diplolepis;* and it is also accurately figured by him in the above-mentioned work; but he does not appear to have been aware of the galls being the same with the *Mala insana.*

The following are extracts from Conder's Modern Traveller:

"There yet remains to be noticed, in connexion with this subject, the far-famed apples described by Tacitus and Josephus as beautiful to the eye, but crumbling at the touch to dust and bitter ashes.* Reland, Maundrell, and Shaw, all express themselves as sceptical concerning its existence. But none of them explored the borders of the lake sufficiently to entitle them to give a decided opinion on the subject, having only seen its northern shore. Pococke is inclined to lay more stress on the ancient testimonies; and he supposes the apples to be pomegranates, "which, having a tough, hard, rind, and being left on the trees two or three years, the inside may be dried to dust, and the outside may remain fair." Hasselquist, however, the pupil of Linnæus, pronounces the *Poma sodomitica* to be the fruit of the *Solanum Melongena* (egg-plant nightshade, or mad-apple), which he states to be found in great abundance round Jericho, in the valleys near the Jordan, and in the neighbourhood of the Dead Sea. "It is true," he says, "that these apples are sometimes full of dust, but this appears only when the fruit is attacked by an insect (Tenthredo), which converts the whole of the inside into dust, leaving nothing but the rind entire, without causing it to lose any of its colour." M. Seetzen, differing from Hasselquist in opinion, supposes the apple of Sodom to be the fruit of a species of cotton-tree, which, he was told, grows in the plain of El Ghor, in appearance resembling a fig tree, and known by the name of *Abeschaez.* The cotton is contained in the fruit, which is like a pomegranate, but has no pulp.

* Book of Wisdom, chap. x. verse 7. "Of whose wickedness even to this day the waste land that smoketh is a testimony, and plants bearing fruit that never come to ripeness; and a standing pillar of salt is a monument of an unbelieving soul."

† See also Wisdom, x. 7.

Chateaubriand follows, with his discovery of what he concludes to be the long-sought fruit. The shrub which bears it, he says, grows two or three leagues from the mouth of the Jordan; it is thorny, with small taper leaves, and its fruit is exactly like the little Egyptian lemon, both in size and colour. "Before it is ripe it is filled with a corrosive saline juice; when dried, it yields a blackish seed, which may be compared to ashes, and which in taste resembles bitter pepper." He gathered half a dozen of these fruits, but has no name for them either popular or botanical. Next comes Mr Joliffe: He found in a thicket of brushwood, about half a mile from the plain of Jericho, a shrub five or six feet high, on which grew clusters of fruit, about the size of a small apricot, of a bright yellow colour, "which, contrasting with the delicate verdure of the foliage, seemed like the union of gold with emerald. Possibly when ripe they may crumble into dust upon any violent pressure." Those which this gentleman gathered did not crumble, nor even retain the slightest mark of indenture from the touch; they would seem to want, therefore, the most essential characteristic of the fruit in question. But they were not ripe. This shrub is probably the same as that described by Chateaubriand. Lastly, Captains Irby and Mangles have no doubt that they have discovered it in the oskar plant, which they noticed on the shores of the Dead Sea, grown to the stature of a tree, its trunk measuring, in many instances, two feet or more in circumference, and the boughs at least fifteen feet high. The filaments inclosed in the fruit somewhat resemble the down of a thistle, and are used by the natives as a stuffing for their cushions; "they likewise twist them, like thin rope, into matches for their guns, which, they assured us, required no application of sulphur to render them combustible." This is probably the same tree that M. Seetzen refers to. But still the correspondence to the ancient description is by no means perfect; there being little resemblance between cotton or thistledown, and ashes or dust. M. Chateaubriand's golden fruit, full of bitter seed, comes nearest to what is told us of the deceitful apple. If it be anything more than a fable, it must have been a production peculiar to this part of Palestine, or it would not have excited such general attention. On this account the *Oskar* and *Solanum* seem alike entitled to the distinction; and for the same reason, the pomegranate must altogether be excluded from consideration. The fruit of the *Solanum Melongena,* which belongs to the same genus as the common potato, is white, resembling a large egg, and is said to impart an agreeable acid flavour to soups and sauces, for the sake of which it is cultivated in the South of Europe. This could hardly be what Tacitus and Josephus referred to. It is possible, indeed, that what they describe may have originated, like the oak-galls in this country, in the work of some insect; for these remarkable productions sometimes require a considerable size and beauty of colour. Future travellers will be inexcusable if they leave this question undecided.—*Transactions of the Linnæan Society of London, Vol.* xvii., *Part* 3*d*, *p.* 445.

II. *On the Apples of Sodom.* By Dr Robinson.

Apples of Sodom.—One of the first objects which attracted our notice on arriving at Ain Jidy was a tree with singular fruit, which, without knowing at the moment whether it had been observed by former travellers or not, instantly suggested to our minds the far-famed fruits

——— which grew
Near that bituminous lake where Sodom stood.

This was the *Ösher* of the Arabs, *Asclepias gigantea vel procera* of botanists,* which is found in abundance in Upper Egypt and Nubia, and also in Arabia Felix; but seems to be confined in Palestine to the borders of the Dead Sea. We saw it only at Ain Jidy; Hasselquist found it in the desert between Jericho and the northern shore; and Irby and Mangles met with it of large size at the south end of the sea, and on the isthmus of the peninsula.†

* Sprengel, Hist. Rei Herbar. i. p. 252.

† Hasselquist, Reise, p. 151. Irby and Mangles' Travels, pp. 354, 450. Comp. Seetzen in Zach's Monatl. Corresp. xviii. p. 442. Burckhardt, p. 392.

We saw here several trees of the kind, the trunks of which were six or eight inches in diameter; and the whole height from ten to fifteen feet.* It has a greyish cork-like bark, with long oval leaves; and in its general appearance and character it might be taken for a gigantic perennial species of the milk-weed or silk-weed found in the northern parts of the American States. Its leaves and flowers are very similar to those of the latter plant, and, when broken off, it in like manner discharges copiously a milky fluid. The fruit greatly resembles externally a large smooth apple or orange, hanging in clusters of three or four together, and, when ripe, is of a yellow colour. It was now fair and delicious to the eye, and soft to the touch; but on being pressed or struck, it exploded with a puff, like a bladder or puff-ball, leaving in the hand only the shreds of the thin rind and a few fibres. It is indeed filled chiefly with air, like a bladder, which gives it the round form; while in the centre a small slender pod runs through it from the stem, and is connected by thin filaments with the rind. The pod contains a small quantity of fine silk with seeds, precisely like the pod of the silk-weed, though very much smaller, being indeed scarcely the tenth part as large. The Arabs collect the silk and twist it into matches for their guns, preferring it to the common match, because it requires no sulphur to render it combustible.†

The most definite account we have of the apples of Sodom, so called, is in Josephus, who, as a native of the country, is a better authority than Tacitus or other foreign writers.‡ After speaking of the conflagration of the plain, and the yet remaining tokens of the divine fire, he remarks, that "there are still to be seen ashes reproduced in the fruits, which indeed re-

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* Irby and Mangles found them measuring in many instances two feet or more in circumference, and the boughs at least fifteen feet in height, a size which far exceeded any they saw in Nubia. P. 450.

† Gregory of Tours would seem to have heard of this tree: "Prope Jericho, habentur arbores, quæ lanas gignant; exhibent enim poma in modo cucurbitarum, testas in circuitu habentia duras, intrinsecus autem plena sunt lanæ." Of this wool, he says, fine garments were made. Gregor. Turonens Mirac. lib. i. c. 18.

‡ The Bible speaks only of the "vine of Sodom," and that metaphorically, Deut. xxxii. 32.

semble edible fruits in colour, but, on being plucked with the hand, are dissolved into smoke and ashes."* In this account, after a due allowance for the marvellous in all popular reports, I find nothing which does not apply almost literally to the fruit of the Ösher, as we saw it. It must be plucked and handled with great care, in order to preserve it from bursting. We attempted to carry some of the boughs and fruit with us to Jerusalem, but without success.†

Hasselquist finds the apples of Sodom in the fruit of the *Solanum Melongena* (nightshade, mad-apple) which we saw in great abundance at Ain Jidy, and in the plain of Jericho. These apples are much smaller than those of the Ösher, and when ripe are full of small black grains. There is, however, nothing like explosion, nothing like "smoke and ashes," except occasionally, as the same naturalist remarks, "when the fruit is punctured by an insect (Tenthredo) which converts the whole of the inside into dust, leaving nothing but the rind entire, without any loss of colour."‡ We saw the Solanum and the Ösher growing side by side; the former presenting nothing remarkable in its appearance, and being found in

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* Joseph. B. I. iv. 8. 4. Ἔστι δὲ κἀν καρποῖς σποδιὰν ἀναγεννωμένην, οἵ χρόαν μὲν ἔχουσι τοῖσ ἐδωδίμοις ὁμοίαν δρεψαμενων δὲ χερσίν ἐις καπνον ανααλυονταί καί τεφραν. Tacitus is still more general, Hist. v. 6: "Terramque ipsam specie torridam vim frugiferam perdidisse. Nam cuncta sponte edita, aut manu data, sive herbæ tenues aut flores, ut solitam in speciem adolevere atra et inania velut in cinerem vanescunt."

† Seetzen was the first, I believe, to suggest the Ösher (which he writes Äöschär) as producing the apples of Sodom, though he appears not to have seen the plant. Zach's Monatl. Corr. xviii. p. 442. According to Irby and Mangles, "there is very little doubt of this being the fruit of the Dead Sea, often noticed by the ancients," &c. p. 450. I am not sure that Brocardus does not refer to the same plant when he says, that "under En-gedi, by the Dead Sea, there are beautiful trees; but their fruit, on being plucked, is found full of smoke and ashes," vii. p. 180. Fulcher Carnot seems to mean the Ösher, when, in describing the productions around Segor (Zoar), he says: "Ibi vidi poma in arboribus, quæ, cum corticem rupissem, interius esse pulverulenta comperi et nigra." Gesta Dei, p. 405.

‡ "Quod pulvere intus repleta sint, verum est nonnunquam sed non semper accidit; nempe in nonnullis, quod Tenthredine punguntur, quæ substantiam totam internam in pulverem redigit, et corticem solum egregie coloratum integrum relinquit." Hasselquist Reise, p. 560.

other parts of the country,* while the latter immediately arrested our attention by its singular accordance with the ancient story, and is moreover peculiar in Palestine to the shores of the Dead Sea.†

On Tropical Miasmata.

In the *Friend of Africa*, and also in this Journal, from that periodical, was inserted an analysis of the waters of the African coast, together with some remarks by Professor Daniell, on its bearing on the Niger Expedition. "We have now the gratification," says the editor of the Friend of Africa, "to add the following letter from Professor Gustav Bischof of Bonn, well known to the English reader by his Observations on Volcanos in Professor Jameson's Edinburgh Philosophical Journal, and who has heretofore shewn a lively interest in the welfare of the Niger Expedition."

"*Poppelsdorf, near Bonn, 20th April* 1841.

"My Dear Sir,—I am much obliged to you for sending *The Friend of Africa.* Deeply impressed with the vast importance of the expedition about to sail for the Niger, I instantly read over those valuable papers. The most interesting to me as a chemist, was the account of the sea-water on that coast, containing, in some instances, more than eleven cubic inches of sulphuretted hydrogen in a gallon.

"In support of the supposition of Professor Daniell, that the probability of a volcanic origin of the sulphuretted hydrogen is small, and that, on the contrary, its origin by the action of vegetable matter upon the saline contents of the water is extremely probable, I venture to call your attention to some experiments I made twelve years ago, and published in the *Jarbuch der Chemie und Physik*, 1829, vol. iii., p. 30, and *Neues Jarbuch der Chemie und Physik*, 1832, vol. iv., p. 377. These experiments being probably unknown to English philosophers, I take the liberty of communicating them briefly to you.

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* Hasselquist mentions it at Ras el Ain, near Tyre, p. 556.

* *Vide* Robinson's Biblical Researches in Palestine, vol. ii. p. 235.

"To each bottle of an acidulous water, bottled in the year 1828, I added from six to eight grains of sugar, and preserved them properly corked and sealed in a cellar. After about three months, I opened some of the bottles; the water was found to smell very strongly of sulphuretted hydrogen. After about thirteen months, a few bottles were opened again, and the water smelled also very strongly of sulphuretted hydrogen. In the bottles a black sediment was found, which I supposed to be a sulphuret of iron. Three years and a half after, many of these bottles were opened, and that black sediment collected. According to my analysis, it consisted of iron and sulphur very nearly in the same proportion as in iron pyrites. There was no doubt but the origin of this sulphuret of iron must be derived from the reaction of the sugar upon the sulphate of soda contained in the mineral water, whereby a sulphuret of sodium was formed, which decomposed the carbonate of protoxide of iron contained in it, and thus produced a sulphuret of iron. Indeed, the water remaining after the separation of this sulphuret of iron, contained scarcely a trace of sulphate of soda, whilst the mineral water taken up from the spring contained, in 10,000 parts of water, 1.098 parts of this salt, without the smallest trace of sulphuretted hydrogen.

"Not only these experiments, but also other facts, favour the views of Professor Daniell concerning the origin of sulphuretted hydrogen in the waters of the rivers on the western coast of Africa. It is well known that mineral waters containing sulphates,—for instance, that at Roisdorf near Bonn,—often acquire a smell of sulphuretted hydrogen, when any vegetable matter, as a small piece of straw, is accidentally present in the bottles. For this reason, in bottling, the greatest care is taken to remove such vegetable matter.

"There is no question but that the sulphuret of copper found by Professor Daniell in the sheets taken from the bottom of the schooner *Bonneta*, has been formed in a similar manner as the sulphuret of iron above alluded to. A further proof of this opinion may be found in considering another observation, made public in the before-mentioned German journal.

"At the bottom of a basin enclosing a mineral spring, pieces of iron pyrites, surrounding different vegetable matters, as pieces of wood, stalks of plants, &c., have been found. This iron pyrites was partly crystallized, and, like the common ore, so hard as to scratch glass. According to my analysis, the composition of this iron pyrites agreed as nearly as possible with that examined by Berzelius. It is beyond a doubt that this sulphuret has been formed by the action of the vegetable matter contained in it, upon the sulphate of soda and the carbonate of protoxide of iron contained in the mineral water. It may be added that traces of the former only were present in it, whereby it may be shewn that even the smallest proportions of sulphates are sufficient to produce sulphuretted hydrogen under the circumstances alluded to.

"Besides the paper published by Signor Gaetano Giorgini, in the 29th vol. of the *Annales de Chimie*, there is another in the 57th vol. of that Journal, p. 148, by M. Bossingault. This philosopher also remarks, 'La cause qui peut influer sur l'insalubrité de certaines contrées, se développe constamment là où la matière végétale morte est exposée à l'action de la chaleur et de l'humidité. Elle est propre à tous les pays chauds et marécageux ou à ceux qui sont entourés de forêts étendues. Son action se manifeste surtout d'une manière terrible là où il se fait un mélange d'eaux douces et d'eaux salées, à l'embouchure de grands fleuves, ou sur le littoral des golfes.' M. Boussingault alludes to many instances occurring within the tropics in America, whereby it is proved, that vegetable matters putrefying by the influence of heat and humidity, spread infection over the neighbourhood of the most destructive kind. The results obtained by MM. Moscati, Rigaud, and Boussingault, prove sufficiently, that, in a marshy country, during the precipitation of dew, an organic matter is deposited with it, which blackens sulphuric acid. This matter is flocky, and, like an animal substance, contains nitrogen. M. Boussingault says, 'On peut même conçevoir l'efficacité de certaines précautions qui ont été indiquées pour se preserver de leurs effets. On a dit, par exemple, qu'il suffisait de se couvrir la figure d'un voile. J'ai vu, en effet, plusieurs fois, dans les marais du Cauca, les personnes obligées de les parcourir, s'entourer le visage d'un mouchoir de manière à ne respirer qu'à travers le tissu."

"All these circumstances lead to the suspicion that it is not sulphuretted hydrogen on which depend the diseases peculiar to the coast of Africa, but organic matter of animal composition. In considering that this matter is formed during the spontaneous decomposition of vegetable substances by an incomplete oxidation of their hydrogen and carbon, it is very probable that, when vegetable substances are oxidized by the oxygen of sulphates, a matter of a similar kind is also formed. As that matter formed by oxidation at the expense of atmospheric air is volatilized, it is to be supposed that the same is done when such a matter is formed by another action. These views being correct, such matters would be evolved together with sulphuretted hydrogen.

"As it is intended by the medical officers of the Expedition, on approaching the coast of Africa, to test the water at different distances, I venture to add the desirableness of testing also the atmospheric air by means of concentrated sulphuric acid, placed in a vessel on the windward side of the deck, and protected against insects. It is scarcely to be doubted that the more the air becomes infective, the more the sulphuric acid will be blackened.

"As for the destructiveness of sulphuretted hydrogen, supposed in *The Friend of Africa*, I may be permitted to suggest a few remarks. It is true that this gas is very deleterious, only $\frac{1}{1500}$ part of it in the atmosphere kills a bird; but in what manner does this gas act on animal life? When not present in such a proportion as to kill a man instantly, it causes inflammation in the lungs. Workmen cementing steam-vessels in the inside, where the cement, after some time, disengages sulphuretted hydrogen, offer instances of this kind. When this occurs before the workman has left the vessel, he risks, at least, a dangerous inflammation on the chest. It is to be supposed that sulphuretted hydrogen, when diluted with air in such a proportion as still to be injurious to animal life, will not affect in a different manner to it. But are the diseases, peculiar to the coast of Africa, of such a kind as those produced by sulphuretted hydrogen?

"There are many places where this gas is evolved in large quantities; for instance, in the Solfatara of Pozzuoli, in the neighbourhood of Naples, in different spots of Sicily, in the neighbourhood of sulphureous springs, &c. Now, do you know any account about diseases proper to such places? On the contrary, sulphureous springs are among the most distinguished fountains of health.

"I think, as to the exhalations of sulphuretted hydrogen, the same holds good as is said of carburetted hydrogen. It is also supposed that this gas, evolved from marshes, causes the intermittent fevers so common in their environs. Were this supposition correct, what diseases ought the miners to suffer, who frequently work in an atmosphere containing above $\frac{1}{10}$ of carburetted hydrogen?

"I believe that sulphuretted hydrogen may just as little take a share in causing diseases, as carburetted hydrogen does, though it is not to be denied, that a much smaller proportion of the former than of the latter is fatal to animal life. It is much more probable that the volatile vegetable matter accompanying sulphuretted hydrogen, evolved from the water on the coast of Africa, originates diseases, as well as that which is mixed with carburetted hydrogen disengaged from marshes.

"Professor Daniell remarks correctly, it is difficult to conceive how such a striking and important fact as the impregnation of the waters of the ocean, upon such a long line of coast, with sulphuretted hydrogen, could so long have escaped observation. It is true, he has turned, on this subject, to some of the accounts of the late travels in Africa, to seek for evidence, and communicated also some important observations made by Macgregor Laird. But in this account a horrid sickening stench peculiar to the miasma is only alluded to. It may still be supposed that this gentleman, when even unacquainted with chemical properties, would have mentioned the similarity of that stench to that of putrefying eggs. An indescribable feeling of heaviness, languor, nausea, and disgust, with which one is oppressed in those swamps, is never experienced on breathing such quantities of sulphuretted hydrogen as to fill a room with an unsupportable stench.

"Otherwise gases, when even heavier than atmospheric air, are very easily distributed through it, and thereby extremely diluted, provided that they are not exhaled in recesses or in enclosed spaces, which do not at all, or but slightly, partake of the external movements of the air. With respect to carbonic acid gas, there are many instances of this kind in the neighbourhood of the *Laacher Sea*. I was many times in the neighbourhood of the village of *Wehr*, on a large plain, most likely an old crater of an extinct volcano, where carbonic acid gas is evolved in immeasurable quantities from hundreds of acidulous springs close to one another, and where, at many points, bubbles as large as the head scatter the water to a height of more than a foot. Nevertheless, in the middle of the marsh, the smell of the gas is hardly, but that of the marshly exhalations very distinctly, perceptible. From this it is to be seen that gases are by far more easily distributed through the atmosphere, than exhalations of putrefying matters.

"In applying these observations to the exhalations of sulphuretted hydrogen from the water on the coast of Africa, it is obvious that they, when even yet so considerable, will hardly affect a ship's company. But the exhalations of putrefying matters doubtless bear quite another relation to those exposed to them.

"I think it will be found that the sea-water in that country will contain far less sulphuretted hydrogen than that analyzed by Professor Daniell, and that this gas for the most part has been produced during the carriage of the waters to England. Indeed, the vegetable matter found in different proportions in all those waters which contained sulphuretted hydrogen, seems to be the remaining part of what has been decomposed by the sulphates in them. All those waters were bottled in the months of September, October, and November, 1839. The Reports of Professor Daniell are dated on the 13th April 1840; when, therefore, the analysis of them was made, they had been preserved in the bottles above half a year. This space of time is, however, according to my researches, more than sufficient to effect decompositions of sulphates by vegetable matters. Besides, according to the experiments of Professor Daniell, mentioned in No. 4 of *The Friend of Africa*, three months are alone sufficient to produce sulphuretted hydrogen, by adding a quantity of newly-fallen leaves to water, in which sulphate of soda had been dissolved. The remark of this able chemist, that this mixture had a most insupportable sickening odour, much more than that of pure sulphuretted hydrogen, is not to be overlooked, because it extremely favours the supposition suggested by me, that by the action of vegetable matters on sulphates, besides sulphuretted hydrogen, an organic substance is produced, which is by far more fatal to animal life than this gas.

"As for the use of the chloride of lime, and the fumigation with chlorine, to decompose sulphuretted hydrogen, and thus to render it innoxious, it is well known that these means of mitigation also effect decompositions of putrefying matters exhaled from the sea-water. Therefore, it is no doubt that these means will be, in every respect, very efficacious.

"Though I am afraid of trespassing too much upon your valuable time, yet I cannot conclude this letter without alluding to a particular decomposition of sulphuretted hydrogen, newly investigated by M. Melloni. You will find this very interesting Report in a letter of this philosopher to M. Arago, published in the *Comptes rendus*, tom. xi., p. 352. M. Melloni found that a small piece of lighted tinder, or a lighted cigar, when placed near one of the *fumaroli*, in the Solfatara, near Naples, instantly produced a vapour, or a thick white cloud, and that this effect reaches to a distance of from five to six feet from the lighted substance. M. Melloni caused M. Payen to examine into this remarkable phenomenon, and this chemist found that sulphuretted hydrogen artificially prepared, and mixed with a large quantity of atmospheric air, is affected by lighted tinder, or by any lighted substance, in the same manner as that evolved in the Solfatara. The products of this effect are sulphureous acid, water, and a few traces of sulphur. Among those circumstances, the ingredients of sulphuretted hydrogen are consequently united with atmospheric oxygen, and form sulphureous acid and water. M. Payen has further detected that iron, and nearly all its natural compounds, as iron-glance, titaniferous oxydulated iron, even iron-pyrites, and lava, all when heated, act precisely like lighted charcoal.

"It is evident then, that a lighted cigar, an article fortunately common on board all ships, will, in some measure, counteract the noxious effects of sulphuretted hydrogen, when such is found to exist distributed through the atmosperic air.*

To Captain Washington, R.N. GUSTAV BISCHOF.

Researches on the Variations which take place at certain periods of the day in the Temperature of the Lower Strata of the Atmosphere. By Professor MARCET. Transmitted by the Author.†

IT appears, from researches now of old standing, and dating, for the most part, from the end of the last century, that the relations which exist between the temperature of the strata of air adjoining the earth, are subject to variations depending either on the state of the sky, or on the time of the day at which the observation is made. Our countryman, M. Marc Auguste Pictet, was the first who, in 1770, studied with care the variations of two thermometers, one of which was placed 5 feet above the ground, the other at a height of 75 feet. He remarked, that when the weather was calm and clear, the temperature of these two thermometers agreed about two hours after sunrise, and from that time throughout the whole day, the thermometer at 5 feet above the ground was constantly higher than that at 75 feet; that the two thermometers again corresponded some time after sunset, and from that time till eleven o'clock in the evening, the lower thermometer underwent a relative depression of about 2½° of the centigrade scale.‡ Pictet adds, that when the sky was completely overcast, or during the prevalence of a strong wind, the difference between the temperature of the two thermometers was scarce-

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* We are informed by letter from Dr Stanger, dated off the Niger, that Dr M'William, who has carefully examined the sea-water near the mouths of all the rivers from time to time, has not yet been able to find any trace of *sulphuretted hydrogen* in *freshly* taken water; but when the waters had been kept a few days in corked bottles, it was twice very evident,—*Edit. of Edin. Phil. Journal.*

† Mémoires de la Societé de Physique et d' Histoire Naturelle de Genève, T. viii. 2me partie.

‡ Throughout this memoir the indications are given according to the centigrade thermometer, unless the contrary is expressly mentioned.

ly perceptible. These experiments were again renewed, in 1784, by the English natural philosopher Six. This observer, having compared, for a considerable length of time, the temperature of three thermometers, one of which was placed at the foot of Canterbury Cathedral, the second on the top of the principal tower of that edifice, at a height of about 200 feet, and the third at an elevation of 110 feet, states, that he has often remarked a difference of from 5° to 6° between the two first thermometers during calm and clear nights, and an intermediate temperature at the station of 110 feet. When the weather was cloudy, the temperature appeared to him to be nearly the same at the three stations; if there was any difference in them, it was the reverse of what had taken place in clear weather, that is to say, the thermometer near the earth stood higher than that at 200 feet. White, in his Natural History of Selbourne, has likewise noticed a difference of from 5° to 6°, and on one occasion a difference of 10° between the temperature of the plain and that of a neighbouring hill about 200 feet in height.

Leslie says, he has remarked* that, in England, about two hours after sunrise, the ground is of the same temperature as the stratum of the atmosphere in contact with it.† From that time till two o'clock in the afternoon, the ground is warmer than the contiguous atmosphere. After two o'clock, this difference diminishes until about two hours before sunset, when the ground again becomes colder than the surrounding air. This difference, the author adds, goes on increasing during the night.

Finally, Wells, in his essay on Dew, published in 1814, has observed that in calm and clear nights, the air at the height of four feet most frequently exceeded the temperature of the ground from 3 to 4 degrees, and sometimes from 5 to 6 degrees.

From all these observations taken together, the two following facts seem to result: 1*st*, During calm and clear nights,

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* Trans. of the Royal Society of Edinburgh, vol. viii. *On Impressions of Cold, &c.*

† The remark appears general; the author does not apply it solely to calm and clear weather.

the air at 4 or 5 feet above the ground, is notably warmer than the ground itself;* *2dly*, During calm and clear nights, and reckoning from the height of 5 or 6 feet, the air becomes warmer as we ascend, according to some unknown law, and to an elevation the limit of which has not yet been determined.

Before proceeding to detail the experiments which I undertook with the design of throwing some light on such parts of this subject as are still obscure, let us return to the observations of Six, the only ones which have been made with some degree of continuity, and at considerable differences of elevation, and let us determine whether they took place in such circumstances as were likely to lead to correct results.

The two following considerations induce me to believe that the results of Six's experiments must very often deviate from the truth. 1*st*, These experiments were made in the centre of a populous town, in which the temperature of the surrounding atmosphere must necessarily have been affected by the vicinity of a constantly renewed source of heat. The influence of this artificial heat must have been particularly felt during the period of nocturnal radiation, by preventing the cooling of the atmospheric strata nearest the earth. In consequence of this, the relative increase of heat, in proportion as we ascend, must have often appeared to Mr Six not so great as it really is. *2dly*, The heat acquired by the walls of the Cathedral, exposed during the day to the rays of the sun, must have often exercised an influence on the results obtained by the English philosopher. No one is now ignorant to what a degree stone and brick buildings become heated, when exposed to the direct rays of the sun, particularly during the warm season; it is so considerable that when a person is passing along by the side of a wall in the evening, he very often feels the heat proceeding from it. Now, the strata of air next the Tower of Canterbury Cathedral must necessarily have been affected, particularly during the earlier part of the night, by the neighbourhood of a mass so heated, the more especially as

* Often, according to Wells, from 4 to 5 degrees. Wilson has seen this difference amount to 8 degrees, the surface of the ground being covered with snow.

the conducting power, which is pretty considerable, of the materials which compose the edifice, must have tended to retard the cooling of the surface by the effects of nocturnal radiation. From this it follows that the increase of the temperature of the atmosphere upwards, might often have appeared more considerable than it really was. In these various respects, the observations of Six, however interesting they may have been at the time when they were made, do not possess a sufficiently exact character, to be of much avail in the present state of the science.*

Another motive which induced me to undertake new researches on the variations which take place in the temperature of the lower beds of the atmosphere, is the connection now well known to exist between that temperature and the radiation of the earth. The discovery of the Ethrioscope by Leslie, which measures the intensity of this radiation, furnishes the means of studying these two facts simultaneously, and of enquiring in what degree they influence each other. The hygrometrical state of the air must also exercise a certain influence, particularly in the evening, on the temperature of the lower beds of the atmosphere: we know, in fact, that the deposition of dew is constantly followed by an elevation of temperature;† therefore, all things being equal in other respects, the cooling of the lower strata of the atmosphere must be in the inverse ratio of the degree of the saturation of the air; or, in other words, of the quantity of dew ready to be deposited.

For the purpose of prosecuting these enquiries, I procured a mast or pole 114 feet long, composed of two pieces of fir securely bound to each other. After having succeeded, not

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* The same thing may be affirmed of White of Selbourne's observations, in which he compares the temperature of the plain with that of the summit of a neighbouring hill. It may be conceived to what a degree the temperature of the air in each of these stations might have been influenced either by neighbouring objects, or even by the character of the ground. Moreover, White expresses himself with little precision on many essential circumstances.

† See my observations on this subject in the 34th Number, p. 353 of the *Bibliothèque Universelle (New Series.)*

without difficulty, in elevating it, I had it fixed vertically in the ground to the depth of six or seven feet. Various precautions had been taken to prevent it being broken or overthrown by the violence of the wind. It was placed in circumstances most favourable for experiments of this nature, that is, situated in the middle of a large meadow, at a pretty considerable distance from any kind of dwelling, and even from groups of trees of any size. Along the mast, at intervals of ten feet, I had placed horizontal bars of fir two feet in length, each having a small pulley at the extremity for the purpose of raising and bringing down the thermometers. The thermometers themselves, which were extremely sensitive and of large size, had their balls covered with a pretty thick layer of a non-conducting substance, such as soft wax, or unspun cotton, in order that their temperature might not vary during the time necessary to bring them down from their elevated position.* At the moment of every thermometrical observation, I noted the state of the atmosphere in its different meteorological relations, and on most occasions I examined Leslie's ethrioscope, as well as Saussure's hygrometer.

The principal object I had in view by undertaking these researches, may be reduced to the solution of the four following questions:—

1*st*, How far is the increase of temperature which takes place at certain times of the day in proportion as we ascend, influenced by the state of the sky and the agitation of the air?

2*dly*, To determine the times of the day at which this increase of temperature commences; does it continue constant, or shew a tendency to augment during the night?

3*dly*, Is the limit of elevation at which the increase of temperature ceases constant, or does it vary according to the meteorological state of the atmosphere?

4*thly*, Do the increase of temperature, as well as its limit in regard to elevation, remain constant, or do they vary according to the different seasons of the year?

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* This interval never exceeded three quarters of a minute. The balls of the thermometers were so protected, that a difference of temperature amounting to five degrees did not begin to affect them for about a minute.

We shall examine each of the questions in succession.

1st Question.—*How far is the increase of temperature which takes place at certain times of the day in proportion as we ascend, influenced by the state of the sky and the agitation of the air?*

It results from my experiments, that the degree of this increase appears subject, as had previously been observed, to the influence of both the circumstances in question. In general, the clearer and more tranquil the weather, and the less aqueous vapour there is suspended in the air, the more considerable is the difference of temperature as we ascend. It appeared to me to vary during the finest season of the year from 2 to 3 degrees; I never saw it exceed 4 degrees in summer and autumn, however clear the weather might be, and however favourable the other meteorological circumstances of a nature likely to have an influence on this phenomenon. If, in this respect, the differences which I observed during the summer are inferior to those mentioned by Six, I differ still more from that natural philosopher in this, that while he limits the increase of the temperature, ascending, to the case of a calm and clear sky, it appeared to me to take place constantly, at least during the finest season of the year and at the time of sunset, and however cloudy the weather might be, provided there was not a strong wind. From nearly a hundred observations, taken at the times and in the circumstances already mentioned, I never failed to remark some increase in the temperature upwards, except in the case of a strong wind. This augmentation, it is true, was often limited to a few hundred parts of a degree, and manifested itself in the very lowest strata of the atmosphere, ceasing sometimes at the height of 40 and even 30 feet.* I have even remarked, on more than one occasion, a complete equality among the different thermometers two or three hours after sunset. This took place,

* On the first of September, at seven o'clock in the evening, in cloudy weather, the wind south-west, and pretty strong, the thermometer at 5 feet above the ground stood at 12°.7, and at 40 feet, at 12°5. From 40 feet up to 108 the thermometer underwent no sensible variation. The same thing took place in the observations of the 6th September and 4th October, made at the same hour.

for example, in my observation of the 20th September, made at ten o'clock in the evening in cloudy weather. In this observation, the thermometer, at 4 feet from the ground, stood at 13°.85, and that at the height of 108 feet, at 13°.80. The mean of the first 50 feet was 13°.81, and the mean of the last 50, 13°76, presenting, as will be perceived, a scarcely sensible variation. It is to be observed that, at the time of this observation, the ethrioscope indicated *zero*, thus shewing that the earth received as much heat from the upper strata of the atmosphere as it sent thither by means of radiation. The same thing happened in my observations of the 21st and 22d September, taken at half-past nine in the evening. At this time the temperature was uniform throughout the whole length of the mast; the ethrioscope indicating in the first case 0°.5, and in the second 1° of coldness in the focal ball. We see, therefore, that when the sky is overcast, the different beds of the atmosphere may sometimes be found at the same temperature some hours after sunset. But I repeat that I have always found a sensible difference, at least during fine weather, when the observation was made at the moment of setting, always excepting in the case of violent winds, particularly if coming from the north-east: in the latter case, I have oftener than once found a uniform temperature throughout the whole length of the mast, even when the sky was not very much obscured.

2d Question.—*To determine the times of the day at which the increase of temperature as we ascend commences. Is it constant, or has it a tendency to augment during the night?*

The result obtained by my observations on this subject is, that, when the weather is clear and calm, the increase of temperature begins to be perceptible about half an hour or an hour before sunset. If the weather be cloudy, it most frequently does not become sensible but at the moment of setting. When the sky is clear, the increase usually attains its maximum at the time of setting or a little after it; from this time it remains nearly stationary, when the weather does not vary. If, however, an abundant dew fall, I have remarked that the difference of temperature has a tendency sometimes to diminish. It was thus, for example, that, on the 17th of

September, at seven o'clock in the evening, the increase of the temperature from the height of 5 feet to that of 108 feet, was 2°. At ten o'clock, the dew being very plentiful, the difference did not exceed 1°6, even although the sky continued perfectly transparent. The increase of temperature as we ascend does not become more sensible at the time of the rising of the sun ; on the contrary, most frequently the difference between the temperature of the stratum of air nearest the ground and of that situate at the height of 105 feet, appeared to me obviously less at the moment of the sun's rising than at that of its setting. This is probably owing to the abundance of the dew which is known usually to increase at sunrise ; I have even remarked that a little before sunrise, and after a strong dew, the phenomenon was sometimes reversed ; that is to say, the temperature seemed to decrease in proportion to the elevation, particularly when the sky was suddenly overcast. In the latter case, the temperature of the earth is almost always warmer than that of the ambient air. Such was the case on the 5th October at half past six o'clock in the morning, the weather being calm and cloudy, with much dew ; the thermometer on the grass indicated 12°31, at the height of 5 feet, 12°, and at 105 feet, 11°.7. The same thing took place on 7th October, at six o'clock in the morning, the thermometer at 5 feet was at 10°.1, and that at 1(5 feet, 9°.75, the temperature of the ground being about 10°.3. We shall afterwards see that, in the severe colds of winter, and when the weather is obscure, the temperature of the stratum of air next the ground is in general warmer than that of the atmosphere at a height of 50 or 100 feet, both at the time of sunset and sunrise.

3d Question.—*To determine the limit of elevation at which the increase of temperature ceases ; is this limit constant, or does it vary according to the state of the atmosphere ?*

When the sky was perfectly clear and serene at the time of sunset, it pretty often happened that the limit of the increase of temperature upwards was beyond the summit of the mast, that is to say, above the height of 108 feet. In general, however, it appeared to me to be found between 90 and 105 feet, that is to say, beyond the latter elevation the increase of temperature ascending was not generally very sensible, however clear the weather might be. I could adduce a great number of observations in support of this assertion; among others, those of the 1st and 2d August, of the 8th and 18th September, of the 3d and 4th October, &c., in which the limit of the increase of temperature was always found below 100 feet. We shall afterwards see that in winter, especially when the weather is not very clear, the increase of temperature at the moment of the rising and setting of the sun, is most frequently not observable except from the surface of the earth to the height of 5 or 6 feet; from that elevation up to a height of 100 feet, the temperature remains uniform, and sometimes even goes on diminishing in proportion as we ascend.

4TH QUESTION.—*Does the increase of temperature which takes place as we ascend at certain periods of the day, vary according to the different seasons of the year?*

The answer is in the affirmative; for although I have not found conspicuous differences between the summer and autumn, such is far from being the case with the winter season, which has presented to me some remarkable results in this respect, especially when the surface of the earth is covered with snow.

Viewed in relation to the increase of temperature as we ascend, winter differs from the other seasons of the year in the two following respects:—

1*st*, The difference of temperature between the strata of air adjoining the earth is much more considerable than at any other period of the year; such is the result of the series of observations made this year during the months of December and January. The maximum of difference observed was on the 20th January, at half-past eight in the evening, the weather being perfectly calm and clear, and the earth covered with snow to the depth of about a foot. This difference amounted to nearly 8° for a change in an elevation of 50 feet; the thermometer, at the height of 2 feet, indicating—16°.2, and at the height of 52 feet—8°.4; at the height of 105 feet it was at—7°.4, giving a total difference of 8° 8 for an elevation of 105 feet.

On the morning of the 21st January, still colder than the preceding, at six o'clock the thermometer, at 2 feet above the ground, was at—21°.2 ; at the height of 52 feet it was at —15°.5 ; and at 105 feet, at—13°.7. The increase of temperature, it is thus seen, is less considerable than on the preceding day ; which is no doubt owing to this, that the cold of the earth's surface had had time to extend itself to the somewhat more elevated strata of the atmosphere. It amounts, nevertheless, to 5°.7 for a height of 50 feet, and to 7°.5 for a height of 100 feet; a difference which exceeds by many degrees the maximum of that which has been observed during the warm season. A mean of twelve observations made both at sunrise and sunset, during perfectly serene weather, and the ground being covered with snow, afforded a difference of 5°.4 between the temperature of the air at the height of 2 feet and that at 52 feet above the ground. By comparing the station at 2 feet with that at 105, this difference was 6°.4.

In winter, when the ground was not covered with snow, the difference between the temperature of the lower strata of the atmosphere appeared to me to be less considerable ; it always, however, exceeded the maximum of what was observed during the serene evenings of summer and autumn. The maximum of difference observed by me when the ground was not covered with snow, occurred on the 1st of December. The thermometer, 2 feet above the ground, marked—4°.7 ; at 52 feet + 0.9 ; and at 105 feet, + 1.4 ; thus giving a difference of 5°.6 between two beds of air separated by an interval of 50 feet, and of 6°.1 for an interval of 100 feet. The mean increase of temperature, calculated from a series of twenty observations, made partly in December and partly in February, was found to be 3°.30 for a difference of elevation of 50 feet, and 3°.45 for a difference of 100 feet. We thus see that, in the circumstances above mentioned, the increase of temperature as we ascend, even during perfectly serene weather, is extremely slight, reckoning on a height of 50 feet ; and we are of opinion that we are not far from the truth by fixing the extreme limit of this increase in winter below 100 feet, however considerable it may be, at the same time, near the surface of the ground.

In winter, when the sky is obscured, the difference between the temperature of the successive strata of the atmosphere and those very close to the earth, is extremely small, even when the ground is covered with snow. And after we ascend above 100 feet, the temperature appears most frequently to be modified in a contrary sense to what takes place in clear weather—that is to say, it decreases in proportion as we ascend. In eleven observations made both at sunrise and sunset, and in the circumstances I have pointed out, the thermometer has been on two occasions *lower* by some centièmes of a degree at the height of 5 feet above the ground than at 2 feet. The mean of the thermometrical difference between the height of 2 feet and that of 50 feet, has been only 0°.4 in favour of the highest elevation; while the mean of the difference between 52 feet and 105 feet, has, on the contrary, been 0°23 in favour of the less elevated station.

2dly, Winter is further distinguished from the other seasons of the year, by the excessively low temperature of the surface of the ground at certain periods of the day, compared with that of the stratum of air immediately adjoining it; that is to say, situate at the height of about 2 feet. This difference appeared to me scarcely appreciable during the finest season of the year, even when the sky was perfectly clear and serene. A mean deduced from a great number of observations made during the summer and autumn of 1837, gave only 0°.54 for the times of sunrise and sunset, the periods of the day when it is at other times most considerable. In winter the difference in question becomes much more remarkable; it amounted on one occasion to 6°, the ground being covered with snow. A mean calculated from twelve observations, in clear weather, both at the rising and setting of the sun, afforded me a difference of 3° between the temperature of the surface of the snow and that of a thermometer placed 6 feet above the ground; at the height of 2 feet this difference only amounted to 1° 5.

I have remarked, oftener than once, in the course of the summer and autumn, that the surface of the ground has appeared momentarily a little warmer than the stratum situated at the height of 5 feet, even when, from the latter elevation, the increase of temperature upwards was already established. Thus, on the 3d October, at half-past five o'clock, the weather being clear, and a few moments before sunset, a thermometer at the surface of the ground indicated 13°.3, and another at the height of five feet only 13°, while the atmosphere at an elevation of 80 feet, was at a temperature of 14°.55. The same thing was observed on the 5th August at seven o'clock in the evening, the weather being slightly cloudy, after a rainy afternoon, when I found the temperature of the turf at 17°, while that of the stratum of air 5 feet above it was only at 16°. This temperature, however, continued gradually to increase to the height of 105 feet, where it stood at 17°.1. My observations, from the 6th to the 8th September, presented the same results. In exceptional cases of this nature, it is not easy to explain the sinking of the temperature in the strata of air nearest the earth relatively to that of the higher strata. The theory of radiation, indeed, ascribes it to the cooling of the ground, as a consequence of nocturnal radiation, which communicates itself to the nearest strata of air, then in succession to the superior ones, with a decreasing intensity as we ascend. But if the ground itself is found to be warmer than the body of air surrounding it, the above explanation becomes inadmissible, at least without some modification. Perhaps the anomaly in question, which, moreover, very rarely presents itself, may be owing to a precipitation of dew, so sudden and abundant, as *momentarily* to warm the surface of the ground; the latter, after a short time, would again cool by nocturnal radiation, and before the slight elevation of temperature it had acquired could communicate itself to the nearest strata of the atmosphere.*

I formerly mentioned, that one of the objects I had in view by repeating Pictet and Six's experiments, was to study the relations which must exist between the indications of Leslie's

* In the course of upwards of a year's observation, I observed the above anomaly only four times, and always a little after sunset, the time when the deposition of dew is most abundant.

ethrioscope as shewing the intensity of terrestrial radiation, and the increase of heat which takes place in certain circumstances in proportion as we ascend. I shall not, however, enter at present into any detail of the observations I made on this subject; because, hitherto, they do not appear to me to have led to any decisive consequence. But the general result of them is, that the variations manifested in the increase of the temperature of successive strata of the atmosphere, in different cases, when the night appeared equally clear and serene, have not coincided in a striking manner with the corresponding variations remarked in the intensity of terrestrial radiation, as the latter is indicated by the ethrioscope. Thus, I have often observed the liquid indicator of this instrument denote the same intensity of radiation during a clear summer night, when the increase of temperature upwards did not exceed 2° or 3°, as during the same kind of weather in winter, when the same increase amounted to 4° or 5°. And even the less important variations which manifested themselves during the summer from one day to another, in weather to all appearance equally calm and clear, were not always accompanied by a corresponding change in the indications of the ethrioscope. There are probably other circumstances besides radiation, which have an influence on the phenomenon in question; and it is only when these have been studied consecutively, that a determinate opinion can be formed on this subject.

The results of the observations described in this Memoir seem to lead to the following conclusions:—

1*st*, The increase of temperature in successive strata of the atmosphere as we ascend, and which is remarked at the time of sunset, however variable it may be either in regard to its intensity or its limit in reference to elevation, is a constant phenomenon in every state of the sky, except in the case of violent winds.

2*d*, The time of the *maximum* of this increase is immediately after sunset; from that moment it is stationary, or even pretty frequently diminishes, particularly when the dew is plentiful. At sunrise, the increase is, for the most part, not so considerable as at sunset.

3*d*, The limit of elevation to which this increase of temperature extends, seems rarely to surpass the height of 100 or

110 feet, even when the sky is perfectly clear and calm. When the weather is cloudy or windy, and pretty frequently in winter, even when it is clear and calm, this limit appears to be less elevated.

4*th*, The increase of temperature, ascending, varies both in regard to its intensity and its limit in elevation, according to the different seasons of the year. It is in winter, and particularly when the ground is covered with snow, that this phenomenon presents the most remarkable results.

Account of the Island of St Kilda, chiefly with reference to its Natural History; from Notes made during a Visit in July 1840. By Mr John MacGillivray, Member of the Cuvierian Natural History Society. Communicated by the Author.

The name of St Kilda is familiar to many, in connection with vague ideas of some remote and barren island, "placed far amid the melancholy main," tenanted by myriads of sea-fowl, and the abode of a race of men living in a state of primitive simplicity. Believing that some account of a place so seldom visited, yet so interesting in every respect to the naturalist, may prove acceptable to the readers of this Journal, I have been induced to complete a series of hasty notes which were written during a few days spent in the principal island of the group.

One of my chief objects in visiting the Outer Hebrides last summer having had reference to the numerous species of water birds which resort to the St Kilda Isles, during the breeding season, after a detention of several weeks by contrary winds, at daybreak on Monday the 29th June, I left Borneray, a small island in the Sound of Harris, and crossed over to Pabbay, another island two miles distant. Here we procured a boat sufficiently large for our purpose, and, after considerable delay, hoisted sail about twelve o'clock, having a strong easterly breeze in our favour. In due time we passed Haskir, a small island 20 miles distant, and famous as being the resort of multitudes of seals* and various species of sea-fowl, espe-

* The *Halichœrus griseus*, Nilsson, or Great Seal, as indicated by a skull

cially the Eider-Duck, which breeds there in considerable numbers. Soon after this, a thick fog came on, accompanied with rain, and as we had still 40 miles to go, without a compass, our situation became rather unpleasant, the more so, as it was judged a still greater hazard to turn back. Having proceeded about 20 miles further, we fell in with a large yacht belonging to the tacksman of St Kilda, who was on board, and, like us, on his way to that island. After following in the vessel's wake for some time, we eventually lost sight of her in the fog. Several grampuses, *Delphinus Orca*, passed us from the westward, and I saw for an instant protruding from the water, the dorsal fin of a large basking shark, *Selachus maximus*, a fish of frequent occurrence among the Hebrides during the summer months. There is something extremely interesting in the sight, when at sea, of any of the larger cetacea, their appearance is so sudden; and as each of these monsters of the deep raises his huge back from the water, noiselessly gliding into the silent depths below, it leaves an indescribable and perhaps unpleasant impression upon the mind. By this time the wind was judged to have shifted, and no landmark of course being visible, our only chance of ever making St Kilda lay in following in the course of the long strings of puffins, auks, and guillemots, and the small parties of gannets, which passed overhead almost incessantly, all flying in the same direction, or toward their home. Several fulmars were now seen for the first time, and land was judged to be not very far distant. Evening was approaching fast, and yet nothing could be seen but the monotonous expanse of waters, and the dreary fog which covered it as with a mantle. The boatmen had begun to lose all hope, and told dismal stories of boats leaving for St Kilda that had never since been heard of, and of others that had been several nights at sea, or glad to take shelter under a rock for a fortnight, as happened once to Mr

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in my collection, and the inspection of numerous skins of adults and young, seen with the Rev. Finlay M'Rae, Vallay. About eighty of these animals are annually killed by a boat's crew from North Uist, who visit the rock in the beginning of November. The seals are surprised at a distance from the water, and easily dispatched with clubs, though many are of large size, one which I measured being 7½ feet in length.

M'Niel, a former tacksman. When matters were in this state, the fog partially cleared up for a few moments, and to our great joy disclosed a black looking rock of vast height, two or three miles to windward. This was immediately recognised as the island of Borreray, the most northerly of the St Kilda group, and distant from our destination about 8 miles. The wind being now adverse, and having increased to a gale, we were fortunate in making, at a single tack under double-reefed square-sail, the lee-side of a rock called Leveinsh, off the entrance of the bay. Here we lowered sail and mast, and emerging from our place of shelter, rowed against a heavy sea till long after the sun had set. In the dim twilight could be observed hundreds of fulmars and stormy petrels passing and repassing, or skimming along the surface of the waves. After rowing two miles in as many hours, about midnight, we entered the bay, and cast anchor. By this time, we observed the singular phosphorescence of the water of the bay. Each dip of the oars, and every ripple on the surface, disclosed myriads of small rounded luminous bodies, while every now and then a large medusa passed us, appearing a globe of fire or submarine meteor. Soon after, I landed by a boat belonging to the Prince of Wales gun-brig, which, together with the yacht, had entered the bay a short time before. I spent the night in one of the huts, and in due time commenced my examination of the island, which occupied me for the four following days, and the result of which I shall now proceed to give.

The islands of St Kilda are situated about 50 miles to the westward of the Outer Hebrides. They are three in number; Hirt, the principal and only inhabited one, generally called St Kilda; Soay, about a mile to the westward; and Borreray, lying eight miles due north. There are besides eight or ten others of smaller size, *stacks* (rocks) as they are called by the natives, all of which agree in general structure, being nearly perpendicular, and of great height. Some of these exhibit very singular forms: thus, one somewhat resembles a church steeple; another forms a tolerably perfect triangle; while a third bears a considerable resemblance to a vessel under sail. Not having been able to effect a landing on any of the smaller islands, I shall confine my observations to the principal and largest one.

Hirt or St Kilda, is about two miles and a half long from east to west, one mile at its greatest breadth, and nearly six in circumference. Roughly speaking, the island may be said to be one great mountain of irregular construction, with perpendicular sides descending to the sea, and forming precipices varying in height from 50 to nearly 1300 feet. Some idea of the rugged nature of the coast may be formed from the circumstance of there being but a single landing-place, accessible only in fine weather or during particular winds. It consists of a flat shelving rock near the upper part of a small bay on the eastern side of the island, where also is a narrow beach. The surface of the island varies from bare rock, covered in many places with loose blocks of stone, which have accumulated in the hollows, and left their debris upon the slopes, to a green carpet of the finest turf. Among the hills, in several places, valleys are formed, one being of considerable size, and descending for more than a mile, with a gradual slope towards the sea. The sea-margin of St Kilda is certainly among the most striking examples of the grandest rock scenery of the British isles, perhaps of the whole globe. No less than four of the promontories are perforated, and as many large caverns are formed, through which the sea passes. Considering the immense height of the mural precipices, it is no wonder that the St Kilda Isles are clearly visible from a very great distance, for they may be distinctly seen from near the level of the sea, when 60 miles distant. It is then indeed a glorious sight, while walking on the sandy beach of some green island, to watch the last rays of the setting sun, as he slowly sinks upon the ocean, lighting up with dazzling splendour the far distant St Kilda Isles, which, it has been no less truly than poetically observed, one may almost fancy some huge volcano newly emerged from the deep, or the unconquerable barriers of some enchanted land.

There are several springs in St Kilda never dried up, even during the hottest summer months. The water is extremely pure, though certainly not entitled to the extravagant encomiums bestowed upon it by the natives. Thus, one is called *Tobir na slainnte*, or Well of Health, the water of which is reputed to cure almost all the diseases in their nosology. There is, besides, another spring, scarcely less famous, *Tobir na h' oige*, Well of Youth, as it is called, issuing from out of the face of a precipitous rock near the landing-place, and to be reached only after incurring considerable danger. As the water, to retain its efficacy, must be drunk upon the spot, it is no wonder that so few old persons have attempted the renewal of their youth by its means, although surprising effects are *said* to have been produced by it in former days. Having tasted of the waters of this modern "Fountain of Youth,"* I can answer for their goodness ; but with respect to the probable longevity to be expected through their means, I can as yet say nothing. There are two small rivulets even in summer, one of them running for about half-a-mile in the bottom of a beautiful glen on the western side of the island, the other entering the bay. Deep ruts are occasionally observable on the slopes, the effects of winter torrents.

From the detached position of St Kilda, its bare surface and great height, it is exposed to every gale that sweeps over the Atlantic. Sudden gusts of wind not unfrequently, even in calm weather, descend from the hills with such violence as sometimes to unroof the huts and do considerable damage. A correct idea of the climate could not be formed from the observations of only four days, and consequently the mean temperature, quantity of rain, peculiar winds, &c., cannot be given.

With respect to the geology of the island I can say but little, my attention having been chiefly directed to more favourite and to me far more interesting pursuits. It is sufficient to refer the reader to Dr MacCulloch's work, which no doubt gives a very full account. The eastern extremity of the island, or about a third of the whole, is composed of syenite, which in one place rises to the height of 1380 feet.† This elevation,

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* See Washington Irvine's "Companions of Columbus," p. 295.

† According to MacCulloch.

known by the name of Conachan, forms the summit and eastern termination of the ridge composing the island, and by its abrupt descent to the sea produces a nearly perpendicular cliff, supposed to be the loftiest precipice in Britain. The remainder of St Kilda consists of trap rock; and the line formed by its junction with the syenite is well marked in various places, particularly on the north side of the island. At the upper end of the bay there has been formed a steep crumbling bank, receding from its basaltic base, which shelves into the sea. At the landing-place may be seen a large collection of granitic masses, some of them weighing several tons, which I was informed by the minister of the place were broken down from a cliff at the entrance of the bay, and washed on land by the heavy swell succeeding a continuance of easterly gales during the winter of 1829.

The vegetation of St Kilda, though profuse among some of the cliffs, is in general extremely stunted. It is truly surprising how so many horses, cattle, and sheep, contrive to subsist on the scanty herbage of the hill pastures, which are, moreover, in many places, nearly ruined by the quantities of turf taken away for fuel, leaving exposed the subjacent rock. The pasturage is chiefly composed of *Festuca ovina* and *duriuscula*, with a few other grasses, as *Aira cristata*, *Avena flavescens*, &c., and a sprinkling of the usual Leguminosæ. *Habenaria viridis*, *Botrychium Lunaria*, *Gentiana campestris*, and *Erythræa centaurium* var. *latifolium*, occur in similar situations, but in small quantity. *Cakile maritima*, *Arenaria peploides*, *Salsola Kali*, and *Atriplex maritima*, are found at the upper end of the bay; *Anagallis tenella*, *Leontodon Taraxacum* var. *palustre*, grow with *Pinguicula vulgaris*, in the marshy spots; while *Chrysanthemum segetum* and *Avena strigosa* occur but too plentifully among the corn. The cliffs in many places are abundantly stocked with *Rhodiola rosea*, *Oxyria reniformis*, *Cochlearia officinalis* and *Danica*, *Statice armeria*, *Silene maritima*, *Ligusticum Scoticum*, and the maritime variety of *Pyrethrum inodorum*, all of them attaining a luxuriance (especially on the north-east side of Conachan) I never elsewhere saw equalled by these species. In the crevices of the rocks, and below the manse, *Asplenium marinum* grows to a large size, as in most of the Outer Hebrides, where it is of frequent occurrence. The pretty *Sedum anglicum* occurs in a few places growing upon dry banks and among moss-covered stones, which it adorns with its tiny blossoms of the most delicate pink. The only alpine species which I observed are *Carex rigida*, and *Salix herbacea*, both of which I found on the summit of one of the hills. The occurrence of the latter at so low an elevation is interesting, as shewing the influence of the sea-coast upon Alpine vegetation, for I had never before gathered the dwarf willow at a less elevation than about 3000 feet. Upwards of 50 species in all of phenogamous plants were gathered by me in St Kilda, chiefly during a short excursion with Mr M'Kenzie, the worthy minister of the island ; but the more common and less interesting of these I have omitted mentioning. Besides these, a few cryptogamic plants may be noticed. Various lichens, and among them *Ramalina scopulorum*, are abundant on the more maritime rocks, where the species just mentioned attains the length of nearly a foot in many places. *Chondrus crispus* is plentiful at the landing-place, and might be collected in large quantity, but its use seems unknown to the natives. There is also abundance of *Rhodomenia palmata* and *Laminaria digitata* in the bay, both of which are occasionally used as food.

The crops of the St Kildians are said to be both better and earlier than elsewhere upon the west coast. Be this as it may, during my visit, the fields of barley and oats were much farther advanced than any of those I had just left in the Long Island. It is curious, that throughout the greater part of the Outer Hebrides the small dark barley termed *black oats* alone seems to thrive.

The inhabitants of St Kilda are about 120 in number, divided into 23 families. The population, after gradually decreasing for about a century, became almost stationary, but is now slowly increasing. This mortality arose not from any deficiency of births, but from the prevalence among new-born infants of a convulsive disease, called *galar na cuigeadh oidhche*, disease of the fifth night, from its usually appearing about that time after birth. Owing, however, to the improved condition of the natives, as regards cleanliness of the person and of their houses, doubtless the predisposing cause, this fatal scourge will soon be rooted out from amongst them, as no cases of it had occurred for more than a year previous to my visit.*

The St Kildians differ little in appearance from their Hebridian neighbours. Being of Danish origin, they are generally of fair complexion, and of small stature, for I believe none of them exceed five feet and a half in height, the average being perhaps two inches less. Their language is of course the Gaelic, but their dialect is slightly peculiar, and they are, moreover, distinguished from all the other islanders by a lisp, which is more apparent in the women.

With regard to the domestic manners of the natives of St Kilda, a great change has taken place, even within the last few years. Their houses are no longer the miserable hovels congregated together in a confused mass that formed their hamlet in former times, but, owing to the praiseworthy exertions of their most excellent minister, encouraged by the proprietor, they are now better lodged, clothed, and fed, than are the great mass of the population throughout the Hebrides. The modern village is built in regular order, with the gable end of each hut touching upon a well-paved footpath, which runs parallel to one side of the bay, and between which and the sea lie the cultivated lands, neatly divided, and kept in excellent order. Each family has two huts, one employed as a dwelling; the other, used as a storehouse for the feathers and oil, is also employed as a stable during winter.† These two houses are always adjacent, separated by a narrow passage into which the doors of both open, and thus mutually protecting each other from the sudden gusts from the hills and the storms of winter. The huts are very neatly built in the ordinary way, having double walls, the interval being filled with earth; while the thatched roof is secured by means of straw ropes hav-

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* I have since seen a fatal case in Berneray, an island in the Sound of Harris, where it was once prevalent, but is now rare.

† On first entering the bay, a stranger is struck with the number of small stone edifices which he sees scattered at intervals along the slopes. These might naturally be mistaken for the dwellings of the natives, but are merely storehouses for turf and winter provisions, such as dried gannets, and the eggs of sea-fowl.

ing large stones tied at each end. They consist of but a single apartment, entered by a very low doorway, on passing which the smell of fulmar oil from within, joined to the compound of villanous odours from the profusion of putrid carcasses of birds always lying about the doors, is sufficient to sicken any one but a St Kildian, possessed of even a moderate degree of olfactory development. The interior is generally filled with smoke, which escapes by the door and accidental apertures in the roof, chimneys being regarded as a superfluous piece of luxury. The roof and whole interior of the hut are thickly encrusted with soot, which, in wet weather especially, is continually dropping. No peat being found in St Kilda, turf is employed as fuel, and the mouldering fire so supported is placed on the middle of the floor, while a pot-hook suspended from the roof dangles above it. Some agricultural implements, a *quern*, or hand-mill, bundles of ropes, a few articles of the rudest furniture, and long strings of the gullets of the Solan goose, filled with fulmar oil, stretched from wall to wall, complete the picture of the interior of a St Kilda hut, in one of which I passed two nights.

The *quern*, or hand-mill, is still used in St Kilda, and each family grinds its corn as required for use. A flat stone, about a yard in diameter, furnished with a central upright pin, is fixed in the ground ; a round slab of smaller size is laid upon the other by means of a hole in the middle, and is made to revolve upon the central pin by a handle. The process of grinding with this primitive kind of mill is extremely tedious and fatiguing, and will probably soon be superseded by some modern invention.

The St Kildians are well characterized by their extreme laziness, a habit, however, more than compensated for by their cheerful disposition, religious principles, and great hospitality. Without going so far as to agree with Martin in his extravagant delusions,* I yet believe that in comparatively few places

* "The inhabitants of St Kilda are much happier than the generality of mankind, as being almost the only people in the world who feel the sweetness of true liberty : What the condition of the people in the Golden Age is feigned by the poets to be, that theirs really is. I mean in Innocency and Simplici-

in the civilized globe, is there to be found a race of men so truly happy and contented with their lot. Although intercourse with strangers has created many artificial wants and previously unknown luxuries, as well as encouraged an avaricious spirit, shewn by the value they place upon the articles offered for sale to strangers; yet it very seldom happens that a St Kildian voluntarily leaves his native rock, dreary and barren though to others it may seem to be, in order to settle elsewhere. It is needless to add another word to this brief notice of their character, for, after all, I can hardly consider myself warranted in drawing conclusions respecting it, from such a slender basis as that afforded by a residence among them of only a few days.

The mammalia of St Kilda consist exclusively of those introduced by the agency of man. I was told that some wild cats are to be found among the rocks, where they live upon the sea-fowl which breed there; however, not having seen any, I cannot state whether they belong to the truly indigenous race, as is highly improbable, or are merely the descendants of individuals that have escaped from confinement. The breed of horses, cattle, and sheep is of small size; many of the latter being of a dun colour, and remarkable for their length of legs and shortness of tail; the wool, however, is very fine. Goats are plentiful among the rocks, where they have run wild. A breed of curs, apparently a cross of the sheep-dog with the Scotch terrier, is sometimes employed in puffin hunting, but could easily be dispensed with. These dogs feed upon the carcasses of birds lying around the dwellings, and are extremely annoying to strangers, which they, as well as the cattle, immediately recognise and follow, to their great annoyance.

The land birds, as might be expected from the remote situation of the St Kilda Isles, are but few in number. *Falco peregrinus* and *Tinnunculus*, the Peregrine Falcon, and Kestrel, both breed in the precipices, but in small numbers. I pro-

ty, Purity, Mutual Love and Cordial Friendship, free from Solicitous Cares and Anxious Covetousness, from Envy, Deceit, and Dissimulation, from Ambition and Pride, and the consequences that attend them, &c."—A Late Voyage to St Kilda, the remotest of the Hebrides, or Western Isles of Scotland; with a History of the Island, &c., by M. Martin, Gent. 1698, p. 137.

cured an egg of the former from the same nest which several years ago furnished two young birds to the Messrs Aitkinson of Newcastle.* *Corvus Corax*, the Raven (*Biodhtach*), is found in small numbers; but *C. Cornix*, Hooded Crow (*Feannag*), is more common. I have frequently seen about a dozen of the latter sitting upon the roof of one of the huts, attracted probably by the numbers of puffins' heads lying about the door. Though seemingly perfectly aware of the dangerous nature of a gun, they could yet be easily approached by a little address. Starlings, *Sturnus vulgaris* (*Truid*), are very numerous, breeding in the old walls; and I often heard the loud clear song of the Thrush, *Turdus musicus*† (*An smeorach*) resounding along the hill-sides, and calling up pleasant recollections and many a rural scene. The Wheatear, *Saxicola Œnanthe* (*An clacharan*, *i.e.* the Mason), breeds plentifully among stones, chiefly about the walls of the huts, as in the other Hebrides. Two species of Pipit, *Anthus pratensis* and *aquaticus* (*An Glashan*), are common, as are also the Lark, *Alauda arvensis* (*An Uishag*) and the Corn Bunting, *Emberiza Miliaria* (*An sparig*). The Twite, *Linota montium* (*An bican*), the only species of the genus observed by me in the Outer Hebrides, occurs also in St Kilda.

To the above species seen by myself, a few others may be added. The cuckoo is said to visit the island at regular intervals; and the Rev. Mr M'Kenzie informed me that, on one occasion during winter, after a succession of easterly gales, a ptarmigan was seen by him on one of the hill tops. Of *Falco Islandicus*, the Iceland Falcon, sometimes reported to breed in St Kilda, I could obtain no information from the inhabitants, who could scarcely allow so conspicuous a bird to escape their observation. That they may breed there, however, is possible, as a friend of mine in North Uist shot and

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* One of these gentlemen, I believe, published an account of St Kilda in the Transactions of the Natural History Society of Newcastle, but this I have not been able to procure.

† I may mention here (for the fact has been doubted) that this Thrush is perfectly identical with that so common over the rest of Scotland, though eggs collected by me in the Hebrides are certainly smaller and of a darker colour than usual.

preserved a beautiful specimen, and another was seen and fired at about the same time in the adjacent island of Pabbay.

The Grallatores, like the land birds, are few in number. The Oyster-catcher, *Hæmatopus ostralegus (An Trilachan)* I found breeding among the loose stones at the upper margin of the bay, and also in some exposed shelving rocks on the west side of the island. Several pairs of the Dunlin, *Tringa variabilis*, were observed upon the hill side, where they doubtless had young. A few Land-rails, *Gallinula Crex (Dreunn)*, are always to be found among the corn, and their cry may be heard all night long, and occasionally during the day.

In addition to these, the minister has occasionally observed the Golden Plover, Common Snipe, and the Woodcock, the last only in winter, when it is found by the rills along with the snipe.

Far more interesting, however, than these, are the numerous water-birds which resort to St Kilda for the purpose of breeding, and whose countless myriads enliven the otherwise dreary solitudes of its rocky isles, and lend a charm to their gloomy and savage grandeur. Some faint idea of one of their breeding-places may perhaps be found, by a perusal of the following extract from my note-book.

Leaving the hut, I set off for the top of a high hill above the village, and after a little scrambling among the loose blocks which covered its declivity, managed to reach it. The day was clear, and with the exception of small patches of fog which were hovering about, scarcely a cloud was to be seen. The dim outline of the Hebrides formed the eastern boundary of the horizon, which they filled as with a dim haze. On all other sides no land was to be seen, save the neighbouring islands of Borreray and Soay, with the adjacent rocks. After walking along the ridge a little way, I came suddenly upon the top of a tremendous precipice, far surpassing all my preconceived ideas of the grandest rock scenery. It was with a feeling of involuntary awe that I looked down

> "High from the summit
> Of a craggy cliff, such as amazing frowns
> On utmost Kilda's shore, whose lonely race
> Resign the setting sun to Indian worlds."

Far below me could be seen the long heavy swell rolling in from the Atlantic, and climbing up the dark rock whose base it clothed with sheets of snow-white foam, as it broke with a sound at times scarcely perceptible, but at intervals falling upon the ear like distant thunder. In many places the rock was scarcely visible on account of the absolute myriads of sea-birds sitting upon their nests ; the air was literally filled with them, and the water seemed profusely dotted with the larger fowl, the smaller ones being nearly invisible on account of the distance. The sound of their wings as they flew past, joined to their harsh screams as they wheeled along the face of the cliff, startled me from the reverie into which I was thrown by the strange scene before me. Every little ledge was thickly covered with kittiwakes, auks, and guillemots; all the grassy spots were tenanted by the fulmar, and honeycombed by myriads of puffins ; while close to the water, on the wet rocks which were hollowed out into deep caves, sat clusters of cormorants, erect and motionless, like so many unclean spirits guarding the entrance of some gloomy cavern. On rolling down a large stone from the summit, a strange scene of confusion ensued. It would perhaps fall upon some unhappy fulmar sitting upon the nest, crushing her in an instant, then rolling down the crags, which reverberated its echoes far and near, tearing long furrows in the grassy slopes, and being shivered into fragments upon some projecting crag, scattering in dismay the dense groups of auks and guillemots. Its progress is all along marked by the clouds of birds which affrighted shoot out from the precipice to avoid the fate which nevertheless would befal many, until at length it reaches the bottom, and is received into the water along with its many victims. The startled tenants of the rock now return to their resting-places, and all is again comparatively quiet.

Several species of gull are of common occurence. *Larus marinus* and *fuscus*, the great and lesser Black-backed Gulls (*An Farspach*), *L. argentatus*, Herring (*Faoileag*), *L. canus*, Common Gull (*Faoileag Bheg*), and *L. tridactylus*, Kittiwake (*Ruideag.*) Of these the last is the most abundant, and the *L. canus* the least so. The kittiwake, unlike some of the others, is a social bird, and occupies the breeding-places, which it selects to the exclusion of almost every other species. It chooses the most inaccessible spots, and forms a regularly constructed nest of turf and dried sea-weed, laying invariably three eggs, as the other gulls mentioned above generally do, with the exception of *L. marinus*, which has usually only two. On disturbing a colony of kittiwakes, most of the birds leave their nests and fly about the intruder, uttering incessantly their clamorous, but not unmusical cry. The noise from a large flock, set in motion by repeated shots, is almost deafening; the flapping of their wings, their loud cries, joined to the deep guttural notes of the passing gannets, and the screams of the larger gulls, form a combination of sounds without a parallel in nature. This bird is not deemed of sufficient importance by the fowlers to serve as an object of pursuit, probably on account of its vigilance.

St Kilda has been long noted as the only breeding-place in Britain of the fulmar petrel, *Procellaria glacialis* (*An Fulmar*, or *Fulimar.*)* This bird exists there in almost incredible num-

* As this bird has rarely been seen in its recent state by ornithologists, perhaps a short description of its colouring, with the measurements taken on the spot from numerous specimens, may be interesting, as it will be seen that my account differs considerably from those to be found in books. Upper parts bluish-grey, darker on the wings, and gradually fading away to the tail; head and neck white, with a slight tinge of yellow on the throat, and a small black spot before the eye, extending slightly over it; bill bluish-yellow, of different shades, notched with darker patches and streaks, whole of the under parts white, except the under surface of the wings, which is bluish-grey, the wing coverts being only slightly tinged with that colour. Legs pale-flesh coloured, darker on outer surface of outer toe.

	Male.		Female.		Female.	
	In.	l.	In.	l.	In.	l.
Length to end of tail,	1	8½	1	7½	1	8½
Extent of wings,	1	10	3	9½	3	8
Wing from flexure,	13	0	13	0	13	0
Tail,	4	3	4	2	4	3
Bill, measured straight,	1	7½	1	6	1	6
Nasal tube,	0	9	0	9	0	8
Gape,	2	2	2	0	2	2
Tarsus,	2	3	2	1½	2	3
Middle, toe and claw,	3	0	3	0	2	9
Outer, toe and claw,	3	1	3	0	2	10½
Inner, toe and claw,	2	5	2	3	2	3

bers, and to the natives is by far the most important of the productions of the island. It forms one of the principal means of support to the inhabitants, who daily risk their lives in its pursuit. The fulmar breeds on the face of the highest precipices, and only on such as are furnished with small grassy shelves, every spot on which above a few inches in extent is occupied with one or more of its nests. The nest is formed of herbage, seldom bulky, generally a mere shallow excavation in the turf, lined with dried grass, and the withered tufts of the sea-pink, in which the bird deposits a single egg, of a pure white colour when clean, which is seldom the case, and varying in size from 2 in. 7 lines, to 3 in. 1½ l. in length, and 1 in. 11 l. to 2 inches in breadth. On the 30th of June, having partially descended a nearly perpendicular precipice 600 feet in height, the whole face of which was covered with the nests of the fulmar, I enjoyed an opportunity of observing the habits of this bird, which has fallen to the lot of few of those who have described them, as if from personal observation. The nests had all been robbed about a month before by the natives, who esteem the eggs of this species above all others; those of the auk, guillemot, kittiwake, and puffin, ranking next, and the gannet, scart, and cormorant, last of all. Many of the nests contained each a young bird a day or two old at farthest, thickly covered with long white down. Such of the eggs as I examined *in situ*, had a small aperture at the broad end, at which the bill of the chick was visible, sometimes protruding a little way. Several addle eggs also occurred. The young birds were very clamorous on being handled, and vomited a quantity of clear oil, with which I sometimes observed the parent birds feeding them by disgorging it. The fulmar is stated in most works on ornithology to possess the power of ejecting oil with much force through its tubular nostrils, using this as a mode of defence; but although I surprised several upon the nest, I never observed them attempt this. On being seized, they instantly *vomit* a quantity of clear amber-coloured oil, which imparts to the whole bird, its nest and young, and even the very rock which it frequents, a peculiar and very disagreeable odour. Fulmar oil is among the most valuable productions of St Kilda, and is procured of two kinds by different processes. The best is obtained from the old bird by surprising it at night upon the rock, and tightly closing the bill until the fowler has secured the bird between his knees, with its head downwards. By opening the bill, the fulmar is allowed to disgorge about a table spoonful, or rather more, of oil, into the dried gullet and stomach of a solan goose, used as a reservoir for that purpose. These, when filled, are secured with a string, and hung on cords across the interior of the huts, until required for use. The oil thus procured and preserved, besides supplying their lamps, is used by the inhabitants as a medicine, being sometimes of considerable efficacy in chronic rheumatism, and acting as a cathartic ; while, from its nauseous taste and smell, it would doubtless prove an effectual emetic also to any but a St Kildian. In the beginning of August, the natives descend the rocks for the young fulmars, which are then nearly fledged, and by boiling with water, in proper vessels, are made to furnish a large quantity of fat, which is skimmed off, and preserved in casks in the solid form. The old fulmar is much esteemed as food by the St Kildians, principally on account of its subcutaneous covering of fat, a substance of which they are immoderately fond. One which I had the curiosity to taste unexpectedly proved tolerable enough, after the envelope in question had been removed. Perhaps the keenness of my appetite deceived me, as it was not blunted by the following bill of fare: fulmar, auk, guillemot, one of each, boiled; two puffins, roasted; barley-cakes, ewe-cheese, and milk; and by way of dessert, raw dulse and roasted limpets *ad libitum.*

It is chiefly in pursuit of the fulmar that the St Kildian requires to endanger his life, by descending the tremendous precipices, on the faces of which it breeds in almost incredible numbers. Their mode of procedure is as follows: Two men go in company, each furnished with several coils of rope,* about half an inch in diameter. The person whose turn it is to de-

* Formerly, ropes of hair and strips of hide were exclusively employed for this purpose, as being less acted on by friction against projecting angles. They are now, however, superseded by those of hemp; less durable, to be sure, but more economical, as being procured ready made.

scend fastens one of the ropes under his armpits, and, holding the extremity of another rope in one hand, is lowered down the cliff. His comrade stands a little away from the edge, holding the supporting rope firmly with both hands, and, letting it out very slowly, while he allows the other or guide-rope to slip out as is required from under one foot, which loosely secures it. When the rope is all run out, another is joined to it, by means of a noose with which it is provided, and the line is thus lengthened to any degree. On arriving at a ledge occupied by birds, the fowler commences his operations, easily securing the eggs and young birds, knocking down the old ones with a short stick, or catching them by a noose attached to a long slender rod, killing them in a moment by dexterously bending the head backwards upon the neck. He then secures his sport by bundling the birds together, and tying them to a rope let down from above, depositing, at the same time, in a small basket the eggs which he has collected. The dexterity of these rocksmen is truly astonishing. The smallest spot is considered by them as a secure enough standing-place; and they will creep on hands and knees, though cumbered with a load of birds, along a narrow ledge, seemingly without concern for their personal safety. When exhibiting before strangers, which they are easily induced to do, they generally choose for the display of their agility a precipice about 600 feet in height, overhanging the sea, at a short distance from the village. One of them will then suspend himself about mid-way down the cliff, and, striking his feet against the rock, shoot himself out some ten or twelve feet or more, rebounding from it several times, and increasing the distance with each rebound; performing this, and many similar feats, with all the agility of a professional performer upon the tight rope. It is truly surprising that no serious accident has occurred for the last ten years, although, a few years ago, a man fell into the sea from an immense height, but was fortunately picked up unhurt by his comrades, who were at hand with a boat. He floated, I was told, for some time, though, like the other natives, unable to swim.

The fulmar flies with great buoyancy and considerable rapidity, and when at sea, is generally seen skimming along the surface of the wave at a slight elevation, though I never observed one to alight or pick up any thing from the water.* It is partially a nocturnal bird, for I seldom observed it at any distance from St Kilda except during the evening and about daybreak; at the latter time, always flying in the direction of St Kilda, as if hastening homewards. I have also, on one or two occasions, when at sea, engaged in cod-fishing to the westward of the Harris islands, in very gloomy and rainy weather, observed a few fulmars flying about the boat, probably attracted by the fish we had caught. At its breeding-places, however, the fulmar is always in motion, comparatively few being to be seen upon the rocks, the great mass being engaged flying in circles along the face of the precipice, and always in the same direction, none crossing, probably on account of the confusion this would cause among such an immense multitude. I never observed them utter any cry when thus engaged, or even when their nests were being robbed. The fulmar does not allow itself to be handled with impunity, but defends itself with its powerful bill, which it can use with as much effect as good will.

Phalacrocorax Carbo and *cristatus*, the common and crested cormorants (*Xarbh-buill* and *Xarbh-beg*), are both found in St Kilda, the latter in great numbers. Their eggs are extremely nauseous, and even the natives hold them in little esteem. They nestle in the numerous caves and recesses throughout the group, seldom; however, breeding at any great height above the water, into which they drop like a stone when alarmed by man, which they seldom are, allowing him to approach within a very few feet.

The gannet, or solan goose, *Sula alba*, (*An Sulair*), is to be seen in vast numbers about St Kilda, from whence a portion of them take their departure every morning to fish in the bays and channels of the other Hebrides, the nearest of which is about 50 miles distant. I have even seen them in Dunvegan Loch, in the Isle of Skye, about 90 miles from St Kilda,

* Several which I dissected had the stomach filled with pure oil, mixed up with the indigestible horny mandibles of some of the *Sepiadæ*, which, we may conclude, form their principal food.

to which I have no doubt they all retire at night. In fact, long strings of gannets may be seen on the approach of evening winging their way to the westward. This bird is apparently very select in the choice of its breeding-places, which it occupies to the total exclusion of every other species. None are to be found in Hirta, but the island Borreray is almost entirely occupied with them, as are also the adjacent rocks Stack Ly and Stack Narmin. The two latter, remarkable for their pointed summits and great height, along with portions of Borreray, appear even from the distance of many miles as if covered with snow, this deceptive appearance being caused by the myriads of gannets with which the rock is thickly covered, as well as the clouds of these birds passing and repassing in the neighbourhood of their nests. The young birds are fledged in August if the produce of the first laying, but not till September if the first egg has been taken away, as it always is in spots of easy access. The ascent of Stack Ly, a rock which seems absolutely inaccessible, is considered the greatest of all the dangers to which a St Kildian can expose himself. Only a single man can land at a time, and that only in fine weather. Even then there is great danger in a near approach, on account of the heavy swell, which many years ago drove upon the rock the only boat belonging to the island, when all on board, with one exception, perished. A second boat had previously been lost at the same place, but the crew were so fortunate as to effect a landing, and were taken off the rock a few days after by a boat from Harris sent to collect the rent. The man who lands first, after scrambling to the top, lowers a rope, by which the rest easily ascend, and commence plundering the nests, throwing down into the sea, to be afterwards picked up, the bodies of the young birds, and such of the old ones as they can secure. The old birds, however, are generally caught in gins, or killed under night when asleep. Great caution is required to prevent any of the gannets from giving the alarm, in which case the courage and ingenuity of the fowler will be exerted in vain.

Great numbers of gannets are taken not only in St Kilda, but also throughout the Hebrides, by cautiously approaching them in a boat under sail, when gorged with fish and asleep upon the water. It requires great dexterity, however, to succeed in this, and I have often seen it fail, especially in calm weather, or when there is only a slight breeze, the bird being awakened by the noise of the gliding of the boat through the water, and rising on wing, when it invariably disgorges with a loud harsh scream. The pasture on the island of Borreray is nearly destroyed by the gannets, which have dug great numbers of large deep holes in the turf, to procure materials for their nests, which are composed externally of sea-weed. The latter substance many of them must procure from a distance of 60 miles or more, there not being a sufficiency in any of the St Kilda Isles. In fact, I have seen a gannet flying apparently from Harris, with a large quantity of sea-weed in its bill. The force with which the gannet plunges from on wing in pursuit of a fish is astonishingly great. The following story, illustrating this point, was related to me by more than one person both in St Kilda and Harris, and I believe to be true. Several years ago, an open boat was returning from St Kilda to Harris, and a few herrings happened to be lying in the bottom, close to the edge of the ballast. A gannet passing over head, stopping for a moment, suddenly darted down upon the fish, and passed through the bottom of the boat as far as the middle of the body, which being retained in that position by one of the crew, effectually stopped the leak until they had reached their destination. The long streak of foam which follows the plunge of the gannet may be distinctly seen at the distance of more than a mile, when the bird itself is far below the surface, and of course invisible.

The account given by Martin of the barren gannets, which roost separately from the others, was confirmed by the natives.

The stormy Petrel is abundant in St Kilda, but whether *Thalassidroma Bullockii* is there equally common with the other species, I am not able to determine. The island of Soay is the principal breeding-place of this bird, where, as well as in several spots among the others of the group, it nestles among debris and in crevices of the rocks, laying, according to my informants, for I never found the nest myself, one, sometimes two eggs. The bird sits very close upon the nest, from which it will allow itself to be taken by the hand, vomiting, on being handled, a quantity of pure oil, which is carefully preserved by the fowlers, and the bird allowed to escape. It is only at sunset and about daybreak that I have observed the stormy petrel at sea, except during gloomy weather, save once while crossing the Minch, being then not far from one of their breeding-places, at Dunvegan Head, in the Isle of Skye.

Puffinus anglorum, the Shearwater, or Manx Petrel, is not uncommon in St Kilda, where it breeds in excavations formed by itself in the soft earth filling many of the fissures among the rocks. Comparatively few are taken by the fowlers, for it is never made a regular object of pursuit; and yet I have seen a bunch of several dozens brought by one of them from the island of Soay. It lays but a single egg, which I was told it deposits upon a slight nest of dried grass at the bottom of its burrow, where it spends most of the day, during which time few are to be seen, it being in a manner nocturnal in its habits. Its flight is very characteristic, and, joined to its dark colour, renders even a single individual very easy of detection, though among a flock of other birds and at a considerable distance.

By far the most abundant species in St Kilda is the puffin, *Mormon arcticus** *(Buikir* or *Boujer)*, which breeds in the crevices of the rocks, as well as in artificial burrows in almost every situation, sometimes at a considerable distance from the water's edge. This bird is taken by the fowlers in two ways: when on its nest, by introducing the hand and dragging out the bird, at the risk of a severe bite; and when sitting on the rocks, by means of a noose of horse-hair attached to a slender rod, generally formed of bamboo-cane (procured probably from some wreck). The latter mode of fowling is most successful in wet weather, as the puffins then sit best upon the rocks, allowing a person to approach within a few yards, and as many as 300 may be taken in the course of the day by an expert bird-catcher.

Of all the St Kilda birds, the puffin probably affords the greatest amusement to the sportsman, as well from the rapi-

* I obtained a nearly white variety when in St Kilda.

dity of its flight, as its habit of congregating in dense masses when sitting upon the rocks. As many as a dozen may often be secured at a single shot, and I have more than once seen a small shelf about the size of a table, which was swept bare at a single discharge, the birds falling into the sea below. The smoke had scarcely cleared away, when the scene of slaughter was as thickly crowded as ever, and many more might have been easily procured. The food of the puffin during my visit I believe to have been chiefly the fry of the coal-fish, *Gadus carbonarius*, from having repeatedly shot the birds flying to their nests with this fish in their bills, and I thus found that both males and females supply the young with food. The puffin forms the chief article of food with the St Kildians during the summer months, and is usually cooked by roasting among the ashes.

Uria Troile, the Common Guillemot (*Lamhi*, or *Lavy*) is very abundant. *U. Grylle*, the Black Guillemot (*Gearra-breac*), less so. The latter is a solitary bird, breeding in holes and clefts among the rocks, while the common guillemot nestles on exposed shelves, usually close to the water's edge.

Alca Torda, the Common Auk (*An Falc*), is nearly as plentiful as the guillemot, generally breeding, like that species, upon exposed shelves, but sometimes in fissures, from which I have dragged both the old and young birds. The cry of the latter, when seized, is a loud plaintive squeak, ending in a hiss.

The Great Auk, *Alca impennis*, was declared by several of the inhabitants to be of not unfrequent occurrence about St Kilda, where, however, it has not been known to breed for many years back. Three or four specimens only have been ever procured during the memory of the oldest inhabitant.

No doubt a considerable variety of fish might be found about St Kilda; in fact there is abundance of excellent cod, ling, tusk, and skate about the entrance of the bay, all of which might be taken by lines fastened to the shore, on account of the depth of water immediately under the rocks; but, either from indolence or the want of proper materials, the inhabitants pay little attention to this important pursuit.

Of the entomology of St Kilda I can give but a very meagre account. Among the few Coleoptera picked up during my rambles, by far the most interesting are *Elaphrus Lapponicus* and *Byrrhus æneus*,* both recent acquisitions to the British Fauna. The latter occurred beneath stones in several places, the former only in some wet ground in a valley on the west side of the principal island. *Carabus catenulatus* and *granulatus* (*cancellatus*† of most authors), *Elaphrus cupreus*, *Atopa Cervina*, *Sclatosomus æneus*, *Ctenicerus cupreus* and *tesselatus*, and *Geotrupes sylvaticus*, complete the list of coleoptera of which I preserved specimens.

Hipparchia Pamphilus, *Charæas graminis*, and *Plusia Gamma*, were the sole representatives of the Lepidoptera that I remember having observed.

Hæmatopoda pluvialis, *Chrysops cæcutiens*, and an undetermined species of *Tabanus*, include the principal Diptera, with the exception of *Gasterophilus Equi*, a pair of which I captured.

With the common *Panorpa communis* I may conclude this brief list of insects, some of which are, however, of considerable rarity. A diligent search would no doubt produce many more.

Having now brought to a close these cursory remarks upon St Kilda, I may mention, that after a residence of only four days I was unexpectedly forced to hurry my departure, in order to take advantage of a favourable breeze that had just sprung up. Accordingly, at noon, on Saturday the 4th July, I bade farewell to this rugged isle and its hospitable inhabitants. The huge rocky piles, and their clouds of sea-fowl, became every moment more and more dim, and at length were lost in a thick fog which enveloped us. It rained most of the day; and just as we had caught a glimpse of Haskir, the wind shifted, night came on, and we had lost our way. The wind

* Since writing the above, I have found this species in great abundance on the sandy links of Old Aberdeen.

† The splendid *C. clathratus* I found to be plentifully distributed throughout the Hebrides, having observed it in North and South Uist, the island of Bernera, as well as the range of flat moors at the southern extremity of the mainland of Harris, associated there with *C. glabratus*.

had been gradually increasing, and now blew a heavy gale, breaking the tops of the huge billows which rolled in majestically from the Atlantic. The small leaky boat in which I was, in company with two St Kildians, proving rather troublesome, was abandoned by our friends in the other, who would tow us no longer. We were thus left to our fate, in a dark night, with a storm blowing off the land, to reach which we had a miserable boat half filled with water, and two oars, one of them broken. After rowing incessantly during the night, without making any progress, and barely escaping from being drifted out to sea, at day-break we found ourselves off the Sound of Harris, and after a long continued struggle, contrived to make the uninhabited island of Shellay, where we landed upon a beach, at the upper part of which lay the dismantled skeleton of a huge grampus, while several pairs of eider-ducks were sporting about. Here we attempted to kindle a fire, intending to remain till the storm subsided, and relief could be sent us. Having fasted since the preceding morning, it was proposed to shoot a lamb and roast it; but it seems we had reckoned without our host, for wet sticks are not easily made to burn, and guns plugged up with rust, and half filled with water, can seldom be induced to go off; so both schemes being found impracticable, were abandoned. After breakfasting on brackish water and raw limpets, I prevailed upon my companions to push off for Pabbay, the nearest landing-place on which was two miles distant. We accordingly embarked once more in our frail vessel, and arrived in safety at our destination, after narrowly escaping being lost among some sunk rocks, on which at one time the breakers were rising fearfully all around us.

Old Aberdeen, *June* 26. 1841.

On Fresh-water Polypi. By M. Coste.

M. Coste has lately presented to the Academy of Sciences a short Memoir on Fresh-water Polypi, from which we supply the following extracts.

On the eve of my departure upon a journey of scientific discovery to the shores of Italy, for the purpose of collecting materials for the completion of my treatise on Comparative Embryogeny, I take leave to present to the Academy some results of a general work upon the Organization and Natural History of the Lower Animals,—a publication which I shall have the honour to submit in its complete form when all the plates are finished. In the mean time, I shall dwell only on the Fresh-water Polypi; and hence this communication is to be considered merely as a minute fragment of more extended researches. The points upon which I wish at present to fix attention are the following: *The muscular apparatus* is composed, 1st, Of the motor tubercular muscles, which are of two sorts,—the one flexors within the parts, the other flexors without: they exist throughout the whole extent of the tentacula, and present, in the course of their progress, a certain number of nodosities or knots. 2*d*, Of the motor muscles of the tongue, which are disposed in two parallel series before and behind, and are used in raising the organ. 3*d*, Of the retractors of the animal, forming two large muscles, which, from the bottom of the cell into which they are inserted, somewhat in advance of the point of attachment of the ovary, mount up on each side of the intestine, to which they send fibres of insertion in passing, and which, on reaching the middle of the œsophagus, divide into two unequal bundles; the larger attaches itself to the sides of the buccal aperture at the base of the arms, and the other at the posterior of the base of these arms. In the Paludicella, the two fasciculi are not divided, the fibres being distributed and inserted round nearly the whole circumference of the mouth. 4*th*, Of the proper retractors of the intestine, two in number, fixed, on the one hand, behind the point of insertion of the ovary, and, on the other, at the posterior part of the stomach, where they appear to terminate, after bifurcating. 5*th*, Of the dilating muscles of the sheath. These are cutaneous, arranged more or less transversely, and very numerous, in a certain extent of the length of the circumference of the free extremity of the cell. They are inserted, in one part, at the internal surface of the skin which covers the extremity of the cell, so, of course, favouring the exit of the animal by overcoming the closure occasioned by the contraction of the sphincter of the sheath to which they are antagonists. The Paludicella present, in this respect, a difference which it would be tedious to explain, but which will be accurately represented in the plates. *6th*, Of the regulator muscles of the sheath, to the number of about ten. They are arranged like so many cords, which, from the anterior third of the length of the inside of the cell into which they are inserted, extend in the form of rays, converging forward from behind towards the circumference of the posterior extremity of the sheath, to the points of whose circumference they attach themselves. Their use seems to be to enable the sheath to maintain, in a permanent manner, the infolded arrangement which is natural to it, and likewise to oppose any undue unfolding of the animal. On this account, we designate them the regulators of the sheath. They are much fewer in the Paludicella than in the horse-shoe plumed polypi (*à panache en fer à cheval*). The dilating and regulating muscles of the sheath are the only portions which have any traces, however obscure they may be, of the radiatory arrangement of the fresh-water polypi; all the rest of the organization being evidently binary.

The Digestive Apparatus, which is composed of three very distinct compartments, the œsophagus, stomach, and rectum. The œsophagus commences in front by a circular and ciliated mouth, surmounted by a tongue which is also ciliated, which serves as an operculum, and varies in form, size, and arrangement, according to the species. It communicates behind with the stomach, by a mouth shaped as in the tench, projecting into the interior of this organ. This tongue and tench-like mouth form an anatomical arrangement which belongs exclusively to the horse-shoe plumed polypi, being absent in the Paludicella, which, in this respect, present an entirely different conformation, and in which it is also found that the absence of a tongue and of the tench-shaped mouth coincides with that of a palmed membrane, which unites the base of the tentacula of the polypi to the horse-shoe plume. The stomach forms a large pouch, terminated posteriorly in a cul-de-sac, and presents throughout the extent of its inner surface many projecting longitudinal folds. The rectum commences towards the anterior part of the stomach, a little behind the œsophagus, by an aperture furnished with a sphincter, and opens externally upon the back of the animal. The coats of the three intestinal divisions are somewhat thick,—have a structure which appears glandular, and exhibit a muscular coat formed of circular fibres, which endows them with a strong contractile power, and which enables the stomach to operate on the aliment by its very marked movements, facilitating, of course, the process of digestion. In the Paludicella this power of contraction being much less, there is substituted a number of very long cilia, which are placed round the opening of communication between the stomach and rectum, and which, by their vibrations, agitate the alimentary molecules.

