THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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OCTOBER 1836...APRIL 1837.

VOL. XXII.

TO BE CONTINUED QUARTERLY.

EDINBURGH:

ADAM & CHARLES BLACK, EDINBURGH;

LONGMAN, REES, ORME, BROWN, GREEN & LONGMAN, LONDON.

1837.

PRINTED BY NEILL & COMPANY, OLD FISHMARKET.

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CONTENTS.

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On Meteoric Stones. By Professor JACOB BERZELIUS.*

METEORIC stones, considered as inorganic masses occurring on the surface of the earth, are to be regarded as objects of mineralogical investigation ; and they are rendered the more interesting by their affording information as to the nature of the mineral productions of other worlds, and thus giving us an opportunity of comparing them with those of our own globe. In a memoir communicated to the Royal Swedish Academy of Sciences, I have given the results of my investigations regarding various meteoric stones which I examined, with the view of studying them as mountain rocks, in order thus to determine the individual minerals of which they are composed. The original cause of my engaging in this investigation was the commission kindly given me by Reichenbach of Blansko, to analyze a meteoric stone, whose brilliant appearance, at six o'clock on the evening of the 25th November 1833, was witnessed by himself. After great expense and trouble, he at length succeeded in collecting scattered fragments of the aërolite in the neighbourhood of Blansko.

The meteoric stones examined by me are those which fell at Blansko in Moravia, Chantonnay in France, Ellenbogen in Bohemia (the *Burggraf*), and lastly, the meteoric iron made known by Pallas, from the district between Abekansk and Krasnojarsk in Siberia.

* From Berzelius's Jahres-Bericht, 1836.

From these analyses I think I have ascertained that meteoric stones are minerals; and since it would be an absurdity to suppose that minerals could be formed in the atmosphere from their component parts, they cannot be atmospheric products; the less so, that many of them exhibit fissures which are filled with a mineral of another colour, and probably of different composition; and it would be a complete absurdity to assume that such were formed in the few instants which the attraction of the earth permits heavy bodies to remain in the atmosphere. They must come from another quarter. They are not ejected masses from volcanoes on the earth's surface, for they fall every where, not merely or chiefly at a greater or less distance from volcanoes; their aspect is different from terrestrial minerals, and different from every thing thrown out by volcanoes. The unoxidised ductile iron which they contain, proves that no water, and probably no air, exists in their place of origin. They must therefore be derived from another heavenly body having volcanoes. That nearest us is the moon, and it has, in comparison with the earth, gigantic volcanoes. It has no atmosphere to retard the ejected masses of volcanoes. It seems also to present no collections of water, and, in short, among the probable sources of aërolites, the moon seems the most likely. But the attaining an idea of the ponderable elements of which a heavenly body is composed, though it be only one which is so near us as the moon, imparts an interest to such an investigation which it would not otherwise possess.

The general results of my investigations are the following: There are two kinds of meteoric stones that fall on the earth. Those belonging to the same species have the same composition, and seem to be derived from the same mountain. *One species* is rare. Hitherto only three aërolites belonging to it have been remarked, viz. that which fell near Stannern, in Moravia, and those which fell at Jonzac and Juvenas, in France. Their distinguishing characters are, that they contain no metallic iron, that the minerals of which they consist are more decidedly crystalline, and that magnesia does not, in them, form a prevailing component part. Of these I possessed no specimen for examination. The *second species* includes the very numerous other meteoric stones which have hitherto been investigated. They are frequently so like one another in colour and aspect, that it might be supposed that they were broken from one piece. They contain ductile metallic iron in variable quantities. There are examples of enormous blocks, consisting of one single connected mass of iron, whose crevices are filled by mineral matter, and which have been preserved during the fall, owing to their being held together by the including iron. Others are composed more of mineral matter, with less iron, and they have therefore less cohesion. These are modified by the heat resulting from the immense pressure exercised during the few minutes of their passage through the atmosphere, a pressure produced by the unrestrained and increasing rapidity of motion of the aërolites towards the earth; and in consequence, their external surface is always melted to a black slag, which is finer than the thinnest post paper. We may hence say that meteoric stones, it being assumed that they are derived from the moon, come from only two different volcanoes, of which the one has either more abundant ejected masses, or the masses go in such a direction that they reach us more frequently. Such a state of things corresponds perfectly with the idea, that a certain portion of the moon has the earth constantly in the zenith, and that all its ejected masses which are thrown out in a straight line are directed by it towards the earth, whither, however, they do not proceed in a straight direction, since they are also subjected to that motion which they previously possessed as parts of the moon. If it is this portion of the moon that sends us meteoric blocks of iron, and if the other parts of the moon do not abound so much in iron, we see a reason why this point should be constantly turned towards the magnetic terrestrial globe.