The Apparatus of Reproduction. Besides the power of propagating themselves by means of gemmæ, the fresh-water polypi also propagate by ova, which are produced in a filiform ovary, situate at the posterior part of the stomach, to which it is attached by one of its extremities, whilst by the other it is fixed to the inner surface of the cell, between the two points of attachment of the retractor muscles of the animal and those of the intestine. All the members of the same polypidon appear to produce ova, and consequently, if there are two sexes, they must be united in the same individual. In general, the ova of the Alcyonella produce two individuals which are united, soft, and contractile throughout their whole extent; so that the new polypidon which results from the co-existence of these two individuals, is capable of displacing itself up to the moment when *the superficial layer of its external envelope becomes solid.* The external envelope of the *Cristatella* never becomes solid, but always maintains the power of contraction. We have observed in the common visceral cavity which is common to the two individuals which proceed from the ova of the Alcyonella a well-defined spheroidal mass, which diminishes in size in proportion as the young polypidon augments, and finally disappears entirely. This temporary organ appears to be connected with the posterior extremity of the stomach, and should be considered, we believe, a kind of umbilical vessel. The young of the Cristatella have the whole of their visceral cavity occupied by a granular matter, which appears to be of the same nature with that which fills the umbilical vesicle of the Alcyonella. This matter extends to the extremity of the tentacula, which clearly proves that these tentacula are hollow throughout their whole extent, and have each a long cul-de-sac, communicating with the cavity which exists between the skin of the animal and its intestine. This communication is also provided, in adults, with a passage for a fluid which circulates in this cavity.

The Nervous System is composed of a double sub-œsophagial ganglion, which supplies posterior filaments distributed along the œsophagus, and anterior ones, which appear to be distributed in front and on the sides.

After thus regarding, then, the complicated organisation of the species of polypi which have been occupying our attention, also the general binary disposition of their organs, the position of their nervous system; after considering, also, that they have mouths, in many respects analogous to that of the mollusca, and that, like them, they produce the envelope which protects them; and when to this we add certain special facts which the Cristatella present, as, for example, having a foot which is everywhere contractile, and their secreting, like the gasteropoda, a copious viscous matter, we shall be led not only to associate them with the class of the mollusca, but likewise to introduce along with them all the animals which are farther down the scale. Before, however, maintaining this as an irrefragably established fact, we shall request another opportunity of explaining some additional results of our researches.

American Geology—Erratic Blooks—Glacial Action.

The October number of the *American Journal of Science* contains an address delivered by Professor Hitchcok to a meeting of geologists, which gives a general view of the progress of the science in the United States. Some of the details are not without interest on this side of the Atlantic.

Geological Surveys.—It appears that in a considerable number of the States, the Government has ordered geological surveys to be made at the public expense. This is a good arrangement, and peculiarly necessary in a country like the United States, where the field is immense, and the men of science few. Besides, a man clothed with public authority gets easier access to useful documents than an amateur ; his object is less likely to be misunderstood ; and being paid for his work, he does it systematically, instead of selecting special subjects of inquiry suited to his private convenience or his individual taste.

Valley of the Mississippi.—Nearly the whole of the vast basin of the Mississippi, from the Alleghanies to the Rocky Mountains, a space equal to two-thirds of Europe, is covered by a series of deposits, which has been divided into thirteen formations,—the upper corresponding to the coal measures of England, the lower to the Devonians or Old Red Sandstone, the Silurians, and the Cambrians. The thickness of the whole is estimated at 40,000 feet, or nearly *eight miles ;* and this is exclusive of the primary stratified rocks. The coal exists only in certain portions of the great basin. The Silurians have been identified by their fossils ; an interesting fact, when we consider that a space of 5000 miles intervenes between the British and American Strata. Mr Murchison was highly gratified to find the British fossils in northern and central Russia, at the distance of 1200 or 1400 miles from the Silurian district of Wales ; but their appearance on the west side of the Alleghanies, is still more important. It enables us to state that the same species of sauroid and shell-fish, and corals, had existed at the Silurian period from the latitude of 40, to that of 60, and from the Volga to the Mississippi. At the present day the range of species is much more limited. The testacea, zoophytes, and fish for instance, of the Red Sea, are as a group extremely distinct from those of the Mediterranean (Lyell's Elements, ii. p. 204.)

The cretaceous formation has been found in the basin of the Mississippi, and identified by the fossils, but the rock does not assume the form of chalk—a case not uncommon. Patches of the oolite have been found in the same region ; and a stripe of tertiary deposits has been traced along the eastern coast from Massachusetts to Florida. Thus an identity, or at least a close correspondence (for we must speak cautiously till the fossils are carefully compared) has been found to exist not only in the oldest but the newest formations, over a space extending from Austria to New Orleans. The Tertiary rocks are believed to have been originally formed in detached basins, and never to have been continuous, and their recurrence in distant parts of the globe was therefore less certain than in the case of the primary and secondary rocks.

Grooved and polished rocks—Diluvium—Boulders.—The phenomena of polished, scratched, and grooved rocks, are more common, Dr Hitchcok thinks, in the United States than in Europe. If the formations of New England were denuded, "one-third of the surfaces," he believes, "would be found smoothed and furrowed." The *diluvium* or *drift* is also similar to some extent, in composition and appearance, to that of Britain. The lowest portion is of sand, clay, gravel, and boulders, seldom stratified; next are horizontal layers of fine blue clay; above this is a bed of sand; and scattered over the whole surface are insulated blocks, sometimes rounded, and sometimes angular. The chief difference between these deposits and ours, is in the second, corresponding to our upper diluvial clay, which we have never seen stratified in this country. The diluvium forms conical and oblong tumuli, and tortuous ridges; features common to it here.

The striæ and grooves on the rocks generally point southeasterly, and this has been found to hold true, with small local exceptions, over a breadth of 2000 miles (meaning, we presume, the region from Florida to Canada); 2. They appear on mountains to the height of 3000 feet, but not on those exceeding 4000; 3. They are feebler and fainter in the south of the United States than the north; 4. In New England erratic blocks have been traced to places one or two hundred miles, and west of the Alleghanies to places four or five hundred miles, from their original locality. The following remark is important, from its bearing on the Glacial Theory:—"It is very natural to ascribe the smoothness and furrowing of the rocks to the action of water. But I have in vain examined the beds of our mountain torrents, and the shores of the Atlantic, where the rocks have been exposed to the unshielded and everlasting concussion of the breakers, and *can find no attrition that will at all compare with that connected with drift*, and I am satisfied that to explain it we must resort to some other agency." He adds, that the work of Agassiz on Glaciers has given us the first glimpse of what seems to be a solution of this problem.

He observes, that, in the United States, the striæ and furrows have not been found to radiate in different directions from a mountain chain (as they do in the Alps, which Agassiz calls a "centre of dispersion"); and further, that *the northern slopes of mountains are grooved*, even though very steep, while the drift covers the opposite side. We have here the phenomenon of "Crag and Tail," so familiarly known in this country, and under the same aspect; for the marks of attrition here are generally found on the west or north sides of hills. New light has been thrown on this subject by Mr Murchison's researches in Russia. He thinks that the striated surfaces there cannot be accounted for by the abrasion of glaciers, but may rather be ascribed to *the action of floating masses of ice, armed with stones or gravel adhering to their bottoms*, and that the mounds and ridges of gravel and clay arise from the action of currents casting up on their flanks masses of ice loaded with debris.

This removes some difficulties; but the question presents itself—why do these furrows, and these ridges or tails of alluvium, generally point north-west and south-east in Russia, Sweden, Britain, and the United States, with the crag or bare scalp of rock on the north or north-west side, and the tail of alluvium on the south or south-east? The phenomena indicate the motion of masses of water, ice, gravel, and clay, from the north or north-west, and may probably be accounted for as follows:—While the northern portions of the new and old continents were for the greater part under the sea, a broad current would set continually eastward, along the regions included in the temperate zone. The grounds which led me to form the conclusion, were stated in my work on the geology of this district. Let us next assume what Agassiz has proved, that the ice which now surrounds the pole and covers the upper regions of our great mountain chains, is but the remnant of much larger masses, which were chiefly seated in high latitudes, and were perhaps heaped up near the pole to the depth of ten thousand feet. When the change of temperature took place, which partially dissolved and broke up this mountain of ice, as it may be termed, the water, liberated by fusion, would flow off on all sides from the pole, forming currents, and bearing with them floating masses of ice. The motion of these would be southward, like that of the icebergs often seen in the Atlantic, and that great floating raft of ice which Captain Parry supposed at first to be fixed, but which he afterwards found was in motion, bearing him southward with nearly the same speed that he travelled northward on its surface.* In moving southward the currents from the pole would meet the easterly currents, be incorporated with them, and the result would be, currents compounded of the two—that is, moving *in a south-easterly direction*. And thus icebergs and floating fragments of ice, loaded at their bottoms with stones, gravel, and sand, and set loose from the polar regions, would be borne along south-eastward, producing striæ and furrows pointing in that direction; the declivities of hills facing the currents—that is, fronting the north-west, when moderately inclined (Corstorphine Hill is an example) would be doubly abraded and grooved, because there the onward pressure of the water aided the weight of the mass of ice; on the other hand, declivities fronting the south-east would scarcely feel the action of the currents, but would be the seat of eddies, where the clay, sand, gravel, and boulders, would be deposited.

Again, returning to the idea started by Mr Murchison; if the south-easterly currents were occasionally choked with ice, which was afterwards torn up and driven along, we can understand that masses of it loaded with drift might be forced out laterally, and lodged on the flanks of the currents, as exemplified in the river Neva. Mr Murchison's hypothesis explains

* The tendency of these masses would not be to move right southward, but rather south-westward, owing to the low velocity of revolution they brought with them from the higher latitudes. The motion of the combined currents however, would still be south-easterly, but a little more to the south.

how the long ridges of clay and gravel so common in Sweden and Finland, and seen also in the United States, might be formed, and the ideas now thrown out may serve to account for the north-west and south-east arrangement they generally affect. This arrangement would not be uniform, but would of course be modified by the position of mountain chains or high lands which rose above the water. In some cases the line of motion might be right southward, in others right eastward, but in the greater number of cases it would be intermediate.

If we suppose the fusion of the ice to be proceeding slowly for a thousand years, and numerous icebergs loaded with gravel and stones to be constantly detaching themselves from the polar nucleus, and pursuing their course south-easterly, we may comprehend how all the rocks at moderate depths might have their upper surfaces scratched and grooved in that direction. Some of the larger icebergs are believed to reach down 1000 feet below the surface of the water, and might scratch rocks even at that depth, while the smaller ones would operate on rocks almost close to the beach. Boulders would be transported by the same agency over great distances.

Mr Murchison's hypothesis, if adopted, does not exclude that of Agassiz. On the contrary, it may be assumed, that, while the *glacical condition* (which caused the great accumulation of ice in the northern regions) continued, every mountain chain which *then* had an elevation of two or three thousand feet above the sea, would be encrusted with ice, perhaps as far south as the latitude of 40. Each of these would be on a small, what the polar nucleus of ice was on a great scale—a " centre of dispersion." Grooving clearly referrible to glacial action, has been traced on Jura and the Vosges, and I believe also on the Scandinavian chain as well as the Alps.

Mr Lyell has shewn that in the present state of our knowledge, the distribution of erratic blocks cannot be explained, without assuming the agency of floating masses of ice in transporting some of them. We have a good example at hand in the Pentland Hills, where a block of mica-slate, which must have travelled from the Grampians, may be seen resting on the soil near the Waterfall at Habbie's How. It weighs 8 or 10 tons, and occupies a position about 1100 feet above the sea. No glacier, by the mere expansion of its mass, could carry this across 50 or 60 miles of low country, and lodge it where it lies.

Strata doubled over, and reversed.—Examples occur in the Alps of strata being doubled over, so that the newer rocks are found beneath the older. A remarkable specimen of this dislocated arrangement is described by Professor Hitchcok, as existing in the United States, and on a magnificent scale. The rocks consist of gneiss, mica-slate, talc, and clay-slate, with limestones and silurians. They extend from Canada along the east side of the Alleghanies, to Alabama, a distance of 1200 miles. He says—" Along a large part of this distance a remarkable apparent inversion of the dip exhibits itself; so that the newer rocks appear to pass beneath the older ones; and that, too, over a great width of surface. The effects of the extraordinary agency under consideration has not been simply to toss over the strata, so as to give them an inverted dip, but in general to produce a succession of folded axes, with a gentle slope and dip on the eastern side, and a high dip, or more frequently an inverted one, on their western side." He thinks that all the strata between the Hudson and Connecticut rivers, a space of 50 miles in breadth, have undergone this replication. He admits, however, that some geologists doubt the fact, and consider the inversion apparent only; but assuming its accuracy, he explains it, as Sir James Hall explained the foldings in the Lammermuir Hills, by supposing that the strata were forced to double over from being compressed edgeways. *C. Maclaren, Esq. F.R.S.E. &c.*

On the supposed Stinging Organs of Medusæ, and the occurrence of peculiar Structures in Invertebrate Animals, which seem to constitute a new class of Organs of Motion. By Professor Rudolph Wagner of Göttingen.

It is well known that it has not yet been ascertained whether the stinging or burning power of Medusæ is to be ascribed to a corrosive liquid, or to a mechanical injury. I think my investigations enable us to approach more nearly the decision of this question.

The origin of the stinging is, at all events, to be sought for in the external surface of the skin of the Medusæ. I have observed in a very beautiful and distinct manner the structure in the *Pelagia noctiluca*.* The outer skin is in that species of a beautiful brownish violet and reddish colour on the convex discoid surface, on the exterior arched edge of the arms, and on the lobes of the rim (*Randlappen*). This variegated membrane is easily separated, especially over the greater part of the convex surface of the disc, and then there appears the homogeneous jelly-like substance which constitutes the real body of the animal. Where the red spots occur, we find, after the skin is detached, round elevations or inequalities, like warts.

By the assistance of a low magnifying power the red spots appear like collections of very small red grains of pigment, n whose vicinity the whole body is covered by that kind of epithelium called a *Pflasterepithelium*, consisting of larger and smaller cells, which contain distinct nuclei. It is an epidermis analogous to that of the frogs and many other animals. The accumulations of pigment occur especially on the above-mentioned arched inequalities, which rise above the surface, and have a substratum of muscular fibres.

Between the red grains of pigment are to be observed round balls or bubbles, out of which frequently, by the aid of a powerful magnifying power (for this whole organization can only be recognised through the microscope), fine threads are seen to project. The largest of these balls present themselves as firm well-filled capsules of $\frac{1}{60}$th part of a line in size, in which lies internally a spirally rolled up thread which often comes out of itself, but always does so on the application of a slight pressure. This thread then appears as a whip-like appendage to the capsule, and has a very elegant outline. It is difficult to form an idea of its structure; sometimes it seems as if it had a canal. When the capsule is closed, while the thread is still rolled up in it, we perceive an inequality to which the

* The examination was made at Nice and Villafranca in the autumn of 1839.

thread when opened up is attached, as if to a stalk; when stretched out, the fine thread is a line long.

These hair or thread capsules are very loosely attached, and easily fall, and are rubbed off along with the slime, when the Medusa loses its skin; they are found in quantity, as are also the threads themselves, in what is termed the stinging slime of the Medusæ (which is nothing else than the cast-off epithelium), as is easily ascertained when these animals are kept in vessels. With more difficulty, there are loosened smaller, long-shaped, clear little capsules, from $\frac{1}{300}$th to $\frac{1}{400}$th of a line in size, which are partially covered with fine short little hairs, or whip-shaped appendages. If we compare the reserve teeth of crocodiles, sharks, and poisonous serpents, we cannot help considering these little capsules as reserve cells, when the larger organs are lost.

Such individual little organs also exist beyond the spots, and extend to the inner rim of the arms, and to the under surface of the disc, where they cease. At the rim of the disc there hang between every two lobes (*Randlappen*), alternating with the crystalline bodies of the edge (*Randkörpern* or *Crystalldrusen*) fine long cylindrical threads of a violet colour. These are covered with shining hairs, and present a cylindrical epithelium, which rests on the muscular fibres; these threads are covered with numerous parcels of small stinging capsules.

It is known that the slightest touch of a Medusa causes a perceptible burning sensation, and I, together with several pupils who accompanied me in my travels, experienced it in bathing. This ensues more feebly or more strongly, according to the vigour of the animal. Medusæ only sting at parts of their bodies where the epidermis is preserved. We never experienced the sensation when we came in contact with portions in which the epidermis had been removed; a circumstance which happens frequently in living animals. If we place a separated portion of a Medusa with its epidermis side on the bare skin, or if we rub off a little epidermis and apply it to the skin, a burning sensation is felt after a period of from a few seconds to a minute; after five minutes a slight redness appeared in my case, and then a simple lentil-shaped elevation, more frequently three or four, near one another. Medusæ swimming in the sea act much more strongly, and even the eruptive appearances called *Quaddeln* are produced, as in the case of the *Essera* or *Urticaria.* The pain soon ceases. It lasted half a-day with one of the party, Dr Will, and, after eight days, a redness was still perceptible.

The internal substance of the body (the so-termed jelly of the Medusæ) never stings, nor does the inner surface of the cavity of the stomach, nor the inner surface of the arms, where the pigment spots, the capsules, and the hairs, are awanting. At the parts of the skin on which I allowed myself to be stung, I always found separated capsules and hairs. It is well known that all Medusæ do not sting; and, for example, I found no power of this kind in the *Cassiopea;* and microscopic investigation proved the absence of those capsules and hairs over the whole surface of the disc. On the other hand, an *Oceania* (allied to the *cacuminata*) stings, but only with the edge threads, and in a much smaller degree than the Pelagia. An examination shewed the existence of capsules, but of a lengthened shape, with long fine threads. But these organs were much smaller and finer; they had a remarkable resemblance to the structures which I described formerly as Spermatozoa of the Actiniæ. A new investigation of the Actiniæ, as, for example, of the *Actinia cereus*, convinced me that those structures formerly described as Spermatozoa are nothing else but stinging threads of the Medusæ; they stand closely studded round the feelers or arms, and on the exterior surface. The threads project from long-shaped capsules with that remarkable movement which I have elsewhere described, and which I found again precisely as formerly. The same organs, but only in a different form, occur again in Polypi, as Ehrenberg and Dr Erdl (one of my companions) found in the Hydræ; and the latter discovered them also in Veretillum.

It is probable that the stinging has a mechanical and chemical origin; just as in the majority of what are termed poison-organs we find a liquid which collects in a little bladder or capsule, and an apparatus capable of doing injury. So it is also with many stinging plants, as the *Loaseæ*, in which fine sharp hairs convey a juice, where circulation can be so beautifully observed.

More extended researches regarding these structures, provisionally considered as stinging organs, will make known much that is remarkable in reference to their occurrence, arrangement, structure, and movement, and will display great riches in respect to phenomena of organization.*

On a Remarkable Structure observed by the Author in the Ice of Glaciers. By James D. Forbes, Esq., Sec. R.S. Ed. Professor of Natural Philosophy in the University of Edinburgh. With a Plate. (Read to the Royal Society, Edinburgh, Dec. 6. 1841.) Communicated by the Author.

The object of the present short communication is little more than to announce and describe a peculiarity which the Ice of Glaciers frequently exhibits, interesting in itself as connected with the theory of their formation and propagation, and perhaps having a bearing upon the explanation of some facts long felt by geologists to be perplexing.

Had I yielded to my own first impulse, this communication would have formed but a part of a much more extensive one, intended to give such an account, as I best might, of the present views entertained respecting the mechanism and conservation of glaciers, and the curious and interesting question of their ancient extension, and perhaps vast geological influence in producing some of the latest evidences of revolution on the surface of the globe. When I considered, however, the great extent which such a communication, to be generally intelligible, must necessarily have,—and farther, that a large share of the material must be drawn from the works and the observations of others,—when I recollected, besides, that however earnest and sustained had been my investigation of these curious points, there was still much left obscure or unproved to my own mind; in short, that the communication I should lay before the Society could not have that completeness, determination, and originality, which could properly entitle it to a permanent place in the Transactions of our Body, it seemed

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* From the *Archiv für Naturgeschichte*, 1841.

to me that the wish which had been expressed by very many of those to whose judgment I am most willing to defer, that I should make such a detailed communication, was one with which, in my official position as Secretary, and having in some degree the control of the order and distribution of business, I could not properly comply.

I do not, however, relinquish the idea of laying before the Society, and even at considerable length, the conclusions which I may ultimately form respecting the great physical and geological questions now at issue, and the facts and reasonings upon which these conclusions are founded. The Glacier Theory, whether it regards the present or past history of those mighty and resistless vehicles of transport and instruments of degradation, yields to no other physical speculation of the present day in grandeur, importance, interest, and, I had almost said, novelty. I look forward to the prospect, which I hope may be realized, of extending much farther, during another summer, my direct observations and experiments, and in the mean time I desire to prepare myself for the task, by a thoughtful review of the experience I have already had, and a close analysis of what has been already argued and written upon the subject. Should the result be successful, the Society may, a year hence, expect the communication of it. For the present I mean to confine myself to the description of a single fact, which appears generally, if not universally, to have escaped the notice of former travellers amongst the Glaciers.

On the 9th of August last (1841) I paid my first visit to the Lower Glacier of the Aar, upon or near which I spent the greater part of three weeks in company with Professor Agassiz of Neufchatel, and Mr J. M. Heath of Cambridge. It is surprising how little we see until we are taught to observe. I had crossed and re-crossed many glaciers before, and attended to their phenomena in a general way; but it was with a new sense of the importance and difficulty of the investigation of their nature and functions that I found something to remark at every step which had not struck me before; and even in the course of the walk along *our own* glacier (as we considered that of the Aar, when we had taken up our habitation upon it), we found on its vast and varied surface something each day which had totally escaped us before. It was fully three hours' good walking on the ice or moraine from the lower extremity of the glacier to the huge block of stone, under whose friendly shelter we were to encamp; and in the course of this walk (a distance of eight or nine miles, on a moderate computation, allowing for the roughness of the way) on the first day I noticed, in some parts of the ice, an appearance which I cannot more accurately describe, than by calling it a *ribboned structure*, formed by thin and delicate blue and bluish-white bands or strata, which appeared to traverse the ice in a vertical direction, or rather which, by their apposition, formed the entire mass of the ice. The direction of these bands was parallel to the length of the glacier, and, of course, being vertical, they cropped out at the surface, and wherever that surface was intersected and smoothed by superficial water-courses, their structure appeared with the beauty and sharpness of a delicately-veined chalcedony. I was surprised, on remarking it to Mr Agassiz as a thing which must be familiar to him, to find that he had not distinctly noticed it before, at least if he had, that he had considered it as a superficial phenomenon, wholly unconnected with the general structure of the ice. But we had not completed our walk before my suspicion that it was a permanent and deeply-seated structure was fully confirmed. Not only did we trace it down the walls of the crevasses by which the glacier is intersected, as far as we could distinctly see, but, coming to a great excavation in the ice, at least 20 feet deep, formed by running water, we found the vertical strata or bands perfectly well defined throughout the whole mass of ice to that depth. An attempt has been made to convey some idea of their appearance in Plate I. Where the plane of vertical section was eroded by the action of water, the harder seams of blue ice stood protuberant; whilst the intermediate ones, partaking of a whitish-green colour and granular structure, were washed out. We did not sleep that night until we had traced the structure in all directions, even far above the position of our cabin, and quite from side to side across the spacious glacier of the Finster Aar.

During the whole of our subsequent residence amongst the glaciers, the phenomena and causes of this structure occupied our thoughts very frequently. We had much difficulty in arriving at a correct description of the manner of its occurrence, and still more in forming a theory in the least plausible respecting its origin.

Its importance, however, as an indication of an unknown cause, is very great; not only because all that can illustrate what is so obscure as the manner of glacier formation and movement, is so, but because it is precisely on this very point of "What is the internal structure of the ice of a glacier?" that the question now pending respecting internal dilatation as a force producing progression, mainly hangs. Some consider ice as compact, others as granular; some as crystallized, others as fractured into angular fragments; some as horizontally stratified, others as homogeneous; some as rigid, others as plastic; some as wasting, others as growing; some as absorbing water, others as only parting with it;—and yet no one seems to have observed, or at least observed as an object of study, this pervading slaty or ribboned structure, to be found probably in one part or other of every true glacier.

With regard to *extent*, this structure was observable on the Lower Glacier of the Aar, from its lower extremity up to the region of the *firn* or *nevé*, where, the icy structure ceasing to exist, it could not be looked for; yet even there, where frequent thaws, induced by the neighbourhood of rocks or stones, produced a compacter structure, the veins became apparent. In some parts of the glacier, it appears more developed than in others: in the neighbourhood of the *moraines*, and the walls of the glacier, it was most apparent. This would seem to infer a relation to the frequency of thaws and recongelation.

It penetrates the *thickness* of the glacier to great depths. It is an integral part of its inmost structure. That it could not be the production of a single season I was speedily convinced, by observing that where old crevices fissured the glacier transversely, the veined structure not only was reproduced on either side, but frequently with a *shift* or dislocation, or series of parallel fissures, presenting sometimes a series of dislocations advancing in one direction.

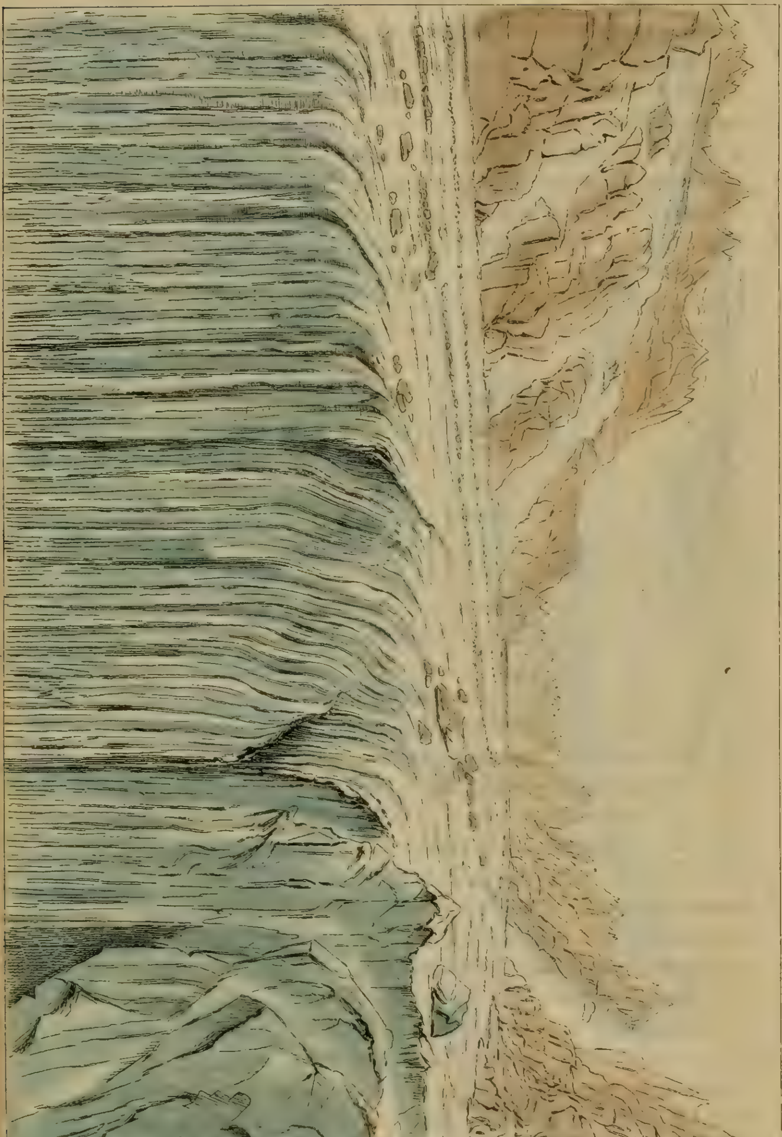
The *course* of the veined structure was, *generally speaking*, on the Glacier of the Aar, strictly parallel with its length, and that with a degree of accuracy which seems extraordinary, if we attribute its production to the remote influence of the retaining walls of the glacier, distant at least half a mile. Near the inferior extremity, where the declivity becomes rapid, the structure varies its position in a manner very difficult to trace satisfactorily. There can be little doubt, however, that the nearly horizontal bands which appear on the steep declivity of the glacier at its lower termination, are nothing else than the outcropping of these bands, which have there totally changed their direction, being *transverse* instead of longitudinal, and leaning forwards in the direction in which the glacier moves at a very considerable angle. The ice in this part of the glacier is distinctly granular, being composed of large fissured morsels, nicely wedged together; and the ribboned structure is greatly obscured. There seems no doubt, however, that the horizontal stratification in the lower part of glaciers, insisted on by several writers, is merely a deception arising from this cause, so familiar to the geologist who gets a section perpendicular to the dip of strata, which therefore appear horizontal. Towards the sides or walls of the glacier, at its lower extremity, the veins have their plane twisted round a vertical axis, having now their dip towards the centre of the glacier, and rising against the walls; and this inclination sometimes extends nearly to the axis of the glacier, or the medial moraine, where I have observed the veins deviating from the vertical by an angle of about twenty degrees, the bands inclining from the centre (or rising towards the walls), as if the pressure arising from the superior elevation of the glacier under the moraine had squeezed them out. The whole phenomenon has a good deal the air of being a structure induced *perpendicularly to the lines of greatest pressure*, though I do not assert that the statement is general. Whilst the glacier is confined between precipitous barriers with a feeble inclination, the structure is longitudinal. As the glacier, by its weight, falls over the lower part of its bed, and moulds itself into the form which the continued action of gravity on its somewhat plastic structure impresses, the longitudinal structure is first annihilated (for throughout a certain space we could detect no indications of one kind or other), and the bands then reappear in a transverse direction, as if generated by the downward and forward pressure, which, at the lowest part of the glacier, replaces the tight wedging which higher up it received laterally. It is not easy to convey without a model a clear idea of the forms of surface here intended, and which yet require considerable correction.

I may mention, however, that the glacier of the Rhone, which I have carefully examined, presents a structure in conformity with the view thus developed. It will be recollected by all who have seen that magnificent mass, that it pours in colossal fragments over the rocky barrier which separates the Gallenstock from the valley of the Rhone, and having reached the last-named valley, it spreads itself across and along it pretty freely—much as a pailful of thickish mortar would do in like circumstances. The form into which it spreads is rudely represented in the annexed figure. In this particular case, even the strongest partisans of the dilatation theory will hardly deny, that the accumulated ice descending from the glacier cataract A would form a centre of pressure at C, and that the lines of equal pressure would be found in the direction of the dotted lines, following nearly the periphery of the glacier. Now these dotted lines precisely trace out the course of the veined structure alluded to; and, moreover, they bend more and more forwards as we proceed from

the centre of pressure C, especially in the direction of D, the line of greatest inclination of the bed, and down which gravity urges the icy mass. The front of the glacier, about E D F, presents the fallacious appearance of horizontal strata, as in the Aar Glacier; but these are found to dip inward at an angle of 10° or 15°, which angle continually increases as we approach the heart of the glacier, rising to 40°, 50°, 60°, and even 70°, as we approach C. It cannot be doubted, that these facts are so far favourable to the view which we have taken, although the establishment of it would require far more extensive observation; and in several glaciers which I have visited, the observation of the convolutions of the veined structure is very difficult and obscure. Before quitting the subject, I must add an observation which I made on the Glacier of the Rhone, and which I am pretty confident is well founded. *The lines of fissure, or crevasses, are always perpendicular to the conical surfaces of the veined structure.* These fissures are denoted in the figure by the full lines *a a a*. Perhaps the primary cause of these fissures is, that the pressure of the ice at C forces the glacier to distend itself into continually widening rings, which its rigidity resists, and therefore it becomes traversed by radial crevasses.

The veined structure itself, I have already said, arises from the alternation of more or less compact bands of ice. The breadth of these varies from a small fraction of an inch to several inches. The more porous of these bands are the likeliest vehicles for the transmission of water from the higher to the lower part of a glacier; and that opinion receives some confirmation from the fact, that, at a certain depth, in crevasses, we may see the veined structure marked out and exaggerated by the frozen stalagmite which is protruded from the section of the more porous layers.

In conclusion (for the present), this structure deserves the attention of geologists generally, as shewing how the appearance of the most delicate stratification, and of sedimentary deposition, may be produced in homogeneous masses, where nothing of the kind has occurred. For a short time, indeed, I was of opinion that this structure resulted from true stratification; but a closer examination of the mass convinced me that, inexplicable as the fact remains, it must be accounted for in some other way. We have endeavoured to shew an empirical connection which appears to exist between the structural planes and the sustaining walls of the glacier, and likewise that the recurrence of congelation and thaw appears to strengthen the formation of the bands. But this cannot be considered as in any degree amounting to an explanation. The analogous difficulty of slaty cleavage in rocks, presents itself as not improbably connected with a similar unknown cause, whose action pervaded the mass of the crystallizing



rock undergoing metamorphic change, as this pervades the mass of the crystallizing glacier. In the former case, we have cleavage planes perfectly parallel, almost indefinitely extending with unaltered features over vast surfaces of the most rugged country, changing neither direction, dip, nor interval, with hill or valley, cliff or scar, and passing alike through strata whose planes of stratification, horizontal, elevated, undulating, or contorted, offer no obstacle or modification to the omnipotent energy which has rearranged every particle in the mass *subsequent* to deposition. The supposition of Professor Sedgwick, who has minutely described and considered this geological puzzle, that "crystalline or polar forces acted on the whole mass simultaneously in given directions, and with adequate power,"* can hardly be considered as a solution of the difficulty, until it is shewn that the forces in question have so acted, and can so act. The experiment is one which the boldest philosopher would be puzzled to repeat in his laboratory; it probably requires acres for its scope, and years for its accomplishment. May it not be that Nature is performing in her icy domain a repetition of the same mysterious process, and that in another view from the one which has recently been taken, the Theory of Glaciers may lead to the true solution of geological problems?

Experiments on the Production and Transmission of Sound in Water, made in the Lake of Geneva. By M. Daniel Colladon. In a Letter to M. Arago.†

Sir,—I beg of you to have the goodness to communicate to the Academy of Sciences the results of some experiments which I have made in the Lake of Geneva.

When I made my first experiments on the velocity with which sounds are propagated under water, at the close of the year 1826, you engaged me to try whether a sound reverberated by the bottom of a lake or of the sea could be heard, in order to measure the depth of the water by the interval that elapsed between the primitive and reverberated sound.

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* Geological Transactions, Second Series, iii. 477.

† Bibliothèque Universelle de Genève, No. 68, p. 364.

This experiment was tried in 1838 on the coast of the United States of America, by order of the Admiralty, by Mr C. Bonnycastl , a professor in the University of Virginia. A notice of these experiments appeared in the 316th Number of the Journal of the Institute, p. 25.*

Mr Bonnycastle's Memoir contains an assertion which appears to me to be opposed to the results I obtained in 1826, the details of which are inserted in the *Annales de Physique* for 1827, and in the 5th volume of the Memoirs of the Institute. The American professor has concluded, from his experiments, that sound is better heard in air than in water, and he indicates the distance of from 8000 to 10,000 feet as the limit beyond which the sound of a bell under water could not be heard. The instrument which Mr Bonnycastle employed was evidently very defective, for, in my experiments in the month of November 1826, using a bell weighing 65 kilogrammes, I could transmit the sound, notwithstanding the noise of pretty considerable waves, to the distance of 13.500 metres.

When we listen close at hand, in the water and in the air, to the sound of a stroke on a sonorous body partially plunged in water, using a hydro-acoustic apparatus similar to that described and figured in the 6th volume of the *Savants étrangers*, we distinctly hear two sounds; the first, conveyed by the water, is shortest, and appears less intense than the second, transmitted by the air; but in proportion as we recede, the relation of the two intensities varies, and at a sufficient distance the noise heard in the water is much more intense than that perceived in the air; and by still further increasing the distance, we continue to hear distinctly the sound in the water, even when it is impossible to hear any sound transmitted by the air, and that in perfectly calm weather and during the silence of the night.

When we strike, with equal force, a bell, alternately placed under water and out of it, we obtain results in every respect like the preceding.

In the air, it is difficult to increase to any great extent the intensity of the collected sounds; the instrument I have de-

* See *Bibl. Univ.* August 1839 (vol. xxii.), p. 360.

scribed has the power of increasing those transmitted by water to an unknown extent, and which my recent experiments have proved to be much beyond what I had previously ascertained. I possess an apparatus, the amplifying power of which is more than double that of the instrument I formerly used, and I am certain that I can still further augment it.

I have had an instrument constructed for me with a horological movement, and a bell of somewhat less than a kilogramme in weight; a hammer moved by the watch strikes the bell by the action of a spring in a continual state of tension. I have likewise made use of a small musical box, which plays under water, whether it be sunk without a covering, or enclosed in a small diving-bell. It is with these two instruments that I have obtained the results I am about to announce. Among other facts, I have ascertained that shrill sounds can be more easily heard under water at great distances than such as are of a deep tone.

Vessels formed of very thin metallic plates, the latter closed at the bottom, form undoubtedly the most suitable hydro-acoustic apparatus; but all kinds of solid bodies, partly sunk in water, and to which the head is applied for the purpose of hearing, may transmit to the ear sounds propagated under water.

When a sonorous body is put into a state of vibration under water, its vibrations, far from being speedily extinguished, may continue for a pretty long period, even although the density of the sonorous body and that of the water be nearly the same. Thus, by striking a small crystal bell of 18 centimeters at the opening, so as to make it vibrate under the water, we can satisfy ourselves, after the lapse of a second, that the vibrations still continue, although no sound be heard, for if we then withdraw the bell from the water, a very distinct sound is perceptible. A large metallic bell entirely submerged produces, when struck, a sound which continues for many seconds; by placing a bar in the water at a little distance from the bell, and at the same time holding it in the hand, we feel a very violent vibratory movement which is transmitted by the water to the bar.

The intonations of the voice may be transmitted to some distance under water; but if the person speaking is placed in a diving-bell, only confused sounds are heard, without the articulations being distinguishable at the distance of a few metres.

The shock of a waterfall, or the action of the paddles of a steam-boat of a hundred horse-power and upwards, produces only a faint and confused sound under water, a kind of slight humming, at the distance of 50 metres. The wheels of a steam-boat produce, under water, a sound analogous to the humming of a bee; and at the distance of 1000 metres no distinct sound whatever is heard. I am therefore inclined to think that it is a mistake to allege, as has been so often done, that the noise of steam-boats has the tendency to drive fishes from the rivers.

Although the sounds transmitted by water, and made sensible by means of my apparatus, are of much shorter duration than those transmitted by the air; yet we determine with the greatest facility, not only the degree of acuteness and the musical value of the sound, but also the tone of the body struck; very frequently we can guess at its nature, and, to a certain point, its dimensions and the manner in which it has been struck. The noise of a chain moved under the water is so distinctly perceptible, that it may be known when a vessel, 3000 or 4000 metres distant, raises her anchor. In maritime warfare this observation may prove of some importance.

I have pointed out, in the memoir quoted, the influence of screens in diminishing the intensity of transmitted sound. This influence is not absolute; if the vibrations are energetic, the sound is transmitted with a certain intensity beyond the solid obstacles it encounters. In an experiment made with a large bell, each stroke was reckoned in a house built at the edge of the water on an embankment, at a distance of about 3000 metres from the bell, although the latter was separated from the house by a promontory: the sound seemed to issue from the foundation of the pillars of the walls. A bell weighing 500 kilogrammes, belonging to one of the churches of the Canton of Geneva, was placed at my disposal for a few days. It was suspended to an apparatus placed on a vessel, by means of which it was easy to sink it in the water and draw it up again. It was sunk to the depth of three metres, in a place where the water was about fifteen metres deep; to strike it a hammer of the weight of ten kilogrammes was used, fixed to a long iron handle, the upper part of which being above the water, was bent at a right angle; the summit of this angle was crossed by an axle-tree, to which the stalk of the hammer was suspended. This hammer, in all my experiments, was worked by one man, who could make a stroke every two seconds.

I hoped to make, by means of this bell, a new series of experiments on the velocity of sound in the water of the lake, the mean temperature of which, measured between the two stations, was found to be 17° C., while by the observations made with much exactness in the month of November 1826, this temperature was 8°.1 C. The ease with which we had heard strokes on this bell at the distance 35,000 metres, determined me to choose this distance for the two stations. Mr Muller, an astronomer connected with the observatory of Geneva, and Professor of Natural Philosophy at Nyon, assisted me in this experiment, and heard the sounds along with me, by means of a second apparatus. Unfortunately, during the only two days given us for the execution of our purpose, the clearness of the weather and the moonlight prevented us distinguishing the lights produced by the burning of a pound of powder at each stroke, at the moment of the shock.

This trial, made on the evening of the 5th August, between Promenthoux and Grandvaux, near Cully, has, however, demonstrated to me the correctness of the views stated in my first memoir, respecting the utility that may result from this economical means of corresponding under the waters of the sea, at such distances that all other means of communication, by signal lights or sounds, conveyed by the air, cannot be made available.

It now appears to me demonstrated that, in certain favourable localities, we may correspond under the sea, by means of very vigorous strokes and well combined acoustic apparatus, at a distance of some hundred thousand metres.

It is very probable that, in seas of nearly uniform depth, the intensity of sound, far from diminishing in proportion to the square of the distance, only diminishes in proportion to the simple distance, or nearly so. I have already mentioned this property of the waves of sound, that when they are transmitted in water and meet the surface under a very acute angle, they become entirely reflected into the fluid mass. A great extent of water, varying little in depth, represents a liquid plate, whose two surfaces, the upper and the lower, concentrate and throw back into the interior of the fluid almost the whole of the vibrations which happen to meet these surfaces under very acute angles.

It may be perceived that, in the bottom of gulfs, the vibrations, moved by the tide and concentrated on certain points, may produce a very intense sound. It is easy, moreover, to conceive a multitude of arrangements and artificial constructions which would facilitate these telegraphic experiments, from which nautical men will derive advantage sooner or later. The agitation of the waves very little disturbs the nearly absolute silence which reigns under the waters of the sea, and does not impede the transmission of sound; this silence should likewise favour the communications which may be attempted to be established under water.*

At the distance of 35,000 metres (about nine leagues by land) each stroke given to the bell was distinctly heard with the two apparatus with which we were provided. One of these instruments was the same that I employed in my experiments in 1826; the sound by it seemed distinctly defined and short. With the other instrument, improved, the sound was a little more prolonged; we were conscious of the tingling of the bell, and could pretty well distinguish its tone.

Neither Mr Muller nor myself could hear any echo, although the configuration of the lake led us to suppose that we would hear many. But Mr Veret, an old pupil of the central school, who during these experiments was moving about in a boat with an apparatus for hearing perpendicularly at the shore some thousand metres from the vessel in which the bell was placed, heard two distinct echoes in certain stations. For the most part, when placed in a similar situation, one heard only

* The sound of waves does not prevent us distinguishing strokes on a bell, provided the construction of the instrument be such that the water glides upon its surface without directly dashing against it. It is for this reason that the form adopted by Mr Bonnycastle, in his experiments in 1838, appears to me disadvantageous.

a kind of ringing sound, produced by the successive repercussions of the sonorous waves by the banks.

My experiments on the possibility of hearing an echo reflected by the bottom, are not yet sufficiently numerous to enable me to decide on the efficacy of this means of measuring the depth of water.

New Views regarding the Distribution of Fossils in Formations. By Professor Agassiz. *With Observations*, by Professor Bronn.

I doubt much if any one possesses such ample materials as I do, for judging of the limits of the species of Trigonia described in my Monograph. I have employed these with scientific care, without regard to prevalent opinions, and have expressed candidly the result to which they have led me, viz. that no species occurs in two geological formations—nay, not even in two different parts of one formation; and I have the more confidence in this conclusion, because I have invariably found it confirmed by fossil fishes and echinodermata. The question as to the extension of the boundaries of a species does not come into consideration here; for the differences ascertained to exist between specimens from two localities—it matters not whether they belong to one or to two different formations—remain for ever the same, whether they can be perceived easily or with difficulty, and whether the individuals be thrown together under the same label, or kept distinct. In order to express my conviction as to species, I state the following to be my opinion: *That no so-termed character—that is, no observable mark—can be so striking as to indicate an absolute specific distinction; but, at the same time, it should never be regarded as so trifling as to point to absolute identity; that characters do not mark off species, but that the combined relations to the external world in all circumstances of life do.* Thus, I believe I am able to shew that many organic beings are specifically distinct,—or, at least, that they stand in no genealogical relations to one another,—although the individuals are so like as to be confounded. On the other hand, it is known that the male and female of a species have been made types of different genera ; a circumstance which has also occurred in regard to differences of age. These, therefore, cannot be recognised by resemblances, but by their whole relations. I do not doubt that, at a future time, *it will become necessary to express the specific difference of organic remains by the circumstances of their occurrence, without it being possible to assign distinctions to them.* Instead, then, of being involved in boundless uncertainty, our science will emerge from its dry foundation to a state of rich development.

In reference to the above letter, Professor Bronn of Heidelberg remarks : " It is hardly necessary to say, that my views do not agree with those expressed by Professor Agassiz on Trigoniæ; for the latter are in opposition to the principles followed in my Lethäa Geognostica, although I am far from wishing to assert that the forms which I have in other places united under any one species, according to the materials I possessed at the time, have been in all cases confirmed as varieties of one species, by the assistance of richer materials and direct autopsy. I am, however, convinced, that there are species which pass from one subdivision of a formation into another, and even from one formation into another ; and, instead of fettering myself by the preliminary assertion that no species occurs in two formations (as Agassiz does in the Mem. de Neuchât. ii. 17) ; or, instead of assuming that there are species which cannot be distinguished by any external characters, but only by their exterior relations (that is, in the case before us, little else but their geognostical and geological relations), I unite under one species all forms which can be proved to derive their origin from one and the same kind of ancestors (as in zoology and botany generally), or which do not differ from these more than they do among themselves ; and I am of opinion that, at the same time, many distinctions adhering to individuals are merely the result of the influence of the relations of the external world."*

* From the *Neues Jahrbuch für Mineralogie, Geognosie,* &c.

*Letter to M. Fischer de Waldheim, Ex-President of the Society of Naturalists of Moscow, from R. I. Murchison, Esq., containing some of the results of his Second Geological Survey of Russia**.

Moscow, Oct. 8. 1841.

My dear Sir,—As you have taken a lively interest in the success of the geological expedition which I have just completed, accompanied by my friends M. de Verneuil, Count de Keyserling, and Lieutenant Koksharoff, I hasten to communicate to you some of its chief results; and I do so with real pleasure, because in requesting you to present them to the Society of Naturalists of Moscow, I acquit myself of a duty towards a distinguished body which has done me the honour of placing my name in the list of its foreign members.

The wide extension in the North of Russia of the Silurian, Devonian, and Carboniferous Systems, as proceeding from the last year's survey, by the same observers and our friend the Baron A. de Meyendorf, is already known to you from the abstracts of memoirs communicated to the Geological Societies of London and Paris. Our principal objects this year were,—1*st*, To study the order of superposition, the relations and geographical distribution of the other and superior sedimentary rocks in the central and southern parts of the empire. 2*d*, To examine the Ural Mountains, and to observe the manner in which that chain rises from beneath the horizontal formations of Russia. 3*d*, To explore the carboniferous region of the Donetz, and the adjacent rocks on the Sea of Azof.

Our last year's survey had pretty nearly determined the limits of the great tract of carboniferous limestone of the North of Russia. On this occasion we have added to its upper part that remarkable mass of rock which forms the peninsula of the Volga near Samara, and which, clearly exposed in lofty, vertical cliffs, and charged with myriads of the curious fossils *Fusilina*, constitutes one of the striking features of Russian geology.

The carboniferous system is surmounted, to the east of the Volga, by a vast series of beds of marls, schists, limestones, sandstones, and conglomerates, to which I propose to give the name of "Permian System," because, although this series represents as a whole the lower new red sandstone *(Rothe todte liegende)* and the magnesian limestone or *Zechstein*, yet it cannot be classed exactly (whether by the succession of the strata or their contents) with either of the German or British subdivisions of this age. Moreover the British lithological term of lower new red sandstone†, is as inapplicable to the great masses of marls, white and yellow limestones, and gray copper grits, as the name of old *red* sandstone was found to be in reference to the schistose black rocks of Devonshire.

* We are indebted to Mr Murchison for a copy of his Letter.

† See Silurian System, p. 51.

To this "Permian system" we refer the chief deposits of gypsum of Arzamas, of Kazan, and of the rivers Piana, Kama, and Oufa, and of the environs of Orenbourg; we also place in it the saline sources of Solikamsk and Sergiefsk, and the rock salt of Iletsk and other localities in the government of Orenbourg, as well as all the copper mines and the large accumulations of plants and petrified wood, of which you have given a list in the "Bulletin" of your Society (anno 1840). Of the fossils of this system, some undescribed species of *Producti* might seem to connect the Permain with the carboniferous æra; and other shells, together with fishes and saurians, link it on more closely to the period of the Zechstein, whilst its peculiar plants appear to constitute a Flora of a type intermediate between the epochs of the new red-sandstone or "trias" and the coal-measures. Hence it is that I have ventured to consider this series as orthy of being regarded as a "System."

The overlying red deposits which occupy a great basin in the governments of Vologda and Nijni Novogorod, have not as yet been found to contain any organic remains except minute *Cyprides* and badly preserved *Modiolæ*; but when we take into consideration their thickness, geological position, and mineral characters, we are disposed to think that they may at some future day be identified with a portion of the "Trias" of German geologists. I am strengthened in this opinion by Count Keyserling's discovering, during our tour at Monte Bogdo, certain fossils which are unknown in other parts of Russia, but which are associated with the *Ammonites Bogdoanus* already described by Von Buch, and which that distinguished geologist refers to the type of the muschelkalk.

True lias does not exist in Russia, as Von Buch had decided from an examination of fossils sent to him; but the Jurassic or oolitic series is divisible into two stages. The lowest of these, which is much more developed than the upper, never occupies any considerable tract of country, being either distributed in patches, or hidden by newer accumulations. From the eastern flanks of the Ural chain in the 64° of N. latitude to the Caspian Sea, it preserves nearly the same mineral and fossil characters. This formation represents the inferior and middle oolite. The ferruginous sands, calcareous grits, and black schists of the Moskwa are of this age; and also those beds which were examined last year on the Volja between Kostroma and Kinshma, at Makarief upon the Unja, as well as those shales and sands which we have seen this year in many other localities, particularly between Arzamas and Simbirsk, between Syzran and Saràtof, at Saragula, and on the river Ilek near Orenbourg.

The upper oolite group occurs in several situations along the Donetz, where it was first recognised by Major Blöde. It is calcareous, often oolitic, of light yellow colour, and contains many *Trigoniæ*, *Nerineæ*, &c., which enable us to compare it with the upper Jura of the Germans, or Portland and Coral rag division of my own country.

The cretaceous system, though composed of very different beds of marls, white chalk, sands and grits (sometimes green), offers for the most part the fossils of the white chalk of Europe, such as the *Inocerami* (Catillus), *Belemnites mucronatus, Ostræa vesicularis, Terebratula carnea.**

Above the cretaceous system, we have not been able to discover in any part of Russia, except in the Crimæa, the "nummulite limestone" which there sets on, and acquires, a great importance in its range through Georgia, Egypt, and the Mediterranean basin.

The equivalents of the lower tertiary formations (Eocene of Lyell) seem to exist in one part only of your country (S. of Saràtof). On the other hand, the middle and upper tertiaries (Miocene and Pleiocene) cover large surfaces on the Lower Volga, in Podolia, Volhynia, and also along the shores of the Sea of Azof and the Black Sea, where the youngest of these strata, very much resembling the "upper crag" of Norfolk, are beautifully displayed.

I have not time to enter upon the numerous and interesting phenomena of the Ural Mountains, the examination of which occupied us nearly three months. We there studied alternately the wonders of the gold alluvia, the sites of the entombment of your great mammalia, and sought for the causes of the astonishing metamorphism of the sedimentary rocks of that chain. For an explanation of the last class of phenomena, the works of Humboldt and Gustaf Rose must always be consulted. I will on this occasion simply say, that far from being *primitive,* as was supposed, this chain, with the exception of its eruptive masses, is entirely composed of *Silurian, Devonian* and *Carboniferous* rocks, more or less altered and crystallized, but in which nevertheless we have been able to recognise in a great number of localities my own *Pentamerus Knightii*†, and many fossils which clearly define the age of the other strata. These rocks, though much broken up, are arranged in parallel bands, the mean direction of which in the North Ural is from N. and by W. to S. and by E., whilst in the South Ural, trending N. and S., they assume a fan-shaped arrangement, spreading out towards the southern steppe of the Kirghis, where, interlaced with porphyries and other trap-rocks, they are often converted into the far-famed jaspers of this region.

Still less can I now pretend to treat of the great carboniferous region of the Donetz; for without entering into details concerning this southern tract, so valuable to the future interests of Russia, I cannot render it the justice which it merits. Still I may say to you as a geologist, that its numerous beds of coal (bituminous and anthracitic), with its grits and shales, are completely subordinate to the mountain limestone series, and represent in no sense the coal-fields of Great Britain, Belgium, and France.

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* After this letter was written, we found in the collection of Professor Eichwald, at St Petersburgh, a fine specimen of Exogyra and other fossils in a green sandstone from the Lower Volga, sent to him from a locality well known to us, which leaves little doubt of the existence also of a true representative of our greensand.—R. I. M.

† Silurian System, p. 615.

In concluding, however, I must tell you of a very interesting discovery we made in returning from Taganrog to Petersburgh. Count Keyserling took the line of Voroneje and the Don, and M. de Verneuil and myself that of Koursk, Orel, and the river Oka, and on meeting at Moscow our results completely agreed.* It was, as you know, generally believed up to this moment, that central Russia presented a regular succession from older to younger deposits as you proceeded from north to south. This is not the case. A great axis of Devonian rocks or old red sandstone, having a width of at least 120 miles, rises in the heart of the country around Voroneje and Orel, and stretches to the W.NW., in which direction it probably connects itself with deposits of the same age in Lithuania and in Courland. This discovery seems, indeed, to have an intimate relation to one which we made in entering Russia early in the spring, near to Schavli in Lithuania, of much red ground and a band of upper Silurian rocks. In fact it also explains the cause of the great difference which exists between the deposits of the carboniferous basin of the Donetz and those of your Moscow region, now proved to constitute a vast *basin.* For as the two seas, in which these deposits were accumulated from high antiquity, were separated by the ancient lands in question, so must we infer that the conditions and nature of their shores, their rivers, their currents and bottoms (on which of course the nature of marine deposits depend), must have been essentially different.

This discovery also proves the symmetry of the opposite edges of the *Moscow basin;* since in advancing from the governments of Tula and Kaluga on the south, we see the same ascending order as that which we before described in the Waldai Hills on the north. In both tracts the Devonian or old red rocks, with *Holoptychius nobilissimus,* and many fishes and shells of that system well known in the British Isles,† pass under the lowest stata of the carboniferous era, and serve as a base line to those thin beds of poor coal, associated with *Unio sulcatus* and *Productus gigas* (*hemisphericus,* Sow.) which are at present the subject of new researches on the part of the Russian Government.

The enormous space we traversed and examined, in all between 13 and 14 thousand miles, might well astonish you, if I did not assure you, that the arrangements for this journey, undertaken under the auspices of the Minister of Finance, Count de Cancrine, were admirably prepared by General Tcheffkine, whose clear directions, united to that spirit of hospitality which characterizes all Russians, and above all the inhabitants of the Ural and Siberia, rendered every enterprise feasible, and enabled us to overcome every obstacle.

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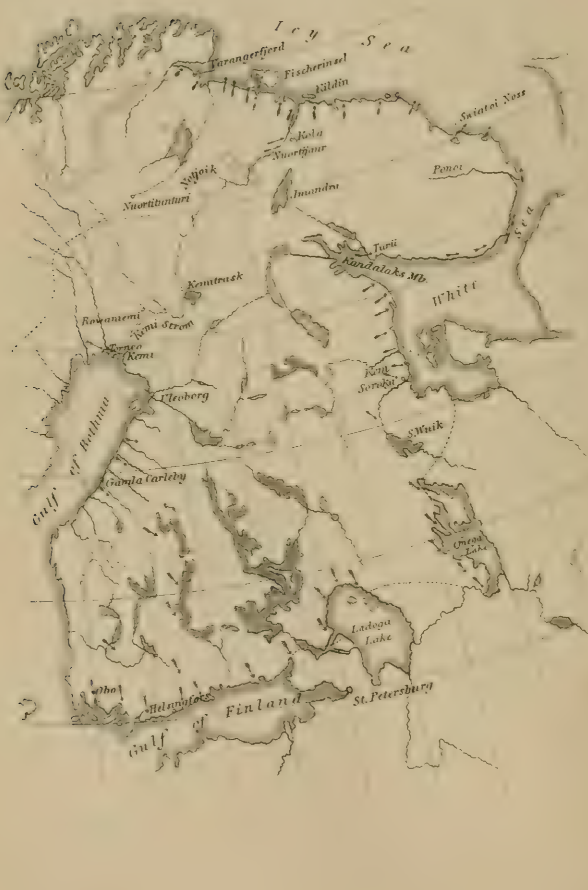
* Colonel Helmersen, so distinguished for his geographical and geological researches in Russia, and who aided us so much in both our surveys, also examined the tract near Orel in the course of the summer, and had come to the same conclusions as our party. I was, however, unacquainted with his opinion when I wrote this letter.—R. I. M.

† See Silurian System, p. 599.

BÖHTLINGK'S OBSERVATIONS ON THE FURROWS ON THE ROCKS OF FINLAND AND RUSSIAN LAPLAND.



J.G. Mitchell, Sc.

I shall communicate to you at a later date, and before our large memoir is prepared, the general table of the order of superposition of all the formations of Russia, with sections.*

Accept, dear Sir, the assurance of the affection and esteem of your devoted servant,

RODERICK IMPEY MURCHISON,
President of the Geological Society of London.

To His Excellency M. Fischer de Waldheim.

On the Scratches and Furrows observed on the Rocks of Finland. With a Map.

IN the *Bulletin Scientifique* of the Petersburg Academy (vol. vii. pp. 107 and 191), Mr Wilhelm Böhtlingk gives a preliminary report of the journey through Finland undertaken by him in the summer of 1839, which, among other interesting information, contains results that go to confirm and extend the observations made by Sefström† on the furrows or scratches on the rocks of Sweden. Everywhere during his journey from Petersburg along the Gulf of Finland to Helsingfors, across the country to Gamla Carleby, along the Gulf of Bothnia to Tornea, up the river Kemi, over the low and marshy water shed at Niortitunturi, to Kola, along the coasts of Lapland washed by the Icy and White Seas, on the east side of the lakes of Onega and Ladoga, therefore as far as the primitive rocks extend, Mr Böhtlingk found the projecting rocky eminences more or less polished, and exhibiting furrows or scratches, frequently with great distinctness, just as was observed by Sefström in Southern and Middle Sweden. In regard, however, to the direction of these scratches, Mr B. found that the facts by no means accorded with the view given by Sefström, viz. that a flood proceeding from north to south over the whole eastern half of the earth was the cause

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* These documents, which were laid before His Imperial Highness in MS., are now in the hands of the engraver.

† See Edin. New Philosophical Journal, vol. xxiii. p. 69, and vol. xxix. p. 165; and Poggendorf's *Annalen*, vol. xliii. p. 533.

of the phenomena. For although the scratches over a large portion of the country visited by Mr Böhtlingk, viz. at the lakes Onega and Ladoga, in Southern Finland, and on the Gulf of Bothnia between Gamla Carleby and Tornea, exhibited a *north-western* direction, and presented to the *north-west* the polished side of the rocky eminences; yet quite the opposite phenomenon was met with on the coasts of the White Sea and the Icy Sea, for there the scratches ran from *south-west* or *west*, and the eminences were rounded and polished towards those directions. This feature occurs on the coast of the Icy Sea, from the Varangerfjord to the Sacred Promontory (*Swiatoi noss*), where not only the cliffs rising up from the sea, but also the rocks elevated to a height of a thousand feet, exhibit the action of diluvial floods with a distinctness not to be mistaken, and where also behind narrow ravines and promontories there are a large number of *Riesentöpfe*,* often of very considerable extent. One of the latter, at the entrance of the bay of Kola, is four yards in diameter, and two fathoms in depth.

The map (Plate II.) gives, by means of arrows, a general idea of the diversity of directions of the scratches, and also shews by a dotted line the eastern boundary of the primitive rocks. From this distribution of the scratches, proceeding as it were from a centre, combined with other proofs, Mr Böhtlingk draws the conclusion that these form part of one and the same phenomenon with the elevation of the Scandinavian primitive rocks.

He controverts the opinion of the French geologist M. Robert, that the projections of the folia of the slates had been regarded as scratches of this kind, and he does so on the following grounds:—1. The direction of the scratches stands in no relation to the direction of the slaty structure. In Southern Finland the strata and plates of mica of the gneiss have an average E.NE. direction; while the scratches have a N.NW. strike, therefore about right angles to the other. 2.

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* For an account of the Riesentöpfe, see the article in this Journal already quoted, vol. xxiii. p. 72, and *Poggendorf's Annalen*, vol. xxxviii. p. 617.

The scratches present themselves on slaty rocks just as they do on massive rocks, and generally proceed uninterruptedly from one rock to the other, undergoing a change only owing to a difference of hardness; that is to say, they are deeper on a softer rock, like hornblende slate, than on a harder rock like granite, gneiss, &c. 3. There is always one side of the rocks specially polished, that being the *north-west* in Southern Finland, and the *south-west* on the Icy Sea, as was remarked forty years previously by Lasteyrie.* 4. Weathering is the greatest enemy of the scratches; for, where the rocks were protected from the weather, the polishing and scratching are the most distinct. 5. The scratches exhibit frequently a deviation from their normal direction where the rocks have a strong lateral inclination, and this deviation takes place, as was previously remarked by Sefström, in the direction of the inclination.

Mr Böhtlingk had also many opportunities of observing those remarkable raised beaches or dikes of rolled stones (masses of pebbles and rolled stones arranged in horizontal terraces), which afford such undoubted proofs of a previously different relative level of the water. He found them as well on the coasts (on the Gulf of Bothnia and the Icy Sea) as inland, surrounding isolated rocky hills (as, for example, the terraces extending to the summit of the Kallikangas near Tornea, which is 174 feet in height; also at Wammavaara, Ounasavaara, on the mountains near Kemitrask, &c.) † It is evident that these banks stand in intimate connection with those narrow long sand ridges (Asern), which are as frequent in Finland as in Sweden, and like the morasses and long lakes

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* Von Leonhard's *Lehrbuch der Geognosie*, 1835, p. 299.

† Similar stone dikes are known to exist on the coast of Norway, as was previously observed by L. v. Buch, and more lately by Bravais. The latter distinguishes two such previous lines of level, of which the upper has a height of 67.4 metres in the *Kaafjord*, which gradually sinks to 42.6 metres at the mouth of the *Jernelv*, and then falls still more rapidly till it reaches *Hammerfert*, where the height amounts to only 28.6 metres. The lower one has similar phases, and is inclined about thirty-five minutes; at *Bosekop*, in the *Altenfjord*, it has a height of 27.7 metres, and sinks at Hammerfert to 14.1 metres. Here, then, we have lines which are neither horizontal nor parallel. See Comptes Rendus, vol. x. p. 691, and Edin. New Phil. Journal, vol. xxix. p. 164.

with which the country abounds, have invariably the direction of the scratches, for example, from N.NW. to S.SE. in Southern Finland. Mr B. remarks, that the peculiar relations of the lakes, morasses, and ridges, will seem the more surprising when we examine the new geographical map of Schubert, which will convey the most striking picture that we yet possess in regard to this district of the direction and the action of the diluvial floods.*

Notices of Earthquake-Shocks felt in Great Britain, and especially in Scotland, with inferences suggested by these notices as to the causes of the Shocks. By David Milne, Esq. F. R. S. E., M. W. S., F. G. S., &c. Communicated by the Author.

(Continued from page 309 of Volume xxxi.)

Chap. II. *Account of Shocks felt at Comrie (Perthshire) since September* 1839, *with Explanations, shewing the nature and effects of the most remarkable of these Shocks, and the extent of country affected by them.*

In the foregoing part of this Memoir, a chronological account has been given of British Earthquakes, from the earliest authentic dates, down to October 1839. In the present chapter will be described those which have occurred, especially in Scotland, since that time. The shocks then became so frequent, and some of them were so violent, that they began to attract more attention and closer observation than had been previously given to the phenomena, at least in this country :—and hence, the nature of the motion and of the sound accompanying the shocks, as well as the occurrence of the shocks themselves, came to be narrowly watched, and pretty exactly ascertained. The author having interested himself in the subject, he had the good fortune to find at Comrie, where the shocks were always most felt, an individual well qualified in every way to observe and register the phenomena. Mr Macfarlane, post-master in that town, to a fondness for scientific

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* From Poggendorff's *Annalen*, 1841, No. 4.

pursuits, added the advantages of a good education, and of considerable natural talents; and being obliged, from his office, to be almost constantly at home, there was no risk that shocks would occur which Mr Macfarlane would not perceive and register. He had begun, even before the author's acquaintance with him, to jot down the shocks as they occurred, as well as to turn his attention towards the invention of instruments for marking them, and in which he displayed much mechanical skill. Having prevailed upon Mr Macfarlane to keep a regular register, the author is now enabled to give a table of all the shocks which have occurred at Comrie during the last two years.

Table of Earthquake Phenomena perceived at Comrie.

Column No. 1. indicates the day of the month.
... ... No. 2. ... the number of shocks in one day.
... ... No. 3. ... the hour of the three strongest shocks.
... ... No. 4. ... the estimated relative intensity of the three strongest shocks, reckoning from 1 to 10, which last number marks the severest shock of 23d October 1840.

A indicates *Ante*, P *Post Meridian.*

1.	2.	3.	4.	3.	4.	3.	4.
1839.							
Oct. 3.	1	$3\frac{1}{2}$ P.	2				
— 7.	5	3 P.		4 P.		$5\frac{1}{2}$ P.	2
— 9.		$2\frac{1}{4}$ A.					
— 10.	1	$4\frac{1}{4}$ A.	5				
— 11.	1	10 P.	1				
— 12.	10	1 P.	6	3 P.	7	4 P.	6
— 13.	3	9 A.	3	11 A.	2	$11\frac{1}{2}$ A.	3
— 14.	4					$2\frac{3}{4}$ P.	6
— 15.	1	3 P.	2				
— 16.	3	$2\frac{1}{2}$ A.	6		2	$5\frac{3}{4}$ P.	5
— 17.	4		1		1		1
— 18.	3		1		1		1
19 to 22.	6		1		1		1
— 23.	3	$10\frac{1}{2}$ P.	10	11 P.	6	12 N.	4
— 24.	12		1		2		1
— 25.	2		1		1		
— 26.	3	7 P.	4		1	$11\frac{1}{2}$ P.	2
— 27.	2		1		1		
— 28.	2		1	$11\frac{1}{2}$ P.	4		
— 29.	1	$2\frac{3}{4}$ A.	4				
— 30.	1		1				
— 31.	2		1				
Nov. 1.	1	$2\frac{1}{2}$ P.	1				
— 2 to 8.	9		1		1		1
— 9.	6		1		1		1
19 to 28.	1	4 A.	1				
— 29.	1		1				
— 30.	3		2		1		1

1.	2.	3.	2.	3.	4.	3.	4.
1839.							
Dec. 2.	1		1				
— 3.	1		1				
— 4.	1		1				
— 5.	1		1				
— 6.	1	2 A.	4				
— 7.	1						
— 8.	2		1		1		
— 11.	1	$9\frac{1}{2}$ P.	3				
— 12.	1	3 A.	2				
13 to 18.	4		1		1		
— 20.	1	$3\frac{1}{2}$ A.	3				
— 24.	1		1				
— 28.	2	3 A.	1	12 P.	1		1
— 31.	1	2 A.	1				
1840.							
Jan. 2.	1	$1\frac{1}{2}$ A.	1				
— 4.	1	$11\frac{3}{4}$ P.	2				
— 8.	2	$12\frac{1}{2}$ P.	2	1 A.	3		
— 11.	2	2 A.	1	12 P.	1		
— 18.	2	$9\frac{3}{4}$ P.	4	10 P.	2		
— 19.	2	5 A.	1	9 A.	1		
— 20.	1	9 A.	1				
— 27.	1	6 A.	3				
Feb. 6.	1	$8\frac{1}{2}$ A.	1				
— 9.	1	9 A.	1				
— 10.	1		4				
— 14.	1	1 A.	1				
— 25.	1	2 P.	3				

1.		2	3.	4.	3.	4	3.	4.
1840.								
Feb.	26.	1	1 A.	1				
March	8.	2	6 A.	1	4 P.	1		
—	9.	1	5½ A.	3				
—	11.	3	5 A.	1	6 A.	1		1
—	13.	1	8 P.	3				
—	14.	1	9½ P.	3				
—	21.	1	12½ A.	1				
—	24.	2	8½ A.	2	11 A.	1		
—	25.	1	P. M.	1				
—	27.	2	1½ P.	1	2½ P.	1		
April	1.	2	1 P.	1	1½ P.	1		1
—	7.	3	4 P.	6	4¼ P.	2	5 P.	
—	11.	1	2¾ A.	1				
—	12.	1	P. M.					
—	13.	1	P. M.					
May	19.	3	1¾ P.	3	P. M.	1	P. M.	1
—	22.	2	1½ A.	2	5½ A.	2		
July	3.	1	11 A.	1				
—	11.	1	11 A.	1				
—	16.	2	3½ A.	1				
—	17.	1	8½ A.	1				
—	23.	1	1 A.	1				
Aug.	5.	1	6 P.	1				
—	6.	1	2 A.	1				
Sept.	19.	1	3½ A.	3				
—	21.	1	3 P.	1				
—	26.	1	3 A.	2				
Oct.	4.	1	9 P.	2				
—	20.	1	11 A.	1				
—	26.	1	6¾ P.	4				
Nov.	12.	1	2½ P.	1				
—	13.	3	2½ A.	1	4 A.	1	7 A.	1
—	16.	2	3 A.	1	6 A.	1		
—	24.	1	4 A.	1				
Dec.	6.	1	7 P.	1				
—	7.	1	12 A.	2				
—	8.	1	12 A.	2				
—	10 or 11	1	A. M.	1				
—	18.	1	2 A.	1				
1841.								
Jan.	6.		12 P.					
—	18.	1	2 A.	1				
—	31.	3	7½ P.	1	9 P.	1	11½ P.	1
Feb.	1.	1		1				
—	14.	1	9¾ A.	1				

1.		2.	3.	4.	3.	4.	3.	4.
1841.								
Feb.	16.	1		1				
March	6.	1	9 A.	1				
—	10.	1	4¾	3				
—	11.	1	1 A.	1				
—	22.	2	1 A.	1	6¼ A.	2		
—	23.	1	1 A.	1				
April	3.	1	8 A.	1				
—	9.	1	7¾ A.	2				
—	12.	1	5 A.	1				
—	14.	1	5 A.	1				
—	17.	1	12 A.	1				
—	24.	2	9¾ P.	1	P. M.	1		
—	25.	1	1 A.	1				
May	5.	1	9 A.	1				
—	8.	1	12 N.	1				
—	22.	1		1				
—	26.	1		1				
—	27.	1	8 A.	1				
—	28.	1	7 A.	1				
—	30.	1	6¾ A.	1				
June	29.	1		1				
July	2.	1	5¾ A.	1				
—	30.	12	8 A.	2	2½ P.	8	3½ P.	2
—	31.	3	8 A.	2		1		1
Aug.	1.	2		1		1		
—	10.	2		1		1		
—	12.	1	10 A.					
—	30.	1		1				
Sept.	8.	2	3 A.	1				
—	9.	1	11¾ P.	5				
—	10.	3	2½ A.	3	4½ A.	1	11¼ A.	
—	16.	2	A.	1	9½ P.	1		
—	17.	2	1 A.	1	4½ A.	1		
—	22.	1	11½ P.	1				
—	23.	1	2½ A.	1				
—	29.	2	A.	1	9¼ A.	1		
Oct.	5.	1	A.	1				
—	23.	1	12 A.	2				
Nov.	3,	1	12 A.	1				
—	5.	1	1 A.					
—	6.	1	8 A.					
—	7.	1		1				
—	8.	1						
—	18.	1	8 A.					
Dec.	3.		8½ A.					
—	6.	1	3 A.	1				
—	7.	1	3 A.	1				

The 4th column in the preceding Table, which states the intensity of the recorded shocks, cannot be depended on as absolutely correct. It represents merely the result of Mr Macfarlane's impressions, aided, however, in most instances, with observation of the effects of each shock. It is also proper to observe, that besides shocks or tremors, there were frequently passing sounds, unaccompanied by shocks or tremors, and which are believed by the inhabitants of Comrie, —and apparently on good grounds,—to be no less connected with subterranean action. Of these sounds, a register has been attempted to be formed by Mr J. Drummond, shoemaker in Comrie, and which is still continued by him.

It may be observed generally, of the foregoing Table, that there are 247 shocks recorded in it, for the two years following 3d October 1839; and that of these, 171 occurred during the six winter months from October to March inclusive, and 76 during the six summer months,—a result remarkably in accordance with the inferences deduced in the former part of this Memoir. This remark, which regards only the *frequency* of the shocks, may be applied also to the *severity* of them,—the most violent having occurred, as the Table shews, during the six winter months.

The author will proceed now to describe some of the more remarkable shocks recorded in the foregoing table, with the view of offering data, from which the nature of the shocks and the source from which they all proceeded, may be ascertained. He thinks that he cannot do this better, than by quoting as much as possible the language used by those who themselves felt the shocks, and who have been so obliging as to communicate their impressions to the author.

He will arrange these reports under the different days on which the shocks occurred; and those will be quoted first, which were given by persons who were at the time nearest to what will afterwards be seen to have been the central spot, from which all these shocks emanated.

3d October 1839.

No particulars have been obtained regarding the shock which occurred on this day, except what are contained in the following extract of a letter from Mr Buchan of *Blairmore*, 10 miles ENE. of Comrie.

"About 3 p. m., I was walking, when I heard a sound somewhat resembling a peal of thunder at a great distance,—or rather the echo which succeeds a louder thunder peal passing along through the clouds. I would have believed it *was* from thunder, had I not felt the motion of the ground under me, as if a heavy carriage had passed over it rapidly at a short distance from me. The sound preceded the movement of the ground about 3″ or 4″."

7th October 1839.

There were five shocks felt on this day by different observers, of which three only are marked in the register. The other two are said to have occurred at $4\frac{1}{2}$ A. M., and $11\frac{1}{2}$ A.M. Mr Maxton at *Cultoquebey* (1 mile east of Crieff), between 11 and 12 A. M., heard a noise loud and rumbling, but no shake; about 3 P. M. he felt a decided shake of the ground, accompanied by a noise in air like thunder. The shake resembled what may be felt on a moving bog or moss. The concussion came from W. He was then on low flat sandy ground. About 4 P. M. he heard a slight noise, but felt no shake.

9th October 1339.

Mr Buchan of *Blairmore* writes,—"Not long after 2 A. M. when in bed, I heard a sound, which, as formerly, somewhat preceded the shaking, appeared much nearer, and with apparently less time intervening; also louder and harsher, somewhat resembling one of these winds called by countrymen 'hearkening winds.' They come in heavy gusts with a roaring sound, die away after a little, and again roll as before. The motion (which almost immediately followed the sound), was very unpleasant. It appeared as if my bed had been suspended to the top of the room, and had then received a smart and violent blow from a heavy mallet. I was not conscious, however, of any swing, but merely a tremulous or quavering feeling, occasioned by the motion of the bed. You may possibly better understand what I mean by the pendulum of a clock when oscillating;—if it is smartly struck by a small instrument, it has a very reverberatory and unsteady motion for a short time."

10th October 1839.

At *Comrie* the shock (says the Rev. Mr Walker), "caused considerable upheaving of the earth. It was accompanied with a very loud noise resembling hollow thunder, increasing in intensity as it approached us, and again decreasing as it receded."

At *Dunira*, 3 miles west of Comrie, the shock is described by Sir D. Dundas as "severe, and weather muggy and close."

At *Strathallan*, about 10 miles SE. of Comrie, there was "rather an undulatory motion of the ground" from the W. A man lying in bed N. and S. was thrown to east.

At *Ardvoirlich*, 10 miles W. of Comrie, there was no shaking felt, and only a sound, which resembled "a carriage driving up to the door," for which it was mistaken.

At *Monzie*, 10 miles NE. of Comrie, there was "merely heard a subterranean noise."

12*th October* 1839.

The Rev. Mr Walker of *Comrie* writes, that "the shocks of 12th at 1 and 4 P. M. (which were very similar and which were attended with a considerable tremor of the earth), were accompanied with a noise resembling a mixture produced by the rush of the strong wind and the peal of distant thunder. It was different from any noise which I ever heard before. The shock at 3 P. M. (which was far more severe than any that had preceded it, and which was attended with greater tremor or heaving of the earth), was accompanied with a noise which at first resembled the murmurings of distant waters. This continued increasing in intensity for about 2″, and then followed a very loud and terrific sound resembling that of a double shot for blasting rock immensely charged.

"The weather has been remarkably wet during the month of October, and indeed for some months previous, and still continues so. No day has brought along with it any other than a moist, and often a *very* moist atmosphere. This was especially the case on the 10th when the first severe shock was felt. In the morning of that day the clouds were evidently surcharged, while in the evening for some hours the rain fell in torrents, accompanied with a very violent wind from the SW. by W. Again, on the 12th, when three severe shocks, and so many slighter ones, were felt, the atmosphere was very moist. The air was much darkened during the shocks, and occasionally there fell a few drops of rain. After the second severe shock this day, I retired to the garden to note the appearance of the sky. I found that it had assumed an appearance peculiarly strange and alarming. The heavens, more especially towards the N. and NW., appeared as if hung with sackcloth. A dense dark indescribable species of mist enveloped the mountains in that direction. In many parts they were completely concealed; while in others, the broken crags could be seen as if growing through in terrible majesty, giving to the scene an aspect ineffably grand, and in some respects horrific. If I remember right, there was no heavy rains that evening nor the night following; nor was there, as on the 10th, any boisterous wind. Before the shocks on the 12th there was a slight breeze. This continued during the morning. Shortly before the first and third shocks there was a momentary calm. After these shocks, the wind again rose and blew gently, but from what direction I have not noted."

Mr Walker adds, that " during the second severe shock on the 12th, some slates fell from houses and some loose stones from walls. On that occasion also furniture was moved, and bells rung in some houses. Many persons felt as if under the influence of electricity. This was especially the case on the 12th. Some complained of pain in the soles of their feet; others in their ankle and knee-joints, and others in the wrists. As for myself, the effects on my frame and spirits were a slight pain in the back, and subsequently a violent headach. My limbs felt exceedingly weak. A general tremor seized me."

Mr Williamson of Lawers thus describes the effects of the shock which occurred at 3 P. M.: " A very severe shock was felt at *Lawers* (two miles east of Comrie), and through the whole of that part of the country, and I believe it was also felt at Stirling, Perth, and Edinburgh. In making observations on the effect of this earthquake, I was placed by chance in a most desirable situation. The night before it had been exceedingly wet, and much rain had fallen on the forenoon of the 12th. About three o'clock in the afternoon, I, with another gentleman, Mr Buchanan, went out with our guns. We had made our way towards the parks in the Strath, below the house of Lawers, and at the time I was standing in the road leading from Lawers to Comrie, and facing the west, a loud explosion was heard, as if from a ten-pounder at a mile distant, and instantaneously the earth became tremulous and shook violently. The report echoed from hill to hill, and travelled on with great rapidity nearly due east. Its course was marked very distinctly along the tops of the hills. The road from Lawers to Comrie is overhung with trees, and every branch and leaf was saturated with water from the previous rains; and as the shock of the earthquake passed, it produced a most singular effect. The water descended from the trees as if it had been from a shower-bath, and I could see the drops falling upon the road like a passing shower, as if driven with a gale. The gentleman, Mr Buchanan, who was with me, but in the neighbouring field, made the same observation. In this shock, another still more singular phenomenon presented itself. The rain had ceased about twelve o'clock, and the day in a manner cleared up, but still the mist hung upon the hills, and there was a remarkable languor and listlessness in the atmosphere. It was a dead calm; but no sooner had the report which accompanied the earthquake died away upon the ear, than a gentle breeze was felt coming from the east. It increased for twenty minutes, when, as a sailor would say, it blew a ten knot breeze. This gradually lessened, and in forty minutes it was again a dead calm. This was remarked also by my friend Mr Buchanan as very singular, and indicated plainly that the atmosphere was put in motion to fill up some vacuum. I should have mentioned that the thermometer stood at 54°."

In farther explanation of the foregoing statements, the following notes may be added, jotted down by the author after a conversation with Mr Williamson.

"I was half way between Lawers and Comrie on the turnpike road, under an avenue of tall trees, walking with my face to west. Suddenly I heard a loud report, as if a ten-pounder had been fired. It seemed to come rather from south of line of road, crossing it obliquely in its course eastward. At same moment, trees above my head shaken; shake came from west. I could not see ground rise, or any objects on it lifted up. I looked back towards east, and saw rain-drops descend from trees, as far as eye could reach. The concussion appeared to travel more quickly than sound,—and at least 800 or 900 yards in 2″. All the shocks and reports felt by me during this month, seemed to issue from same locality. Mr Thomas Stirling of Struan told me, he was standing at this time on edge of a bank near river Erne, when ground gave way beneath him."

Mr Stirling told the author that he felt one of the shocks at *Struan*, as if coming from the northwards. There was a sound which preceded the shock. The earth seemed to tremble. He had a strong sensation of sea-sickness.

At *Crieff*, six miles east of Comrie, the following sensations were experienced by Mr White, in a distillery half a mile S.W. of Crieff, as noted by the author after a conversation with him. "About 1½ P.M. the chairs on which we were sitting, were suddenly moved or shoved out of their places. The owner of the distillery instantly rushed out to see if any of his works had fallen in. At the door he met his clerk, who said that when in the court-yard he had felt himself raised up two or three inches. The noise was louder than the loudest thunder I ever heard, and lasted altogether nearly 2′. The shaking or tremor of the ground passed in 5″ or 6″. The day was hot and sultry. At 3 P.M. I was in Crieff and felt a shock; but it was only a low rumbling sound which I heard. It lasted 4″ or 5″; and it was in the air. It passed from W. to E. Mr Forrester, the schoolmaster, was standing beside me, and said that he felt a motion of the ground."

At *Kinkardine*, about seven miles E. by S. of Comrie, Mr White's uncle felt the first of these shocks. At a quarter before 2 P.M. he was in a room of the upper storey of a house. "The first sensation I experienced, was as if the west wall of the room was leaning over upon me. I rushed towards the door, which was on the opposite side of the room. The door then gave a crack. There was all this time a hollow rumbling sound, apparently subterranean, which seemed to be travelling in a S.E. direction. It lasted only a few seconds."

At *Dunira*, the several shocks are thus described. General Sir Dougal Gilmour writes—"About 2 P.M. of the 12th, while walking in the neighbourhood of the farm-yard, a most tremendous noise was heard, not unlike the blowing up of a magazine, and immediately afterwards a quick undulating movement which lasted about 2″, and apparently in the direction of N.E. to S.W. The tremulation was fully stronger than I ever felt at Lisbon or elsewhere, with the addition of the tremendous crash previous to it."

Sir David Dundas writes regarding the second shock. "I had walked out with two friends, and we were standing talking at my home farm-steading, when a flock of turkeys came flying out among us as if very much frightened. A remark was made upon it; and we immediately were sensible of a tolerably severe shock under us. The pigeons also at the same time kept flying about, as if in a state of alarm. We all at the moment attributed this to the earthquake. The day was close and oppressive. The rain came on at two o'clock, and continued very heavy all the rest of the day."

At *Monzie* Mr Laurie, the parochial schoolmaster, writes. "I heard two long loud peals, and there was a tremulous motion observed by some persons. A pond in Monzie Park was seen to be agitated as if by the wind, though it was a perfect calm at the time."

A correspondent at *Blairgowrie* thus describes the shock in that district, which is probably about forty miles E.NE. of Comrie. The first one felt there in October was about 3 P.M. It was felt "only in the valley of Glenshee, about ten or twelve miles to the north of this town. The concussion was preceded by a hollow rumbling noise, which induced those near a road to fancy that there were several carriages passing along at a rapid rate, and those at a distance from any road, to imagine in some cases that it was occasioned by thunder, and in others by some of the outhouses falling to the ground. After the noise had continued about 5″ or 6″, a tremulous motion or tremor was felt, but without any movement from side to side, or in an upward direction. One man who happened at the time to be fishing on a hill burn, about fifteen miles to the N. of this, in Glenshee, gives a very distinct account of the phenomena observed by him. He states, that he was at the moment walking across a patch of heather, when he heard a noise as if of a large covey of muir-fowl flying at a little distance from him, and he indeed imagined the sound to proceed from this cause. Finding that it continued, and seemed approaching him, the thought immediately struck him that it must be the approach of an earthquake, such as those he had been frequently reading of in the newspapers of late as having occurred about Crieff and Comrie. He therefore stood quite still, leaning on his fishing-rod to observe the phenomenon, and heard the sound distinctly approaching, until it seemed to surround him, when he felt the ground tremble under him (to use his own words) '*as if shaken in a riddle*.' He states the sound to have proceeded from a west or NW. direction, and as resembling the sound of 'Muir-burn,' or the rattling, crackling, and hissing noise made by a large extent of heather on fire."

At *Kenmore* (at the east end of Loch-Tay, and eighteen miles north of Comrie), the Rev. Mr Duff heard "a hollow, rolling, continuous sound," which he at first attributed to thunder; but by subsequent observations he was satisfied it was connected with an earthquake. "Some masons happened at the time to be dressing stones at Kenmore, and they mentioned that they perceived a tremulous motion in the blocks which lay before them. They stated their impression to be, that the noise and motion came to them from the S. or SW."

14*th October* 1841.

At *Tullybanocher*, situated about half a mile west of Comrie, the shock is described by the tenant of that farm as "a very alarming one. Some of my horses happened to be yoking in the carts at the time, and were observed to tremble exceedingly. I felt myself lifted, or rapidly heaved up and down."

At *Dunira*, as Sir Dougal Gilmour relates, "another tremendous crash took place, which shook the house, and a considerable quantity of soot and lime was driven down into the chimney. It was from the same point (viz. NE.), and though the house is situated close under lofty mountains, there was no reverberation along them like what is produced by thunder. The weather was warm and muggy, with thick fog."

Sir David Dundas writes that this day was "very wet; at $3\frac{1}{2}$ P.M. a very severe shock occurred. Plaster from the inside of several chimnies, brought down."

At *Monzie*, Mr Lawrie writes—"I heard a noise approaching from the west, and although I knew the cause, I was taken by surprise, for the house in which I was, received in that direction such a concussion as I had no previous conception of. I do not say this in regard to the severity, so much as the nature of the shock. Suppose the house to have been a ship lying in still water, and a heavy body to have been unexpectedly pitched against it, and you will have a tolerably good idea both of the concussion and of our sensations. I also felt an undulating motion pass along the room (which is on the ground) from W. to E. The desk at which I was seated was sensibly lifted up, as was also a stove with its flue. Not only during the concussion, but before and after it, the windows shook violently. The sound did not rise out of the ground on all sides, but moved in a track like a train of gunpowder exploding. It passed away to the E. with prodigious velocity; and nothing could give a finer idea of rapid motion than it did. After it had reached an immense distance, its vibrations still continued for many seconds, but they rapidly became deeper and fainter until they died away in the distance.

"After the concussion there followed a general shuddering of the ground. The noise was subterranean. It was a stifled sound, proceeding from the ground. It resembled the falling of snow from the roof of a house during thaw, and was equal to loud thunder. The clouds were very low, and generally there was a thick small rain."

At *Glenalmond* (9 miles E.N.E. of Comrie) Mr Robert Rutherfurd, W.S., writes that "the concussion was as if a heavy cart of stones were driven violently against the house. There was an undulatory motion, and the room seemed to heave up, beginning at the SE. corner, and sinking down to NW. The chairs, and people sitting on them, seemed to rock like a boat at sea, affected by a ground swell. The pots and pans hanging in the kitchen vibrated, and rattled on the wall. I was reading in the room with Mr Paton, when the shock was felt, and was astonished, both at the noise and seeing the chairs undulate; insomuch, that I thought Mr Paton was swinging on the back of his chair. I felt my own chair distinctly undulate, and felt a little affected with headache. There was a very loud noise, like the emptying of a cart of stones. The cattle in the field clustered together, and looked as if they were afraid. It had rained very much that morning and the preceding two days. Towards the afternoon, the day became very close, with a Scotch mist."

At *Dumbarnie* (about 20 miles E. of Comrie), Dr Joseph Bell was walking along a road with some friends. Suddenly they heard "a rushing noise like the letting off of steam. One of the party was conscious about the same period, of an unusual feeling, which led him to suppose that some illness was impending. This did not last above 15″ or 20″.

At *Kenmore*, as the Rev. Mr Duff relates, "at 3 P.M. a seaman happened to be employed in a boat-house close upon the river, when the building shook to such an alarming degree that he rushed out in the dread that it would be instantly in ruins; and on reaching his house, which is also but a few yards from the river, he was told by his wife that the bell in one of the rooms had been ringing." In a subsequent letter, Mr Duff says, that "the first circumstance which attracted the seaman's attention was a tremulous motion of the loose objects in the building; and, as he expresses it, a clattering of the slates over his head. The house merely trembled, and he was not sensible of a general movement in any direction. The thing bearing the greatest similitude to what he felt, is the tremor in a steam-boat, occasioned by the stroke of the arms of the wheels in the water."

The Rev. Mr Dewar was that day riding on a *turnpike road* on *north side of Loch Tay*. He heard a noise, apparently towards NE., similar to that of two or three carriages. His pony was startled by it. The day was very wet and rainy.

October 16. 1841.

At *Dunira* several shocks were felt by Mr George Clerk Craigie, who thus writes regarding them:—"At about 2½ A.M. every inhabitant of the house was awakened by a shock so severe as to shake the whole house, and accompanied by a noise as loud as, and much resembling, a severe thunder clap. The motion was at first of a lifting description, as if some one was forcing up the bed, and finished with a tremulous motion. The time occupied was from 15″ to 20″. The sound seemed to be both in the earth and air. The atmosphere was cloudy and calm, what we are accustomed to call muggy. Much alarm was felt by the domestics of Lady Dundas's household, and likewise by some of the peasantry. Another shock took place at 6 A.M., but comparatively slighter."

At *Ardvoirlich*, the first of these shocks is stated by those who there heard it, "as particularly severe, and the noise was described as having a sort of hissing sound, and was compared to a large steam-vessel letting off the steam."

At *Blairhill*, near the Rumbling Bridge (about 25 miles

SE. of Comrie), the shock between 2 and 3 A.M. "was very violent, causing the bed to shake greatly, and the articles in the basin-stand to rattle strongly."

At *Kenmore*, about 3 A.M. one of the maid-servants in the manse "declares that her bed shook like a cradle, and that the basin-stand made a rattling noise on the floor. She was so frightened, happening to be alone, that she was on the point of descending to take refuge in the apartment of her mistress."

October 23. 1841.

Leichdin, a farm-house situated half a mile N.W. of Comrie village. "The great jolt felt between 10 and 11 P.M. came from the north, and apparently from some point a little to the west of Lord Melville's monument. It created the sensation that the house and whole ground adjoining had been suddenly pushed and moved to the south, and then instantly brought back to its former position. There seemed to be two such jolts, with an interval of a second between them. There was a subterranean noise, which preceded the shock. Before midnight a similar subterranean sound was heard twelve times, accompanied on one occasion only with a shaking."

Comrie House.—About a quarter of a mile N. of Comrie village, Sir John Mansel (who then resided there) writes,—"The most violent shock occurred at about 10 5′ P.M. From the first report to the ceasing of the sound, there might have been 45″ or 50″. As it was dark, I am unable to say whether an undulation of the earth's surface was produced; but some seconds after the shock, and while the vibration was still continuing in the earth, it appeared to heave up. The sensation conveyed to me by the concussion, as I was standing on the ground-floor, was as if the earth was being rent asunder under my feet; and this for some seconds I fully expected to happen, from the violent movement, apparently in the bowels of the earth. This shock, like all the others, seemed to originate a short distance north of this house. The rumbling noise follows a direction from NW. by N. to SE. by S. A loud noise accompanies every shock, proportionate in loudness to its strength, and in the more violent ones the vibration is of equal continuance with the sound; but in the lesser ones no vibration is perceptible, merely the peculiar report is heard. In the great shock of the 23d there were two reports, with an interval of 4″ or 5″ between the first report and the commencement of the second, before any sensible vibration or concussion ensued. The nature of the noise usually resembles the report of a gun discharged among rocks, when the sound produced is deep and hollow. This marks the first explosion. Then follows the sharp rumble, as if through a cavity in the earth, and in the sharper shocks produces a jingle like the jarring of some metallic body in the earth.

" Towards the termination of the principal shock on the 23d, there was a strong smell of a combination of sulphureous and metallic air emitted through the floor; and though I felt perfectly convinced this was not the production of fancy, yet it has been satisfactory to me having heard from others since that they experienced the same. In connection with this, it may be noticed, that some linen placed on the ground 1½ miles east from hence, to bleach on the morning of the 23d, was on the following day discovered entirely covered with small particles of black. The clothes were on the usual spot for dressing the linen, and removed fifty yards at least from a solitary house, and with high trees intervening. I could not learn that the under surface next the ground was discoloured.

" In my kitchen, several tin covers hanging on nails, and a few other things on an elevated situation, not firmly fixed, were thrown down with the shake.

" I have now resided at Comrie more than six years, and so far as my recollection carries me, in each month of November, I have experienced one and sometimes two shocks, usually occurring between 9 and 11 P. M.; and I do not remember having felt any at any other period of the year, except once at 7 A. M. on a bright morning in April. I do not think the general effect, character, or direction of these former earthquakes differed in any respect from those I have felt and heard during the past months of October and November, except as regards the great one of the 23d, which was totally and essentially different from any I have ever heard, for they as well as the recent ones varied in strength, but possessed precisely similar effects, as their power increased, and they appeared to occupy the same locality.

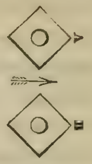
"The season for a long while prior to and during the first earthquakes, up to the 16th October, was extremely wet, with generally very heavy rain. I understand, that on the 17th the weather cleared up, and there were slight frosts till the 20th. The 21st October was a hazy lowering day without rain. It commenced raining at 7 A. M. on the 22d, and continued without any cessation till the evening of the 24th. On the 22d the rain was heavy. On the 23d it was less so, with the atmosphere very thick and mild. On the 24th the rain was periodically heavy, but the atmosphere clearer. It therefore appears, that, during the short change in the weather from that humid state to a more dry and clear atmosphere, the shocks abated, and with the return of that humidity they likewise returned. From the 24th to the 31st October the weather still continued very moist, but some of the nights a little frosty. The first four days of November were extremely close, with a considerable quantity of rain falling, especially during the night. This is certain from observation, whatever influence (if any) the weather or atmosphere may have in producing these convulsions of the earth, they undoubtedly occur more, in certain states of it; and the prevailing one is a depressed, still, muggy atmosphere; and this is the more plainly borne out by the circumstance, that they almost invariably take place here in November, a season so generally presenting that peculiar state. It is also worthy of remark, that whatever effect heavy rains may have on combined substances in the earth, the general feeling of the inhabitants is, that fair weather will put an end to the shocks; and it is asserted, the first earthquakes that are remembered at Comrie commenced during a very wet summer and autumn, about fifty or fifty-two years ago."

Comrie Village.—There are three individuals of intelligence and observation, from whose separate reports the following statements are extracted.

(1.) Rev. Mr Walker.—Before his account of the shock and the effects of it is given, it may not be inappropriate to notice some remarks made by him on the situation of Comrie village. "Comrie lies as in a basin, being almost completely surrounded by hills and rising grounds. It is bounded on the north by the base of the Grampian range,—on the west by the Aberuchills hills,—on the south by a range of rising grounds, the highest of which is named Top Turlom, on the east by a ridge of similar grounds or hills crossing the valley of the Earne at Strowan and Clathin. In connection with the north boundary we have Glenlednaig separated from Comrie by the conical hill of Dunmore, being the eastern extremity of a range of hills forming a part of the base of the Grampian range, commonly termed the hills of Dunira. Among these, almost direct north from the east end of Locherne, lies a small lake of the name of Lochboultachan, in the centre of a small circular glen of the same name. Among these hills, and near this lake, general opinion has placed the seat of the earthquakes."

"The shock of the 23d, at half past 10. P. M., which was by far the most severe of any remembered in this neighbourhood, and which was attended with greater tremor or heaving of the earth, was accompanied with a noise in nature and intensity indescribably terrific,—that of water, wind, thunder, discharge of cannon, and the blasting of rocks, appeared combined. Giving a short warning by a distant murmur, it gradually increased in intensity for some seconds, when at length becoming louder than thunder, and somewhat similar to the rush of the hurricane, it suddenly changed, and a noise resembling that of a blasting rock thrice repeated followed, which again died away like distant thunder." In reference to the effects of this shock Mr Walker states, that "in the village towards the north, one house, whose gable had been formerly slightly rent in different parts, had these rents considerably enlarged. The gable thus injured looked towards the east. The rents were, after the earthquake, from top to bottom. Several other houses in the village had portions of their chimnies loosened, and cans thrown down,—and the parts thrown down, fell almost invariably towards the west. At Dundurn, five miles west from Comrie, three chimney-tops were shattered, and one is said to have been *twisted*, but in what direction I have not learned."

The chimney-tops here referred to by Mr Walker were pointed out to the author by Sir D. Dundas, on whose estate the house is situated. The chimney-stalks were about four feet high, and were built of polished freestone. They were a few inches apart from each other, and had their angles exactly opposite, in the way represented by the adjoining woodcut A B. The effect of the shock is stated to have been to turn each chimney inwards, in the direction of the arrow, so that their faces came nearly opposite to each other.



" Posterior to the shock of the 23d (Mr Walker says), I heard from two respectable witnesses, that two cats were noticed by them to be wonderfully agitated. Of these, the one was seen passing from the ground to a considerable height, and then screaming and retiring to another part of the room. The other, between the first and second shocks, was seen to run from room to room, till at length burying itself amongst a quantity of bed-clothes, it lay as if completely paralyzed with terror. A respectable correspondent in Crieff adds on this subject, 'birds in terror fell to the bottom of their cages, while at Lawers the horses in the stables became quite furious.' "

In regard to the state of the weather at the time of the principal shock on the 23d, Mr Walker says, that, " When it was felt, the rain was falling very heavy, and without intermission. Indeed, for about forty-eight hours previous to this, it may be said to have rained incessantly. During the 23d it was very dark, and more so towards the afternoon. Returning then from Crieff, I distinctly observed a dense dark cloud of mist floating over the eastern side of the village, and settling down upon the rising grounds by which it is bounded on the south. The Grampian range were at this time not perceptible, nor did they become so during the evening. In consequence of the heavy rains, the river Erne, with its tributaries, became very much swollen. The Erne during the evening might have risen about four feet above its usual banks. This rise, which may appear great to a stranger, was less than was expected from the known character of the river, taken in connection with the great quantity of rain that had fallen. It has, during this season, risen not only as high but higher, and, upon one occasion (15th September), far higher. It must be said, however, of this last rising, that for thirty years previous, there had been none like it." Mr Walker adds, generally, of the previous part of the month of October, that 'the air felt mild, inclining to warm, and saturated with moisture,—circumstances that frequently and for long have been remarked as concomitants of these phenomena."

(2.) Mr Cameron, parochial schoolmaster.—"The nature of the noise has been compared to various things; but certainly the more violent appeared to me to resemble thunder more than any thing else,—certainly much deeper toned and more awful, and felt as if immediately under us, and causing some immense body to strike two or three strokes under our feet, with a momentum to make the earth and every thing on it to vibrate to and fro, and then move off with a tremulous motion till it dies away in the distance. The slight ones are more aptly compared to the noise caused by the blasting of a soft rock at a considerable distance, followed by the reverberation of the surrounding mountains. Noises of the louder kind continue very nearly a minute,—the slight ones not above one-third of that time. As to the direction of the shocks, many of the gentler kind which were distinctly heard in Comrie, were not heard to any distance to the north or south of the village; and while they were not traceable much further west than Dunira, they were distinctly felt to the east, at least as far as Crieff. By this test, the direction of the noise seems to be from west to east. This is corroborated by the appearance of the chimney-tops here that were moved. Any stones that fell, fell to the west; and when any were observed off the perpendicular, the inclination was westward; and from the circumstance of more of the milder shocks being heard at *Leichdin* to the north of the village, it would appear that the centre of these is a particular spot to the north or north-west of Comrie, and such certainly was my own impression from the direction in which they were heard. When shocks occur, the atmosphere is almost invariably hazy and foggy. The 23d October was a deluge of rain. On the 12th October, when we had seven or eight shocks, the day was remarkably dark and murky. On the 14th (when shocks also occurred) the same,—the mercury very low, and weather calm and rainy. After the 23d, however, the mercury got unusually high. On the 23d, the cows were observed to be all on their feet (quite unusual after 10 P.M.); very restless, and showing every symptom of fear. The dogs in a farm-house ran to the door, and howled mournfully. The only other circumstance which occurs to me connected with these earthquakes, is the sulphureous smell which was perceived. This was supposed to come off the river; but several persons at a considerable distance from the river were sensible of it. Although I heard of many who said they perceived this, I would not believe it, till one evening Mrs C. was standing at the water-edge, and wishing to convince me of its reality, asked me to go to the water-edge. I did so; and I must say that the smell was so strong, that it could not be mistaken. It was a little after sun-set, and the evening having suddenly turned to intense frost, the whole course of the river could be traced from a distance, by a sort of vapour or mist that arose from it,—most favourable for giving out any effluvia. Having mentioned the circumstance to a friend, and gone with him to the same spot about two hours afterwards, neither of us could then detect the smell."

(3.) J. Drummond, shoemaker, in some written observations, with the perusal of which the author was favoured, says —" Where the shock is perpendicular, we feel in general two violent concussions—sometimes there is only one. In the great shock of 23d October, there were three concussions. At each concussion there is a quivering of the earth, with a rumbling noise—the undulating shocks causing the earth to rise like two waves."

On the foregoing passage, Mr Macfarlane makes the following remarks. " This double shock or ' dunt' (the first most violent), is certainly a remarkable accompaniment of many of these earthquakes, and that not of the apparently perpendicular ones only. Subsequently to the first comparatively violent part of the shock, there is a trembling of the earth and hollow rumbling noise proceeding from the point where it is supposed to commence swelling (if the shock is not given directly below), till it pass under the observer, and then dying away in the distance. I never noticed two waves."

J. Drummond continues,—"When the great shock of 23d October occurred, I was between the outer and inner doors of my house. I felt the shock strike the ground perpendicularly under my feet *three* times, like the stroke of a ponderous hammer, and, as far as I can guess, lifted the ground six or eight inches. Having some sticks in my hand, the first concussion tossed them out of it, and I felt something squeeze my heart that forced an involuntary cry. I was powerless between the first and second concussions, but when I got the third I recovered. I made to the door instantly, expecting the house immediately about my ears. I thought each concussion would have tossed the house from its foundation. The quivering of the ground was fearfully sublime, as well as the concussions. The noise in the earth and the rattling to and fro of the house and furniture, was truly awful. I felt the shock before I heard the sound, and the first concussion was the greatest,—the last weakest. There was not one moment between each concussion. Between the first, and the end of the sound of the last, there was about one minute. There were about twenty houses more or less damaged, chiefly to the east and west of Comrie. Though it rained for fifty-two hours before the shock, the barometer stood at fair. The rivers were greatly swollen, but instantly after they began to fall, though the rain continued the most of the night.

Comrie Manse, situated about a mile to the south of Comrie village. The Rev. Mr Mackenzie, the parochial clergyman, states, that his manse faces the sun at 10 A.M., so that its gables run in a north-west and south-east direction. On the evening of the 23d, "An inmate of the manse was very sensible of one undulation, *i. e.* as if the north-west corner of the house was first lifted up. It seems to be the prevailing opinion, that the shock heaved up the ground. The rent in Mrs M'Ewan's back wall seems to me clearly the effect of an undulating heave. This house is situated in Comrie village on the south side of the Earne, and runs from west to east. The rent is perpendicular, and is near the west end of the wall. The inner lobby partition has separated from the south wall at both sides of the front door, so far as to admit the little finger into the fissures. I conceive that these two injuries prove that the shock came from the north-west, causing the front wall to separate from the partition. In the manse, a person leaning against the east (*quære*, S.E.), side of a wall running south and north (*quære*, S.W. and N.E.), felt herself pushed forward. The cracks in the ceilings of the manse are chiefly from west to east. A dyke of stone and lime running east and west on the north side of the river Earn at Woodend, fell to the south into the river. Several loose stones fell from a dyke near the manse. This dyke runs east and west, and the stones fell to the north. One of my servants was passing at the moment. The loose caps of several chimney-cans were moved and turned to the west—proving, as I think, that the shock came from the west. I was of opinion, that formerly all the shocks proceeded from the opening to Glenlednock, just above the village of Comrie; and this was the settled opinion of a gentleman who lived at Comrie-house for nine years, and had spent many years in the West Indies; but if so, they would strike the north side of the manse, and not its west gable, as they appeared to do. I am now inclined to conclude, that they come from some part of the hill between Dunira and Lord Melville's monument, and that there is a probability that the central radiating point has removed a little from east to west.

(*To be continued.*)

Anatomical and Physiological Studies of a Species of Musca, with the view of Illustrating the History of Metamorphoses, and the Pretended Circulation of Insects. By M. Leon Dufour.

Before I am in a condition to present to the Academy the results of my numerous dissections of insects of the entire order Diptera, I am desirous to submit my researches on the organization, exterior as well as interior, of the three forms of a well known species of Musca, the *Musca carnassière* of Olivier, or *Sarcophaga hæmorrhoidalis*. I have likewise undertaken, considering the subject in a less restricted light, to examine and decide, by facts and reasoning, a disputed question of the highest interest to general physiology, and which divides the scientific naturalists of the present day, namely, the pretended circulation of insects.

I hope the Academy will permit me to lay before it a sketch of this work on metamorphoses and circulation, which are the two natural divisions of the subject.

After describing and figuring the larva, the nymph, and the winged insect, displaying the prodigious differences of those three states in the same individual, whose collective life presents a real trinity—after tracing the changes and developments, step by step, I have removed the tegumentary coverings, and, armed with a scalpel and microscope, have examined the various organic structures in their respective metamorphoses. I have endeavoured to initiate myself into the mysteries of organogeny. It is by dissections of the living animal, a hundred times repeated, that I have witnessed these three organisms unrolled; dissimilar indeed they are to each other, yet destined to become blended together and form only one. I have studied, in their inconceivable changes, the creation of the viscera of the *larva*, a headless, apodous, crawling, mandibular, carnivorous worm, growing with great rapidity, but of no sex, and without the power of generation; those of the *nymph*, which, by its inertness and absolute insensibility, is the real image of a mummy, but concealing a living principle; lastly, those of the *perfect insect*, which flies, runs, and is full of activity, sucks with moderation a subtile aliment, does not grow, has two separate sexes, and reproduces its kind by generation. I have attempted to catch, in the play of their material elements, the changes of these partial lives for a common or definitive life, which is the type of perfect organism. I have been fortunate enough at times to seize those interesting moments when one organism became blended with the remains of another which was in the act of being destroyed—those fleeting instants, in which organs about to be lost still lent their aid to others just forming.

In the interest of this threefold study of transformations, I have been led, by the modifications of the facts, to establish in the organism intermediate between the larva and the fly, and forming a series of links between the one and the other, namely, in that of nymph, three ages, phases or stages, which have not been remarked by my predecessors, and which are of great importance to the understanding of the progress of metamorphoses. The first age, w ich I call the *first transition*, is that which immediately succeeds the passage of the larva into a nymph. There is still some organic connection of the latter with the envelope cast off by the larva. The second, the name of which is a sufficient definition, is the *fully-formed nymph*. The latter is uniformly whitish. The third, which corresponds to the change of the nymph into a fly, is the *second transition*. The eyes have a violet tint.

In the three changes of the Sarcophaga, the *sensitive apparatus* consists of two single central nerves, the *brain* and the *thoracic ganglion*, from which emanate all the nerves which distribute the movements of life throughout the various tissues. The brain is deeply bilobed, or is composed of two hemispheres. In the acephalous larva it cannot be included in the head. In the fully-formed nymph, notwithstanding the existence of a large vesicular head, it is still on the outside of the latter, not entering within it till the second transition, and in the fly. A rudimentary retina is first observed in the mature nymph, and it is not till the following age, and particularly in the fly, that we see this retina developed, and forming the *pigment* of the choroid, both to the eyes and ocelli. In the larva and two first ages of the nymph, the brain and thoracic ganglion seem confounded in one and the same mass; while in the second transition and in the fly, the thoracic ganglion is separated from the encephalic by a very distinct rachidian cord. The latter is simple in the Diptera, a discovery I can claim for myself. It is double in all the other orders of insects. The thoracic ganglion of the larva, like that of many other dipterous forms, is furnished with numerous pairs of peculiar bodies of an ambiguous nature, which have not been previously mentioned, and which I have designated by the name of *ganglionoidal bodies.*

Respiration in insects is a true circulation of air, and the vascular apparatus through which it takes place is the seat of the two most important functions of the animal. To this part of the subject I shall again revert. In the larva, the *stigmata,* or respiratory orifices, consist of two pairs. Each of the anterior pair is in the form of a moveable fan with fifteen digitations; the posterior, lodged in what I have called the stigmatic cavity, the structure of which is worthy of admiration, are rather large, rounded, somewhat reniform, placed near each other, and incapable of motion, each having three small linear openings. When the transformation into a nymph takes place, the two pair of stigmata are rejected by the larva, and left adhering to the walls of the pupal capsule, which is merely the hardened and coloured tegument of that state. At the same time, the nymph, notwithstanding its embryo condition, and apparent death, is not destitute of a respiratory apparatus. We find in it a single pair of stigmata, namely, the anterior pair; but it is very likely that they cease to exercise any active functions. After the fly is evolved from the nymph, it is provided with eight pair of simple stigmata, two bivalvular ones with hairy valves on the thorax, and six on the abdomen which are small, rounded, and encircled with a ring.

The tracheæ, the only vascular system in insects, are, in the larva, wholly of a tubular or elastic description, and constitute a perfectly symmetrical apparatus. The latter consists, in each half of the body, of a wide dorso-lateral canal, which deserves the name of the tracheal artery, continued in a direct line from the posterior to the anterior stigma, and emitting on the right and left a determinate and regular number of nutritive branches. This arrangement incontestably proves that the inhalation of air or respiration takes place by the posterior stigmata. The two tracheal arteries communicate with each other anteriorly by a transverse canal. The tracheal system of the nymph closely resembles that of the larva; but as no posterior stigmata exist, the tracheal artery is closed at its hinder extremity, or terminates in a cul-de-sac. At this place there is a considerable interlacement of tracheæ. Numerous transverse branches establish a direct communication between the two great canals. The amount of respiration, always proportioned to the degree of vital energy, causes the necessity for a much more ramified system in the fly than in the preceding metamorphoses. The condition of the winged insect likewise requires utricular tracheæ, which are truly aërostatic, situate chiefly at the base of the abdominal cavity, exactly in the centre of the body, and designed to diminish the specific gravity as well as to balance the insect in its movements through the air.

Let us now proceed to consider the *digestive apparatus* in the larva which is voracious in its propensities,—in the nymph which does not eat at all,—and in the fly which laps or sucks a liquid food.

The digestive canal of the larva is seven or eight times longer than the body, filiform, rolled upon itself in numerous circumvolutions. It commences in a large buccal expansion, a rigid gizzard, and four ventricular bags. These three organs are not to be met with either in the nymph or perfect fly. This greater development of the digestive system is a cause or a consequence of the voracity and rapid growth of the larva. The salivary glands consist of two filiform vessels scarcely half the length of the body, and united by a salivary epiploon, which I have met with for the first time in these insects. There are four hepatic vessels, long, and as slender as a thread, yellow or greenish, free at one end, and uniting in pairs to a *canal cholédoque,* where they discharge bile.

After the transformation of the larva into a nymph, the buccal cavity, the gizzard, and ventricular bags have disappeared, and the alimentary canal has lost two-thirds of its length. The chylific ventricle, which is narrow and oblong, and more ample than in the two other states of the insect, has a rudimentary crop at its origin, and a new bag very different from that of the larva. It contains a liquid like syrup, and an intra-ventricular vesicle, the singular relict of the evolution of the digestive canal in the larva. The salivary glands are still those of the latter, but their elements shew a disposition to separate in order to assume a new form. The hepatic vessels, organs of the earliest formation, present no difference from those of the larva and the fly.

The winged insect seems to have resumed the alimentary canal of the larva, but without the three organs at its commencement. The salivary glands, which have now entirely changed their primitive form, have taken their place; a bag with a long neck and a bilobed reservoir is now placed at the termination of the œsophagus, and the intra-ventricular vesicle has not left the least trace of its existence. All the successive modifications of creations, all the substitutions, and changes offer points of the highest interest, and their parallelism throughout the different metamorphoses furnishes considerations of great advantage to organogeny.

The *genital apparatus* should have been spoken of in this place; but as it is the exclusive attribute of the perfect insect, I have reserved the consideration of it for my general work on the Diptera.

The *adipose splanchnic tissue* exists in three forms in the Sarcophaga, and performs an important part in the formation of the organs. That of the larva is in large sheets, or membranous folds drilled with holes ; but when the period of change approaches, it is converted into a net-work, the irregular meshes of which are granulated. In the nymph they appear as detached globules, floating in a copious liquid. These granules are plastic materials fully formed, and ready to enter into the construction of the parts. I have often succeeded in observing these organogenic marrows disposed in linear series, dissolved in flakes, or laid out in plates, in order to form conduits, articulations, and membranes, in virtue of a law of organic affinity, not yet formally expressed, and of elective sensibility, with which human pathology furnishes us numerous examples.

I have given provisionally the name of *dorsal organ* to an organ found in all the states of the Sarcophaga, in the median line of the back, and which is the analogue of the dorsal vessel of authors. In the Dipteron now under consideration, it is much more complicated than in other insects, and would seem consequently to have a physiological pre-eminence. We distinguish in it an *axis* and *wings*. The axis is a cord without cavity or divisions, fixed at one extremity to the hinder part of the dorsal tegument, and at the other to the origin of the chylific ventricle, without penetrating into the cavity of the latter. Its thoracic portion is naked, free, and a little attenuated. The wings are exclusively confined to the abdominal portion. They consist, for the third part of the length from the hinder extremity, of a double series of twelve reddish *sphericles*, which are sessile, and terminate in the same number of ligaments, and, for two-thirds of the anterior part, of a sort of epiploon or mesenteriform strawberry, composed of very small granulations, and supported on both sides by four ligaments. A minutely careful examination of the form and structure of this dorsal organ (new to science), proves that it has no analogy either to a heart or a vessel, and that consequently it cannot be considered as a circulating apparatus. It is possible that it may be a secreting organ, but of a particular kind, and having no relation to the ordinary glands of insects. In regard to this part of the subject, I have established a classification of secreting organs which are pretty frequently met with among these animals, and its peculiar structure will exclude it from these. I have hazarded the conjecture, without attaching much importance to it, that the dorsal organ of the Sarcophaga may not be wholly unconnected with the formation and support of the tegumentary envelope of the Dipteron.

The examination of the circulation of insects in general terminates my work. Although apparently foreign to my researches on the Sarcophaga, it nevertheless arises out of them, from the details I have entered upon respecting the dorsal organ of this fly. For the solution of this problem, I have brought forward materials furnished by insects of every order, as well as the opinions expressed by all men of science.

Among those who are in doubt about the existence of this circulation are Malpighi, Swammerdam, Lyonnet, Cuvier, MM. Marcel de Serres, Duméril, Duvernoy, Audouin, &c.; and among those who contend for it are MM. Comparetti, Straus, Wagner, Carus, Behn, Duges, &c. We thus perceive that the most respectable and eminent names are to be found arrayed on both sides.

Everlasting fame be assigned to our illustrious Cuvier! At a period remote from our own (upwards of forty years ago) he had established, in reference to insects, by that inspiration which belongs to genius alone, this fundamental law of physiology, that the existence of an aëriferous vascular apparatus excludes that of a sanguineous vascular apparatus; or, to express it in the sacred words of this legislator in science, *the nutritive fluid being unable to come into contact with the air, the air is caused to repair to it, in order to combine with it.* Since that period, the progress of discovery occasions no necessity for modifying the expression of this law. It still preserves, in my opinion, all its spirit and force.

It is very singular that instead of choosing the largest species of insects for the purpose of demonstrating a circulating system, the savans who contend for its existence, have, on the contrary, selected the most minute, usually larvæ in their earliest stage, and the movements of a liquid contained in the cavities of the body, and seen through the pellucid integuments, have been considered sufficient to prove a circulation in these animals. And yet the experiments and injections made by Cuvier, repeated on an extensive scale by M. Marcel de Serres, were altogether opposed to such a view of the subject.

I have scrupulously analysed, and, I conceive, successfully opposed the specious and sometimes contradictory assertions of M. Carus, who considers that the circulation, the double circulation of insects, is carried on by *currents* of liquid, by *vessels without walls*, which he does not hesitate to qualify by the terms *arterial* and *veinous*. These currents, subject, in my opinion, to the laws of capillarity and organic affinities, cannot be regarded as constituting a circulating system.

M. Straus has described and figured the supposed heart of a cockchafer, as being pierced with eight lateral pair of auriculo-ventricular openings, and the like number of ventricles or chambers separated by valvules. According to his view, the blood of the cavities enters the heart directly by these openings, passes into the artery which crosses the thorax, and spreads itself over the head, whence it returns to the cavities. While admitting, along with M. Straus, the existence of a similar structure, I prove that we cannot reasonably adduce it, as he does, to demonstrate a double circulation. The movement, in my opinion, is limited to the continual play of a siphon, which can never accomplish the physiological purpose of a circulation. My dissections of the same cockchafer have not enabled me to detect any opening in the dorsal organ of that insect. This organ is closed at its two extremities, and one of these is fixed, as in the sarcophaga, to the œsophagus of the insect, without penetrating into the interior of the digestive canal. This fact alone completely destroys the system of M. Straus and the other advocates of circulation. Lyonnet, in his posthumous work, has noticed another of the same description.

On taking a review of the dorsal organ in the various orders of hexapod insects, we find in all the following characters: 1*st*, It is situated in the median dorsal line of the body, immediately beneath the teguments; 2*d*, its axis, which is more particularly the heart or the dorsal vessel of authors, is a fibro-fleshy simple cord, without divisions, openings, or cavities; 3*d*, it is fixed and closed at the two extremities; 4*th*, its abdominal portion is furnished at the sides with wings, sometimes membranous, cut or entire, or fixed with ligaments (as among the Hemiptera) under the form of a narrow linear border, without any means of connection from one end to the other; 5*th*, the most skilful dissections, the most delicate injections, have never detected the least vascular ramification in this organ, and almost all anatomists have admitted this negative fact, which is of such high importance in reference to the question of circulation.

The movements of the dorsal organ, which have been so imprudently designated by the names of *systole* and *diastole*, and the agents which determine them, have been the object of my attentive study. They are either wanting or very difficult to be determined in many insects. The general movements are principally regulated by the ligaments, the muscles attached to the skin, the tracheæ put in motion by the act of respiration, and the fluctuation of the nutritive liquid. Its proper movements, or *pulsations* (an improper term), depend principally on the contractibility of the fibre. These movements are irregular, and Malpighi has even said that he has seen them, in the same individual, sometimes directed from the anterior part backwards, and at other times from the hinder part forwards; a grave testimony against a circulating system.

What adds still further to the numerous proofs of the non-existence of a heart and circulating system in insects is, that immediate death does not ensue from cutting the supposed heart through the middle, while the same operation, performed on the dorsal vessel, the true heart of a pulmonary Arachnid, instantly destroys life.

I conclude from my dissections, experiments, and reasonings, that the existence of an aëriferous vascular system adapted to convey the physiological benefits of respiration to all the organs and tissues, is incompatible with the presence of a circulating humour. I am satisfied that the latter does not exist in insects provided with tracheæ, and that the organ which has been supposed to perform this function is merely rudimentary, bearing some resemblance to the heart of the Arachnides; in fact an obsolete heart, an organ deprived of every well-determined physiological attribute, and perhaps a mere elementary tissue.*

* From Annales des Sciences Naturelles, tom. xv. p. 5.

On Falls of Dust on Vessels traversing the Atlantic.

The west coast of Africa, between Cape Bojador and Cape Verd, and thence outwards, is, during the dry season, that is, from November to May, constantly enveloped in fog. This stratum, which was at an earlier period considered as the land itself, and is a sure sign of its proximity, consists of nothing else but dust or sand, which, on account of its extraordinary fineness, is raised into the atmosphere by the slightest current of air, and retained in a state of suspension.

The projection of this sand, and its falling on ships which traverse the Atlantic Ocean at a considerable distance from Africa, is, it is true, a well known fact, but still, details are wanting as to the distance to which the sand of the African deserts can be carried; and the Journal kept on board the Prussian ship Princess Louisa contains instructive information on the subject. The phenomenon was observed both during the outward and the homeward voyage of the vessel, as the following abstract of a portion of the journal shews:—

	N. Lat.	W. Long.		Distance from land.
1839.				
Jan. 14.	24°20′	26°42′	Sails rendered quite yellow by sand, which had probably been brought from the coast of Africa.	12°
— 15.	23°05′	28°18′	Sails still yellower; when we struck the sails we found the colour was produced by fine sand, which was thus loosened.	do.
1840.				
May 6.	10°29′	32°19′	We remarked a yellow appearance on the sails like that seen during our outward voyage.	17°
— 7.	12°20′	34°0′	The sails more yellow than they were yesterday.	18°
— 8.	14°21′	35°24′	Sails and ropes covered with yellow dust.	19°
— 9.	16°44′	36°37′	No increasing dust visible on the sails.	20°

How we should be surprised if dust, which had been brought to us from Sahara, were to fall on the plains of Northern Germany, or if we heard that the ashes of a new eruption of Ætna had fallen at Copenhagen or Riga! These are distances which may be compared to those of the Princess Louisa from the coasts of Africa at the time when the sails were covered with Senigambian dust.

About a fortnight after the time when this ship crossed these parts of the Atlantic on her outward voyage, an analogous phenomenon was observed on board the English ship Roxburgh. One of the passengers, the Rev. W. B. Clarke, communicated the following notice of it to the Geological Society of London:—"On Tuesday, February 4, the latitude of the ship at noon was 14°31′ N., longitude 25°16′ W. The sky was overcast, and the weather thick and insufferably oppressive, though the thermometer was only 72°. At 3 P. M. the wind suddenly lulled into a calm, then rose from the S.W., accompanied by rain; and the air appeared to be filled with dust, which affected the eyes of the passengers and crew. At noon on the 5th of February, the latitude of the Roxburgh was 12°36′ N., longitude 24°13′ W.; the thermometer stood at 72°, and the barometer at 30°, the height which it had maintained during the voyage from England. The volcanic island of Fogo, one of the Cape de Verds, was about forty-five miles distant. The weather was clear and fine, but the sails were found to be covered with an impalpable reddish-brown powder, which, Mr Clarke states, resembled many of the varieties of ashes ejected from Vesuvius, and evidently was not sand blown from the African deserts."

Although Mr Clarke thus decidedly expresses himself against the sand-dust, yet the author of this notice is inclined to ascribe to it the phenomenon observed on board the Roxburgh; for, had it been produced by volcanic ashes, we must have heard of a simultaneous eruption of the volcano of Fogo, but such was not the case.

Mr Clarke also mentioned the following instances of similar phenomena, chiefly on the authority of the officers of the Roxburgh:—"In June 1822, the ship Kingston of Bristol, bound to Jamaica, while passing near Fogo, had her sails covered with a similar brownish powder, which, it is said, smelt strongly of sulphur. In the latitude of the Canaries, and longitude 35° W., showers of ashes have been noticed two or three times. At Bombay, dust on one occasion fell on the decks of the vessels to the depth of an inch, and it was supposed to have been blown from Arabia. In January 1838, dust was noticed by the crew of a ship navigating the China Sea, and at a considerable distance from the Bashee islands, one of which had been previously seen in eruption. In 1812 ashes fell on the deck of a packet bound to the Brazils, and when 1000 miles from land."—(From *Berghaus's Almanach.*)

Descriptions of some New Species of Pycnogonidæ. By Henry D. S. Goodsir, Esq. Read before the Wernerian Society, March 1841. Communicated by the Author. (With a Plate.)

Class, Crustacea.—*Sub-Class*, Haustellata.

Order, Araneiformes.

Genus I. *Phoxichilidium* (*Orythyia*, Johnston).

Species 1. *Phoxichilidium globosum* (Mihi). Rostrum a little longer than the first joint of the mandibles; eyes large and shining; fourth articulation of the ambulatory legs very much dilated; no spines on the eighth joint of the leg; whole body covered with fine hairs.

The whole animal is of a light pea-green colour, of a robust form, and covered with fine hairs, which are thickest on the legs. The rostrum is shorter and thicker than in the other species of this genus. The mandibles lie on the upper surface of the rostrum, so as to hide it, and are hispid. The oculiferous tubercles are prominent, situated immediately behind the origin of the mandibles, and bear four black shining eyes. The three first joints of the ambulatory legs are equal; the fourth very much dilated, almost spherical; first and second tibial equal; first tarsal joint minute, second equal to the two first coxal, and bearing no spines on its inferior surface, but armed with a strong claw. The length of the body rather more than half a line; span of the legs three lines.

This species is easily distinguished from the *Orythyia coccinea* of Dr Johnston, by the eyes being quite distinct, black, and covered with punctures. The most prominent characters, however, are the extreme dilatation of the thigh joint, and the absence of the spines on the inferior surface of the second tarsal joint.

Taken by Messrs Edward Forbes and John Goodsir in Orkney.

Fig. 1.

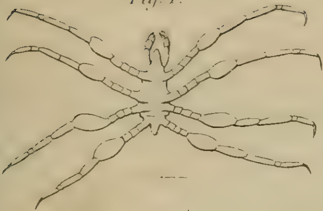


Fig. 2.

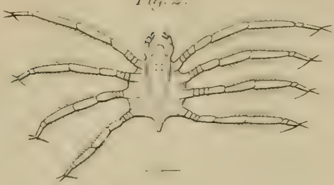


Fig. 3.

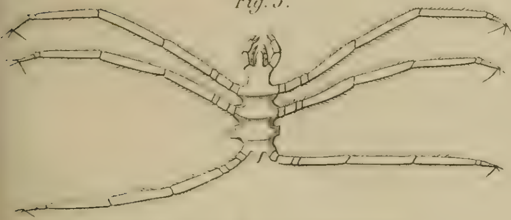


Fig. 4.

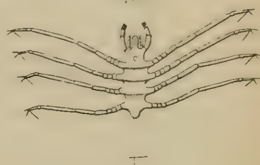


Fig. 5.

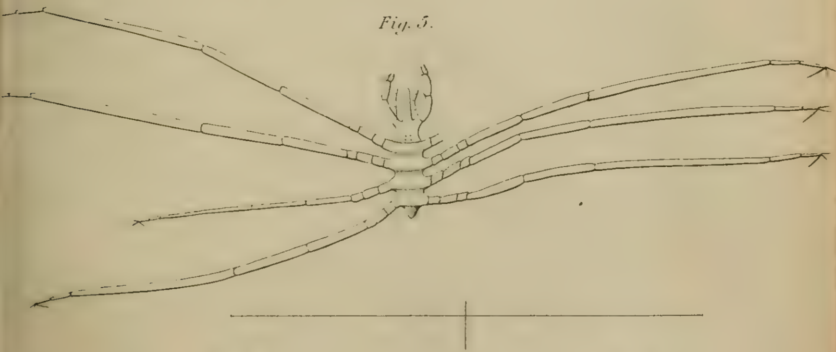


Fig. 6.

Fig. 7.

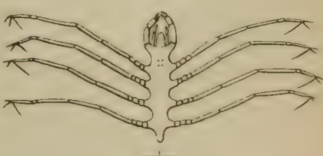


Fig. 8.

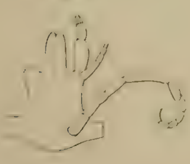


Fig. 9.

Genus II. *Pallene* (Johnston).

Species 2. *Pallene circularis* (Mihi). Body almost circular, from a sinuated ridge which surrounds it, and covers the origins of the legs, extremely rough and spiney; two tibial joints with three rows of strong hairs on the upper surface; auxiliary claws obsolete; abdomen very prominent and pointed.

The body and legs are covered with hairs, which are scattered irregularly over it, except on the two tibial joints, where they are arranged in three rows along the upper surface. The rostrum is as long as the first joint of the mandibles. The first joint of the body is very short, so that the rostrum, mandibles, and first pair of legs, are inserted close to one another. The body surrounded by a spiny sinuated ridge, which covers the insertions of the legs. The oculiferous tubercles with eyes, obtuse, black, shining, and placed in a quadrate form. The abdomen erect, pointed, and very prominent. Body one line in length; span of the legs two lines; colour dark straw. Hab. Firth of Forth.

For the animal which shall be presently described, I have found it necessary to establish another genus. The animal is remarkable, inasmuch as it forms a connecting link between the non-palpate and palpate genera of this order.

Genus III. *Pephredo.**

Rostrum short, cylindric; palpi 3-jointed, as long as the rostrum; oviferous legs 6-jointed; first tarsal joint minute; no auxiliary claws.

Species 3. *Pephredo hirsuta* (mihi). Animal robust, opaque; rostrum as long as first joint of mandibles; palpi with a bush at the extremity; thigh not so long as the first tibial joint; abdomen short and pointed.

The animal is of a dark straw-colour. The rostrum cylindric. The three coxal joints are equal, and as long as the thigh-joint. The oculiferous tubercle is obtuse, and situated a little before the insertion of the anterior pair of legs: the eyes obscure. The articulations of the body are very narrow,

* Pephredo, one of the sea-nymphs.

the origins of the legs being placed close to one another. The last joint of the abdomen is not much produced, but pointed. Oviferous legs are moniliform, the last joint armed with a straight claw or spine.

Hab.—German Ocean.

Genus IV. *Nymphon.*

Species 4. *Nymphon Johnstonii* (mihi).* Body granular: legs smooth, without spines or hairs, except at the distal extremity of the second tarsal joint, which is armed with a fringe of strong spines: oculiferous tubercle projecting considerably above the eyes.

The whole animal is of a straw-colour, except the claws at the extremities of the mandibles, and the edges of the oral aperture, which are black. The rostrum is longer than the first joint of the mandibles. The oculiferous tubercle is situated on the posterior edge of the cephalo-thoracic segment of the body, and projects considerably backwards: the eyes, instead of being arranged on its summit, being arranged around its sides. The legs are slender, a deep sulcus runs along the sides of each of them, beginning at the proximal extremity of the thigh, and ending at the distal extremity of the second tarsal joint. The second tarsal articulation is armed with a fringe of strong spines, which are situated in a line above the auxiliary claws, and cover the bases of the latter. The abdominal segment is prominent, and the anal aperture is very distinctly seen in it. Length of the body two lines: span of the legs two inches and three quarters.

Hab. German Ocean.

Species 5. *Nymphon pellucidum* (mihi). Animal slender, pellucid: body without spines: legs armed with spines placed at regular intervals, patent on the second tibial joint, third coxal joint about half as long as the first, second tibial very long and slender: auxiliary claws strong: abdomen prominent, extremity bifid.

Hab. Firth of Fort .

Species 6. *Nymphon minutum* (mihi). Animal slender, pel-

* I have named this species after Dr Johnston of Berwick—a naturalist who has done much to elucidate the natural history of this family of Crustacians.

lucid: rostrum not so long as the first joint of the mandibles: thigh longer than the first tibial joint: auxiliary claws obsolete: abdomen produced and pointed.

The body and legs are covered with spines. The segments of the body are elongated. The three coxal joints are equal; the three tarsal joints minute. The body is nearly one line in length; the span of the legs two lines.

Hab. Firth of Forth.

Species 7. *Nymphon spinosum* (mihi). Rostrum longer than the palpi: posterior edges of the three middle segments of the body armed with a fringe of strong spines: first tarsal joint minute.

The body is covered with punctures, except at the posterior edges of the three middle segments, which are armed with a fringe of strong thickset spines. The whole animal is stronger and coarser than any of the preceding species. The second coxal joint is longer than the first and third united; the first tarsal joint minute. The first joint of the oviferous legs is the longest. The abdomen is erect and prominent.

Description of the Plate.

Fig. 1. Phoxichilidium globosum.
Fig. 2. Pallene circularis.
Fig. 3. Nymphon spinosum.
Fig. 4. Nymphon Johnstonii.
Fig. 5. Nymphon pellucidum.
Fig. 6. Nymphon minutum.
Fig. 7. Pephredo capillata.
Fig. 8. Rostrum and first segment of the body of N. spinosum, with the oviferous legs, palpi, and mandibles attached.
Fig. 9. Same parts in Pephredo capillata. The circular body in the middle of the first segment appears to be connected with the organs of circulation.

Account of the Arran Baryto-Sulphate Pigment. By Professor Traill.*

About two years ago I read a short notice of the Denbighshire manufacture of a pigment from Sulphate of Baryta. Since that I have visited the works lately erected in the isle of Arran by the Duke of Hamilton for the same purpose; an account of which I beg leave to submit to the Society, pre-

* Read before the Wer. Nat. Hist. Soc., 11th Dec. 1841.

mising that the manufacture has now extended to some other places, and has assumed importance, as the conversion of a substance, hitherto considered as almost useless, into a product of considerable value.

The works now to be described are about half a mile from the shore in Glen Sannox, within three or four hundred yards of several considerable veins of a very pure Sulphate of Baryta, traversing the granite of Goatfell. The veins, which seem to be those discovered long ago by Professor Jameson, cross the impetuous mountain torrent that collects the waters of this wild glen; and two of them have been wrought on both sides of the stream. Two open cuts have been made on the north side of the torrent, and wrought to the depth of 16 feet. The veins on that side seem to decrease in width as they recede from the stream; but, on the south side, they appear to widen, and are now worked by means of a short adit, and a shaft, which at present is 25 feet deep. This shaft is kept dry by a pump, wrought by a small water-wheel, moved by one of the numerous streams that rush down the rocky sides of the glen. There are two principal veins, about 20 yards asunder. The direction of the most western is from N.NE. to S.SW.; the eastern runs from N. by E. to S. by W.; and both possibly may be branches of one great vein. They are nearly vertical where now opened.

From these veins a large quantity of a very pure, crystalline, translucent sulphate is extracted. Some masses have a slight brownish tint. It is the straight lamellar variety, and, for purity, exceeds greatly the spar employed in the Ayrshire and Welsh manufactories of *Baryto-Sulphate* pigments.

The works for preparing the paint are very well constructed. All the machinery is moved by an overshot water-wheel, 26 feet in diameter and 6 feet wide. The spar is first sorted and washed. It is so brittle that it is easily broken into small pieces, when it is washed with warm diluted sulphuric acid to remove any colouring matter; and it is afterwards crushed to powder by a pair of granite stones hooped with cast-iron, and revolving on their edges in a well-made circular trough of hewn granite. These stones weigh five tons.

The powder thus produced is introduced into cast-iron tubs, of about 10 feet in diameter, paved with slabs of granite, where it is ground, below the surface of water, by the attrition of four large blocks of granite, each of which is attached by iron chains to the arms of a vertical axis, put in motion by the water-wheel.

A stream of water is at intervals admitted into the tubs, and its overflow carries off the finer particles, which are collected in oblong troughs, where the water deposits the sediment in the form of an impalpable powder. There are four such grinding tubs in one large room, which contains also the crushing apparatus.

The collected sediment is drained and moulded into the form of thin bricks. These are removed to a stove kept at the heat of about 200°; and when dry, they are crushed, and packed into casks, to be sent to market.

The works are under the direction of a very intelligent overseer, Mr William Morton, who has had considerable experience in other chemical works.

The machinery at this place is capable of making twenty tons of white pigment a week, or more if there were two relays of workmen: at present, with only six workmen, ten tons per week are produced.

This white sulphate is ground up with oil as a paint, and is also mixed with white lead, to form a cheaper though inferior basis of a pigment. But, at this manufactory, I found that various colours are also imparted to the sulphate; such as blue, yellow, and green of various shades. The colours are either here ground with oil into prepared pigments, or are sent to Glasgow, where the colours are sold by Messrs Fleming and Hope, in Hanover Street.

The dry colours are sold at the following prices:—

Prepared White, at . .	L.4, 15s.	per ton.
Blue, from . . .	L.15 to L.20	...
Ordinary Green, at . .	L.20	...
Finest Green, at . .	L.25	...

I did not ascertain the price of the yellow; but it is probably about the same as the best green.

Of course, I did not ask how these colours were prepared; but I analyzed them, and then succeeded in imitating them, by precipitating various colours on the prepared sulphate, diffused in water—or rather in the metallic solutions which afforded the different tints. Thus, when it is diffused in a solution of triple prussiate of potassa, the addition of sulphate of iron produces a fine blue; when diffused in a solution of chromate of potassa, sugar of lead affords an excellent yellow. It is more difficult to procure a fine green from copper. I have not yet succeeded in procuring by precipitation so beautiful a green as that prepared in Glen Sannox. A fine green was obtained by precipitating Scheele's green, or the sulphate of baryta diffused in a solution of ammoniaco-sulphate of copper by means of arsenic.

The remarkable fact is, that when thus precipitated, the colouring matter is less easily separated by acids than from mere mixtures of the materials; as if there was some affinity between the metallic colours and the sulphate of baryta.

Description of a Portable Diorama, constructed by George Tait, Esq. Advocate. Communicated by the Royal Scottish Society of Arts.

The diorama, the ingenious invention of the celebrated French artist Daguerre, is a painting fitted up so as to receive light both in front and behind, by the full or partial admission, or the total exclusion, of either of which lights a great variety of effects may be produced. No light is admitted to the eye except that which proceeds from the painting.

The diorama is usually executed on an extensive surface of canvass, and placed in a large building fitted up for the purpose.

It occurred to me that it might be made upon a much smaller scale; and, accordingly (before the publication of Daguerre's description), I constructed for the reception of sketches in water-colours, which I painted for the purpose, a small box having, for the admission of light before and behind, openings capable of being closed by moveable shades, and having also a small opening in front through which the sketches might be viewed. Upon trying a variety of sketches in this apparatus, I have found that many pleasing and striking effects may be produced; for example, passing gleams of sunshine; day melting into moonlight; day fading into darkness, followed by morning gradually disclosing the landscape, having its former verdure shrouded in snow.

I shall now describe the apparatus in detail.

1. *The Box.*—Stretching frames are to be prepared for receiving the paper or linen on which the pictures are to be executed; and as these are confined within the inner edges of them, the frames ought to be made thick and narrow, so as not unnecessarily to increase the width of the box, and should be bevelled off to allow access to the brush in painting the back. Those frames are inserted in succession through a slit in the top of the box, about two-thirds distant from the front, and are received into a groove projecting from the top, sides, and bottom of the box, of such a breadth as fully to cover the front of them.

Two openings, one above in front and the other behind, admit the light; and both should be as large as possible. The front opening ought to be of the form seen in the figure, in order to admit the light gradually; an erect right angled triangle, with its base across the breadth of the box, being placed immediately behind the front-opening to aid this object. The openings have a ply of fine tissue-paper, Persian silk, or other appropriate material, placed over them, to diffuse the light. This is moveable, and is usually white, but may be of an orange, purple, blue, or other tint for particular purposes; and one or two plies may be used according to circumstances. The shades for the openings may be made to open and close in any manner found convenient, but so as to exclude all light when closed.

The small opening in the front, through which the pictures are to be viewed, ought to be opposite to the ordinary height of the horizon of pictures, perhaps about a third or a fourth part of their whole height. A small tube of about two inches in length, is fixed before that opening. The outer end is to be about an inch and a quarter in length, and about an inch in height, and is to be made to fit the eye, so as to screen it from extraneous light; while its inner end must expand into an oblong opening, so as to allow the spectator to view the entire picture. The tube may be made to receive lenses to magnify the pictures if desired. The internal end of this tube must be so constructed as to prevent light from above shining into it.

The inside of the tube, and every part of the box seen through it, ought to be made as black as possible; for which purpose black velvet is very effectual. The rest of the inside, including the inner surface of the shades, ought to be white, in order to reflect light. The front of the box ought to be black outside, and surrounded by a black curtain.

It is necessary to have a small opening and tube through which an exhibitor may view the pictures, when the spectator is unacquainted with the management of the apparatus. It should be on the same level as the spectator's tube. If the box be large, so as to admit of a distance of 8 or 9 inches from the spectator's tube, it may be on the front; if not, it will be necessary to have it on the side close by the front, and the pictures may be reflected to it by a very small mirror within the box. There should be placed over and behind it, to screen the eye of the exhibitor from the light without, a black moveable shade, which may be conveniently made of two parts, the upright part to support the horizontal part when in use, and both when not in use to fold upon the box. The part of the box within this shade is to be painted black.

The front and back shades should be fitted up in such a manner as to be opened conveniently, either by a spectator or by an exhibitor.

The box may be made of any size or proportions—the larger, the more striking the effect. And it may be supported upon a stand, or in any other manner convenient.

The annexed figures show a perspective view, side elevation, and plan of the box. The letters of reference are the same in all the figures.

A, Eye-hole for the spectator.

B, Ditto for the exhibitor, with a shade over it.

C, Small mirror reflecting the picture to the exhibitor.

DEF, Form of front light.

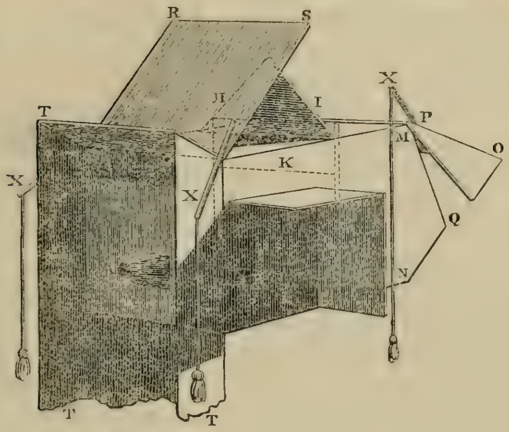
HI, Triangle to prevent a too sudden increase of light on raising the shade RS.

KL, Picture in its groove.

MQN, Back-light. The slope NQ is close. The slope MQ is open. It and the front-light DEF, are covered with tissue paper or other appropriate material. The back-shade PO extends beyond the opening. The intention of this construction is to admit the light in a proper position, and very gradually.

TT, Curtain hung in front, to shade completely the light from the spectator.

XXX, Levers for raising the shades easily, with cords attached.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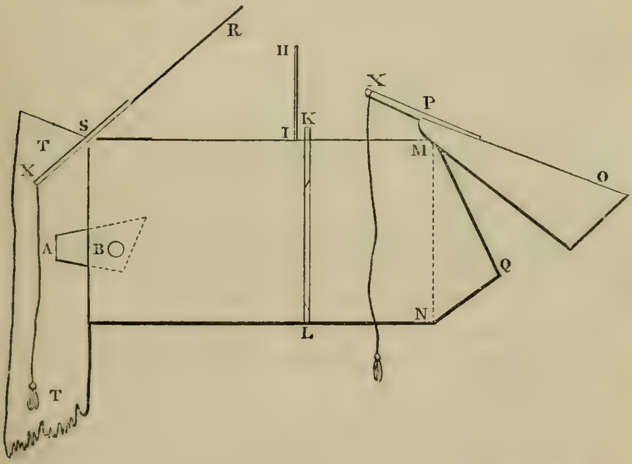
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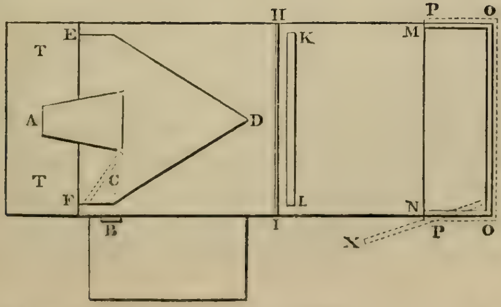
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2. *The Pictures.*—The pictures may be either in water-colours upon paper, stretched in the usual manner on the frames, or in oil upon linen.

In painting the front, whether in water-colours or in oil, the lights are left out, as in ordinary water-colour painting, so as to admit the light from behind to pass through, and body colours are to be avoided. The back of the pictures is covered with a strong semi-transparent tint in those parts where it is wished that light shall not pass freely, or it may be rendered opaque if required. When painting the back, no light is to be used except that transmitted through the front.

Objects painted behind are, of course, not seen by the front light; and objects painted in front appear so faint when seen by transmitted light, that it is easy to paint the back in such a manner as to make them disappear when the back light only is admitted, by which means great changes may be produced.

For farther information with regard to the execution of the pictures, see Daguerre's description of his method of dioramic painting. There is an English translation of it by Dr Memes.

The appearance of fog, which is not mentioned in Daguerre's description, is produced by painting the objects intended to be affected by it on a second surface, immediately behind the front surface. Light is admitted behind. When the second surface is removed more or less from the other, the objects on it appear more or less involved in fog. And, as it is brought into contact with the other, the fog appears to clear away.

A great variety of effects of day-light and moon-light may be produced by judicious management of the pictures, and by the adoption of contrivances sufficiently known or obvious to those who have paid any attention to art generally.

3. *The Light.*—*In day-light* the back of the box is placed close to a window, and no more light ought to be admitted into the apartment than is necessary fully to light the box. *At night* the openings may be lighted with oil or gas, or even with a few candles, if the box be small. The very strong orange tinge of ordinary artificial light is unfavourable to the

natural and pleasing effect of the pictures; but it may be so far counteracted where necessary, as sometimes in night-scenes or snow views, by interposing tissue-paper or other appropriate material, tinted blue.

The effect produced depends in a great measure on the management of the light, and a few experiments will soon enable any one to regulate its admission so as to exhibit every change of effect.

I have been induced, by the representations of friends, to bring this Portable Diorama under the notice of the Royal Scottish Society of Arts; and I have no doubt that the experiments of others may lead to many improvements in its construction. G. Tait.

Edinburgh, 1st *November* 1841.

Analyses of new Mineral Species. Communicated by Dr Thomas Anderson of Leith.*

Aphrodite.—A mineral found at Taberg and Sala, and long supposed to be Meerschaum, has, on analysis, been found to be Serpentine. A mineral, however, of the same sort, from Langbanshyttan, and which is identical in external characters, is found to have a different composition, and has been called Aphrodite, whose composition is

Silicic acid, . . .	51.55
Ox. manganese, . . .	1.62
Protox. iron, . . .	0.59
Magnesia, ...	33.72
Alumina, . . .	0.20
Water, ...	12.32
	100.00

This is therefore the third bi-silicate of magnesia which occurs; the other two being Picrosmine and Picrophylle.

Berzelite.—Under this name Kuhn has described a mineral from Langbanshyttan, of an impure dirty white or honey-yel-

* The above communication was sent from Stockholm by Dr T. Anderson, who is at present studying there under Berzelius.

low colour, and of a waxy lustre. Sp. gr. 2.52; hard. 5—6. It gives signs of a cleavage plane; is brittle and easily pulverised; before the blowpipe behaves as Pharmacolite. It appears to be a mixture of arseniates of lime, magnesia, and manganese. The composition is

Lime,	20.96
Magnesia,	15.61
Protox. manganese,	4.26
Arsenic acid,	56.46
Iron—a trace,	
Loss,	0.43

Esmarkite.—Under this name Erdmann has described a mineral found about 100 paces from the locality of the Praseolithe (to be afterwards noticed); it occurs in granite, in the form of large irregular crystals, which seem to be prismatic, with the edges and angles rounded; they are for the most part covered with a glittering coat. The crystals have an evident cleavage at right angles to the principal axis, and this cleavage has a feeble pearly lustre. The longitudinal fracture has a resinous lustre; hardness between calc spar and fluor spar; sp. gr. 2.709. Before the blowpipe gives water and becomes bluish grey; melts on the thin edges only, to a green glass; fuses with borax and microcosmic salt, with the colour of iron; gives a yellow slag with soda. Its composition is

Silicic acid,	45.97
Alumina,	32.08
Magnesia,	10.32
Ox. of iron,	3.83
— — manganese,	0.41
Water,	5.49
Lime, oxides of copper, lead, cobalt, and titanium,	0.45
	98.55

Euxenite.—Under this name Scheerer has described a mineral from Jölster in Norway. It is amorphous, dark brown, of a metallic resinous lustre, and has an imperfect conchoidal fracture. In thin plates it is transparent, with a red colour; gives a pale red powder; sp. gr. 4.60; hardness near that of Thorite, which, however, it scratches; does not melt alone before the blowpipe; fuses in borax and gives a yellow colour; with microcosmic salt, if well neutralized, it gives after cooling a green glass which becomes darker with tin. The composition is

Tantalic acid, . . .	49.66
Titanic acid, . . .	7.94
Yttria, ...	25.09
Protox. of Uranium, . .	6.34
— — Cerium, . .	2.18
Ox. of lantanium, . .	0.96
Lime, ...	2.47
Magnesia, . . .	0.29
Water, ...	3.97
	98.90

Leucophane.—This mineral, which is found on a small rock near the mouth of the Langesundfjord in Norway, was discovered by Esmark, and analyzed by Erdmann. It occurs in syenite along with albite, elaolite, yttrotantalite, and another new mineral named Mosandrite. Leucophane is seldom regularly crystallized, but has three distinct cleavages. When cleaved it gives four-sided prisms, with angles of 53°.24′.7, and 36°.26′.3, which appear to belong to the triclinometric system. Colour varies from pale impure green to dark wine yellow. In thin plates it is colourless. It gives a bluish phosphorescent light, and becomes slightly electric when heated. Hardness nearly that of fluor-spar. Sp. gr. 2.974. Melts before the blowpipe into a clear, somewhat violet enamel. With borax gives a clear amethyst glass; with a little soda it gives an opaque globule; with more it melts into the charcoal; with microcosmic salt in a tube it gives fluosilicic acid gas. Its composition is

Silicic acid, . .	47.82
Glucina, . . .	11.51
Lime, . . .	25.00
Protox. mangan., . .	1.01
Potassium, . .	0.26
Sodium, . . .	7.59
Fluorine, . . .	6.17
	99.36

Mosandrite.—This mineral was found by Erdmann along with

Leucophane. It is a silicate and titanate of the oxides of cerium and lantanium. It is in part crystallized in imperfectly-formed prisms, and in part amorphous. It has one evident, and several obscure cleavages. The first of the two varieties has a lustre between resinous and vitreous; the latter is resinous. Colour dark reddish-brown, in thin plates, red by transmitted light. Gives a greyish-brown powder, has the hardness of fluor-spar, and sp. gr. from 2.93 to 2.98. Before the blowpipe yields much water, and by ignition becomes brownish-yellow; melts easily into a brownish-green pearl; with borax gives an amethyst-coloured glass, which in the reducing flame becomes nearly colourless; does not fuse so easily with microcosmic salt, and in the reducing flame gives the colour of oxide of titanium. As yet it has been only quantatively analyzed, and found to contain silica, titanic acid, oxide of lantanium, manganese, lime, a little magnesia, alkali, and water. The four first are the chief ingredients.

Praseolithe.—Discovered by Pastor Esmark, and described by Erdman. It is found at Bräkke, near Brevig, in Norway, in granite, accompanied by chlorite, titaniferous iron, and tourmaline. It is irregularly crystallized, and seems to form four-sided prisms, which, however, are often got with six, eight, or twelve sides, with the angles and edges rounded off. Colour green, from light to dark green. It has only one cleavage; fracture splintery and conchoidal; lustre small; hardness between calc-spar to fluor-spar; gives a light green powder; sp. gr. 2.754. Before the blowpipe gives water, and melts with difficulty on the sides to a bluish-grey glass. Its composition is

Silicic acid,	40.94
Alumina,	28.79
Protox. of iron,	6.96
— — mangan.,	0.32
Magnesia,	13.73
Water,	7.38
Oxides of lead, copper, cobalt, and lime,	0.50
Titanic acid,	0.40
	99.02

Rosite.—This is the name given by Swanberg to a new mineral from Aker, long taken for amphodelite, which it closely resembles in external characters. It is found disseminated in calc spar in grains about the size of hemp seed. It is not regularly crystallized, but has a crystalline fracture, with natural cleavage planes. It is softer than calc spar, but harder than gypsum. Sp. gr. 2.72. When heated before the blowpipe, it gives off water and loses colour. It melts with great difficulty into a white slag; with borax and microcosmic salt, it fuses with great difficulty; with soda it melts easily, and an additional quantity does not render it less fusible. The distinctions between it and amphodelite are these, that amphodelite scratches fluor spar, but Rosite is scratched by it; amphodelite is more difficultly fusible alone, and easily so with a little soda, but with a larger quantity is infusible. The composition of Rosite is—

Silicic acid, . . .	44.901
Alumina, . . .	34.506
Perox. of iron, . .	0.688
Ox. manganese, . . .	0.191
Potassa, . . .	6.628
Soda—trace.	
Lime, ...	3.592
Magnesia, . . .	2.498
Water, ...	6.333
	99.337

Saponite.—Under this name, Swanberg has described a mineral found in the Braskvedst Svartvik mines in Dalecarlia; it is met with filling up a cleft in the rock about an inch wide. When first obtained it is soft and of the consistence of soap or butter, but by exposure to the air, becomes hard, forming in part lumps, and in part falling into powder. It is easily scratched by the nail. Colour white, yellowish, or red; has an unctuous feel; adheres to the tongue. Before the blowpipe, it gives much water, and becomes black, like most magnesian minerals; fuses with borax and microcosmic salt, and, with soda, gives an opaque glass. Its analysis gives the following composition:—

Silicic acid,	50.8
Magnesia,	26.5
Lime,	0.7
Alumina,	9.4
Perox. of iron,	2.0
Water,	10.5
	99.9

Is Graphite the Metal of Carbon? By Professor HAUSMANN of Göttingen.

I HAVE to thank the kindness of Professor Wöhler for a remarkable variety of Graphite from Ceylon, which he lately found in the possession of an apothecary. It is of the foliated kind, has a thick columnar structure, and shews in some places a tendency to individual crystalline development. In the pieces now lying before me, the length of the columnar portions is two Parisian inches. They are partly straight and uniform, partly bent. The pieces are bounded by parallel surfaces, in regard to which the columns are either at right angles or somewhat obliquely placed; and it is not improbable that they were obtained from a vein. The individual columns afford longitudinally an extremely perfect cleavage, to the smallest lamellæ. By inserting the knife in one end of the columns, thin stripes may be taken off along the whole length, which retain their continuity, and become bent in a curved manner, just as bark may be peeled from a young branch. The breadth of the folia depends on the size of the distinct concretions, and generally measures from a half to two lines. The cleavage surfaces have a high lustre, and are quite brilliant. When we examine them under a lens, we perceive on them sometimes lozenge-shaped perpendicular fissures, that seem to indicate concealed cleavages which cut the principal ones at right angles, and have previously been noticed in Graphite. If we place one of the separated folia on an anvil, it can be made somewhat thinner and larger by hammering, which property (not, I believe, hitherto observed), in combination with the perfect opacity of its thinnest folia and its electrical characters, afford a new proof in favour of Karsten's opinion that graphite is to be regarded as the metal of carbon. According to the experiments of Professor Wöhler on this foliated Graphite, it can scarcely be burnt by means of oxygen gas, although the diamond itself is consumed in this way; and it does not of itself continue in the least to burn in the gas. It appears to leave no ashes.*

A Notice by Humboldt regarding Ehrenberg's Discovery of Living Infusoria in Beds in and around Berlin.†

M. de Humboldt lately presented to the French Academy of Sciences, on the part of M. Ehrenberg, Member of the Academy of Berlin, and corresponding member of the Institute, specimens of the turfy and argillaceous bed which, at the depth of twenty feet below the pavement of the city of Berlin, was found filled with infusoria still in a living state, and having their ovaries perfectly preserved. The marks of this subterranean life are observable eight feet below the bottom of the Sprée. Since M. Ehrenberg pointed out, in 1836, immense masses of fossil infusoria, and the siliceous and calcareous envelops of microscopic animals in particular geological formations of very recent date, then in chalk, in the oolitic limestone of Cracow, and even in the more ancient (transition) limestones of Russia, he has ascertained that organic agents are still so active in mud taken from rivers and harbours, that, for example, of a mass of 2.592,000 cubic feet, taken in 1839, and 1.728,000 cubic feet taken in 1840 from the harbour of Swinemünde, on the shores of the Baltic, the one-half, or at least the one-third, was composed of microscopic organisms. The landes or heaths of Luneburg contain a bed of fossil infusoria twenty-eight feet thick. In the strata found at Berlin, extending to twenty, and in some localities (in the form of a funnel), even to sixty feet in depth, a great number of Gallionellæ are met with, having their cells filled

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* From "*Studien des Göttingischen Vereins*," 1841.

† Similar beds occur near Edinburgh, as on Arthur's Seat.—Edit.

with green eggs. The animals cannot come in contact with the oxygen of the air in any other way than by means of the water which moistens the turf; but we cannot doubt that they have the power of multiplying. In the subterraneous Naviculæ, spontaneous movements have been at times seen, but those movements were much slower than in the Naviculæ found near Berlin on the surface of the ground. The greatest number of forms in the subterraneous bed are not found either near Berlin nor in the Baltic Sea, but in the neighbourhood of Plieger, among the strata of fossil infusoria, which alternate with lignites and beds of free-stone. The slender spines so characteristic of marine sponges likewise abound, and appear to indicate that this extraordinary phenomenon is of pelagic origin. In some quarters of Berlin, the solidity of buildings is endangered by this bed of living infusoria. M. Ehrenberg presents at the same time an extract from five memoirs, a translation of which is to be desired for some of our journals of natural history. The observations of this philosopher embrace the most distant countries, Dongola, Nubia, the delta of the Nile and its mud, the infusoria of North America (214 species, of which 94 are living and 120 fossil), Siberia, the Malvina and Marianne islands. M. Ehrenberg intends to publish, at the close of this year, a great work in folio, similar to his magnificent publication on living infusoria, entitled—*Forms of Life and Primitive Organization in the Solid Part of the Crust of the Globe*; with thirty-five plates engraved from the author's drawings.*

On the Deposition, Composition, and Origin of Masses of Tin Ore. By M. Daubrée, as reported on by the French Academy of Sciences. (M. Dufrenoy, Reporter).

The use of metals goes back to the remotest antiquity, and there is no country where we do not find numerous traces of the working of mines of lead, copper, or iron. It is therefore natural to suppose, that if there remained anything to be dis-

* From Comptes Rendus, No. XVIII., 2d Nov. 1841, p. 897.

covered in the grand laws which have regulated the formation of the earth, the history of metallic beds is at least fully known. Such, however, is by no means the case, and the mineral kingdom presents us with the singular circumstance, which has already been remarked, that the phenomena least known are almost always those which we are in a condition to observe every day. Indeed, if we read the numerous descriptions which have been published on mineral deposits, we remark differences which may well excite surprise. This is often owing, in part, to the observations having been made on a small scale, and to the circumstance of particular cases or exceptions having been too frequently mistaken for general laws. In this respect, M. Daubrée's Memoir is of great interest. He has visited the greater number of tin mines in Europe; and the remarkable conclusions he draws from their comparison, with respect to the origin of these metalliferous beds, deserve the full attention of geologists and chemists. Before giving an account of them, we think we should state the principal circumstances mentioned by this young professor.

Tin mines are disposed to assume two kinds of arrangement, which are carefully distinguished by the miner; some form very circumscribed masses; others, on the contrary, constitute veins of small width, but often of considerable extent. It will be understood, by these words alone, how different the modes of working them must necessarily be; in the one case the works, included in a very small space, are merely required to raise the bed in a mass; in the other they are placed at some distance from each other, and form a long train. These differences in form are almost always accompanied with still greater differences in the disposition of the mineral; in the case of the arrangement in masses, the oxydized tin composes very slender veins, which, taken together, form a net-work diffused in an almost uniform manner throughout the rock, in such a way as to appear contemporaneous with it.

This arrangement is observed in the mass of Geyer, in Saxony, where the oxide of tin is disseminated throughout the matrix in fine particles, often imperceptible to the naked eye.

In mines where the tin occurs in veins, the metalliferous part is, on the contrary, completely distinct from the enclosing rock; and when the latter is schistose, as is the case with the killas of Cornwall, we perceive the veins cutting across the lamina of the slate in a very obvious manner; distinct *salbandes*, besides, separate the ore, so that, to the least experienced eye, it is evident that the tin ore is more modern than the formation in which it occurs; that the latter, after being formed, was rent, and the fissure afterwards filled with the tin and its matrix. But a contrary origin has often been admitted for the massive deposits, and some geologists still believe that the tin is separated from the mass of the rock by simple crystallization, or that it has, so to speak, percolated across.

M. Daubrée proves that, in the masses, as in the veins, the formation of the oxide of tin is more modern than the enclosing rock, even when this mineral is found disseminated throughout the very mass of the rock in invisible portions, as in the granite of Geyer. This arrangement takes place only in certain places, which together form a determinate zone, a kind of cap which envelopes the rock on all sides. There is therefore a difference of origin in the granite and tin; and what proves this difference is, "that when the granite is stanniferous it loses its ordinary nature, its felspar disappears, it passes into a rock chiefly quartzose, with a little mica arranged like small veins; there is even a connection between the hyalomicte (granite without felspar) and the presence of tin, as if the penetration of the oxide of tin in a granite had been followed by the removal of the felspar." The difference of origin becomes still more obvious when we study the small veins of the oxide of tin which always exist in the best characterized masses. That of Geyer, which we have mentioned as an example of the intimate penetration of tin in granite, likewise presents numerous little veins, which, although distinct at first, diminish in thickness by degrees, and at last become confounded with the mass; but in such places, when they vary from 1 to 5 centimetres in thickness, they offer all the distinctive characters of veins. "They are then composed principally of quartz and mica, and fully formed *salbandes* are observed in them."

These details, which might be much extended, therefore prove, that, notwithstanding apparent differences, there is still almost an identity between the two classes of formations in tin mines. This identity becomes almost absolute when we examine the nature of the minerals which usually accompany tin, whether in masses or in veins. It is the study of these which forms the truly novel part of M. Daubrée's work, and it has led him to ascribe a common origin to them.

He has found that in all the formations quartz exists in great abundance, and that its existence is so connected with the presence of oxide of tin, that when the enclosing rocks are impregnated with that mineral, they become in general more quartzose, as is seen at Geyer and Altenberg.

After the quartz, which always predominates, whether in the large or small veins, and also in the enclosing rock, the most constant accompaniments are the fluoric compounds, principally fluo-silicates, sometimes fluo-phosphates or fluorides.

Thus the micas which accompany tin are in general rich in fluorine. That of Altenberg contains 3.47 per cent. This substance enters in the proportion of from 4.84 to 8.00 in the two varieties of Zinwald mica analysed by Gmelin.

Topaz and schorlite, which contain even a greater quantity of fluorine than these micas, are very frequently found in the *stockwerks* of tin; and the latter substance forms a great mass in the formation of Altenberg. Lastly, we pretty frequently find apatite or the fluo-phosphate of lime, and even the fluoride of calcium.

The granitic veins of Finbo, near Fahlun, which contain oxide of tin, with tantalic oxide, likewise produces topaz, fluor spar, and various fluorides of cerium and yttria.

In the celebrated topaz and emerald mines of Adon-Tschelon, on the Chinese frontier of Siberia, we sometimes find oxide of tin, along with wolfram and mica, analogous to that of Zinwald. Lastly, it may be observed that the specimens of tin from Greenland, which are to be found in most mineralogical collections, come from the same locality as the cryolite, so rich in fluorine.

Thus, according to M. Daubrée, all the stanniferous masses known are characterized by the presence of fluorine, the proportion of which is often considerable, if we compare it, not with the total volume of the mass, but with its richness in tin. The boric minerals, without being so frequent as those of a fluoric nature, appear in many circumstances to have a rendezvous (so to speak) likewise assigned them in these same metallic deposits. Tourmaline, which contains nearly 6 per cent. of boric acid, occurs in the greater number of stanniferous masses. It even often happens, as at Carclaze and Mont St Michel, in Cornwall, at Villeder and Pyriac in France, that it is disseminated in abundance through the enclosing rocks.

Such constant occurrence of fluoric minerals in deposits of tin, leads M. Daubrée to suppose "that the fluorine has performed an important part in the formation of stanniferous masses." According to him, "this body, which has been so little attended to, that it has actually been passed over in silence in all descriptions of formations of tin, appears notwithstanding as active an agent as sulphur and the combinations of sulphur in the greater portion of other kinds of metallic deposits.

"The fluoride of tin," he says, "being a fixed combination at all temperatures, and very volatile, we may suppose that this metal has come up from a depth which appears to be the general reservoir of metals in the state of fluorides; it is probably the same thing with tungsten and molybdena, the constant accompaniments of tin. Boron having a strong affinity for fluorine, and forming with it a combination which cannot be decomposed by heat, and is very volatile, one is led to suppose that the transport of this body has likewise taken place in the state of a fluoride. Finally, silicium, which abounds in deposits of tin in the state of Silica, combines with the fluorine in a manner analogous to the boron, and it is equally natural to admit that a portion of the Silica has been conveyed to its destination under the form of a fluo-silicic acid. In support of the theory which he brings forward in regard to the transport of tin by means of fluoric acid, M. Daubrée refers to the mine of Huelcoath, near St Agnes Beacon, in Cornwall, where oxide of tin is found in the form of felspar crystals. This remarkable *epigenic*, which is so difficult to understand by the natural reactions between the elements of felspar and tin, is very easily explained when we admit that the fluoric acid has served both as a vehicle for the tin and as the agent which destroyed the felspar.

We remember that about twenty years ago M. de Buch ascribed this latter effect to fluorine, to account for the decomposition into kaolin of certain porphyries in the neighbourhood of Halle, in Saxony; but M. Daubrée is the first who has assigned to this simple substance a power which may be said to be creative.

The intervention of fluorine in the formation of the oxide of tin is in accordance with the greater part of the circumstances which accompany these metalliferous deposits. At the same time this ingenious theory is not free from all objection. M. Daubrée announces, at the end of his memoir, that he is engaged with researches in the laboratory which will throw light on this important subject.

Your commissioners hope that the details into which they have entered regarding M. Daubrée's memoir, will prove to you, that, independently of the ingenious theoretical considerations to which it leads, the work contains a great number of carefully observed facts, and new and judicious applications of them.

They consequently propose to you that thanks should be returned to this young professor for his interesting communication, and that he should be invited to continue the researches he has commenced on the action of fluorine in the formation of metallic deposits. They likewise ask of you to vote for the memoir being printed in the collection of the *Savants Etrangers*, if the means of publication have not been already provided in the *Annales des Mines*.

The conclusions of this report were adopted.*

Account of the Belemnites of the Lower Cretaceous Formations in the neighbourhood of Castellane. By M. Duval-Jouve, as reported on by the French Academy of Sciences.

Belemnites, which abound in a fossil state in secondary formations, and which owe their name to the rude resemblance they bear to a dart or arrow, have, for a long time,

* From Comptes Rendus, No. 17, 25th October 1841, p. 854.

attracted the attention of naturalists; commentators have supposed they recognise them in the *Lyncurium* described by Theophrastus, or in the *Dactylus idaeus* of Pliny; and howsoever the case may be with these obscure indications, we can, with certainty, trace the observations of which these bodies have been the object as far back as Agricola. The list of authors who have successively treated of them from the first half of the fifteenth century up to our own era, is of very great length. It is only, however, in later times that observers have agreed as to the nature and origin of these remains of animals no longer existing, and, in order to do away with all uncertainty in this respect, not only the profound researches of many zoologists into their internal structure was necessary, but the discovery, besides, of a Belemnite expanded at its anterior extremity like the bone of a cuttle-fish, and still enclosing in a cavity thus formed an ink-bag similar to those of the Cephalopodes of our own seas. This fact, which M. Agassiz has determined in two fossils found by a lady at Lyme-Regis, effectually proves that Belemnites are not spines of Echini, or the cutaneous appendages of some other echinoderm, as Klein supposed upwards of a century ago, and as M. Raspail contended only a few years since, but really internal shells belonging to a mollusc whose organization must offer many points of analogy to the cuttle-fish (*Loligo*) of the present era. This result will not be seriously questioned by any one who is capable of appreciating at their just value the researches on this subject, published by Miller, by our learned associate M. de Blainville, and also by Voltz, an observer as exact as he was laborious, whose recent death we have to lament. The nature of Belemnites was no longer, therefore, a problem requiring a solution; but the study of the differences these fossils present among themselves was but little advanced, and much uncertainty prevailed regarding the distinction of the species,—an interesting question to the zoologist, but still more important to the geologist, who might desire to find in those remains characters capable of fixing the date of the deposits in which they are found embedded.

In order to throw light on this part of the history of Belemnites, it was not enough to compare and describe the variations observed in the exterior configuration, it was necessary to examine with care the modifications of internal structure which these fossils present, to determine the differences arising from the age of the animals to which they belonged, and to endeavour to ascertain the limits of the variations to which individuals of the same species are subject, in consequence of the circumstances in which they have lived, or the accidents to which they have been exposed. Many naturalists have collected observations on this subject, more or less precise; M. de Blainville, M. Voltz, and M. d'Orbigny, for example; but the small number of specimens which these gentlemen had generally at their disposal did not permit them to carry their researches so far as they would unquestionably have done, had materials been supplied to them. The author of the memoir now under examination, was placed in more favourable circumstances; and skilfully availing himself of the paleontological riches with which his mountains supply him in profusion, he has been enabled to add new facts to those already known, and to solve in an explicit manner an important part of the questions hitherto unanswered. The vicinity of Grasse, where M. Duval is established as a professor of philosophy, is one of the localities where Belemnites are found in the greatest abundance; and during the ten years that this observer has applied himself to the study of these bodies, he has not ceased to explore the various strata of the lower cretaceous formations in which they are found, both in the north-west portion of the Department of Var, and in that bordering on the Lower Alps, near Castellane. M. Emeric, who inhabits the same district, and who likewise actively devotes himself to paleontological pursuits, has furnished him with a valuable collection, so that our author has had at his disposal not fewer than upwards of ten thousand individuals. It has been easy for him, therefore, to follow step by step the changes produced by growth in the form and structure of these curious shells; to multiply as much as he pleased sections for the purpose of shewing the arrangement of their constituent parts, and to appreciate the value of the variations remarked in them. We cannot, without encroaching too far on the time of the Academy, follow M. Duval step by step in his exposition of the results to which he has thus been led; but to shew the most prominent features of his work, it will be sufficient to indicate some of the facts which this observer has established.

The naturalists who have treated of Belemnites are not agreed as to the degree of importance which ought to be attached to differences of form in these fossils; and in order to shew to what an extent this difference of opinion has been carried, it may be sufficient to state, that thirty-three of the species described by M. Raspail are referred by M. d'Orbigny to one and the same species—namely, the *Belemnites dilatatus* of M. de Blainville. This is owing to the first of these authors regarding all the variations of external form as characteristic of distinct species, while M. d'Orbigny looks upon these variations as being dependent for the most part on the changes which the age of the animal occasions in the shape of the shell. This latter opinion was supported by powerful arguments, but its accuracy was not demonstrated; and we were not in possession of a certain rule for distinguishing the specific peculiarities of different individuals, produced by the progress of its growth. Now, this rule has been definitely laid down by M. Duval; and, in the greater part of instances it admits of no uncertainty.

Belemnites are found to be composed of two principal parts —namely, a conical alveolus or socket, a kind of cup divided by partitions, open in front, and a sort of sheath covering this socket, and prolonged more or less posteriorly, so as to form a *rostrum* directed backwards. The cup or socket increases by the formation of new chambers placed before those already existing, and secreted by an organ lodged in the interior; the rostrum, on the contrary, acquires size nearly in the same manner as the stalk of an exogenous plant, by the successive deposit of layers applied exteriorly to the more ancient layers, and produced very probably by the action of a part which, in its turn, covered all this portion of the shell. These superimposed layers are, in general, very distinct among themselves; and, consequently, by making suitable sections of the Belemnite, it becomes easy to ascertain in an adult individual the form which it must have borne after the deposition of each of these plates or layers—that is to say, at different periods of its growth. We thus see that, in certain species, the general form remains nearly constant, notwithstanding the increase of volume, because each new layer covers the entire rostrum, and is of the same thickness throughout; while in other species the layers are deposited only on a part of the length of the rostrum, and vary among themselves in respect to their thickness in different parts of their extent, whence more or less considerable variations ensue in the exterior form of the shell, in proportion as the animal increases in age. Now, this very simple circumstance enables us to appreciate the influence of the progress of growth on the configuration of these fossil bodies, and furnishes a certain rule for distinguishing the peculiarities of form inherent in the species, and the variations depending on the age of individuals; for each species carries along with it the indication of the form through which it has passed, and thus offers points of comparison for determining individuals of a less advanced age. It is in this way that M. Duval has been convinced that the *B. linearis*, *elegans* and *augustus* of M. Raspail, are young individuals of *B. dilatatus* of Blainville; that *B. complanatus*, and *B. spathulatus* of Raspail, are individuals of the same species a little more advanced in age; and that *B. sinuatus*, *ellipsoides*, and *emarginatus* of the latter author, likewise pertain to this same species; while *B. Emerici*, which may easily be confounded with *B. dilatatus*, and considered a variety of that species by M. d'Orbigny, is distinguished by its conformation when in a young state.

The attentive study of the interior structure of Belemnites has led M. Duval to another result still more unexpected, and not less interesting, for it has enabled him to ascertain how the exterior form of these bodies may be modified in a multitude of ways more or less singular, in consequence of the fracture of the terminal portion of the rostrum, and the means of consolidation employed by nature to repair the injury. He has satisfied himself that, after such a fracture, the deposition of the concentric layers of the rostrum may continue to go on, either after the fall of the posterior fragment, or around the same fragment more or less thrown out of its normal position, and that in all the cases the shell has become deformed in a greater or less degree. Nothing is more common than to find among the cretaceous formations of the Lower Alps Belemnites of irregular form and strange appearance, such as *B. triqueter*, *B. mitra*, *B. mitraeformis*, *B. difformis* of M. Raspail; now a longitudinal section invariably shews that these shapeless individuals have undergone fractures, the marks of which can be easily recognised, and that the malformation they exhibit precisely corresponds to the seat of this mechanical injury. It is consequently evident that the existence of such irregularities of form cannot constitute a specific character; and it is by arguing on this fact that M. Duval proves, for example, that the four pretended species mentioned above have been properly referred by M. d'Orbigny to the species provisionally denominated *B. dilatatus* by M. de Blainville.

A third fact recorded in M. Duval's Memoir, and of such importance that we cannot omit to mention it in this place, refers to the position of the siphon which traverses the chambered portion of the Belemnites. In all the species previously known, the canal appears in the median line, near the ventral face of the shell; this character M. Duval has recognised in all the cylindrical Belemnites submitted to his examination; but he has ascertained that in all the compressed Belemnites which occur in such great abundance in the cretaceous formations of the Lower Alps, the siphon is situate on the opposite side; that is to say, contiguous to the dorsal partition of the socket. This peculiarity does not appear to have been previously noted, and it furnishes our author with a basis for the classification of these fossils, which he divides into three families—Biparties, Notosiphites, and Gastrosiphites.

M. Duval does not confine himself to these general observations; he figures and describes, with minute care, the sixteen species of Belemnites which he admits to exist in the cretaceous formations of the Lower Alps, and supplies interesting considerations respecting the geographical distribution of these fossils; a subject which had previously been taken up by M. d'Orbigny. Lastly, we shall still further add, that M. Duval, in illustration of this part of his work, gives a geological description of the inferior cretaceous formations of the environs of Castellane, and distinguishes two stages in the neocomian formations of that country, only the upper part of which contains Belemnites. M. Duval has submitted to our examination a considerable number of specimens demonstrative of the zoological facts of which we have had the honour to give an account, and the observations of this naturalist have appeared to us exact and interesting. This work will contribute greatly to advance our knowledge of Belemnites, and it appears to us in every respect deserving of approbation. We propose, therefore, that the Academy should thank M. Duval for his communication, and encourage him to study in the same spirit the other fossils met with in the neighbourhood of the town where his duties at the university render it necessary that he should reside.—*From Comptes Rendus, No.* 17 ; 25*th October* 1841, *p.* 860.

On certain kinds of Fishes and Reptiles which cannot be absolutely classed as either belonging to salt or fresh water. By M. Valenciennes, in a letter to M. Elie de Beaumont.*

It is very true that the form of the caudal, and the nature of the scales which cover the base of that fin, establish relations between Palœoniscus and the Sturgeons, but they established others as striking, and more intimate between other fishes belonging to families different from Sturgeons, and intermediate between the pike and the herring ; or, to speak in ichthyological language, between the *Lucioïdes* and the *Clupeoïdes ;* and these are fishes which, like the Sturgeons, reside in fresh water (the *Lucioides*), or which pass from fresh water into salt, and *vice versa* (the *Clupeoïdes*). From this you may infer what is the residence of Palæoniscus.

We must look at the question regarding the residence of these animals in a more general way, making no distinction between marine and fresh-water animals, whether they inhabit fresh-water or salt without breathing through the medium

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* Having been occupied with the question, whether certain coal basins generally considered as fresh water can strictly be regarded as such, I found a difficulty in the presence of species of *Palæoniscus,* inasmuch as fishes of the same genus exist in great numbers in the *Zechstein,* which is a marine formation. Having consulted M. Valenciennes on this point, I received for answer the communication given above, which must, I think, possess interest for all paleontologists.—*L. E. de Beaumont.*

of the water, or whether (what is more singular in a physiological sense) their respiratory organ being branchial, they can respire only through the medium of water.

In the first case, nothing can have a more completely marine form than the Cetacea; whales, dolphins, and porpoises generally belong to the sea, but we have the *Platanista* of Pliny,* which lives in the water of the Ganges above Benares, to which the water of the sea never ascends. Porpoises (*Toninas*) are found in the Orinoco above the cataracts of Atures and Maypures, and the Beluga of Steller occurs in lakes and places where the water is fresh. So much, then, for the Cetacea.

Among the mammifera, the seals likewise afford us another example of animals generally marine occurring also in fresh waters; thus they are met with in lake Baïkal, in the small lake Aral, and in the Caspian Sea, which, being less salt than the sea, may just as well be considered a collection of fresh water as a sea, or at least it forms a passage or connecting link between the two.

I need not say any thing to you respecting aquatic birds; but among reptiles no form can appear more peculiarly adapted to fresh waters than Crocodiles, and it is in fact in all the great rivers of Africa, Asia, and America, that they take up their abode. But the *Crocodilus biporcatus* which inhabits the Sechelles, and others of the small islands of the Amirantes, as well as the other islands of Polynesia, Timor, Ceram, &c., swims in the sea, and obtains its food there. We must not, in a discussion of this kind, insist upon the difference of species, for those slight modifications of form which we seize upon, and to which we assign that importance which they really ought to possess in the determination of species, do not affect the basis of organization. It is of small consequence that there are two projections on the muzzle of the *Crocodilus biporcatus*, and that the same part in the crocodile of the Nile is smooth; both of them are still crocodiles, formed on the same type of organization, breathing, moving, and feeling alike. Accordingly, when we find the *Crocodilus biporcatus* on the coast of Coromandel, where there is a great conflux of fresh water, the animal lives in the rivers.

* The *Platanista* of Pliny is by some authors considered to be the *Delphinus gangeticus* of modern zoologists.

I am not acquainted with a genus of fishes which can be given as a marine form. Thus the Rays, an extensive sea family, inhabit the fresh waters of America; a Pastenague (a genus of the Ray tribe) is found in the Rio-del-Magdalena, at a height to which the water of the sea never reaches; it is fished for in the neighbouring ponds.

The Pleuronectes (*Limandia* and *Soles*) ascend rivers, the Loire, for example, even in its tributaries, so that they can be obtained for food at Roanne. Thus you see that *Pleuronectes flesus* would have a shorter course in returning to the sea by taking the Rhone as its conveyance to the Mediterranean. I have caught *Limandia* in the Seine at the Isle of St Denis, near Paris. The sole ascends the Rhine as far as Neuwied and Coblentz, where it is obtained for the table as at a sea-port.

The Twaite Shads (*Clupea alosa*, L.) ascend periodically from the sea into fresh waters, and in the Seine they are found as far up as Provins. Some kinds take up their abode in the lake of Garda, and never leave the fresh waters; this is the case with the Agone of the Italians, which likewise lives in the Mediterranean. Eels when full grown pass from the fresh water into the sea, and again ascend when they have bred; the contrary takes place with the Aloses and Salmon. The lake of Biserte and others lying along the coast of Africa as far as Tunis are full of Spari and Sciænæ, &c., marine fishes, and of which large shoals live in both kinds of water. Mullets do the same in our basins of Arcachon. These seem to me a sufficient number of examples. The Mollusca in this respect, are as well known to you as they are to me. In Sweden and Norway, Nilson found our Anodontes on the shores of the sea, where there was no fresh water; and the curious experiments of M. Macculloch, which I shall repeat in another form if ever I have an opportunity, have likewise been made on the Mollusca. All animals with a branchial respiration, always find enough of oxygen in the water for breathing, although the two kinds of water are not charged with the same quantity of air.*

* From Annales des Sciences Naturelles, tom. xvi. p. 110.

Botanical Climatology—Comparative Note as to the Epochs of Vegetation in different Countries. By M. Auguste de Saint Hilaire.

Being desirous of comparing the vegetation of the tropics with that of northern countries, I took advantage of the close of last summer and beginning of autumn, to pay a hasty visit to Norway and the Scandinavian chain. Although my progress was very rapid, it enabled me, notwithstanding, to rectify some of the notions I had formed respecting the distribution of plants in these countries, and the influence which climate exercises in that distribution. Two days only having elapsed since my return to Paris, I am unable to give a full account of my observations to the Academy, which, however, will be introduced into a work of some extent with which I am now engaged; I shall therefore confine myself at present to a brief indication of the comparative epochs of vegetation in different countries.

In a memoir I read to the Academy many years ago, and which has probably not been without benefit to botanical geography, I stated, that after having left at Brest, on the 1st April, the peach-trees without leaves or flowers, I met with them at Lisbon, eight days later, entirely covered with flowers, and the same thing was observed with *Cercis*, many species of *Lathyrus*, *Vicia*, *Juncus*, &c.: that on the 25th, at Madeira, the peaches were fully formed and the wheat in ear; lastly, on the 29th, at Teneriffe, the harvest was commenced, and the peaches were fully ripe. In the journey which I have just concluded, I may be said to have noticed the vegetation in an inverse sense. On the 10th of August the oat-harvest was completed in the vicinity of Orleans; on the 23d it terminated between Beauvais and St Omer; on the 31st between Hamburg and Lubeck; on the 2d September, cherries were still on sale in the Copenhagen market; on the 27th the oat-harvest was finished in the country around Christiania; and from the 10th to the 18th I always observed it in progress between that town and Trondhjem in the 64th degree. It would be natural to suppose that, in returning from the latter town to Christiania, I should find the same harvest completely finished;

but, on the contrary, during the whole of my journey between Trondhjem and Christiania the oat-harvest was still going on, as it had been when I went from Christiania to Trondhjem. Those who have traversed mountainous countries, and who are acquainted with the influence of secondary causes in such places, will not be surprised at these apparent singularities. Thus, in Hedemarken, a very moist plain, the seed-time is extremely late, and consequently the harvests are so likewise; on one of the banks of the great lake Miösen, the harvest is much earlier than on the other bank, the former having a southern exposure.