The mineral matter of meteoric stones is composed of different mineral species. These are,

1. *Olivine.* It contains magnesia and oxide of iron, and is colourless or greyish, seldom yellow or green like all terrestrial olivine. This proves that there is no oxygen present further to oxidise the iron. Like the terrestrial, it is soluble in acids, leaving behind the gelatinised silica. Like it, also, it contains traces of oxide of tin and oxide of nickel. The olivine of the Pallas iron is an exception, for it contains no nickel, and its colour is greenish yellow; but it contains tin. The olivine constitutes about half of the non-magnetic mineral matter. We separate the olivine by treating it with acids, and then after-

wards dissolving the silica in boiling carbonate of soda. There remain, then,

2. *Silicates of magnesia, lime, oxide of iron, oxide of manganese, alumina, potash and soda,* which are not decomposed by acids, and in which the silica contains twice the oxygen of the bases. Probably there occur mixtures of several of these silicates which I could not separate. We might thus deduce an augite like $\left.\begin{matrix}Mg\\ f\\ C\end{matrix}\right\} S^2$, and a leucite-like mineral, in which lime and magnesia replace, in the first term, a part of the potash and soda: $\left.\begin{matrix}Mg\\ C\\ N\\ K\end{matrix}\right\} S^2 + 3\,A\,S^2$ The cause of the augite not being coloured like the terrestrial, is the same as in the case of the meteoric olivine.

3. *Chromate of Iron.*—It is contained in both species of meteoric stones, and in both in equal quantity; it is never awanting, and is the source of the chrome in meteoric stones. It can be obtained undecomposed by decomposing the non-magnetic part of the meteoric stone in hydro-fluoric acid, which is then expelled by sulphuric acid; and by afterwards separating the sulphate of lime and other sulphates by boiling water, when the chromate of iron remains in the form of a blackish-brown powder. It is the cause of the greyish-black colour of meteoric stones, when regarded in the mass.

4. *Oxide of Tin.*—It is mixed with chromate of iron. We can be convinced of its presence by fusing the latter with sulphate of potash, then treating the mass with water, and passing sulphureted hydrogen through the solution, by which sulphuret of tin is precipitated. It contains traces of copper.

5. *Magnetic iron* probably does not occur in all. We recognise it by its property of dissolving in muriatic acid with a yellow colour, and without evolution of hydrogen.

6. *Sulphuret of iron* is contained in all. It was impossible for me to separate a portion for examination. Every thing seems to indicate that it contains one atom of each of its constituent parts. We cannot imagine an excess of sulphur in a mass where an excess of iron every where predominates. A portion of the sulphuret of iron follows the magnet at the same time with the iron; another portion remains in the powder,

and is not attracted by the magnet. This amounts sometimes to several per cent. Whether the cause of the circumstance be a chemical combination similar to that of the sulphuret of manganese in helvine, or merely the adhesion to the powder, was not determined by my experiments; the latter is the more probable, as sulphuret of iron is only feebly magnetic; but the first is not impossible. The sulphuret of iron is the cause of the powdered meteoric stone giving out sulphureted hydrogen gas when mixed with muriatic acid.

7. *Native Iron.*—This iron is not pure, although it is very ductile. It contains carbon, sulphur, phosphorus, magnesium, manganese, nickel, cobalt, tin, and copper. It is also mixed with minute imbedded crystals of a combination of phosphuret of iron with phosphuret of nickel and phosphuret of magnesium. These crystals are insoluble in muriatic acid, and are therefore separated during solution. Their quantity is not constant. Ellenbogen iron yielded $2\frac{1}{2}$ per cent. and the Pallas iron not $\frac{1}{2}$ per cent. A portion of them is so finely divided in the mass of iron, that during the solution of the iron they are precipitated in the form of a black powder. The cause of the Widmanstadt figures is, that the foreign metals are not uniformly mixed, but separated in imperfectly developed crystalline arrangements. When the iron is dissolved in a solution of sulphate of iron mixed with acid, the pure iron almost alone is dissolved, and these layers fall in flakes.

The simple bodies hitherto found in meteoric stones amount to exactly one-third of those with which we are acquainted, viz. oxygen, hydrogen, sulphur, phosphorus, carbon, silicium, chromium, potassium, sodium, manganese, nickel, cobalt, tin, and copper.