It is known that, in northern counties, the shortness of the summer is compensated by the length of the days, and that in them vegetation goes through its various states in a much shorter time than in more southern regions. On leaving Christiania on 10th September, it was nearly in the state which it attains in the middle of France during the last weeks of the same month; at Röraas, one of the most elevated points of the Scandinavian chain, where the mercury freezes every year, and where the *Betula nana* grows in abundance, vegetation appeared on the 14th September in the same condition it exhibits among us in the earlier weeks of November; that on the banks of Guldelf, at a little distance from Trondhjem, had reached the same point on the 20th September as that of France during the last weeks of October; finally, in Dovrefjeld, at a height of 3000 feet above the level of the sea, vegetation appeared, on the 22d September, such as we see it in Sologne in the earliest days of December.*

On the Phosphorescence of Zoophytes. By the Rev. David Landsborough, of Stevenson, in Ayrshire.†

Dr Johnston, in his "History of British Zoophytes," quotes, in his description of *Sertularia pumila*, the following passage from Stewart:—"This species, and probably many others, in some particular states of the atmosphere, gives out a phosphoric light in the dark. If a leaf of the above *Fucus serratus*

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* Comptes Rendus, No. 18, 2d Nov. 1841, p. 882.
† Annals of Natural History, vol. viii. p. 257.

with the *Sertularia* upon it, receive a smart stroke with a stick in the dark, the whole coralline is most beautifully illuminated, every denticle seeming to be on fire."* I have lately discovered that it is not only *probable* that many others exhibit the same phenomenon, but that it is absolutely certain that they do so. I had thought that in making the experiment it would be necessary to put the sea-weed to which the *Sertularia* was attached into a vessel of sea-water, but I find that it can be made with less trouble.

About two months ago I brought from the shore in a pocket *vasculum* or tin-box, some zoophytes attached to sea-weeds, and laid the vasculum on the lobby table till I should have leisure to examine them. When night came I put my hand into the vasculum to remove some of the zoophytes for inspection, and on moving them I found to my surprise and delight that they began to sparkle. Remembering what I had read in the extract given above, as I took them up, I gave them a hearty shake, and they instantly became quite brilliant, like handfuls of little stars or sparkling diamonds. To ascertain what were the zoophytes that emitted this phosphorescent light, it was necessary to take them up singly by candle-light, and afterwards to make the experiment in the dark. The first I tried was *Valckeria cuscuta*, with which I was successful. From *Sertularia polyzonias* and *Cellularia reptans* little light arose ; *Laomedea geniculata* was very luminous, every cell for a few moments becoming a star ; and as each polype had a will of its own, they lighted and extinguished their little lamps, not simultaneously, but with rapid irregularity, so that this running fire had a very lively appearance. *Flustra membranacea* also was very beautiful, though very different from the former ; for as the cells are so closely and regularly arranged, it exhibited, when shaken, a simultaneous blaze, and became for a little like a sheet of fire. With *Flustra pilosa* I was very successful. That variety of it which is spread on a flat surface, and which, from the form that the polypidom assumes, is the *Membranipora stellata* of Thompson, on being bent or shaken, became doubly entitled to the name of *stellated*, for every polype in its cell lighted up a very bril-

* Stewart's Elements of Natural History, vol. ii. p. 425.

liant little star, and for a short time the polypidom became like an illuminated city.

After some days, I repeated the experiment with other zoophytes, and with similar success. A third time I brought home a well-filled vasculum; but as I happened to be otherwise occupied, it was allowed to lie unopened for five or six days, when, thinking that the zoophytes would be dead, I cast them out along with the sea-woods to which they were adhering. They lay in the open air for a night and a day, and as it rained heavily during the whole time, weeds and zoophytes were constantly drenched. When the second night had set in, I thought I would try whether there were any symptoms of remaining life. I shook *Laomedea geniculata*, but its tiny fires were quenched. *Membranipora stellata* lighted up just one bright star; and *Flustra membranacea* shed one faint gleam of light, and refused to repeat the fire, however much shaken.

About a week after, I brought home a fresh supply; and on repeating the experiment, not only did the zoophytes sparkle, but my fingers in handling them became brilliant, being adorned with little stars.

The next time I made trial of these "minims" was in the end of October, when a very frosty morning had been succeeded by a very sunny day. On that occasion *Sertularia polyzonias*, *Cellularia reptans*, *Flustra membranacea*, and *Membranipora stellata* would emit no light. As the specimens had lain for hours on the shore exposed to the morning frost and the mid-day sun, it is probable that the polypes were dead. *Laomedea geniculata* was taken up quite moist and fresh, having been covered with sea-weeds; and when the darkness of evening came, not only did they brightly sparkle when roughly handled, but they emitted a strong smell of phosphorus. On being allowed to rest, they immediately ceased to be luminous; and though, on being shaken or pressed with the fingers, they shone forth again, if often repeated the light became fainter.

On this occasion I made an experiment with a creature belonging to another department. Having found a very large specimen of *Botryllus Schlosseri*, one of the *Mollusca tunicata*, I subjected it to the *experimentum crucis* by shaking it roughly in the dark, and I had the satisfaction of seeing that it was as much disposed as the zoophytes to resent the insult. In this case, however, it was not the sparkling wrath of a pigmy multitude, but the overspreading glow of one massy creature, which all shone, though with a lurid and sullen-looking fire.

The last time I repeated the experiment was in the beginning of the present month of November. I tried *Sertularia pumila*, the zoophyte mentioned by Mr Stewart as phosphorescent; but though roughly shaken it remained dark. I was equally unsuccessful with several others; but the tiny polypes had lain for hours on the shore, under a November sky, and the spark of life I suppose had become extinct. A specimen of *Laomedea geniculata*, which from being covered was quite fresh, was as brilliant as usual, and emitted as formerly its phosphoric odour. I tried for the first time the elegant *Plumularia cristata*, and though it had been too long exposed to the cold air, it emitted, on being shaken, a little light. Only a few of the denticles sent forth their stars, and they were very minute and of a darker red.

From these experiments, may we not surmise that the power of emitting phosphoric light is more generally possessed by the inhabitants of the deep than we are apt to imagine? We are not yet at liberty to say that it is possessed by all marine zoophytes; but certain it is that it is by many. Neither are we entitled to say that it is possessed by all *Mollusca tunicata;* but we know for certain, what I think was not known before, that it is the property of them; and what is possessed by one may also belong to more. As little are we entitled to say that it is possessed by all the little *Medusæ* which, as transparent jellies, abound in the sea; but as it is known that it is possessed by some of them, may they not in general be phosphorescent when agitated? And as they are at times very numerous in the sea, may not the beautiful phosphorescence of sea-water at certain seasons, when put in motion, be owing to them and to marine Infusories, which in numbers numberless are found in the deep? And is it certain that it is not possessed by some fishes? The first time I spent a summer night at sea was in the herring-fishing season; and the sailors shewed me how to ascertain whether the herring shoals were near at hand. When a smart blow was given to the vessel, the percussion was communicated to the deep, and immediately a flash of light was seen at a considerable depth, and this the sailors assured me was from the shoal of herrings. If this was phosphoric light emitted by these finny wanderers, then is this phosphorescent quality possessed by zoophytes, *Medusæ*, *Mollusca tunicata*, and fishes. D. L.

Notice on the Discovery of a complete Skeleton of Metaxytherium. By M. Marcel de Serres.

The genus *Metaxytherium* has recently been established by M. Christol, on various fragments of bone belonging to a marine mammiferous animal, which appears intermediate between the Lamantin and Dugong. Under the latter name we have described the numerous remains of the cetaceous animal we met with in the upper marine tertiary sands in the neighbourhood of Montpellier. These fragments consist chiefly of the bones of the head, there being a great many of the jaw-bones armed with teeth; the next in quantity are vertebræ and the bones of the limbs. Since that time, M. Christol has found various bones of the same animal in the inferior marine deposits of the departments of Charente and Maine-et-Loire.

Availing himself of all the separate pieces, which he has compared with singular skill, he has found materials to constitute his genus *Metaxytherium*, in which he has united the two species of hippopotamus described by Cuvier under the names of *Hippopotamus medius* and *dubius*. We need not be surprised that even such a skilful anatomist as Cuvier was deceived by the teeth of this marine mammifer, and that he supposed it to be of terrestrial habits. In fact, the molars when worn down, assume the *en trefle* appearance which characterizes the grinders of the hippopotamus to such a degree, that when they are not seen planted in the jaw, it would be easy to make the same mistake, if at the same time one's attention was not directed to the form and arrangement of their roots. And it is not a little singular that this observation did not escape Cuvier, which proves that the teeth referred by Peron to the hippopotamus really belonged to the Dugong.*

The genus Metaxytherium, of which we possess the principal pieces entering into the skeleton, makes a near approach

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* Recherches sur les Ossemens fossiles de G. Cuvier, t. v., first part, p. 261.

in the form of its head and jaws to the Lamantins, and to the Dugongs in the form of its limbs. A nearly entire skeleton of this last genus was recently discovered (August 1840) in the centre of a mass of coarse limestone composing tertiary stony banks, wrought at Beaucaire for building.

This individual, of which a certain number of fragments have been shewn us by the obliging attention of Dr Quet, appears to have been found nearly in a complete state, as we have already noticed. Unfortunately the pieces of bone brought to us, have taught us nothing more than we formerly knew, from those preserved in our own collection.

According to the statement of the workmen, the Metaxytherium met with at Beaucaire, would appear to have been in an extended state, when it was enveloped by the stony deposit in which it was found. With regard to those which have hitherto been observed in the vicinity of Montpellier, it is only in marine tertiary sands that they have been noticed. They have not been observed, at least up to the present time, as low as Beaucaire; but they exist in much more ancient strata in the departments of Charente and Maine-et-Loire; that is to say, in the inferior marine tertiary formations.

It might be said, according to these facts and a multitude of others which we have brought forward in our work on tertiary formations, that the same fossil species have perished much later in the south than in the north of France. It is at least certain that their remains are found in much more recent formations in the one than in the other.

The individual found at Beaucaire was of much larger dimensions than those met with at Montpellier, a circumstance which seems to have depended solely on their relative age. That of the former of these localities was full grown, while those of Montpellier were young, their second teeth having not grown beyond the sockets. Thus we are left in doubt whether there really existed many species of this genus, whereas, M. Christol admits several influenced solely by their size. But, although the dimensions of the Metaxytherium of Beaucaire and Montpellier are very different, the individuals have not presented any other characters adequate to make us regard them as really constituting two species.*

* From Annales des Sciences Naturelles, tome xv. p. 16.

On the Identity of Albumen, Fibrin, and the White Matter of the Globules of Blood and of Caseum. Letter of M. Liebig. Communicated to the Academy of Sciences by M. Liouville.*

I have at last the satisfaction, says M. Liebig to M. Prosper Denis, to inform you that the whole of your experiments regarding the identity of the composition of fibrin and albumen have been found to be quite correct. We have succeeded in entirely dissolving pure fibrin in a saturated solution of nitre, and in maintaining them together at a temperature of between 122° and 133° Fahr. The fibrin at first became gelatiniform, leaving only a few insoluble flakes. The filtrated liquid possesses all the properties of albumen. I repeat, that we have succeeded without the employment of caustic alkali, which at first appeared to me to be indispensable and decisive. We have also remarked that boiled fibrin is indissoluble. The composition of dissolved fibrin, that is, fibrin changed into liquid albumen, was exactly that of common fibrin and albumen. And the formulary, carbon 48, hydrogen 74, nitrogen 14, oxygen 11, expresses the relative proportions of its elements. We have likewise succeeded in precipitating albumen under the form of globules, by adding a sufficient quantity of water to serum neutralized by an acid, and we have not been less fortunate in obtaining fibrins from the globules of blood, by following the procedure which you pointed out. By adding a little caustic potash to albumen, it was precipitated by means of alcohol, under the form and with all the properties of caseum. Thus, Sir, I rejoice that I have in any way assisted in placing your important discoveries beyond doubt. I am now busy with a memoir, in which I explain the analyses which have been made in the prosecution of my object.

Composition of Fibrin, made soluble according to M. Prosper Denis's method, and precipitated by cold alcohol from its nitrous solution, and afterwards treated with boiling alcohol and ether.

	1st Analysis.	2d Analysis.	3d Analysis.	
Carbon,	54.508	55.002	54.511	In combustible matter, 1.351 in 100. Carb. to Nitr. : : 7 : 1.
Hydrogen,	6.874	7.280	6.974	
Nitrogen,	18.032	18.197	18.037	
Oxygen,	20.586	19.521	20.478	

Fibrin of Blood, subjected to the direct action of water, cold alcohol, boiling alcohol and ether, without previous solution.

Carbon, . . .	54.988	Carb. : Nitr. : : : 7 : 1.
Hydrogen, . .	6.876	
Nitrogen, . . .	18.190	
Oxygen, . . .	19.946	

* Comptes Rendus, 22d March 1841.

Albumen prepared by dissolving serum which had been dried in the open air at the usual temperature, then precipitating it in cold alcohol, and purifying it with boiled ether.

	1st Analysis.	2d Analysis.	
Carbon,	54.726	54.765	Carb. : to Nitr. : : : 7 : 1.
Hydrogen,	7.312	7.065	
Nitrogen,	18.105	18.118	
Oxygen,	19.857	20.052	

Serum of the Blood, subjected, without previous solution, to the action of cold alcohol and boiling ether.

Carbon, ...	55.233	Carb. : Nitr. : : 7 : 1.
Hydrogen, ...	7.156	
Nitrogen, . . .	18.275	
Oxygen, ...	19.336	

All these analyses were made in the laboratory of Giessen, by Dr Scherer; and I have taken all necessary pains to ensure their accuracy.

On the Causes of the Green Colour in certain kinds of Oysters. By M. A. Valenciennes.

The observations I have made on green oysters have led to some results which appear to me sufficiently curious to deserve being communicated to the Academy.

It is well known that the explanations hitherto given of the colouring of oysters still leaves much to be desired.

Some have thought that feeding on certain ulvæ was the cause of the green colour in oysters; others have ascribed it to the absorption of the microscopic animalcules named *Vibrio ostrearius;* while others have maintained that oysters change colour, and become green, solely by absorbing the green matter produced in the enclosures where they are kept.

It may be remarked, in the outset, that we are occupied, as too often happens, in explaining a singular phenomenon, without observing how it takes place in an animal which we may examine by hundreds every day.

In a green oyster there is only a single organ visible on the exterior which assumes this colour; this is the four leaflets of the branchiæ. By raising the upper part of the mouth, we perceive that only the inner surface of the labial palpi is green, and on examining the internal parts, we speedily ascertain that the intestinal canal alone beyond the stomach is of a fine green colour, which injects it and renders it very easy to be traced, because it is thereby very distinctly defined on the white bed formed for it by the fatty matter. The liver is of a blackish-green colour instead of its usual reddish tint. But neither the great attaching muscle, nor the muscular fibres of the mouth, nor the cirri which surround it, nor the heart, blood, nerves, nor fatty substance, have undergone any change of colour.

This colouring substance, existing only in the organs named, presents nothing remarkable when examined by the microscope, but it possesses the following properties:—

It is insoluble, whether cold or warm, in distilled water, in alcohol, and in sulphuric ether. These three reactives produce no change on its shade of colour.

All the acids change it into blue, slowly when cold, rapidly when warm. Weak sulphuric, hydrochloric and citric acids, as well as vinegar, produce this change equally well.

Ammonia reproduces the green colour.

Nitric acid, when weak and cold, colours the matter blue; when warm it destroys it, and communicates that yellow colour which so often appears from the action of nitric acid on animal substances.

Chlorine rapidly discolours the green matter and leaves the branchial leaflets entirely white.

Sulphuretted hydrogen does not discolour it.

Ammonia, after a long time, destroys the colour by changing it into a very faint impure olive.

Caustic potass dissolves the branchial leaflets and produces a brown liquid, from which acetic acid precipitates impure green flakes.

These changes of colour take place in the intestinal canal in the same manner as in the branchial leaflets.

Our accomplished fellow-member, M. Dumas, has made some experiments to ascertain whether the green matter does not acquire a part of its colour from Prussian blue. They afforded negative results.

I made these observations on large oysters, of the kind named *Green Marennes oysters*, the branchiæ of which, and portions of the intestinal canal subjected to the different agents above-mentioned, I have now the honour to present to the Academy. I found the same results from what are called *Green Ostend oysters*, although the latter are not so deeply coloured.

Every thing, then, leads us to believe that the green colour of oysters belongs to an animal matter distinct from all green organic substances hitherto studied. As we see it appear in the intestinal canal, may we not venture to suppose that it is owing to a particular state of the bile, there producing a colouring substance which fixes itself by assimilation on the parenchyma of the two lamellar appendages of the oyster, its branchiæ or labial palpi, by a physiological phenomenon analogous to that which M. Flourens has observed in regard to the assimilation of madder, which gives a red colour only to the bones of an animal, while the cartilages, ligaments, and tendons, remain white.*

Additional Notice regarding St Kilda.

In reference to the subject of a preceding paper, we are favoured by James Wilson Esq., F.R.S., &c. (who visited St Kilda last summer) with the following supplementary observations :—

Mr Wilson states, that besides the Eastern or Village Bay, mentioned by Mr MacGillivray, and now commonly called Dickson's Bay, there is an excellent and capacious shelter on the other side, opening to the west or north-west, and called M'Leod's Bay. It is of consequence that this topographical feature should be known, because when the wind blows *into* one bay, and causes a surf which renders landing dangerous or difficult, the same wind blows *from* the opposite bay, which will probably at the same time be found free from surf.

In regard to horticulture, Mr Wilson observed that cabbages of different varieties, and a scanty supply of potatoes, were growing within the smaller enclosures. The minister has tried both carrots and onions with some success. Turnips seem to thrive well for a time, but are speedily cut off by some kind of injurious insect. Peas and beans blossom, but produce no pods. Mustard was growing healthily near the manse. Such, however, is the injurious effect of the salt spray during

* Comptes Rendus, t. xii. No. 7, 15th Feb. 1841, p. 345.

winter, even on their hardiest vegetation, that savoys and German greens, which with us are improved rather than deteriorated by the winter's cold, almost invariably perish soon after the commencement of autumn. This, however, is not owing to the rigour of the climate, but solely to the salt spray which the boisterous winds carry up from the turmoil of the raging shores, and spread upon the surrounding vegetation. The minister has endeavoured to prevent this by recently raising a stone dyke ten feet high around a small enclosure, in which his cabbages lie ensconced. In other respects, the climate is in truth extremely mild. The ice, which is formed even during the coldest night in winter, is scarcely thicker than a penny piece, and usually disappears entirely, if the sun is at all visible in the course of the ensuing day.

The following table, kept by Mr Mackenzie, the clergyman of St Kilda, shews the temperature and direction of the wind for the months of January and February 1840 :—

Jan.	Therm.	Wind.	Feb.	Therm.	Wind.
1	45°	N.NW.	1	40°	E.
2	45	SW.	2	39	E.
3	34	NW.	3	38	E.
4	38	NE.	4	39	E.
5	34	NE.	5	40	E.
6	34	NE.	6	37	E.
7	34	E.NE.	7	35	E.
8	38	S.SW.	8	34	E.
9	39	S.	9	38	S.
10	40	S.SW.	10	42	S.
11	40	SE.	11	45	S.
12	41	E.	12	50	SW.
13	39	E.NE.	13	45	SW.
14	40	E.	14	47	S.
15	40	E.	15	46	SW.
16	38	SE.	16	47	SW.
17	40	NE.	17	47	SW.
18	40	N.NE.	18	47	S.
19	38	N.	19	48	S.
20	39	N.	20	48	SW.
21	39	N.	21	48	S.SW.
22	40	SW.	22	49	SW.
23	39	NW.	23	49	SW.
24	40	N.	24	48	N.NW.
25	47	SW.	25	49	NW.
26	40	NW.	26	45	NW.
27	50	SW.	27	44	N.NE.
28	45	SW.	28	43	W.
29	46	SW.			
30	47	E.			
31	43	SE.			

We have no thermometrical record for August, but in relation to the other warm months, we may observe that the greatest heat did not exceed 59°. Even that height was rarely attained; and the 26th and 27th of May was as warm as any day throughout the year, the thermometer standing, on each of these days, at 59°. The only day in June which equalled that heat was the 17th, and no day in July exceeded 58°.

Mr Wilson's observations on the zoology of St Kilda accord with those of Mr Macgillivray. The clergyman made mention of an extremely beautiful foreign bird, of considerable size, which was observed to frequent the island one season for several weeks. Its plumage "glittered in the sun," and was of a resplendent green and blue colour. This was, probably, a stray example of the roller (*Coracias garrula*), a bird well known in Germany, and not unfrequent in Sweden during summer.

We shall only further observe, that the population of St Kilda, at the period of Mr Wilson's visit in August last, amounted precisely to 105.—Ed.

Researches on the influence which Light and the Green-coloured Organic substance often found in Stagnant Water exercise on the quality of the Gases contained in the latter. By Mr A. Morren.

The author has had occasion to analyse the water of many fountains and wells in the town of Angers, as well as to examine the gases they contain. He has convinced himself that these waters, as well as those of the Loire and Maine, have nearly the twenty-fifth part of their volume, as is generally the case with well aired running water in its normal state, formed of a gas composed of 32 per cent. of oxygen and 68 per cent. of azote. On one occasion, in the summer, he analysed the gas extracted by boiling from the water of a fish pond which had a greenish appearance, and was surprised to find that it contained from 56 to 58 per cent. of oxygen. On resuming this experiment the following day, only 25 per cent. of oxygen was produced in the morning; about mid-day, 48 per cent.; and at five o'clock in the evening 61 per cent. The volume of air dissolved increased with the proportion of oxygen; the carbonic acid likewise varied, but the quantity of azote continued very nearly constant.

By continuing these experiments, he perceived that, independently of the evident influence of light on the oxygenation of the water, the cooling of the air, rain, and, above all, the presence or absence of the matter which gave a green colour to the water, had the effect of considerably modifying the results, both as to the quantity and proportion of the gases dissolved in the water of the pond. As soon as the green substance reappeared, accompanied with heat and the solar influence, the oxygenation of the water was considerable; it diminished rapidly, on the contrary, in the absence of the sun and heat.

The author has devoted nearly a whole year to the daily examination (noting at the same time all the accessory circumstances) of the gases contained in the water of a deep-fish pond, fed by springs and rain, and containing about 8000 cubic feet of water. The walls of it were composed of slate-stones cemented with mortar, and it contained scarcely any conferva visible to the naked eye. He has likewise examined the water of many other ponds, and also that of the Maine and Loire. These experiments were generally made at the same hour, between one and three o'clock in the afternoon, although many of them were made at other times of the day. Mr Morren gives circumstantial details respecting the mode of operation which he prefers, the instruments he employed to disengage and collect the gases dissolved in the water, and the analytical methods he adopted. They are of such a nature as to inspire perfect confidence in the accuracy of his results.

His memoir likewise contains a table in which are inserted the proportions of the gases in the water of the pond, taken day by day for nine months, as well as the state of the weather, and the presence or absence of the green matter. From his long-continued researches, he thinks himself authorized to draw the following conclusions:—

The oxygenation of the water is most considerable in proportion to the intensity of the solar light and the elevation of the sun itself. It nevertheless takes place, though in a smaller degree, under the influence of a diffused light. It either ceases altogether, or cannot be appreciated in a rainy day.

It commences at day-break, increases slowly at first, then rapidly, and reaches its *maximum* at four or five o'clock P.M.

In winter, there must be a long succession of fine days before the water attain the same degree of oxygenation as in summer. The variations are much more rapid in this latter season, and the quantity of the oxygen of the air dissolved in the water, sometimes diminishes so much that certain kinds of fishes can no longer live in it.

The least oxygenated water contained 16 to 17 per cent. of oxygen in the dissolved air, and that which was at the *maximum* contained 61 per cent.

The quantity of azote has varied little, and the carbonic acid seems to undergo variations the reverse of those of the oxygen.

When a black curtain was extended over the whole surface of the pond, the oxygenation was seen to diminish rapidly (from 49 to 22 per cent.), although the weather was fine and the other circumstances favourable.

What became of the oxygen with which the water of the pond was charged, at the moment of its greatest oxygenation? The author placed in the pond a reversed globular vessel, open at the lower part, allowing the water of the pond to communicate with that contained in the vessel. Numerous air-bubbles were disengaged, and this gas, when analysed, contained nearly the half of its volume of oxygen. Nevertheless, the oxygenation of the water contained in the vessel, and from which this air, so rich in oxygen, had been disengaged, had in no degree diminished, and was equal to that of the water of the pond at the time when it was placed in it. We must conclude from this that the oxygen absorbed by the water is not employed to form carbonic acid by combining with the organic matters it may contain, but that it is constantly carried off by the atmosphere. This source for the production of oxygen must be considerable, for, according to the calculations of the author, made in a favourable day, the pond he examined, and which contained 8000 cubic feet of water, disengaged 128 cubic feet of oxygen.

The running waters of the Maine and Loire, even when the current is slow, as in the former, do not present very sensible variations in their oxygenation. The author has ascertained that, when the oxygenation of the water, either by a sudden swell and overflowing of the neighbouring meadows, or by the unexpected destruction of the green matter, descends to 18 or 20 per cent. of oxygen in the air it contains, fishes can no longer live in it, and they are seen to perish in great numbers as if from asphyxia. The author has witnessed the same phenomena, on two occasions, in the fishpond; and on the 8th June 1835, after a sudden swell of the Maine, almost all the fishes perished, and their dead bodies diffused a mephitic odour. The voracious fishes were the first that suffered, and the author is convinced that in all these cases the oxygenation of the air contained in the water was very low.*

It appears that, when the oxygen is found in water in considerable proportion, it is merely dissolved in it, and not chemically combined, as it is in Mr Thénard's oxygenated water. In fact, the oxide of silver does not disengage the oxygen, as it does in the latter. It is possible, however, that this preponderance of oxygen may be the cause of the whitening of linen on the bleaching green, the oxygen of the water performing the dehydrogenating office of chlore on vegetable colours.

* Very slight differences in the composition of the water in which fishes live are sufficient to cause death. The late Prof. de Candolle has remarked that, when the saltness of the salt-pits increased in a warm day one-half per cent., that was sufficient to kill all the fishes inhabiting them when this saltness approached the extreme limit which these animals can endure. In the morning, the saltness being 7°, they were very vigorous, in the evening, the saltness being 7½°, they were dead.

The author has endeavoured, with that attention which the subject deserves, to discover what is the real cause of the abundant disengagement of oxygen which he has ascertained to take place in stagnant waters. He has satisfied himself that oxygenation was at its greatest height when the water, under the influence of a strong solar light, had acquired a very deep tint of green. He easily discovered, by means of the microscope, that this colour was owing to the presence of green monodarian animalcules, the greater part being the species named *Enchelis monadina virescens* by M. Bory de St Vincent. It was sometimes accompanied by a larger species, also of a green colour, the *Enchelis pulvisculus viridis* of Muller. When these were sufficiently abundant in the water of the pond to give it a green colour, the sun at the same time shining brightly, the oxygenation was rapidly developed, until it contained 60 in the hundred of oxygen in the gas disengaged, and it sunk if the animalcules became less numerous or disappeared.

We must therefore admit that these beings, which no naturalist has refused to consider as animals, possess, like plants, the property of decomposing carbonic acid, and disengaging oxygen from it; and their immense numbers, small size, and power of locomotion, which enables them to put themselves in the most favourable position for the complete action of the light, may explain the intensity of the effect produced. Their green colour, which becomes not so deep when they are kept for a time in the shade, seems to assimilate them to vegetables; but their property, discovered by the author, of disengaging oxygen like leaves, appears to render it impossible to draw any definite line of demarcation between animals and plants.

After the commencement of spring, the monadine enchelides appear in great numbers on the first fine day, and give a light green colour to the surface of still waters. Their colour by degrees becomes deeper. The duration of their lives is very variable. When the weather is mild, the air calm, and the sun unclouded, they press to the surface of the water, and engage in their manifold gyratory movements; but if the sky be overcast, the air agitated, or rain falling, they retire to the bottom of the water, apparently to shelter themselves from sudden changes of temperature, which are always fatal to them. By means of insensible and gradual variations, these animalcules may, however, be brought to live at a temperature many degrees below zero; their movements are then extremely sluggish. They ultimately disappear at the bottom of the water, and change into a mucous matter, from which, in due time, new generations of enchelides are produced.

When viewed by the microscope, the monadine enchelid appears rapidly to dart forth a very delicate biciliary apparatus, which enables it to produce a rotatory movement. It likewise makes use of this to fix itself to any body, for example, to the object-glass. It then commences a swinging movement with the cilia as a centre.

At the moment when the oxygenation of the water is at its height, great numbers of infusory animalcules, furnished with ciliary and rotatory apparatus, make their appearance ; they descend below the surface, when the enchelides on which they prey likewise descend along with them.

In recapitulating the facts deduced from these experiments, the author thinks he has proved that, with the assistance of light, the green animalcules which live in stagnant waters decompose the carbonic acid contained in it, and absorb its carbon, and that the oxygenated gas disengaged dissolves in the water in the state of a nascent gas.

The oxygenation of the water diminishes in proportion as we descend below the surface ; thus, at 3 feet, the air of the water contained 43 parts in 100 of oxygen, while there were only 34 parts in 100 at the depth of 13 feet.

The maximum of oxygenation runs from 56 to 61 in 100, and takes place about four or five o'clock in the evening.

It was important to ascertain whether the green colour was indispensable to the existence of the property of decomposing the carbonic acid in the microscopic infusory animalcules living in stagnant water. After many fruitless researches, Mr Morren at length succeeded in procuring the means of reproducing a great number of an animalcule of a fine purple colour, which he at first took for a *Protococcus nivalis*, but which he afterwards found to be nearly allied to *Trachelomonas volvocina* of Ehrenberg. He filled numerous bell glasses, containing from eight to ten *litres* with filtered rain water. He then poured into each of them half a litre of water well replenished with trachelomonas, and at the end of a month, all his vessels were shining with a magnificent reddish-purple colour.

He then had it in his power to repeat with these animalcules all the experiments he had made on the green ones, and he obtained results absolutely identical. Only the proportion of oxygen never exceeded at the maximum 47 per cent., instead of 61 obtained in the fish pond ; but it is easy to perceive that the artificial conditions of life in which the trachelomonas were placed may explain these differences. It is evident, therefore, that the green colour of the animalcules is not an indispensable element in the decomposition they cause of the carbonic acid contained in the water ; that the phenomenon is reproduced with those of a red colour, and that it is probably also an attribute of animalcules of every colour and condition of existence. This constitutes another bond of connection between the two great kingdoms of the organic creation, and a new and powerful agent in the purification of the atmosphere.*

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* From Bibliothéque Universelle de Genève, No. lxx., Oct. 1841, p. 386.

Proceedings of the Wernerian Natural History Society.

The thirty-fifth Session commenced on the 20*th November* 1841, Professor Jameson, P., in the Chair. The following office-bearers were elected for the ensuing year:—

President.

Robert Jameson, Esq. F.R.SS.L. & E., Professor of Natural History in the University of Edinburgh.

Vice-Presidents.

W. A. Cadell, Esq., F.R.SS.L. & E.
Dr Robert Hamilton, F.R.S.E.
Dr Robert Graham, F.R.S.E.
Sir Wm. Newbigging, F.R.S.E.
Right Hon. Lord Greenock, F.R.S.E.
Sir C. G. S. Menteath, Bart., F.R.S.E.

Dr Patrick Neill, F.R.S.E., *Secretary*. T. J. Torrie, Esq. F.R.S.E., *Assistant-Secretary.*——A. G. Ellis, Esq., *Treasurer.*——James Wilson, Esq. F.R.S.E., *Librarian*. R. J. H. Cunningham, Esq., *Assistant-Librarian.*——P. Syme, Esq. *Artist*. W. H. Townsend, Esq., *Assistant-Artist.*

Council.

David Falconar, Esq.
Dr Robert Paterson.
Edward Forbes, Esq.
Robert Stevenson, Esq. F.R.S.E.
David Milne, Esq. F.R.S.E.
John Stark, Esq. F.R.S.E.
Thomas Brown of Lanfine, Esq.
Sir Wm. Jardine, Bart. F.R.S.E.

December 11.—Professor Jameson, P., in the Chair. Dr Traill read a Notice of a mine of Sulphate of Baryta in Glen Sannox, Arran, and of the manufacture of pigments from that mineral, which he illustrated by specimens of the various preparations (published in this No. of Journal, p. 139). A paper was read on the Island of St Kilda, by Mr John MacGillivray (published in this No., p. 47). The Assistant-Secretary then read a letter from Dr Stanger giving an account of the progress of the Niger Expedition, and a communication from a correspondent regarding the Scientific Reunion at Florence.

Proceedings of the Geological Society.

This Society commenced its session on the 30th inst.; Mr Murchison, President, in the chair. Two communications were read, —1. a supplement to a paper entitled, "A synopsis of the English series of Stratified Rocks inferior to the old Red-Sandstone," with additional remarks on the carboniferous series and old red-sandstone of the British Isles, by Professor Sedgwick. The author commences by stating that his former synopsis is now modified; *first*, by the new classification of the stratified rocks of Devon and Cornwall; *secondly*, by a larger knowledge of fossils, derived from some of the groups described; and, *thirdly*, by new observations made during the past summer in the south of Ireland, the south-west of Scotland, and the north of England.

New Red Sandstone.—The upper part of this series of strata is shewn, by sections derived from Warwickshire, to be sometimes unconformable to the lower portion, which represents the magnesian limestone and inferior beds; and the latter division is also shewn to pass into the coal measures, the intermediate strata being loaded with common carboniferous plants. In the neighbourhood of Whitehaven, however, there is no passage from the lower new red sandstone into the coal measures, though the carboniferous flora apparently existed in full perfection during the period in which the former strata were deposited. The new red sandstone of Dumfriesshire is shewn to be continuous with that of the plains of Carlisle; but the lower divisions of the series are considered to be wanting. The strata near Dumfries are stated to be mineralogically the same as those of Corncockle Moor, and to contain impressions of footsteps. To the north of the Galloway chain the new red series occurs at very few localities; and coupling this fact with the great development in many parts of Scotland of red sandstones of the carboniferous series, the author concludes that the highest stratified beds of Arran do not represent the new red-sandstone, but a portion of the coal measures, though there is no counterpart in England of the upper conglomerate of that island.

Carboniferous Series.—The changes in this series, in its range from the north of England to the basin of the Tweed, are briefly noticed, and the coal-field of the latter district is shewn to be geologically far below the great coal-field of Newcastle, assuming the Scotch type, though the coal-field on the south side of the Firth conforms to the English type. The carboniferous series of Scotland is then stated to be divisible into the three following groups;—*first*, the rich deposits, with numerous beds of coal, presenting, in their general characters, the closest analogy to the English coal-fields, though their exact position in the geological sequence cannot be determined; *secondly*, a great group, forming the base of the most productive coal measures, and containing beds of coal of an inferior quality, also many thin bonds of limestone alternating with sandstones and shales, and having generally thick beds of limestone at the top; *thirdly*, a variable deposit of red sandstone, shales, &c., containing, in the higher portions, coal-measure plants, with even thin beds of coal, and passing downwards by insensible gradations into the old red-sandstone. The author next points out the perplexity which has been introduced into the geological map of Scotland, by representing the carboniferous series and the old red-sandstone of one colour; and by confounding, along a considerable part of the country bordering on the north shore of the Solway Firth, the new with the old red-sandstone.

Old Red-Sandstone.—The extraordinary irregularity of this formation in the British Isles is first noticed; the old red conglomerates of Cumberland are then compared with those on both sides of the Galloway chain; and the sections in the south of Ireland, connecting the old red-sandstone with the carboniferous series, and constituting a good passage, are next described. The lower carboniferous shales there pass into roofing slates, resembling the black slates at the base of the Devonshire culm-measure; and the great coal-field in the west of Ireland overlying the mountain-limestone assumes the characters of the same culm-measures. These facts, the author says, remove the difficulty in classification presented by the mineral structure of the Devonshire culm-series. From the details connected with the above statements, Mr Sedgwick draws the inference, that no new formation can be interpolated between the old red-sandstone and the carboniferous series, the sequence of strata being complete; and as the sections in the silurian country described by Mr Murchison, shew that no member is wanting between the old red-sandstone and the Ludlow rocks, there is consequently one continuous unbroken succession from the lower division of the new red-sandstone down to the Llandeilo Flagstone; and, therefore, that the argument for the true place of the Devonian system is complete. For any formation with fossils intermediate between the carboniferous and silurian systems must have an intermediate position,—must, therefore, be on the parallel of some part of the old red-sandstone which fills that whole intermediate position.

Sections of North Wales.—The author, after referring to his former description of the great masses of North Wales, states that his Snowdonian fossils have been found to be identical with Silurian species; and that the same result has been obtained from an examination of the organic remains of the Berwyns. Hence, he concludes, that in the great section of North Wales, there is no positive zoological distinction in the successive descending groups, the only difference being the gradual disappearance of species which occur in the higher beds.

Cumbrian Groups.—The groups exhibited in a section from Keswick, through Kendal, Kirby-Lonsdale, are, 1*st*, that by Skiddaw Forest; 2*d*, a group essentially composed of quartzoze and chloritic roofing-slates, associated with innumerable igneous rocks, and bounded by calcareous slates, which extend from the south of Cumberland to the neighbourhood of Shap Falls; 3*d*, a great series of beds, ranging from the calcareous slates to the carboniferous series, and separated provisionally by the author into two divisions, the lower consisting of slates and flagstones, with occasionally thick, hard, arenaceous strata, the fossils containing many species characteristic of the lower Silurian rocks, and the upper being composed of arenaceous flagstones, with beds of hard greywacke, calcareous matter occasionally occurring, but no beds of limestone fit for use. The fossils of this division, a list of which, by Mr J. Sowerby, accompanies the paper, contains numerous species belonging to the upper silurian rocks of Mr Murchison, or to the beds which have been considered to form the base of the old red-sandstone in Shropshire. From the above specific determinations of organic remains, the author says the following definite information is obtained, namely, that the lower division is lower silurian, and that the upper ends at the very top of the silurian system. Two other sections are then briefly noticed, one from the Shap granite, through the fossiliferous slate to Howgill Fell, the beds of which are placed in the upper division of the silurian system, but not the highest part; and the other from the western boundary of the calcareous slates to Ulverston, including, 1*st*, the calcareous slates (*Caradoc*) of Millom, in Cumberland; 2*d*, quartzose flagstones; 3*d*, the roofing-slates of Kirby-Julith; 4*th*, a second band of calcareous slates with lower silurian fossils; and 5*th*, an upper series of flags and slates, which reach to the neighbourhood of Ulverston. The last beds are overlaid by strata of a coarse composition, but which, in a section continued to Morecambe Bay, do not shew any upper fossiliferous bands.

Ireland and South of Scotland.—Some sections in the counties of Waterford and Kerry, to which the author was conducted by Mr Griffith, are then briefly noticed. He afterwards shews that Mr Griffith's present grouping of the older strata in the south of Ireland is not only sanctioned by the section, but removes the supposed anomaly of carboniferous fossils reappearing at different levels in a descending series. The silurian fossils of the north of Ireland, preparing for publication by Captain Portlock, are also noticed; but it is stated that the sections of that part of the kingdom do not appear to connect these fossiliferous rocks in such a manner with the older formations, as to materially assist in their subdivisions or grouping.

Mourne Mountains, Galloway chain, &c. After a few details on the physical features and mineral composition of Devonshire, Mr Sedgwick describes the chain, extending from the Mull of Galloway to St Abb's Head. The prevailing strike of this range, like that of the Mourne Mountains, is about NE. by E., even in the neighbourhood of protruded masses of granite. The strata consist generally of a hard, fine or coarse greywacke, passing occasionally into roofing-slates, and destitute of fossils, except in the finer schists in which the *Graptolites foliaceus* has been found. The strata which break out from under the carboniferous basin of Girvan Water in Ayrshire, are next described, and shewn to contain many silurian fossils. Lastly, a synoptical table is given of the great groups, ranging from the carboniferous series to the lowest beds of the north of England, the classification being as follows:—1*st*, the Carboniferous series; 2*d*, the old red sandstone (Devonian system); 3*d*, Silurian system; 4*th*, the Subsilurian, or upper Cambrian; 5*th*, the lower Cambrian, including the great groups of North Wales, between the Bala limestone and the old roofing slates of Cumberland; 6*th*, the lower Cumbrian or Skiddaw slates, and containing provisionally the chloritic slates of Anglesea and Caernarvonshire.

Proceedings of the Royal Scottish Society of Arts.

18*th October* 1841.—Andrew Fyfe, M.D., F.R.S.E., President, in the chair.

PRIVATE BUSINESS.

1. The Royal Charter of Incorporation of the Society was laid on the table.

2. The draft of the Laws of the Society, as altered and amended by the Council, were read and considered, and, after some farther alterations, adopted.

3. Arrangements relative to the Curatorship of the Museum remitted to the Council to consider and report.

4. A letter from the Treasurer of His Royal Highness Prince Albert, K.G. &c., was read, acknowledging his Royal Highness's election as an Honorary Member.

25*th October* 1841.—Andrew Fyfe, M.D., F.R.S.E., President, in the chair.

PRIVATE BUSINESS.

The Laws of the Society, as altered, amended, and adopted by the Society at last meeting, were again submitted for approval, and were finally adopted.

Notice of the Meeting of the Italian Scientific Association held at Florence in September 1841.

Nothing could have gone off better than the meeting here, which lasted a fortnight, and at which nearly 900 persons enrolled their names. Twenty-two British subjects entered their names, among whom were R. Brown and Mr Babbage. I arrived here on the 14th September, the day before the Congress assembled, and on enrolling my name received a card, on the presentation of which all the public institutions of Florence were open to the members, with a small book and map of the city, prepared and printed expressly for the occasion. On the 15th, the first meeting was preceded by a mass in music, performed in the church of Santa Croce, the Florentine Pantheon, where all the savans and most of the aristocracy of Florence were present; the effect was very grand in the midst of the tombs of Machiavelli, Michel Angelo, and Galileo, and surrounded by the *chefs d'œuvre* of Giotto, Gaddi, and the other founders of the Florentine school of painting. From the church we adjourned to the great hall of the Palazzo Vecchio, constructed for the purpose of assembling the Florentine citizens during the Republic, and which, for nearly three centuries, had never witnessed so numerous an auditory. There, in the presence of the Grand Duke and his family, the President, the Marquis Ridolfi, opened the business of the Congress by a very good speech, which elicited general and well-merited applause. This done, the members repaired to another building, the Museum of Natural History, to be present at the inauguration of the statue of Galileo, and to divide themselves into sections and name their officers. I must first of all say a few words respecting the Tribune of Galileo. The present Grand Duke of Tuscany, Leopold II., is one of the sovereigns of the present day who has done most, compared with his means, to encourage the arts and sciences in his state. Among other things, he has collected, at a very great expense, not only every MS. of Galileo he could procure, but also those of his pupils, who formed the celebrated and too short-lived Academia del Cimento, as well as the instruments used by Galileo and his followers, and by means of which they founded the modern school of experimental philosophy. Having done this much, Leopold II. determined to raise a monument to his immortal countryman, and to inaugurate it on the occasion of the Italian Association for the advancement of science assembling at Florence; and to place in a tribune, dedicated to Galileo, every thing that had been collected relating to him. The Museum of Natural History, which contains also the observatory and the cabinet of philosophical instruments, and which adjoins the grand ducal palace, was selected as the site of this temple to the cause of science in the person of its greatest founder. It forms a beautiful tribune, with a magnificent statue of Galileo in the centre, surrounded by niches, in which are placed busts of his pupils, and with presses containing the instruments with which he made his greatest discoveries. The walls are inlaid with marble and jasper, a kind of work for which the Florentine artists are so celebrated, and the ceiling painted by the first artists of the day, representing different events in the life of the Tuscan philosopher. Every thing that art and taste could effect to render the edifice worthy of its object has been done, and the result has been admirable. What the world does not know generally is the great sacrifice which the Grand Duke has made for this monument. I have been assured that the outlay hitherto (and there still remains something to be done to complete the tribune), amounts to L.36,000 Sterling, not including the purchase of the manuscripts of Galileo above alluded to—what an example for more powerful sovereigns! To return to the Congress,—it divided itself into five sections, viz. Agriculture; Medicine; Geology, Mineralogy, and Geography; Natural Philosophy, Mathematics, and Astronomy; Zoology and Botany. The sections met at different hours; those of Agriculture, Natural Philosophy, and Medicine being the most numerously attended. The Grand Duke and his Duchess attended one or more of the sections every day without any state or ceremony. The greatest good humour prevailed at all the sections, and I was astonished to witness the great facility with which the Italian savans spoke on the most abstruse subjects. In the geological section we had some very good papers on Italian geology, and several interesting discussions. I took some part in the latter, having, during my former journeyings in Italy, attended much to the subject, and I communicated at the first meeting a brief outline of Ross's brilliant discoveries in the Antarctic regions, which created subsequently a good deal of interest in Florence. On another occasion I gave a sketch of the geology of the Andes, as compared with that of some other mountain regions, and especially with the Apennines by which we were surrounded. We had all the best Italian geologists present, viz. Passini, Pareto, Savi, Sismonda, and Collegno. At our recommendation the Grand Duke has consented to found at Florence a Geological Museum, to contain a collection from every part of Italy, accompanied with sections, maps, and every thing necessary to convey an accurate idea of the physical constitution not only of Tuscany, but of every other state of the Peninsula. He will pay all expenses and the salaries of curators; and the different geologists will be invited to send duplicates of their collections. His highness has consented to found a similar central museum, for the vegetable productions of Italy, which will contain an herbarium of its different regions. This generous conduct on the part of Leopold II. will give you some idea of the liberality and enlightened views of the sovereign of this happy state, who, I may say without exaggeration, is most sincerely beloved by all classes, from the peasant to the highest nobleman in his dominions. Our meetings continued every day, except Sundays, until the 30th, and every one saw their approaching termination with regret. We geologists made some very pleasant excursions in the neighbourhood, and wherever we went, dinners were prepared for us by the gentry of the vicinity. Towards the close of the Congress the Grand Duke, who, during its continuance, had invited in parties of twenty several of us to his table, gave a grand banquet at one of his villas close to Florence (Poggio Imperiale) to the whole Association. The dangerous state in which his eldest daughter then was (she died three days afterwards), prevented his being present; but the great officers of the household did the honours, and nearly one thousand persons sat down to dinner in the most perfect order. On the last day of the meeting a general assembly of the Italian members (foreigners not being allowed to vote) took place to fix the place of assembling in 1843, in consequence of the Ex-Empress Maria Louisa, who now governs Parma, having refused her sanction to the Association going to Parma, as previously agreed upon. Lucca was selected, and the Duke of that principality has given his consent. In 1842 the Association will assemble at Padua, where I think it will meet a kind and hospitable reception, although we cannot expect to be treated as we have been here; but Padua, nevertheless, offers many facilities in its extensive university, and its environs have many points of attraction for the geologist in the Euganean hills, and the tertiary deposits of the not far distant districts of Verona and Vicenza, whilst I believe that the Austrian authorities, far from setting their face against the Association, as those of Rome and Naples have done, will do every thing to encourage it. A medal had been ordered to be struck to commemorate the Florentine meeting, a copy of which was given at its close to each of its members, in silver to the Presidents, Vice-Presidents, and Secretaries, and in bronze to the other members. In addition to this, the Grand Duke in his liberality had printed a new and enlarged edition of the acts of the Academia del Cimento, and an illustrated description of the Tribune of Galileo, of both of which copies were presented to all members not Florentine, on going for their passports, and have been given since to many of the latter. An account of the proceedings of each day, with a list of new members, was printed every morning and sent round to all the *scienzati*, and in a few weeks a large volume will be published containing the detailed proceedings of the Association. From France we had M. de Blainville for a few days; from Belgium the king sent a formal mission in the person of Professor Morren of Liege, the botanist; and from Germany there were the venerable and excellent botanist Link of Berlin, Charpentier, the geologist of the Pyrenees, and of the modern glacier theory, Professor Mahlmann of Berlin, Mittermayer of Heidelberg, and others. We had also a few Americans, Greeks, and Spaniards, and a Spanish American medical man. As to Italians, the number would have been greater had not the Roman and Neapolitan governments opposed the coming of their subjects. Several, however, eluded the prohibition, and amongst others Tenore the Neapolitan botanist; as to Austria and Sardinia, every facility and encouragement were afforded to those who wished to be present on the occasion. The result of the Florentine meeting has been to bring Italians together after a lapse of some centuries, and to give an impulse to science throughout the peninsula, which, I am persuaded, will be attended by very beneficial results. We know what have been the good effects of such ambulatory meetings in Germany and Switzerland within the present century; and in Italy, placed as its inhabitants are, under different governments, whilst speaking the same language, I think we are justified in anticipating equally profitable consequences, considering the genius of the people, their past history as regards literature, science, and the arts, and the protection of the principal sovereigns, as already evinced by those of Austria, Piedmont, and Tuscany. As to the immediate scientific results of the meeting, several very good papers were presented on geology, botany, and zoology, and some very interesting researches on magnetism and mechanics in the physical section. (*Letter from a Correspondent, dated Florence, October* 18. 1841.)

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

Register of the Weather and Climate of Orkney. By Rev. Charles Clouston.* I have kept a register of the weather for the last twelve years; the latter half only in this parish, and the former in the manse of Stromness, where there is no great difference in the climate. As the temperature and pressure of the atmosphere, the direction and force of the wind, with the state of the weather, were noted twice a-day, at 10 A.M. and 10 P.M., during all that period; it would occupy too much space to insert the whole of that register here; but the following tables, shewing the mean state of the barometer and thermometer for each month and year, may be interesting, as applicable to Orkney in general, and must be pretty accurate, being formed from extensive data.

TABLE *shewing the mean monthly and annual height of the barometer, from* 1827 *till* 1838 *inclusive; the line below shewing the mean of each month during that time, and the mean of the years.*

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	An.
1827,	29.269	29.767	28.945	29.222	29.156	29.337	29.398	29.683	29.503	29.269	29.305	29.010	29.322
1828,	29.295	29.290	9.141	29.567	29.447	29.272	29.205	29.348	29.437	29.398	29.322	29.219	29.328
1829,	29.955	29.682	29.893	9.386	29.993	29.974	29.532	29.849	29.640	29.859	29.934	30.112	29.817
1830,	30.099	29.708	29.780	29.623	29.894	29.843	29.820	29.828	29.604	30.072	29.614	29.694	29.798
1831,	29.936	29.715	29.752	29.858	30.038	29.930	29.946	29.916	29.883	29.602	29.694	29.604	29.822
1832.	29.846	29.920	29.690	30.074	30.010	29.938	30.067	29.860	29.963	29.815	29.638	29.596	29.868
1833.	30.123	29.298	29.910	29.860	9.912	29.634	29.870	29.767	29.799	29.601	29.508	29.233	29.712
1834.	28.370	9.478	29.804	30.096	29.835	29.760	29.924	28.736	29.924	29.712	29.744	29.983	29.697
1835,	29.759	29.278	29.664	29.899	29.761	29.998	29.851	29.743	29.524	29.626	29.783	30.027	29.742
1836.	9.538	29.654	29.682	29.490	30.298	29.674	9.672	29.769	29.690	29.520	29.321	29.304	29.634
1837,	29.637	29.530	29.880	29.776	29.838	29.853	29.815	29.835	29.761	29.633	29.423	29 703	29.723
1838,	29.145	29.293	29.284	29.171	9.294	29.188	29.189	29.140	29.272	29.282	29.004	29.124	29.223
Month.	29.939	29.551	29.618	29.668	29.789	29.700	29.690	29.622	29.666	29.615	29.524	29.550	29.64[illegible]

* From this clergyman's Statistical Account of the parish of Sandwick, in Statistical Account of Scotland.

Table shewing the mean monthly and annual temperature, from 1827 *till* 1838 *inclusive, mith the mean temperature of all these twelve years, which may be considered the mean temperature of our climate.*

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	An.
1827,	35.09	35.09	38.59	43.83	49.16	53.40	55.61	55.04	54.33	50.95	43.11	43.24	46.45
1828,	40.22	38.82	41.45	43.60	45.30	56.04	58.25	57.26	55.41	54.19	45.53	43.24	48.27
1829,	36.14	39.46	40.69	41.51	49.99	53.43	57.12	54.36	50.21	45.56	41.40	39.51	45.78
1830,	37.96	35.71	41.83	44.80	50.77	51.66	56.14	53.14	53.46	49.41	42.76	36.33	46.24
1831,	36.70	37.71	42.65	44.88	48.70	55.13	57.86	58.90	54.73	51.73	40.50	44.07	47.88
1832,	41.49	42.22	42.22	46.24	47.31	54.73	54.25	56.07	52.61	49.38	45.43	41.40	47.77
1833,	37.14	38.37	38.68	43.23	51.43	51.60	54.73	52.40	52.34	49.20	41 58	39.28	45.83
1834,	38.90	40.21	41.11	43.05	48.75	58.02	58.03	56.89	52.90	48.67	44.01	45.17	47.92
1835,	39.75	39.48	41.20	42.25	46.01	51.76	53.57	54.77	53.01	45.70	45.68	40.44	46.13
1836,	39.14	37.46	39.61	41.39	47.77	52.03	52.51	51.83	48.35	45.91	40.93	33.57	44.62
1837,	38.82	39.32	36.54	39.13	45.24	51.06	50.55	53.75	51.58	49.36	41.59	42.44	44.94
1838,	33.56	31.31	38.64	39.23	44.75	48.20	53.86	52.28	50.28	45.77	39.71	41.78	43.28
Month.	37.90	38.01	40.23	42.76	47.93	53.17	55.20	54.72	52.43	48.76	42.68	41.28	46.25

Of the meteors, the polar lights are the most remarkable here, being often extremely brilliant and beautiful.

The west or south-west wind is understood to be the strongest, and the stone and lime on that side of a house most exposed to it, are generally the first to give way. A gale from that quarter is frequently prognosticated by the great swell of the sea, which rages even during a perfect calm. On this subject I take the liberty of repeating an observation which I have made elsewhere.* "This great swell, or 'sea,' as it is here called, generally indicates a storm in a distant part of the ocean, which may reach Orkney a day or two afterwards; hence, on the west coast, this great swell is considered a prognostic of west wind. From this we infer, 1*st*, that the agitation caused by the wind on the surface of the ocean travels faster than the wind itself; and, 2*d*, that the breeze begins to windward, and takes some time to reach the point towards which it proceeds to leaward, which tends to overturn the usually received theory as to the cause of winds. Sometimes, however, the distant storm which causes this agitation does not reach these islands at all." In proof of this, I may mention, that, in August 1831, from the 9th to the 13th inclusive, the great swell of the sea is remarked in my register, every day being also marked calm, with the barometer high and steady. Afterwards, however, I learnt that on the 7th and 8th of that month, there was a gale, in latitude 57° 21′ north, longitude 13° 15′ west, which damaged a vessel that put back to Stromness to repair, and on the 11th it began at Barbadoes, and devastated that and other West India islands, but the gale never reached Orkney, though its effects on the sea were so conspicuous.

Climate.—Our insular situation prevents the extremes of tempera-

* Guide to the Highlands and Islands of Scotland, p. 629.

ture that are felt in continents of such a high latitude, the surrounding ocean tempering the heat of summer, and the cold of winter; so that for more than 12 years, the thermometer has only once fallen so low as 18° of Fahrenheit, and the snow does not lie so long here as in the more inland parts of the south of Scotland, or, I believe, the north of England. Indeed, the mean temperature of every month was above the freezing point, except that of February 1838. Our mean annual temperature is 46° 25′, and the mean height of the barometer 29.640, as will be seen from the annexed tables, but the nature of our climate will be more correctly understood by comparing the mean temperature of each month, as there stated, with that of other places. The highest hill commands an extensive view, not only of the west mainland, but of part of the north and south isles, and from it, and other elevated grounds near the west coast, may be seen the hills of Hoy, terminating in stupendous precipices, and, in calm and clear weather, those of Sutherland in the distance, stretching out towards Cape Wrath, add much to the beauty of the scene; but during a storm from the west it is awfully grand. The huge accumulations of water that then roll after each other, foaming with terrible violence to the shore, impress the mind with their irresistible power, and might well give a stranger a feeling of insecurity, and when they dash themselves against the precipice, it seems half sunk, for a time, like a wrecked vessel amid the waves; sheets of spray are thrown far up into the air, and carried over all the country, making springs a mile from the coast brackish for some days, and encrusting every thing with salt, even fifteen or twenty miles off. I am told by those living a few hundred yards from the spot, that the floors of their cottages are shaken by the violence with which the waves strike the crags; and I have seen innumerable sea insects alive on their summits, and even a limpet adhering to them after such a storm; also numerous fragments of the slaty stone, some of them a foot long, which had been whirled into the air, and had penetrated six inches into the soil in falling.

Our climate, in short, is more remarkable for dampness and storms, than for cold; the atmosphere being often loaded with sea spray in winter, and moistened with the constant evaporation in summer. Pulmonary and rheumatic complaints seem to be prevalent, owing to this peculiarity of the climate; and on our sudden and frequent changes of weather, some cases of cramp may also be ascribed to the dampness; and a neighbouring clergyman, who is afflicted with loss of voice, has, more than once, been immediately cured by the air of Edinburgh. Dyspeptic complaints are very common among the peasantry, but they are probably caused by poor diet.

Electrical Light on Bayonets, &c.—An officer of the Algerian army, sent a note relative to certain unusual phenomena of electricity observed in Africa. During a violent storm on the 25th of September 1840, he had observed that the arms of the men, when piled in stands, exhibited no symptoms of the electric fluid playing about them; but when the men carried them, the points of the bayonets were strongly luminous, not, however, giving out any sparks. The drops of rain that fell during the storm on the beards and mustachios of the men, remained hanging from them in a state of phosphorescence. When the hair was wiped, the phenomenon ceased; but was renewed the moment any fresh drops fell on it.—*Literary Gazette*, No. 1269.

ZOOLOGY.

"*On the Corpuscles of the Blood.*"—By Martin Barry, M.D., F.R.SS. L. and E.*

After remarking that no clear conception has hitherto existed of the mode in which the floating corpuscles of the blood conduce to nourishment, the author states that he has found every structure he has examined to arise out of corpuscles having the same appearance as the corpuscles of the blood. The following are the tissues which he has submitted to actual observation, and which have given the above result, namely, the cellular, the nervous, and the muscular; besides cartilage, the coats of blood-vessels, several membranes, the tables and cells of the epithelium, the pigmentum nigrum, the ciliary processes, the crystalline lens itself, and even the spermatozoon and the ovum.

The author then traces the nucleus of the blood-corpuscle into the pus-gobule; showing that every stage in the transition presents a definite figure. The formation of the pus-globule out of the nucleus of the blood-corpuscle is referable to the same process, essentially, as that by means of which the germinal spot comes to fill the germinal vesicle in the ovum. This process, which, in a former memoir, he had traced in the corpuscles of the blood, he now shews to be universal, and nowhere more obvious than in the reproduction of the tables of the epithelium. The epithelium-cylinder seems to be constituted, not by coalescence of two objects previously single, as has

* The Memoir of which the above is a notice, was read before the Royal Society of London in June 1841.

been supposed, but by division of a previously single object. Certain objects, called by the author *primitive discs*, exhibit an inherent contractile power, both when isolated, and when forming parts of a larger object; an incipient epithelium-cylinder having been observed by him to revolve by this means. Molecular motions are sometimes discernible within corpuscles of the blood. The author has noticed young blood-corpuscles, exhibiting motions, comparable to the molecular, and moving through a considerable space; and he has met with the nuclei of blood-corpuscles endowed with cilia, revolving and performing locomotion. In his first paper on the Corpuscles of the Blood, he described certain instantaneous changes in form which he had observed in blood-corpuscles, and afterwards expressed his belief, that these changes were referable to contiguous cilia, although he had not been able to discern any such cilia. He now states that subsequent observation inclines him to think that these changes in form arise from some inherent power, distinct from the motions occasioned by cilia. The primitive disc, just mentioned, seems to correspond, in some instances, with the "cytoblast" of Schleiden. Thus the very young corpuscle of the blood is a mere disc; but the older corpuscle is a cell. The author minutely describes the mode of origin of the pigmentum nigrum; shewing that it arises in a similar manner in the tail of the tadpole, and in the choroid coat of the eye. He had before described the Graafian vesicle as formed by the addition of a covering to the previously-existing ovisac: this covering, he afterwards stated, becomes the corpus luteum. He now confirms these observations, with the addition, that it is the blood-corpuscles entering into the formation of the covering of the ovisac, which give origin to the corpus luteum. The spermatozoon appears to be composed of a few coalesced discs. The fibres of the crystalline lens are not elongated cells, as supposed by Schwann; but coalesced cells, at first arranged in the same manner as beads in a necklace.

The author concludes with the following recapitulation:—1. The nucleus of the corpuscle of the blood admits of being traced into the pus-globule. 2. The various structures arise out of corpuscles having the same appearance, form, and size as corpuscles of the blood. 3. The corpuscles having this appearance, and giving origin to structures, are propagated by division of their nuclei. 4. The corpuscles of the blood, also, are propagated by division of their nuclei. 5. The minuteness of the young blood-corpuscles is sometimes extreme; and they are to be found in parts usually considered as not being permeable by red blood.

In a postscript, the author adds, that blood found in the heart immediately after death by bleeding, presents incessant alterations in the position of its corpuscles. Among these, when a single corpuscle is examined very attentively, it is seen to change its form; and the author is disposed to think it is this change of form that produces the alterations in position. The changes in form are slight, compared with those previously described by him as observed in blood elsewhere, and are not seen without close attention. The motions resemble those called molecular; and in the minutest corpuscles, which are mere points, nothing besides molecular motion can be discerned. It may be a question, the author thinks, whether molecular motion differs in its nature from the motion of the larger corpuscles just referred to. The division of the blood-corpuscles into corpuscles of minuter size, though apparent in blood from either side of the heart, has seemed more general in that from the left side; which, it is suggested, is perhaps deserving of notice in connection with the subject of respiration.

GEOLOGY.

Remarks on the Freezing of Water.—By Professor KRIES of Gotha.*—On a previous occasion I had an opportunity of repeating Professor August's observation on the freezing and non-freezing of water *in vacuo*,† by means of a beautiful double water hammer which our cabinet received from the collection of Duke Ernest II. This instrument had remained many winters quietly hanging in a shut-up cabinet, but, in the severe winter of 1829–30, it was unfortunately frozen in two, and the ice and water fell out; so that I had no opportunity of remarking the nature of the former. I cannot say what temperature caused this to take place; for, as my house is not in communication with the collection of instruments, several days often elapse without my visiting it.

I had at another time an opportunity of making an interesting observation on the freezing of water in the case of an electric light apparatus, which, during a very cold night, had stood not far from the window of a cold room which was never heated. The fine glass ball, about eight inches in diameter, was entirely filled with water, and I imagined that by the morning it would certainly be broken in two. But, on the contrary, it was entire, and the water perfectly pure and liquid. I opened carefully the cock, and allowed some water to escape, so as to provide space for expansion when the re-

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* From Poggendorf's Annalen. 1841. No. 4. † Ib. vol. lii. p. 184.

maining water should freeze. I then took the ball cautiously between my hands, and carried it slowly into the neighbouring warm room. I had scarcely entered it when a portion became frozen, and the whole was filled with a multitude of small icy needles. Here, then, the slight movement, notwithstanding the warmth of my hands and of the air of the room, was sufficient to cause the freezing, inasmuch as the requisite expansion of the water now met with no obstacle. It seems probable that the resistance of the glass when the globe was full, prevented the freezing during the night.

It appears to me a circumstance worth noticing in the observation of Professor August, that the ice in the broken tube was entirely free from bubbles. This does not agree with the observation of Lichtenberg, who allowed water to freeze *in vacuo* under an air-pump, having as much as possible removed all air from it by boiling and exhausting, and, instead of solid ice, obtained a frozen froth-like mass (*Erzleben Naturlehre*, 6th edition, p. 361.) This matter deserves the more to be further investigated, because, according to the observations of Hugi (*Naturhistorische Alpenreise*, p. 224), during the melting of ice, the bubbles did not give the smallest vesicles of air, and therefore could not, as Professor August supposes, be attributed to the absorbed air.*

ARTS.

New Musical Instrument.—In a very recent report given in to the Academy of Sciences by a joint commission of that body and the Academy of the Fine Arts,† there are the following remarks by M. Seguier the reporter:—The commission are most anxious to assure to M. Isoard, an artist so worthy of commendation for his knowledge of acoustics, and for his perseverance in applying it to useful purposes, the honour and the fruits of the invention of his new method of producing sounds. It is not to a lucky accident that his invention is to be ascribed; in its present state so remarkable, it is yet, we hope,

* In Hugi's Travels, there are interesting details regarding the structure of glacier ice. The occurrence, in ice, of the geometrical, granular, tabular, concentric, stratified (both kinds), jointed, and venigenous structures, need excite no surprise, when we recollect that ice is a mineral, and consequently capable of taking on the structures observable in the more solid mineral masses of which the earth is composed.—Editor.

† This commission consisted of the following distinguished individuals, viz. MM. Cherubini, Berton, Halévy, Carafa, and Spontini, of the Academy of the Fine Arts; and MM. Arago, Puissant, Becquerel, Dutrochet, Poncelet, Pouillet, and Seguier, of the Academy of Sciences.

destined to produce the most powerful musical effects. A mechanician by profession, being a manufacturer of steam-engines in the establishment of Chaillot, M. Isoard was led by an irresistible fondness for music to attend the lectures of M. Savart, and it is from that rich source of information that he has derived his knowledge of the theory of vibrations; and from listening to these fertile instructions on the application of such theoretical views that he has deduced the possibility of impressing on a string powerful vibrations, causing it to perform the part of the reed of a wind-instrument. The novelty of the contrivance excited the surprise of the professor, and the extent to which it might be carried immediately struck his acute perception. The ingenious artizan, who had been his assiduous and attentive pupil, became his friend; and I recollect with pleasure having been admitted by M. Savart to partake in his sympathies, and more than once I was a witness of the warm interest with which he was inspired by the undaunted mechanician who, in the pursuit of his object, abandoned the sure resources of his profession, sacrificed every thing he had acquired by his toil, and sold piece by piece his furniture and even his tools. The talented professor of acoustics warned his pupil of all the difficulties of his undertaking; and it is only now after ten years of constant and expensive experiments, that he presents the feeble but interesting specimen of the effects which will one day be produced by the application of the new method of producing sounds.

To convert the ordinary vibration of the string of a piano into a powerful sound of a wind instrument, all that M. Isoard does is to place under the strings a moveable case, divided into as many compartments as there are different strings which he wishes to cause to vibrate. Each compartment communicates with a common port-vent by means of a valve. The air, compressed by double bellows, is stored in a special magazine; and it is admitted at the proper time into each compartment by means of the opening of the valve upon touching the key. The emission of the air, thus introduced for the purpose of continuing and augmenting the vibration of the string, takes place through a longitudinal slit in which the string may be inserted at will. We say intentionally, that the string struck by the air continues to vibrate; for M. Isoard, like his predecessors in 1790, has had to contend with the slowness with which certain strings commence their vibration; like them he has been able to triumph over the obstacle, but by a very different means. The much more simple mechanism of the hammer which strikes the string, has been preferred by him to the very ingenious but very complicated apparatus which rubs the string in order to cause its vibration to commence.

The choice of the hammer is happy, because it affords M. Isoard the real advantage of restoring to his strings their original sound; by lowering the moveable case, the string being struck when out of the slit where it receives the action of the air, emits only the sound of the piano. He can then, by means of a simple pedal, which raises or depresses the air-case at pleasure, suddenly change the nature of the sound of the instrument, and this power offers numerous resources for varying the musical effects. By dividing the air-case into several portions separately moveable, each including an octave, it would be easy to combine the two kinds of sounds; for example, the sound of the piano might be retained for the high strings, and that of the reeds given to the low strings, or *vice versa.*

The poverty of the artist has prevented him from presenting to you his work realized according to his designs, and he has been obliged to submit it attached to a very poor piano. He regrets exceedingly being unable to allow you to hear a much more powerful instrument, but he feels confident that in the rudiments of so incomplete a specimen, your sagacity will recognise its fundamental principle.—(*Comptes Rendus*, vol. xiii. p. 969.)

List of Patents granted for Scotland from 22*d September to* 22*d December* 1841.

1. To Thomas Gore of Manchester, in the county of Lancaster, machine-maker, "certain improvements in machinery or apparatus for roving, spinning, and doubling cotton, silk, wool, and other fibrous materials."—24th September 1841.

2. To James Warren of Montague Terrace, Mile End Road, in the county of Middlesex, gentleman, "an improved machine for making screws."—30th September 1841.

3. To George England of Westbury, in the county of Wilts, clothier, "improvements in weaving woollens and other fabrics, and for twisting, spooling, and warping woollen and other fabrics; also for improvements in the manufacture of woollen doe-skins."—30th September 1841.

4. To William Church of Birmingham, in the county of Warwick, gentleman, "certain improvements in hooks and eyes, and in machinery for manufacturing the same."—4th October 1841.

5. To Joseph Miller of Monastry Cottage, East India Road, in the county of Middlesex, engineer, "an improved arrangement and combination of certain parts of steam-engines used for steam navigation."—8th October 1841.

6. To John Varley of No. 3 Bayswater Terrace, Bayswater, in the

county of Middlesex, artist, "an improvement in carriages."—11th October 1841.

7. To John Barwise of Saint Martin's Lane, in the county of Middlesex, chronometer maker, and Alexander Bain of Wigmore Street, in the said county of Middlesex, mechanist, "improvements in the application of moving power to clocks and time-pieces."—15th October 1841.

8. To William Craig, engineer, Robert Jarvie, rope-maker, and James Jarvie, rope-maker, all of Glasgow, in the kingdom of Scotland, "certain improvements in machinery for preparing and spinning hemp, flax, wool, and other fibrous materials."—19th October 1841.

9. To William Edward Newton, of the office for Patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, being a communication from abroad, "certain improvements in the manufacture of fuel."—19th October 1841.

10. To Floride Heindriickx of Fenchurch Street, in the city of London, engineer, "certain improvements in the construction and arrangement of fire-places and furnaces applicable to various useful purposes."—20th October 1841.

11. To Joseph Wright of Carisbrook, Isle of Wight, mechanic, "improvements in apparatus used for dragging or skidding wheels of wheeled-carriages."—27th October 1841.

12. To Robert Logan of Blackheath, in the county of Kent, Esquire, "improvements in obtaining and preparing the fibres and other products of the cocoa nut and its husk."—27th October 1811.

13. To Joseph Chisild Daniel of Tiverton Mills, near Bath, "improvements in the manufacture of manure, or composition to be used on land as manure."—27th October 1841.

14. To Alfred Jeffrey, late of Prospect Place, New Hampton, in the county of Middlesex, and now of Lloyd Street, Pentonville, in the same county, "a new method of defending the sheathing of ships and protecting their sides and bottoms."—27th October 1841.

15. To William Neilson, builder, residing in Glasgow, and David Lyon, builder, residing in Tradeston of Glasgow, both in the county of Lanark, and Peter M'Onie, engineer, residing in Kinning Place, Glasgow, in the county of Renfrew, all in Scotland, "a mode or modes of, or an improvement or improvements in, cutting, dressing, preparing, and polishing stones, marble, and other substances, and also in forming flat or rounded mouldings and other figures thereon."—29th October 1841.

16. To James Whitelaw of Glasgow, in the county of Lanark, and James Stirrat of Paisley, in the county of Renfrew, manufacturer, "improvements in rotary machines to be worked by water."—3d November 1841.

17. To Martyn John Roberts of Brynycaeran, in the county of Caermarthen, gentleman, and William Brown of the city of Glasgow, merchant, "improvements in the process of dyeing various matters, whether the raw

material of wool, silk, flax, hemp, cotton, or other similar fibrous substances, or the same substances in any stage of manufacture, and in the preparation of pigments or painters' colors."—10th November 1841.

18. To John Annes of Plymouth, in the county of Devon, painter, "a new and improved method of making paint from materials not before used for that purpose."—12th November 1841.

19. To William Palmer of Sutton Street, Clerkenwell, in the county of Middlesex, manufacturer, being a communication from abroad, and partly by invention of his own, " improvements in the manufacture of candles."—17th November 1841.

20. To George Bent Ollivant and Adam Howard, of Manchester, mill-wrights, " certain improvements in cylindrical printing machinery, for printing calicoes and other fabrics, and the apparatus connected therewith, which is also applicable to other useful purposes."—17th November 1841.

21. To John Steward of Wolverhampton, in the county of Stafford, Esq., " certain improvements in the construction of pianofortes."—22d November 1841.

22. To George Lowe of Finsbury Circus, in the city of London, civil engineer, " improved methods of supplying gas under certain circumstances, and of improving its purity and illuminating power."—24th November 1841.

23. To William Edward Newton, of the office for patents, 66 Chancery Lane, in the county of Middlesex, civil-engineer, being a communication from abroad, " certain improvements in the production of ammonia."—1st December 1841.

24. To James Balderston of Paisley, in the county of Renfrew, manufacturer, " certain improvements in machinery, or apparatus for doubling, twisting, twining, and finishing cotton and other fibrous substances."—7th December 1841.

25. To James Colman of Stoke, Holy Cross, in the county of Norfolk, starch-manufacturer, " improvements in the manufacture of starch."—10th December 1841.

26. To Alexander Parkes of Birmingham, in the county of Warwick, artist, " certain improvements in the production of works of art in metal by electric deposition."—10th December 1841.

27. To William Irving of Prince's Street, Rotherhithe, in the county Surrey, gentleman, " improvements in the manufacture of bricks and tiles."—10th December 1841.

28. To George Hickes of Huddersfield, in the county of York, agent, " an improved machine for cleaning or freeing wool and other fibrous materials, of burs and other extraneous substances."—10th December 1841.

29. To Joseph Needham Tayler of Devonport, in the county of Devon, a post-captain in Her Majesty's Navy, " a certain method or certain methods of abating or lessening the shock or force of the waves of the ocean, lakes, or rivers, and of reducing them to the comparatively harmless state known by the term, "broken water," and thereby preventing the injury done to

and increasing the durability of, breakwaters, mole-heads, piers, fortifications, lighthouses, docks, wharfs, landing-places, embankments, bridges, or pontoon bridges, and also of adding to the security and defence of harbours, roadsteads, anchorages, and other places exposed to the violent action of the waves."—11th December 1841.

30. To Robert Holt of Manchester, in the county of Lancaster, cotton spinner, and Robinson Jackson of Manchester, aforesaid, engineer, "certain improvements in machinery or apparatus for the production of rotary motion for obtaining mechanical power, which said improvements are also applicable for raising and impelling fluids."—11th December 1841.

31. To William Hill Darker senior, and William Hill Darker junior, both of Lambeth, in the county of Surrey, engineers, and William Wood of Wilton, in the county of Wilts, carpet-manufacturer, "certain improvements in looms for weaving."—14th December 1841.

32. To Archibald Templeton of Lancaster, in the county of Lancaster, silk-spinner, "a new or improved method of preparing for spinning, silk and other fibrous materials."—16th December 1841.

33. To James Colley March of Barnstable, in the county of Devon, surgeon, "certain improved means of producing heat from the combustion of certain kinds of fuel."—16th December 1841.

34. To Christopher Dumont of Mentz, in the kingdom of Germany, but now residing at Mark Lane, in the city of London, gentleman, being a communication from abroad, "improvements in the manufacture of metallic letters, figures, and other devices."—16th December 1841.

35. To Morris West Ruthven of Rotherham, in the county of York, engineer, "a new mode of encreasing the power of certain media when acted upon by rotary fans or other similar apparatus."—16th December 1841.

36. To Henry Augustus Wells of Regent Street, in the county of Middlesex, gentleman, being a communication from abroad, "improvements in machinery for driving piles."—17th December 1841.

37. To Henry Booth of Liverpool, Esq., "improvements in the method of propelling vessels through water."—17th December 1841.

38. To John Hall of Breezes Hill, Ratcliff Highway, in the county of Middlesex, sugar-refiner, "improvements in the construction of boilers for generating steam, and in the application of steam to mechanical power."—17th December 1841.

39. To Henry Browne of Codnor Park Iron Works, in the county of Derby, iron manufacturer, "improvements in the manufacture of steel."—18th December 1841.

40. To William Newton of the office for patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, being a communication from abroad, "certain improvements in engines to be worked by gas, vapour, or steam."—20th December 1841.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On the Geological Investigations and Writings of Baron Alexander von Humboldt. By the late Professor Frederick Hoffmann of Berlin.

Alexander von Humboldt attended the Mining Academy of Freyberg simultaneously with Leopold von Buch, and, like him, he not only fully adopted Werner's views, but also endeavoured to disseminate and confirm them by his own personal observations. After finishing his studies,* his first years were devoted to mining, and from 1795 to 1797 he was *Ober-Bergmeister* (Superior Director of the Mines) in the *Fichtelgebirge.* Among the geognostical investigations which he prosecuted at that period of his life, the discoveries regarding the magnetic properties of certain mountain rocks are remarkable, and more especially his examination of the magnetism of the serpentine of the Heidberg near Zell, which attracted the attention of naturalists. He afterwards made his first journey in the Alps along with Von Buch, and then accompanied him

* Baron Humboldt was born at Berlin on the 14th September 1769, and studied at Göttingen and Frankfort on the Oder. He also received instructions from Büsch at the Commercial Academy of Hamburg, and in 1790 he made a journey, in company with G. Forster, to the Rhine, Holland, and England. The first essay by him with which we are acquainted, is an ingenious dissertation on the basalts of the Rhine, dedicated to Forster, and published at Brunswick in 1790. It is entitled *Mineralogische Beobachtungen über einige Basalte am Rhein.* Edit.

and Gay-Lussac to Vesuvius. We find, however, that comparatively little was then done by him in the way of special geognostical observations, for he was occupied to a much greater extent with the general consideration of the natural sciences connected with physical geography, and no subject of this description escaped him. No one has succeeded in so high a degree as he has done, in mastering and extending all the branches of that science. Soon after he had an opportunity of personally studying nature, he was attracted by Geognosy, and more especially by some of the more important problems which are of the greatest moment for enabling us to form an opinion regarding the relations of our globe at the earlier periods of its existence.

The subject which chiefly occupied his attention, was the change of climate which the earth must have undergone during the periods that preceded our epoch. It is well known, that, in the different layers composing the crust of the globe, there occur remains of races of animals and vegetables which have successively existed and become extinct; and that their forms correspond most nearly with the species of tropical climates, their whole organisation proving that there alone they could flourish. We do not yet know over what extent of our earth these primeval organisms were distributed, but of this much we are certain, that many of them are met with in comparatively very high latitudes, in the temperate zone, and near the Polar regions, where they never could have flourished if the climate had not at that time been very similar to that of the tropical zone at the present day.

Various attempts have been made to explain this remarkable phenomenon in a manner consistent with nature; and, as the distribution of heat on the earth's surface depends on the elevation which the sun attains above the horizon at each place, it has been assumed from an early period, in order to resolve the problem, that there formerly subsisted quite a different relation from the present one, as regards the position of the earth in reference to that of the sun. Instead of the plane of the ecliptic (the course of the earth round the sun) being, as at present, inclined at an angle of about $23\frac{1}{2}°$ to the plane of the equator (whence it follows that it is only at places which are within the distance of 23½° from the equator that the sun acquires a perpendicular position, and can exercise its greatest heating power), it was assumed that the reciprocal inclination of the two planes had formerly been different. It might of course have been either greater or smaller, and consequently two extreme cases are possible, which serve as the explanation of all the remaining intermediate ones. The planes of the ecliptic and the equator could either at one time have been perpendicular to each other, or they could have been identical. In the first case the sun would stand perpendicularly over each point of the earth's surface successively, and twice a year, and it would do so over the poles themselves, and would thus produce at each point a tropical summer; but it would also, upon the same supposition, not rise at all during a certain period of the year at any part of the earth's surface, except only at the equator. All these places therefore would have simultaneously a more or less continued real polar winter. Thus this division of the seasons would by no means correspond with the nature of our tropical climates. But, supposing that the plane of the ecliptic was the same with that of the equator (as was considered probable by the ancients, who thought that this cause had produced the condition of perpetual spring which they supposed to have primarily existed), we would of course have had the sun visible at the equator from all points of the surface of the earth; day and night would thus have been of equal length in all portions of the earth (with the exception of the poles, where there would have been perpetual twilight), and every distinction of season would have ceased. Under such circumstances the sun with us would never rise higher than 37½° above the horizon, while at present it rises to 61° in summer; we should throughout the whole year have the low temperature of our equinoctial periods, the more northern localities would be constantly dreary, and, even in the tropical zone, its products would flourish at comparatively much smaller distances from the equator than at present.

Hence it is clear that the climate of earlier periods cannot be explained by an altered position of the sun in relation to the earth. The assumption of such a change of position is so much the more daring, inasmuch as astronomical reasons also are much against its probability; for, if a certain alteration in the obliquity of the ecliptic has really taken place, La Place has proved that it was confined within fixed and periodically recurring limits, which he, agreeing with De Lambre, believed he might assume to be about 1° 29′. Another supposition which has been advanced to explain this problem is just as inadmissible, that the axis of rotation of the globe has been changed by a sudden shock; for that such alterations cannot have been of magnitude, at least since the time when our earth was consolidated, is proved by the flattened form at the poles.

A. von Humboldt believed, therefore, that in order to solve this problem, we must proceed from quite another basis, and he developed his ideas in an important paper on the disengagement of Caloric considered as a geognostical phenomenon. *(Ueber die Entbindung des Wärmestoffs als Geognostisches Phänomen betrachtet.*)* He directed attention to the fact, that the original deposition of mighty mountain masses presupposes the evolution of a large quantity of free caloric; for a body cannot pass from a state of solution into that of compactness, without at the same time losing a certain quantity of its heat, which was necessary to preserve it in its previous condition. This heat set free must naturally have been communicated to the nearest strata of the atmosphere. In his elucidations he proceeds from the fundamental principle, that all portions of the earth must have been dissolved in a common chaotic menstruum, whether that was in a liquid or an elastic (gaseous) condition. The first precipitation (produced by unknown causes) being regarded as given, had, by the consolidation of large masses, produced a considerable development of heat; this heat caused evaporation, and consequently a diminution of the volume of the liquid resting upon consolidated mass. Repeated precipitations were the result; with each of these the temperature was at the same time elevated; in fact, they would have continued to go on with constantly increasing rapidity, had not the ac-

* Von Moll's *Jahrbuch der Berg-und-Hüttenkunde*, iii. p. 1—15, 1799.

tive evaporation filled the atmosphere with vapours of the most varied description. In this way it exercised a much greater pressure on the closely covered solution than previously, and hindered its rapid vaporisation; the solution must have acquired a greater heat ere new precipitates could be produced, and the separation of its constituents must have taken place more slowly. By this supposition was explained, in a very ingenious manner, the highly crystalline condition of the older rocks, which were formed at a lower temperature, and the more earthy, imperfectly crystalline aspect of all newer formations, which were separated more rapidly at a higher temperature. The heat arising from these events must for some time have produced, at all parts of the earth's surface, a climate similar to a tropical one, which disappeared so soon as the heat developed was lost by radiation and dispersion in space, and remained only for that portion of the surface in which the position of the sun rendered possible the continuance of a considerable development of heat.

This able view has this great advantage, that we do not require, as in those mentioned above, to introduce violent means for explaining the phenomena. Farther, it agrees extremely well with the known laws of the phenomena of nature, as these are exhibited in fluid bodies when they pass into the solid state; and this is certainly a great recommendation. However, we can, by a general consideration of the phenomena presented by nature, very easily convince ourselves that it is not sufficient as an explanation in the manner just described. It is certain that the greater portion of the deposits which resulted from the general mass of water at the different periods of the formation of the crust of the earth, and which furnished the stratified rocks, were more of a mechanical than a chemical nature. The immensely extensive formations of sandstone and conglomerate are composed of parts which were formerly suspended and not dissolved in the water. The masses of clay belonging to them, the clayslates, the slate clays of the coal formation, the slaty clays of the newer sandstones, are evidently chiefly the result of the destruction of the previously existing very felspathic older rocks, which, by decomposition, are partially converted into masses of clay before our eyes. It is only in a scattered and isolated manner that we find in them traces of chemical action in the siliceous nature of the uniting basis, or in the crystalline-granular deposits of quartz. The originally chemical formation of a large portion of the mountain masses of limestone is more probable, because that rock is deposited at present in a similar way from solutions in carbonated waters; nevertheless, very many of them also, such as the limestones rendered impure by clay, resemble so perfectly the strata deposited by mechanical agency, that we cannot avoid regarding them as formed in a similar manner. We thus find, therefore, that the deposits produced in a chemical way are reduced to comparatively a very small portion of the crust of our globe, and these can have contributed but little to the elevation of the temperature of the ancient world; for, a more close investigation proves that these, as well as all other deposits, at least all the finer mechanical deposits, must have been formed very gradually, and during very long periods. The occurrence of remains of plants and animals in the strata of the crust of the globe affords incontrovertible evidence on this head; thus we generally find in limestone rocks the shells and zoophytes in whole beds together, and in all periods of life next one another; we find also broods of shells in the cavities of coral reefs, pholades in the hollows bored by themselves, and all these contained in regular strata. Hence, undoubtedly, a very long period must have elapsed while these strata were in the course of being deposited, and while they enveloped throughout a long time the bodies of animals of many successive generations, which had existed in a state of undisturbed development. Thus, also, the rocks of the coal formation contain in certain strata, in the greatest abundance, the products of a vegetation contemporaneous with themselves, in a full grown state; colossal, and partly upright trees, must thus have had to perfect their growth previous to the deposition of the clays in which we find their individual portions at present enveloped. Hence it appears, that, though we should admit in its fullest extent the chemical mode of formation of rocky strata, yet the influence of the heat developed by deposits can have been of very little moment.

But another consideration comes here to be taken into account. When Humboldt elucidated the above view, he assumed the fundamental principles of Werner, that all the older crystalline rocks, such as granite, had been likewise produced by deposition from water; but we now know that these could not have been formed by the action of water, and we have thus to separate such substances from the series. As, however, these rocks have been produced by volcanic action, although we lose them as a support of the theory by precipitation, there is opened to us another and more powerful source of heat, arising from the eruption of large masses of burning matter, and from the disengagement of their accompanying hot vapours. These phenomena have, at different periods of the history of the earth, included at one and the same time a space of many thousand square miles; and hence, in recent times, it has become a probable opinion that the uniformly elevated temperature of the ancient world is to be ascribed to the much more vigorous activity of volcanic agency; nay, even Humboldt himself has been one of the first to express openly this belief, and to argue in its favour. In the year 1823 he treats of this view in an extremely beautiful memoir on the structure and mode of action of volcanos.

This last opinion as to the causes of the higher temperature which prevailed over the ancient surface of our globe, approaches the remarkable hypothesis of Buffon; and it cannot be denied that it is much more capable of explaining the phenomena in question. Nevertheless, there is one fact which has hitherto defied all attempts to include it in this solution of the problem. After the heat and the general character of the tropical climate had existed for an unlimited period, over a large portion of the earth's surface, it must have terminated by some suddenly occurring event. It is well known that the elephants, buffalos, and rhinoceroses which at one period inhabited Siberia, and some quarters of North America, and especially the banks of the Wilui and Lena, were, with their soft parts, enveloped by the ice in which they are now found. Hence, at a certain time, when they were living in full vigour and tranquillity, they must have been surprised by the inconceivably sudden occurrence of a cold approaching nearly that which prevails at the present day in these regions The same thing is indicated by the beds of shells and corals, and by the vegetable forms, which are found in the newest strata of the tertiary series; for even their forms belong to a tropical world, and they are preserved with as much freshness and integrity in their most delicate portions, as if they had been destroyed at the period of their fullest perfection, by a change of climate which they could not resist, at the last revolution which has affected our earth.

This suddenness of the change is not taken into account by Humboldt, in his suppositions regarding the causes of the alteration of temperature. According to his view, a successive diminution of the previously existing higher temperature, produced by the gradual disappearance of the quantity of heat communicated to the atmosphere, must have taken place, and the products of a tropical climate must gradually have been incommoded and enfeebled, and have been replaced by such products as correspond with the present arrangement of the climate. The largest portion of the former would have been extinct, and, at least in so far as regards the more delicate forms, destroyed, long before they were covered by the superimposed strata. But there is no trace in the strata of the crust of the globe of such a gradual diminution of fitness for certain forms, or of such a mingling of the products of the tropical climate with those of the present distribution of the heat of the surface of the earth. Both races, that of the newest, and that of the immediately preceding ancient period, are sharply separated from each other; and hence, also, one of the greatest naturalists of our time who has devoted himself to this subject, Cuvier,* has laid especial weight on this sudden occurrence of the last of the revolutions which have taken place on the surface of our earth. We thus at once perceive, that all attempts to explain this wonderful fact have been unsatisfactory, and that it must still be reserved for the future, as a problem of extreme importance, in the knowledge of the various events in the formation of our earth's crust.

In the view promulgated by Humboldt, we find the first

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* *Discours Préliminaire* to the Recherches sur les Ossemens Fossiles.

mention made of a circumstance which is rich in consequences, and well deserving of notice. This is the assumed condition of greater density (of increased pressure) which is ascribed to the atmosphere, at early periods of the formation of the earth. It is certainly not improbable, that the atmosphere, like the water, was at early periods loaded with a quantity of foreign substances,which, by the action of volcanos, ascended in their vapours at a high temperature, and were afterwards separated from them, just as partially takes place on a small scale at the present day, in volcanic eruptions. The greater heat thus produced in the solution, and the greater elasticity of the particles caused by increase of pressure, must necessarily have increased the dissolving power of the general body of water; and it may thus be naturally explained how the water, at early periods of the earth's history, could contain a large quantity of matters dissolved, which at the present time are, it is true, still contained in it, though in very small quantity. This circumstance is of great consequence in the explanation of many details, which we must here pass over ; but it affects, on the great scale, not only the quantity of lime formerly dissolved in such large quantity in the water, but perhaps still more the silica which at certain places has been precipitated in large quantity from a chemical solution. On this point we find a remarkable example in the springs of the Geysers, in Iceland, where, at a high temperature, and under increased pressure, the water is able to take up a much larger quantity of silica than it can under ordinary circumstances. Lastly, we know that, under high pressure, not only gaseous bodies can be converted into liquid ones, but also that water can absorb large quantities of gaseous bodies. But we have here, at the same time, a mode of explaining the altered chemical action of many bodies on each other, and the possibility of the union of these in the earlier conditions of the earth, which could not occur under the present general state of matters, but which are by no means in opposition to the laws of nature. Hence many of the most distinguished naturalists have adopted this view of the increased atmospheric pressure, accompanied by elevation of temperatue, which existed at early periods, and it has more especially attracted the notice of Mitscherlich.

This view, which was undoubtedly first started by Humboldt, is one of the richest in consequences which have been brought forward in recent times; and many others were linked with it, which at that time occupied the attention of this great naturalist. He was at that period, like Leopold Von Buch, much engaged in the investigation of the parallel strike of mountain chains, and of the strata belonging to them. He had previously made the observation respecting this parallelism in the Fichtelgebirge, mountains which belong to the system of the Erzgebirge; he found it confirmed in the Alps; for accident led him to investigate there a mass of mountains, whose line of strike had the same direction as that of the Erzgebirge; further, he had made a tour to the Rhine, and also occupied himself there with the study of its basalts, whose neptunian origin he at that time defended with great acuteness. He found again there, that the strata of the widely extended slate mountains had the same direction as the Alps, and thus arrived at the conclusion, that the line of strike of all the older strata of mountains, over the whole surface of the earth, had an uniform direction from S.W. to N.E. He expressed this by saying, that the strata of the mountains formed with the meridian a certain constant angle (of about 52°), and he believed that this phenomenon was founded on certain cosmological relations. He was now in the highest degree anxious to ascertain if observation would confirm also, in respect to the new world, on the continent of America, a fact which seemed to him established in regard to the old. It was this, as he expressly says, which formed one of the motives that caused him to undertake his voyage to America in 1799. There he first reached the coast regions of Caraccas and Venezuela, where, notwithstanding the totally different circumstances, the line of strike of the Alps also prevails in the arrangement of the mountains, and the strata of which they are composed. This struck him with wonder; and his first letters sent to Europe are therefore full of enthusiasm as to this unexpected discovery, by which what appeared to him a general law of nature in the formation of the globe, seemed to be confirmed in a remarkable manner. He intended to make this subject the object of an extensive examination and investigation after his return, in order to discover the causes on which it was based. But such views became much altered, after he penetrated into the interior of the region of the Cordilleras, for he there found that a line of strike from N. to S. or N.W. to S.E. presented itself, with at least as much distinctness, and on as great a scale, as did the direction corresponding with that of the Alps.

A. von Humboldt's scientific travels in America continued uninterruptedly from the year 1799 to 1804 inclusive. It is not our object to indicate at all in detail how much these expeditions contributed to our particular science, as they did to all branches of natural knowledge. The results were not only in this respect important, that they made us acquainted with a number of mountain rocks occurring in America which could be perfectly well compared with the more minutely studied ones of Europe, and that it was ascertained that the same law obtained there as in Europe as to the order of succession of strata ; but we have also to thank the exertions of this remarkable man for the possession of a very perfect view of the structure and arrangement of the mountain chains, as well as of the elevations and depressions of America. It results, that we cannot doubt of the applicability of the view entertained regarding the origin of other mountain chains, inasmuch as the constitution of the Cordilleras, the vastest display of mountains in the world, possesses so completely the structure of a variously shattered and protruded wall rising from a fissure.

Another very great service rendered by these investigations, consists in the valuable extension of our views regarding the phenomena of volcanos, and the intimately connected subject of earthquakes. Our indefatigable traveller found himself in a remarkably favourable field for the observation of such objects in America, and his rare gift of combination allowed him to place in the necessary and useful connection with one another, phenomena which previously had only been known in an isolated state. Thus we have to thank him for the first descriptions of the mightiest volcanic phenomena which exist on the earth, and which, in some degree, may be placed in comparison with the analogous phenomena which must have occurred during the early periods of the formation of the crust of our globe. Humboldt taught us for the first time that the focus of volcanic activity, which we find so abundantly and powerfully displayed in the region of the chain of the Cordilleras, must be regarded as standing in connection with another at a distance of hundreds of geographical miles; he shewed us how, in this respect, a kind of constant propagation of volcanic phenomena takes place; at one time from south to north, and at another in a contrary direction. He pointed out the connection in which the littoral regions of the Mexican Gulf and the Antilles stand in relation to the series of earthquakes and volcanic eruptions; and how the operations of subterranean shocks are felt simultaneously over a space of several thousand square miles.

We have to thank Humboldt for the investigation at the very place, and for the delineation of one of the greatest volcanic catastrophes which has happened in historical periods— the eruption which, in September 1759, caused in a few days the production, on the plateau of Mexico, of the mountain of Jorullo, which has a height of 1578 German feet; and which, moreover, caused to be formed out of it five other similar hills, and covered nearly four square German miles* to a height of 500 feet with lava, sand, and slag.† With this investigation may be appropriately united, as one of the most remarkable results of this expedition, the discovery of the fact, that the continent of America, between the 18th and 19th degree (18° 59′ and 19° 12′), is intersected by a rent, 150 German miles long, extending right across from the coast of the Atlantic to that of the Pacific, and on which rise behind one another, and sometimes to upwards of 16,000 feet, the volcanos of Tuxtla, Orizaba, Puebla, Nevado di Toluca, Tancitaro, and Colima. This rent is probably continued to a great distance in the South Sea; for, if prolonged westward, it would meet at a distance of more than 50 German miles, the entirely volcanic Revillagigedo islands; and it is certainly not entirely accidental, that in its direction there should be found, in the midst of the South Sea, the Archipelago of the Sand-

* The German mile = $4\frac{3}{5}$ English.

† *Vue des Cordilleras*, ii. 216. *Essai Politique*, vol. i. p. 248.

wich islands, with the mountain of Mowna Roa, which has a height of 15,000 feet.

These remarkable facts, by which our geognostical knowledge has been so essentially enriched, are related, along with a multitude of detailed observations, in Humboldt's Travels in the equinoctial regions of the New Continent (*Reisen in die Aequinoktial gegenden des neuen Kontinentes*), in 4 volumes,* and the *Essai Politique sur la nouvelle Espagne,* 4 volumes, 2d edition, 1825. The description of the rocks of America, and their comparison with those of Europe, are contained in the more general work, *Essai Géognostique sur le Gisement des Roches dans les deux Hémisphères,* 1823.† In this last work there is given a very complete general view of the known mountain rocks, with full information on the literature of the subject. Directly connected with this work is an essay, rich in clear views on the structure and action of volcanos, read to the Academy of Sciences of Berlin, on the 24th of January 1823.

In later times, Humboldt has not ceased devoting himself with zeal to the objects of our science. His journey to Asiatic Russia, undertaken in 1829, and which extended to the frontiers of China, has produced important results for the extension of our geognostical knowledge. One of the objects of this journey was to obtain more accurate information respecting the constitution of the metallic repositories of the Ural, and more especially to compare with analogous phenomena in America the characters of the alluvial matters containing gold and platina, which had been recently met with covering a large extent of country on both sides of that chain.

He found in this respect a remarkable agreement; for both in the Ural and on the west side of the Cordilleras of South America, the gold and platina are separated precisely in a similar manner in repositories quite distinct from each other. The auriferous alluvial matters presented themselves together, and with extremely trifling exceptions, in a district extending along the east side of the Ural; they there include an extent

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* Translated into English by Helen Maria Williams.

† Translated into German by C. von Leonhard; and into English, 1823.

of about 80 geographical miles in length, viz. from about 14 German miles north of Boguslawsk to near Miask, between 54° and 60° N. L., and the gold has apparently been derived from the disintegration of auriferous iron pyrites* contained in rocks rich in felspar and quartz, just as it is found existing in the granite veins of the mines of Beresovsk near Katharinenburg. This destruction can very well be fixed to have taken place in the latter part of the diluvial period; for the teeth and bones of the species of elephant destroyed during the last revolution were met with in the auriferous sand. The occurrence of platina, on the other hand, was confined, as it is in the Cordilleras of Choco, to the west side of the mountain chain. Masses have been found of a previously unheard of size, for Humboldt brought back one weighing 3 pounds 6½ loth,† and afterwards a much larger one was discovered, weighing 10⅔ Russian, or 9.3 Prussian pounds. The chief locality is a marshy plateau (called Martian) near Nischne-Tagilsk, about 1800 feet above the level of the sea.

For a long time, the original occurrence of platina in fixed rocks was unknown; the notice published by Von Engelhardt of its being found in a greenstone was not confirmed. Now we know, from the labours of Gustav Rose, that platina is met with in grains embedded in chromate of iron; and as the latter is generally accompanied by serpentine, of which large masses present themselves in the neighbourhood, it was probable that the serpentine was actually the matrix of the platina; and this has more recently been confirmed by direct observation.‡

All the repositories of platina are poor in gold, but still the latter does occur in them, though in small quantity.

Guided by the analogy with the phenomena presented in America, Humboldt was the cause of the discovery of diamonds in these remarkable alluvial deposits. They were first found in July 1829, on the western declivity of the Ural,

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* Jameson's Journal, vol. xiii. p. 189.

† The Prussian pound is equal to 1.25 lb. Troy, and the loth is equal to half an ounce.

‡ Poggendorff's Annalen, xxxi. p. 673, and Jameson's Journal, vol. xviii. p. 366.

along with gold sand, near the iron-works of Bissersk, at the small stream of Poludennaja, which falls into the Kama, after having previously joined the Tschussovaja. According to the accounts given by Von Engelhardt,* it is probable, although by no means certain, that the rock in which these diamonds originally occur is a granular dolomite.

In the course of the same journey, a multitude of remarkable facts on the geognostical constitution of the Ural Mountains was collected, and accurate determinations made regarding their mountain rocks; which will be very beneficial for our knowledge of the rocks occurring near us at home, and an account of which is now in preparation by Gustav Rose.† The journey was continued across the Ural by Tobolsk into the valley of the Irtisch, and to the frontiers of China.

On the western declivity of the Altai Mountains, Humboldt discovered an extremely remarkable geognostical fact. On the lofty rocky banks of the Irtisch, between Bucktarma and Ust-Kamenogorsk, the granite not only breaks through the clay-slate, as it frequently does, more or less distinctly, in England, Scotland, France, and Germany, but it spreads itself horizontally over the surface of the clay-slate for distances of several German miles in length. By means of this important discovery, we have attained a convincing proof of a kind which we did not previously possess, of the volcanic origin of granite, and of its actually having, at former times, flowed over large tracts of country.

One of the most valuable results of the same journey is the delineation of the *connection of the mountain chains in the interior of Asia*, which was derived from the numerous observations made on the subject. Upon this was founded the remarkable observation, that, in the interior of the Asiatic continent, and partly at distances of upwards of 100 German miles from the coast of the sea, there are volcanos of considerable size, and still in a state of continued activity, a fact of which we had previously not a single example, and which we were formerly often inclined to deny, from theoretical grounds, on

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* Poggendorff's Annalen, xx. p. 524, and xxxi. p. 608.

† Since published.

account of the probably necessary connection of the focus of volcanos with the sea. The essay in which this remarkable phenomenon is described forms a portion of a collection, entitled *Fragmens de Geologie et de Climatologie Asiatiques.* 1831. 2 vols. It is also published in Poggendorff's Annalen, vol. xviii. p. 1, and entitled, "On the Mountain-chains and Volcanos of Central Asia" (*Ueber die Bergketten und Vulkane von Inner-Asien.*)

We must here necessarily pass over all that Humboldt has contributed to our knowledge of the physical relations of our globe, to geography, meteorology, and the geographical distribution of plants, of which last subject he has himself created several new branches.*

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* From Hoffmann's *Hinterlassene Werke.* We think it may be useful for our readers to subjoin a list of the papers by Humboldt which have appeared in this Journal, many of which are specially referred to in the above summary of his geognostical investigations. *Edinburgh Philosophical Journal:*—On the Earthquake which destroyed the Town of Caraccas, vol. i. p. 272; on the Detonating Mud of South America, &c., vol. i. p. 423, and 424; Account of Electrical Eels, vol. ii. p. 242; on Isothermal Lines, and the Distribution of Heat over the Globe, vol. iii. p. 1 and 256, vol. iv. p. 23 and 262, and vol. v. p. 28; on the Great Cavern of the Guacharo, vol. iii. p. 83; on the Temperature of the Mines of South America, vol. iii. p. 286; on the Distribution of Vegetable Forms, vol. vi. p. 273, and vol. vii. p. 47; on Fossil Organic Remains, vol. ix. p. 20; on Rock Formations, vol. x. p. 40 and 224; on the Horary Variations of the Barometer under the Tropics, vol. xiv. p. 328. *Edinburgh New Philosophical Journal:*—On the Principal Causes of the Difference of Temperature on the Globe, vol. iv. p. 329; on the Structure and Action of Volcanos in different Regions of the Earth, vol. v. p. 222; Discourse delivered at the Extraordinary Meeting of the Imperial Academy of Sciences of St Petersburg, vol. ix. p. 97; on the Mountain-chains and Volcanos of Central Asia (with a map), vol. xi. p. 227, and vol. xii. p. 145; on Two Attempts to ascend Chimborazo, vol xxiii. p. 291.—Edit.

On the Use of Chlorine as an Indication of the Illuminating Power of Coal Gas, and on the Comparative Expense of Light derived from different sources. By ANDREW FYFE, M.D., F.R.S.E., F.R.S.S.A. Communicated by the Royal Scottish Society of Arts.*

IN a paper published in the Edinburgh Philosophical Journal for 1824, I recommended the condensation of the heavy hydro-carbons by chlorine, as an easy and efficacious method of ascertaining the comparative illuminating power of coal-gas, while, at the same time, it had the advantage of enabling us to compare one gas with another, though not brought directly into contrast with it, and thus, by fixing on one as a standard, to state the illuminating power numerically.

With regard to the methods now in use, I mean the specific gravity, the quantity of oxygen necessary for combustion, and the depth of shadow, the last is the only one in which we can place any confidence. As to the specific gravity, if the gas be pure, that is, free from carbonic acid and sulphuretted hydrogen, then the heavier it is the more likely is it to be of high illuminating power; but this is not always the case: thus the specific gravity of olefiant gas and of carbonic oxide is the same, but the latter burns with a feeble blue flame, whereas the former gives forth a brilliant light. Now, suppose coal-gas to contain little of the heavy hydro-carbon, and a large proportion of carbonic oxide, then the specific gravity may be such as to induce us to expect the illuminating power to be high, when in fact it is not.

The same remark is applicable to the mode of testing by the quantity of oxygen necessary for complete combustion. A gas with much olefiant will no doubt require much oxygen, this gas taking no less than thrice its own bulk; but let us suppose a variety of gases to have the same proportion of olefiant

* Read before the Royal Scottish Society of Arts, 10th January 1842.

or of heavy hydro-carbons, while the proportion of the other inflammable gases varies, which, though they consume oxygen, give out little light during their combustion, and we shall find that the amount of oxygen required gives no indication whatever of the illuminating power.

Thus, suppose the composition to be

Olefiant,	13	13	13
Carburetted hydrogen,	83	65	51
Carbonic oxide,	4	14	8
Hydrogen,	0	8	28
	100	100	100

the first would require 207, the second 180, the third 159, of oxygen, yet the illuminating power would be nearly the same in all. Supposing the heavy hydro-carbons to vary, and even to become considerable, yet the quantity of oxygen may not be in proportion, owing to the hydrogen and carbonic oxide, which require only half of their bulk of that gas for combustion. The mode of ascertaining the illuminating power by the shadow is one in which we may place the utmost reliance, provided we burn the gases with the same kind of burners, and pay particular attention to the circumstances affecting the appearance of the shadow; for it is well known that the colour of the shadow varies even from the same gas, when the flames from different burners are contrasted; besides, the reflection of light from surrounding objects will also occasion a difference. Great care is therefore necessary when conducting the trials in this way; and it requires nicely adjusted metres, and a regular pressure, so that the consumpt shall not vary during the performance of the experiment.

The other method which I formerly recommended is not liable to these fallacies. In the paper to which I have already alluded the results of numerous trials are given, in which the illuminating power, as shewn by the chlorine test, very nearly agrees with those indicated by the photometric process; and these experiments were performed with every possible attention to the circumstances likely to affect the results, *so far as they were then known.* In a paper subsequently published by

Drs Christison and Turner, the accuracy of the chlorine test was called in question, partly because, when testing the gases by the photometric process, as pointed out by Rumford, due attention was not paid to the different circumstances affecting the combustion, and partly owing to the opinion expressed in the paper by the authors, that other ingredients than olefiant exist in coal-gas, which afford light by their combustion, and which are also condensible by chlorine. As to the latter objection it is of little value, provided we find the results indicated by the chlorine test, to agree with the photometric one. With regard to the latter, it must be admitted, that in some of the trials, where two gases were compared with each other, due attention was not paid to the height of the flame, and to the other circumstances affecting the combustion, which, at the time that I was engaged in the inquiry, were not known to have an influence on the illuminating power. The influence of these has now been fully investigated, and made known, in the paper by Drs Christison and Turner, and also in that which I read to the Society in 1840. Since then, I have again had my attention drawn to the subject, and have had many opportunities of putting the chlorine method to the test of experiment; and I must say that I am more and more inclined to put the most implicit confidence in it, not only as a very simple, but at the same time a correct method of ascertaining the comparative illuminating power. I trust the results of the trials will not be devoid of interest.

In fixing the illuminating power of the gases by the shadow, two accurately adjusted metres were used, one for the one gas, the other for the other. Sometimes the gases were contrasted with each other; in which case, similar burners, consuming the gas under the same circumstances, were employed; and with the view of securing accuracy in the results, the burners were sometimes changed from one gas to another; at other times, the light given by the gas was contrasted with that from candles. The gases subjected to trial were sometimes those with which Edinburgh is at present supplied, sometimes they were prepared by myself, in a small apparatus, with the view of having the illuminating power as varied as I could possibly obtain.

It is well known that the quality of coal-gas, even when manufactured from the same kind of coal, depends much on the mode of manufacture; when slowly prepared, and when the same charge of coal is long subjected to heat, a larger quantity of gas is given off, than when the time for the charge is shorter; but then the illuminating power is low, owing to the gas which is last evolved having very little of the heavy hydro-carbons; and hence those companies who dispose of their coke to advantage, have, besides the quantity of gas to be got, another object in view, viz, the freeing of the coke from all its gaseous ingredients, otherwise it is not considered valuable, indeed will not be purchased by those in the custom of using it. It is this which, in addition to the difference in the quality of the coal employed, makes such a difference between the quality of gas prepared in England and Scotland; for, as the coke from English caking-coal is more prized than that from parrot-coal, which is much used in Scotland, the English companies may generally be considered, not only as gas companies, but also as coke companies, indeed derive a great deal of their profit from the coke. Hence, in judging of the price of gas, we must take into account its quality; and hence I conceive the importance of having an easy method of ascertaining this, and of comparing different gases with each other.

In the first series of experiments, the results of which I am now to give, two gases, manufactured under different circumstances, were compared with the light afforded by a wax candle kept burning, as nearly as possible with a uniform flame; the gases being consumed in jet burners with a 5 inch flame. Taking the average of several trials, gas A gave a light as 2.16, compared to that of the wax-candle as 1; the condensation by chlorine was 15. Gas B, under similar circumtances, gave a light as 1.98; condensation by chlorine 13, and 15 : 13 : : 2.16 : 1.86; by the shadow it was 1.98.

In another trial with other gases the light was compared with that afforded by a *tallow* candle (short six). Gas C, the light was as 2.81, to that of the candle as 1; condensation by chlorine 15. Gas D. the light was 2.27, chlorine test 12,

and as 2.81 : 2.27 : : 11 : 8.02
and as 15 : 13 : : 1 : 8.00,

which is a very close approximation.

Two gases were next contrasted with each other, being consumed with fish-tail burners. By the shadow the light for equal consumpt was 1 to .827, by the chlorine, 14 : 12, and as 14 : 12 : : 1 : .857. In another trial with the same burners, but with gases prepared at another time, the average of numerous trials by the photometric process, gave the result as 1 to .945; condensation by chlorine was 12.5 and 11.5, and as 12 5 : 11.5 : : 1 : .92.

With jets and with other gases, the results were by the shadow 1 to 1.185, and by chlorine 11 to 14, and 11 : 14 : : 1 : 1.272. Here the approximation is not so close as in some of the others.

The chlorine test was then tried with a gas, the illuminating power of which was inferior to that of the preceding. The trial by the shadow was made at different distances, to secure accuracy. By the one the result was as 1 to 1.347, by the other to 1.338, average 1 to 1.342. The condensation by chlorine was 10 and 14, which very nearly coincides with the others.

The results above stated, very nearly agree with each other. In one trial, however, I found that they did not come so close. By the shadow they were 1 to 1.33, by the chlorine 11 to 17, now as 11 : 17 : : 1 : 1.54.

In this instance the discordance may, I think, be accounted for. It is well known that when the illuminating power of a gas is high, as when it is prepared by the decomposition of oil, it requires a burner with smaller apertures than those used for common coal-gas, otherwise it is not consumed to advantage. Now, in the experiment last recorded, in which the condensation by chlorine amounted to 17, a coal-gas jet was used, by which the gas would not give the same amount of light that it would have given, had a burner with smaller apertures been employed. Hence the illuminating power indicated by the shadow does not come up to what most likely it would have been with a differently constructed burner. May not this exception prove the accuracy of the proposed test?

From what has now been said with regard to the test which I have proposed, I think we are warranted in placing implicit confidence in it, as a means of indicating the illuminating power of coal-gas; indeed I have no hesitation in stating, that when the trial is properly conducted, it leads to results more satisfactory than those given by the shadow; for it has this advantage, that while it is much more easily conducted, it points out the amount of light that ought to be afforded by one gas as compared with another; whereas, unless all the different circumstances that affect the combustion of the gases are attended to, the results by the shadow will not be correct. One of them, in particular, is the kind of burner,—for when gas is rich in matter condensible by chlorine, and a common coal-gas burner is used, the illuminating power indicated by the shadow will, most probably, be below what it really is, owing to the burner not being adapted for the combustion of that peculiar kind of gas; and hence one of the advantages of the chlorine test.

The process practised in the experiments I have detailed is, with a slight modification, the same as that formerly described. Two tubes of about half an inch in diameter, and 12 inches long, of the same calibre, and graduated to 100 parts, are employed; into the one 50 degrees of the gas under investigation are introduced, and afterwards into the other there are put 50 of chlorine; the water of the trough being heated to 50, or thereabouts. The coal-gas is then transferred into the chlorine, and the tube instantly covered with a shade, to prevent the action of the light. In the course of five minutes, the condensation is complete. Should only one graduated tube be used, the coal-gas must be measured first, and then put into another tube, after which the chlorine is measured, and the *coal-gas transferred* into it; for, if otherwise, a part of the chlorine would be absorbed by the water, during its passage through it, and thus lead to variable results. As chlorine is absorbable by water, a slight absorption takes place during the continuance of the experiment. Before proceeding to any trials, it is therefore necessary to ascertain the amount of this, and then to deduct it from the condensation occasioned by the action on the coal-gas. In the tube which I have used, I found the absorption to be exactly 1 degree for every five minutes, and which continues in the same ratio, after the action of the chlorine on the hydro-carbon is over. I have, therefore, always deducted 1 degree for each five minutes, from the total loss, as indicated by the rise of the water in the tube. As, however, the action is over in five minutes, I have seldom continued the trial beyond that time, of course deducting 1 degree from the loss sustained. As chlorine and the condensible matter act on each other in equal volumes, a condensation of 10, when 50 of each are used, indicates ten per cent. of loss by the coal-gas.

Should this method of ascertaining the illuminating power of gases be ultimately found to be correct, another important result may follow its introduction into practice. If we can, by it, fix the illuminating power of one gas compared with that of another gas, the quality of which has been previously determined, and which is consumed with a burner that is known to burn it advantageously, and if the gas which we are subjecting to trial by the shadow test does not show such a high illuminating power as we are led to expect, from the known condensation by chlorine, the probability is, that the burners are not adapted for consuming the gas advantageously, and hence the necessity of altering the apertures, till the power by the shadow is what it ought to be, according to the chlorine test.

There is still another advantage attending the introduction of the chlorine test in addition to those mentioned; it is the facility of comparing different gases with one another, when they cannot be brought together, so as to try them by the shadow. The illuminating power may be considered just as the condensation by chlorine, and thus, then, we may state it *numerically*. Thus taking a coal-gas having only 1 per cent. of matter condensible by chlorine, its illuminating power may be considered as *unity*, and all others would be as *the per centage of condensation*. Hence, also, the illuminating power of gases may be ascertained as compared with other sources of light.

It is evident from what has been said, that, in finding the value of a gas as compared with other sources of light, attention must be paid to the *quality* of the gas; a circumstance which by many has been totally disregarded, and hence the very discordant results which have been obtained. In comparing the gas by the shadow given by other lights, we must in fact not only attend to the different circumstances affecting the combustion; we must also at each trial ascertain the amount of condensation by chlorine; for the quality of a gas manufactured on different days, at the same place, will be found to vary considerably. In the trials I am now to state, made with the view of finding the comparative expense of light as got from candles, oil, &c., I have uniformly kept this in view; and by doing so, we are enabled to judge of the expense, not only in this town, but also in other places, provided, of course, we know the illuminating power of the gas by the chlorine test.

The first series of experiments were those with candles, of which ten different kinds were tried. Tallow single wick, tallow double wick, cocoa, palm, composite, margerine, diaphane, composition, spermaceti, wax,—all short sixes.

Tallow.—Very different statements have been given of the illuminating power of coal-gas as compared with that from tallow candles, and which has been accounted for by the difficulty of getting the light from the candle to be uniform; the chief cause of the discordance is, however, more probably the difference in the quality of gases manufactured at different places. In conducting my trials, I have paid due attention to the former; trying the candles at different times, so as to have a wick of various lengths. The standard gas light, in all the trials, was a jet burning under a uniform pressure, with a flame of five inches, and consuming exactly one foot per hour.

From numerous trials, I found that the tallow (single wick, short-six), when compared with the gas, and taking the average of all the trials, was as 1 to 3.75. A short-six will be found, when properly snuffed, to last for six hours, or very nearly so;

and supposing candles to be 7½d. per pound, then the cost for each candle is 5 farthings. Suppose the gas to cost 8s. 4d. per 1000 feet,* then six feet will cost 2½ farthings, or very nearly so; accordingly, for half the expense, 3.75 times the amount of light is obtained; in other words, for the same light, the expense of tallow candles is 7½ times that of gas. The gas I employed in these trials contained, on an average, 12 per cent. of condensible matter. Should the gas contain more or less, then the comparative expense would be greater or less just according to the quantity. In Edinburgh I have found the chlorine test to indicate from 11 to 14, and 15, very rarely is it up to the latter; of late I have rarely found it to go beyond 13. Considering the foregoing calculation as applying to the gas now supplied to Edinburgh, and presuming it to contain 12 per cent. of matter condensible by chlorine, then the expense of tallow candles is 7½ times greater for *the same light* than that of gas consumed by jet burners.

In England, where the gas is generally manufactured from English caking-coal, the illuminating power is inferior to that of gas got from parrot-coal, or from a mixture of it and common Scotch coal. Now, suppose the price of the gas the same, and that the condensation by chlorine amounts to 6, then the comparative expense of candles and of gas for the same light would be 3.75 to 1.

Similar trials were made with the other candles mentioned.

Double-wicked tallow, 1s. per pound.—This candle burns for 5½ hours at a cost of 8 farthings; the light compared to that of the jet is as 1 to 2.1, making the expense as 7.1 to 1. This candle has the advantage of not requiring to be snuffed.

Cocoa candle, 11s. per pound, will burn for nine hours, at a cost of 7.3 farthings; the light compared to the jet is as 1 to 3.6, or the same as that of the common tallow candle; thus making the expense as 7.3 to 1.

Palm candle, 1s. 2d. per pound, will burn for 6.6 hours, expense 9.3 farthings, light 1 to 3, expense as 10.5 to 1.

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* I have taken this as being easy for calculation. It is not far from the price of gas in Edinburgh, and in other towns in the neighbourhood of the coal districts.

Composite, 1s. 1d. per pound lasts for eight hours, expense 8.6 farthings, light 1 to 3, expense 8 to 1.

Diaphane (French), 1. 8d., will last 6.6 hours, at a cost of 13.3 farthings, light 1 to 3, expense 15.1 to 1.

Margerine, nearly in every respect the same as diaphane.

Spermaceti, 2s. 6d. per pound, will burn for eight hours, cost 20 farthings, light 1 to 2.6, expense as 16.2 to 1.

Composition candle the same.

Wax 2s. 6d., burns nine hours, cost 20 farthings, light as 1 to 2.6, expense therefore as 14.4 to 1.

Thus the *tallows*, with the exception of the palm, are nearly of the same comparative expense, light for light; the *composition* is a very little more expensive, the others are more than double the expense.

In the foregoing calculations, I have supposed the gas to be consumed by jets; but I have already shewn in the paper read before the Society, and published in its Transactions for 1840, that this is the least profitable method of burning it. For *equal consumpts*, the light given by other burners is much greater; thus taking the jet as 100, that from a fish-tail is 140, from the bat-wing 160, and from a properly constructed argand 180. Accordingly, by consuming the gas with these, the comparative expense will be still farther reduced. The following table gives the comparative light and expense according to the kind of burner used.

Candles. Short Sixes.	Burns Hours.	Light compared with Jet. Candle 1.	Cost in Farthings.		Expense of Candle compared with Jet. Candle. Gas.	Light compared with Fish-Tail.		Expense compared with Fish-Tail.		Light compared with Argand.		Expense compared with Argand.		Comparative Expense of Candles for equal Light.
			Candle.	Gas.		Candle.	Gas.	Candle.	Gas.	Candle.	Gas.	Candle.	Gas.	
1. Tallow.														
Single wick...............	6	1 to 3.6	5	2.4	7.5 to 1	1	5.	10.5	1	1	6.48	13.5	1	1.0
2. Tallow.														
Double wick	5.5	1 ... 2.1	8	2.2	7.1 ... 1	1	2.9	9.94	1	1	3.76	12.78	1	1.46
3. Cocoa.....	9	1 ... 3.6	7.33	3.6	7.33 ... 1	1	5.	10.22	1	1	6.18	13.5	1	1.0
4. Palm.........................	6.6	1 ... 3	9.33	2.6	10.5 ... 1	1	4.2	14.70	1	1	5.40	18.90	1	1.32
5. Composite.................	8	1 .. 3	8.66	3.2	8.12 ... 1	1	4.2	11.34	1	1	5.4	13.18	1	1.1
6. Diaphane..................	6.6	1 ... 3	13.33	2.4	15.1 ... 1	1	4.2	21.14	1	1	5.4	14.18	1	2.08
7. Margerine................	6	1 ... 3	13.33	2.4	15.6 ... 1	1	4.2	22.68	1	1	5.4	27.5	1	2.15
8. Spermaceti................	8	1 ... 2.6	20	3.2	16.2 ... 1	1	3.64	22.7	1	1	4.86	28.44	1	2.16
9. Composition..............	8	1 ... 2.6	20	3.2	16.2 ... 1	1	3.64	22.7	1	1	4.86	29.2	1	2.16
10. Wax.........................	9	1 ... 2.6	20	3.6	14.4 ... 1	1	3.64	20.16	1	1	4.86	25.92	1	1.96

In the above calculations no allowance is made for outlay in gas-fittings, &c. &c.

In conducting experiments with the view of ascertaining the illuminating power of oil, compared with that of gas, I used argand oil-lamps of the common construction, and also others with contrivances adapted to them, which have been lately recommended for increasing the light. The first trials were made with *sperm* oil, the cost of which, at the time the trials were made, was 9s. 8d. per gallon, that is, 1s. 2½d. per pint. It was burned in a common argand, consuming the oil under the most favourable circumstances. In endeavouring to fix the illuminating power, I contrasted it with an argand gas burner, having forty-two holes, and consuming three feet per hour. I found, however, considerable difficulty in coming to accurate results, partly from the variation in the flame of the oil, partly also from the difference in the appearance of the shadow. Six trials were made at different times, and with the lights at different distances. These varied from 2 to 2.4, taking the oil as 1. The average of the different trials gave 2·35. A pint of oil was found to burn 14 hours, at a cost of 14½d.; the consumpt of gas for the same time (3 × 14) was 42 feet, at an expense of 4¼d., but the light was as 2.25 to 1. The comparative expense, therefore, light for light, would be as 14½d. × 2.25 to 4¼d.; that is, as 8 to 1, or very nearly so.

Rectified *whale* oil was next tried, the cost of which was 4s. 8d. per gallon. A pint, when consumed under the most favourable circumstances, was found to burn 12 hours; and contrasted with the gas argand as before, the light was as 1 to 2.54. The cost of oil was 7d., that of gas for the same time was 3½d., but the light was as 1 to 2.54; the expense was, therefore, for the same light, as 7d. × 2.54 to 3½d.; that is, 5 to 1.

In the preceding trials the oil was consumed in a common argand, due attention being paid to the different circumstances affecting the consumpt, such as the kind of wick, the height of flame, &c. The next trial was made with the lamp lately introduced under the name of *solar lamp*. In this a cylinder surrounds that containing the wick, with the upper part bent inwards, so that the aperture being contracted, the current of air that passes up between the one cylinder and the other, striking against the horizontal part of the outer one, causes a contraction and lengthening of the flame; a longer and narrower glass chimney is at the same time required. The advantages said to attend the use of this construction of burner, are, that an oil of inferior quality may be used, while at the same time the light is greatly increased.

The solar lamp, containing *solar oil*, with a flame as high as could be got to be steady, and without smoke, was contrasted with the gas argand as before, burning three feet per hour. On comparing the lights, and taking the average of numerous trials, conducted at different distances, and when the wick was in different conditions, they were as 0.98 to 1; so very nearly equal that we may consider them as so. The oil, per gallon, costs 3s. 8d.; a pint was found to burn eight hours, or very nearly so, at a cost of 5½d. The gas required for the same time is 24 or say 25 feet, which would cost 2½d.; accordingly the expense is rather more than twice, or say twice, that of the gas.

To ascertain whether or not there is any saving by using the apparatus adapted to the solar lamp, the solar oil was consumed with a solar wick in the same argand with which the trials with the sperm and whale oils were made, and the light, as before, was contrasted with the argand, burning three feet per hour. The light and the consumpt of oil were found to be the same as with the other oils. The cost of the solar oil per pint is 5½d., that of the whale oil 7d.; accordingly the expense is as the cost of the oils. It has been already stated, that by using the solar apparatus, the oil gave a light equal to that from an argand consuming three feet per hour, and that the pint of oil will last for eight hours; the expense is therefore as 2½d. to 5½d., or say 1d to 2d. Now when the solar oil was burned in the common argand, and contrasted with the gas argand, the light was as 1 to 2.54. As the oil lasted for twelve hours, the cost of gas for that time would be 3½d., or very nearly so. The comparative expense was therefore as 5½d. × 2.54 to 3½d.; that is, as 3.98 to 1; whereas, by the solar lamp, it was only as 2 to 1; thus making a saving by the use of the solar lamp of nearly one-half of the expense. This peculiar construction of lamp is therefore a very great improvement; for not only is there a saving in expense in the outlay for oil, but for the lighting of large apartments a smaller number of lamps is required than when common argands are employed.

Naphtha.—This article has lately been recommended as an economical source of light. Though naphtha gives a beautiful and steady light, yet it emits an offensive smell, and unless cautiously burned, is very liable to smoke; the slightest blast against the flame causing dense black smoke instantly to appear. The appearance of the shadow is so different from that from coal-gas, that it is not easy to fix their illuminating power and consequent comparative expense. In the experiments I have performed, I used the gas-argand as before, consuming 4 feet per hour. The naphtha-lamp had a wick of 4 inches in breadth, and burned with a flame of about half an inch in height. In one trial I made the illuminating power of the flames, as naphtha 1 to gas 4.233; in another, they were as 1 to 4.239;—giving an average of 1 to 4.236. The consumpt of naphtha was a pint in 24 hours, at a cost of 3s. 6d. per gallon, that is $5\frac{1}{4}$d. per pint. The gas for the same time would be 24, or say $25 \times 4 = 100$—that is 10d.; but the light was as 4.236 to 1—therefore the comparative expense comes to be as 2.2 to 1, or very nearly so. Suppose that I have overrated the illuminating power of the gas as compared with that of the naphtha, say, that instead of 4.236, it was about 4, this would reduce the cost of the latter, and thus make the comparative expense as about 2 to 1.

Table shewing the Consumpt and Expense of Oils, and of Gas, in Argands burning three feet per hour.

Oils per Pint.	Pint burns Hours.	Light of gas compared with oils as 1.	Cost in farthings of		Comparative Expense for equal lights.		Comparative Expense of Oils for equal Lights.
			Gas.	Oil.	Gas.	Oil.	
Sperm in Argand,	14	2.35	17	58	1	8	4
Whale do.	12	2.54	14	28	1	5	2.5
Solar do.	12	2.54	14	22	1	3.98	1.99
Solar in Solar lamp,	8	1	10	22	1	2	1
Naphtha lamp,	24	3.17	40	21	1	2	1

Table shewing Comparative Expense of Light from different Sources; Coal-Gas containing 12 *per cent. of matter condensible by Chlorine, taken as unity.*

Argand Gas,	1.00				
Fish Tail,	1.40	Fish Tail,	1.00		
Single Jet,	1.80	...	1.40	Jet,	1.00
Solar Lamp,	2.00	...	1.55	...	1.11
Naphtha,	2.00	...	1.55	...	1.11
Solar Oil in common Argand,	3.98	...	2.84	...	2.21
Whale Oil do.	5.00	...	3.88	...	2.77
Sperm do.	8.00	...	6.22	...	4.41
Tallow Candle (2 wicks),	12.7	...	10.0	...	7.18
Cocoa Candle,	13.1	...	10.2	...	7.33
Tallow do. (1 wick),	13.5	...	10.5	...	7.50
Composite,	14.5	...	11.3	...	8.12
Palm,	18.9	...	14.7	...	10.5
Wax,	25.9	...	20.1	...	14.4
Diaphane,	27.1	...	21.1	...	15.1
Margerine,	28.4	...	22.6	...	15.6
Spermaceti,	29.2	...	22.7	...	16.2
Composition,	29.2	...	22.7	...	16.2

On the General Movements of Serpents. By M. Dumeril.

The manner in which serpents move is evidently the consequence of their absolute want of limbs; at the same time, their destination to live in atmospheric air is indicated by the presence of lungs. Serpents are besides under the necessity of providing for their subsistence solely from animal food, which they must seize in a living state, and swallow at once entire, since nature has not granted them, as with other reptiles, cutting instruments suited for dividing their food into regular portions. These circumstances united, have impressed the characters we find inscribed, not only on the exterior of the bodies of ophidians, in regard to their configuration, but also on the interior throughout the whole of their structure. In the present case we are about to consider them merely in relation to the movements which these animals execute. Even with this in view, we shall have occasion to describe some of the manners and habits of serpents, as well as the modifications which they have required in many parts of their organisation.

The body of a serpent consists of a trunk considerably elongated, without any notable distinction of regions for the different parts of its extent. In the interior this body has for a solid stalk, or principal support, a very numerous series of small bones, which are moveable, although securely and strongly attached to each other. These are vertebrae, all of them nearly alike, which thus afford a point of insertion to a great number of fascicles of moveable fibres destined to produce and repeat, each by itself, in a continuous and most regular manner, all the movements which are impressed upon them singly. This long spine, or moveable frame-work, is moreover perforated throughout its whole length, forming a continuous canal, which receives and protects the nervous marrow prolonged from the brain. Through holes, symmetrically arranged between each of these numerous vertebrae, issue at like intervals pairs of nerves which are distributed and terminated in every part of the body.

This general structure of the organs adapted for movement, seems to have necessitated the most important modifications in respect to their forms and relative situation, in all the instruments which exercise the functions of general or vegetative life, such as those of nutrition and propagation. Yet the means which serve to establish the relations between these animals and the external world, by the aid of the senses, are nearly the same as in other reptiles.

A serpent being deprived, at least to appearance, of instruments adapted to divide its prey, which must be swallowed without chewing, the victim must necessarily be pursued, stopped, laid hold of, and swallowed entire, as it were at a single mouthful. These circumstances have caused faculties altogether of a special nature to be attributed to serpents. Sometimes an extreme and sudden agility, an excessive flexibility, suppleness, and rapidity in its movements, are conferred on a serpent, in order that it may be able to reach the animal it covets as a prey; at other times, and more frequently, exerting a prodigious constrictive power, and the most active muscular energy, the serpent attacks animals greatly surpassing itself in size. It darts upon them, envelopes them, squeezes them together, and suffocates them, compressing and breaking their bones between its tortuous folds and numerous circumvolutions, although they are often thicker than its own body. It can enlarge the size of its belly, however, at pleasure, and succeeds in getting them into it after bruising their flesh within the skin that covered it.

Other species, of inferior activity and strength, are capable of fascination, a power which has been regarded as magnetic or supernatural, producing in the prey on which they fix their gaze, a kind of stupor or instinctive dread, which paralyzes the animal's movements and efforts, in vain desirous to withdraw and escape the fatal destiny which awaits it. In like manner, we see how a pointer dog can influence from a distance, solely by his look, the game he has discovered; the latter dare not move for the purpose of escape, for fear of betraying its presence by its motion; it then appears arrested by a magical power which suspends all its faculties; it seems impossible for it to escape from a danger so imminent; it gives way to the torture of despair, and if its strength fail, sinks and is devoured.

Finally, some other kinds of ophidians, after having borne very long abstinence, and when they feel the urgent need of food, are all at once excited by an impetuous ardour of courage and unwonted energy. They become furious at the sight of an animal which they wish to make their prey. In an instant, and with the speed of an arrow, they dart upon it with an open mouth, in front of which are arranged the sharp points of some elongated and curved teeth, and throughout the whole length of these runs a canal or groove affording a passage for a venomous humour which is introduced into the flesh. This is an active poison secreted for the purpose, and reserved in a small bladder which nature has protected with wonderful foresight. Penetrating beneath the skin, these poisoned darts deposit there a small quantity of this deleterious humour, which, soon absorbed, is not long in producing divers destructive effects, either suddenly paralyzing the movements of the animal wounded by this simple sting, or throwing it into a lethargic sleep, happily, perhaps, thus releasing it from pain by the loss of sensibility, but in every case placing it out of its power to escape death, and avoid the destruction become necessary for the preservation of the serpent, which had no other resource but this to obtain the mastery over it in order to feed on its flesh.

We shall attempt to describe the forms and structure of the organs which, in serpents as well as in all other animals, produce the various movements which their locomotion requires. We shall then indicate the varied circumstances which determine the diversity of this action.

The general form and dimensions, in every sense, of the body of serpents are determined by the number, always considerable, of the bony pieces which constitute the whole of their skeleton, that is to say, by the vertebræ and the ribs. This spine, however, is most simple and uniform, because it supports neither sternum, pelvis, nor articulated limbs. In respect to the bony parts subservient to movement, it may be said that, of all vertebrated animals, the ophidians are those whose skeleton is longest in proportion to its diameter, and composed of the most moveable pieces, perhaps the most numerous and likest each other.

The spine of serpents represents in the interior of the body a solid axis, which serves as a base of support to the general movements; while at the same time its separate pieces, although extremely moveable upon themselves, and of very firm texture, transmit to each other the impulsions they receive in the different regions in the length of the trunk.

This insularity or independence of the vertebral column presents, in this respect, a very different mechanism from that found in other animals provided with an interior skeleton. In fishes, for example, the vertebræ receive and support unequal fins, which represent oars in swimming; then, in all the mammifera, birds, and the greater part of other kinds of reptiles, the spine constantly serves as a support to the bones of the limbs, and other solid organs designed to produce the motions of the body, when such accessory parts occur in their skeleton.

The character common to all the vertebræ of a serpent, and which may be considered as essential, is inscribed on the central region of these small bones; it is the most solid portion, the centre on which they move. It follows from the particular mode of their junction with each other, hitherto observed only among these animals, that every vertebra of an ophidian is scooped out in the anterior part in the form of a concave, regular, hemispherical depression, cut somewhat obliquely at its circumference; and that this same central part of the vertebra bears behind a kind of convex head, regularly rounded, corresponding in its curvature to the concavity which is to receive and enclose it. This head, or salient bone, is itself supported by a kind of neck or small constricted portion. The two articular facettes which thus correspond in their inverse curvatures, are covered with a true cartilaginous incrustation, and protected by a synovial membrane covering a fibrous capsule, so as to admit of movements similar to those which mechanicians designate by the name of a knee'd joint. It is an enclosed ball, which can turn upon itself in all directions.

It is necessary to keep this arrangement in mind, because the differences presented by the numerous salient points projecting from these vertebræ on the back, belly, and even laterally, limit, check, and facilitate, by their extent, inclination, and curvatures, the variety of the movements of the whole body. They indicate in the different races of serpents the particular mobility of each piece in the whole skeleton, and this examination enables us to comprehend beforehand, and explains the numerous modifications which have been required for each special mode of progression. It enables us, in fact, to understand the mechanism of the movements of ophidians on the earth, both at its surface and in deep sands, their mode of clasping and twisting themselves round the branches and trunks of trees, and continuing suspended there for whole days; and lastly, the means they employ to move on the surface and in the depths of waters.

What first strikes our notice in this series of vertebral bones in serpents, is their resemblance and uniformity in the two regions of the trunk and tail, insomuch that it would be impossible for the most skilful zootomist to assign its exact rank in the series to each of the pieces, with the exception perhaps of the hinder vertebræ, which often diminish gradually in size. They are the links of a chain so closely resembling each other, that they seem successively to have come out of the same matrix in which they had received their solid forms and impressions, to enter into a concatenation so perfect and regular.

These vertebræ are generally short, broad, and of a compact tissue, consequently very solid and capable of great resistance, so that it is more easy, in violently striking the backbone of a serpent, to separate the pieces than to fracture them. Their number varies much according to the genera and species. It is observed that the number is not always the same in the regions; it amounts sometimes to 400 in some Boas and Pythons. It is rarely below a hundred; serpents, therefore, have in reality the greatest number of vertebræ of all animals, as frogs and other tail-less Batracians have the smallest, only eight or nine at the most. It is remarked, moreover, that the vertebral bones are comparatively longer and narrower in the climbing species which live habitually on trees.

It is owing to the prodigious number of bones composing the vertebral column, and their great mobility, that the body of serpents owes its extreme flexibility, and the power it possesses of adapting itself to all surfaces, whatsoever may be their curvatures, in order to find points of support. Their movements take place principally to the sides, from the right to the left, and reciprocally; sometimes, but more rarely, from above downwards, and from before backwards. Although each of the pieces of the spine should turn very little on its axis, the smallest deviation which can take place, becomes the centre of a flexible ray represented by the prolonged part of the column from the side of the head, or towards that of the tail. As progression most frequently takes place by lateral movements, it is to that direction that the reciprocal gliding upon each other of the vertebral articulations seems best adapted.

The ribs of serpents are prolonged levers, lateral appendages of the vertebræ, which, although destined for the mechanical act of respiration, serve still more for progression. As they are not joined together by a sternum, they can recede from each other sideways, and from before backwards, in the different parts of the extent of the trunk. Their number is considerable; it amounts nearly to three hundred and upwards in some Pythons and Trigonocephali. Half that number is found in the viper, so that no kind of animal has in reality a greater number of ribs than the ophidians.

We shall not examine in this place the numerous fascicles of muscles which, fixed to the different parts of the vertebræ and ribs, produce uniformly, and repeat on each of these bones the partial movements from which the acts of locomotion arise; the latter are to be examined in a collective sense.

Sometimes it is the weakness of a supple body, slender and very flexible throughout its whole length, that permits or facilitates agility and nimbleness in the locomotive power; sometimes, on the contrary, it is the strength and rigidity of the trunk which, joined to its considerable volume, and the energetic and successive action of the muscles, determine the prodigious power which very large serpents can exert when they envelope, strangle, and crush in their tortuous folds the bodies of the animals destined to become their victims.

When serpents creep, they change their place by alternate flexuose undulations or sinuosities. They then draw themselves in, and again turn outwards, and fold their body upon itself, forming so many curves in the form of the letter S, by numerous contours and varied revolutions; but they can likewise stand erect and raise themselves into a nearly vertical position, at least in part, by stiffening certain regions of their spine which they support and cause to move on another portion of their own body. Some of them remain immoveable, and in ambush, on trees, having their long folds interlaced among the branches to which they cling, suspending and balancing their mass in order to dart suddenly to a great distance, as if by the movement of a sling. Others burrow in the earth or insinuate themselves into subterranean galleries, either for the purpose of shelter, or to prey upon the animals which live in them. There are some which swim and support themselves on the surface of the water, or plunge into its depths; for it is there only that they can find and pursue their victims, which they must seize alive and swallow at a single mouthful, or at once, without dividing it.

Creeping is the most general mode of progression among serpents; this act is produced by a series of successive contractions communicated to their long spine by the numerous muscles inserted in the vertebræ and ribs. In order to understand rightly how this act, or *reptation,* takes place, we must suppose that the animal, being stationary, or having made a momentary pause, has halted on a surface more or less resisting, on which it finds a point of support. Most commonly it is the belly or under part of the body which is applied to such support. It first raises the posterior moveable edge of one or more solid horny plates, with which the abdomen and tail are furnished, in such a way as to move forward the plates situated further forward, on which it then seems to glide, then successively on all those which precede; for these plates act by means of the ribs which are inserted into them, so that they move like so many feet, which would nearly correspond to those we observe in the body of Juli and other myriapodous insects. These movements taking place at the same time, and in the same manner, follow each other regularly, and are repeated in a beautiful successive order along the whole length of the inferior region of the body. We may thus conceive how the direct displacement of the mass is produced, as it is necessarily urged from behind forward, so that the head is carried more and more in advance, and the tail follows nearly in the same direction. This progression, however, in the greater number of cases, takes effect at the same time on the lateral parts of the body by a series of undulations or sinuosities, which obtain for the serpent points of support on the objects which present some resistance to it on the right or left. It may then be observed to curve its spine regularly according to its length, to produce sinuous and arched lines in it, which are successively effaced, become formed anew, and reproduced as often as the obstacle encountered continues to offer resistance to the pressure. This is the mode of moving we observe in eels, as well as in certain saurians with a very long body and destitute of feet, such as the species of the genus Anguis; and it is therefore likewise called, when it takes place among these animals, a serpentine motion. Such is the mechanism of creeping or reptation.

When a serpent requires to raise itself, or place a portion of its body in an upright position, if it then meet with a solid object, it applies its trunk to it, elevates and stiffens its body by directing its efforts to the fixed point, and making the series of plates in the anterior part of the belly, and consequently those succeeding, form an arch. When, on the contrary, the ground is level, the same movements are produced on the parts of the trunk which rest on the ground. The whole anterior region of the body there finds a kind of solid fold, which supports it like the base of a pillar raised upon itself. The serpent is then seen to carry its head vertically, somewhat like a swan's neck, in order to turn and move it gently in every direction, as may be witnessed in the Najas or hooded snakes, when they assume various singular attitudes, appearing at the same time to follow the measure of music varied by the instruments or songs of the Indian jugglers, who often publicly exhibit these kinds of dances, in which the snakes have been previously exercised by various manœuvres.

The active leap is produced, as is known, by the darting of the whole living mass, which all at once completely and voluntarily leaves the surface on which it rested, in order to spring freely over a distance more or less considerable. Although destitute of articulated limbs, serpents still enjoy this power, but by processes as peculiar as can well be conceived. Thus at times the reptile, having its body rolled in a circle on itself, keeps it stretched like an elastic spring, remaining spirally twisted by the contractile force of the muscles of the internal lateral region, concave or concentric to the spine; but all of a sudden it relaxes itself by the instantaneous shortening of the convex or external edge of the circumference, which, becoming suddenly elongated or extended, unfolds with great force and rapidity. Sometimes, in order to effect a more rapid change of place, to recede or advance with more celerity, the serpent executes in this way a series of successive bounds, which are produced in the direction of its length by means of undulations on the sides, from before or from above downwards, and reciprocally, with slight sinuosities which alternately correct each other.

The act of swimming, whether it take place on the surface or under water, is likewise produced by these diverse undulations. It is a mode of progression similar to that which takes place on the earth or on moveable sand. In these circumstances the serpent, being able at pleasure to become heavier or lighter than the water it displaces, in consequence of the variable quantity or volume of gas contained in its very long lungs, can support itself on the fluid, and communicate to it an impulsive power. It avails itself of the reaction produced by the shock it gives to the ambient fluid. It is principally by the tail and the hinder part of the trunk that the serpent supports itself in water. For this purpose the tail is often widened and strongly compressed from right to left, in the form of a vertical fin, as may be seen in the Hydrophides, Enhydres, and Platures. Other species, as certain kinds of snakes (Gen. coluber), can become hydrostatically heavier than water, and lie flat and immoveable at the bottom, remaining on the watch in the currents of torrents and small rivers, in order to seize upon the fishes and other aquatic animals on which they feed, which they afterwards carry to the bank and swallow. It may be presumed that in such a case, and to enable it to keep under water, the serpent has diminished its volume by expelling all superfluous air from its lungs, and retaining only what was necessary for the purpose of respiration.*

A General View of the Environs of Pekin. By M. Kovanko, Major in the Corps of Engineers of Mines; translated by Lieutenant-General Lord Greenock, F.R.S.E., from the Annuaire du Journal des Mines de Russie, année 1838. Published at St Petersburg, 1840.

Pekin is situated in a plain bounded on the north-west by a series of mountains belonging to branches of the chain *Tkaĭi-Khane*, which takes its origin at the Yellow River, and is prolonged to the north-east nearly as far as the sea of the same name.

The Chinese distinguish these mountains as Northern and Western, according to their position relatively to the capital; they are, besides, equally to be distinguished by the nature of their rocks.

Limestone, together with dolomite, predominate in the Northern Mountains, and in those of the West, diorite (greenstone), with all its varieties, as well as sandstone and slates containing beds of coal. These two series of mountains being cut in different directions by defiles and steep valleys, it is difficult to determine their point of connection.

The Northern Mountains are a day's journey from Pekin, which does not imply any considerable distance: the Chinese travel so slowly that they never go farther in one day than from 60 to 80 li,† or 34 or 44 versts. The road in the di-

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* An abridged extract from a manuscript chapter of the 6th volume of a work entitled *Erpétologie Générale*, by MM. Dumeril and Bibron, published in Comptes Rendus, No. 12, 20th September 1841.

† The li is equal to 274½ sagénes of Russia.

rection of these mountains passes over alluvial clays containing much lime. In very dry weather, this clay becomes so hard that it can scarcely be broken with a pickaxe, while in wet weather it becomes entirely liquid, and forms mud that is nearly impassable. In summer this road is very picturesque; vast fields extend beyond the view on both sides. Notwithstanding the labour and expense which are required at that season for the cultivation of this land, the farmer is amply repaid by the abundance of the harvest, which supplies at the same time bread for himself, food for his cattle, and even fuel, for the grain of the yellow millet (*Syao-mi-tsra*), furnishes meal, the only food of the peasants, and chopped straw for the cattle in place of hay, which is never cut, and of the use of which even they have no idea in China.

It is with the straw of a kind of millet called *Gao-lianes*, which grows to the height of fifteen feet, that the peasants make fences for their gardens; they employ it also for fuel in their houses, and to burn bricks. The grain is used instead of oats to feed the mules, and brandy is obtained from it by distillation.

About 15 li (8 versts) before arriving at the Northern Mountains, is seen the little hill *Syao-Tan-Chan*, composed of compact grey limestone, traversed by veins of quartz, which give it great hardness. This mountain, though of little elevation, deserves particular notice from the existence in its neighbourhood of two hot springs, which burst forth nearly vertically from an unknown depth. These springs, at the distance of a few sagénes from each other, have different temperatures, one of 40°, the other of 45° Reaumur (122° to 133° F.) The water from these springs flows into basins lined with a masonry of compact limestone, from whence it is conducted by leaden pipes into baths cut in the limestone, and lined with sheets of lead.

A palace, surrounded by a garden, has been erected near the baths, destined for the imperial family. The stone-wall by which it is enclosed is in a complete state of dilapidation, no repairs having been made there for fifteen years, although the buildings of the Chinese are frequently in need of them. The water is perfectly transparent, and contains no salt in solution. Its use consists in procuring the bathers a copious perspiration. The baths are frequented by many persons of the inferior classes in the spring, who either come there for their health, or merely as an object for an excursion.

Three li to the west of *Syao-Tan-Chan*, there is another insulated mountain called *Da-Tan-Chan*, a little more elevated than the former, and formed like it of compact limestone full of quartz veins. The base of this mountain gives rise to many springs, one of which has a temperature of 16° R. (68° F.) and the water is very pure.

There was formerly at this place an establishment for baths of cold water, but it is now in ruins, as are also the temples which were in the neighbourhood of the spring. In general, the priests of the temples of the religion of *Khe-Shan* and of *Da-o*, exercise hospitality. Travellers may always find a lodging with these hermits; it is true that their services must be largely remunerated, but they must of necessity have recourse to them, there being no other places where accommodation can be obtained. In the convents, 10 roubles* is the lowest price for a rest of a few hours, and, for a whole day, 25 roubles are not considered to be sufficient. From this it may be easily judged how costly even the shortest excursions in the environs of Pekin must be.

The outline of the Northern Mountains is pretty uniform; they are, generally speaking, nearly bare, their flanks being rarely covered by small bushes, and alluvia of little importance.

These mountains are of considerable elevation, particularly that of *Syao-Chan*, situated 30 li to the north-east of the temple *Loun-Tzouan-Sy*, which is distant 60 li north from Pekin. It is principally composed of granite, of which the lower part, being large grained, decomposes into gravel; the upper portions are small grained, and shew no signs of disintegration. This granite consists of red felspar, clear

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* 10 roubles = 11 francs 50 centimes; 25 roubles = 28 francs 75 centimes.

grey quartz, with a vitreous lustre, and black mica, altogether imperceptible in some places. No other minerals of any consequence have been found in it. To judge from the name it bears (*In-Shan*), which means the mountain of silver, there is reason to believe that it formerly furnished the ore of that metal; and, indeed, one of the hermits dwelling in the neighbourhood, a man of about seventy years of age, assured me that in his youth a vein was worked in that mountain, the ore from which was taken out at night and secretly smelted to obtain the silver.

The shaft of the mine to which he alluded, is now filled up and covered with buildings; there was therefore no means of ascertaining the truth of this tradition.

At the foot of Mount *In-Shan* there existed anciently an immense temple of the religion of *Khé-Shan*, inhabited by 400 monks, the traces of which are still to be seen. A path made on the flank of the mountain led quite to the summit, and the steps hewn in the granite exist at the present day. The path is now obstructed by stones, and overgrown with bushes, so as to render it difficult to climb the very steep acclivity of the mountain. Having proceeded by this path about three verstes, I was obliged to surmount a precipice nearly vertical, in which small holes were cut of a size barely sufficient to enable the points of the feet to rest in them. But the trouble of overcoming all these obstacles is well repaid, for the view from the summit of the mountain is of itself an object for the sake of which it is worth undertaking this excursion. The plateau on the summit is encompassed by a balustrade of granite, very handsomely worked. In the middle there is an altar cut out of a single block of the same rock, and close to it, an enormous bell of cast-metal suspended to pillars of granite.

Notwithstanding the number of ages these monuments have existed, they are in a perfect state of preservation, which proves the solidity of their construction.

The heat was insupportable during my ascent of *In-Shan*, and I was dying of thirst; but a fresh breeze, and some mulberries which I gathered on the summit of the mountain, restored my strength. A kind Providence seems to have thrown some seeds of that tree into a fissure of the altar expressly to alleviate the fatigues of the traveller. With the exception of this mulberry tree, there was not a single plant to be seen in that enclosure.

While I was resting myself, the guide astonished me by his fool-hardiness. The abyss over which the mountain projects is so deep that it is hardly possible to look down into it without feeling giddy; but this man, careless of danger, springing upon the top of the ballustrade, went twice round the plateau, jumping from pillar to pillar, distant about one and a-half archine from each other. It made me shudder to see him expose himself to so much danger, but he preserved the greatest coolness, and I did not observe the slightest trace of emotion on his countenance.

The view from the summit of *In-Shan* is magnificent. It is the most commanding point in the country. Before me, the crests of the mountains, illuminated by the setting sun, stretch out like the waves of the sea; over head, is a clear blue sky, and in the horizon other chains appear, varying as much in their forms as in the beauty of their tints. From this spot the view embraces an immense space—a pure and light air is inhaled with delight. While I am observing, a majestic eagle hovers so near as almost to graze my head; around me is the silence of the desert; alone in the distance, on the flank of the mountain, a shepherd is driving his flock towards the plain; and here and there rich pastures display their verdure.

Water is very generally wanting in the northern mountains, and only small rivulets, formed by the moisture derived from the atmosphere are met with in the valleys; one of them takes its rise at the base of Mount *In-Shan*, disappears for half its course under detrital blocks and alluvia, to appear again as a spring near the temple of *Loun-Tzouan-Sy*. Its water is very pure, and is reckoned the best in the environs of Pekin. It has been dammed up for the purpose of turning a flour-mill with a horizontal wheel. This place is extremely agreeable during the summer heats. However high the temperature of the air may be, the water remains constantly cool.

In the month of July, at the time of the greatest heat, it is much frequented by bathers: but until then the Chinese are afraid to venture into the water, so great is their dread of the sensation of cold.

The Russians who reside in Pekin astonish the natives a good deal by drinking cold water at their meals in winter as well as in summer; while the Chinese warm even their wine, and never drink cold water except in the hot weather of July.

A great number of fruit-trees, proceeding from plantations, grow in the ravines and valleys of the Northern Mountains, especially many Indian fig-trees, as also peach, apricot, pear, plum, and walnut trees. It appears even that the trees which do not bear fruit, such as the fir, the willow, the juniper, and the cypress, owe their existence to artificial cultivation, which is the reason that not a single forest of any considerable extent is to be met with in the whole chain of the Northern Mountains.

The rocks of which these mountains consist, belong, as has been already observed, to a formation of dolomite, which is there largely developed.

It commences at the temple of *Loun-Tzouan-Sy*, and extends to the north-east as far as the base of *In-Shan*. The mountains of *Syo-Tan-Shan* and *Do-Tan-Shan*, are of that formation; several varieties of dolomite are also found in it; near the temple of *Loun-Tzouan-Sy* it is very compact, small-grained, and the presence of particles of quartz gives it much hardness. All the monuments in the burial-places, the masonry of the door-ways and of the steps in the palace, are of this stone. The compact varieties are seldom white, but generally of a grey colour. When the quartz is absent in this rock, its fracture has the appearance of sugar, and, like that substance, is entirely white, and translucent when in thin fragments. It bears much resemblance to the marble of Carrara. We should not be warranted in assigning a very ancient origin to this rock, although it does not contain organic remains. It has little cohesion of its parts, and is easily reduced to powder; it is in this form that it is used to complete the process of cleaning the rice. Its texture has not the appearance of being foliated, but it is always divided by a great number of fissures into irregular masses, which renders the quarrying of it very difficult.*

The limestone, in a half decomposed state, containing a great quantity of white sand, enters into this formation in subordinate beds. In some places this limestone decomposes to such an extent as to form a white powder which covers the whole surface.

Sandstone, small grained, of a dark colour, traverses this formation also in beds, which alternate occasionally with those of the predominating rock. These beds of sandstone have only a thickness of 1 or 2 archines.

The porphyry, which rises in the form of a mamelon, near the temple of *Ba-or-Sy*, three li to the north-west of that of *Loun-Tzouan-Sy*, appears to have had some influence in the formation of this dolomite.

This porphyry, of a deep red colour, gives out a strong smell of clay. It has but little consistence, and its surface is fissured all over.

The ferruginous red sandstone, which is divided into rhomboidal faces by joints, ought likewise to be classed as belonging to the dolomite formation. It does not constitute any considerable masses, and is only found lying on the flanks of the compact dolomitic limestone. The sandstone, in decomposing, forms an excellent soil for cultivation.

One li to the north-west of *Loun-Tzoun-Sy*, a small outcrop of a chloritic slate, having a coarsely foliated structure, is seen bordering upon the dolomite, which disappears almost entirely under alluvial clay. Its dip is very highly inclined, the beds being very irregular and singularly contorted. Some traces of lime are found in it, but no other minerals.

The Western Mountains, as has already been said, are com-

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* *Note by the Author.*—About 6 francs (French money) are paid for the extraction of 150 pouds of this rock. The carriage of 15 pouds to the capital, distant 60 li, costs about 60 francs.

posed of different rocks. Three formations are distinctly observed in them.

1*st*, Diorite ; 2*d*, compact grey limestone, which appears to correspond with the mountain or carboniferous limestone of England; and, *lastly*, the coal formation.

A formation is besides observed, the independence of which is not altogether demonstrated. This is a species of conglomerate intimately connected with the diorite, and which will consequently be described at the same time with that igneous rock.

Dioritic Formation.—Diorite (greenstone) appears at the surface at the village of *San-Ourad-Yan*, and extends in ascending the course of the river *Bourbouse* to the village of *Van-Pin-Koon*, a distance of more than 30 li.

The diorite, small-grained, of a light green colour, is divided by fissures, giving it the form of beds inclined about 15° to the east. This rock is not very hard, except in its inferior portions; but as it acquires elevation, it loses its granular texture, becomes friable and slaty, and passes into indurated clay containing nodules of quartz and of greenstone, which frequently exceed the size of a nut. In some places these nodules occur only in veins in the friable dioritic mass, but sometimes they are accumulated to such a degree as to form enormous masses of compact conglomerate.

The thickness of the beds of the latter, which have the same inclination as the diorite, is about 1 sagéne. They alternate with ferruginous clay of a brownish red colour, forming in some places considerable elevations. This clay also contains nodules of quartz and of greenstone, which, by the decrease of their bulk, pass into a fine-grained sandstone without admixture, and are traversed in different directions by veins of white quartz.

Every thing concurs to lead us to admit that this conglomerate, so intimately connected with the diorite, does not, properly speaking, belong to the dioritic formation, produced to all appearance by volcanic agency (porphyry conglomerates). In my opinion it constitutes a sedimentary rock in the fullest acceptation of that term, in the formation of which the diorite might have concurred.

It would appear that the conglomerate is more recent than the diorite, and that it would be better to class it in the coal-formation, considering it as an equivalent to the old red sandstone of England.

The diorite cropping out at the base of the mountain *Lao-Goua-Shan* to the west of *Van-Pin-Koon*, as well as the conglomerate which overlies it, has a dip nearly vertical. This peculiar inclination might be attributed to some more recent revolution which these rocks have undergone, occasioned apparently by the dioritic porphyry which rises from beneath the diorite, but which, however, does not form any considerable masses.

Vertical seams of coal lie in some places between the diorite and the conglomerate, having the latter for the roof and the former for the floor.

Slate-clay, which has the properties of a combustible slate, from the great quantity of bitumen it contains, forms a border to the coal on the side of the roof.

The border on the side of the floor, although equally composed of slate-clay, contains less bitumen, and has not so much lustre as the former. This coal very much resembles anthracite, because it is shining, of compact texture, difficult to ignite, does not flame in burning, or give out any smoke. Its substance is entirely homogeneous, and every thing respecting it leads to the belief that there had been a great development of heat at the period of its formation.

The beds of conglomerate occupy, in some localities, nearly a horizontal position. In this case the coal included between the conglomerate and the diorite, occurs in beds of more importance, as, for example, at *Daor-Yao* to the east of *Van-Pin-Koon*, where the seam of coal is 1½ archine in thickness.

That which is worked at *Daor-Yao* is brittle, and breaks easily into small fragments of the size of a pea. The blacksmiths, and those who work in copper, consider it preferable to any other coal for their use, on account of the intense heat it gives out.

The conglomerate does not form thick masses. In its upper bed it passes into a true sandstone, which the quartz renders very hard. Occasionally the presence of particles of mica give it a slaty texture, and it becomes friable where clay is principally the basis of its cement.

The brook *Tsin-Schoui-Khé* flows 15 li to the north of *Van-Pin-Koon*, and, in cutting through a mass of diorite, it has laid bare all the varieties of this rock. Granitic diorite, compact diorite, and porphyritic diorite, alternate with each other, all passing at length into a conglomerate, which appears to differ from that to which the seams of coal are subordinate, and is the dioritic conglomerate properly so called. The beds of this conglomerate, and those of the diorite itself, alternate with beds of ferruginous clay, having a porphyritic appearance. This rock in some places passes into euritic porphyry, which being sometimes separated, and afterwards reunited afresh by the same rock, forms a breccia, in which the imbedded fragments of porphyritic rocks are from 1 verchok up to $\frac{1}{4}$ of an archine in diameter. This porphyry is of a brick red colour, with white crystals of felspar; its hardness middling, and it forms continuous masses of an irregular appearance.

Carboniferous Limestone.—This limestone shews itself to the west of *Van-Pin-Koon* in considerable masses, which may be regarded as an independent formation. The mountains which are composed of it have their flanks so steep, that the summits are sometimes inaccessible. The texture is foliated in thick laminæ, and in some localities the stratification of the beds is nearly horizontal. It is traversed by veins of perfectly white calcareous spar, which gives to it a variegated grey colour. A great many caverns of different dimensions, and all of them vaulted, are met with in this limestone, some of which contain stalactites, but they are destitute of organic remains.

The limestone is traversed in the defile of *Van-Li-Gaou* by veins of galena and brown specular iron-ore, of a quarter of an archine or more in thickness.

Small-grained greyish-yellow sandstone appears in subordinate beds in this limestone. It is not very hard, contains a considerable quantity of clay, and its beds have a thickness which is rather considerable.

The upper beds of this limestone have a great resemblance to that which forms such enormous masses in the Northern Mountains, and it is probable that they both belong to the same formation.

The limestone of Mount *Tzo-Tkhai*, which is distinguished by the great pagoda situated on its flank, near the village of *Shim-En-Gin*, appears equally to belong to the carboniferous limestone. It is very compact, and the particles of quartz give it so great a degree of hardness as to strike fire with steel. Its texture is foliated, but in thick laminæ. In some places it has the aspect of a compact mass. It abounds also in caverns, one of which, *Thao-Yan-Doun*, is remarkable for its size. It is situated on a very steep slope, which renders it difficult of access. Many persons ascend the mountain on purpose to visit this cavern, but there are very few who have the courage to descend into it. Many absurd traditions exist among the Chinese respecting it. They pretend that there is a subterranean passage leading as far as *Katgane*, and that there are stone-bridges over streams running through it, &c. &c. I made the descent into the cave out of curiosity. It appears like a steep gallery, at first tolerably high, but which becomes progressively lower, so as at last to render it necessary to crawl upon hands and knees. It terminates suddenly in a well ascending vertically. It was impossible to explore its farther direction, for at this point the burning wood which served me as a torch gave so little light, that I could scarcely distinguish the nearest objects. The air in the cave is very moist. There are two lateral galleries, one of which is under water; the other descends very rapidly, and is not any more accessible than the others. The cavern may be about 150 sagenes in length. On the bottoms stalagmites are met with, but no organic remains.

Coal Formation.—Slate-clay is largely developed to the east of *Van-Pin-Koon*. So much coal enters into its composition, that in some places it might serve for fuel. The beds often change their direction, and sometimes have a dip nearly vertical: the compact diorite (greenstone) which is intruded into this slate in subordinate beds, appears to have been the cause of the irregularity of those which overlie them. The slate-clay alternates with beds of fine-grained sandstone traversed by veins of white quartz, which render it very hard. Beds of coal lie between the slate and the sandstone.

The slate-clay is, as it were, pounded on the surface, and forms a kind of alluvium which covers its flanks. Thick beds of coal are likewise found in this rock, but their quality is very inferior to that of the coal which lies under the sandstone. The coal which the pounded slate covers varies in its properties. It is often decomposed, and its particles have so little cohesion between them, that they are almost reduced to a state of powder.

Beds of ferruginous sandstone, of little hardness, under which are sometimes found rich beds of coal, lie under the slate-clay. Thus the Western Mountains abound so much with coal, that two or three versts cannot be passed over without meeting with outcrops indicating the presence of a great quantity of this combustible substance, which has never as yet been touched by the hand of man.

The coal used for fuel in Pekin, where wood is very dear, is worked on a great scale; but whether in consequence of the abundance of this mineral, or of the obstinacy of the Chinese in rejecting improvements, the result is, that the process of mining is still in its infancy with them, while the preparation of charcoal is carried on there with more success and economy than any where else.

Generally speaking, we may consider that the art of mining is still in its infancy in China. They know nothing of the machines which give facility to the work; they have not even a notion of the pumps which are indispensable for the exhaustion of the water. Vertical shafts are not used by them. The imperfection of the works renders the air very dense in the mines, often to such a degree that it is necessary to make openings above on that account, in which are placed ventilating wheels put in motion by the hand. This wheel, although turning incessantly, introduces very little fresh air into the mine. The galleries of the mines are so low that the workmen can scarcely move in them except by crawling.

When the horizontal beds are to be won, continued timbering is used; but in winning the vertical beds, only the roofs and floors are timbered, particularly the latter, in order that the trains which are employed to transport the coal to the surface should slide easily upon them.

The timbering employed by the Chinese is not above two or three vershoks in thickness. It costs, nevertheless, about two copecks per poud.*

The winning of the horizontal bed is carried on in the following manner:—A gallery is opened in the bed of coal itself, 1½ archene in height. After having penetrated into it several vershoks, a cross beam is fixed in the roof, by the two ends being let into the walls of the rock; having advanced another archine, a fresh joist is fixed, which is bound to the first by beams placed lengthwise above them. These beams having a distance between them of a quarter of an archene, are covered with brush-wood made into fascines; when this work is finished, they continue to advance within the thickness of the bed, and following its direction.

The floor of the gallery is in like manner fitted with cross beams placed near together; the gallery is thus pushed on until the want of air renders it necessary to put a stop to the work. Below this gallery a second is opened, to continue the working of the coal.

The only difference in the process of working the vertical and the horizontal beds of coal is, that in the first the galleries are not only timbered above and below, but also on their sidewalls.

The coal taken out is put into baskets, placed upon sledges, which are raised to the surface by manual labour; one basket may contain about three pouds of coal, and one man can raise to the surface about eight in a day; he generally receives at the rate of 30 copecks per basket. The water which accu-

* Note by the author.—Wood in China is sold by weight.

mulates in the mines is emptied by means of small casks, brought up in the same manner.

If the local circumstances are very favourable, adits for letting out the water are driven; but as they are very expensive, they are very seldom had recourse to; at least if the irruption of the water becomes too considerable, it often happens that the works are altogether abandoned.

The only instruments used by the Chinese in working the coal are the pickaxe, the pick, and the hammer. They cut a groove with the pickaxe, and place in it the pick, which is struck upon with the hammer; it is by this means that fragments of coal, weighing from two to three pouds, are detached.

The number of workmen differs much in the Chinese collieries, for few among them make their agreement for a work of any long duration; for the most part they never come until the period when they have finished their labour in the fields. The pickers of coal receive about 1½ rouble for half a-day's work, and the overseers for the day about 3½ roubles, and their nourishment besides.

At the place where it is worked, at *Lao-Gao-Shan*, the coal is sold for 60 copecks per poud: its carriage through the mountains on the backs of mules to *Mem-Toou-Goou*, distant 30 li, where are situated the store-houses of the depot, costs about 20 copecks; from thence the coal is transported to Pekin upon camels. In the city the price of coals is 1½ rouble per poud.

There is besides a kind of coal met with at Pekin, brought from the neighbourhood, which is much cheaper, particularly when it is mixed in the proportion of one-half with coal-gravel (or detritus). This coal sells for only 1 rouble per poud, but it gives out but little heat, and is very quickly consumed. The coal-gravel in question is previously mixed with yellow clay, to give it greater consistence. The process is very simple; eight parts of coal-gravel are mixed with two of clay pouring into the mixture as much water as is required to render it a thick paste. When the whole of the mass has been well mixed, it is put into moulds, in the same manner as in the manufacture of bricks. The pieces thus prepared and dried are used as coal; they produce little heat, and the fire must be constantly fed with fresh doses. This fuel is only made use of among the indigent classes.

Russian Linear Measures.

The Sagéne, or Russian toise, is divided into 7 feet, or into 3 archines,

The foot,	...	...	...	into 12 inches,
The inch,	...	...	...	into 10 lines,
The archine or ell,		...	...	into 16 vershoks,
The vershok,		...	...	into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$,

The verst, or mile, is 500 sagenes in length, and is equal to 1.067 French kilométres. A verst is nearly $\frac{3}{4}$ of an English mile, or exactly 5 furlongs, 67 yards.

Weights.

The Russian pound is divided into 96 zolotniks,

The zolotnik	...	...	into 96 doleis or parts.
The poud consists of		...	40 pounds,
The berkovetz	...	...	10 pouds.

Coins.

The silver rouble is worth 4 francs (French),

The copec is the $\frac{1}{100}$ part of the rouble, worth 0.04 centimes,

The paper rouble varies according to the exchange, from 110 to 115 centimes,

The copper copec, the $\frac{1}{100}$ part of a paper rouble, is consequently worth 1 cent $\frac{1}{10}$ or 1 cent $\frac{1}{7}$, according to the course of exchange.

The Chinese li is equal to 274$\frac{1}{4}$ sagénes of Russia.

On the Cultivation of the Sugar-Cane in Spain. By THOMAS STEWART TRAILL, M.D., F.R.S.E. (Communicated by the Author.) Read before the Royal Society of Edinburgh.

The cultivation of the sugar-cane is now generally allowed to have been introduced into Arabia, Egypt, and the western parts of Asia, from India.*

* Since this essay was written, I have seen the able and laborious memoir of Ritter on this curious subject, which completely establishes this point. It appeared in the Royal Transactions of Berlin for 1839.

The first distinct account in classic authors of this important production is derived from the discoveries of Nearchus, the officer sent down the Indus by Alexander the Great to explore the Indian seas, in the year 325 B.C. According to Strabo, he describes it as a honey prepared from a reed without the agency of bees.

Εἴρηκε δὲ καὶ περὶ τῶν καλαμων, ὅτι ποιοῦσι μέλι, μελλισῶν μὴ ὀυσων.

Lib. xv.

Sugar is spoken of by Varro as a sweet fluid expressed from a reed. (*Fragment. ap. Isidorum.*)

Dioscorides describes σακχαρον as a concrete honey obtained from reeds, which he compares to salt in consistence, and in crashing between the teeth.* Pliny's description is to the same purpose. "Est autem mel in arundinibus collectum, gummium modo, candidum, dentibus fragile." Lib. xii. c. 8. He also states that sugar of India is superior to that of Arabia. From Arrian we learn that σακχαρι was an article of commerce in the Erythræan Sea. He speaks of it, among other merchandise, as wheat, rice, butter, oil of sesame, linen cloth, girdles, καὶ μέλι τὸ καλαμινον τὸ λεγομενον Σακχαρι. *Periplus Mar. Erythr.*†

Sugar is also mentioned in a fragment of Theophrastus as μελιτος γενεσις δ'ἐν τοῖς καλαμοῖς.

We have now no doubt that the sugar cane is indigenous to India, and perhaps to China, although, as with other plants long cultivated by man, it may be difficult to point out the precise district where it was first discovered. The antiquity of the Indian cultivation of the sugar-cane is matter of history; and recent investigations have proved that the Chinese have, from remote epochs, been acquainted with the preparation of sugar.

The appellations by which it is known might almost lead us to conjecture the source from which different countries obtained their knowledge of the plant. The Sanscrit name

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* Καλειται δὲ τι σακχαρον, ἔιδος ὀν μελιτος, εν Ινδιὰ πεπηγολος καὶ τῆ Ε'υδαιμονι Αραβιω, ἵυρισκομενον ἐπι τῶν Καλαμων, ὅμοιον τῆ συστασει ʽΑλσι καὶ θραυμενον ὑπο τοῖς ὀδοῦσι καθαπερ ἁλές; Lib. II. c. 104.

† Σιτος, καὶ ὀρυζα, καὶ βουτυρον, καὶ ἐλαιον σησαμιον, καὶ ὀθονιον, ἥ τε μοναχὴ, καὶ σαγματογηνη, καὶ περιζώματα, καὶ Μελι τὸ Καλαμινον, τὸ λεγομενον Σακχαρι. Perip. Ed. Stuck. Ludg. 1577.

Sarkara, corrupted in various Indian dialects into *Sakkara*, *Sakar*, and *Sukir*, is evidently the root whence the name of the product of the cane among all European nations is derived. In Sumatra, Java, and other Malayan islands, it is named *Taba*, *Tubbu*, or *Tebu;* and from some dialect of these is very probably derived its appellations of *Tao*, *Too*, and *To*, which it obtains in the group of the Sandwich and Friendly islands, and in Taheite. In the latter, on its discovery by Captain Wallis in 1767, the sugar-cane was found growing wild in great luxuriance; and such is the value of the variety of the plant produced there, that the British Government have carried it to the West Indies from Taheite, while the French have also introduced that variety of the cane into their colony at the Isle of France. The Chinese name for sugar is said to be *Tang*, which possibly is an adaptation of the more euphonious Malayan name into the monosyllabic language of that singular race. It may not, then, be an improbable conjecture, as similarity in the name would suggest, that all the western nations owe their knowledge of the sugar-cane to the peninsula of India, while the smaller islands of the Pacific, and perhaps also China, received it originally from the Malayan archipelago.

Some writers have insisted that the sugar-cane is also indigenous to America; but this opinion is founded on very questionable assumptions. A principal argument is derived from this plant being mentioned as growing in Hispaniola during the second voyage of Columbus. But it should be recollected that a colony was then founded on that island, that this voyage lasted upwards of two years, and that the Spaniards carried with them all manner of domestic animals and useful vegetables. P. Labat,* indeed, quotes Peter Martyr and some other authorities to shew the early cultivation of the cane in the other parts of the West Indies; and Father Lafitau has pronounced his arguments as conclusive on this head; but the evidence so much relied on, that of Peter Martyr, expressly mentions the sugar-cane, along with melons, cucumbers, and the like, among the useful vegetables cultivated by those Spa-

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* Nouveau Voyage aux Isles de l'Amerique, contenant l'Histoire Naturelle de ces Pays, &c. tom. ii. La Haye, 1724.

niards in their inclosed garden during the stay of Columbus in Hispaniola. " Cannarum radices ex quarum succo saccharum extorquetur, sed non coagulatus succus, *cubitales cannas* intra quindecim diem emiserunt." (*Decas I. lib. iii. P. Martyr.*) This extraordinary growth shews how rapidly the plant might be propagated in the West Indies; and had it been indigenous, what need was there of rearing it in their experimental garden?

We know, moreover, that the only plants mentioned by Columbus as growing in his New World that were known to him, were the *palm* and the *pine.* Had so valuable a product as the sugar-cane been found there, he would scarcely have omitted it.

We have, moreover, the direct testimony of Antonio de Herrera, who is lauded by Robertson as the most faithful of the Spanish historians on the discovery of the New World, as to the importation of the sugar-cane. He states that its cultivation was first introduced in 1506 by a Spaniard named Aguilon, who brought it to the West Indies from the Canary Islands.* The experiment of Columbus had shewn the congeniality of the climate to the rapid growth of the cane, and this was a natural consequence among a people then the most enterprizing in Europe.

The other authorities cited by Labat are too distant from the period of the Spanish discoveries to decide the question respecting a plant so easily propagated; and, besides, amount to no more than that the sugar-cane has been seen growing apparently without human care in America, in places and climates very similar to those regions where it is found wild in the eastern world, yet *not* where Europeans had not before landed, and therefore might have introduced it.

We have no certain data to fix the era of its first introduction into Europe. Some writers ascribe it to the Crusades, but it certainly was known in the Morea, Rhodes, Malta, and Sicily before the Crusades. We know that it was extensively cultivated in Egypt, around Assuan, as early as the year 766

* Historia general de los Hechos de los castillaños in las Islas y Tierra Firma de mar oceano. Tom. i., p. 320, fol. Madrid, 1601.

of our era ;* that it was first introduced into Sicily between 1060 and 1090, and had become in that island a considerable agricultural object in 1166, when a sugar-mill is mentioned in a charter of Guglielmo II. of Sicily.†

It is even said that the sugar-cane was brought from Malta to Sicily, and had been previously known in the Morea.

There is considerable reason to believe that the cane was introduced by Arabian or Moorish conquerors into Spain soon after their settlement in the peninsula in the year 714. It seems to have been well known in Andalusia as early as 1150, but the Spanish historians are totally silent on this subject.

Certain it is, that the cultivation of sugar was greatly fostered by the Moors of Spain, and most successfully pursued by that active and enterprising race, who long held the foremost place in the career of European arts and learning. These sugar-plantations extended over a great part of the eastern shores of Valencia and Granada ; and where the soil or climate were less fitted for this species of industry, the rearing of silk-worms, the cultivation of the fig, the orange, the lemon, and the olive, with wheat and barley of the finest quality, gave full employment to Moorish agricultural industry.

I do not find any certain data in the Spanish historians from which to collect the extent of the sugar cultivation in their country ; but for some time after the final subjugation of the Moors of Spain, large tracts of land in Valencia and Eastern Andalusia were still under sugar-cane. The first severe check it received was from the extension of sugar cultivation in the West Indian islands, and its second from the barbarous and most impolitic expulsion of the Moriscoes from Spain in 1609. The arts and industry of Valencia, in particular, sustained a shock, from which they never recovered ; and the cultivation of the sugar-cane was soon extinguished in that kingdom, except a feeble remnant that lingered, even to this century, in the duchy of Gandia, a small territory about thirty miles south of the city of Valencia. As I did not visit that part of Spain, I am unable to state whether it has there survived the French

* Edrisi.

† Father Lafitau, Histoire des Découvertes et Conquêtes des Portugais. Paris, 1733.

invasion; but in 1814 I found sugar still a considerable article of agricultural industry in the eastern parts of Andalusia, especially in the neighbourhood of Marbella, a town thirty-five miles south of Malaga; and also at Velez-Malaga, a small town in a fertile valley, twelve miles to the eastward of that city. This cultivation, indeed, extends along the whole coast of the eastern projection of Andalusia to Torrox, Motril, and Adra, where, until the French invasion of 1808, it was also very flourishing.

The whole sugar district of Andalusia may be considered as a narrow tract between a chain of rugged mountains and the Mediterranean, above 130 miles in length, with a medium breadth of four or five miles. It is not meant to assert that all this tract is under sugar, or even capable of furnishing it; but merely that this cultivation may be traced throughout the district now mentioned. Its southern part is screened by the moderate elevations of the Sierra Bermeja and mountains of Malaga; its north-eastern portion is overhung by the rocky crests of the mighty Alpujarras; a stupendous group terminating in the perennial snows of the Sierra Nevada, which among European mountains yields in altitude to the Alps alone.

Notwithstanding that snowy peaks may be seen in some parts of the sugar district, yet it possesses many characters of an intertropical climate. The heaths of the north are supplanted by the dwarf palm, *Chamærops humilis;* the fields are divided by hedges of the aloe, *Agave Americana*, and of the prickly pear, *Cactus opuntia;* while the tall form of the date palm, *Phœnix dactylifera*, another remnant of Moorish times, is still occasionally seen to rear its graceful head against the deep azure of a cloudless sky.

My meteorological observations, though necessarily imperfect from frequent change of place, may serve to give some idea of the climate. During my rambles in that neighbourhood, in the latter half of May, the average temperature

At 9 A.M. = 69°.5 F.

At 9 P.M. = 62°.5

I found the average range of Deluc's whalebone hygrometer during the same period = 36°.5.

The average temperature at Gibraltar and its vicinity, throughout June, at 9 A.M. = 73°.

at 9 P.M. = 70°, while the monthly average of Deluc's hygrometer = 41°. During this period, the hygrometer was twice observed to indicate only 35°, and it was once as high as 52°: the last was during a *Levanter*, or south-east breeze, with an obscure atmosphere and oppressive heat.

In the month of July, while still to the south of the Sierra Morena, the average temperature from the 1st to the 24th of the month was at 9 A.M. 86°.

at 9 P.M. 82°.5.

At the hottest time of the day, the thermometer in the shade usually stood from 92° to 96°; and on one occasion I found it as high as 99°.5. An accident to my hygrometer rendered the observations with that instrument imperfect.

For several months of the year, scarcely any rain, except an occasional thunder-shower, falls in Andalusia; but the dews are most copious. In severe winters, there are sometimes slight nocturnal frosts, which are very injurious to the sugar-canes. But the climate along the Mediterranean coasts of Andalusia is so mild, that tropical plants in general need scarcely any protection; and the nightingale is said to remain there throughout the year.

It is well known that the range of the barometer is extremely limited in the south of Europe, and it is still less in equatorial regions. By consulting the register of this instrument, kept at the Garrison Library in Gibraltar, at a few feet above the level of the sea, I found that for eight years the barometer had generally stood from 30.01 to 30.10. During the whole period, it had been once so low as 29.70, and once so high as 30.20: the first happened during a thunder-storm in the winter of 1810; the latter in the summer of the same year.

It might have been expected that a branch of agriculture so interesting, so little known in the rest of Europe, would have arrested the attention of British travellers in Spain; but it has scarcely been noticed by any of our travellers. In the Antiquarian Travels of the Rev. Edward Clarke, published in 1763, we perhaps ought not to expect to find any notice of this subject. But neither in the valuable "*Journey* *through Spain*" of the Rev. Joseph Townsend, which abounds with information on the agriculture and manufactures of the Peninsula, nor in the more superficial Narratives of Dillon, Swinburne, Semple, and Inglis, do we find any account of this branch of Spanish industry. Townsend contents himself with stating that the cultivation of the *sugar-cane*, of rice, and cotton, were introduced into Spain by the Moors; as were the manufactures of silk, paper, and gunpowder, when they were unknown to the rest of Europe. Dillon merely states that the sugar of Andalusia is equal to that of the West Indies, and gives the number of sugar-mills along the eastern coast. Swinburne repeats the story; but neither traveller appears to have seen a sugar-plantation. Semple was in too great a hurry to observe them; and Inglis is equally barren on this subject. The only modern traveller in Spain that has afforded any useful information on the cultivation of the sugar-cane in that country is Laborde, whose few remarks are scattered through the five volumes of his *Itineraire.*

During a visit to Spain of several months, in the year 1814, among other objects of high interest, my attention was drawn to this branch of agriculture; and I propose to lay before the Society my own observations, with some statistical remarks which I was permitted to extract from the memoranda of one of the most extensive sugar-planters in the Spanish Peninsula.

The cultivation of sugar in the kingdom of Granada has been subject to many fluctuations during the two last centuries: often from the interference of an arbitrary government; and once, at least, from religious persecution of one of the most enterprising planters, who died in the prisons of the Inquisition at Granada. It flourished exceedingly about 1808, when long continued maritime warfare had enhanced the price of colonial sugar. Sugar-plantations, both large and small, then abounded along the coast from Adra to the southward of Estepona; and mills for crushing the canes, either moved by water-wheels or by mules, were established, especially at *Adra, Motril, Salobreña, Almuñecar, Frigiliana, Torrox, Velezmalaga, Churriana, Torre de Molinos, Mijas, Castillo di Fungirola, Marbella*, and at *Manilba*, about 15 miles north of Gibraltar. Southward of Malaga, there were twelve of these sugar-mills. Some of the works were ruined during the subsequent war ; but many of them were still in existence at the period of my journey in 1814. The finest and most perfect sugar estate I saw was that belonging to *Messrs Grevigny and Kirkpatrick* of Malaga, of which I shall presently give some details, furnished by the latter gentleman. The mode of cultivation there was on the most approved system of the English planters in the West Indies ; the works were very complete, and produced, in good years, 4600 loaves of white sugar—the produce of canes grown on not more than 38 English acres of good land. Many of the other plantations, however, are very small ; and such cultivators usually sell their canes to the larger proprietors, or several of them unite in erecting a mill and boiling-house for the fabrication of *muscovado* sugar.

On large plantations the ground is prepared by the plough ; but on almost all those I visited the labour is chiefly performed by the spade, and by a species of large hand-hoe. The principle, however, of preparing the ground is similar in them all.

The soil best adapted for sugar-cane is a rich loam, light, and of a brown colour when recently turned up. The general soil of all this district is clay, much mixed with calcareous matter. The best soil usually rests on clay-slate, and this on mica-slate ; but around Velezmalaga limestone covers the slate. The soil should not be too retentive of moisture, but occasionally requires irrigation, which is ingeniously effected by means of earthenware tubes, that convey the water either from the streams descending from the mountains, or what is raised by means of the *noria*, or Persian wheel—a common mode of procuring water in Andalusia since the time of the Moorish conquest. The water is conveyed to the upper parts of the sugar-fields, whence it is permitted to escape into channels cut for its distiibution to the roots of the canes.

When a plantation is to be formed, the land is duly prepared, by digging or ploughing to the depth of 8 or 10 inches ; paths are left for convenient access to the canes ; the soil is enriched by compost manures of animal dung, mixed with decaying vegetables and earthy matters ; and the field is divided by parallel trenches, about 12 inches asunder, and 8 inches deep. The earth turned out is laid on the intervals between the trenches. The width of these trenches is different at different places. The trenches being finished, the planter proceeds to place horizontally in their bottoms the shoots or tops of the canes of the former season, which, for this purpose, have been carefully preserved. These shoots are of such lengths as to have four or five buds in each. The pieces I saw buried, in renewing the worn-out roots in a plantation at Velezmalaga, were about 9 inches in length, and two were placed sideways in each furrow. Each pair were placed about 6 inches from the adjacent pair. A portion of the earth is then thrown on the shoots; and as the buds rise above the ground, more soil is gradually added from the heaps, until about the end of five months, when the whole earth of the heaps has been accumulated around the young plants. During this period of their growth, they are carefully weeded, and irrigated, if necessary, as already described. The great enemy of the Spanish sugar-planter is an occasional, though slight, frost, which is very apt to kill the young canes. I observed in many places very high fences of the Spanish reed (*Arundo Donax*) used as defences against the chilling winds from the mountains.

When the young canes are about 15 inches high, they are hoed up to 6 or 7 inches; and hoeing and weeding are continued during the growth of the plant.

The sugar-cane comes to its maturity in two years; so that a plantation ought to have one-half of its produce ready for cutting annually.

The cutting in Spain begins in November, and is a season of hilarity and mirth, like that of the vintage in every part of Europe.

The ripe canes, when cut, are carried to the mill, where they are crushed between three cylinders of wood plated with iron, turning on vertical axes. The power is applied to the middle cylinder, on which is fixed a trundle-wheel or pinion applied to spur-wheels on the two other cylinders. In many works the apparatus is rude; and in one small mill I observed a horizontal water-wheel. But the whole apparatus at the

Marbella plantation of Mr Grevigny was well constructed. The expense of a good sugar-mill is considerable. Laborde states that some mills cost 100,000 livres tournois, or upwards of L.4000 Sterling.

The expressed juice of the cane is conveyed from the mill in wooden gutters, lined with lead or copper, to the boiling-house. The best works have a series of three boilers, in which the juice undergoes purification, and hence are called *clarifiers*. These are of different sizes, placed in brick-work, and each is heated by a separate fire. In the first copper, *milk of lime* is added to absorb the acid always existing in cane-juice; the heat is raised nearly to the point of ebullition, and then the fire is cut off by a damper. A thick scum has by this time collected on the surface, which is allowed to accumulate for an hour, when the subjacent clear liquid is drawn off by a cock on the lower part of the clarifier. The liquid is next conveyed to the second boiler, when it is subjected to a boiling heat, to inspissate the juice; but lime-water is added in this step of the process, and the scum which rises is laded off repeatedly. The clarified juice is usually subjected to a similar process in a third clarifier, whence it passes into the principal boiler, or *teache*, as it is termed by our West Indian sugar-planters. Here it undergoes its final evaporation; and when judged to be sufficiently concentrated for crystallization, the syrup is laded off into wooden coolers of about 10 inches deep, with a surface of 20 or 30 square feet. Here it granulates; and the imperfect crystals thus obtained are removed to the curing-room and drained, just as in the manufacture of West Indian sugar. In the sugar-works of M. Grevigny at Marbella, the sugar is also *clayed* and baked, as in our refineries; and the quality of both their muscovado and loaf sugar is excellent.

The following particulars, extracted from the books of my excellent friend the late William Kirkpatrick, Esq. of Malaga, give an account of the state of that large establishment in 1806, when he was manager. The plantation at Marbella became the property of his father-in-law, M. Grevigny, in 1800, under a royal charter. As these documents refer to a period previous to the operation of the famous Berlin and Milan decrees of Napoleon, the calculation of profits is not affected by the adventitious state of the commerce of the world consequent on those ebullitions of the Imperial hatred of Great Britain; and they are more worthy of consideration, as proceeding from an intelligent gentleman intimately conversant with the subject, and as conveying the only real statistical information, that has fallen under my observation, on the cultivation of the sugar-cane in Europe.

"The Marbella Establishment, on the scale it is now carried on, yields in every current year, free of frost, after the tithes are paid, 4600 loaves of refined sugar; which, sold at the usual *peace prices*, and allowing for the value of the molasses, will bring at least 10 hard dollars per loaf, or 46,000 duros. To produce this quantity, it is necessary to have 120 *fanegadas* of good rich land under canes.* Only one-half, however, of this land can be cut annually, so that the produce above stated is obtained from 60 fanegadas. But, to be so productive, the land must be fully manured, the canes must be well cleaned and hoed, and the irrigation carefully performed; under these circumstances, 60 fanegadas will readily afford that quantity of sugar and molasses, or even more.

The first planting of the canes is, however, very expensive, amounting to 200 duros per fanegada. But if this operation be judiciously conducted, the annual cost of maintaining the plantation, of hoeing and weeding the canes, of replanting the perished roots after every cutting, and again manuring the land, which must be done after every crop, will not exceed 75 duros per fanegada.

Our labour is performed at a very cheap rate. The daily pay of each labourer is,—

For six months,	=	7 Reales Vellon,	= 1s. $7\frac{1}{4}$d.
For four active months	=	8 R. V.	= 1s. 10d.
For two hottest months	=	11 R. V.	= 2s. $6\frac{1}{4}$d.

They receive no maintenance, but find themselves in food and other necessaries.

To make the plantation profitable, a sufficiency of water

* A *fanega de tierra*, or *fanegada*, is = 25,920 Spanish feet; or eight fanegadas are rather less than five English acres. *Duro* is the silver dollar.

for irrigation, and dung for manure, must be provided. This last article is a work of some difficulty, and requires a considerable command of capital. In order to insure a sufficient supply, besides 300 or 400 cart-loads of dung annually furnished by cattle reared on an adjoining farm, and those employed on the plantation, there are 3000 sheep kept on the farm, which are penned every fair night, from December to the end of May, on the land which requires *dunging*. During rainy nights, they are kept in stables, from which the dung is collected in the morning; and the floors are so constructed that the urine flows into a tank, whence the needy and backward canes are watered, a process by which they are materially advanced.

A well-planned sugar plantation, if judiciously managed, and if the roots which have perished be renewed after every cutting, will last twenty or thirty years. But for prosecuting this branch of industry successfully, the additional one of *farming* should be conjoined. The work of the plantation, sugar-mills, and farm, employs eighty oxen, forty mules, and twenty asses; fifty servants and overseers are also to be maintained, but their wages do not exceed those of the day-labourers. The cattle and servants annually require 600 quintals of wheat,* 1400 quintals of barley, for the horses and mules, 300 quintals of beans or other pulse, 5000 quintals of chopped straw, the ordinary food of cattle, all which is raised on the farm; but this additional expense is well repaid by the produce of that farm, the dung, and the work done by the cattle, which save a considerable sum to the sugar establishment.

As the proprietors of the Marbella estate have thus every requisite for the plantation, for two sugar-mills, and for the farm, within themselves, they have only to calculate the annual charges incurred in making 4600 loaves of sugar. This business should be performed in eighty days, at the rate of sixty loaves every twenty-four hours; but unavoidable delays with the *claying* of the sugar, bring up the working days to 100, of which the expenses may be stated at 100 duros per day; 180 men and 75 mules being employed during that pe-

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* A Spanish quintal is 102¾ lb. avoirdupois.

riod. If a sufficient quantity of *cane-trash* has been properly dried and laid up for supplying the boiling-house and kitchens, no addition has to be made for fuel; but if fuel has to be purchased, an addition of 25 or 30 dollars a-day must be made to the expenses of the establishment.

The canes are ground by a water-mill; but when water fails, or any accident happens to the machinery, the mule-mill is put in operation; thirty-six mules are set apart for this work: six are yoked to it at once, and work it for two hours in the morning and two hours in the afternoon, during each twenty-four hours. This brings an additional charge of 36 duros per day.

Each *form* or cooler in which the sugar crystallizes regularly affords from 47 to 50 lb. of sugar, and 60 or 65 lb. of molasses daily.

The establishment contains the two mills, stables for 80 mules, extensive rooms for depositing the canes till ground, two boiling-houses, and crystallizing and curing rooms.

The erection of these works, purchasing a spare mill, and a dozen of additional copper boilers, have caused a heavy outlay. But besides the sum required in these erections, the proprietors have expended in the purchase of 800 fanegadas of land, planting 120 of them, in stocking the farm with horned cattle, sheep, and mules, and in building stores and granaries, 80,000 duros.

Yet the returns of this double establishment have been, even in bad years, at least seven per cent., in middling seasons eleven per cent., and in favourable seasons from sixteen to twenty per cent., clear of all charges, on the capital embarked in the undertaking.

These remarks will shew that the cultivation of the sugar-cane might still become an important branch of Spanish industry, notwithstanding the competition of foreign sugar; and that little is wanting but a firm and equitable government, to afford from this source a very profitable investment of capital, if managed with the judgment and skill displayed in the establishment at Marbella.

Notice of Experiments regarding the Visibility of Lights in rapid Motion, made with a view to the Improvement of Lighthouses, and of some peculiarities in the impressions made by them on the Eye. By ALAN STEVENSON, LL.B., F.R.S.E., Civil Engineer. Communicated by the Author.

IN the spring of 1836, my attention was called, by our distinguished countryman Captain Basil Hall, to a plan by which he proposed to increase the intensity and power of fixed lights for lighthouses, to such an extent as to render their constant effect little inferior to that of the bright flashes which alternate with the dark intervals in revolving lights. Since that time Captain Hall has made some experiments on the subject, which he has described in the United Service Journal; and I have lately, at his request, and with the sanction of the Northern Lights Board, repeated his experiments, and also tried some others which appeared to me to bear on the subject. The object of this notice is to state the results which were obtained from these experiments, as well in regard to the object for which they were originally designed, as in reference to some curious phenomena connected with the distribution of light and its effect in producing impressions on the eye, which were observed in the course of these trials. It is necessary, however, that I should, in the first place, give a short account of the instruments which were employed and describe their action, so that the purpose for which the experiments were made may be brought fully into view, and the nature of the results which they afforded may be made more intelligible to those who have not previously given any consideration to the subject.

In revolving lights on the dioptric principle, the annular lens of Fresnel is employed. This instrument consists of a centre lens in one piece, and several concentric zones arranged so as to form a square of about 900 inches of surface; and it possesses the property of projecting to the horizon, in the form of *one* pencil or beam, all the light which falls on its inner face from a lamp placed in its principal focus. The consequence of this action is, that when several lenses are so arranged as to form a right prism which circulates round a lamp placed in the common focus, a distant observer receives from each lens, as its axis crosses his line of vision, a bright flash, which is succeeded by total darkness, when one of the dark spaces intermediate between the beams passes over his eye; and this succession of bright flashes alternating with dark intervals, produces the characteristic appearance of a revolving light.

The fixed light, on the other hand, presents to the eye a steady and unchanging appearance; and the chief object to be obtained in its construction, is to unite the greatest brilliancy with an equal distribution of the light in every direction. This condition of perfect distribution is most rigorously fulfilled by the use of refracting zones or belts, which form, by their union, a cylinder enveloping the flames placed in its centre. This cylinder is a true solid of revolution, generated by the rotation of the mixtilinear central section of a great annular lens, round a vertical axis passing through its principal focus; and must, therefore, possess the property of refracting the light in the vertical direction only, without affecting its natural divergence horizontally. The light which is incident from the focus on the inner surface of the belt is therefore projected forwards in the shape of a flat ring of equal brilliancy all round the horizon.

This very brief account of the instruments used in the fixed and revolving lights on the dioptric principle will, it is hoped, be found sufficient to render intelligible the following outline of the plan proposed by Captain Hall for the improvement of fixed lights, and the account of the trials that were made with this object in view.

The familiar experiment of whirling a burning stick rapidly round the head, so as to produce a ribbon of light, proves the possibility of causing a continuous impression on the retina by intermittent images succeeding each other with a certain velocity. From the moderate velocity at which this continuity of impression is obtained, we should be warranted in concluding, *a priori*, that the time required to make an impression on the retina is considerably less than the duration of the impression itself; for the continuity of effect must, of course, be caused by fresh impulses succeeding each other before the preceding ones have entirely faded. If it were otherwise, and the time required to make the impression were equal to the duration of the sensation, it would obviously be impossible to obtain a series of impulses so close or continuous in their effects as to run into and overlap each other, and thus throw out the intervals of darkness, because the same velocity which would tend to shorten the dark intervals, would also curtail the bright flashes, and thus prevent their acting on the eye long enough to cause an impression. Accordingly, we find that the duration of an impression is in reality much greater than the time required for producing the effect on the retina. It is stated by Professor Wheatstone, in the London Transactions for 1834, that only about *one millionth part* of a second is required for making a distinct impression on the eye; and it appears, from a statement made by Lamé, at p. 425 of his Cours de Physique, that M. Plateau found that an impression on the retina preserved its intensity unabated during *one hundredth* of a second, so that, however small these times may be in themselves, the one is yet 10,000 greater than the other.

It has been ascertained by direct experiment,* that the eye can receive a fresh impression before the preceding one has faded; and indeed, if this were impossible, absolute continuity of impression from any succession of impulses, however rapid, would seem to be unattainable; and the approach to perfect continuity would be inversely as the time required to make an impression.

From this property which bright bodies passing rapidly before the eye possess of communicating a continuous impression to the sense of sight, Captain Hall conceived the idea, not merely of obtaining all the effects of a fixed light, by causing a system of lenses to revolve with such a velocity as to produce a continuous impression, but, at the same time, of obtain-

* Lamé, Cours de Physique, p. 424. L'impression peut subsister encore lorsquela suivante a lieu.

ing a much more brilliant appearance, by the compensating influence of the bright flashes, which he expected would produce impulses sufficiently powerful and durable to make the deficiency of light in the dark spaces almost imperceptible. The mean effect of the whole series of changes would, he imagined, be thus greatly superior to that which can be obtained from the same quantity of light equally distributed, as in fixed lights, over the whole horizon. Now this expectation, if it be considered solely in reference to the physical distribution of the light, involves various difficulties. The quantity of light subjected to instrumental action is the same whether we employ the refracting zones at present used in fixed dioptric lights, or attempt to obtain continuity of effect by the rapid revolution of lenses; and the only difference in the action of these two arrangements is this, that while the zones distribute the light equally over the whole horizon, or rather do not interfere with its natural distribution, the effect of the proposed method is to collect the light into pencils, which are made to revolve with such rapidity, that the impression from each pencil succeeds the preceding one in time to prevent a sensible occurrence of darkness. To expect that the mean effect of the light, so applied, should be greater than when it is left to its natural horizontal divergence, certainly appears at first to involve something approaching to a contradiction of physical laws. In both cases the same quantity of light is acted upon by the instrument, and in either case any one observer will receive an impression similar and equal to that received by any other stationed at a different part of the horizon; so that unless we imagine that there is some loss of light peculiar to one of the methods, we are, in the physical view of the question, shut up to the conclusion, that the impressions received by each class of observers must be of equal intensity. In other words, the same quantity of light is by both methods employed to convey a continuous impression to the senses of spectators in every direction, and in both methods equality of distribution is effected, since it does not at all consist with our hypothesis that any one observer in the same class should receive more or less than his equal share of the light. Then, as to the probability of the loss of light, it seems natural to expect that this should occur in connection with the revolving system, because the velocity is an extraneous circumstance, by no means necessary to an equal distribution of the light, which can, as we already know, be more naturally, and at the same time perfectly, attained by the use of the zones.

On the other hand, it must not be forgotten, that although the effect of both methods is to give each part of the horizon an equal share of light, there is yet this difference between them, that while the light from the zones is equally intense at every instant of time, that evolved by the rapidly circulating lenses is constantly passing through every phase between total darkness and the brightest flash of the lens; and this difference, taken in connection with some curious physiological observations regarding the sensibility of the retina, gives considerable countenance to the expectation on which Captain Hall's ingenious expedient is based. The fact which has already been noticed, and which the beautiful experiments of M. Plateau and Professor Wheatstone have of late rendered more precise, that the duration of an impression on the retina is not only appreciable, but is much greater than the time required to cause it, seems to encourage us in expecting, that while the velocity required to produce continuity of effect would not be found so great as to interfere with the formation of a full impression, the duration of the impulse from each flash would remain unaltered, and the dark intervals which do not excite the retina would, at the same time, be shortened, and that, therefore, we might in this manner obtain an effect exceeding the brilliancy of a steady light distributed equally in every direction by the ordinary method. Many persons, indeed, who have speculated on this subject, seem to be of opinion, that, so far from the whole effect of the series of continuous impressions being weakened by a blending of the dark with the bright intervals, the eye would in reality be stimulated by the contrast of light and darkness, so as thereby to receive a more complete and durable impulse from the light. It is obvious, however, that this question regarding the probable effect to be anticipated by a revolution so rapid, as to cause a continuous impression, can only be satisfactorily answered by an appeal to experiment.

In experimenting on this subject, I used the apparatus formerly employed by Captain Hall. It consisted of an octagonal frame, which carried eight of the discs that compose the central part of Fresnel's compound lens, and was susceptible of being revolved slowly or quickly at pleasure, by means of a crank handle and some intermediate gearing. The experiments were nearly identical with those made by Captain Hall, who contrasted the effect of a single lens at rest, or moving very slowly, with that produced by the eight lenses, revolving with such velocity as to cause an apparently continuous impression on the eye. To this experiment I added that of comparing the beam thrown out by the central portion of a cylindric refractor, such as is used at the fixed light of the Isle of May, with the continuous impression obtained by the rapid revolution of the lenses. Captain Hall made all his comparisons at the short distance of 100 yards; and in order to obtain some measure of the intensity, he viewed the lights through plates of coloured glass until the luminous discs became invisible to the eye. I repeated these experiments at Gullan, under similar circumstances, but with very different results. I shall not, however, enter upon the discussion of these differences at present, although they are susceptible of explanation, and are corroborative of the conclusions at which I have arrived, by comparing the lights from a distance of 14 miles; but shall proceed to detail the more important results which were obtained by the distant view. Several members of the Royal Society witnessed the results of the experiments which I shall briefly describe in the following order:—

1. The flash of the lens revolving slowly was very much larger than that of the rapidly revolving series; and this decrease of size in the luminous object presented to the eye, became more marked as the rate of revolution was accelerated, so that, at the velocity of 8 or 10 flashes in a second, the naked eye could hardly detect it, and only a few of the observers saw it; while the steady light from the refractor was distinctly visible.

2. There was also a marked falling off in the brilliancy of the rapid flashes as compared with that of the slow ones; but

this effect was by no means so striking as the decrease of volume.

3. Continuity of impression was not attained at the rate of 5 flashes in a second, but each flash appeared to be distinctly separated by an interval of darkness; and even when the nearest approach to continuity was made, by the recurrence of 8 or 10 flashes in a second, the light still presented a twinkling appearance, which was well contrasted with the steady and unchanging effect of the cylindric refractor.

4. The light of the cylindric refractor was, as already stated, steady and unchanging, and of much larger volume than the rapidly revolving flashes. It did not, however, appear so brilliant as the flashes of the quickly revolving lenses, more especially at the lower rate of 5 flashes in a second.

5. When viewed through a telescope, the difference of volume between the light of the cylindric refractor and that produced by the lenses at their greatest velocity was very striking. The former presented a large diffuse object of inferior brilliancy, while the latter exhibited a sharp pin point of brilliant light.

Upon a careful consideration of these facts it appears warrantable to draw the following general conclusions:—

1. That our expectations as to the effects of light, when distributed according to the law of its natural horizontal divergence, are supported by observed facts as to the visibility of such lights, contrasted with those whose continuity of effect is produced by collecting the whole light into bright pencils, and causing them to revolve with great velocity.

2. It appears that this deficiency of visibility seems to be chiefly due to a want of volume in the luminous object, and also, although in a less degree, to a loss of intensity, both of which defects appear to increase in proportion as the motion of the luminous object is accelerated.

3. That this deficiency of volume is the most remarkable optical phenomenon connected with the rapid motion of luminous bodies, and that it appears to be directly proportional to the velocity of their passage over the eye.

4. That there is reason to suspect that the visibility of dis-

tant lights depends on the volume of the impression, in a greater degree than has perhaps been generally imagined.

5. That as the size and intensity of the radiants causing these various impressions to a distant observer, are the same, the volume of the light, and, consequently, *cæteris paribus*, its visibility, is, within certain limits, proportionate to the time during which the object is present to the eye.

Such appear to be the general conclusions which these experiments warrant us in drawing ; and the practical result, in so far as lighthouses are concerned, seems sufficient to discourage us from attempting to improve the visibility of fixed lights in the manner proposed by Captain Hall, even supposing the practical difficulties connected with the great centrifugal force generated by the rapid revolution of the lenses to be less than they really are.

I shall be excused, I hope, for saying a few words in conclusion regarding the decrease in the volume of the luminous object caused by the rapid motion of the lights. This effect is interesting, from its apparent connection with the curious phenomenon of irradiation. When luminous bodies, such as the lights of distant lamps, are seen by night, they appear much larger than they would do by day; and this effect is said to be produced by irradiation. M. Plateau, in his elaborate essay on this subject, after a careful examination of all the theories of irradiation, states it to be his opinion, that the most probable mode of accounting for the various observed phenomena of irradiation is to suppose, that, in the case of a night-view, the excitement caused by light is propagated over the retina beyond the limits of the day-image of the object, owing to the increased stimulus produced by the contrast of light and darkness ; and he also lays it down as a law confirmed by numerous experiments, that irradiation increases with the duration of the observation. It appears, therefore, not unreasonable to conjecture, that the deficiency of volume observed during the rapid revolution of the lenses may have been caused by the light being present to the eye so short a time, that the retina was not stimulated in a degree sufficient to produce the amount of irradiation required for causing a large visual object. When, indeed, the statement of M. Plateau, that irradiation is proportional to the duration of the observation, is taken in connection with the observed fact, that the volume of the light decreased as the motion of the lenses was accelerated, it seems almost impossible to avoid connecting together the two phenomena as cause and effect.

On the Classification of Invertebrate Animals. By Dr W. P. Erichson.

It has, in recent times, been the practice almost universally to unite the articulated worms with insects, the two conjoined being regarded as forming one single principal division, the Articulata; whether this division be considered (as it is by Blainville and others) as including all invertebrate animals possessing to a certain extent a symmetrical structure, or whether (as Ehrenberg, from a more profound study of internal organisation, proposes) it be limited to animals in which the articulation of the body is shewn to be a true one, by the existence of a nervous system consisting of a row of ganglions with radiating nerves. It comes to be a question, however, whether symmetry and articulation of the body, and the form of the nervous system connected with the latter, indicate so much that is not afforded to systematic writers by other considerations. I have at least myself arrived at the conviction that we must return to the Linnæan classification, and, in accordance with nature, divide invertebrate animals into two great divisions, of which the one would correspond with the Linnæan insects, and the other with the Linnæan worms. I shall discuss this in the following remarks.

The first distinction that strikes us between the two consists in this,—that the one group possesses a certain system of organs of motion, but the other does not, and, as no passage takes place, but, on the contrary, all the Linnæan insects, at least during a certain period of life, are provided with these, while in the Linnæan worms there is nothing analogous, this distinction is constant and decided; and, as voluntary motion is one of the most prominent animal characteristics, this appears also to be a very essential distinction. In the Linnæan worms the progression of the body is accomplished in various ways, but where it is not by means of cilia, as in the infusoria and in the young of many radiata, the alternate dilatation and contraction of the whole body perform the principal part. The lateral cirri and bristles of the majority of the Annelides are of themselves not in the condition to move the bodies, but at most serve as points of support, just as the Gasteropods do not glide forwards by means of the lower surface of the stomach, but do so upon it by means of extensions and contractions of the whole body. The arms of the Cephalopods, like those of the polypi intended for the same purpose, serve to seize their prey and to convey it to their mouths, and are only employed occasionally for dragging their bodies forwards. What are termed the feet of the Echinodermata also are not limbs, but belong entirely to the skin. In insects, on the other hand, the organs of motion form not only a particular system of limbs, which this whole division of animals possesses in a constant fundamental type, though one which exhibits various modifications, but they form a system which also gives rise to a peculiar external skeleton-structure, and stands in close connection with a further articulation of the body. We may assume that in the articulated insect each joint or segment had originally a pair of articulated legs, as we find in the Myriapods, for example in the Scolopendridæ, which apparently exhibit a passage to the Annelides and first of all to the Nereidæ. Nevertheless, the fundamental type of the structure of insects is quite different, and we perceive, when we glance at the whole series of this large division of the animal kingdom, with reference to the history of development, that with the appearance of limbs which take upon themselves the function of the progressive movement of the body, there are united other relations of the articulation of the body which are of essential importance for the organisation.

The various functions of life of the Linnæan insects are more or less centralized in different segments of the body. First of all, there is separated that portion which contains the organs of the vegetative functions, or, in other words, the organs of nourishment and propagation; that is, the posterior part of the body from the anterior part, which latter alone contains the animal functions, inasmuch as it is provided with the organs of motion and those of the senses. The separation in insects is still more apparent and decided, when viewed in a narrower sense; for we find the anterior part of the body divided into two parts, viz. the head, with the organs of sense, and the thorax, to which are exclusively confined the organs of motion. In the Arachnidæ, the body is divided into only two parts, viz. anterior and posterior; and here also, the first alone contains the organs of motion. In the Crustacea, each of the segments of the posterior part of the body has a similar pair of feet, as have the segments of the thorax; and thus the thorax in this class loses its original signification, and so much the more because the pairs of feet belonging to it, when those of the posterior part of the body either assume entirely or principally the office of the progressive movement of the body (in the true Crustacea), at the same time become converted either wholly or in part into portions of the mouth. It follows, from the history of the metamorphosis of various Decapods, that no other type lies at the foundation of the structure of their bodies but that of insects, inasmuch as at a very early period of their existence no other legs except those of the thorax present themselves, and which at that time exercise the functions of organs of motion. The Myriapods (Julus) also come into the world with three pairs of feet, and exactly those corresponding to the three pairs of feet occurring in insects. In the same manner, in the Lernaeadæ, we find, for the most part, that they come out of the egg with three pairs of feet; and it is only gradually that the posterior part of body, at first without feet and scarcely observable, is developed in a prominent manner.

Another essential peculiarity of insects, considered in the Linnæan acceptation, is their possessing three pairs of jaws in the mouth, which, although variously modified, are always present. There is nothing analogous in the Linnæan worms, for neither the dental plates in the mouth of the leech, nor the hooks in the gullet of the Annelides, nor even the peculiar dental apparatus in the gullet of the Rotifera, have any resemblance to the three pairs of jaws in insects. Although the jaws of insects are actually identical with the legs, as is evident from their conversion into legs (as in the Arachnidæ), and, *vice versa*, from the conversion of legs into jaws (as in the true Crustacea), the assumption that the head of insects, like the thorax, is composed of three segments, can in no way be made out. The constant occurrence of three pairs of jaws, however, admits of the supposition that the head, even where it is apparently awanting, inasmuch as it is blended with the immediately following sections of the body,—as in the Arachnidæ, the Decapods, the Stomapods, and the Entomostraca,—is nevertheless an essential portion of the body of insects. This also may be deduced from the constant presence of the brain as a central organ of the nervous system, even where, externally, a determinate well-marked head is awanting.

In the Linnean worms (Vermes), on the other hand, a head is not present, in the sense in which it is in the whole vertebrate animals, in all insects in the more confined signification, and in the greater number of Crustacea, even in the Myriapods, in which the further division into the larger subdivisions of the body is the least developed; and I cannot convince myself that Linnæus was so far wrong as he is thought to be by many distinguished naturalists, when he denies that the Vermes possess a head. A head, strictly speaking, can only be considered in contradistinction to the trunk. This distinction does not occur in the Linnæan worms, where the whole body is nothing else but a living abdomen, where, even when the body is articulated, no other distinctions prevail between the individual subdivisions than sometimes the ramification of the circulating system, and where, lastly, at the same time, the anterior portion is distinguished by the cirri and organs of sense (viz. the eyes) placed there, and this only because the mouth-opening is there situated. Thus, even in the Cephalopods, the anterior portion of the body not included by the mantle, presents itself not as an actual head, and so much the less because this part of the body is turned downwards, and is that on which the animal creeps; and still less can the same portion claim such a title in the Pteropods, inasmuch as in that group the eyes are not even placed there. In the Annelides, it is true, the first segment of the body is frequently distinguished by the stronger cirri which it supports, although the cirri do not so much belong to it as to the mouth; and how little distinction prevails between it and the following segments, is best observed where several eyes are present, and not on the first segment alone, but also on several of the succeeding. Lastly, what is termed a head in the Cestoids is in fact an œsophagus, as occurs often in the Annelides; and we require only to compare a nereid with an œsophagus, with a tape-worm, in order to be convinced of the identity of the part in question. This connection will be more easily attained if we take a Sipunculus or Priapulus, where the œsophagus is at the same time crowned with a circle of hooks. It appears to me, however, not altogether impossible that the Tæniæ can expand and contract this part just as well as the Nereids and Sepunculus, although it may be immoveable in the Bothriocephalus.

As the Vermes are thus, generally speaking, headless, so likewise there is awanting in them a central organ of the nervous system, a brain, such as is possessed by the Linnæan insects in the ganglion placed over the œsophagus,* and which here really gives the head its actual meaning. In the Annelides, the first ganglion (or the œsophagal ring) has not the same importance as in insects, but the principle of life appears to be more distributed over the whole chain of ganglia, whence it is apparent how animals of this division, when cut in pieces, continue to live and are developed as individuals, whenever only a part of the ganglionic chain is preserved in the portion. In insects, limbs, at most, are reproduced. The principle of life is least of all centralized in polypi and planariæ, in which separate pieces, divided at will, preserve their inherent life, and become entire animals. Probably the earliest centralization of the principle of life appears in the single portions of molluscous animals; but upon this subject we are not in possession of sufficient observations.

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* Thus, when in insects, the brain with the head is separated from the trunk, the movement does not cease, although the voluntary motion dies; at least I have never been able to convince myself that, after the loss of the head, the movements, which do not immediately cease, indicate a will inherent in the trunk.

It thus appears, from what has been said, that between the two chief divisions of invertebrate animals which with Linnæus we term *Insecta* and *Vermes*, there is a clear distinction, nay, in many instances, a marked contrast, inasmuch as insects are distinguished from worms by possessing a system of peculiar organs of motion, by the division of the mass of the body into different portions for the various vital functions, and by the centralization of the principle of life thus produced; and as they indicate, at the periods alluded to, the foundations of a higher collective organization, although one which has not attained its development in all the individual parts. Nature, it is true, is anxious to round off the sharpness of her divisions, but still the boundaries drawn by her are not the less fixed and determined. Thus we have neither intermediate forms nor a direct passage between insects and worms,* just as we have no intermediate steps between vertebrate and invertebrate animals.

The further subdivisions of the Linnæan insects is sufficiently distinct. The first class includes the insects taken in a more confined sense, with their division of the body into head, thorax, and abdomen, where the thorax alone possesses organs of motion, invariably six (or three pairs of) legs, and generally also wings, whose occurrence is only possible here, because here alone a thorax exists, which is shut off from the head as well as from the abdominal part of the body. The second class, the Arachnidæ, are distinguished from the insects in this, that the head is blended with the thorax, and hence the constant want of feelers, and the conversion of the third pair of jaws into a fourth pair of feet, thus giving rise to eight legs. In both classes the abdominal or posterior part of the body is without organs of motion, which make their appearance in the third class, the Crustacea. In the true Crustacea the mouth lies before the legs, and the pairs of feet which belong to the thorax become converted either wholly or in part into portions of the mouth; in the Entomostraca

* *Peripatus* has been often instanced as a natural uniting link between the Myriapods and Annelides, but I must say that I have never been able to find in it the slightest approach to an insect.

there is no direct passage of the legs into parts of the mouth, but the mouth lies behind the first pair of feet.*

In the Linnæan worms, an exact further subdivision is much more difficult, because the external structure offers but little for this purpose, and our knowledge of their external organization still exhibits important blanks. The *Mollusca* undoubtedly form the first class, for in them the internal structure, viz. the composition of their organs of nutrition, presents the greatest degree of perfection. A *second class* would be formed by all those worms which, with a symmetrical structure of body, exhibit a linear type of that structure, and which, like the Mollusca, have a perfect intestinal canal, with a mouth and anus, therefore the Annelides, Turbellariæ, the Nematoideæ of the Helminthoidæ, and the Rotatoriæ. Here we find, along with a similar type of the bodily form, likewise several approximations to insects, such as in the Nereidæ to the Myriapods, and in the Rotatoriæ to certain Entomostraca, which indeed cannot escape notice. A *third class* are the Radiata, with a radiated type in the structure of their bodies, for the most part with a central digestive cavity, and also a central mouth, which in the free-moving species is directed downwards, but in the adherent species is turned upwards. In the last classes the alimentary canal is vessel-like, and is simply branched in two in the Helminthoidæ (with exception of the Nematoideæ), branched in a tree-like manner in the Planariæ, and leads to a multitude of simple stomachs in the polygastric Infusoria.

It is much to be desired that we should possess as complete

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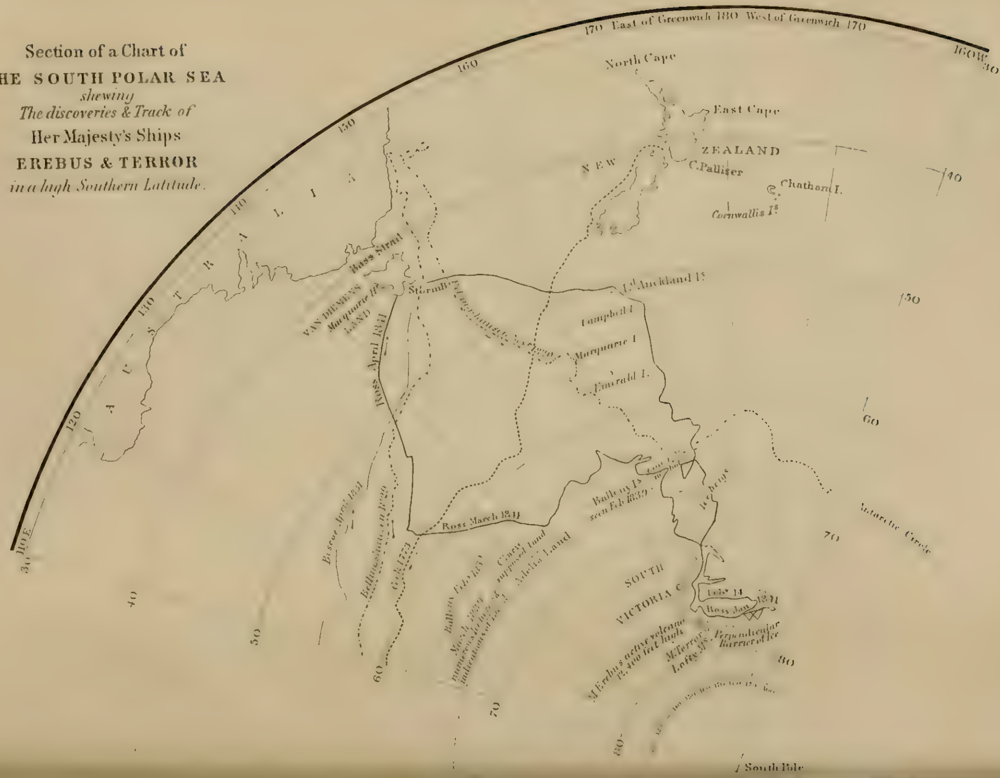
* Perhaps the most complete system is an apparently artificial one, inasmuch as it draws the characters from one single part. In all the Linnæan insects, the portions of the mouth present a sufficient variety to allow of the greater subdivisions being determined by that organ alone. All have originally three pairs of jaw-bones. In insects, strictly so called, there is no passage from these to legs, but still apparently there are only two pairs present, for the third is united to the under lip. In the Arachnidæ, likewise, there are only two pairs apparently present, for the third is converted into the first pair of feet. In the Crustacea, on the other hand, there are apparently a larger number of pairs of jaws, inasmuch as the first (seldom the two first) or the three first pairs of feet, assume the form of jaws. In the Entomostraca there are three simple pairs of jaws, which lie in the opening of the mouth behind the first pair of feet.

Section of a Chart of
THE SOUTH POLAR SEA
shewing
The discoveries & Track of
Her Majesty's Ships
EREBUS & TERROR
in a high Southern Latitude.



and comprehensive a work on the organization and natural history of the Planariæ, as Ehrenberg has given us on the Infusoria. (From the *Archiv für Naturgeschichte*, 1841.)

Notice of the Magnetometric, Geographical, Hydrographical, and Geological Observations and Discoveries made by the Expedition under the command of Captain James Ross, R.N., F.R.S. being copy of Extracts from a Despatch addressed to the Secretary of the Admiralty.—With a Chart on Plate IV.

I have the honour to acquaint you with the arrival of Her Majesty's ship under my command, and the Terror, under my orders, this afternoon at this port.

I have further to report to you, for the information of my Lords Commissioners of the Admiralty, that, in accordance with the intentions expressed in my despatch to you, dated from Hobart Town on the 11th of November last, I proceeded to Auckland Islands, and satisfactorily accomplished a complete series of magnetometric observations on the important term-day of November last.

Under all the circumstances, it appeared to me, that it would conduce more to the advancement of that branch of science for which the expedition has been more expressly sent forth, as well as for the extension of our geographical knowledge of the Antarctic Regions, to endeavour to penetrate to the southward, or about the 170th degree of east longitude, by which the isodynamic oval, and the point exactly between the two foci of greater magnetic intensity, might be passed over and determined, and directly between the tracks of the Russian navigator Bellinghausen, and our own Captain James Cook; and after entering the Antarctic Circle, to steer S.W. towards the Pole, rather than attempt to approach it directly from the north, on the unsuccessful footsteps of my predecessors.

Accordingly, on leaving Auckland Islands on the 12th December, we proceeded to the southward, touching for a few days at Campbell Island for magnetic purposes; and, after passing among many icebergs to the southward of 63° latitude, we made the Pack Edge, and entered the Antarctic Circle on the 1st day of January 1841.

This pack presented none of those formidable characters which I had been led to expect from the accounts of the Americans and French; but the circumstances were sufficiently unfavourable to deter me from entering it at this time, and a gale from the northward interrupted our operations for three or four days. On the 5th January we again made the pack about 100 miles to the eastward, in latitude 66° 45′ south, and longitude 174° 16′ E.; and although the wind was blowing directly on it, with a high sea running, we succeeded in entering it without either of the ships sustaining any injury, and, after penetrating a few miles, we were enabled to make our way to the southward with comparative ease and safety.

On the following three or four days our progress was rendered more difficult and tedious by thick fogs, light winds, a heavy swell, and almost constant snow showers; but a strong water-sky to the S.E. which was seen at every interval of clear weather, encouraged us to persevere in that direction; and on the morning of the 9th, after sailing more than 200 miles through this pack, we gained a perfectly clear sea, and bore away S.W. towards the Magnetic Pole.

On the morning of the 11th January, when in latitude 70° 41′ South, and longitude 172° 36′, land was discovered at the distance, as it afterwards proved, of nearly 100 miles, directly in the course we were steering, and therefore directly between us and the Pole.

Although this circumstance was viewed at the time with considerable regret, as being likely to defeat one of the more important objects of the expedition, yet it restored to England the honour of the discovery of the southernmost known land which had been nobly won, and for more than twenty years possessed, by Russia.

Continuing our course towards this land for many hours, we seemed scarcely to approach it. It rose in lofty mountain peaks of from 9000 to 12,000 feet in height, perfectly covered with eternal snow; the glaciers that descended from near the mountain summits, projected many miles into the ocean, and presented a perpendicular face of lofty cliffs. As we neared the land, some exposed patches of rock appeared; and steering towards a small bay, for the purpose of effecting a landing, we found the shore so thickly lined for some miles with bergs and pack-ice, and with a heavy swell dashing against it, we were obliged to abandon our purpose and steer towards a more promising looking point to the S.E., off which we observed several small islands; and on the morning of the 12th I landed, accompanied by Commander Crozier and a number of the officers of each ship, and took possession of the country in the name of Her most gracious Majesty Queen Victoria.

The island on which we landed is composed wholly of igneous rocks, numerous specimens of which, with other imbedded minerals, were procured. It is in latitude 71° 56′ S. and longitude 171° 7′ E.

Observing that the east coast of the mainland trended to the southward, whilst the north shore took a N.W. direction, I was led to hope that, by penetrating to the south as far as practicable, it might be possible to pass beyond the Magnetic Pole, which our combined observations placed in 76° S. nearly, and thence, by steering westward, complete its circumnavigation. We accordingly pursued our course along this magnificent land, and on the 23d January we reached 74° 15′ S., the highest southern latitude that had ever been attained by any preceding navigators, and that by our own countryman, Captain James Weddell.

Although greatly impeded by strong southerly gales, thick fogs, and constant snow-storms, we continued the examination of the coast to the southward, and on the 27th we again landed on an island in latitude 76° 8′ S., 168° 12′ E., composed, as on the former occasion, entirely of igneous rocks.

Still steering to the southward, early the next morning, the 28th, a mountain of 12,400 feet above the level of the sea was seen, emitting flame and smoke in splendid profusion. This magnificent volcano received the name of Mount Erebus. It is in latitude 77° 32′ S. and longitude 167° E. An extinct crater to the eastward of Mount Erebus, of a somewhat less elevation, was called Mount Terror. The mainland preserved its southerly trending, and we continued to follow it, until, in the afternoon, when close in with the land, our farther progress in that direction was prevented by a barrier of ice stretching away from a projecting cape of the coast directly to the E.S.E.

This extraordinary barrier presented a perpendicular face of at least 150 feet, rising, of course, far above the mast-heads of our ships, and completely concealing from our view everything beyond it, except only the tops of a range of very lofty mountains in a S.S.E. direction, and in latitude 79° S.

Pursuing the examination of this splendid barrier to the eastward, we reached the latitude of 78° 4′ S., the highest we were at any time able to attain, on the 2d February, and on the 9th, having traced its continuity to the longitude of 191° 23′, in latitude 78° S., a distance of more than 300 miles, our farther progress was prevented by a heavy pack, pressed closely against the barrier; and the narrow lane of water by means of which we had penetrated thus far, became so completely covered by rapidly forming ice, that nothing but the strong breeze with which we were favoured enabled us to retrace our steps.

When at a distance of less than half a mile from its lofty icy cliffs, we had soundings with 318 fathoms, on a bed of soft blue mud.

With a temperature of 20° below the freezing point, we found the ice to form so rapidly on the surface, that any farther examination of the barrier in so extremely severe a period of the season being impracticable, we stood away to the westward, for the purpose of making another attempt to approach the Magnetic Pole, and again reached its latitude (76° S.) on the 15th of February; and although we found that much of the heavy ice had drifted away since our former attempt, and its place in a great measure supplied by recently formed ice, yet we made some way through it, and got a few miles nearer the Pole than we had before been able to accomplish, when the heavy pack again frustrated all our efforts, completely filling the space of 15 or 16 miles between us and the shore. We were this time in latitude 76° 12′ S. and longitude 164°, the dip being 88.40, and variation 109.24 E. We were, of course, only 160 miles from the Pole.

Had it been possible to approach any part of this coast, and have found any place of security for the ships, we might have travelled this short distance over the land; but this proved to be utterly impracticable; and although our hopes of complete attainment have not been realized, it is some satisfaction to feel assured that we have approached the Pole more nearly, by some hundred miles, than any of our predecessors; and from the multitude of observations that have been made in both ships, and in so many different directions from it, its position can be determined with nearly as much accuracy as if we had actually reached the spot itself.

It had ever been an object of anxious desire with us to find a harbour for the ships, so as to enable us to make simultaneous observations with the numerous observatories that would be at work on the important term-day of the 28th of February, as well as for other scientific purposes; but every part of the coast where indentations appeared, and where harbours on other shores usually occur, we found so perfectly filled with perennial ice, of many hundred feet in thickness, that all our endeavours to find a place of shelter for our vessels were quite unavailing.

Having now completed all that it appeared to me possible to accomplish in so high a latitude, and at so advanced a period of the season, and desirous to obtain as much information as possible of the extent and form of the coast we had discovered, as also to guide in some measure our future operations, I bore away, on the 18th February, for the north part of this land, and which, by favour of a strong southerly gale, we reached on the morning of the 21st.

We again endeavoured to effect a landing on this part of the coast, and were again defeated in our attempt by the heavy pack, which extended for many miles from the shore, and rendered it impossible.

For several days we continued to examine the coast to the westward, tracing the pack-edge along, until, on the 25th February, we found the land abruptly to terminate in latitude 70° 40′ S. and longitude 165° E., trending considerably to the southward of west, and presenting to our view an immense space occupied by a dense pack, now so firmly cemented together by the newly-formed ice, and so covered by recent snow, as to present the appearance of one unbroken mass, and defying every attempt to penetrate it.

The great southern land we have discovered, whose continuity we have traced from nearly the 70th to the 79th degree of latitude, I am desirous to distinguish by the name of her most gracious Majesty Queen Victoria.

Following the edge of the pack to the NW. as weather permitted, we found it to occupy the whole space between the NW. shore of the great southern land and the chain of islands lying near the Antarctic Circle, first discovered by Balleny in 1839, and more extensively explored by the American and French expeditions in the following year.

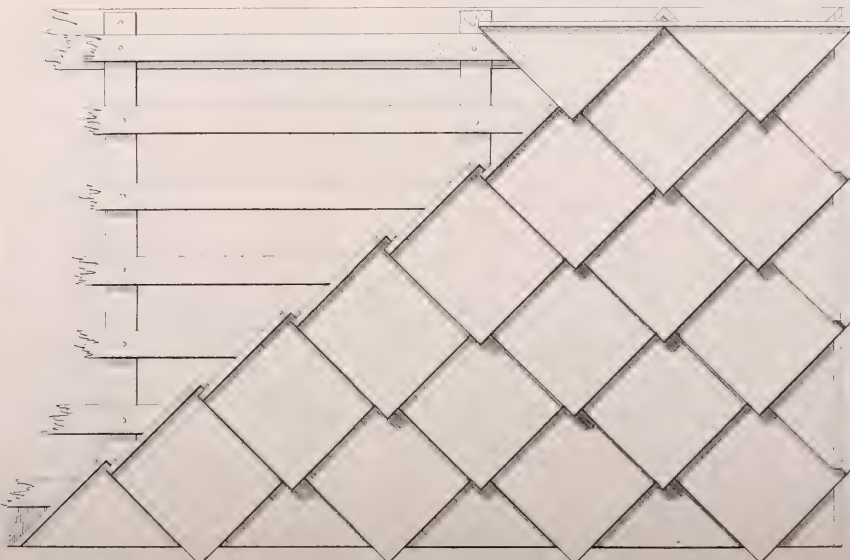
Continuing our course to the westward, we approached the place were Professor Gauss supposed the Magnetic Pole to be, and having obtained all the observations that were necessary to prove the inaccuracy of that supposition, we devoted some days to the investigation of the line of no variation; and having completed a series of observations, by which the isodynamic lines and point of greater magnetic intensity may be determined, and which I had left incomplete last year, I bore away on the 4th of April for this port.

A chart, shewing more plainly the discoveries and track of the expedition, is herewith transmitted; and a more detailed plan, containing all magnetic determinations, shall be sent as soon as they are reduced.

I have much satisfaction in being able to add, that the service has been accomplished without the occurrence of any casualty, calamity, or disease of any kind, and there is not a single individual in either of the ships on the sick-list.

It affords me the highest gratification to acquaint you, that I have received the most cordial and efficient co-operation from my well-tried friend and colleague Commander Crozier of the Terror, and no terms of admiration that I can employ can do justice to his great merit; nor have the zeal and persevering devotion of the officers of both ships been less conspicuous, under circumstances of no ordinary trial and difficulty; and whilst the conduct of our crews has been such as to reflect the highest honour on their characters as British sailors, it has given to myself, Commander Crozier, and the officers of

New French Roofing Tile, communicated by Sir John Robison K.H. Presidt. R.S.S. Arts



Portion of a roof laid with French tiles Scale 1½ inch to a foot.

1841

1. View of the Jungfrau taken from the Glacier of the Aletsch.
2. Summit of the Jungfrau seen in profile.
3. Ground plan of the summit of the Jungfrau.

the expedition, the most confident assurance of more extended success in pursuing the important duties we have yet to fulfil.

H. M. S. Erebus, Van Diemen's Land, *April* 7. 1841.

Ascent of the Jungfrau, accomplished on the 28th August 1841, *by Messrs Agassiz, Forbes, Du Chatelier, and Desor; preceded by an account of their passage across the Mer de Glace from Grimsel to Viesch in the Valais.* By E. Desor. With a Plate.

We resided for three weeks on the lower glacier of the Aar, continuing the meteorological and geological observations which were the principal object of our stay, and making excursions from time to time among the neighbouring mountains. We had visited in succession many of the numerous summits which surround the Hotel des Neuchâtelois. Messrs Agassiz, Forbes, and Heath, had crossed the Col de Gauli, and penetrated by the névé* and glacier of the same name into the valley of Urbach; while, for my part, I had traversed the glacier of Gries and the adjacent mountain masses. Messrs Forbes and Heath, who had been associated with us in our labours from the commencement of the expedition, were about to take leave of us, in order to descend into the Valais and visit the glaciers of Mont Rosa. We accompanied them as far as the hospice of Grimsel, that we might sup there together for the last time; and it was here that these gentlemen conceived the idea of descending into the Valais by the Mer de Glace, crossing the Col de l'Oberaarhorn. They proposed to us to accompany them. This passage is considered one of the most difficult in the Oberland; it was accomplished for the first time by Mr Weiss in the beginning of the present century; by the brothers Meyer of Arau in 1812; more recently by M. Hugi, in 1832; and by several Balôis in 1840. It was the only one of all the cols pertaining to the mass of the Finsteraarhorn which we had not traversed.† Such a proposal had necessa-

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* The meaning of this word, for which we have no corresponding term in English, will be better understood by consulting the note on the ice of high summits appended to this narrative.—Ed.

† On the preceding year, we passed the Strahleck on our way to Grindel-

rily great attractions for us. We could not fail to observe interesting phenomena; moreover, it was of importance that we should become acquainted with the character of certain gneiss rocks, of rather a peculiar structure, the debris of which are transported by the upper glacier of the Aar. At the same time, the Jungfrau presented itself to our minds. We recollected that, when upon the glacier of the Aar the preceding winter, we had formed the design of attempting the ascent, and that our guide Jacob, to whom we mentioned the subject, promised to conduct us. No more was necessary to bring Agassiz to a decision. "I have made my mind; to-morrow we cross the Mer de Glace of Viesch, and the day after ascend the Jungfrau!" With regard to myself I was not altogether of the same opinion; for a journey of from twelve to fifteen hours, which it must necessarily take to cross the Col de l'Oberaar, did not appear to me to be the most fit preparation for the ascent of the Jungfrau. At last, however, we came to the agreement, that this ascent should, in the mean time, remain a matter of secondary importance to the crossing of the Glacier of Viesch, and that we should attempt it only in case of finding ourselves free from fatigue at the end of our journey. Messrs Forbes and Heath refused to come to any decision with respect to the Jungfrau; but M. Agassiz did not fail, notwithstanding, to enjoin Jacob to take provisions for them likewise.

Passage of the Col de l'Oberaar.

This route had been determined upon during supper, and the same evening we made the necessary preparations for our departure. Jacob Leuthold, the same individual who had conducted us the preceding year to Grindelwald by the Strahleck, was again appointed captain of the expedition; and M. Agassiz likewise intrusted to him the selection of the other guides and porters who were to accompany us. M. Zippach furnished provisions, consisting of wine, cheese, meat, and a quantity of bread, which we found to be excessive. Each of us prepared his package, taking care to exclude every thing not absolutely necessary. A frock-coat, trowsers, and vest, for a change in case of need, were all we intended to carry. The

wald; and M. Agassiz had descended, some days before, into the valley of Hasli by the Col de Gauli.

weather was remarkably fine at bed-time, and we reckoned on it being the same on the following day. But, contrary to what usually happens, the weather on this occasion was not favourable to us; the wind had changed during the night, and although, at three o'clock, the mountains were still clear, Jacob declined to set out. At six o'clock, threatening clouds rose from all parts of the horizon; and at eight, we were enveloped in one of those interminable rains with which the traveller is so often and profusely favoured at the Grimsel. This was on the 24th August. On the 26th the weather began to improve, and our guides gave us reason to hope that this would continue. Among the travellers who had arrived at the Grimsel, and who had heard of our intentions, two in particular expressed a desire to accompany us. These were M. du Châtelier of Nantes, and M. de Pury of Neuchâtel, a student in theology, and formerly one of M. Agassiz' pupils. We willingly consented, on condition that these two gentlemen should accompany us that same day to our hotel, where M. Agassiz had orders to give relative to our outfit; and as we were in the habit of accomplishing this in very short time, it would enable us to form an opinion as to the fitness of our candidates. Both of them underwent the proof with credit, and our guides were the first to admit that they were in a condition to follow us. On our return to the hotel, we again commenced our preparations for setting out, and this time were successful. The next day, 27th August, at four o'clock in the morning, we left Grimsel, directing our course towards the glacier of the Oberaar, or upper glacier, which is separated from the lower by the masses of Zinkenstock. We were twelve in number; namely, M. Agassiz, Mr Forbes, professor of natural philosophy at Edinburgh, Mr Heath, professor of mathematics at Cambridge, M. du Châtelier of Nantes, M. de Pury, student of Neuchâtel, and myself; accompanied by six guides—Jacob Leuthold, Johannes Wæhren, Johannes Aplanalp, Michel Bannholzer, Johannes Jaun of Meyringen, and Johannes Jaun of Imgrund, all in the service of Mr Zippach. Before commencing our journey, I think I should mention a trait of one of our guides, which will serve to make the character of these mountaineers better known, and at the same time explain the unlimited confidence we placed in them.

Johannes Wæhren, the inseparable friend of Jacob, and one of the most intelligent among all the guides of the Hospice, had been in our service upwards of a month. He was, in some measure, Jacob's lieutenant; and when the latter was not at the hut, it was he who took charge of the cooking department. He had long pleased himself with the prospect of conducting us to the Jungfrau, for he and Jacob were the only individuals who were in the secret of this expedition. But it happened, the day before our departure, while descending with us to the Hospice, that he was seized with a violent inflammation in the knee, which M. Vogt, in his medical capacity, considered very serious. In spite of the pain he was suffering, the poor fellow still hoped that it would turn out nothing; and it gave us the greatest pain to make him understand that he must no longer think of the Jungfrau. It has been seen that the bad weather compelled us to delay our departure for two days; during this time Wæhren's knee became much better, so much so, that on the evening before we set out, he came limping to us to assure us that he could go, having no doubt that he would be quite well on the morrow. M. Agassiz, as may be well supposed, refused his consent, pointing out to him all the dangers to which he would be exposed. The unfortunate Wæhren could object nothing to these reasons; but the greatest sorrow was depicted on his countenance, and he retired to a corner of the apartment, where he continued sobbing while his comrades were making preparations for departing. Next day, having occasion to enter the servants' apartment, I was much surprised to observe our man at breakfast with the other guides. As I expressed my surprise, he asked me if he was not, then, to be permitted to bid us adieu. I thanked him for his attention, and again recommended him to be careful of his knee; Agassiz did the same, and we set out. We had not proceeded for a quarter of an hour, when on suddenly turning round a rock, we saw him mingled with the other guides. Immediately every one called out to him, asking if he had really lost his senses. We still wished to persuade him to abandon an undertaking which we believed would be fatal to him; but all the reply we could obtain was, that he had reflected on the dangers he ran, and that he would rather die than not be of the party. No longer insisting, we contented ourselves by recommending him to be prudent, and could not help indulging in some serious reflections on what must have passed in the mind of this man, usually so calm and submissive, before he could come to such a resolution as he had just announced.

We were on the summit of the small mountain which rises on the margin of the river, when the first rays of the sun struck the crest of the high mountains, while their base was still shrouded in that crepuscular whiteness which follows the setting, and precedes the rising, of the sun. Among the other peaks, there was one in the distant horizon which shone with surpassing lustre,—it appeared wholly on fire: this was the Jungfrau! Our whole company appeared, as it were, electrified at this spectacle. Each of us felt his courage increase, and from that moment I no longer doubted that we would reach it.

In two hours we attained the extremity of the Oberaar glacier. We were surprised to perceive that the glacier, which was stationary the year before, was this year yielding to the progressive movement which has taken place, for some years back, in all the glaciers of the Bernese Oberland. It has pushed its moraines considerably forward, particularly the terminal one, and that on its left flank; the latter, by encroaching on the sides of the valley, has completely removed the turf, which is cut up and turned over as if it had been furrowed by a ploughshare. The back of these newly moved moraines has a great inclination, a medium of 50° and upwards. Before proceeding farther we went to visit the hut of the Oberaar shepherd, which is at a short distance from this place. It is impossible to imagine a more wretched dwelling: it is a mere kennel, composed of four walls and a stone roof, through which the wind blows without mercy. The shepherd himself is, this year, a poor little boy of twelve years. He was ill-clothed, had a sickly appearance, weak limbs, and a stupid expression. Provisions for three months had been sent to him from Valais, and they consisted of a certain ration of black bread, as hard as the stones of his hut, and a little dried up cheese. Some days before, the artist of the expedition, Mr Bourckhardt, passing near his hut, gave him the remains of his dinner, and he declares that never did shark devour its prey with greater avidity.

The ascent of the glacier of the Oberaar afforded us an opportunity of making some interesting observations on the relations of the level between the line of polished rocks and the surface of the glacier. At the extremity of the glacier, this line is about 500 feet above its surface ; but in proportion as we ascend, this difference diminishes, and we at last arrive at a point where the two lines meet under an acute angle, the polished rocks becoming lost under the névé. This point here, at nearly a league from the Col, is at a height of upwards of 9000 feet.* The moraines disappear earlier ; thus the névé is completely deprived of them, and none are observed but some bands along the little collections of ice which slide into the great basin. At ten o'clock we arrived at the summit of the Col, after crossing with great difficulty numerous fissures, covered only with a frail roof of snow. Fortunately, the sun had not yet had time to soften the surface, so that we could pass directly over many of these snow-bridges, which we would necessarily have been obliged to make a circuit to avoid some hours later. The thermometer indicated + 2° C. (35° 6 F.) The summit of the Col is 10,023 feet above the sea, according to Hugi's observations. It is about 100 feet broad, and is enclosed between two large peaks, the highest of which, on the north, is the Oberaarhorn. It is a mass of very schistose gneiss, passing, in some places, into an earthy slate, very soft, and strongly resembling the rock vulgarly known by the name of *pierre morte.*

We spent a quarter of an hour in contemplating the view enjoyed from this elevated point, gazing on this multitude of gigantic peaks rising around us on all sides, some of them like huge gothic spires, others resembling immense cupolas covered with snow. The Galenstock, which feeds the glacier of the Rhone, presented, in particular, a very beautiful appearance. The beautiful ridge of the Oberaarhorn, the summit of which is alone visible from the Hotel des Neuchâtelois, rose vertically

* I shall further consider the importance of this level of the *roches moutonnées* in a separate article.

at our side; and in the distance it gave us pleasure to recognise, among the peaks which we commanded, the Pic du Siedelhorn, the extreme point of view to which the ambition of the tourists who visit the Grimsel ventures to aspire.

From the Col de l'Oberaar we descended to the plateau of snow which feeds the glacier of Viesch. It is a vast circus of more than half a league in diameter, bounded on the north by the immense masses of Finsteraarhorn, and encircled by ten large peaks, which all bear among the Valaisans the name of Viescherhörner, and the least elevated of which are upwards of 11,000 feet high.* It was in the centre of this beautiful circus that we halted for dinner, a dinner as frugal as it well could be, but which we nevertheless found delicious, thanks to the appetite we brought to it. Our first intention was to cross the masses which separate the névé of Viesch from that of Aletsch; but thick mists which rose on our right, and our instruments, which seemed to agree with them in presaging rain, (Saussure's hygrometer instantly descended to 76°, and the thermometer rose to + $5\frac{1}{2}$ C., about 42° F.), made us resolve to descend to the chalets of Mœril, even though by so doing some leagues would be added to our journey next day. Some of us would have preferred to economize time, and sleep in some subterranean cavity of the glacier of Aletsch; but the guides were opposed to this, alleging that it was better to rest comfortably, and regain the lost time by starting on the morrow before daybreak. The majority assented to Jacob's opinion, and M. Agassiz and I were of that number, for we had still a very lively recollection of the dismal night we spent last year, in the midst of mists, on the summit of the Siedelhorn.

* A strange confusion prevails among the mountaineers in regard to the names they give to the different peaks. Thus the Schreckhorn is called the Lauteraarhorn in the valley of Hasli: the Finsteraarhorn itself has not escaped this unfortunate synonomy, being called Schwartzhorn among the Haut-Valaisans. But it is in reference to the Viescherhörner that this confusion reaches its height. Not only the summits here spoken of are all *Viescherhörner*, but the Valaisans likewise designate by this name all the peaks of the ridge which extends from the Faulhorn to the Faulberg, between the glaciers of Aletsch and Viesch (See the map of the brothers Meyer). Lastly, there are also the Viescherhörner of the Grindelwald, likewise called Walcherhörner, which separate the glacier of Grindelwald from the narrow band of the névé of Viesch.

We therefore descended the fields of snow which stretch southwards, towards the Valais. The snow was perfectly homogeneous, without any trace of rolled rocks or foreign bodies on its surface. The crevices had almost entirely disappeared, or if any were still to be seen, they were on the sides of the valley, never extending so far as the place where we were. We were thus walking on with perfect security, when we remarked, at some distance from us, many small openings. Curious to know the cause, we turned aside to examine them, but what was our surprise, when, on looking into one of these sky-lights, which was not more than three inches broad, by a foot long, we saw that it concealed an immense precipice! And in this precipice an azure light prevailed, which surpassed in beauty, transparency, and softness, all that we had hitherto seen among glaciers. What a pity that I have not the power of reproducing, in language worthy of the subject, all the poetry that was embodied in this simple combination of light and snow! Never had I seen a more attractive spectacle; our eyes were so fascinated by it that we did not at first perceive that the crust of snow which covered this enchanted cavern did not exceed, in this place, a few inches; I do not, however, think that we ran very great danger, for the snow was very compact, and the sun had not softened it that day. After contemplating the attractive effect of this unique phenomenon, we were desirous likewise to become acquainted with its nature and cause. It was an immense fissure of more than 100 feet in width, and of a depth varying from 100 to 300 feet. At the place from which we examined it, it had no other opening but the small loophole of which I have spoken; but farther on it corresponded to a large crevice, open near the right bank, by which the light entered, and the intermediate roof, by tempering the reflection of the snow walls, gave them an indescribable mildness and beauty. The sides of these caverns, like immense walls of crystal, were composed of horizontal and parallel layers two or three feet in thickness, of a snow much hardened by pressure, but still crystalline, for it had not yet assumed the granular form of the névé met with further down. Between these layers of snow there was usually a narrow belt of ice, but the ice was vesicular and not compact, although of a deeper tint than the rest of the walls. Our guides all agreed in affirming that each of these layers represented the snow fallen in one year, and this explanation appeared to us, in reality, the most natural. With regard to the narrow bands of ice which separated the beds of snow, they are undoubtedly owing to the action of the sun, which took effect successively during a summer on the surface of all the annual beds.

On continuing our route, we still met with many fissures similar to that just described, and soon became certain that the surface on which we walked was wholly undermined, for, on looking into an open crevice, we usually saw it prolonged into the interior of the mass, far beyond its superficial limits; others were open at the surface throughout their whole length.

In order to account for the formation of these fissures, it is not necessary to have recourse to an inequality of tension similar to that which is supposed to act in the mass of glaciers, properly so called, or the névé, when crevices are formed in them. Such a tension would be even inadmissible, as the mass does not possess sufficient adherence. According to all appearance, things proceed, in this instance, in a much simpler manner. The crevices are nothing more than an effect of the declivity of the ground; what proves this is, that they have neither the continuity nor the regularity of glacier-fissures, and that they are everywhere found on great declivities, where they in general attain a very considerable size (from 30 to 100 feet, a breadth which is seldom witnessed in glaciers, properly so called). It is to be observed, besides, that when these rents are concealed, it is not, as in the névé or glacier, by a roof of fresh snow. I examined attentively the edge of one of these crevices, and I saw that the beds of snow in it were perfectly homogeneous from above downwards, and corresponded up nearly to the surface; whence I concluded, that when a fissure is concealed, it is commonly because the separation has not extended to the surface.

The fact that the crevices and cavities of these plains of snow exhibit an azure hue, is not unimportant; it is a new proof that this tint is peculiar to the water of our mountains in whatsoever form it is found. Whether liquid, in the state of snow, névé, or compact ice—there is no difference, except in the intensity of the tint, which increases in proportion as the congealed mass becomes more compact. M. Agassiz, in his work on Glaciers, has already shewn that this blue tint of the fissures cannot be produced by the reflection of the sky, since it is equally observable in cloudy weather.

After proceeding for nearly an hour along the fields of snow, we entered upon the névé. As walking on the latter is much easier than on the snow, it is usually the part of the glacier preferred to every other. That of Viesch was remarkable, this year, for the quantity of red snow which it contained, and which, at a distance, imparted to it a rose-coloured reflection. We brought a few handfuls of it with us, in which M. Vogt, who had the charge of the microscopical observations, discovered a new infusorial form, not found, it would appear, on the glacier of the Aar. As the minute organisms which compose red snow are usually accumulated in greatest numbers some lines below the surface, it happened that we rendered them more apparent by trampling upon them ; and each step we took left, as it were, a bloody mark, which the eye could follow to a great distance. The névé, which at first had a southern direction, soon turned to the south-west ; and everywhere, on the steep inclinations, the mass was so rent and altered, that it was very difficult for us to recognise the primitive direction of its beds. This displacement is here also produced by the declivity ; for the adherence of the névé is not sufficient to counterbalance the force of gravitation in the masses.

The névé which we had just passed, although very extensive, does not form the most considerable arm of the glacier of Viesch. On going round the Rothhorn, which here forms the extremity of the ridge of the Viescherhörner, we came to the great conflux which descends between the Grünhorn and the ridges which the brothers Meyer have inserted in their map under the name of Walcherhörner or Viescherhörner of Grindelwald (*Grindelwalder Viescherhörner*). This conflux has no particular name ; it is called the Névé de Viesch (*Viescherfirn*), like the one we had descended. We had to cross it in order to regain the right bank ; and as it is very full of crevices at the point of contact, we took nearly an hour to accomplish it, although its breadth is not greater than a quarter of a league. A little below this confluence, the glacier of Viesch begins to assume that irregular appearance which gives it the character of being one of the most varied in the Valais. Not far from this place, the first needles of ice appeared, and they seem here to be intimately connected with the median moraine; for even where the whole surface of the glacier is cut into small pieces, the needles along this moraine are remarkable for their bolder and more prominent shapes.

It was here, on the right side of the glacier, at a distance of about three hours from the village of Viesch, that we encountered the most difficult passage. We had to decend a wall of rock, nearly vertical and very high, at the foot of which fell a beautiful cascade. The path was a kind of opening, which presented here and there some slight projections on which the foot rested. When these points of support were insufficient, the passenger was obliged to cling, in the best way he could, against the walls of the opening, assisting himself with his pole, which is always ready to lean upon ; or he was forced to call for the help of one of the guides—a step, however, which his self-love made him unwilling to adopt. When we were again on the glacier, and looked at the descent we had accomplished, it seemed impossible that this could be the road the shepherds usually take. But Jacob assured us that there was no other. We were still at a greater loss to understand how they got their sheep across ; Jacob knew nothing of the matter himself, but still maintained that they ascended by this passage. We were afterwards informed at Viesch that this is really the only way to the upper pastures, and that they hoist up the sheep by means of ropes tied to the horns, or, when the latter are wanting, round the neck. The shepherds themselves do not often pass this way. When the sheep are once over it, they are left to themselves till the autumn, and are only visited by a shepherd from time to time, for the purpose of conveying salt to them.

We had many opportunities, along the glacier of Viesch, of determining the manner in which the glacier polishes its banks. The predominating rock is gneiss, sometimes in fine grains, sometimes in large crystals, which does not prevent it being, in a multitude of places, as smooth as polished marble. We likewise remark in it, in a very distinct manner, the parallel striæ which constitute one of the distinctive characters of the polished surfaces produced by glaciers. These effects of the ice we contemplated with the greater interest, because it was on this same glacier that our friend Escher became convinced of the reality of the glacier's action on the rock, a sufficient proof that the evidences of such action must have been strongly marked.

It was four o'clock in the afternoon when we made our last halt; this was still on the right side of the glacier of Viesch, at a place from which we could descry, for the first time, the bottom of the Valais. Here we observed many ancient moraines, which extended to a great distance on the left side of the glacier, to a height of many hundred feet above its actual level. A quantity of erratic blocks were, besides, scattered about, at levels still much higher, and seemed to rise to the very summit of the mountain. Among the blocks of gneiss composing the moraine, we remarked one of enormous size, which was beautifully polished on one of its sides; we concluded from this that it was a fragment detached from the walls of the valley, which are here polished to a very great height. On examining the bottom of the glacier, we saw some pebbles of considerable size, enclosed in the ice on its lower face. At first sight we were somewhat struck with this, as a fact opposed to the general rule, that a glacier never retains foreign bodies within its substance. But we remarked, at the same time, that the bed containing them was of a duller tint than the rest of the glacier, and we were at last convinced that it was a layer of snow transformed into ice, and which had not yet had time, in consequence of its want of compactness, to reject the pebbles which were originally mingled with the snow.

We had still two leagues to travel. No one was much fatigued, although we had been on foot for twelve hours; but an exclamation of surprise escaped us, when, on turning the angle of a mountain, Jacob pointed out the path which we must follow. It was a very steep ascent, about 1000 feet high, along which ran a narrow and apparently a very incommodious footpath. The disappointed air of some of us, and the resigned expression of others, would have made a subject for a good picture, if there had been an artist among us not too fatigued to undertake it. At last we arrived, about six o'clock in the evening, at the cottages of Mœril, where we were to pass the night. We were very cordially received by the shepherds, who promised to supply us with the best they could afford.

Ascent of the Jungfrau.

Of all the mountains of the Bernese Alps, the Jungfrau is the one that enjoys the greatest popularity. Strangers arriving at Berne are desirous, before every thing else, to see the Jungfrau, and, in the country, children learn to know it first. This indisputable preference, and perhaps also its poetical name, have always made the public feel a particular interest in the attempts that have been made to ascend it; very animated discussions have likewise taken place whenever the subject has been brought forward. Before we thought of ascending it ourselves, we had paid but little attention to these controversies. We merely knew that the ascent of the brothers Meyer, of Arau, was very generally disputed among the mountaineers, who regarded none as authentic except that of the Grindelwald guides; but when once we had succeeded in our enterprise, indifference would have been out of place; and that we might not run the risk of giving a rash judgment, which would not fail to be ascribed to a mean jealousy if it had been void of foundation, we availed ourselves of every opportunity of collecting information respecting the history of expeditions to the Jungfrau, both by questioning the mountaineers, and perusing what had been published on the subject.

Perhaps I may be permitted to state briefly in this place the result of our investigations on this point.

MM. Rudolph and Jerome Meyer, of Arau, conceived, in 1811, the idea of ascending the Jungfrau and others of the most elevated summits of the Alps. Leaving Natters, in the Valais, in the course of the month of August 1811, they traversed the glacier of Aletsch and others in its vicinity in all directions. The narrative they have published of these expeditions* states, that after a first unsuccessful attempt, they succeeded in reaching the summit of the Jungfrau on the 3d of August.

But it appears that the announcement of this ascent was received with much suspicion by the mountaineers, since, in the preface to his second journey,† M. Rudolph Meyer himself admits that this was one of the reasons which determined them to attempt a second ascent the following year. On the first occasion they ascended by the western side, consequently in the same direction we followed; the second time (8th August 1812) they appear to have succeeded in reaching the summit by ascending the east side. Unfortunately the work of the brothers Meyer is not drawn up in such a manner as to inspire confidence in those who are prejudiced against them. The account of their journeys has one capital defect, an entire want of precision; and a reader must be well predisposed to do so before he can recognise the road to the Jungfrau in their itineraries. But, on the other hand, it is unquestionable that the physiognomy of glaciers may undergo a considerable change one year after another; such a route as was perfectly practicable thirty years ago, may now no longer exist, and if, at present, it be almost impossible to climb to the summit of the Jungfrau on the eastern side, it may easily have been otherwise in the time of M. Meyer. In such a case, it is best to avoid giving a decided judgment; but if my opinion can be of any weight, I should say that I am more disposed to believe in this double ascent than to doubt it. The principal merit of the brothers Meyer consists in the map they have published of their journey.

M. Hugi tried, by various efforts, to ascend the Jungfrau

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* *Reise auf den Jungfrau-Gletscher und Esteigung seines Gipfels, von Joh. Rudolf Meyer und Hieronymus Meyer aus Aarau, im August-monat* 1811 *unternommen.*

† *Reise auf die Eisgebirge des Cantons Bern und Ersteigung ihrer höchsten Gipfel im Sommer* 1812. This journey, as well as the preceding, appeared, in the first instance, in the *Miszellen für die neueste Weltkunde,* drawn up by M. Zschokke.

by the Rottthal; but he did not even reach the col which separates that valley from the glacier of Aletsch. This naturalist relates that, in 1828, some Englishmen made the same attempt, and that they had nearly fallen victims to their rashness. After having reached the Col du Rottthal with great difficulty, they were obliged to descend again by the same path. M. Hugi again returned to the charge in 1832. He ascended this time by the lower glacier of the Grindelwald, behind the Eiger, and would, no doubt, have succeeded in gaining the summit of the Jungfrau, if bad weather had not overtaken him when on the platforms of snow.

M. Rohrdorf, attached to the museum of Berne, took the same route in 1828, but was not more successful than M. Hugi. However, this latter attempt was not altogether a failure, for some days later (8th September) the guides who had accompanied him, with J. Baumann at their head, ascended, and fixed the flag, which M. Rohrdorf had given them when he departed, on the summit of the Jungfrau. The account these men gave us of their progress, in every respect agrees with what we ourselves observed. No one, accordingly, has ever questioned their ascent, and hitherto they were looked upon throughout the whole of the Oberland as the only individuals who had enjoyed a near view of the Virgin Peak. A last attempt was made a few weeks before our ascent by Mr Cowan, an Englishman, who ascribed the failure of his enterprise to the unskilfulness of his guides.

The cottages of Mœril, where we passed the night, are situated in a little valley which opens above the valley of Viesch, at an elevation of about 6000 feet, and which abuts on the great valley of Aletsch.* Although not very comfort-

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* In fact this valley is a direct prolongation of that of Aletsch. But as it is a few dozen metres higher than the valley of Natters, which here meets the valley of Aletsch at right angles, it follows that the glacier, instead of continuing its course in a straight line from north to south, in the direction which seems presented for it by the topographical lines, turns suddenly to the west, and continues till it abuts above Natters. (See the map of the brothers Meyer.)

A difference of level from 20 to 30 metres has consequently been sufficient to cause the glacier to deviate from its original direction. I insist on this able, these chalets are of immense utility to naturalists. They occupy a central point in the midst of the glaciers, whence they can turn their researches in any direction, and penetrate in a day even to the remotest corners of the Mer de Glace. About six months before, M. Escher de la Linth had established his head-quarters here; and eight days previously, the same savant passed the night here with M. Studer. It was from this point also that we were to commence our journey to the Jungfrau. But an unforeseen circumstance had nearly thwarted our design at the very outset. In order to attempt such an ascent, a ladder was indispensable; we had not brought one with us, because Jacob, who accompanied M. Hugi in 1832, had left the one he then used near the great fissure. He had not the least doubt that he would find it again, nine years afterwards, in the same spot where he left it. What, therefore, was his surprise when he learned from a shepherd that his ladder had been carried away some years before by a peasant of Viesch! He instantly despatched a messenger to the village to demand back his ladder, but the detainer refused to restore it, alleging that it was now his property, because he had had it repaired. Let any one conceive our disappointment when, at midnight, our delegate returned empty handed! What were we now to do? Were we to delay our journey for another day? That would have been to sin against our star which visibly protected us, for all the mists of the previous evening were dispersed, and there was not a cloud in the sky. Should we attempt the ascent without a ladder? Jacob assured us that was altogether impossible. Not knowing what plan to adopt, we decided on sending off a second messenger to this refractory personage, to intimate to him that, if he did not instantly restore our property, we would

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fact, because it is, in my opinion, a capital objection to the manner in which M. de Charpentier accounts for the progress of his ancient glacier of the Rhone; an objection which I shall again refer to in a subsequent article, giving an account of the ancient levels of glaciers among the Alps. Moreover, the valley of Mœril has likewise been at a certain epoch covered up by ice, as the polished and furrowed rocks on its sides prove; at this epoch, the glacier of Aletsch must have had two outlets, one near Natters, and another above Viesch.

come down in a body to Viesch, to do ourselves justice. This second messenger left us at midnight, promising to execute our orders promptly. At four o'clock in the morning every one was awake, waiting with anxiety for the messenger, who failed to appear; five o'clock approached, and he had not returned, and still the sky continued as clear as at midnight! At last we saw him approaching with the ladder on his back. A cry of joy resounded through the air. We proceeded at last to make ready for starting. In an instant every one was prepared; but before setting out, Jacob called us around him, and harangued us nearly in the following terms: "We should have set out at three o'clock, it is now five: these two lost hours we must make up on the plain of the glacier. Let us, therefore, advance at a quickened pace; those who do not feel strong enough to follow me must remain behind, for we will wait for no one." Such an address might well make those hesitate who, like myself, had not slept the whole night, owing to the dampness of the hay; but every one was filled with such ardour that none held back. I was delighted to visit again the Lake Mœril, with its floating ice, which had so interested me when I visited it for the first time with M. Agassiz in 1839.* This small lake, situated at the bottom of the valley of Mœril, where it is bounded by the glacier of Aletsch, whose left side it washes, then seemed to me to be about a quarter of a league long, and some hundred feet broad. Now I was greatly surprised to find it completely changed; it seemed to me much smaller than formerly, and its level considerably lower. The floating masses of ice were likewise less numerous, and of smaller size. I intimated my surprise to a Valaisan shepherd who accompanied us, and he informed us that the lake had been drained towards the end of last autumn, and had not yet attained its ordinary level. This explained to us why, on the preceding evening, we had found the canal dry by which it discharges itself, on ordinary occasions, into the glacier of Viesch. This canal was cut by order of the governor of Valais, for the purpose of affording a constant outlet to the lake, and thus prevent the mass of water which runs down

* M. Agassiz has published a very beautiful lithograph of this lake in his *Etudes sur les Glaciers*, Pl. 12.

from the glacier accumulating in too great quantity. Formerly this lake had no regular outlet, but it happened sometimes to empty itself suddenly, by breaking out a passage under the glacier, causing great disasters in the valley of Natters and in the Valais. Now that it can no longer rise above a certain level, it discharges itself less frequently under the glacier, and when that happens, it is usually not attended with any great inconvenience.

From the margin of the lake we immediately ascended to the glacier of Aletsch. Here, at the place where the glacier bends, we enjoyed a magnificent view in two directions: the Dent-Blanche, Mont-Cervin and the Strahlhorn* formed the back-ground of the picture to the south-west; while before us, to the north, we perceived at the bottom of the glacier the great peaks of the Jungfrau, the Eiger and Mönch, which seemed to invite us to perseverance, so near to us they appeared. It is reckoned six leagues from the place where we mounted the glacier to the point where the ascent becomes steep; but we were so influenced by Jacob's exhortation, that we accomplished the distance in less than four hours. The glacier is upwards of half a league long, and often nearly half a league broad. It is inclosed, throughout its whole length, between very high mountains, which are, on its left side, from south to north, the Walliser Viescherhörner, the Faulberg, the Grünhorn, at the foot of which the brothers Meyer erected their hut in 1812, the Trugberg, the Mönch; and, on the right side, the Aletschhorn, a mass of mountains separated from the Aletschhorn by the Col de Lötsch, to which I propose to give the name of *Kranzberg*, and in the distance the Jungfrau.† The sides of these mountains have preserved numerous traces of the action of glaciers; traces, however, which are not always very distinct on account of the friable, and often slaty, nature of the rock (gneiss and mica-slate). We remarked the latter rocks with polished projections on the sides of the Kranzberg, in front of the Grünhorn; and what proves that we were not under the influence of a blind con-

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* It is the latter mountain which many people mistake for the true Mont-Rosa.

† See the map of the brothers Meyer.

fidence is, that M. Hugi has already taken particular notice of these rounded forms. The better to shew their importance, this naturalist has even published a section of them in his work on the Alps*. (Pl. XI.)

The glacier of Aletsch is in general very smooth; of all the Swiss glaciers it is the one having the smallest inclination (its mean inclination is 2° 58′, according to M. Elie de Beaumont). We walked for nearly two hours on the compact ice, after which we arrived at the region of fissures, which is at the limit between the ice and the névé. This region is more than a league broad. The névé which succeeds it is the most beautiful in Switzerland. It begins nearly at the height of the Faulberg. We can recognise it at a distance by a certain air of antiquity, which forms a very striking contrast with the sparkling whiteness of the superior fields of snow. It is moreover perfectly homogeneous, and without any traces of crevices over a space of many square leagues. Its surface is depressed and raised at the sides, which is an essential character of all the névés. We arrived at half past nine at the snow-fields, which commence with the ascent. It was here that we made our first halt, at a place which we called the *Repose*, because the passage we had made, and the immense heights which rose in stages in front of us, naturally invited us to take some refreshment. In the mean while, a discussion had arisen among our guides respecting the identity of the Jungfrau. The Valaisan guide affirmed that it was the peak we saw to our right; "it was, at all events," he said, "that which was called the *Frauelihorn*" (the name the Valaisans give to the Jungfrau). The other guides, and Jacob among the number, asserted, on the contrary, that it was the highest of the great summits rising in stages on our left. Each brought forward his reasons; but as I shewed some inclination to acquiesce in the opinion of the Valaisan, Jacob was so much hurt that he got into a violent passion, and, throwing the articles he carried at my feet, declared, that to ques-

* It is known that M. Hugi, who had then no doubts about the connection of these polished rocks with the movement of the glacier, looked upon them as different, in their mineralogical nature, from the rocks with unaltered angles which are lying above them.

tion his knowledge of mountains was to commit an outrage upon him; that although he had not yet been on the Jungfrau, he was not on that account less acquainted with it, and that he would leave us on the instant if any doubt continued to be entertained about the paltry peak on the right. On Agassiz' suggestion, it was then determined that we should follow Jacob whithersoever he might lead us. In fact we ascertained soon after that he was not mistaken. The peak which the Valaisan pointed out to us, and to which we gave the name of Trugberg, on account of the error into which it must have led us, is a less elevated mountain, situated to the south of Mönch, and forming part of the mass of the Grünhorn, while it is assuredly on the summit of the Jungfrau that the flag was placed, which still floats on the highest point of the Bernese Alps.

The *Repose* is one of the most beautiful situations on a glacier that can possibly be met with. We here find ourselves in front of an immense amphitheatre, in which five great confluent branches of the glacier of the Aletsch become confounded with each other. Two of the most considerable of these occupy the background. They descend, one from the sides of the Jungfrau—and it is this which many travellers name the *Glacier of the Jungfrau*—and the other from the summit of Mönch; this latter, which one is naturally inclined to call the *Glacier of the Mönch* (as far as the name of glacier can be applied to such collections of snow), is in no respect inferior to that of the Jungfrau. The three others are more lateral; one of them is on the right side, and two on the left; the most considerable of the last are connected with the same Trugberg, which some of our guides took for the Jungfrau. The Eiger sends no affluents into the valley of Aletsch. The Mönch on the right, and the Jungfrau on the left, are in some measure the two columns of the great amphitheatre which in this place separates the Swiss plain from the Valais. The col lying between the two peaks is nearly 11,000 feet high. Rohrdorf crossed it in 1828, when he tried to ascend the Jungfrau. M. Hugi likewise passed over it, when he repeated this attempt in 1832. Although of no great breadth, the col here presents itself in an entirely different form from what it has in the plain; thus, he who was not aware that it was the Jungfrau and Mönch that were under his eye, would have no doubt that the back part of the great circus corresponds to this same apparently rectilinear ridge, which, seen from the plain, seems to unite these two great peaks. To the west of the *Repose*, on our left, a vast hollow ran downwards between the Jungfrau and Kranzberg, and in this we distinguished a series of terraces rising one above another: it was by this we were to ascend.

We left at the *Repose* the greater part of our provisions, carrying with us only a little bread and wine, some meteorological instruments,* and articles of different kinds, among others a ladder, a hatchet to cut steps, and a cord to tie us together. It was ten o'clock when we set foot upon the first plateau of snow; an hour after mid-day we hoped to be on the summit, if no accident occurred; some of us even thought that we would reach it in two hours. Contrary to our expectations, we at first found the snow not in a very favourable state; it was neither sufficiently compact, nor covered with a crust thick enough to bear us, so that we sunk very deep, in many places up to the knee. We soon came to the fissures, which are everywhere frequent where the declivities begin to become steep. These are crevices produced by sinking (crevasses de tassement), like those of the névé of Viesch. We saw some of them here nearly 100 feet wide, but they were not very continuous, so that we were able to go round them, or else they were masked, and in that case our guides had to use the greatest caution to guard us from danger. On this account we advanced much less quickly than we wished, and, in spite of all precautions, many of us sunk down, but without sustaining any injury. In this way we scaled many terraces, and, always directing our course westward, we arrived at a vast expanse,

* The reader will, no doubt, be surprised to learn that the most essential instrument, the barometer, was not among them. Unfortunately we had broken three during our abode on the glacier of the Aar, and the fourth had admitted air; there was no means of getting them repaired at the time; so that we had no alternative but to set out without a barometer.

commanded on all sides by mighty peaks, the highest of which was the Jungfrau. Jacob made us halt here a second time, no doubt for the purpose of reconnoitring the ground. With regard to ourselves, we saw nothing but insurmountable difficulties on all sides—on the right, vertical precipices ; on the left, masses of ice, which threatened to crush us by their fall ; and in front, the great fissure, to all appearance impassable, so widely did it yawn. I could not avoid asking Jacob in what direction we were to ascend ; but he refused to answer my question, contenting himself with saying, that we had only to follow him with all confidence, and that, for himself, he already saw the road we should take. I afterwards saw that he had good reason for eluding my question, for it is very likely we would never have arrived at the summit if every one of the company had given his opinion in the difficult parts of our passage.

After resting for an instant, we again resumed our route. It was now near mid-day ; the heat was excessive, and the guides, in order to refresh themselves, placed handfuls of snow on the nape of their necks. Many of us did the same, in spite of the remonstrances of others, who, alarmed at such imprudence, forgot that in these elevated regions the material organism, as well as the moral nature, is much more independent of hurtful influences than in the plain. The reflection of the light from the snow was likewise most intense, and almost insupportable. In such circumstances one can scarcely do without a veil ; but it has the great inconvenience of rendering one's steps less secure, and considerably increasing the heat of the face, by preventing the fresh air reaching it. On these accounts, Agassiz preferred running the risk of having his face broiled rather than use one. We proceeded straight in the direction of the great fissure, which we reached after surmounting a fourth terrace. It is a gulf of unknown depth, opening upon the declivity of the last terrace but one, and penetrating somewhat obliquely into the snow ; in no place is its breadth less than 10 feet, so that there is no means of crossing it without a ladder. Before going to the other side, we went to examine the debris of a fallen mass, which were lying on our left, and which seemed to have been detached a short time before, for the marks they had left by rolling on the surface of the snow were still quite fresh. This was the only avalanche we met with during our expedition; and its confused appearance, which made it easily recognizable at a great distance, contrasted in a striking manner with the uniformity of the declivities of the snow-terraces, which, whatever a celebrated geologist may allege, are here in no degree made smooth by the avalanches, although their inclination exceeds 40 and 50 degrees, as we assured ourselves by repeated measurements.* We saw with interest that the fragments of this avalanche, detached from a peak of upwards of 11,000 feet in height, were composed of alternate beds of compact ice and congealed snow. These various layers, from two or three inches to a foot in thickness, alternated three or four times in blocks of a few cubic feet. This fact interested us the more warmly, because we saw in it the confirmation of an opinion expressed by M. Agassiz, and previously by M. Zumstein, on the mode in which bands of ice are formed in the midst of snow, even on the highest mountain summits, when the atmospheric and topographical conditions of the place are favourable.†

Our ladder was 23 feet long; it was consequently more than sufficient to stretch across the great fissure. But immediately above the latter, the steepness of the terrace was fearfully great for a space of about 30 feet. We estimated it at 50°; and, moreover, the snow, which had hitherto been very incoherent and almost powdery, had suddenly become of extreme density, to such a degree that the guides were obliged to cut steps. Our courage was here put to the first proof. Jacob and Jaun were the first to mount. When they were half way up the terrace, they let down the rope to us, holding it by one of the ends, and the other being fixed to the ladder, it served us as a kind of stair. All of us in this way arrived at the summit of the terrace without mishap, but not without some

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* M. Elie de Beaumont asserts, that "all the slopes of snow with an inclination approaching 30°, are smoothed down by avalanches, which renders them as rectilinear as the angles and cones produced by eruption."—*Mémoires pour servir à une description géologique de la France*, t. iv. p. 216.

† See my note at the end of this article.

difficulties. The guides themselves, perhaps, exaggerated a little the dangers of this first passage, for they were lavish in their directions to us, and so liberal in their assistance, that we would have found it superfluous, if not injurious, some hours later.

There now remained only one eminence for us to surmount, in order to reach the Col du Rottthal, which leads from the valley of Rott to the névé of Aletsch. The soft snow had again replaced the hard snow of the steep ascent, so that we walked with the greatest ease. But when we arrived at the centre of the last terrace, which we went along in a sloping direction, we encountered another fissure, which seemed as if it would stop our progress; it penetrated, like the great fissure, obliquely into the mass of the snow, so that one of its walls was thinner than the other and ran beneath it, a circumstance which rendered the passage more difficult. As Agassiz, Jacob, Jaun, and I, had gone a little in advance, while our companions were still engaged in climbing the first ascent, I proposed that we should wait for them, that we might at least get the rope. Jacob thought we could pass it well enough without this precaution. In fact he found a place where the fissure was sufficiently narrow to allow him to stride over it; after having done so, he stretched out his hand and assisted us to do the same. While three of us were standing on the edge of the northern lip of the fissure, we witnessed a very extraordinary occurrence. We suddenly heard a dull crackling noise beneath us; at the same time the mass of snow on which we stood sunk about a foot. The guide, Jaun, was at this moment on the other side; and upon hearing the noise, he saw simultaneously the space which supported us sink down. He was so alarmed, that he cried out to us,—"*Um Gottes Willen, schnell zurück*" (In God's name, return quickly!) Jacob, on the contrary, far from allowing himself to be disconcerted, told him instantly to hold his tongue; and making a sign to us to follow him, he continued the ascent at a quickened pace, repeating in his Haslian dialect,—"*Es ist nüt; Ganget numme vorwärts!*" (This is nothing; always go forward.) Although we had great experience in glaciers, and were in some degree familiarized with all the dangers they present, I must however confess, that at this moment I felt my heart beat quicker than usual; but such was our confidence in our guide, that we hesitated not an instant in following him, although, in other circumstances, it would have appeared much more natural to go back. Our example decided the guide Jaun, who lost no time in rejoining us. We then began to discuss the probable cause of the accident. The guides alleged that it was the layer of fresh snow sinking on the older layer, and Jacob mentioned more than one example of his having found the surface sink many feet under him; and I myself recollected having experienced something similar the day before, when walking with a guide, on the snow plateau of Viesch. Proceeding a little further along the fissure, we thought that we could remark pretty extensive hollows in the interior of the mass, for we felt our poles sink without any resistance, which never happened elsewhere, however soft the snow might be. From this we concluded, that these vacuities are the effect of the sinking of the lower beds, while the upper bed remains supported in the form of an arch, in consequence of the adhesion of its particles. When this upper layer is not very thick, it would naturally give way under a weight more or less considerable; and it was this that happened in the accident I have just described. Our other companions joined us a few minutes after; they crossed the fissure and the place that sunk without difficulty, having no suspicion of the adventure that had occurred to us.

It was two o'clock when we arrived at the Col de Rottthal, which is indicated in Plate V., figure 1, by an R. This col greatly resembles that of the Oberaar; like the latter, it is bounded by two very high peaks, the Jungfrau on the north, and the extremity of Kranzberg on the south. I do not know whether it has ever been crossed. Its breadth at this place is a few mètres. The mists collected in the bottom of the Rottthal allowed us only a few transitory glimpses into this savage and disrupted valley, in which the people of the country fix the abode of those turbulent spirits, known under the name of *Seigneurs du Rottthal.**

* M. Hugi, in his work on the Alps, endeavours to connect these fables with electrical phenomena.

We could not judge of the state of the névé in this direction; but all that we did see of it, led us to presume that the ascent would be very toilsome. The acclivities which extended immediately before us, were at least as steep as those we had scaled. We rested for an instant on the col before encountering the last peak, which we expected to be the most difficult. Up to this time, every one was extremely vigorous, none feeling fatigue except M. de Pury. He had not taken care to provide himself with sufficiently strong shoes, so that his footing was not sure enough to attempt so hazardous an ascent. Perhaps, however, he would have succeeded, by a great effort, in reaching the summit along with us; but the guides were opposed to his making the trial, alleging that they could not run the risk of compromising the whole party for an individual. It was with great regret that we left him, intrusted to the care of J. Wæhren, who conducted him safe and sound to the *Repose.*

We estimated the height of the last peak at from 800 to 1000 feet above the col, and we hoped to climb it in less than an hour, notwithstanding its extreme steepness. We soon found, however, that the ascent was more difficult than we had supposed: instead of snow, we every where encountered nothing but compact ice, in which the guides were obliged to cut very deep steps to prevent us slipping; we, therefore, advanced very slowly. We continued ascending for an hour, without the summit coming sensibly nearer, when we were enveloped in a very dense mist, which scarcely allowed the hindermost of us to distinguish those at the head of the column. This occurred at precisely the steepest part of the ascent. Mr Forbes, upon measuring it, found the acclivity to be 45°. The ice was so hard and tenacious, that, for a short time, we could not accomplish more than fifteen steps in a quarter of an hour. The cold, besides, was very keenly felt, so much so that there was every reason to fear our feet would get frozen, in spite of the care we took to keep them as much in motion as possible, by assisting to enlarge and clear the steps of the stair. Seeing that our position, at this time, was really becoming critical, Agassiz asked Jacob if he still hoped to convey us to the summit. He replied, with his habitual composure, that he never doubted it; and, at the cry of *vorwärts*, we again commenced our ascent with as much ardour as at first. Here, one of the guides left us: he could no longer bear the sight of the precipices on our right; and, in fact, the path we were following was well calculated to alarm every one who had not full confidence in his head and legs. The uppermost ridge is nearly in the form of the section of a cone with vertical walls, overlooking on the east the fields of snow which we had crossed, and on the west the glacier of Rottthal. The inclination is, however, a little greater on the west side than on the east; for the fragments of ice, loosened by each stroke of the hatchet, all rolled into the last-mentioned valley. As we had no time to lose, we ascended in a straight line, without making any zigzag. This was, besides, the most rational and certain method; for, according to the laws of mechanics, a person has much greater strength resting on the points of his feet, and turning his head against the acclivity, than in mounting obliquely; so that if, by mischance, one of us had slipped down, it would not have been impossible for the others to draw him up, while otherwise that would have been more difficult. Besides this, Jacob made us walk on the edge of the ridge, because the ice in that place was in general somewhat less hard, and this greatly accelerated our ascent. It followed from this arrangement that we had constantly the precipice under our eyes, being separated from it only by a slanting roof of snow, the breadth of which varied from one to three feet. Often when my pole went farther than usual, I felt it penetrating through this snow-roof, which in some places was not more than two feet in thickness, and we were thus enabled, every time the fog dispersed for a moment, to look down through the hole made by the pole into the bottom of the great circus at our feet. Far from dissuading us from this, our guides encouraged all to do it who were free from giddiness, and I believe, in reality, it was an excellent means of giving us confidence. The mists, however, still continued to envelope the summit; the view was not open except eastward to the Eiger, the Mönch, and the peaks which inclose the glaciers of the Oberaar and Unteraar. Already we despaired of enjoying the spectacle which our imagination was attempting to portray, when all at once the veil of clouds which concealed it from us rose, as if touched by our perseverance, and the Jungfrau displayed itself to our admiring eyes in all the beauty of its mighty and majestic forms. I leave you to conceive the delight we experienced at this unexpected change! If I am not deceived, it somewhat resembles the history of human life.

After ascending for some time in the same direction, we suddenly turned to the left, in order to reach a place where the naked rock was exposed, thus traversing the inclined surface of a semi-cone, the breadth of which, even at this place, is many hundred feet. During this short passage the summit was concealed from us; and when we arrived at the rocky place, we saw, as if by enchantment, at a few paces from us, the summit of the mountain, which hitherto seemed to recede from us in proportion as we advanced. Of the thirteen who formed our party on leaving the cottages of Mœril, eight reached the summit. These were M. Agassiz, Mr Forbes, M. Du Chatelier, and myself,* accompanied by four guides,

* The notice of this ascent in the Parisian journals, cannot but make us feel the ignorance and superficiality of the French journalists in regard to every thing not comprised within the radius of Paris and its jurisdiction. The following is the account of it given in the *Journal des Debats* of 11th September. "Six travellers. MM. Duchâtelet, a young geologist of Nantes, Professor Agassiz of Zurich, Professor Forbes of Edinburgh, Professor Heath of Cambridge, Etienne Desoer of Liege, and Pury-Shod of Neuembourg, ascended, on the 27th of last month, the highest peak of the Jungfrau-horn, a glacier of the canton of Berne, the height of which is about 2872 French feet. After they had reached a height of about 800 feet, they were obliged to cut, with a hatchet, steps in the ice to support their hands and feet. They were guided in this perilous ascent by six peasants of the neighbourhood, who were themselves directed in their march by an octogenarian shepherd (!) Jacques Leuthold, who had already ascended this celebrated mountain three times. On the summit of the Jungfrau-horn, the travellers made meteorological observations, and fixed a flag, on which their names, and the date of their ascent, are inscribed."

I do not know how far it may be permitted to those who believe themselves to have a mission to enlighten the public, to suppose that there can exist in our latitudes a place where steps had to be cut in the ice at a height of *eight hundred* feet, and to be ignorant that the Jungfrau is one of the highest mountains in Europe, and consequently must be more than 2872 feet. (It is impossible to suppose this to be a typographical error, on account of the ice

Jacob Leuthold, Michel Baunholzer, Johannes Alplanalp, and Johannes Jaun of Meyringen ; so that, as one of my friends has remarked in the *Gazette Universelle d'Augsbourg*, Switzerland, England, France, and Germany, were each represented in this ascent.

From this point we could now view, for the first time, the Swiss plain : we were on the western side of the section of the cone, having at our feet the masses which separate the valley of Lauterbrunnen from that of Grindelwald. From this moment the scene appeared entirely changed ; the mountain masses, which seemed to us to repeat each other in proportion as we ascended, now enlarged to the whole height that we had surmounted. A little further on we reached a kind of small elbow, which is only about ten feet below the highest peak, and which can be easily distinguished from the plain with a good telescope, and even sometimes with the naked eye. Here we saw, not without some alarm, that the space which separated us from the real summit was an almost sharp ridge, in some places ten, in others eight, and in others six inches broad, by a length of about twenty feet, while the declivities on the right and left had an inclination of from sixty to seventy degrees.* "There is no means of reaching that," said Agassiz ; and we were all nearly of the same opinion. Jacob, on the contrary, affirmed that it was not at all difficult, and that we would all go. Laying aside the articles he was carrying, he began to advance, passing his pole over the ridge so as to have the latter under his right arm, and walked along the west side, where he endeavoured to make solid steps for us by treading down the snow as much as possible with his feet : for from the place where we found the rock cropping out, the ice had given place to a rough snow, very hard, but at the same time very porous, so that, notwithstanding its

being placed at 800 feet.) I can easily fancy to myself this redacteur of the *Journal des Debats*, who, appreciating heights by the measure of his knowledge, imagines that a mountain three times the height of Montmartre must really be an enormous one. After that, what more natural than to deduct 10,000 from the 12,872 feet of the Jungfrau !

* Fig. 2 of Plate V. represents this ridge, as seen from the small elbow where we halted. Fig. 3 is a ground plan, with the marks of our feet on one side, and those of the poles on the other.

hardness, it admitted of being easily beaten down. A few minutes were sufficient to enable him to gain the summit.

So much assurance and sang-froid gave us courage, and when the guide rejoined us, no one any longer thought of staying behind. Jacob took Agassiz by the hand and conducted him, without difficulty, to the summit. It is a kind of triangle, about two feet long by a foot and a half broad, which has its base turned towards the Swiss plain nearly as represented in figure 3 of the engraving, A being the base of the triangle, and B the ridge which led to it. As there was room for only one person at a time, we went by turns. Agassiz remained upon it for nearly five minutes, and when he rejoined us, I saw that he was greatly agitated; in fact, he confessed to me that he never experienced so much emotion. It was now my turn; I found no difficulty in the transit; but when I was on the summit, I could not prevent myself, any more than Agassiz, from giving way to great emotion at a spectacle of such overpowering grandeur. I remained only a few minutes; long enough, however, to remove any fear that the panorama of the Jungfrau will ever be effaced from my memory. After examining attentively the most prominent points of this unique picture, I hastened to rejoin Agassiz, for I feared lest an impression so powerful should deprive me of my usual confidence; I had need of grasping the hand of a friend, and I venture to say, that I never felt so happy in my life as when I had seated myself by his side on the snow. I believe that both of us would have wept had we dared; but a man's tears ought to be modest, and we were not alone; and such is the strength of the habits which society makes us contract, that, at 12,000 feet, there was still a regard to etiquette! Mr Forbes and M. Du Châtelier visited the summit in their turn, and I have reason to know that they were not less edified than we. It may be safely affirmed that he who could remain indifferent at such a spectacle is not worthy of contemplating it.

It is not the vast field which the eyes embrace that constitutes the charm of these views from elevated mountains. The experience of the preceding year on the Col of the Strahleck, had taught us that distant views are, in general, very indistinct. Here, from the summit of the Jungfrau, the outlines of the distant mountains appeared to us still less accurately defined. But, even had they been as distinct as the line of the Jura, seen from an eminence in the plain, I believe that they would not long have attracted our attention, so fascinated were we by the spectacle presented by our immediate neighbourhood. Before us lay extended the Swiss plain, and at our feet the anterior chains were piled up in stages, and they seemed, by their apparent uniformity, still farther to increase the size of the mighty peaks which rose almost to our level. At the same time, the valleys of the Oberland, which at the moment of our arrival were shrouded in thin mists, could be descried in many places, and we were thus allowed to contemplate the lower world, in some measure, through the openings. We distinguished on the right the valley of Grindelwald, with its glaciers ; on the left, in the depth, an immense crevice, and at the bottom of the latter a shining thread which followed its windings ; this was the valley of Lauterbrunnen, with the Lutschinnen. But, above every thing else, the Eiger and Mönch attracted our attention. We had some difficulty in forming an idea as to what these summits were which seemed nearer heaven than earth, when seen from the plain. Here we contemplated them, looking down upon them from above, and their near proximity allowed us, in some measure, to observe them in detail, for we were separated from them only by the circus of the névé of Aletsch. Opposite, on the western side, rose another peak, less colossal, but more beautiful ; its sides entirely covered with snow, obtained for it the name of *Silberhorn* (Silver Peak). In the same direction, we observed many other peaks, alike crowned with snow, the nearest and most prominent of which appeared to us to be the Gletscherhorn ; the other, which is visible from the plain of the glacier, is the Ebene-Fluh. These summits, and many others which have yet obtained no name, form, as it were, the immediate attendants upon the Jungfrau, which rises like a queen in the midst of them.

Beyond the Eiger and Mönch, in an eastern direction, the mountain masses which bound the glaciers of Finsteraar and Lauteraar, form another group of greater extent and more savage character than that in the midst of which we were placed;

these are the Vieschcrhörner, the Oberaarhorn, the Schreckhörner, the Berglistock, the Wetterhörner, and, in the centre, the Finsteraarhorn, the highest mountain in Switzerland. It alone rose above our level,* and its abrupt and rocky sides seemed to bid defiance to our ambition. Some weeks before we had been speaking about trying to ascend it; but now when we had a near view of this immense ridge, we felt our zeal sensibly cool, and we could not but the more admire the energy of our guides, Jacob and Wæhren, the only individuals who have reached the summit.

On the southern side the view was intercepted by the clouds which had been collected for some hours on the chain of Mont-Rosa. But this disappointment was more than compensated by a very extraordinary phenomenon, which took place under our eyes and interested all of us extremely, but more particularly Mr Forbes, as a natural philosopher. Thick mists had accumulated on our left, in the direction of south-west. They always rose from the bottom of the Rottthal, and began to extend to the north upon the mountains which separate this valley from that of Lauterbrunnen. We were beginning to fear that they would envelope us a second time, when they suddenly stopped at some feet from us, no doubt from the effect of some current of air from the plain which prevented their extending farther in this direction. Thanks to this circumstance, we found ourselves all of a sudden in presence of a vertical wall of mist, the height of which was estimated at 12,000 feet at least, for it penetrated to the bottom of the valley of Lauterbrunnen, and rose many thousand feet above our heads. As the temperature was below the freezing point, the minute drops of the mist were transformed into crystals of ice, which reflected in the sun all the colours of the rainbow; one would have said that it was a mist of gold which sparkled around us. It was a spectacle at once terrible and

* The height of the Finsteraarhorn, according to Tralles, is about 13,428 feet, that of the Jungfrau 12,870. M. Rudolph Meyer states that the Valaisan guides who accompanied him in 1812, accomplished the ascent of the Finsteraarhorn; this is an error, for it is impossible to go in three hours from the summit of the Oberaarhorn to the summit of the Finsteraarhorn, as M. Meyer alleges.

attractive; and in contemplating the ebullitions of those vapoury masses which continually rose from the bottom of the Rottthal, as from an immense caldron, it seemed to me that it was nearly such as my juvenile fancy had formerly represented the mouths of hell, that merciless gulf, into which at pleasure I plunged all those who had the misfortune not to think and believe like myself.

When we had all again returned to the elbow or projecting angle mentioned above, Jacob poured out a glass of wine for each of us, and we drank with great feeling to the health of Switzerland.* We then stretched ourselves for an instant on the snow to contemplate as naturalists the spectacle which surrounded us. I question whether there exists in the central chain a point more fitted to afford an exact view of the true form of mountains, respecting which ideas more or less erroneous are generally entertained. Before seeing these colossi of the Alps near at hand, it often happened, when contemplating them from the plain, that I was astonished at the contrast which prevailed between the almost cutting ridges of the Schreckhorn, and particularly of the Finsteraarhorn, and the great pyramids of the Jungfrau, the Mönch, and the Eiger. I constrained myself to find some vague explanation of this singular difference in the action of the raising force ; and as I saw the latter only in front, it seemed to me natural that their extreme breadth implied a proportional thickness. Here, on the summit of the Jungfrau, when we were so placed as to command them on all sides, I was not a little surprised to see that the Mönch, which I had believed to be so massive, is nothing more than an immense ridge nearly as sharp as the Finsteraarhorn, but running from east to west, while the latter is directed from north to south. The Jungfrau itself is far from being so compact as it appears from Berne and even from Interlacken ; and in this respect it does not gain by being seen close at hand ; for, instead of forming a continuous mass, it is composed of a series of ridges drawn up one behind another,

* It is, no doubt, from inadvertence that the *Constitutionnel Neuchâtelois* has omitted this toast in the translation there published of a letter addressed by us to M. Schneider, Counsellor of State at Berne, and inserted in the number of the *Verfassungsfreund* for 2d September 1841.

and separated by deep cuts or valleys. These ridges are arranged according to their height, so that the first, or that nearest the plain, is the least elevated, and the last the highest. This particular disposition can be discovered at a great distance; for when we examine the Jungfrau attentively in clear weather, we easily distinguish the deep cuts by their darker tint; the last (that which separates the highest peak from the one next to it) is the most obvious. Lastly, the Eiger, although more massive than the Mönch, is still much less pyramidal than it appears to be.

I believe that we may find the explanation of these trenchant forms in the nature of the rock, which is generally gneiss or mica-slate, that is to say, a rock more or less fissile, which splits in large plates, so that the colossal ridges of the Finsteraarhorn, the Mönch, the Jungfrau, the Schreckhorn, and the Eiger, represent in some degree, on a large scale, the slaty cleavage of the fallen masses which are detached from their sides, and which the glaciers carry along with them under the form of moraines. Wherever the rock is real granite or protogine, the peaks are always more massive, as may be seen in Mont Blanc, Mont Maudit, and others.

This form of the Bernese Alps does not well agree, I admit, with the opinion of those who regard the different peaks as so many links of one and the same great chain; but Mr Studer has demonstrated that the Alps, far from being a continuous chain, are composed, on the contrary, of separate ellipsoidal masses, more or less independent of each other.* It has likewise been long admitted that, in a geological sense, the high ridges are only accessory, while the essential phenomenon must be sought for in the masses which support them.

Polished rocks never ascend to these levels; we saw none beyond those I have mentioned above, as occurring on the right side of the névé of Aletsch, in front of the Grünhorn. Wherever the rock appeared at the surface, it was under the

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* For details on this head, I refer to an article by M. Studer on the geognostical constitution of the Alps, which will appear in an early number of the Bibliothèque Universelle de Genève.

form of dentelated and jagged ridges, eloquent proofs of the mighty convulsion the crust of the earth must have undergone when the Alps were raised.

The connection between these ridges and the surrounding plains of snow appeared to us, from this place, in quite a different light from that in which it is usually regarded. When we say that such a glacier or névé descends from such a summit, we always exaggerate the importance of the peak to which they are referred ; the ridges are supposed to be an indispensable condition—a *sine qua non*—of the glacier, while it often happens that they contribute very little to its sustenance. They can still less be regarded as lines of separation or watersheds between two different basins; for it is only necessary to ascend to a height of 10,000 feet, to be convinced that all the plains of snow correspond with each other, and that the peaks which, seen from a distance, appeared to us so predominant, are in reality only rocky islets rising from an immense sea of ice which surrounds them on every side. The brothers Meyer have already insisted on this fact, and one is therefore the more surprised to see quite a contrary state of things on their map, which represents the mountains as great continuous ridges, establishing marked separations between the different glaciers.

While we were making these reflections, the thermometer indicated $-3°$ C. (26°.6 F.) in the shade; but we were so engrossed with our subject, that we did not feel the cold. Saussure's hygrometer stood at 67°, notwithstanding the proximity of the column of mist I spoke of. The sky over our heads was perfectly clear, and of so deep a blue that it approached to black; we endeavoured to discover the stars in it, which are said to be visible during the day at great heights, but we did not succeed. It has been pretended that this deep tint is only the effect of the contrast with the snowy surfaces which surround the observer on all sides. But if this were the case, the intensity of the hue would be equal in every part of the celestial vault. Now, this is precisely what did not take place, for, on looking from the zenith to the horizon on the east, where the sky was likewise perfectly clear, we saw the azure gradually become paler as our eyes turned downwards. Unfortunately we had neglected to bring a cyanometer with us, which would have enabled us to indicate the difference in the degrees of intensity. Mr Forbes observed the polarisation of the sky, and found it perfectly normal and similar to what he had observed in the plain at the same hour, although a little less intense. Now, as the intensity of this phenomenon depends on the quantity of reflected light, it is natural that it should be less sensible when the sky is of a very deep colour.

The rock in situ, near the summit, on the edge of the ridge which overlooks the Rottthal, is gneiss. Although very compact, it easily splits into small fragments; its surface assumes a coppery appearance from the effects of oxydisation, but the fresh fractures are greenish, with large crystals of felspar, having a pearly lustre. The existence of this rock, in such a locality, is an important fact for geology, for this reason that gneiss being, to all appearance, a metamorphic rock, its presence on one of the highest summits of the Alps is sufficient of itself to demonstrate, that the elevation has not been effected here by crystalline masses rising from the bosom of the earth, and spreading over the summits of the crests, as must have been the case with many systems of mountains, among others that of Mont Blanc, the centre of which is protogene, flanked with gneiss and other stratified rocks. It is long since our most skilful geologists have expressed the opinion, that true granite does not exist in the chain of the central Alps, and that all the crystalline rocks, even the most compact, shew marks, more or less distinct, of stratification (the *demi-granite* of MM. Studer and Escher), and are, consequently, metamorphosed rocks. Now, assuredly there is no granite on the summit of the Jungfrau, and it may be presumed that it is likewise wanting on the less elevated peaks in its vicinity.

To our great surprise, we discovered on the surface of the exposed rock, as well as on the fragments detached from it, many lichens in a very fresh state, some of which occupied a surface of many inches in diameter. Our celebrated lichenologist, the minister M. Schærer, recognised among them five species,* which are in part the same as those which Saussure collected on the summit of Mont Blanc and the Géant, and one new species, to which he has given the name of *Umbilicaria Virginis*, in commemoration of our ascent.

We could not expect to find living beings at such a height; it seemed that even the Podurella of the glaciers (*Desoria glacialis*, Nic.) did not ascend thus far, for we did not meet with one. To make up for this, however, we perceived

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* These five species are :—

1. *Lecidea conglomerata*, Ach. Schær. Spicil. p. 121. Ejusd. Lich. Helv. exs., No. 169.
2. *Lecidea confluens* (var. *sterisa*), the same which Saussure found on Mont Blanc and the Col du Géant.
3. *Parmelia elegans α miniata*, Schær. Spicil. p. 428. Ejusd. Lich. exs., No. 338; likewise found on the Col du Géant.
4. *Umbilicaria atro-pruinosa γ reticulata*, Schær. in Ser. Mus. Helv. d' Histoire Naturelle, I. p. 109, pl. 14, fig. 5-9; also found by Saussure on the Col du Géant.
5. *Umbilicaria Virginis*, Schaer. Mscr. 1841.

The following is M. Schærer's description of this species, from specimens communicated to him by M. Agassiz :—

Diagn. U. glauca, subtus ochroleuca, hirsuta; apotheciis superficialibus, disco æquabili, margine tenui prominente.

Descript. Thallus coriaceus umbilicatus, juvenilis monophyllus, orbicularis, ambitu integriusculo; adultior plures emittit lobos, ambitusque ejus crenatus fit et lobatus. Diameter in speciminibus quae coram habeo, a paucis lineis ad bipollicarem usque extenditur. Pagina adversa in juniori lichene æquabilis est, in adultiori rugosa et undata fere ut in *Umb. pustulata*; color ejus in statu humecto glaucus, in sicco murinus vel obscurior tenuissimoque pulvere albo obductus, unde adhibita lente tenuissime exasperatus apparet. Pagina aversa ochroleuca est, ad ambitum fusca, vel pilis validis simplicibus ramosisque concoloribus praeter umbilicum dense vestita, vel bulbilliscorum exasperata.

Hactenus cum *Umb. hirsuta*, Hoffm. ad assem fere convenit. Aliter vero *Apothecia* se habent; non enim ut ibi juniora in thallum deprimuntur, sed jam ab initio superficialia occurrunt et in unico specimine adultiore, cujus facies adversa rugosa est, et undata hisce asperitatibus coarctata sunt, indeque thallo immersa videntur. Gyris etiam concentricis omnino carent discumque praebent per omnem aetatem aequabilem marginique cinguntur, non, ut ibi, crasso, sed tenui, in junioribus integro, in adultioribus vero flexuosa. Praeterea pleraque specimina apotheciis abortivis verrucaeformibus apiceque impressis horrent. Apotheciorum denique color ater absque splendore. Quoad thallum hic lichen ad *Umbilicarias*, quoad apothecia vero ad *Lecideas* pertinet. (Schaerer.)

a hawk hovering in the air above our heads. One would have said that our presence excited its curiosity, for it described many circles around us, but not sufficiently near to enable us to distinguish the species to which it belonged.

There is another point on which it remains for me to say a single word, and that is the influence of the air, in elevated situations, on the human frame. Many naturalists and physiologists will doubtless expect that some new facts were observed by us; but I must confess, that during the whole time we were on the summit, and also during the ascent, we experienced none of those occurrences, such as nausea, bleeding at the nose, ringing of the ears, acceleration of the pulse, and so many other inconveniences which those who have ascended Mont Blanc tell us they were subject to. Must we ascribe this to the difference of 1500 feet which there is between the height of Mont Blanc and that of the Jungfrau? Or rather should we not seek the cause in the habit we had contracted while living for many weeks at the height of near 8000 feet? But it ought to be remarked, that M. Du Chatelier, who had been among the mountains for only a few days, was not more affected than we. Without pretending to decide this question, which belongs more particularly to the domain of physiology, I am, however, inclined to believe that there is some degree of exaggeration in all that has been said on the subject. Perhaps, also, some travellers have allowed their imagination to deceive them, like those students of medicine who believe themselves every day affected with the malady their professor has been describing. The German physiologists even pretend, if I am not mistaken, to have observed the most extraordinary symptoms on mountains of a few thousand feet in height.

We could not quit the summit of the Jungfrau without leaving some traces of our visit; and as we had not brought a flag with us, it was determined that we should employ M. Agassiz' pole for this purpose, as it happened to be the longest. For my part I was willing to sacrifice my cravat, and was about to attach it to the end of the pole by means of some holes I had pierced in the wood; but one of the guides, lamenting the fate of the cravat, which he doubtless thought too pretty to be delivered up to the fury of the tempests, asked permission of me to substitute his pocket handkerchief for it. We thus managed by means of a travelling pole of fir, and a purple-coloured rag, to manufacture a kind of flag, which Jacob went and fixed on the summit we had just left. He sunk the pole nearly two feet into the hard snow, so that it rose only two feet and a half above the surface.

It was after four o'clock when we again commenced our journey. The difficult moment was about to commence; the ascent had been sufficiently painful; what must the descent be! I am certain that, in measuring with the eye the immense declivity we had to pass, the greater part of us would have been well pleased to be already at the bottom. The inclination was too great for us to walk in the usual manner; we, therefore, descended backwards. I confess that the first few steps gave me some uneasiness; for as Agassiz and I had no guides before us to direct our feet, we were obliged to look constantly between our legs to find the steps, which made the steepness appear much more giddy. But a few moments were sufficient for us to recover ourselves; and such was the regularity of the steps, that, after a few hundred paces, we knew them by the touch of our legs, and had no need of looking at the place where we set our feet. The slope, however, was always nearly the same, varying between 40° and 45°, according to Mr Forbes's repeated measurements, that is to say, nearly equal to that of the roofs of our Gothic cathedrals. There was even one place where it must have been near 47°. In spite of this excessive steepness, we did not take more than an hour to reach the Col de Rottthal, for it was about five o'clock when we arrived there. We crossed without the least inconvenience the crevice near which the sinking of the surface took place which I have mentioned above, as well as the great fissure. We had now surmounted near all the dangers, and had only some platforms of snow to descend, in order to rejoin M. de Pury and the two guides who awaited us at the *Repose.* So much assurance had we gained in this descent, that we ran rather than walked, no longer paying any regard to fissures, although they were perhaps more treacherous than in the morning, for the sun had softened the snow during the day. Jacob did not cease, accordingly, to recommend caution, repeating with the same calmness as when he ascended, *Hübschle, nur immer hübschle!* (Gently, always gently!)

At six o'clock we reached the *Repose*, thus accomplishing, in two hours, a distance which had cost us six in ascending. M. de Pury was the first to meet us, and congratulate us on the successful issue of our undertaking. Far from being distressed at not having formed one of our party, he thanked us, on the contrary, for having dissuaded him; for on seeing us climb the last ridge, he was the first to acknowledge that his shoes were not fit for such an ascent. Thus every one was satisfied; and as we brought from our journey an appetite such as may be conceived, we seated ourselves on the snow to refresh ourselves with a piece of meat and the remainder of our wine. The first glass was offered by Agassiz to our captain Jacob; we drank his health by turns, and I believe that never was toast more sincere, for it was obvious to us all, that without him we would never have reached the summit.

Six leagues had still to be travelled to regain the cottages; so that it happened, as we had foreseen, that we had to cross the part of the glacier most abounding in fissures after nightfall. But no one seemed in any way annoyed at this; moreover, the moon would soon be up, and the clouds had almost entirely disappeared from the horizon. We traversed with accelerated pace the three leagues of névé which succeed the plateaux of snow; it was done without any difficulty, for the névé there presents a perfectly regular surface, on which one walks with as much security and ease as on a turnpike road. Scarcely had night fallen, when we saw the moon rise opposite to us.

We were then at the height of the two cols I have formerly mentioned—that of Lötsch on the west, and that which leads to the névé of Viesch on the east. The moon was directly in the axis of the glacier, so that the whole of this great river of ice was uniformly illuminated, and reflected a light which must have appeared to us the milder, from having suffered so much from that of the sun during the day. The entrance to the two cols of Lötsch and Viesch formed a most interesting contrast with this luminous surface, for as they lie at right angles with the direction of the glacier, the mountains which bound them to the south there threw out shadows of fantastic grandeur, while large black clouds accumulated behind the Aletschhorn, gave to the picture all the force worthy of such a subject. When to this it is added that a perfect calm in the atmosphere, and an absolute silence prevailed around us, it may easily be conceived that we still experienced extreme pleasure in admiring this unique spectacle, although we had contemplated so many grand views in the course of this day.

We soon entered the region of fissures. We then thought it proper again to have recourse to the rope, for although the moonshine was very clear, the light was not sufficiently strong to enable us to distinguish with certainty the old snow from the fresh, particularly during the first quarter of an hour of our progress. We flew top over tail, so to speak, each in his turn, the guides as well as ourselves; for a short time one might have entertained rather serious apprehensions regarding the issue of this passage, for at each step one or other of us was obliged to retire from a crevice. However, we learned by degrees to avoid the crevices covered with snow, and we again extricated ourselves from this unpleasant situation, without having to lament any severe accident.

On this subject I think it right to remark, that in general there is a tendency to exaggerate the dangers of fissures. A fall into a gulf, concealed by a bridge of snow, is no doubt a very serious matter, as we had too frequently occasion to experience. But it is not without mitigating considerations, for it is rare that in such cases one falls to the bottom of the precipice; the snow which has given way under your feet always affords more or less support, and, unless when leaping with the feet joined, one rarely sinks up to the breast. Strains are most to be feared in such cases.

It was near nine o'clock, when, all of a sudden, we heard the cry of a shepherd in the distance. "Bravo!" we all exclaimed, "it is our Valaisan." That we might not run the risk of fasting, in case of any accident happening to us, we had given him orders, on leaving the cottages, to start with provisions at six o'clock in the evening, and go forward until he met us. After having exchanged with him some of those shrill and piercing sounds, which the mountaineers can make to penetrate to the distance of leagues, we perceived that he was on the left side, so that before we could join him, we had to cross a considerable part of the glacier, which in this place is nearly a league broad. The brave fellow was loaded like a mule, for besides the provisions we had required of him, he brought an entire *boille** full of excellent new milk still warm. This was unquestionably the most delightful refreshment that he could have offered to us, and almost every one left the wine for the milk. We seated ourselves in a circle around our amphitryon, taking draughts in our turn from his immense vase, till it was nearly empty. This was the most picturesque repast, and, at the same time, one of the most grateful I have enjoyed in my life.

After supping heartily we again set out to complete our last stage. Nearly three leagues yet remained; but, with the exception of the fissures which we had to stride over, the road was easy, and we arrived almost before we were aware at the banks of lake Mœril. Here we made our last halt, in order to admire an unique spectacle. The blocks of floating ice which swam on the surface of the water had a most attractive effect, when seen by the beautiful light of the moon. At the same time the section of the glacier, in the background, appeared to us like an immense wall of crystal; and what farther added to the beauty of this spectacle was, that we arrived just at the moment when the moon was passing behind the mountain mass which overlooks the lake, and we saw in a quarter of an hour the most varied effects of light, and the most striking and interesting contrasts. It was a finale worthy of such a day. But as the moon and its effects are a little out of fashion, as well as the loves of the shepherds which it formerly inspired, I shall not enlarge farther on the subject. If, how-

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* A provincial word to denote one of the large wooden vessels in which the shepherds carry milk. The Genevese Glossary says: "Bolles, vessels of wood to carry milk on an ass; *un paire de bolles,* a term known in our Alpine romances. Romansch *bouille,* a kind of scuttle for the vintage. Celtic root *boil,* the belly."

ever, any naturalist happen to pass the night at the same cottages where we found a sleeping-place, I would advise him not to neglect to visit the lake. It is, besides, the only one in Switzerland, if I am not mistaken, in which there is floating ice.

At half-past eleven o'clock we re-entered the hospitable roof of our good Valaisan shepherds, after a journey which occupied us upwards of eighteen hours. As for fatigue, we did not feel it even now, so pre-occupied were our minds with all the things that had passed under our eyes, and moved our hearts, during the day. Next day we descended to Viesch, where we met our friend M. Escher de la Linth, who regretted deeply that he had not arrived some days sooner, that he might have accompanied us. On the following day we again repaired to Grimsel, to our excellent friend Zippach, who was interested in us, more than any other, during our absence. With regard to our guides, they left us at Viesch, and we afterwards learned that the two days they spent in their return were a continual triumph to them. There was not a hut in the valley of Conches, from Viesch to Obergesteln, which they did not enter and proclaim their success.

And now that we have succeeded in this ascent, without experiencing too much difficulty, do we advise our friends and the amateurs of glaciers to follow our steps? To those who have perfect confidence in their head and legs, I would say without hesitation, "Go, provided you find good guides; the harvest is rich in these regions both for the geologist and natural philosopher. The whole journey is composed of a series of studies, every one of them more interesting than another: the glacier of Aletsch, which leads to it, is the most beautiful in Switzerland; and if, after traversing it, you succeed in reaching the summit of one of those majestic peaks which encircle it, the impressions you will then receive will not soon pass away; you will find them always fresh in your memory, and the day on which you have contemplated the Swiss plain from the height of the Jungfrau will be reckoned among the most interesting of your life."

Note on the Ice of elevated Peaks.

It may be perceived, by the preceding narration, that glaciers are divided into three regions, each of which has its peculiar characters; these are—compact ice, the névé, and the snow. Although the limits of these regions do not correspond to a certain level, they always present themselves in the same order of succession, so that in ascending a glacier from its termination to its source, we first meet with the compact ice, along with its moraines and the other accidents peculiar to it; then the névé, which is characterised by its granular structure and the absence of moraines; and lastly, the fields of snow, which usually occupy the highest parts of the valleys and the sides of the mountains which bound them. These different states are the result of the transformations which the frozen water, falling in the form of snow, has undergone in its course to the lower regions; the compact ice, which is at the extremity of the glaciers, has previously gone through the states of ice and névé. But this order of succession is constant only in the valleys: the high summits are often exceptions to the rule. Those who have read the preceding narrative will recollect the ice we encountered even on the summit of the Jungfrau, and which is consequently much more elevated than the névés and fields of snow which occupy the bottom of the circus of Aletsch. We likewise know that Saussure found ice on the summit of Mont Blanc; Zumstein speaks of it on the summit of Mont Rosa; our guides, Jacob Leuthold and Johannes Wæhren, intelligent men and worthy of credit, inform us that they met with it nearly up to the summit of Finsteraarhorn; and no one can cross névés between 9000 and 10,000 feet of absolute height, without seeing some of those small glaciers, whose terminal portion is of compact ice, come forward to terminate at the edge of the abrupt walls which overlook the valleys. I may mention, as examples, the foot of the Strahleck; many small glaciers abutting above the névé which feeds the lower glacier of the Grindelwald; many small affluents of a similar kind on the sides of the Oberaarhorn above the névé of the Oberaar; and lastly, some pretty considerable collections of ice above the névé and snow-fields of the Aletsch. The ice which covers the highest ridge of the Jungfrau has all the characters of the ice of ordinary glaciers; the same hardness, the same angular texture, the same roughness of surface, the same capillary fissures. It differs only in being of a less bluish tint, which is no doubt owing to the greater number of air-bubbles it contains; in this respect it more resembles the ice of glaciers in winter. Its thickness probably undergoes more or less considerable variations; we found it perfectly homogeneous, without any trace of intercalated snow as far as the hatchet penetrated; that is to say, nearly to the depth of a foot. It is only close upon the summit that it begins to lose its hardness, and for the last twenty feet it again becomes granular snow.

No one, in my opinion, has hitherto explained this phenomenon in a satisfactory manner, although it in every respect deserves careful consideration, were it only on account of the difficulties it presents. All now nearly agree in admitting that the ice of glaciers is snow transformed into ice by means of water, which, by congealing, acts like a cement. The more frequent these alternate infiltrations and congelations are, the greater compactness the ice acquires. Thus, when, ascending a glacier, we reach a point where the névé gives place to incoherent snow, we conclude that this arises from there not being enough of water to cement it, and that appears to us natural enough, knowing as we do that the temperature goes on diminishing as we rise upwards. But how then does it happen that the summits, which are highest of all, and consequently surrounded with a colder atmosphere, are covered with ice? Without pretending to solve this problem in a definite manner, I still think that we may find a partial explanation in the detached situation of these high peaks, which are more exposed than the lower plains to the action of the solar rays and to that of winds. Suppose the wind to carry off the snow as fast as it falls, the sun will then have time to change all that remains into ice; in this case, the broad surfaces exposed to the south will necessarily be more affected by the action of the sun than the narrow surfaces and such as are turned to the north; and this is, in fact, what appears to take place. We remarked, while ascending the Jungfrau, that while the southern slope, on which we travelled, was covered with ice, the eastern, western, and northern sides were clothed with snow, and we even remarked numerous furrows of avalanches in it. The fact of the highest summit being of snow and not ice, may be explained by its narrowness, which presents less scope for the action of the solar rays.

The theory of the canon Rendu seems at first sight more conformable to the nature of the phenomenon. This naturalist, in order to account for the ice accumulated on the summit of Mont Blanc, supposes that it is the product of the condensation of the vapours which continually collect round the higher peaks of the Alps, and annually deposit upon them a layer of ice of greater or less thickness. But if this were the case, this ice would be spread equally over all the faces of peaks, which is by no means the fact; we cannot, moreover, understand, according to this hypothesis, why the extreme summit should be a worse condenser than the rest of the mass. Lastly, as I have already shewn in a former article,* the ice formed in this manner should have an entirely different texture; it should neither contain air-bubbles, nor be rough on the surface, like the ice of glaciers, but should rather have the appearance of glazed frost (*verglass*).

The bands of ice interposed between the beds of snow, examples of which were found in the snow-fields of the glaciers of Viesch and Aletsch, occur, according to observations we have made of late years, nearly every where in the plateaux of snow. Their formation is analogous to that of the ices which cover high summits, and is likewise to be ascribed to infiltrated water, since it is the only agent capable of transforming snow into ice. But if we consider that the quantity of water which can result from melting at such a height (fields of snow seldom descend below 10,000 feet) must be very inconsiderable, on account of the great evaporation and the temperature, which does not often rise above 0° (32° F.), we must come to the conclusion, as has been demonstrated by M. Agassiz, that these bands represent the value of the melting influence of the solar rays, and perhaps also of the rain, on the surface of the fields of snow, during a given time.

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* See Bibliothèque Universelle de Génève, tom. xxxii. p. 159 (March 1841.

In the snow-fields of the glacier of Viesch, to which reference was made in the beginning of this account, the bands of ice have almost a uniform thickness of a few inches; it is the same with the intervening beds of snow (which are from two to three feet thick), so that, considering their regularity, we are naturally led to regard them as annual beds. Where the alternations are less regular, they may not improperly be ascribed to the reiterated variations of temperature in one and the same season.

Care must be taken not to confound the phenomenon of bands of ice interposed between layers of snow with that of small beds of snow everywhere met with in compact ice. The latter occurrence is owing to other causes, which we will explain in another article.*

Reminiscences of Werner and Freiberg, and of Malte-Brun. By Professor HENRY STEFFENS *of Berlin.*†

I.—WERNER AND FREIBERG.

OUR‡ first impressions of Freiberg were by no means agreeable. The barren hills appeared exceedingly dreary. We saw the mine of Himmelfahrt and Abraham on our left, and a bell marked at uniform pauses the revolutions of the great hydraulic wheels of the mines. It seemed as if the spirits of the mines were already engaged in their mysterious and noisy orgies. We became silent as we passed through the streets; and the necessity of our remaining for some time resident there, was by no means agreeable to us. When, however, we had left the inn, and established ourselves in an agreeable lodging—though one surrounded by poor and wretched houses—our first dissatisfied feelings were soon blunted. The new occupations which lay before us—the descent into the mines, the subterranean activity which had existed here on so large a scale for

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* From Bib. Univ. de Genève, No. 71, p. 112.

† From Professor Steffens' very interesting work, "*Was ich Erlebte,*" now in course of publication.—EDIT.

‡ Möller, a Norwegian, and therefore a fellow-countryman of Professor Steffens, was his companion.—EDIT.

centuries—excited our curiosity; and we hastened to make the acquaintance of the two most distinguished men of the town, viz. of *Berghauptmann* (captain-general of mines) Von Charpentier, and of *Bergrath* (councillor of mines) Werner. I was not entirely unknown to them, for my little work on mineralogy and mineralogical studies had attracted some notice at Freiberg.

Freiberg had at that time reached the zenith of its celebrity. Throughout the whole of Europe Werner was unhesitatingly recognised as the first mineralogist of the day, nay, as the founder and author of the science. No one could compete with him as an oryctognost, and even Linnæus never possessed more universal authority in botany than did Werner in oryctognosy. In geognosy the Neptunists had obtained a decided victory over the Vulcanists, and Hutton's theory was scarcely mentioned. Mineralogists streamed to Freiberg from all parts of Europe and America. Humboldt, L. V. Buch, Esmark the Norwegian, Elhyar the Spanish Mexican, Andrada the Brazilian Portuguese, had been there during the preceding six years. In my time, I found still there Mitchel, an Irishman, who had already obtained in England considerable reputation in his department; and Jameson, a Scotchman, whose services to geognosy had been universally acknowledged since his travels in Scotland. Among those who subsequently became distinguished as celebrated mineralogists, there were D'Aubuisson the Frenchman, Mohs, and Herder. Werner was then in the prime of life, being nine and forty years of age.

His appearance was very distinguished, and struck me exceedingly at my first interview. He was middle-sized, and broad-shouldered; his round and friendly countenance did not at first sight promise much, but, when he began to speak, he at once commanded the most marked attention of every one. His eye was full of fire and animation; his voice, from its high tone, was somewhat sharp, but every word was well-weighed; a cautious clearness, and the most marked decision in the views he expressed, were apparent in all that he said. With all this, however, there was united a goodness which irresistibly won every heart.

Werner suffered uninterruptedly from a stomach complaint, and he was anxiously careful about his health. He was very warmly clothed; his stomach was always covered with an animal skin, and when he was in pain he added a hot tin plate. The climate of Freiberg is severe; but still I was not a little struck, on visiting him in the month of July, to find the stove lighted. He was exact even to pedantry. He was in the habit of taking with him in his carriage the pupils he was particularly fond of, to visit such spots as exhibited any remarkable geognostical peculiarity; and on such occasions he fixed with great precision the hour of starting, no one venturing to be a moment too soon or too late. If one went too early, he not unfrequently continued his labour, and looked attentively first at the individual and then at his watch; if he came too late, if it were but a few minutes, he was placed in embarrassment by finding Werner standing waiting on the stair, wrapped up, even on pretty warm days, in a greatcoat and fur. As it was my good fortune for a long time to accompany him on such expeditions almost every week, I was particularly careful to set my watch exactly with his. I was inexpressibly attached to that great and remarkable man. I was myself not unfrequently a sufferer from cramp in the stomach, but entirely forgot my complaint when the pain was over, and never thought of attending to my diet or mode of life. Werner, however, was constantly anxious about my health, and unceasing in his counsels about the system I should adopt. From respect to him, I was externally extremely attentive to what he said; but advice in this matter went but a short way with me.

I was present at an occurrence which, on one occasion, placed me and all his pupils in great perplexity. Werner's collection of precious stones was celebrated, and the suite illustrative of crystallization was one of the most perfect in Europe. At one of the lectures, a tray containing spinels was circulated, and every one, knowing Werner's peculiarities, endeavoured to move the tray with the greatest care and caution, in order that there might be no disorder produced among the crystals, no one venturing to touch any of them. Unfortunately, one of those present inadvertently struck the tray while it was going round. It was inclined, the crystals were thrown together, and it seemed as if they were about to be thrown down. It was an anxious moment. It is well known how great may be the value of even the smallest specimens, and how difficult it is, nay, almost impossible, to gather up all the crystals in such a case, when they have been scattered on the floor, and have fallen into the openings between the boards. Werner became pale, and was silent. The misfortune did not take place. The students carefully pushed the tray to the middle of the table, so that it might be in perfect safety; and we sat waiting anxiously for nearly ten minutes ere Werner recovered himself so as to be able to say, "Do not be offended at my having been so much agitated; the loss which might have happened would have been irreparable." He then told us, that some years before, a tray of precious stones had actually been upset in a similar way, and that the students had remained to assist in gathering up the small crystals. It is well known that Werner was the first who proved that the sapphire and ruby belong to one genus. "I possessed," he said, "a sapphire of three colours, white above, ruby red in the middle, and indigo blue below. It was the only specimen of the kind in the world. The piece was large, and it disappeared on that occasion; and if you should ever see such a specimen, claim it, for it must be the one which was stolen from me." The lecture was then abruptly terminated, and Werner did not entirely recover his composure for some days.

The chief service rendered by Werner to oryctognosy, was his sharp discrimination of the most delicate distinctions. In recognising and exhibiting these, his whole demeanour presented a combination of earnestness and assured conviction. Every single obscurity annoyed him, and he almost compelled his hearers to distinguish, with the greatest possible certainty, the most trivial variations in the mixtures of colours occurring in minerals. All the characters of minerals were classified with the most extreme minuteness; and every deviation from the arrangement so decidedly fixed by him, every case of doubtful apprehension vexed, nay, injured him. Although he employed no mathematical formulæ for the determination of crystals, yet his descriptions were the clearest and most exact that had been given previous to the time of Hauy, and were rendered so by the simplest means. The crystalline structure of minerals was first of all recognised by him; and the number of cleavages and their relative positions, even then contained the germ of the idea of a certain fundamental form of all the varieties of crystallization of individual genera, a view which afterwards became so important.

In oryctognosy Werner could follow every step of his pupils, could reprovingly notice any uncertainty and obscurity, and afford guidance for the acquiring that precision which was so characteristic of himself. In geognosy, on the other hand, he was obliged to leave his scholars more to themselves. But whoever, under his instructions, undertook a mountain expedition, received an extremely minute plan, according to which he was to make his observations. Every deviation, even the slightest one, from the rules thus laid down, and every neglect of any portion of them, was severely blamed. If one wished to derive any advantage from his intructions, it was necessary for him to give himself up unconditionally to his master; for the whole system was so intimately linked together, and the various elements of discrimination in oryctognosy were so closely united with the mode of observation in geognosy, that the disturbance of any of these rendered all the others uncertain and doubtful. I have never, either before or since, known a second individual whose personality was locked up with such decision in itself. It was this, in fact, which produced that unlimited sway which Werner exercised in his science, and which only in his later years he saw (doubtless not without grief) giving way.

There are examples enough of the triumphant power with which he not unfrequently dealt with his opponents. I here adduce one instance among many. Von Born had attacked him, and Werner revenged himself by a sharp criticism on his account of the minerals in the Raab collection at Vienna. It is well known that Werner was not a great traveller, and hence Vienna and its mineralogical museum were quite unknown to him. Von Born had described a tray in the collection, which, according to him, contained crysolites: Werner proved, in the most decisive manner, that the said tray did not contain a single crysolite, but that most of the specimens in it belonged to the variety of apatite, termed by himself asparagus stone. After the appearance of his criticism, Von Born avoided shewing this tray to mineralogical tourists.

We all know that Werner published but little, but the notes of his lectures formed the foundation of many oryctognostical manuals which appeared during his time, such as those of Wiedemann, Emmerling, Reuss, &c. down to that of Breithaupt.

I have heard from his publisher how anxious Werner felt during the publication of his "Theory of Veins,"* a work which must be regarded as a model of precision of its kind, and which is more particularly distinguished by its minute and exact distinction of the vein-formations, and of the peculiar composition of the various groups of substances occurring in veins. The printing lasted for years, and was often interrupted for months together, while Werner could not come to a decision as to the mode of illustrating his subject. Sheets already printed, were, three or four times in succession, cast aside, and entirely remodelled. The publisher was in despair.

As Werner printed little, his reputation was almost entirely founded on the complete devotion of his pupils; and Esmark's description of the Hungarian Trachytes, by means of which he endeavoured to illustrate the Neptunian origin of pearlstone, obsidian, and even of pumice, proves, in a remarkable manner, how completely the master controlled the views of his scholars.

Werner was in every respect a patriotic Saxon, and was thoroughly devoted to his sovereign and country. His reputation in France was great and decided. The leaders of the Republic were anxious to distinguish him, and sent him a diploma as *citoyen.* The monarchical, and by nature anxious burgher, was placed in great perplexity. He communicated the circumstance to his court, as he himself told me, but I do not remember if he obtained permission to accept the honour.

It is very remarkable how rarely the power exists of transmitting a true historical judgment of a man distinguished at a previous period. Few are able to exhibit with clearness at the

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* An excellent translation, with additional notes, by Dr Anderson of Leith, was published in 1809.—EDIT.

present moment the condition of science at a former time; and it is more especially in the case of a science, like natural history, which is developed with rapid strides, and in a few years acquires quite a different form, that we almost lose the power of estimating properly what is no longer received directly, but is obtained indirectly by means of the intermediate links of development. I cannot here enter into a scientific disquisition on the services of Werner. Probably most of my readers will say that I have dwelt too much on him; but I must be allowed to make this observation, that, notwithstanding his errors, Werner probably did more for the establishment of his science than Linnæus accomplished for zoology and botany. It is undeniable that less progress had been made in mineralogy, prior to the time of Werner, than in the sciences treated of by Linnæus, previous to him; and the former found an entirely rough material to work upon, which he left behind him in a state of good arrangement, and in many respects clearly defined. Even a triumph over him was only possible by means of the very arms which he himself had placed in the hands of his opponents.

Werner had received me with great friendship, and I continued to advance in his good graces, although I had sometimes deviated from his views in the work already mentioned. He knew well how little a well secured structure like that he had reared could be affected or shaken by feeble and abstract sketches of that kind.—Charpentier was Werner's rival. Although the latter occupied himself also with the practical parts of mining, yet mineralogy was always his chief subject. Charpentier, on the other hand, was, from his situation as *Berghauptmann*, and also from his previous occupations and inclinations, more particularly a practical miner. His services in this respect are universally known. He had established the great and remarkable amalgamation work at Halsbrücke, and had introduced great improvements in smelting as well as in the mining operations. Nevertheless he was very fond of geognostical investigations, and his observations on the occurrence of basalt in the great *Schneegruben* of the Riesengebirge had directed the special notice of geognosts to that display. These, it is true, did not appear till some years after I left Freiberg, but they were made many years before, and his view regarding that singular phenomenon was then well known. Upon the whole, he was no friend to a decided theory which should include all geognostical observations in one point of view, but held that geognostical investigations had not yet reached that degree of maturity which authorized us to bring forward such a theory. He was inclined to assume the occurrence of great expansions of gas in the interior of the earth, and to ascribe to these a great influence in the formation of mountain masses; while Werner endeavoured to explain every thing by mechanical and chemical precipitations, and by mighty floods. Thus these two individuals stood as scientific opponents to each other; and probably they only met when on business. Some ideas in my little essay coincided with Charpentier's views, and met with his approbation, and I received a welcome reception at his house. His family were much distinguished for their talents as well as for their varied acquirements. One daughter was married to General Thielemann, one of the bravest and best officers in the Saxon army; and a second was the wife of Doctor Reinhard, who had attracted great notice, and was universally respected as a learned theologian, a celebrated orator, and as the head of the Protestant Church in Saxony. I did not make the acquaintance of these meritorious men, but their ladies often visited their parents. A third daughter, Caroline, was unmarried, and was distinguished for her varied knowledge, her talents, and her matured judgment; she was also a skilful pianoforte player. The youngest daughter, Julia, beautiful, feminine, and with a melancholy expression, particularly attracted my attention, for she was the bride of Hardenberg (Novalis). I was eagerly desirous of the acquaintance of that remarkable and original poet, whose aerial-phantastic nature and powerful lightning-like expressions had seized hold of my mind in a wonderful degree. I had not previously met with a family so ennobled by refinement, and in which so much was to be met with that was mentally exciting; and a request to appear amongst them was at all times agreeable to us both, my friend Möller having been also a welcome guest at the hospitable mansion.

While our two most important individuals were Charpentier and Werner, our communication became extended with the most distinguished men of foreign countries, who were attracted by the high reputation of the latter. The life at Freiberg had now a great charm for me, in consequence of the new world which was opened up. We provided ourselves with mining dresses, in which we diligently traversed the mines. Werner had advised us to begin with the united mine of Himmelfahrt and Abraham, because its passages, &c. were the least complicated. We went there twice a week; and the mining world made a great impression on me. These subterranean regions, and the deep night which reigned in the shafts and galleries, presented to me something irresistibly attractive. It certainly cost us no small labour to distinguish the veinous masses, and the minerals of which they were composed, in the darkness which was so sparingly illuminated by the mining lamps, and in the midst of wet and mud. It was still more difficult—nay, it appeared at first almost impossible—for us to follow the direction of the veins, in which we directed our course by the compass, and to learn clearly how they crossed one another, cut each other at acute angles, or were interrupted by fissures. When we descended the perpendicular ladders, when the blue of heaven gradually disappeared through the opening; when the great wheel, by means of which the water of the day was set in motion, made its revolutions close to us in the narrow rocky aperture, and the sound of the bell indicated each turn; while around us, on all sides, the drops, quietly murmuring, unceasingly fell down:—we were at first peculiarly affected by singular and strange feelings. By degrees, we descended the more distant mines of Beschert Glück, Himmelsfürst, and Kurprinz, with their rich ores. A stranger attending the academy receives, on application, directly from the Elector, the permission to examine all the mines of the Erzgebirge, with the exception of the arsenic and cobalt mines of Annaberg and Schneeberg. My fancy was highly excited as I gradually witnessed the great extent, and the mighty, far-extending internal connection of the subterranean workings. For a period of five hundred years, the interior of the rocks had been penetrated in all directions, the numerous veins which everywhere traversed them had been opened up, and not a few of them fully exhausted. The shafts were sunk perpendicularly, or more or less slantingly downwards to points the most different in situation. Sideways from these shafts, the vein-masses had been pierced and mined above and below. At certain depths, at an equal level, the different mines were united together by galleries running horizontally, which were conducted to the surface. Formed with a slight inclination, they serve to carry off the water from the mines, to transport the ore by an easier route than the shaft, and to introduce a fresh current of air. The deeper the gallery-connection, the more advantageous it is.

I have touched on these well-known circumstances, because they made a deep impression on my imagination. I asked myself the question: When thousands of years shall have passed away, what will remain of our times? What that can be compared with the gigantic walls of former races, with the remains of Cyclopean buildings, with Susa and Palmyra, with the ruins of Greece and Rome, with their roads and aqueducts? Our slightly built towns will scarcely leave a trace behind; our palaces will crumble away, our largest manufactories, changeable as the speculations which called them forth, will speedily disappear. Here and there the walls of a church of the middle ages may support the tradition of a fine taste in architecture; every thing else produced by the modern period will be swallowed up in the immeasurable mass of what has been written and printed, nay, will be as dimly perceptible from this abyss, as are the sagas and mythological fables from mere oral tradition. When, then, a curious traveller shall wander through the desert places of formerly flourishing states, when an accident of any kind shall open up the entrance to one of these deeply situated galleries,—when bold men shall have courage to penetrate deeper and deeper, when openings in different directions shall afford access to a knowledge of the connection of these subterranean workings, though they may not admit of their being directly followed through all their ramifications; then will subterranean works be encountered, gigantic like the works of the ancients; and it appeared to me as if it were by means of this vast series of mining operations alone, that we should leave behind us a monument of stupendous art, which might be compared with the remains transmitted to us by periods long gone by. The more I became acquainted with the mines of Freiberg, so much the more did the importance of the whole system become apparent. Mining had enriched mineralogists with observations of the most important kind, while at the same time it was in fact intended to exercise a great influence on the interests of the state. The miners also did not interest me less, than the value and financial importance of their labours. I visited their huts with great interest. They are a good-humoured, peaceable race; but I could find but few traces in them of subterranean imagination, or any thing at all poetic that might have given a higher character to their laborious occupations. Pinching poverty and ceaseless anxiety for the immediate future, allowed neither pleasure, pain, hope, nor fear, to exhibit itself in a poetically joyous or sad form.

I had a private course of instruction from Köhler on the administration of the mining system, and on mining itself, in so far as it was important for my purpose. At my desire he also added some historical information respecting the origin and progress of the mines, and, in this respect, the organization of the Saxon mining system is very remarkable. It was naturally and quietly developed, as necessity gradually called it forth. This was the first time that I had clearly followed out the history of any particular practical subject; and this voluntary limitation to an entirely isolated topic, seemed to me to promise unexpected conclusions as to other branches of the development of the human species. The result, however, of this history of mining left a disagreeable, nay, a mournful impression on my mind. The mining operations began in the 13th century, and rumours of the unbounded richness in native metals and noble ores form the foreground of this history. The oldest masses which were formed, clothed the walls of both sides of the open fissures in rocks. Newer formations produced a new covering, and the oftener these formations were repeated, many of which were of entirely different kinds, the more were the fissures contracted. Thus, as Werner believed, were the vein-masses filled from above in the primitive geognostical period. For the most part, however, there remained in the so-called upper-depth (*obere tiefe*), a small space, which was for a long period empty. Chemical changes in the old vein-masses surrounding this space, now took place. Crystals projected from the walls into the cavity; new products lined these walls; various ores and minerals were gradually produced there, and it is extremely interesting to follow out the accumulation of these formations. It is not alone in the veins themselves, but also in separate hand-specimens in museums, that we can observe the multifarious alternations of processes, the direction in which the crystalline precipitates were deposited, and the limitation of the varied products. Here shot out the native silver in delicate twisted hairs, in a coralliform or dendritic form, or in thick compact masses. Here were formed the richest ores, accessible without much labour to the miner, and which were of such a nature as to be won in the fine metallic state by the simplest and least expensive processes. This richness of the *upper depth* had disappeared. By constantly increasing exertions, and always augmenting cost, the less rich and more difficultly treated ores were obtained; and thus labour and expense increased with the poverty of the rocks. Then came extraordinary expenses, the restitution of this additional outlay, and but little real profit. The extraordinary contributions afterwards increased, the restitution became rarer, and but few mines produced profit. I was interested and grieved by seeing how the slightest glimmer of hope was seized in every new mining operation, and I do not remember having, during my stay, seen such hopes realized. I am unacquainted with the present condition of the Saxon mines. I believe that the rapidly increasing manufacturing activity of the Erzgebirge must continue more and more to take away, upon the whole, in a beneficial way, the hands formerly employed in the much less productive mining operations. This continued sinking of the mining interests, and chiefly of those at Freiberg, produces on me an extremely sad impression. I know of no bleaker sight than that of the accumulation of the constantly increasing hills of barren stones round the mouths of the mines, in the midst of rubbish. Not only have the woods disappeared from the vicinity of such heaps, but the soil admits of no smiling vegetation, and even the grass is stunted; the wind whistles cheerlessly over the bare lifeless heights, which are extended into long flat surfaces, and which, together with a few isolated, dreary-looking huts near the shafts, constitute the whole landscape.

But however much I endeavoured to limit myself voluntarily to empirical clearness in following up a narrower object; however little of an attractive nature was presented to me by the barren scenes I have described, yet all this was but the external portion of my being, and a richer life actuated me and was enjoyed by me in all its phases in the midst of apparent poverty. Although actually at Freiberg, I lived chiefly at Jena; for, a constant correspondence, especially with Schelling, informed me of every thing that took place there. The Wernerian geognosy continued to acquire more and more importance in my eyes; these were moments which excited me to speculation, and a view was darkly shadowed forth which was peculiar to myself, and which made a deeper and deeper impression on my mind. I could not conceal that which filled my soul, and I communicated my views confidentially to Werner. It was natural that one like him, so completely shut up within his own views, should not be entirely pleased with me. He openly expressed his dissatisfaction, and seemed to hint that in the fuller delineation of his doctrine of formations, there was something hidden which occupied his attention, but which was not yet developed. My relations with him nevertheless became more intimate. The deep respect which penetrated me, the regard for his peculiar firmness and decision, the confidence which I shewed him in every case, even the hope that his doctrine might receive from me a deep intellectual signification, and should enter as an important element into the great fermentation of mind which should call forth a new element in history, drew him onwards, and caused a union between master and scholar which had not previously existed. And yet every modification, every gradation of expression was disagreeable to him; and it was of no avail if I attempted to make it clear to him, that within the bounds of his scientific circle, his modes of expression would and must retain their value. He seemed to see more distinctly than I myself did at that time, that his last explanatory reasons in opposition to my views might not be able to stand. He appeared to fear that, proceeding from this dangerous centre, his whole geognostical doctrine must undergo a change, by which its peculiar characters would be destroyed. Werner exercised a most decided influence over his scholars, and, all the more distinguished among them at least, seemed to expect much from me, and yet to regard me at the same time as a foreign, disturbing, alarming element.

I lived on friendly, nay, on confidential, terms with the more distinguished strangers who then resided at Freiberg on Werner's account, and more especially with Herder and Von Herda, and with the Englishmen, Mitchel and Jameson. The Pole Mielesky, now *Berg-Hauptmann* in Westphalia, and Count Beust, now *Ober-Berg-Hauptmann*, although then very young, especially the latter, were much with me. I was requested by them to give lectures on philosophy, and I was glad to have an opportunity of speaking of what seemed to me so important. Schelling's transcendental *idealismus* had just appeared; this work, which for its clearness, and for the ingenious and gradual development of his method, must ever be regarded as an unrivalled master-piece, constantly occupied me. I endeavoured to make clear to myself, as well as to my hearers, the relation of the ideal part of philosophy to the real, the apparent parallelism of the two, and their higher unity. But though I succeeded in attaining clearer views myself, I was scarcely able to communicate this perception to my scholars. Mielesky had a tutor called Haberle, who accompanied him to all the lectures, and he seemed the most interested in my disquisitions. He afterwards attracted notice as a meteorologist, by connecting himself with Howard's doctrine on clouds; and when at Erfurt, he entered into communication with Göthe. But even to him the subjects of my instructions remained entirely unknown, and I did not win any proselytes to my views. Philosophy was too far removed from the other occupations of my companions; and in all Germany, it would have been impossible to find a more unfavourable place, than Freiberg then was, for gaining supporters. The Englishmen, being strangers, were, it is true, curious to learn what German philosophy actually meant. I soon saw, however, that my prelections were quite fruitless, and I resolved to discontinue them. D'Aubuisson did not attend them, and Mohs also, who possessed an acute logical mind, and to whom a clear perception of a subject was every thing, took no part in our meetings. But with him I was intimately connected in the field of mineralogy. In geognostical investigations he was my guide and conductor, and I made many excursions in his society. He followed entirely the directions given by Werner, and mastered them entirely, and with greater precision than I did.

II.—Malte-Brun.

Malte-Brun was a student in Copenhagen about the same time as myself; we saw each other often, and friendly relations existed between us; a confidential intercourse could not however subsist, as such was only possible with me when my internal mental tendencies met with some sympathy and encouragement. Malte-Brun had almost a boyish appearance, and although, as he himself said, he easily excited confidence, yet one easily discovered something changeable and undecided in his character. He was strong and fair; his person was somewhat effeminate, and his gait, like his demeanour, somewhat unsteady; but, at the same time, he was extremely active and restless, without being violent. He had the reputation of possessing good school acquirements, and the desire of making himself speedily, and in the easiest way, remarkable, was his leading propensity. Thus, soon after his examinations, he became a political writer, and attained as such a certain reputation. He wrote pamphlet after pamphlet, and, as little attention was paid to the first, he became so much the bolder. On one occasion, when his violence was loudly complained of, he disappeared, and concealed himself under the protection of friends. I generally knew his abode, and it of course happened that the pursuits of the police excited greater sympathy than his attacks had ever obtained for him. I scarcely read the latter; but the knowledge of his place of concealment, and my visits to him there, possessed for me a hazardous interest, as every political secret has for the young. At last his position became so precarious, that it was thought necessary for him to fly to Sweden, and his friends took it into consideration how his escape should be managed. Malte-Brun's personal timidity was well known, and one of those who took part in the deliberation having thought it necessary that he should be provided with loaded pistols, another of them, Rahbek, exclaimed, "Would you put arms into the hands of his enemies?"

I met Malte-Brun at Leipsic in 1799. He had now, as Heiberg* had previously done, left his country for ever, in order to push his fortune in Paris. He possessed the power of easily obtaining the command of foreign modern languages for conversation or writing. The young man sighed after his native country, but prophesied the overthrow of the government, and a speedy deliverance. As he was then disposed, he only wanted some one to direct him, who should be upright and bold, for his inclinations were entirely ruled by the opinions that prevailed around him. A few years afterwards his celebrity became known to us from Paris. He was the original founder of universal and scientific geography in France; he was the first to supply a national deficiency in that country; and not there alone, for he treated his science in a freer, clearer, and more comprehensive manner than it had ever been discussed in England or Germany. As Humboldt founded the new science of physical geography, so Malte-Brun was the first who employed it, though not to the full extent necessary, in general geography. There was an emulation in France to out-bid for foreigners whose merits were acknowledged. It succeeded in this case; geographical societies were everywhere formed, and Malte-Brun was long the recognised centre of these undertakings. But his early developed political tendency was not at rest; he sold himself to Napoleon, and took an active part in the *Journal des Debats*, which for some time was called the *Journal de l'Empire*. When Blucher retreated after the battle of Epernay, in order to concentrate his forces, this journal was published at Napo-

* Heiberg was originally a violent democratic writer at Copenhagen, and was afterwards employed by Talleyrand.—EDIT.

leon's head-quarters. The articles there printed, which announced that the battles of Brienne and Epernay were victories obtained by the French, and that the army of Blucher had been completely broken up, were, as was confidently asserted, the compositions of Malte-Brun. When I heard this at the head-quarters of Blucher, recollections of the early days I had spent at Copenhagen recurred to my mind with renewed freshness; and it was singular to reflect how Malte-Brun and myself were now engaged on opposite sides in the mighty warfare of foreign nations.

I afterwards met Malte-Brun in Paris, in the district inhabited by men of letters, in the *Rue St Jacques*, and he still had his boyish appearance, but now wore a white cockade. He lived very respectably; and his little wife, a native of Laon, was an interesting, pleasing person. I do not remember if they had been long married, but they were very affectionate to each other. The following day he gave a splendid *dejeuner*, at which there were several scientific men, and among others Cuvier, whom I had already visited; Humboldt had sent an apology. He was unfeignedly happy to see me after so long a separation, and expressed himself freely regarding his position. He would not admit that he had accompanied the imperial head-quarters, although I heard the report confirmed by several scientific men. I soon remarked that he had lavished on this breakfast a large portion of the sum which he had at his command. It was evident that his circumstances were extremely straitened, and at last he made no concealment of it. "Brun," I said, "it must be disagreeable to change your political opinions so frequently. You left Denmark as a democrat, nay, almost a demagogue, in order to become the political servant of Napoleon; you now wear a white cockade; and though the protection, nay, even the honour, with which the conquerors of France shew you, should continue, yet, in a few years, the country will rise up, acting as a mighty kingdom, and, feeling itself oppressed by a dynasty forced upon it, will supplant it by another. You will then have to wear a cockade of a different colour, in place of the white, which, I think, you have adopted prematurely and too hastily. It is doubtful if you will be able to hold out under the Bourbons;

therefore leave Paris, and at Bonn, where a new university is being formed, I do not doubt that your fame will secure you an honourable situation. You can make your own demands, and such a place would be secured to you for your whole life. You will then be removed from all uncertainties in your future existence, and from all politics; living in the vicinity of France, you may devote yourself entirely to your science." I was entitled at that time to persuade him to take such a step, for his reputation as the first in his department in Europe, was so decided, that, if I had but hinted to Hardenberg that his services could be obtained, an offer would undoubtedly have been made to him. "My friend," he replied, "it is true that my position here is by no means a certain one; at present it is a straitened one, and my immediate future prospects are doubtful, but you err when you believe that this causes me much uneasiness. When one has money enough, there is no place where one can live more agreeably than in Paris, and also no place where one can live less disagreeably with little money. I have no children, and love my wife, who has not been spoiled; actual want is still remote, and when affairs are somewhat brought into order, and peace returns, my position will at all events be improved. I know the Parisian public, and can live independently as a writer. But I shall never quit Paris, and shall never take my young wife to a strange country; I can live no where but in Paris, the atmosphere of this town is to me the breath of life, and I should die in any other place; conveniences and pleasures are no where to be met with as they are here, whether one be rich or poor." He could not express himself sufficiently strongly on the necessity of living in Paris alone. During this period of narrow circumstances I found him but rarely at home, but we made appointments in the gardens of the Tuileries, in the Champs Elysées, and at various cafés, and he and his wife seemed always free from care and happy. The Journal des Debats probably did not appear at that time, but he published for a short period a journal whose title I have forgotten; I made use of it in order to introduce some essays, translated by him into French, intended to inform the French of their position in regard to the victorious armies. They must have seemed too temperate in the state of things which then prevailed, and, amidst the confusion which existed, they were probably scarcely read, and certainly not attended to.

Malte-Brun deserted his Emperor, in such an incomprehensible manner, that it may well be supposed his want of feeling was very distasteful to me, and was disgusting to a man of such determined principles as Heiberg. The latter hated such weak characters, and Malte-Brun seemed to fear his countryman, so that they never saw each other.

Some years after the war, I saw mentioned in one of the French newspapers, that Malte-Brun had opened a *salon* which was much frequented. He died during the Restoration.*

Notice of Professor Steffens' Geological Writings.

THE author of the preceding paper, Professor Steffens, is one of the most remarkable men of the present day, for the diversity and accuracy of his acquirements, the multifariousness and brilliancy of his writings, and the singularly varied events of his personal history. He has distinguished himself as a naturalist, a theologian, a moral philosopher, a novelist, an orator, and a soldier. At present we propose giving a short sketch of his contributions to geology, which we borrow from Hoffmann's *Hinterlassene Werke*.

Although Steffens did not receive all his geological instruction in the school of Freiberg,† yet he attached himself with peculiar zeal to the views there promulgated, and endeavoured to impart to them a higher philosophical meaning, by attempting to prove the internal connection of many of the phenomena of the formation of the earth's crust. The natural-philosophical school, which was in the course of being formed at the early period of his career, and of which Schelling may be regarded as the first representative, endeavoured to explain a

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* Malte-Brun died suddenly at Paris in 1826, in the midst of his labours as Secretary of the Geographical Society. His widow received a small pension from the *Journal des Debats*.—EDIT.

† Before going to Freiberg he published his essay, "*Ueber Mineralogie und das Mineralogische Studium.*" Altona, 1797.—EDIT.

great many natural phenomena, by the idea of their being placed in a necessary contrast to others, a contrast with which the phenomena of polarity, observed in so many natural objects, might be compared. Steffens was the first, nay, the only one, who attempted, and that in a most able manner, to apply to geology this mode of investigation, to which we are indebted for numerous additions to our knowledge of the natural sciences. At that period he wrote a work, which was received with the most lively interest by his contemporaries, and was entitled, Contributions to the Natural History of the Interior of the Earth (*Beiträge zur innern Naturgeschichte der Erde*, Freiberg, 1801). This book contains many attractive delineations, is filled with a rich collection of geological views, and is altogether most remarkable for the time at which it was written. He regarded the alkalies and earths as metallic oxides (as had previously been supposed by Lavoisier and Bergmann); and his account is peculiarly animated of the great contrast, which he himself first pointed out, between the siliceous and calcareous series of the newer formations of the crust of the globe, by means of which all rocks of the Neptunian origin can be arranged under two principal groups. He directed attention to the remarkable fact, that, of the higher extinct organisms, stratified rocks belonging to the siliceous series contain chiefly remains of plants, the largest accumulations of which present themselves in the rocks of the coal formation, and hence he concluded that the development of such organisms was necessary for the formation of the coal itself. In the rocks of the calcareous series, on the other hand, there is the same predominance of animal remains; it is there that the coral rocks and beds of shells are found, which seem to require for their formation the existence of a considerable quantity of lime in the surrounding medium. Beds of coal in limestone rocks were at that time quite unknown, and are even yet a rare and inconsiderable phenomenon. Steffens therefore concluded that the origin and further development of nitrogen was connected with the appearance of lime, and hence considered that the great contrast which was expressed in the higher organisms, by the simultaneous advancing development of the animal and vegetable kingdoms, had been

ILLUSTRATIVE OF PROFESSOR ESCHRICHT'S MEMOIR ON INTESTINAL WORMS.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6

Fig. 7.

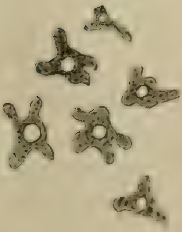

Fig. 9.

Fig. 8.

J. G. Mitchell, Sculpt.

PLATE VIII.

25.30.40.

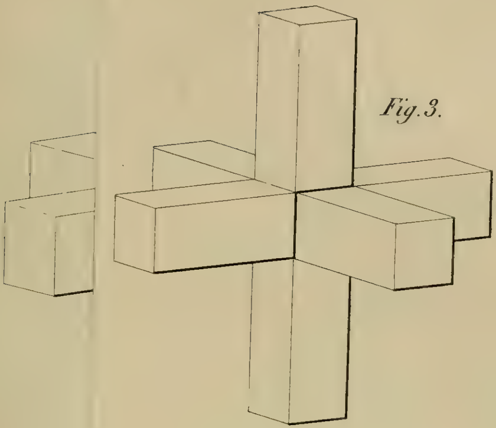

Fig. 3.

20.30

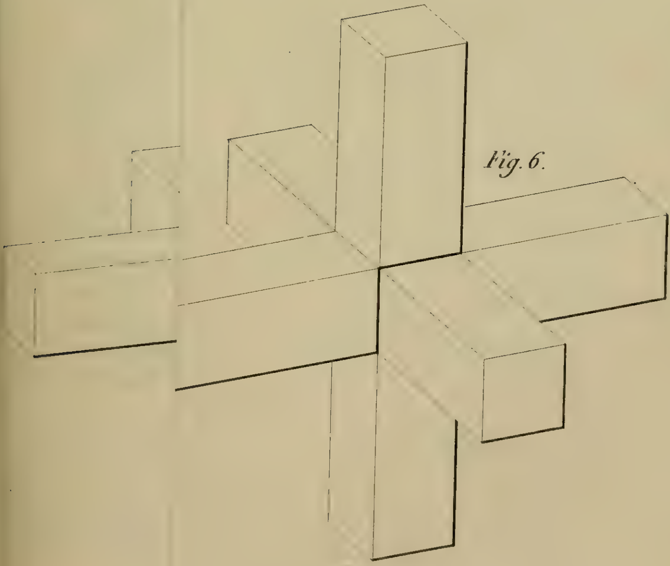

Fig. 6.

Edin.r New Philosophical Journal
Vol XXXI. P. 385.

PLATE VIII.

40 50 60

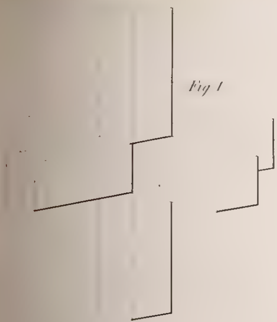

Fig 1

10. 10.10 ISOMETRICAL

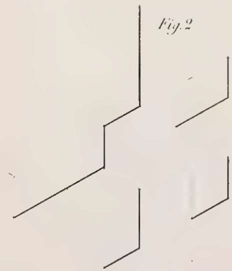

Fig. 2

25 30 40

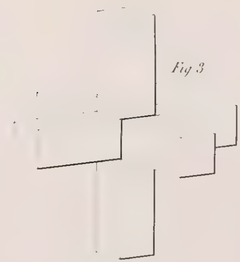

Fig 3

10 20

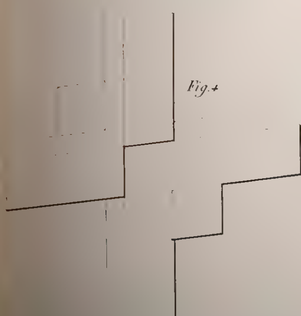

Fig. 4

10 30

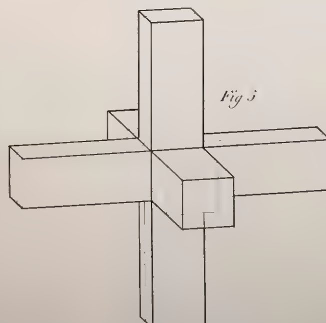

Fig 5

20 30

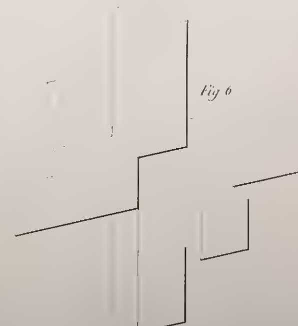

Fig 6

Mr John Sang on Orthographic Projection.

first established in a more imperfect and lower grade at the appearance of the calcareous and siliceous series in the formation of the crust of the earth. We now know that this can be explained in a much simpler and more natural manner, by the consideration, that the strata of the siliceous and argillaceous series of the newer formations of the earth were always formed under circumstances of disturbance, inasmuch as the surface of the earlier continents was at such periods broken up and the plants stripped off, which latter formed, as they do on the continents of the present day, by much the prevailing mass of bodies of higher organization. The rocks of the calcareous series, on the other hand, were deposited slowly and tranquilly under a great ocean, and it is in the bosom of the deep that by much the largest quantity and the most varied kinds of animal beings are still produced. It does not, however, remain the less an essential and valuable service rendered to geology by Steffens, that he was the first to point out with exactness, and to illustrate this contrast; and it is to the appearance of this essay in a great measure, that we are to ascribe the greatly augmented interest evinced at the time in the progress of our science.

This is the most important of the works by Steffens devoted to Geognosy. He published a continuation of it at Hamburg in 1810, entitled, *Geognostisch-geologische Aufsätze,* which contains a variety of important observations. He there gives a lively and original account of the phenomena of the coal formation, in which he explains the innumerable, often a hundred times recurring, parallel beds of coal, by the probably different nature of the climate of the earth at earlier periods, regarding them as the products of an alternation of energetic summers, and winters abounding in floods. The work likewise includes some very curious observations on geognostical phenomena occurring in the great plain of Northern Germany, on the two remarkable projecting gypsum hills of Lüneberg and Segeberg, whose age he endeavoured to determine, and which were not more minutely investigated until long afterwards.*

* Steffens published a work on Mineralogy, entitled "*Handbuch der Oryktognosie,*" 3 vols. Halle, 1811-15.—Edit.

Among the subsequent scattered writings of Steffens there are also some geological essays, and there is one that I must specify,* in which he proves, in a very convincing way, that the deep hollow of the Hirschberger and Warmbrunner valley, on the north side of the Riesengebirge, and which is surrounded by high mountains, owes its origin to a great breaking up of a previously existing connection, and in fact to a great sinking.†

Note and Tabular Statement of goods exported via *Delhi across the North West Frontier of India to Cabool, from May* 1838 *to* 30*th April* 1841.

The annexed statement will shew the enormous increase which has taken place in the export trade to Cabool during the past year, aggregating on the three descriptions of produce, no less than 38,08,873 rupees as compared with the preceding year.

Of the three denominations of exports, one only, being country produce, is prepared from official records (chokie registers). No account being taken at the customs' chokies of free goods, I have been obliged to refer to the merchants themselves for information as regards them, and they have obligingly allowed me access to their ledgers, from whence the amount of exports under the heads of 'British manufactures and Productions,' and Sea Importations, has been ascertained, not in exact details, but sufficiently accurate to meet the object in view.

I may as well mention, that previous to the occupation of Affghanistan by our troops in 1838–39, the exports from these provinces were trifling to a degree, the returns for the imports being for the most part sent back in specie. Within the last year or two, however, the demand for our exports has so greatly increased, that instead of taking back specie, Hoondies to a very large amount are sent to Dehli from Cabool, to

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* See Steffens' *Schriften, alt und neu.* 1821. Vol. i. p. 190.

† Many geological disquisitions are contained in Steffens' "*Anthropologie*," published at Breslau in 1822, in 2 vols. The first half of the 1st vol. is occupied with what he terms "*Geologische Anthropologie.*" The second part of his "*Polemische Blätter,*" published at Breslau in 1835, is entirely devoted to discussions on the recent progress of Geology.—Edit.

meet the deficit caused by the excess of exports from these provinces, over the imports from Affghanistan. Some time last year, one merchant sent us a single remittance, Hoondies on Delhi from Cabool for no less a sum than forty thousand rupees, to be invested in the purchase of British goods.

Formerly the whole of the Export trade with Cabool, was carried on by the fruit merchants, who merely took back a small portion of their returns in British manufactures. There are now several highly respectable merchants wholly unconnected with these traders, who confine their operations to exporting from our provinces goods for which, at present, they are unable to find a return in kind.

As it shews how anxious they are to establish a return trade, I will mention, that more than one instance has been reported to me of Russian goods (principally hardware and spurious gold tissue) having been brought across my frontier line, the packages having Moscow marked on them; these goods were, however, of so inferior a description, as to be rejected by the natives whenever offered for sale. Indeed the cutlery was inferior to that made at Monghyr and in the Delhi Bazaar.

In reply to your second question, as to whether I can do nothing to help the Cabool merchants, I can only state, that I have done, and am doing, all in my power to encourage this enterprising and deserving class of men, in every way possible.

In the mean time, I would suggest that the first object of Government should be to open the route for trade, through the Khyber Pass, by obtaining from the intermediate states some modification of their present system of duties, which press so hard on the merchant as to drive him round by the circuitous route now taken, where they are subjected to exactions it is true, though less oppressive and vexatious in their nature than those in force in the Seik states.

P.S.—To shew the enterprising disposition of the Cabool merchants, I will mention that a short time ago I gave one of them a note to Mr Clarke to aid him in his endeavours to take an investment of Indigo, Jewellery, Gold Lace, &c. to Yarkund.

STATEMENT OF GOODS EXPORTED *via* DELHI ACROSS THE N. W. F. TO CABOOL, FROM 1ST MAY 1838 TO 30TH APRIL 1841.*

NAMES OF GOODS.	From 1st May 1838 to 30th April 1839.		From 1st May 1839 to 30th April 1840.				From 1st May 1840 to 30th April 1841.				REMARKS.
	Quantity.	Invoice Value.	Quantity.	Invoice Value.	Increase in Value.	Decrease in Value.	Quantity.	Invoice Value.	Increase in Value as compared with 1838-39.	Increase in value as compared with 1839-40.	
British Manufactures and Productions.											
Long Cloth, bleached	5,000 pieces	65,000	3,500 pieces	42,000	...	23,000	25,000 pieces	3,00,000	2,35,000	2,58,000	Unbleached Long Cloth is preferred to the bleached, as it is more durable, and admits more readily of being dyed blue, the favourite colour of the North.
Ditto, unbleached	4,340 do.	40,000	2,400 do.	18,000	...	22,000	45,000 do.	4,20,000	3,80,000	4,02,000	
Muslins, plain and flowered	11,000 do.	55,000	8,000 do.	40,000	...	15,000	77,000 do.	3,95,000	3,40,000	3,55,000	Flowered Muslins in high demand.
Jaconet Muslins	6,000 do.	40,000	4,000 do.	32,000	...	8,000	42,000 do.	3,36,000	2,96,000	3,04,000	The finest quality prized.
Cambrics	5,400 do.	48,000	2,000 do.	20,000	...	28,000	28,000 do.	2,90,000	2,42,000	2,70,000	Scotch Cambrics eagerly bought up.
Dimities	4,000 do.	36,000	3,000 do.	27,000	...	9,000	28,000 do.	2,52,000	2,16,000	2,25,000	This includes coarse Chintzes also, which, from the durability of the colour, are valued.
Handkerchief Pieces	2,000 do.	35,000	1,500 do.	22,250	...	12,750	14,000 do.	2,20,000	1,85,000	1,97,750	Used chiefly for Turbans.
Broad Cloth	3,000 do.	81,000	2,000 do.	54,000	...	27,000	21,000 do.	5,87,000	5,06,000	5,33,000	Coarse quality and sombre colours preferred.
Velvets	... ...	...	... ...	...	...	...	400 do.	60,000	60,000	60,000	Very little used in Affghanistan Proper, but great demand for Balks, Bokhara, Khorassan, and Tabreez Markets.
Brass, Copper, and Iron	50 mds. and 200 sheets	5,000	30 mds. and 160 sheets	3,500	...	1,500	350 mds. & 1,400 sts.	28,000	23,000	24,500	British Metals, not only from the original superiority of the ore, but from the superior method of smelting, are in great demand throughout Asia.
Pewter and Lead	250 pigs	10,000	175 pigs	7,000	...	3,000	1,750 pigs	77,000	67,000	70,000	
Iron, &c. scales	1,000	1,000	600	600	...	400	7,000	7,000	6,000	6,400	
Copper, Brass, Iron, and Block Tin Pots and Pans	581 mds.	29,050	557½ mds.	27,875	...	1,175	4,067 mds.	2,03,350	1,74,300	1,75,475	British Hardware, next to Cloth, is so much prized, that it is expected it will comprise one of the chief staples of commerce.
Cutlery, Knives, Scissors, &c.	20¾ gross	2,450	11 gross	2,325	...	1,925	145¾ gross	29,750	25,500	27,425	
White Lead	... ...	...	... ...	...	...	...	512 mds.	10,250	10,250	10,250	
Glass Ware	... ...	..	... ...	...	...	...	800 scores	20,317	20,317	20,317	Bought up at Cabool, and exported to Herat, Balk, Bokhara, &c., but chiefly to Persia.
Flints	... ...	...	... ...	...	...	...	5,111 gross	10,000	10,000	10,000	
Alum	... ...	...	... ...	...	...	...	1,660 mds.	25,000	25,000	25,000	
Total	... ...	4,49,300	... ...	2,96,550	...	1,52,750	... ...	32,70,667	28,21,337	29,74,117	
Sea Importations *via* Calcutta and Bombay.											
Spices, Drugs, &c.	25 mds.	700	18 mds.	450	...	250	3,500 mds.	75,000	74,300	74,550	
Logwood	32½ do.	224	... ...	...	...	224	2,400 do.	23,000	22,776	23,000	
Brimstone	... ...	...	... ...	...	...	...	530 do.	8,480	8,480	8,480	
Quicksilver	... ...	...	... ...	...	...	...	30 do.	5,000	5,000	5,000	
Pigments	5½ mds.	68	... ...	...	...	68	500 do.	24,000	23,932	24,000	
Sandal Woods	... ...	...	... ...	...	...	...	320 do.	4,800	4,800	4,800	
Beetle-nuts	10,000 mds.	50,000	600 mds.	3,000	...	47,000	70,000 do.	3,50,000	3,00,000	3,47,000	
Cornelian Stone	... ...	...	... ...	...	...	...	2 do.	2,000	2,000	2,000	These are brought to Delhi from Bombay *via* Palee. They are originally imported from the Persian Gulf.
Malas or Rosary Beads	... ...	...	... ...	...	...	...	28,000 strings	3,500	3,500	3,500	
Total	... ...	50,992	... ...	3,450	...	47,542	... ...	4,95,780	4,41,788	4,92,330	

* From Journal of the Asiatic Society of Bengal, No. CXIV. 1841, page 476.

Country (Indian) Productions and Manufactures.											
Piece Goods, Cotton, Silk . . . Brocades & Benares Dooputtas	49,226 pieces	85,502	28,923 pieces	82,628	...	2,874	1,60,832 pieces	2,78,501	1,92,999	1,95,873	The rich stuffs of India are very much admired, and the coarse linen cloths are preferred to those of the north, in consequence of their being woven with country and English yarn.
Indigo	1,500 mds.	1,65,000	1,143 mds.	1,25,763	...	39,237	2,405 mds.	2,63,641	93,641	1,37,878	Indigo is the only article of commerce which is not conveyed directly by the Cabool merchants. It is, in the first instance, consigned by the Delhi merchants to Bewamie and Amritsir, and from thence is exported to Cabool, where it meets with a ready market. The quantities herein exhibited are not a tithe of what are actually exported from India, as, within the last few years, immense quantities have been raised west of the Jumna, especially at Munny majra in Sirhind, the whole of which are carried to the northern marts. There is no possibility of ascertaining quantities correctly, but 5000 mds. are assumed as the annual supply sent to Cabool. Indigo, manufactured after the native manner, is preferred to that produced by Europeans, both from cheapness and the facility of applying it to purposes of dyeing.
Shoes	93¼ pairs	545	1,713 pairs	905	360	...	4,408 pairs	2,182	1,637	1,277	
Spices	1½ mds.	282	... ...	...	...	282	8 mds.	283	1	283	
Gotah Kenarie Gold and Silver Lace and Tissues	... ...	...	... ...	...	...	...	1,074 tolahs	2,511	2,511	2,511	Spurious gold and silver lace and tissues used formerly to be imported into Cabool from Russia, but these have now given place to the rich and beautiful manufactures of India.
Embroidered Goods	... ...	...	... ...	...	...	...	72 pieces	821	821	821	
Mirzapore Carpets	... ...	...	... ...	...	...	...	255	868	868	868	
Beetle-nuts	16 seers	12	... ...	...	...	12	26¾ mds.	215	203	215	
Cocoa-nut Oil	... ...	...	... ...	...	...	...	20 do.	280	280	280	
Hides, raw and tanned	14¼	65	... ...	...	...	65	585	434	369	434	
Leather Stockings	... ...	...	... ...	...	...	...	100 pairs	300	300	300	
Wax Candles	... ...	...	... ...	...	...	...	7¼ mds.	580	580	580	
Verdigris	... ...	...	... ...	...	...	...	35 seers	96	96	96	
Amber	... ...	...	... ...	...	...	...	43 tolahs	129	129	129	
Cocoa-nuts	... ...	...	... ...	...	...	...	3,300	132	132	132	
Wrought iron	... ...	...	... ...	...	...	...	58¼ mds.	190	190	190	
Brown Sugar	... ...	...	... ...	...	...	...	5¼ do.	46	46	46	
Oil Seeds	... ...	...	... ...	...	...	...	31½ do.	63	63	63	
Hookah Snakes	... ...	...	... ...	...	...	...	2	20	20	20	
Old Brass	... ...	...	... ...	...	...	...	2¼ mds.	101	101	101	
Spikenard	... ...	...	... ...	...	...	...	1 do.	10	10	10	
Pigments	... ...	...	... ...	...	...	...	36 seers	48	48	48	
Sandal Wood	... ...	...	... ...	...	...	...	11 do.	2	2	2	
Brimstone	... ...	...	... ...	...	...	...	12½ do.	13	13	13	
Gum	... ...	...	... ...	...	...	...	19¼ mds.	137	137	137	
Ivory	... ...	...	... ...	...	...	...	35 seers	88	88	88	
Lac	... ...	...	... ...	...	...	...	2¼ mds.	23	23	23	
Tobacco	... ...	...	... ...	...	...	...	1½ do.	8	8	8	
Total . .	... ...	2,51,406	... ...	2,09,296	360	42,470	... ...	5,51,722	3,00,316	3,42,426	
Grand Total	... ...	7,51,698	... ...	5,09,296	360	2,42,762 360 2,42,402	... ...	43,18,169	35,66,471	38,08,873	

Note.—This Statement, being compiled from Official Returns, and the Ledgers of the Delhi merchants, as well as those of the Cabool traders' agents in Delhi, is considered to be tolerably correct; but as much time would be taken up in calculating small numbers, the quantities and values of British goods and sea importations are given in the rough,—care being taken to keep below the mark, to the end that no exaggerated idea of the extent of the trade might be conveyed.

The *bona fide* export trade with Cabool is only embraced in this Statement, and no account is taken of the goods exported from Delhi and Juggadree to Bahwulpore, Scinde, and the Punjab, the export trade with which is reported to have increased in the same ratio as that with Cabool.

The great decrease in the exports of 1839-40 is attributed to the unsettled state of the north during the period.

Notices of Earthquake Shocks felt in Great Britain, and especially in Scotland, with inferences suggested by these notices as to the causes of the Shocks. By David Milne, Esq., F.R.S.E. M.W.S., F.G.S., &c. Communicated by the Author.

(Continued from page 127 of No. lxiii.)

In the immediately preceding number, an account was given of the effects and impressions produced in the village of Comrie, by the shock of 23d October 1839—the severest, unquestionably, of any which, within the memory of the oldest inhabitants, had been felt there. In the present number it is intended to describe the effects and impressions produced by the same shock, in localities more distant than Comrie, from the apparent focus of violence. This detail is excusable, considering the singular, and, in this country, unexampled severity of the shock—the extent of country over which it was felt—the importance of determining the point from which all the Strathearn shocks emanate—and the value of many of the circumstances observed, indicating, as they do, the nature and progress of the shock.

The accounts received from different parts of the country will be submitted in the following order :—*First*, There will be given those which relate to the glen or valley of Strathearn; and, *second*, There will be given those which relate to more distant parts of the country.

I.—Accounts from Strathearn.

Tullybanocher, about half a mile west of Comrie.—Mr M'Isaac writes :—" On Wednesday 23d, at 10^h $15'$ P.M., we had the most alarming earthquake that has been felt in this place, and which was followed in rapid succession by other ten—the last of which was at a little past 12 o'clock. We had the first seven of these in the short space of $20'$. I felt all the shocks come from the direction of the hill Dundownie, on which the monument in honour of Lord Melville stands, and which is due N. from my house. They commence like an explosion, and instantaneously the shaking commences, and is accompanied and followed with a loud noise. There is no interval between the noise and the concussion. The noise continues fully double the time of the concussion. The noise is like what one hears when standing under an arch, and a heavy carriage passing rapidly over. The river Earn runs close by my house, and did not rise on the 23d October as at other times, although it had rained for two days and two nights previously. The weather was thick and warm, with some difficulty of breathing. I have felt many earthquakes before this year; I heard many of them from 1795 to 1799, and they were generally in the harvest time. I felt a very violent one in September 1801. I do not think there was any difference in their character, from those we had lately. But none were so violent as that on 23d October, and there have not been in any one year so many of them as in this year. All of them proceeded from the same quarter. In regard to my stacks, they were all standing right at nightfall of the 23d, and next morning one was found overturned, lying to the W.S.W., and another almost over, in the same direction. Others were swung about on the props, and leaning in the same direction, and had all to be taken down. The stacks were of oats, and standing on level ground, and properly propped with props $10\frac{1}{2}$ feet long. At the bottom the stacks were $10\frac{1}{2}$ feet wide, and were 14 feet high."

Lawers House, 2 miles east of Comrie.—Mr Williamson, who was staying there at the time, writes:—"Nothing particular occurred between the 12th October and the night of the 23d, except that every day up to that date, more or less rain had fallen. The clouds were black and heavy, the mist hung upon the hills, and the atmosphere motionless. At 15 minutes past 10 o'clock in the evening, without any previous warning, a loud and terrific explosion struck the ear, and instantly followed the shock, appearing to the sense as if a blow had been given to every piece of furniture in the room, and the earth for a few seconds was thrown into violent agitation. I did not experience in this, or any of those previous shocks, any waving of the earth; but a tremulous motion, passing along to the East, was imparted to every object. I immediately ran to the barometer (and I fortunately had set it at 12 o'clock on the day of the 23d), I found it had fallen nearly an inch; and immediately marked it again, standing at $29\frac{8}{10}$, and retired to my room. Thirty minutes had now passed, when we were all alarmed by another loud explosion, and the same tremulous motion followed, but not so severe. I immediately went to the barometer, and examined it minutely. I found the mercury which I had left presenting a convex surface, *now* evidently concave, and tending downwards, but no further depression took place. I examined the barometer every half hour until 2 o'clock in the morning, when it presented a convex surface; and by 10 the next morning, it had risen nearly half an inch. The effect in the atmosphere was very remarkable, after the first shock. The atmosphere, as I have mentioned, was motionless; but before 11 o'clock it blew a gale from the east,—in a direct opposite course from which the report and the shock came; by 1 o'clock it was again a dead calm. Having observed this on the day of the 12th, I was particular in making this observation on the night of the 23d. This gale was also accompanied with rain. The thermometer stood the whole night at 52°, and no change appeared to take place in the temperature until next morning, when it began to rise. I must remark what appeared most extraordinary on the night of the 23d, was those repeated explosions which were not accompanied with any tremulous motion. I counted twelve or fifteen that night, but I understood the next morning that twenty had been heard. Those explosions I can compare to nothing but a six-pounder fired in a coal-pit, the report appearing as if muffled, and sometimes as if it was discharged in the open air. The excitement of this phenomenon led me the next day (the 24th) to examine the house, the stables, and farm-offices, as I understood that much damage had been done. I found at the farm-offices large quantities of slates had fallen off, and I observed there was three times the quantity lying on the *west* than on the *east* side, and this was also the case at the stables. I also found that the chimney-tops and high objects that had been moved from the perpendicular, *inclined* to the west."

Clathick, 3 miles east of Comrie.—Mr Colquhoun, who was at home when the shock occurred, writes that it was felt by him "about 10^{h} $10'$ P.M. I happened to be in my room on the second floor, and was standing. The effect on me was as if the room was falling, and the walls on each side of the room closing together upon me. The floor seemed to rise up under my feet. The report was exactly like the nearest and loudest peal of thunder, only instead of being over head, it seemed to rise up *immediately* under the house. The ladies, Mrs C. and her sister, were in one room ; the latter was woke from sleep. They were both so shocked and alarmed, that they could not explain their feelings. In all our house, the floors were covered with little bits of plaster from the ceilings, which fell just like a light shower of snow. A wall of the stable, which runs E. and W., was cracked from top to bottom, and several of the lath and plaster partitions had rents made in them. In the drawing-room, an iron plate at the back of the grate fell into the grate towards the west. A great deal of soot and mortar came down several chimneys. About 15 to 20 roods of dry stone dykes, previously in a sound condition, were partly thrown down, partly loosened by the shock, on the hill as well as on level ground. These were quite entire at dusk the same evening. In a farm-house here, two large stone-tiles were loosened and came down two separate chimneys with great force. The east gable of a farm-house, which runs N. and S., had a rent made in it. In one cottage a mile from this, the interior partition wall dividing two houses fell down.

" A second shock was felt about half an hour after the first ; report not near so loud, but shaking of the houses considerable, and a rushing sound as if dying away to the south-eastward. The rain had fallen incessantly for two whole days and two nights, the atmosphere being on Monday morning, 21st, so close and heavy, that I told several people we should certainly have a shock of earthquake. The rain began that night, atmosphere continuing close and oppressive, so that even the working people felt it so, till the evening of the 24th, when the rain abated.

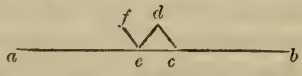
" The physical effects were most singular, but somewhat similar on most inmates of the house. The shocks which succeeded the first, produced a feeling of sickness, like that felt before fainting. It was almost impossible to rally one's spirits, in order to prevent others from being alarmed. Even the workmen and farmers were completely awe-struck, and could say little till it was over. A maid-servant in the house fainted and became hysterical, and even persons of stronger nerves felt very nearly as much depressed."

Monivaird Manse, about 4 miles E. by S. of Comrie.—" Part of a chimney-top of a house at the south-west end of Monivaird Loch was thrown down. The chimney-top runs nearly between south-west and north-east, and the stones fell towards the *south-east.* Two chimney tops of a lodge on the road-side, about a mile to the eastward of Monivaird Church, were partially shifted from their position. This house stands nearly east and west—the chimney-tops, of course, run nearly south and north—the stones (all hewn and firmly put together) were shifted towards the *east or south-east*, and as regularly, I am informed, as if a mason had laid them in their positions; one chimney-top corresponded so exactly with the other. A house at Greenend, on the Turret, and at the north-east side of Monivaird parish, suffered very much. The house runs from north-west to south-east. An inner wall or partition was thrown very much off the perpendicular, nearly twelve inches at the top, and it *inclined* towards the *south-east;* pieces of wood, &c. were thrown down from this partition wall, and fell inclining in like manner to the south-east. The *east* gable was also thrown considerably off the perpendicular, and inclines to the south-east. This is an old and clay-built house. At the Manse of Monivaird the shock was not preceded by any sound, it appeared to strike, with the force of some immense object, the house on the west side; it shook the body of the house from the top to the foundation for two or three seconds, then seemed to retire eastward, or rather to the south-east, and a loud roar, like that of the blast-furnaces in a large iron-work, was heard for about ten or twelve seconds, gradually departing eastward, and dying in the distance. I was not sensible of any heaving or undulating motion; but different individuals have mentioned to me that they felt the ground heaving below them, the earth or floor first rising on the east side and sinking a little on the west, and then immediately rising on the west side and sinking on the east. Persons have also told me that they observed the walls or partitions of their houses shaken, and first inclining westward and then inclining again to the eastward. My own feeling was, that an immense body struck the floor under my feet, as well as the other parts of the house, with great violence."

Monzie, about ten miles north-east of Comrie.—Mr Laurie writes:—"On the 23d, at 13 minutes past 10 in the evening, we heard the well-known sound again approaching. When it had continued a few seconds, we felt one or more abrupt concussions, similar to that of the 14th, but more severe; this was followed by a violent tremor which lasted a good many seconds. The concussion already described formed, in both cases, the commencement of the earthquake, if we except the mere sound; after the concussion, followed a general *shuddering* of the ground where we stood or sat. The shocks of the 14th and 23d were preceded, accompanied, and followed by a subterranean noise. The quantity of rain that fell in October this year, was very great. The shock of the earthquake affected the nerves disagreeably, and left a painful impression. It reminds me vividly of the shock from an electric machine; you wish to experience it, but having once done so, you never wish it repeated."

Blairmore, about ten miles north-east of Comrie.—Mr Buchan, an intelligent farmer there, relates:—"I was in bed at the time. Of the sound that preceded, I had no consciousness. I felt confused, and had a strong presentiment of some approaching danger. In this state, which was but for a few seconds, I felt as if some one had taken hold of my body and given it a violent shake, which added greatly to the confused and unpleasant sensations I had before. This motion or shake, again, was followed at the distance of about two seconds of time by a sudden and fearful heave upwards, with great unsteadiness or quavering motion, and immediately an equally sudden motion downwards, when all appeared to rest as before. The force by which the upward movement of the earth was occasioned, which appeared tremendously great, did not appear to me to act exactly perpendicularly, but rather in a slanting direction, as if something had been forcing a passage a little below the surface of the ground, from west to east, and going with great rapidity, for the bed on which I lay stands east and west, and the *west* end was raised *first*, and seemed to be falling back again when the opposite end was elevated. I only state the idea I had of it at the time, but must confess that my sensations and feelings were so strangely agitated, that I could not attend to the different particulars accompanying it. You will observe I consider this last shock of earthquake as double; first the tremulous motion or jumble, and then the angular roll or jolt upwards. The interval between the two appeared to be about two seconds. The sound that preceded the shock, although likely from below the surface of the ground, yet appeared to me to be above it in the second instance, and in the first to be high in the air. I have thus stated simply my ideas and feelings of these visitations of earthquake, as I heard and felt them. It will be the province of wiser men to unfold their nature and tell us their cause."

Foulis Manse, about ten miles north-east of Comrie.—The Rev. Mr Maxton writes:—" The concussion remained perceptible about four seconds. It was an undulation or movement of the ground, whereby objects on it were lifted up and let down again. I was in bed when I felt the concussion, in which I was sensible of three oscillations, which may be described in the following manner:—



Suppose *a b* to be the surface, *c* to be the spot where I felt the concussion moving from north-west; at *c*, I was lifted up to *d*; I was then let down again to *e*, and then lifted up to *f*. Objects rocked like a cradle, or a boat lifted up by a wave. The shock was stronger in the first oscillation than in any of the rest. The shock, from the noise which accompanied it, appeared to come from the north-west, and to proceed in the direction of south-east. There was a noise which preceded, and another which accompanied, the concussion, and the interval between them was about 4″. The noise remained perceptible about 3″. The noise which preceded the concussion was hard and rattling, as if the stones of a wall or dyke had been falling down. The noise which accompanied it was hollow and rumbling, like distant thunder, and by some it was mistaken for it. The former appeared to be in the air, the latter in the earth. Both of them came from the north and died away in the south, and, although different in sound, were equally loud. The concussion was felt more in the upper parts of houses than in lower parts. The appearance of the atmosphere, at the time of a shock, is sometimes calm and dense, but often boisterous rainy weather precedes or follows after an earthquake."

From *Crieff*, about six miles east of Comrie, several reports were received, from which the following extracts are made:—

(1.) Dr Murray Porteous, M.D., states:—" At 10^{h} 15′ P.M., we had the most severe shock within the memory of man; and 20′ afterwards, another shock, very severe, but not nearly so severe as the one preceding. Each shock of earthquake consisted of two concussions, with a heave in the interval between the concussions, and noise both before and after the concussions, and very loud between them. Each concussion was therefore but momentary, though altogether the shock would last from 14 to 15 seconds. The concussion was the same as that produced by the fall of some large and heavy piece of furniture. Immediately after the first concussion, the house appeared to be *lifted up* and carried *forwards*, the *western* end being highest. It then fell back, and went into its proper position, when it formed the second concussion. Many walls were rent, but no mortar-built walls were thrown down; dry stone-dykes were. Houses were so shaken and distorted, that the doors could not be shut, without the aid of a carpenter. Of the two concussions, the first was always the strongest. To almost every person east of Comrie, the shock and sound appeared to come from the west or north-west, and to pass to the east or south-east. To those west of Comrie, the sound and shock appeared to come from the east. I have seen a very few at Crieff, who fancied the shock to come from the north-east. I have seen no one, except one man, who can say that one part of a house was first struck before another. This man's house is situated on the hill-side, at a very considerable elevation above the low ground. He heard the things rattle in one end of the house, before it shook his bed and the things in the east end. But though none here can say which part of a house was first struck, to myself and others the *west* end or side was first heaved up, or the only part heaved up. I was, during one of the shocks, sitting in a chair with its back to the west. When the shock took place, I felt as if one had taken the chair by the back, and tried by a jerk to empty me out of it. I seized by its arms to hold on. The same happened to others. On another occasion, I observed a chest of drawers, which stands against a partition-wall running north and south, to move *eastward* from the partition, and then regain its position with a crash. Some stacks of corn near Crieff were turned round from the west several feet, so that that part of the stack which faced the west now faces the north, and the props of the stack are twisted round its outside. This would be explained by the props not being applied so as to bear upon the centre of the stack, so that when the shock came, it struck the props' ends on the ground ; they communicated this shock to the stacks, and caused them to turn as on a pivot. This turning of the stacks happened on the night of the 23d. On the same night, several of my friends, who were standing at the time, on feeling the west side of the house moving upwards, staggered first *eastwards*, catching at the furniture, and then *westwards*, as the house *subsided*. This was on the low ground near Crieff, where the shock was very severe. Many *gable-walls* have been rent, but I have heard of no side-walls being so in this quarter. Of the gables of those houses which stand by themselves E. and W., as far as I have heard or seen, it is always the *eastern* gable which is by far the most damaged. This applies only to all east of Comrie. In some houses, the eastern gable is entirely separated from the side-walls of the house. No trees or tall objects were thrown off the perpendicular in this quarter. During a shock, I observed a table-cloth wave eastward. Some doors were also thrown open ; they opened *westward*, as they could open in no other way. A noise preceded, accompanied, and followed the concussions. It preceded the first concussion of each shock by about 3 seconds, and continued about as long after the second concussion. During the great earthquake, the noise continued about 15 seconds. The noise began at a distance in the west. It was like an immense number of carriages coming at full speed, growing louder as it approached. The house then received a concussion, as if struck near the foundation with a cannon-ball; appeared lifted up and carried forwards; after this first concussion, the noise was hideous. The house now fell back into its position with another concussion. On this second concussion, the sound became fainter, and died away in the east with a distant growl. While the noise was still distant, it resembled the rumbling of carriages; but between the concussions, it was like the burr of a great many wheels running on each other. It was like thunder under the feet. It was in the earth only. When the sound was first heard before a shock, it was to the west side, but it died away on the east side. Concussions were felt far more in the *upper* parts of houses than in the lower; some shocks being severely felt at the top, which were hardly felt at all at the bottom. The concussions were much *more* severe in houses built on clay, gravel, or loose soil; also on houses on low ground, near the river Earn. The higher the situation of houses on the hills, the less severe the shock. During some of the shocks which occurred during the day, the river Earn is said to have appeared to stand still for an instant. A gentleman walking by a mill-lead at the time of the great shock, heard the water dash against the sides, as if a steamboat were forcing its way against the stream. The sky was very heavy, the clouds creeping close to the ground. They had a sort of dull yellow colour; the air was warm and close. The same kind of appearances have always had place here, before earthquakes. The inhabitants shewed their alarm, the women by fainting and cries, and the men by rushing out into the streets. Many did not go to bed at all that night, afraid that the next shock would bring the house down or swallow them up. The alarm shewed itself among the lower animals, by the gabbling of geese, the furious leaping of cats about the room; cattle endeavoured to break from their stalls, and moaned; horses stood so as to prevent themselves from falling. Earthquakes which occurred here in former times took place in October, sometimes later. Those shocks had only one concussion, with a tremor, and no heave. They also appeared to come from the west. The earthquake the most severe till the one of October last, occurred forty years ago. The sky had then the same appearance as it had on the late occasions, and the sound was as loud, but there was only *one* concussion, and no heave of the ground. It rained continually that day and the day before; and at the time of the shock, the rain *poured.* The rivers have been larger this year than for forty years before; and springs have been very copious ever since, and before they were diminished for a short time by the shock."

(2.) Dr Gairdner, M.D., writes:—"I was sitting in a room on the ground floor reading, when suddenly there was felt and heard as if a large body was propelled with great force on the ground forming the north-west foundation of the house, from which it seemed to rebound on a part of the ground nearer the house, causing a violent shake or tremor. The feeling was exactly as if the house had been driven an inch or two to the east, by some very powerful shock upon its westerly foundation. Immediately the shock occurred, I threw myself back in my chair, and planted my feet forwards; I was sitting with my face to the west. And the question occurred to me, Was this an instinctive movement to preserve the equilibrium, disturbed by a change in the horizontality of the ground? If so, from the nature of the position taken, the ground must have been *upheaved before*, and was at that moment (when the shock was being felt) returning to its former level. Being intently leaning over a book at the time, I could not pay much attention; but it was always impressed on my mind, that there was something strange immediately preceding the shock. However, although there were a number of articles in the room that would have been sensibly affected by this or any undulatory motion, I could perceive no sign of it in any of them. They, of course, partook of the tremor or vibration which was general at the time. The shock, although double, was momentary, hardly a second intervening; and the accompanying shock did not last above a couple of seconds, but the duration of the vibration would vary with the body operated on. The rumbling noise which succeeded the shock appeared to last about 15″. It resembled what we might suppose the noise produced by a number of carriages running over the macadamised road of a wide tunnel stretching to the south-east; or, as I have stated of the lesser shocks, like the noise (but now much increased) of the mail or stage coach, after they have passed my house about thirty yards; at which distance, the sound communicated through the ground, &c., is heard more than that through the air."

(3.) Mr D. Drummond of Stirling happened to be in Crieff during the shock. He writes, that the first concussion occurred "at $10^h\ 16'$ P.M., and another about 35′ thereafter. Both shocks were what are called double concussions. The first concussion of the first shock lasted 2″, the second concussion 3″; the period of time betwixt each was about 3″. I was in bed during the first shock, and on the fourth floor from the ground. The nature of the concussion was as if men were lifting the bed up and down, while, at the same time, it was shaken with great violence; so much so, that the canopy of the bed struck the wall and broke the plaster. A tremor preceded the concussion about 2″, and followed it, lasting 10″ or 12″. Several walls were cracked; one or two, I observed, from top to bottom. One gentleman in the neighbourhood of Crieff pulled down a chimney, to prevent its falling on the roof. This chimney I saw, with the stones shifted from their bed at least half an inch. When the concussion took place, I was lying with my feet due west, and on my back. It occurred to me at the time, that the shock came from the point west and by south, from the circumstance that my left foot felt the bed move first. Immediately preceding the undulation, I heard, with the most perfect distinctness, door after door shut with great violence, the first at the far *west* end of the town, until it passed me, dying away at the far *east* end. I might have heard ten doors shut in whole. The rate at which they travelled appeared to me at least double the speed of the quickest locomotive. This circumstance, I am fully impressed with the certainty of. Gable-walls which stood north and south, were in most instances cracked *horizontally;* whereas those which stood east and west were cracked *up and down.* The waiter in the inn where I was, had been leaning with his shoulder on the west wall of the passage which runs north and south, when, with the concussion, he was thrown with considerable force on the opposite wall. The noise was as loud, as if a sixty-pounder had been discharged at the bottom of a coal-pit 300 or 400 yards away. The concussion was felt much more severe in the *upper* flats of houses. When the first shock came, I was four flats up, and it was so severe, and alarmed me so, that I started out of bed and went down stairs to the ground-floor, and on this floor I felt the second shock, and then perceived the difference. The shaking and lifting of the furniture was not half so much, although the noise was almost as loud as that which accompanied the shock which I felt up stairs. Water was thrown out of the ewers in *top* flats, when there was no appearance of this below. On the morning after the shock, I learned from a gentleman who was passing a mill-dam at the time, that he distinctly observed (being moonlight) first a tremor in the water like water near the boiling-point; then the whole dam agitated, like the flowing of the tide on a smooth sea-beach. The atmosphere was particularly dense and very warm—quite disagreeably so. Previous to the shock, a thick rain fell during 33 hours, and continued 18 hours after without intermission. The most remarkable effect observed was, that the first shock jammed a room-door so close that it could not be forced open, until the second shock (35 minutes after), relieved it quite as it used to be, and no crack was seen in that house. In Crieff, the inhabitants were so alarmed that hundreds ran out of their houses, uttering hideous screams, many of them in their night-clothes, and would not venture in again for long after, and several of them walked about the street all night. I myself would have fallen into syncope, had I not, by a singular effort, thrown myself out of bed. Immediately after the shock, I got out of bed, and, on looking from my window, beneath which were a number of trees, I observed that the branches of the trees were all bent towards the east, as if a strong but steady gale had been blowing upon them. I looked until they recovered their erect position, after which not a leaf moved. During the time, I heard a hollow *sugh* in the air, resembling the draught of a furnace; this continued about 20 seconds after the concussion."

(4.) Mr James Young of Crieff says, that at the time of the great shock he experienced " a kind of headache, similar to what I have often felt in a thunder storm, or in an apartment highly charged with electricity."

(5.) Mr Philips of the Glenturret Distillery, situated close to the Bridge of Crieff, writes that there was a double shock, "the second shock following the first at the distance of about 12″ or 15″, with a much increased shaking and noise. Our premises, you are aware, are situated low down in the bottom of the Strath. At first there was heard, by a young man in the counting-room, a noise low, heavy, and distant, like that of machinery, for the space of about 3″; then a shock, like a great weight falling against the foundations of the house, accompanied by a brisk continued shaking and a tremendous noise; then about 12″ or 15″ afterwards, a shock much heavier than the former, the shaking and noise very much increased, *even terrific*. Dust, scales from the whitened walls and ceiling, and even pieces of plaster from a stone partition, fell in abundance. The young man ran out of the house into the open air amid the darkness, but the noise through the court or square was such as to actually frighten him. He thought, indeed, that the chimney-stalk (new built) and the houses were all falling, and he ran back instinctively to save himself. The shaking and noise then gradually died away together. The whole, from first to last, may have lasted for one minute and a half. The shocks and the noise appeared as if proceeding from N.NW. to S.SE. The shake or motion resembled that of a *wave*, *i. e.* it moved rising and falling, as well as to and fro. Those in quiet places heard the noise, before the shock, while those beside machinery or other noise did not hear it until the shock was felt; but then indeed the noise of the earthquake obliterated that of machinery and every thing else, and some of the workmen ran to ensconce themselves in places of safety, under the impression that the houses and utensils were coming down into a heap. These observations as to direction of the shocks and as to the motion and noise, correspond exactly with what the excise-officers and workmen throughout the rest of the premises felt, and with what I, with my mother and brother, felt in our dwelling-house in Crieff, distant say 500 yards and on higher ground, as well as with what we all felt repeatedly in regard to the other lesser shocks before and since. This description corresponds also with what was experienced by others in Crieff. A stone partition built N.NW. to S.SE., 9 feet high and 16 long, and dividing this counting-room from the spirit warehouse, was rent in two places from *top* to *bottom*, each open about $\frac{1}{4}$ of an inch, and pieces of the plaster fell from each side of the openings to the floor, but the partition did not lean towards any side. Plaster fell from many parts of the buildings (which are coarse but are firmly built with lime) to the floor, and particularly upon the NW. side of the different apartments. The chimney-top of an old dwelling-house about 400 yards northwards of this was thrown down, and a dyke, also hard by, built of round water stones, tumbled down in four or five places, each place varying from 5 to 20 yards in length. In Crieff too, a few chimney-tops and canns and loose stones were thrown down, and one gable of a house of four storeys was rent from top to bottom nearly three inches wide. My mother, who has been in this neighbourhood above 50 years, and has felt many of those shocks, says that she has felt them always proceeding from about the same airt; but that the shock I have just described was by far the greatest and the noise the loudest of any she has felt."

The Honourable Mr Drummond thus describes the shock as felt at *Strathallan Castle*, situated about twelve miles S.SE. from Comrie:—" On the 23d the shock here came decidedly from the west, perhaps a point or two to the *north*. The vibration is described as from blows from the westward, and the undulation as first *rising* from the *west*, then *down* again and rather lower than natural, and *up* again to its proper level. In this house a clock fronting the south, a point or two to the westward, had its glass-door opened to the west and left so. At Crosshill, two women were sitting at the fire, facing the NE., and were both thrown out of their chairs on the fender. The door of a room in which several men were sitting, opening to the eastward, was opened but not closed again. A noise preceded the shock by one or two seconds, and continued till near the end of the shock. There have been more northern lights seen this year during September and October, than for some years past. The following phenomena, although not connected with the earthquakes, as they happened considerably after them, are perhaps worth mentioning, as they are curious, particularly the latter. I was driving home from Abercairney, on the 9th or 10th November between 12 and 1 o'clock, with a groom, when a ball of fire seemed to fall within a few yards of us; the light was as strong as a vivid flash of lightning, but lasted a good deal longer, rather more than a second perhaps; the track of light continued in the thin misty clouds, till after the ball of fire disappeared. The night was warm and close, and very dark. On the night of the 11th of December the under-factor was returning home about 11 o'clock, and, when about a mile and a half from Strathallan, he saw a strong red light to the south-east, just over the Castle, and was convinced that it was on fire; he immediately ran as hard as he could towards it, and on reaching the farm and finding all quiet, he went up to a height above it, and again saw the light, which he says was then higher, being along the top of the Ochil Hills, and a good deal broader than when he first saw it; he describes it as a very strong red light, stronger than the reflection of a house on fire. The night was very wet, and the rest of the sky quite dark. There had been a week of frost, and the weather changed that night, and a great deal of rain fell during the two or three days following, but without wind."

At *Cultoquhey*, situated about two miles east of Crieff, three miles north of the river Earn, the effects of the shock were thus represented to the author by Mr Maxtone, who was there at the time. "We were sitting in an upper room when the shock occurred. The whole house was shaken. Two explosions were heard at the same moment, as if two cannons had been fired below ground. The west side of the house was first affected; and every one distinctly perceived either that the west side was elevated or the east side was sinking. A lady felt herself falling off her chair towards the east, and seized hold of a table to save herself. The noise and the motion were distinctly observed to pass away towards the east."

At *Bellevue*, a few miles SE. of Crieff, Lieut. Græme, R.N., states that "three undulations were felt, each of which was attended with a crashing and smashing sound, and was separated by an interval of from 3″ to 10″. At the instant of the second shock or undulation I was standing, and then found myself with my left leg bending, my right leg extended towards the NW. The preserving the centre of gravity must have been divested of error. At the same time I felt exactly as in a vessel taking a heavy lurch, and suddenly recovering herself. In fact, the whole sensation was that of being in a steward's berth, surrounded by crockery all in motion."

It is natural to suppose that an earthquake, which produced such effects as those described in the foregoing accounts, should have produced no small alarm in the district of Strathearn. On this point, it may be sufficient to quote the testimony of John C. Colquhoun, Esq., of Killermont, who, within a few weeks after the shock, was resident at Lawers and Clathick. He says that the effects now alluded to "were most striking;—people running out of bed,—flying in Comrie to the meeting-house (though at midnight), and remaining there for two hours engaged in devotion,—abandoning all work the following day,—a commercial traveller, who felt one of the lesser shocks, flying the same night from Comrie,—a dissenting minister, who had come to officiate, refusing to remain,—several women fainting, and an impression of horror seizing upon the minds of men of the boldest youth and strongest nerve, which completely unmanned them. On the night of the great earthquake, not an eye, I believe, was closed within this whole valley. The most careless, who were curious to feel an earthquake, never speak of them now but with terror."

(To be continued.)

Researches on the Structure of Mucous Membranes. By M. Flourens.

M. Flourens, at the meeting of the Académie des Sciences on the 29th November last, 1841, read an interesting memoir on the Structure of the Mucous Membrane of the Nose, Windpipe, and other parts, which we now submit to the notice of our readers.

It will be recollected that this is not the first memoir on mucous membranes which has been presented by the able author. Upon former occasions, he availed himself of opportunities to explain the structure of the skin, both in the fair and dark coloured races of man; also of the mucous membrane of the tongue, mouth, œsophagus, and intestinal tube. On the present occasion, those of the nose, windpipe, bladder, and arteries, are particularly dwelt upon.*

* All these memoirs, in extract, have been inserted in previous numbers of this Journal.—Editor.

1. *On the Mucous Membrane of the Nose, generally designated the* Pituitary Membrane.—Even up to the present day, the minute structure of this part is but little understood. About the middle of the seventeenth century, Schneider* completely overturned the erroneous and ancient notion which made the mucus descend from the brain, and demonstrated that it was the mucous membrane of the nose itself which was the true organ of the secretion. Shortly afterwards, Ruych† pointed out the distinction between the periosteum covering the nasal bones, and the mucous membrane which was wholly different. Haller was among the first who called attention to the *epidermis* of the pituitary membrane; ‡ but neither Bichat, nor Meckel, nor Béclard, though much later than Haller, make the slightest allusion to it. Bichat, like Ruych, seems to have recognised only two layers in the pituitary membrane, the one being the periosteum and the other the mucous layer.§ Meckel's account corresponds with Bichat's;|| and Béclard only says, that "in certain parts—for example, the nasal fossa—the disappearance of the epithelium is gradual and insensible, so that it is impossible to assign precisely its limits."¶ Thus Bichat and Meckel only dwell upon the *chorion* and the *dermis* of the pituitary membrane; Béclard speaks only of the *epidermis* at the external margin of the membrane; and no one had previously pointed out that the *Mucous body*, that *body* and special *layer* which has already been demonstrated in previous memoirs, and on which we are again about to insist, is invariably interposed in every mucous membrane between the *dermis* and *epidermis*,—in popular language, between the *true* and the *scarf* skin.

We repeat, then, that three layers, superimposed the one above the other, form invariably the mucous membrane; and these three layers are very distinctly seen in the specimen No. 1 which I have now the honour of submitting to the inspection of the Academy. It is a portion of the pituitary membrane of a horse. There will be observed, at the bottom of

* Conradus Victor Schneider, De Catarrhis, &c. "Illa membrana pituitam condit, continet et emittit;" lib. iii. cap. 8.

† And the perichondrium, which covers its cartilages. "Præterea consideratione dignum judicio, septum narium cartilagineum, non solum investiri membrana mucosa, verum quoque sub hac immediate membranula tenuissima. Hæc continuatio est periostii, nasi partem osseam obducentis, atque perichondrum dici meretur." Epist. viii.

‡ "Quam habet sibi superjectam epidermidem," he remarks (Elementa Physiol. &c. t. v. p. 144). It is curious that, as authority for this assertion, Haller quotes Winslow, whose account is contained in this confused phrase: "Vers le bord des narines externes, la membrane pituitaire est trés-mince, et y paraît comme un tissu dégénéré de la peau et de l'epiderme." (Exposition Anatomique de la Structure du Corps Humain; Traité de la Tête, No. 336.)

§ "Un feuillet fibreux, qui est le perioste ou le périchondre de cavités nasales, se joint, dit Bichat, au feuillet muqueux pour former la membrane pituitaire. . . . . Le feuillet muqueux, dit-il encore, epais, spongieux et mou, est formê d'un chorion tres-prononcé qui lui donne cette epaisseur." (Anatomie Descriptive, t. ii. p. 573.)

|| Manuel de l'Anatomie, t. iii. p. 279.

¶ Eléments d' Anatomie Générale, &c. p. 256.

the preparation, the *dermis*, all furrowed with lines, arranged like the markings of a leaf; above the dermis is a fine membrane, which is the *mucous layer* or the *mucous body;* and above the mucous body is a layer finer still, which is the *epidermis*. The dermis, then, together with the mucous body and the epidermis, exist united, and superimposed the one above the other, in the mucous or pituitary membrane of the nose.

2. We now proceed to the *Mucous Membrane of the Windpipe.*—The structure of this new membrane has not been better described, nor is more accurately understood, than that of the pituitary membrane. Haller admitted that it possessed an epidermis,* and Bichat denied it. Bichat says expressly, "In no part of the mucous membrane of the air-passages, can the existence of the epidermis be demonstrated."† In opposition to this statement, I here exhibit, in the specimens Nos. 2 and 3, the *epidermis*, and the mucous body, and the dermis of the mucous membrane of the windpipe. These two specimens are two portions of the windpipe of the horse. The epidermis is exhibited in the former. It has been removed in the latter; but still two detached and superimposed layers remain—the anterior is the *mucous layer* or *body*, the posterior is the *dermis*. Hence, then, the mucous membrane of the windpipe, like that of the nose and all other mucous membranes I have hitherto examined, possesses a dermis, a mucous body, and an epidermis.

3. It is the same with the *Mucous Membrane of the Bladder*. The specimen No. 4. which I now exhibit, is the bladder of a rabbit; and any one may clearly perceive three distinct layers, all of them very delicate, and superimposed the one above another. The anterior, or the most delicate, is the epidermis; then follows the *mucous layer*, and then the dermis, and behind the dermis is the *membrane*, or rather the *muscular layer* of the viscus. The epidermis of the bladder had been previously observed by Haller;‡ it had also been noticed by Ruych;§ but both of these eminent men had seen it only as the result of lesions and diseases of the

* "Epidermis est levis, sui similis, simplex. . . . Eam in funesta puerorum angina frequenter ægroti reddunt." (Elem. Physiolog. t. iii. p. 148.)

† Anatomié Descriptive, t. iv. p. 56. "L'unique preuve, ajoute-t-il, que l'on puisse acquerir ici de l'existence de l'epiderme, se tire des cas pathologiques où des fragments membraneux on été rendus par expectoration. Haller en cite plusieurs, et n'admet que d'apres cela un epiderme muqueux pulmonaire. Mais cette preuve est insuffisante, ces lambeux pouvant être analogues aux escarres plus ou moins profondes produites sur la peau par les brûlures," &c.

‡ Membrana vesicæ nervea . . . ex cute evidentur continuata, præcipua est vesicæ tunica. . . . Intima membrana, levissima . . . tenuior quam nervea, epidermidis est propago. . . . Cum epidermide, cui continuatur, id habet commune, ut secedat de nervea, de quo corpore exeat, . . . et perinde renascatur." (Elementa Physiologiæ, &c. t. vii. p. 326.)

§ "Pauca superaddi de interiore membrana, quæ vesicæ urinariæ cavitatem urinæ contiguam facit. De qua imprimis notasse juvet portionem ejus, a reliqua separatam posse per vias urinæ excerni. (Adversarior Anatomic. Decas secunda, p. 24.)

bladder—as the result of pathological derangement. On this occasion, I exhibit it isolated—detached from the other membranes by a process which is regular, methodical, and certain; nor do I exhibit the epidermis only—I display the three, the epidermis, mucous body, and dermis.

The mucous membranes, then, have all one and the same fundamental structure, which structure is complex. None is simple. All of these, however attenuated and delicate they may be, are always possessed of three layers or distinct membranes. And this is so universally the case, that even the internal *Membrane of the Arteries,* which some anatomists have already classed among the mucous membranes,* supplies the three layers or membranes, distinct and superimposed, upon which I am dwelling. The specimen No. 5, which I now submit, is a portion of the aorta of the ox; and here the three layers are conspicuous as in the former examples.

These layers, I now add, can be completely isolated and detached from each other by slow maceration, methodically conducted, the only means by which it can be effected, and a good illustration of the vast importance of the kind of process we pursue in investigating anatomical structure. Malpighi employed the process of boiling for the purpose of detaching the several layers of mucous membrane from each other, and by this process he obtained the *mucous* NET-WORK of the tongue. I, on the other hand, used a slow and careful maceration, and, instead of a *net-work,* procured a continuous and complete layer. In a former memoir,† I have shewn that this famous net-work of Malpighi is entirely a factitious one, and that the mucous membrane of the tongue is essentially a continuous and complete layer. The perforations which transform this continuous *layer* into a *net-work* are owing to the tearing open of the sheaths, which the mucous body supplies to the papillæ of the dermis. Each of these papillæ has, in fact, a double sheath, as I have already shewn;‡ the one supplied by the mucous body, and the other by the epidermis. If, then, the method of boiling is employed, as was done by Malpighi, the epidermis becomes brittle and contracts. Every one of the sheaths of the mucous body is thus ruptured and compressed in each sheath of the epidermis; and when, after this, the epidermis is removed, the whole of the sheaths of the mucous body are torn and removed. Wherever, then, there is naturally a mucous sheath, a vacuity is produced, and the whole mucous body, which is normally a *continuous layer,* now appears a complete *net-work.*

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* Bichat, Anat. Gener., t. ii. p. 52. "What is the nature of this internal or common membrane of arteries? On this point I am in complete ignorance." Beclard again, says, "The lining membrane has been compared to serous membrane, and to mucous or cellular tissue; it may, however, resemble the arachnoid membrane." Elem. d'Anat. Gener., p. 371. Later anatomists, who have compared them with mucous membranes, have come much nearer the truth.

† *Comptes Rendus,* vol. iv. p. 445. ‡ Ibid.

In the specimen No. 6, I exhibit the tongue of an ox prepared after the method of Malpighi, and here is certainly displayed a magnificent, but wholly artificial, net-work. In specimen No. 7, is shewn the tongue of a calf, prepared according to the method I have recommended, and the mucous body exhibits the appearance so often already described. Specimen No. 7 exhibits the continuous layer on its external aspect. Specimen No. 8, prepared from the tongue of an ox, shews this same layer on its internal aspect. Finally, in specimen No. 9, the dermis, continuous mucous body, and epidermis, are exhibited in the tongue of the sheep.

Hydrometrical Observations. By David Stevenson, Esq. Civil Engineer.*

Velocities of Currents.—For the purpose of ascertaining the surface velocities of currents, various methods may be employed.

The most common, but by no means the most satisfactory, mode of proceeding, is to throw into the water a float composed of some small body (whose specific gravity is merely great enough to sink it to a level with the surface), at a point about 30 or 40 feet above the line of section, so as to insure its acquiring the full velocity of the current before it reaches the cord. An observer, stationed at the cord, notes exactly the moment at which the float passes, and follows it down the stream till he reaches the line of two poles, which have been fixed in reference to the observations, when he again notes the exact moment of its transit at the lower station. The elapsed time between the two transits is then noted in the book, along with the distance between the two places of observation, which, owing to the irregularity of most rivers, with regard to width, depth, and velocity, can seldom be got to exceed 100 feet. This operation has, of course, to be repeated for every compartment of the cross section.

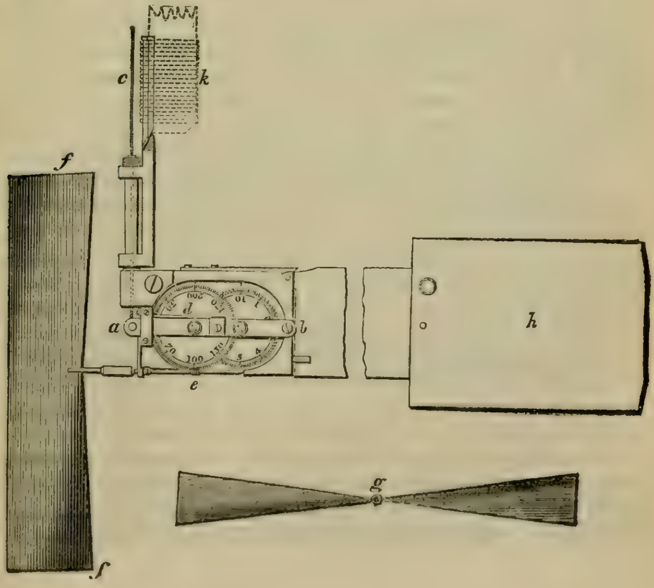
Certain disadvantages attend this method, which render it not generally applicable. For example, it is only adapted to rivers of limited breadth, owing to the impossibility of an observer being able to discover with sufficient accuracy when the float passes the station lines, if it be viewed from a distance, as from the bank of a broad river. There are, however, greater objections than this, which, when pointed out, will be sufficiently obvious to every one. In any part of the river passed over by the floats, the slightest irregularity of the bottom produces a disturb-

* The interesting observations and experiments in this article are taken from a valuable work just published, and which we recommend to the particular attention of engineers, viz.—"A Treatise on the application of Marine Surveying and Hydrometry to the practice of Civil Engineering, by D. Stevenson, Civil Engineer, and author of a Sketch of Civil Engineering in America, &c. 1 vol. royal octavo, with numerous plates and plans, &c. Adam and Charles Black, Edinburgh; Longman & Co., and L. Weale, London. 1842."

ance in the motion of the stream, and alters the velocity of the current, so that the result indicated by the elapsed time is more or less vitiated, and the mean velocity deduced from such data, is not, in almost any case, that which exists at the line of cross section. It is also impossible, by this method, to obtain a sufficient number of distinct and independent observations, applicable to each division of the stream, as the eddies and irregularities of the current which exist in all rivers, generally cause the lines passed over by the floats to cross and interfere with each other in such a manner as to destroy all connection between any given series of observations, and the several compartments of the river, whose mean velocity they were intended to ascertain.

The superiority of the method which I am about to describe, consists in ascertaining the velocity of each portion of the stream, in the exact line in which the cross sectional area is taken. The instrument employed for this purpose is a modification of the tachometer of Woltmann, which is in general use in France and Germany, both as an anemometer and a hydrometer, being made of the degree of delicacy suited to the purpose to which it is to be applied. In this instrument the velocity is measured by the current impinging on a vane and causing it to revolve, the number of revolutions made by the vane being registered on an index, which is acted on by a set of toothed wheels.

The construction of this beautiful instrument, and the manner in which it acts, will be best described by a reference to the accompanying cut, fig. 7., which is taken from

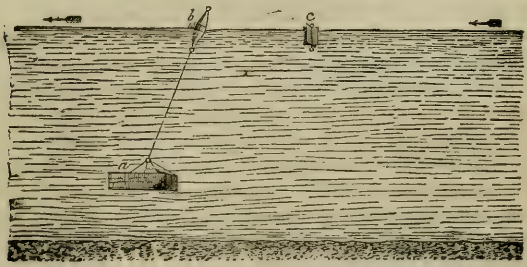


a tachometer or stream guage made by Mr Robinson, optician, London, and is drawn to a scale of one-third of the full size. In this view, *f f* represents what may be termed the driving vane, which is acted on by the stream, and of which *g* is a plan. The plane of this vane is twisted as represented by the dark shading in the cut, so as to present, not a knife-edge, but an oblique face to the action of the current, which, by impinging on it, causes it to revolve exactly in the same way that the wind propels the sails of a windmill. On the spindle or shaft of this vane, an endless screw is fixed at *e*, which works in the teeth of the first registering wheel, and causes it to revolve, when the vane is in motion and the screw in gear. Letters *a* and *b* represent a bar of brass, to which the pivots on which the registering wheels revolve, are attached. This bar is moveable on a joint at *b*; and at the point *a*, a cord *a c* is fixed, by pulling which the bar and wheels can be raised, and on releasing it they are again depressed by a spring at *d*. When the bar is raised, the teeth of the wheel are taken out of gear with the endless screw, and the vane is then left at liberty to revolve, the number of its revolutions being unregistered; but when the cord is released, the spring forces down the wheels, and immediately puts the registering train into gear, in which state it is represented in the cut. Letter *h* is a stationary vane (which is shewn broken off, but measures about 9 inches in length) for keeping the plane in which the driving vane revolves at right angles to the direction of the current, and *k* is the end of a wooden rod to which the tachometer is attached when used. The different parts of the instrument itself are made of brass.

The moveable bar for the registering wheels and the application of the cord and spring which have been described, afford the means of observing with great accuracy in the following manner. The instrument having been adjusted by setting the registering wheels at zero, or noting in the field book the figure at which they stand, the cord is pulled tight so as to raise them out of gear, and the instrument is then immersed in the water. The vane immediately begins to revolve from the action of the current, and is permitted to move freely round until it has attained the full velocity due to the stream. When this is supposed to be the case, a signal is given by the person who observes the time, and the registering wheels are at that moment thrown into gear by letting the cord slip. At the end of a minute another signal is given, when the cord is again drawn and the wheels taken out of gear, and on raising the instrument from the water, the number of revolutions in the elapsed time is read off. This operation being completed in the centre of each division of the cord, the number of revolutions due to the velocity at each part of the very line where the cross section is taken, is at once obtained.

Before using the tachometer, it is obvious that the value of a revolution of the vane must be ascertained; and although this is done by the manufacturers, it is proper that the scale of each instrument should be determined by the person who uses it, and that it be tested if the instrument has been out of use for some time, before being again employed in making observations. A scale sufficiently accurate for most hydrometrical purposes (though not for the instrument when used as an anemometer) may be obtained by applying it to some regular channel, such as a mill-lead formed of masonry, timber, or iron, where the velocity is nearly the same throughout, and noting the number of revolutions performed during the passage of a float over a given number of feet, measured on the bank. In this way it was found, by the mean of 62 observations, that each revolution of the vane in the instrument of which a drawing has been given, indicated the passage of the water over 46 inches. The number of revolutions at several parts of the stream was ascertained to be the same in equal times, at both the commencement and the end of the experiments. This number, therefore, becomes in the instrument alluded to, a constant multiplier of the number of revolutions indicated by the vane; and hence, the number of feet passed over by the water in the given interval of time is ascertained.

The direction of the under current, which it is sometimes interesting to know, cannot, however, be obtained by means of the tachometer, and I shall describe a plan for obtaining an approximation to both the velocity and direction of under currents, which is of easy application, and may be useful to those employed in engineering investigations. The plan to which I allude was devised and used at the Cromarty Frith in 1837, by Mr Alan Stevenson, who discovered, by means of the instrument he employed, the interesting fact, that, at the depth of 50 feet, the velocity of the current, at both flood and ebb, is in certain places of the Frith nearly double that at the surface. This instrument, which of course merely gave an approximate result, consisted (as shewn in the accompanying cut, at letter *a*) of a flat plate of sheet iron, measuring 12 by 18



inches, having a vane made of the same material, and measuring 4 feet in length, fixed at right angles to the centre of it. The lower edges of the plate and vane were loaded with bars of iron, for the purpose of causing the instrument to sink to the requisite depth; and it was so slung as to preserve the surface of the plate in a vertical plane. This apparatus was secured by a cord of sufficient length to sink it to the required depth, and the whole was attached to a tin buoy, letter *b*, which floated on the surface, its form being such as to produce little resistance to its passage through the water. The buoy served not only to preserve the vane plate at the same depth, but also indicated its progress through the water in a very satisfactory and often interesting manner.

The plate, sunk at the depth of 50 feet, when acted upon by the force of a strong under current, was hurried along, carrying the buoy, which floated on the surface, along with it, a circumstance which was ascertained by the buoy passing the floats thrown out on the water as gauges of the velocity and direction of the upper current, one of which is shewn at *c*. The only precaution to be observed in making such observations, is to exclude that part of the commencement of the buoy's course, which is more rapid than it ought to be, owing to the effort made by it to overtake the plate, which, being sunk first, has been influenced by the velocity of the under current before the buoy has been launched. It is evident that, by means of this simple apparatus, we can approximate to the direction as well as to the velocity of under currents; but it must be kept in view that, in either case, there are several deranging influences in operation, which tend to render the results obtained merely rude approximations to the truth.

The direction of surface currents may be easily observed by means of a string of cork floats. Any change in the direction of the line traced by the floats is noted by observations made with the surveying compass or the sextant, by an observer stationed in a boat, which is rowed alongside of the line marked out.

The last hydrometrical topic which shall engage our attention, is the method of obtaining specimens of water at different depths, with a view to ascertain its qualities in regard to the proportion of sea salt which it contains, or the quantity of sand or mud held in mechanical suspension.

The first observations made on this subject, so far as I am aware, were those instituted by my father on the River Dee in Aberdeenshire, in the summer of the year 1812, when engaged in surveying that river in reference to a salmon fishing case.* "He observed in the course of his survey that the current of the river continued to flow towards the sea with as much apparent velocity during flood as during ebb tide, while the surface of the river rose and fell in a regular manner with the waters of the ocean. He was led from these observations to enquire more particularly into this phenomenon, and he accordingly had an apparatus prepared, under his directions, at Aberdeen, which, in the most satisfactory manner, shewed the existence of two distinct layers or strata of water; the lower stratum consisting of salt or sea water, and the upper one of the fresh water of the river, which, from its specific gravity being less, floated

* Report to the Earl of Aberdeen and the other proprietors of the "Raik" and "Stell" fishings of the River Dee, at Aberdeen, by Robert Stevenson, Civil Engineer. Edinburgh, Feb. 1813.

on the top during the whole of flood as well as ebb tide. The apparatus consisted of a bottle or glass jar, the mouth of which measured about 2½ inches in diameter, and was carefully stopped with a wooden plug, and luted with wax; a hole, about half an inch in diameter, was then bored in the plug, and to this an iron peg was fitted. To prevent accident in the event of the jar touching the bottom, it was coated with flannel. The jar so prepared was fixed to a spar of timber about 20 feet in length, which was graduated to feet and inches, for the conveniency of readily ascertaining the depths to which the instrument was plunged, and from which the water was brought up. A small cord was attached to the iron pin for the purpose of drawing it at pleasure for the admission of the water. When an experiment was made, the bottle was plunged into the water: by drawing the cord at any depth within the range of the rod to which it was attached, the iron peg was lifted or drawn, and the bottle was by this means filled with water, of the quality at the depth to which it was plunged. The peg was again dropped into its place, and the apparatus raised to the surface, containing a specimen of water. In this manner, the reporter ascertained that the salt or tidal water of the ocean flowed up the channel of the River Dee, and also up Footdee and Torryburn, in a distinct stratum next the bottom and under the fresh water of the river, which, owing to the specific gravity being less, floated upon it, continuing perfectly fresh and flowing in its usual course towards the sea, the only change discoverable being in its level, which was raised by the salt water forcing its way under it. The tidal water so forced up continued salt, and when the specific gravities of specimens from the bottom, obtained in the manner described, were tried, and compared with those taken at the surface, by means of the common hydrometer of the brewer (the only instrument to which the reporter had access at the time), the lower stratum when compared with that at the surface was always found to possess the greater degree of specific gravity due to salt over fresh water."

The appearance of the fresh water floating on the surface of the sea, is no doubt familiar to most persons. It occurs at the mouths of many of our rivers, and is most apparent when they are in flood, from the brown tinge given to the water, which is easily discoverable for many miles at sea. The great American rivers furnish many remarkable instances, particularly La Plata and the Amazons. On this subject, the following passage from the work* of Father Manuel Rodriguez, a Spanish Jesuit, is interesting, and its correctness, as regards the extent to which the influence of the river is felt, has since been corroborated by the investigations of Colonel Sabine.† "This river," says Rodriguez, in speaking of the Amazons, "is like a tree; its roots enter as far into the sea as into

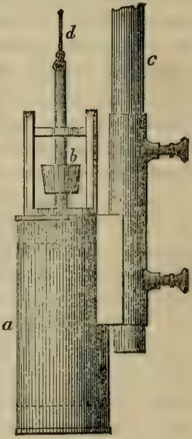
* El Maranam y Amazonas. Madrid, 1684, p. 18.

† An Account of Experiments to determine the figure of the Earth, as well as on various other subjects of philosophical inquiry, by Edward Sabine. London, 1825, p. 445.

the land, so that it communicates to it a flavour; so that at 80 leagues within the sea, its waters are seen and taste sweet, and in a semicircle of 100 leagues in circumference, they form a gulph not in the least brackish, so that the sailors call it the fresh sea."

The instruments now used for obtaining water from different depths, are more perfect in their construction than that already alluded to as having been used at the Dee, which, as has been seen, was made for a temporary purpose. Instruments of various constructions have of late been tried for experimenting on this subject; and as I am not aware that any work on marine surveying, or on surveying instruments, contains a description of such an apparatus (to which I have applied the name of the *hydrophore*‡), the following account of two modifications of it, both of which I have been in the habit of using, may perhaps be instructive.

Fig. 9. represents a hydrophore used for procuring specimens of water from moderate depths, drawn on a scale of one-tenth of the full size. It consists of a tight tin cylinder, letter *a*, having a conical valve in its top *b*, which is represented in the diagram as being raised for the admission of water. The valve is fixed *dead*, or immovable, on a spindle working in guides, the one resting between two uprights of brass above the cylinder and the other in its interior, as shewn in faintly dotted lines. The valve-rod is by this means caused to move in a truly vertical line, and the valve attached to it consequently fits the hole in the top of the cylinder with greater accuracy than if its motion was undirected. A graduated pole *c*, which, in the diagram is shewn broken off, is attached to the instrument, its end being inserted in the small tin cylinder at the side of the large valve or water cylinder, and then fixed by the clamp screws shewn in the diagram; the bottom of the water cylinder may be loaded with lead to any extent required. The spindle carrying the valve has an eye in its upper extremity to which a cord is attached for the purpose of opening the valve when the water is to be admitted, and on releasing the cord, it again closes by its own weight. When the hydrophore is to be used, the cylinder is lowered to the required depth by the pole which is fixed to its side; or if the depth be greater than the range of the pole, it is loaded with weights, and let down by means of a rope so attached as to keep it in a vertical position. Care must be taken while lowering or raising it, that the small cord by which the valve is opened be allowed to hang perfectly free and slack. When the cylinder has been lowered as far as is required, the small cord is pulled, and the



* ὕδωρ and φορέω.

vessel is immediately filled with the water which is to be found at that depth. The cord being then thrown slack, the valve descends and closes the opening. The instrument is then slowly raised to the surface by means of the rod or rope, as the case may be, care being taken to preserve it in a vertical position. This apparatus is only applicable to limited depths, but will generally be found to answer all the purposes of the civil engineer.

The form of hydrophore, represented in this figure, is used is deep water, to which the small one is inapplicable. It consists of an egg-shaped vessel, letter *a*, made of thick lead, to give the apparatus weight, having two valves *b* and *c*, one in the top and another in the bottom, both opening upwards; these valves (which are represented as open in the diagram) are, to ensure more perfect fitting, fixed on separate spindles, which work in guides, in the same manner as in the instrument shewn in the last figure. The valves, however, in that which I am now describing, are not opened by means of a cord, but by the impact of the projecting part *d*, of the lower spindle on the bottom, when the hydrophore is sunk to that depth. By this means, the lower valve is forced upwards, and the upper spindle (the lower extremity of which is made nearly to touch the upper extremity of the lower one, when the valves are shut) is at the same instant forced up, carrying along with it the upper valve which allows the air to escape, and the water rushing in fills the vessel. On raising the instrument from the bottom, both valves again shut by their own weight and that of the mass of lead *d*, which forms part of the lower spindle. The mode of using this hydrophore is sufficiently obvious. This instrument weighs about half a hundred weight, and has been easily used in from 30 to 40 fathoms' water in making engineering surveys, and could, no doubt, be employed for much greater depths if necessary.

In all these experiments, the water being emptied into bottles, is corked up, and labelled with certain numbers, which should be entered in a book containing remarks as to the place of observation, time of tide, and such other particulars as, from the nature of the inquiry, seem to deserve notice; and the water thus preserved may be subjected to analysis, produced in evidence, or employed in any other way required by the circumstances of the case.

The marine productions of an estuary, such as the fish, shells, and plants which occur in it, occasionally affect questions regarding which an engineer may be consulted; but as it is not my present intention, as stated at the beginning of this chapter, to enter into the nature of the questions in which these investigations are required, or the manner in which they bear upon them, it is not considered necessary, in mentioning these productions, to do more than simply direct attention to the subject.

Description of a new Roofing Tile manufactured by M. Courtois of Paris. Communicated by Sir J. Robison, K.H., F.R.S.E., to the Royal Scottish Society of Arts.* With a Plate.

This form of tile possesses many important advantages over those generally used throughout Europe. From the way in which the tiles combine at the joints, they may be made, by the application of a little mortar or cement, more completely wind and water proof than the best slated roof; as the joints afford no lodgment for water by capillarity, none can be blown in, and there is none to be affected by sudden frost, the frequent cause of decay in other tiled roofs.

An inspection of the plate will sufficiently explain the peculiarities of the form, and will serve to shew how the tiles are combined in covering a roof.

It will be obvious that, to make the full advantages of M. Courtois' system available, the tiles must be accurately made by good machinery, and that due precautions must be taken in drying and firing them, to prevent them from being bent or warped, as a small deviation from the normal shape will prevent that accurate fitting at the joints in which their excellence consists. The size which is found to be the best for these tiles is about 10 inches square, over all; their thickness half an inch; the ledges turned downwards on two sides, and upwards on the other two, are each half-inch thick, and a half inch above the flat surface of the tile, excepting at the upper and lower angles, where a small portion of the ledge (as shewn in the plate) has double of this projection to enable it to lock into the angle, and in the case of the lower angle, to enable it to carry the drip to the surface of the next tile below it.

When manufactured in these proportions, each tile will weigh about $4\frac{1}{2}$ lb., and sixteen of them will make a square-yard of roofing, which will weigh 68 lb.

The tile commonly used in Scotland weighs $6\frac{14}{16}$, and sixteen of them likewise make a square-yard, weighing 110 lb., or 42 lb. more than the Courtois tile.

* Read before the Royal Scottish Society of Arts, 13th December 1841.

The French Government appointed a Commission in 1839 to examine M. Courtois' system, and to report on it to the Director-General of Public Works; the report of the Commission was favourable in every respect, and dwelt particularly on the efficiency of the system in affording protection against the access of water.

EDINBURGH, *4th December* 1841.

Remarks on a Paper by Dr Scoresby, " On the Colours of the Dew Drop," in the Edin. Phil. Jour. vol. xxxi. p. 50. In a Letter to the Editor. By PROFESSOR FORBES.

EDINBURGH, *21st March* 1842.

MY DEAR SIR,—In Dr Scoresby's paper on the Dew Drop, in your Journal for July last, a variety of optical phenomena are described as new, or at least as unexplained. I wish that some other person than myself had pointed out to Dr Scoresby and your readers that the facts in question are only particular cases of well known results of optical laws. The description of the phenomena is so precise, as to leave no doubt as to their causes, which, in almost every particular, have been completely explained.* I therefore reluctantly trouble you with a few words respecting the real state of our knowledge on this interesting branch of science.

The ingenious observations of Dr S. are on two classes of phenomena essentially distinct; though in both cases the result is a series of circular coloured bands formed by minute drops of water.

The coloured rings having a radius of 40° or 50° (p. 52 of Dr S's. paper), are true rainbows. The *order* of colours was the same nearly as in the common rainbow; why they have not *pure* tints will immediately be noticed.

" In the globules at *small* angular distances the reverse order of colours" was observed (p. 52). The origin of these appears to be the diffraction of light, and is exactly similar to the *glories* of 6°, 12°, 18°, &c. observed on clouds round the

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* A condensed analysis of this branch of Optics will be found in my Report on Meteorology, in the Report of the British Association for 1840.

shadow of the observer. The colours are always the reverse of those of the rainbow. Such phenomena have been formerly described by Dr Scoresby himself.*

The question then comes to be, (1.) how were the rainbow colours perceived at varying angles in the case of the dew-drop, whereas in the rainbow the angle is nearly constant? (2.) how come the two sets of phenomena to be nearly mixed up together, so that it was impossible to tell where the one begins and the other ends? In a word, this arose entirely from the *smallness* and from the *varying size* of the rain drops. The phenomena described by Dr Scoresby are precisely what any one acquainted with the modern theory of the rainbow founded by Dr Young would have predicted, and which indeed form but a particular case of M. Babinet's very pretty experiment of shewing how the radius of any coloured arch of a rainbow produced in a fine cylindric streamlet of water varies as the diameter of the stream alters. The diameter even of the *primary* rainbow varies with the size of the drops (Report on Meteorology, p. 129), so that each drop produces a spectrum of its own at an angular distance from the sun depending upon the drop's diameter. But besides this, each drop produces its *supernumerary* bows, which are of greater distinctness as the drops are smaller, and of which M. Babinet has had the patience to count sixteen interior and nine exterior repetitions of colour.

The colours described by Dr Scoresby, even for the bows of 40°—50°, are not *pure*, since from the minuteness of the drops the interference of the light arriving at the eye from different parts of the same drop determines their angular measure, so whenever interference enters there must be mixed colours depending upon superpositions, as in Newton's rings.

There were *particular positions* at which Dr Scoresby saw most light of any colour, which correspond to the dimension of the rainbow for the *mean sized* drop.

The full range of colour was only seen in drops fifteen or twenty yards off (p. 52), whilst those much nearer the eye shewed only three colours. The explanation is, that the de-

* See the Report above cited, p. 138.

finition of the colours depending upon the interference of light falling on different parts of the drop, when the drop subtends a considerable angle, the interference becomes indistinct.

The aid obtained by the use of the telescope in Dr Scoresby's experiments does not, I apprehend, consist in magnifying the drop itself (p. 51, 55); and the most effectual focus would not be found to coincide with that which would give a distinct view of the drop. In the case of very minute drops only a feeble pencil of rays emerges truly parallel in any position; but a telescope adjusted so as to concentrate approximately all the somewhat scattered rays which fall upon the object-glass will give a more regular spectrum, just as a spectrum formed on a wall with a lens is better than one which has not been concentrated.

Finally, Dr Scoresby attributes (p. 54, 55) the variation in the angle at which the spectral colours appear, to the observed want of sphericity of the dew-drops; and he farther proposes to apply this to the explanation of supernumerary rainbows. It is only necessary to say that this view was long since proposed by Venturi (Report on Meteorology, p. 126), but has been generally abandoned since the discoveries of Dr Young. I am, my dear Sir, yours very truly,

James D. Forbes.

To Professor Jameson.

Dr Martin Barry on Fibre.

Martin Barry, M.D., read before the Royal Society of London, in December 1841 and January last, a memoir *on Animal Fibre.* In this memoir the author observes, that, in the mature blood-corpuscle, there is often seen a flat filament, already formed within the corpuscle. In Mammalia, including Man, this filament is frequently annular; sometimes the ring is divided at a certain part, and sometimes one extremity overlaps the other. This is still more the case in Birds, Amphibia, and Fishes, in which the filament is of such length as to constitute a coil. This filament is formed of the discs contained within the blood-corpuscle. In Mammals, the discs entering into its formation are so few as to form a single ring; and hence the biconcave form of the corpuscle in this class, and the frequent annular form of the filament it produces. In the other Vertebrata, the discs contained within the blood-corpuscle are too numerous for a single ring; and they consequently form a coil. At the outer part of this coil, the filament, already stated to be flat, often presents its edge; whence there arises a greater thickness of the corpuscle, and an appearance of being cut off abruptly at this part; while in the centre there is generally found the unappropriated portion of a nucleus; and hence the central eminence, surrounded by a depression, in those corpuscles which, from the above-mentioned cause, have the edge thickened. The nucleus of the blood-corpuscle in some instances resembles a ball of twine; being actually composed, at its outer part, of a coiled filament. In such of the invertebrata as the author has examined, the blood-corpuscle is likewise seen passing into a coil.

The filament, thus formed within the blood-corpuscle, has a remarkable structure; for it is not only flat, but deeply grooved on both surfaces, and consequently thinner in the middle than at the edges, which are rounded; so that the filament, when seen edgewise, appears at first sight to consist of segments. The line separating the apparent segments from one another is, however, not directly transverse, but oblique.

Portions of the clot in blood somctimes consist of filaments having a structure identical with that of the filament formed within the blood-corpuscle. The ring formed in the blood-corpuscle of Man, and the coil formed in that of Birds and Reptiles, have been seen by the author unwinding themselves into the straight and often parallel filaments of the clot; changes which may be also seen occurring in blood placed under the microscope before its coagulation; and similar coils may be perceived scattered over the field of view, the coils here also appearing to be altered blood-corpuscles, in the act of unwinding themselves; filaments, having the same structure as the foregoing, are to be met with apparently in every tissue of the body. The author enumerates a great variety of organs in which he has observed the same kind of filaments.

Among vegetable structures, he subjected to microscopic examination the root, stem, leaf-stalk, and leaf, besides the several parts of the flower: and in no instance of phanerogamous plants, where a fibrous tissue exists, did he fail to find filaments of the same kind. On subsequently examining portions indiscriminately taken from ferns, mosses, fungi, lichens, and several of the marine algæ, he met with an equally general distribution of the same kind of filaments. The flat filament seen by the author in all these structures, of both animals and plants, he states to be that usually denominated a *fibre.* Its appearance is precisely such as that of the filament formed within the corpuscle of the blood. It is known, he remarks, that discoid corpuscles circulate in plants; and it remains to be seen whether or not filaments are formed also in these.

By gradually tracing the fibre or filament above mentioned into similar objects of larger size, the author endeavours to shew that it is not possible to draw a line of separation between the minutest filament, and an object being, to all appearance, composed of two spirals running in opposite directions, and interlacing at certain regular intervals; an arrangement which produces in the entire object a flattened form, and gives it a grooved appearance. It is, in fact, the structure which, for want of a better term, he has called a *flat filament*. The edge of this filament presents what, at first sight, seem like segments, but which, in reality, are the consecutive curves of a spiral thread. A transverse section of such an object is rudely represented by the figure 8. This is also precisely the appearance presented by the minutest filament, generally termed *Fibre:* and the author particularly refers to the oblique direction of the line separating the apparent segments in the smaller filament, in connection with the oblique direction of the spaces between the curves of the spiral threads in the larger one.

The spiral form, which has heretofore seemed wanting, or nearly so, in animal tissues, is then shewn to be as general in animals as in plants. Nervous tissue, muscle, minute bloodvessels, and the crystalline lens, afford instances in proof of this. And if the author's view of identity in structure between the larger and the smaller filaments be correct, it follows that spirals are much more general in plants themselves than has been hitherto supposed; spirals would thus appear, in fact, to be universal as a fibrous structure.

The tendency to the spiral form manifests itself very early. Of this the most important instance is afforded by the corpuscle of the blood, as above described. The author has also obtained an interesting proof of it in cartilage from the ear of a rabbit, where the nucleus, lying loose in its cell, resembled a ball of twine, being composed at its outer part of a coiled filament, which it was giving off to weave the cell-wall;—this cell-wall being no other than the last-formed portion of what is termed the intercellular substance—the essential part of cartilage. These nuclei in cartilage, as well as those in other tissues, there is ground for believing to be descended, by fissiparous generation, from the nuclei of blood-corpuscles.

The author then describes the mode of origin of the flat filament or fibre, and its reproduction in various animal and vegetable tissues, which he enumerates. He conceives that each filament is a compound body which enlarges, and, from analogy, may contain the elements of future structures, formed by division and subdivision, to which no limits can be assigned.

He then traces the formation of muscle out of cells, which, according to his observations, are derived from corpuscles of the blood, to the state where there exists what is denominated the *fibril*. In this process, there are to be observed the formation of a second order of tubes within the original tube; a peculiarly regular arrangement of discs within these second tubes; the formation, first of rings and then of spirals, out of discs so arranged; the interlacing of the spirals; and the origin, in the space circumscribed by these, of spirals having a minuter size; which in their turn surround others still more minute; and so on. The outer spirals enter for the most part into the formation of the investing membrane discovered by Schwann, but for the only complete description of which, in a formed state, we are indebted to Mr Bowman. The inner spirals constitute what are denominated the *fibrillæ.* The fibril appears to the author to be no other than a state of the object which he designates a *flat filament;* and which, as he shews, is a compound structure. The fibril he finds to be, not round and beaded, as it has been supposed, but a flat and grooved filament; the description above given of the structure of the filament being especially applicable here. This flat filament is so situated in the fasciculus of voluntary muscle, as to present its edge to the observer. It seems to have been the appearance presented by the edge of this filament, that is to say, by the curves of a spiral thread, that suggested the idea of longitudinal bead-like enlargements of the fibril, as producing striæ in the fasciculus of voluntary muscle. In the author's opinion, the dark longitudinal striæ are spaces (probably occupied by a lubricating fluid) between the edges of flat filaments, each filament being composed of two spiral threads, and the dark transverse striæ rows of spaces between the curves of these spiral threads. The filament now mentioned, or its edge, seems to correspond to the *primitive marked thread* or *cylinder* of Fontana—to the *primitive fibre* of Valentin and Schwann—to the *marked filament* of Skey—to the *elementary fibre* of Mandl—to the *beaded fibril* of Schwann, Müller, Lauth, and Bowman—and to the *granular fibre* of Gerber. The changes known to be produced by the alternate shortening and lengthening of a single spiral are exhibited in the microscope by a fasciculus of spirals, not only in its length and thickness, but in the width of the spaces (*striæ*) between the curves of the spirals. And a muscle being no other than a vast bundle of spirals, it is in contraction short and thick; while in relaxation it is long and thin; and thus there occurs no flattening of bead-like segments in contraction. The author has found no segments that could undergo this change. These observations on the form of the ultimate threads in voluntary muscle, were first made on the larva of a Batrachian reptile; and have been confirmed by an examination of this structure in each class of vertebrated animals, as well as in the Crustacea, Mollusca, Annelida, and Insects.

He finds that the toothed fibre, discovered by Sir David Brewster in the crystalline lens, is formed out of an enlarged filament; the projecting portions of the spiral thread in the filament, that is, the apparent segments, becoming the teeth of that fibre.

The compound filaments are seen with peculiar distinctness in the blood-vessels of the arachnoid membrane. In connexion with the spiral direction of the outer filament in these vessels, the author refers to the rouleaux in which the red blood-discs are seen to arrange themselves, in the microscope, as probably indicating a tendency to produce spiral filaments. To form rouleaux, corpuscle joins itself to corpuscle, that is to say, ring to ring: and rings pass into coils. The union of such coils, end to end, would form a spiral. But the formation by the blood-corpuscles of these rouleaux is interesting in connexion with some facts recorded by the author in a former memoir; namely, that many structures, including blood-vessels, have their origin in rows of cells derived from corpuscles of the blood. The human spermatozoon presented a disc with a pellucid depression, each of the two sides of the peripheral portion of which was extended into a thread; these two threads forming by being twisted on the part usually designated as the tail. The occurrence of two tails, observed by Wagner, is accounted for by the author by the untwisting of these threads.

The author has noticed very curious resemblances in mould, arising from the decay of organic matter, to early stages in the formation of the most elaborate animal tissues, more particularly nerve and muscle. Flax has afforded satisfactory evidence of identity, not only in structure, but in the mode of reproduction, between animal and vegetable fibre.

Valentin had previously stated that in plants all secondary deposits take place in spiral lines. In the internal structure of animals, spirals have heretofore seemed to be wanting, or very nearly so. Should the facts recorded in this memoir, however, be established by the researches of other investigators, the author thinks the question in future may perhaps be, where is the "secondary deposit" in animal structure, which is not connected with the spiral form? The spiral in animals, as he conceives he has shewn, is in strictness not a secondary formation, but the most primary of all; and the question now is, whether it is not precisely so in plants?

In a postscript the author observes, that there are states of voluntary muscle in which the longitudinal filaments ("fibrillæ") have no concern in the production of the transverse striæ; these striæ being occasioned by the windings of spirals, within which very minute bundles of longitudinal filaments are contained, and have their origin. The spirals are interlaced. When mature, they are flat and grooved filaments, having the compound structure above described. With the shortening of the longitudinal filaments ("fibrillæ") in muscular contraction, the surrounding spirals, and of course the striæ, become elongated and narrow; while in relaxation these changes are reversed.

Dr Barry requests us to add the following, in connection with his Memoir on Fibre.

The "white substance of the nervous fibre," surrounding Remak's "band-like axis," consists of filaments having the remarkable structure above described, and often curiously interlaced with one another, as though each of them had a spiral direction. In examining the substance of the optic, olfactory, and auditory nerves, as well as that of the brain and spinal chord, Dr Barry employed for the most part such as had been preserved in spirit; and, besides using extremely minute portions, he very often avoided adding any covering whatever, the weight of thin mica itself being sufficient to rupture or to flatten this delicate substance, and thus entirely prevent its structure from being seen. In the parts last mentioned, he finds red discs, which pass first into rings and then into spirals.

In fasciculi from the spinal chord, and surrounded by spiral filaments, he met with a " band-like axis," which perhaps corresponds to that of Remak in the nerves: but if so, Dr Barry's observations go farther even than Remak's. The " axis" described by this observer was found by him to be susceptible of division into filaments. So also is the one described by Dr Barry. But the latter adds, that each filament is a compound object, which enlarges, and, from analogy, may contain the elements of future structures, formed by division and subdivision, to which no limits can be assigned. The spermatozoa, mentioned in the abstract, were from the epididymis of a person who had died suddenly. The depression noticed in their discoid extremity—corresponding apparently to the " sugient orifice" of some authors—is probably analogous to the source of new substance in other discs. In these examinations, Dr Barry has generally added to the objects dilute spirit (sp. gr. about 0.940), containing about $\frac{1}{200}$th of corrosive sublimate. Spirals from the leaf-stalk of the strawberry, after the addition of this reagent, were seen to have divided into parallel filaments having the same structure as those above described. Flax presented a quadruple coil of such filaments. In the early states of voluntary muscle also, there were seen double and quadruple coils, evidently produced by the same means—division. Dr Barry compares the appearance of the vegetable " dotted duct," in its several stages, with that of objects found in the mould, in the cornea, in the crystalline lens, and in voluntary muscle; all of which are produced by associations of minute spiral threads. The distribution of the remarkable filaments above described is so universal, that they are found in silk, in the incipient feather, in hair, in the feather-like objects from the wing of the butterfly and gnat, and in the spider's web.

Dr Barry informs us, that he has had the opportunity of shewing to several physiologists the principal appearances described in his memoir on fibre. And Professor Owen permits him to state, that he has exhibited to him spirals in voluntary muscle,—muscular " fibrillæ" having a flat, grooved, and compound form,—the filamentous structure of the " white substance in nervous fibre,"—the vegetable spiral becoming double by division,—a coiled filament within red blood-discs,—and the incipient unwinding of the coil in coagulating blood.

Further Remarks on Fibre. By Martin Barry, M. D., F.R.SS.L.& E.

Dr Barry examined the following objects, from two of the Mollusca, at the desire of Professor Owen, who dissected them out for the purpose, namely, from the *oyster*,—the branchial ganglion, and the branch connecting it with the labial ganglion; from the *Loligo*,—the optic and brachial nerves. In all of these, Prof. Owen recognised filaments (fibres) having the same remarkable appearance as those which Dr Barry had previously shewn to him in muscle.

On a subsequent occasion, several physiologists being present, one of whom was Prof. Owen, there were seen muscular "fibrillæ"—not only flat, grooved, and compound, but separated at the end into their single and simply *spiral* threads,—the really ultimate threads of muscle. In this instance chromic acid was substituted for the re-agent above-mentioned as usually employed by Dr B. in these researches; and in examining muscle he now finds the chromic acid to be even preferable thereto.*

To find the muscular "fibrillæ" of a size proper for examination, and so loosely held together that they may be separated with ease, the heart of a fish or reptile should be employed. Dr Barry has used the heart of various fishes, as well as that of the turtle, newt, and frog,—and chiefly the frog.

To find those states of voluntary muscle in which the transverse striæ are produced by the windings of comparatively large interlaced spiral filaments (see abstract of the postscript to Dr B.'s paper "on Fibre"), he recommends muscle from the tail of the *very minute* tadpole—when this larva is only 4 or 5 lines in length (as at the present season), or muscle from the leg of a boiled lobster, as being very easily obtained. In these states of muscle, the interlacing spirals are seen to dip inwards towards the centre of the fasciculus, in a manner that may be represented by making the fingers of the two hands to alternate with one another.

To find the filament in red blood discs, Dr Barry recommends the blood of a Batrachian, such as the frog or newt, on account of the large size of the discs in these animals. The blood should be examined just before its coagulation, as well as at various periods during the formation of the clot. Dr B. has usually added one of the above re-agents or nitrate of silver.

* We are indebted to Dr Hannover for bringing into notice the use of the chromic acid for such purposes.

Proceedings of the Wernerian Natural History Society.

(Continued from p. 185.)

January 8. 1842.—Dr R. Hamilton, V. P., in the Chair. Mr R. J. Hay Cunningham read a paper on the modes by which the older crystalline strata are connected with each other, and illustrated it by numerous coloured sections. The Assistant Secretary read a notice by Alan Stevenson, Esq., of a miniature mirage observed at Skerryvore in August 1841. Lord Greenock described and exhibited a series of Fossil remains of Fishes from Dryden and Queensferry.

January 22.—The Right Honourable Lord Greenock, V. P., in the Chair. The Assistant Secretary read an account of the Salt Mines of Hall, Hallein, Berchtesgaden, Reichenhall, Trauenstein, and Rosenheim in Bavaria, by William Fairbairn, Esq. Portions were then read of an elaborate essay on the arenaceous formations as they occur in Scotland, by the late Mr Blackadder, communicated by A. Blackadder, Esq., Stirling.

February 5.—Professor Jameson, P., in the Chair. The Assistant Secretary read two notices on the Meriones Labradoricus, and Arvicola Pennsylvanica, both by J. W. Dawson, Esq. of Pictou, Nova Scotia. He then read Mr Laurence Jameson's geognostical description of the district of Albany, Cape of Good Hope, which was illustrated by numerous specimens. Dr Traill exhibited a hen's Egg containing a perfect specimen of the Limax agrestis imbedded in it; also a fine specimen of Hypersthene from Skye, specimens of Black Chalk from Horse-shoe Cove on the east side of Kerrera, and a fine specimen of carbonate of barytes from Rhualt mine, Flintshire.

February 19.—Professor Jameson, P., in the Chair. The Assistant Secretary read a paper on ancient Scandinavian tumuli by Professor Eschricht. Professor Jameson afterwards exhibited and described specimens of the bluish-grey breed of rabbits from the Island of Isla, supposed to have been derived from the stock that exists on the Island of May, which, again, is conjectured to have been accidentally brought thither from the East; also a splendid head and antlers of the red-deer, from the Cromarty estate; a fine specimen of the Egyptian goose lately shot near Kirkaldy, by John Fergus, Esq.; and various other objects of Natural History.

March 5.—Dr R. Hamilton, V. P., in the Chair. There was read a communication on the tidal phenomena of the Cromarty Firth, by Alan Stevenson, Esq., LL B., civil-engineer, which was illustrated by a chart, &c. A splendid specimen of the white bull from the park of Hamilton Palace, presented to the Museum by the Duke of Hamilton, was exhibited, and also other objects of Natural History.

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.

March 10. 1842.

Acacia diptera, *Lindl.*

A. *diptera*; glauca, capitulis in pedunculo solitariis; stipulis minimis, ciliatis, caducis; phyllodiis bifariam decurrentibus, velutinis, apice incurvo-mucronatis, nervo unico marginem superiorem eglandulosam arcte approximato; internodiis linearibus, longissimis.

Description.—*Stem* much branched from the bottom (the whole plant in the specimen described being about 4 feet high). Branches long, diffused, winged in two rows, internodes long, linear. *Stipules* very minute, soft, ciliated, deciduous. *Phyllodia* decurrent, densely covered with short soft hairs, having a single nerve passing near their upper edge, and terminated by an incurved soft mucro, entirely without gland or tooth, excepting the mucro at the extremity; capitula solitary on short peduncles. *Flowers* of uniform pale yellow, and everywhere glabrous. *Calyx* 5-cleft, segments ovate. *Corolla* twice as long as the calyx, 5-partite, segments ovate, concave. *Stamens* thrice as long as the corolla; anthers of rather deeper yellow than the rest of the flower. *Pistil* scarcely longer than the stamens; stigma minute, capitate; germen slightly pinkish.

We received this plant, native of Swan River Settlement, at the Royal Botanic Garden, Edinburgh, from the Botanic Garden, Glasgow, as *A. platyptera*, in 1840, and it flowered sparingly in the greenhouse in the course of the second winter after.

Acacia platyptera is precisely similar to this in habit, but easily distinguished by its bright green not glaucous colour, by the hairs with which it is clothed being less uniform, and some of them more harsh; by the stipules being subspinescent; by the phyllodia having their solitary nerve near the centre; by their having a gland on their upper edge similar to that in *Acacia alata*; by the mucro with which they are terminated being recurved, and by the capitula being smaller and of deeper yellow. *Acacia alata*, also nearly allied, is glaucous, the internodes are short, and the mucro terminating the phyllodia is straight, and much more rigid and pungent than in either of the others. I have native specimens of *A. diptera* from Mr Gould. They differ from the cultivated plant only in being much more nearly glabrous.

Brownea coccinea, *Jacqu.*

B. *coccinea*, foliolis 2-5 jugis, ovali-oblongis, acuminatis, floribus fasciculatis, ramis petiolisque glabris.

Brownea coccinea, *Jacqu.* Amer. 194, t. 121.—*Willd.* Sp. Pl. 3. 715.—Pers. Synops. 2 236.—*DC.*, Prodr. 2. 477—*Spreng.* Syst. Veget. 3. 75.

Description.—*Trunk* (in the specimen described, an old plant, 10 feet high) erect, brown and rough with the dark desquamating cuticle, branched; branches pendulous, twigs glaucous and warted. *Leaves* alternate, abruptly pinnated, pendulous; petiole (3-9 inches long) slender, green and shining; pinnæ in 2-5 pairs, sub-opposite, oblong, acuminate, green and glabrous on both sides, subcoriaceous, the most distant (6-8 inches long, 2½-3¼ inches broad) the largest, generally smaller towards the plant, midrib prominent below, flat above, veins oblique, curved, and terminating before reaching the margins. *Flower-bud* large globular terminal or subsessile in the axil of the petioles incased with large, round, rose-coloured scales, which are villous on the outside, shining within. *Flowers* fascicled, of uniform, brilliant, vermilion rose colour, pendulous, the terminal ones expanding first, and the others gradually downwards. *Calyx* coloured like all the parts of the flower; tube long, fleshy, obconical, slightly angled, persistent, glabrous on the outside, and also within except at the apex where it is pubescent, rising from the axil of a subulato-filiform *bract* as long as itself, and incased by two blunt *bracts*, which are of equal length, coalesce to above their middle, and are villous; limb 5-lobed, segments as long as the tube, unequally cohering, adpressed, elliptical, blunt, glabrous, concave, thin, and deciduous. *Corolla* ($1\frac{1}{4}$ inch long) 5-petalous, funnel-shaped, petals obovate, tapering into long claws, inserted into the throat of the calyx, and projecting half their length beyond its limb, subequal, undulate, emarginate or entire, nervation penniform. Stamens inserted with the petals, and nearly twice as long as them, monadelphous and pubescent on their outside to the middle, free above the apices of the calyx limb, cleft to the base; anthers versatile, small; pollen orange-yellow, granules oblong. *Pistil* shorter than the stamens; stigma small, capitate, dark; style straight, filiform, glabrous; germen densely pubescent, stipitate, the foot-stalk adherent to the calyx-tube; ovules numerous.

Few things can exceed the elegance, or the richness of colouring, in the beautiful flowers of this shrub, but unfortunately they are rarely produced in our stoves, and are very fugacious, scarcely lasting more than twenty-four hours. The specimen described produced several fasciculi in short succession in February 1842.

Gesnera zebrina, *Hortul.*

G. *zebrina*; caule tereti, erecto, pubescente: foliis oppositis, longe petiolatis, cordato-subrotundis; racemo terminali, erecto; bracteis subulatis, involutis; pedicellis simplicibus, longissimis, erectis; corolla nutante, segmentis superioribus brevioribus.

Gesnera zebrina, *Paxton*, Mag. of Bot. 8. 96.—*Lindl.* in Bot. Reg. Ann. 1842, 16.

Description.—*Root* tuberous. *Stem* (including the raceme, $2\frac{1}{2}$ feet high in the specimen described) round, erect, stout, branched, as well as the whole plant, exclusive of the flowers, densely covered with unequal spreading simple pubescence. *Leaves* (6 inches long, $5\frac{1}{2}$ broad) opposite, petiolate, ovato-subrotund, slightly cordate at the base and slightly pointed, or reniform and somewhat oblique, thick and velvet-like, 3-nerved, reticulate, pale below, full green above, and darker along the nerves and veins, which are strongly prominent below, the reticulations flat, the lateral nerves generally divided at the base; petioles nearly as long as the leaves, the lower spreading, the upper suberect, deeply channelled above. *Raceme* terminal, pedicels simple, 4 inches long, erect, tapering a little upwards, springing from the axil of a small subulate, involute, green, coriaceous bract. *Flowers* suspended very gracefully from the apices of the pedicels. *Calyx* green, persisting, spreading previous to the fall of the flower, afterwards connivent over the germen. *Corolla* ($1\frac{1}{2}$ inch long) campanulate, ventricose below, compressed laterally, glanduloso-pubescent externally, and there of brilliant red colour, excepting in a broad yellow stripe along the lower side, on the inside yellow, glabrous, and sprinkled with red spots, which are largest on the lower part of the tube, smaller and more crowded on the limb, of which the lobes are subpatent, blunt, unequal, the two lateral ones being rather the largest, and the two upper the smallest and least yellow. *Stamens* arising from the cartilaginous base of the corolla, included; anthers oblong, the cells being in front of a broad cartilaginous connective, and becoming coherent as in the Genus; pollen white, granules very minute, abortive filament short and subulate. *Pistil* as long as the upper lip; stigma concave, compressed dorsally, villous on the outside; style stout, pubescent, filiform; germen pubescent, half superior, this upper portion being surrounded at its base by the erect lobed edge of a thin white disk. *Ovules* numerous.

Even in this beautiful genus the species now described will be looked upon as eminently attractive, both on account of its colour and its shape. We received it from the rich collection of Mr Low of Clapton, and both in the Botanic Garden and in Mr Cunningham's nursery, Comely

Bank, Edinburgh, it flowered profusely in the end of September and in October.

Goldfussia isophylla, *Nees von Esenbeck.*

G. *isophylla*, foliis lanceolatis, æqualibus, remote serrulatis, septuplinerviis.

Goldfussia isophylla, *Nees von Esenbeck* in Wall. Pl. Asiat. Rar. 3. 38.—*Wall.* Cat. No. 7162.—*Grah.* in Botanist.

Description.—*Stem* erect, slender, much branched, angled, glabrous. *Leaves* opposite, equal, narrow lanceolate, much attenuated at both extremities, distantly serrulate, entire towards the base, glabrous, dark green above, paler below. *Flowers* in terminal or axillary, lax, capitula, each subtended by a lanceolate glabrous bract. *Calyx* deeply but unequally 4-5-cleft, segments unequal, lanceolate, blunt, whitish but brown and pubescent on the sides and edges. *Corolla* lilac, veined, angled, funnel-shaped, curved towards the upper side, undulate, sparingly glanduloso-pubescent, lower part of the tube white, hairy on its upper side within; limb 4-lobed, lobes blunt or emarginate, the lower frequently bifid, the number of lobes of the calyx varying with those of the corolla. *Stamens* included, didynamous, without the rudiment of a fifth; filaments hairy; anthers suborbicular, attached by their backs, lobes bursting along their face. *Pistil* longer than the stamens, extending nearly to the division of the limb of the corolla; stigma linear, narrow, extending a little way along the back of the style; style glabrous, swelling towards its extremity, and terminating in a cone; germen obovato-lanceolate, compressed, ciliated at its apex opposite the edges of the dissepiment. *Ovules* few.

In habit this species exceedingly resembles that longer known one, *Goldfussia anisophylla*, but is at once distinguished by the uniformity of its opposite leaves, and it is a smaller plant. They are both natives of Sylhet. I have only seen the present species in cultivation in the nursery of Mr Cunningham, Comely Bank, where it thrives well, and flowers freely during a great part of the year in the stove; but I have received a specimen in flower from the collection of my friend Mr Gray of Greenock.

Loasa pinnata, *Grah.*

L. *pinnata*; foliis inferioribus oppositis, superioribus alternis, petiolatis, pinnatis, summis, integris oblongis, pinnis lanceolatis inciso-serratis; calycis lobis obovatis, integerrimis, subacutis; seminibus reticulatis.

Description.—*Stem* erect (above 2 feet high), pale green, with streaks which are at first dark-green and become white, greatly resembling a miniature specimen of *Dahlia arborea*, branched, paniculate at the top. *Leaves* (1 foot long, 9 inches across) opposite, petiolate, spreading horizontally, pinnate, pinnæ opposite, in four pairs, lanceolate, doubly incise serrated, the three lowest pairs generally auricled at the base, reticulated, middle rib and veins prominent behind, terminal lobe 3-fid; petioles round, slightly furrowed on the upper side, and like the whole of the plant, except the corolla, stamens, and style, provided with long stinging hairs, arising from the summits of large glands, of which they are the excretory ducts, mixed, as in other species of the genus, with short capitate hairs, but not, as in them, barbed; towards the top of the stem the leaves are alternate, and the uppermost are small, simple, oblong, and incise-serrated. *Peduncles* ($1\frac{1}{4}$ inch long) solitary in the axils of the upper leaves, erect, cernuous. *Calyx* persistent, 5-partite, lobes dark green, obovate with a short point, spreading, erect at the apices. *Corolla* (1 inch across when fully expanded) white, petals 10, alternately alike, the larger ones spreading horizontally between the calyx segments, and twice as long as them, boat-shaped, unguiculate, sharply keeled, densely covered with short, capitate, soft hairs, terminated with two long, narrow, revolute points, and having two short teeth on their edges near the claw; shorter petals, half as long as the others, opposite to the calyx-lobes, erect, ovate, boat-shaped, without keel, ciliated at the base, with hairs similar to those on the longer petals, everywhere else sub-glabrous, white, and marked in the middle with two transverse red bands, and a few red spots higher up, truncated at the apex, and there terminated with four blunt revolute teeth, of which the outer are the broadest and longest. Stamens numerous, ten barren placed in pairs within the shorter petals, than which they are scarcely longer, subulate, concave internally, villous, meeting at their points in the centre of the flower; fertile stamens much more numerous, lodged within the longer petals, and erected in succession as in the genus, longer than the shorter petals, glabrous, filiform; anthers versatile, yellow, becoming leaden coloured, oblong, bursting along the sides, pollen white, granules minute, nearly spherical. Pistil shorter than the stamens; stigma minute, dentate; style straight, stout, persisting; germen half superior, the only part within the calyx which has stinging hairs, unilocular, bursting by three acute valves in its free portion; placentæ 3, parietal, alternating with the valves. Ovules numerous. Seeds numerous, oblong, dark, reticulated.

This is a native of Mexico, and seeds were obligingly communicated to the Royal Botanic Garden, Edinburgh, in 1841, from the London Horticultural Society. Two plants flowered in the stove in January and February 1842, and have ripened seed. It can hardly be considered ornamental, but is interesting as being a perfectly distinct species.

Stylidium recurvum, *Grah.*

S. *recurvum*, caule ramoso, foliis apice ramorum confertis, subulatis, recurvis, marginibus basin versus membranaceis; pedunculis confertis, subcymosis, subterminalibus; germine lineari.

Stylidium recurvum, *Grah.* in Bot. Mag. 3913.

Description.—*Stem* (in the specimens described 6 inches high) suffruticose, slender, much branched in tufts, and there sending down long wiry roots, glabrous, red, almost incased in leaves. *Leaves* numerous all along the branches, but much crowded and spreading in a stellate form at their apices, subulate, mucronulate, arched backwards, shining, somewhat rough, of deep green colour, with a membranous colourless ragged border on each side near the base. *Peduncles* crowded from the apex of the branches, pubescent, cymose. *Calyx* 5-partite, unequal, persisting, segments elliptical, concave internally, pubescent on the outside. *Corolla* (9 lines across in the greatest diameter) 5-cleft, in the unexpanded bud yellow on the outside, reddish-orange within; tube glabrous and shining, pale green, twisted; limb spreading flat, salmon-coloured and glabrous in front, yellow in the throat, white and glanduloso-pubescent behind; lip recurved, small, ovate, of nearly uniform reddish colour, turgid and shining, having at its base two erect teeth white or greenish and tipped with red:—Other segments of the limb elliptical, the pair most distant from the lip being the largest. *Column* flattened, green and twisted immediately above the germen, of uniform brown tinge in front beyond the first flexure and green behind, beyond the second flexure (which forms a right angle) green both in front and behind, but edged with brown, and having a whorl of spreading crystalline moniliform partly coloured hairs at the apex. Anthers green, bursting along the front, and then reflexed in two parallel lines across the column of fructification; pollen abundant, granules small, greenish-white. *Stigma* rounded, villous. Germen linear, 3-gonous, equal at the apex, distinctly furrowed along two sides, more obscurely along the third, pubescent, the hairs, as well as those on the peduncle, pedicels and calyx, short, spreading, glandular.

I first saw this species in the nursery of Mr Cunningham, Comely Bank, Edinburgh, where it flowered in a frame in May 1840. In the month following we received it at the Botanic Garden, Edinburgh, from Mr Henderson's nursery in the Edgeware Road, and at the same time from Mr Jackson, nurseryman, Kingston, Surrey. It is native in the neighbourhood of Swan River, Australia, and in the arrangement of the species should stand near *Stylidium breviscapum.*

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