The following analysis of meteoric iron may here be given, and I add one made by Wehrle at the same time:—

	Pallas Iron.	Ellenbogen Iron.	
		My analysis.	Wehrle.
Iron, . .	88.042	88.231	89.90
Nickel, . .	10.732	8.517	8.44
Cobalt, . .	0.455	0.762	0.61
Magnesium, .	0.050	0.279	———
Manganese, .	0.132		98.95
Tin and Copper,	0.066	a trace.	
Carbon, . .	0.043		
Sulphur, .	a trace		
Metallic Phosphurets,	0.480	2.211	

The metallic phosphurets contained—

	Pallas Iron.	Ellenbogen Iron.
Iron, . .	48.67	68.11
Nickel, . .	18.33	17.72
Magnesium, .	9.66	
Phosphorus, .	18.47	14.17
	95.13	100.00

These last analyses have no claim to great accuracy, as the whole quantity of metallic phosphurets which I could appropriate to analysis, amounted, in the first case, to 3 centigrammes, and in the second to 2.8. Wehrle's analysis will be seen to agree still more closely with mine, when I add, that he mixed the phosphorus and manganese with the iron, and that the magnesia was precipitated with the oxide of iron, as ammoniacal phosphate of magnesia.

Wehrle has also published several other analyses of meteoric iron, which I here copy:—

	Agram.	Cape.	Benarto.
Iron, .	89.784	85.608	90.883
Nickel, .	8.886	12.275	8.450
Cobalt, .	0.667	0.887	0.665
	99.337	98.770	99.992

Wehrle has endeavoured to discover fixed relations between the metals, which I consider a fruitless attempt.

Before concluding this subject, I must give one other result of my experiments. The meteoric stone of Alais fell into an earth when placed in water; this had the odour of clay and hay, and contained carbon in an unknown combination. It is thus proved that, in the place of origin of meteoric stones, the rocks can, as on the earth, separate into clay-like mixtures. The question arises, If this earth, containing carbon, and derived from another world, includes organic remains, do organic bodies exist there, having more or less analogy to those that are terrestrial? We can figure to ourselves the interest with which an answer would be sought to this query. We cannot reply in the affirmative, and to do so in the negative would be to deduce a more certain conclusion than the data warrant. The earth was formed of weathered olivine, containing nickel and tin. The magnet drew out the black oxide of iron in grains, among which shining particles of metallic iron could be detected, with the assistance of a microscrope. Water removed the sulphate of magnesia, together with a small quantity of sulphate of nickel, but nothing organic, and also nothing which could be extracted by alkalies. By dry distillation I obtained carbonic acid gas, water, and a blackish-grey sublimate; but no empyreumatic oil, no carbureted hydrogen gas—in a word, the substance containing carbon was not of the same nature as the *humus* in the earth of our planet. The residue was carbonised and black. When heated in oxygen the sublimate afforded no trace of carbonic acid or water, and was converted into a white uncrystalline volatile substance, soluble in water. The water was not rendered acid by it, nor was a precipitate formed in the solution by the addition of nitrate of silver. What this substance is, I know not; to me it is entirely new. Can it be an elementary body which originally does not belong to our earth? It would be premature to answer this question in the affirmative.

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*On the Relations of Colour and Smell in the more important Families of the Vegetable Kingdom.**

G. Schübler and F. J. Köhler have lately published (in an inaugural dissertation by the latter, Tübingen, 1831, 8vo) the results of some very interesting investigations on the relations of colour and smell in the more important families of the vegetable kingdom, and have thrown much light on this hitherto little cultivated field.

They examined the relations of the flowers of 4200 plants belonging to twenty-seven different families, of which latter twenty were dicotyledonous, and seven monocotyledonous. In twenty-one of these families the whole genera and species are considered, in so far as particular information could be obtained; and in six the more important genera were submitted to a careful examination and calculation.

Among the monocotyledons the following natural families

* Extracted from a work entitled, "Ueber das Licht Vorzugsweise über die Chemischen und Physiologischen Wirkungen desselben," by Dr Landgrebe of Marburg.

were investigated :—The Liliaceæ, Dec. ; the Hemerocallideæ, Dec. ; the Amaryllideæ, Dec. ; the Scilleæ, Reichenb. ; the Irideæ, Dec. ; the Smilaceæ, Dec. ; and lastly, the Cannæ, Dec. On the other hand, among the dicotyledons were more especially the Jasmineæ, Dec., the Solanaceæ, Dec., and the Gentianeæ, together with seventeen others which were not so extensively examined as the three first, viz., the Boragineæ, the Heliotropiæ, the Lysimachiæ, the Primulaceæ, the Polemoniæ, the Convolvulaceæ, the Campanulaceæ, the Violariæ, the Lenticulariæ, the Sarmentaceæ, the Stellatæ, the Rosaceæ, the Ranunculaceæ, the Papaveraceæ, the Nymphæaceæ, and the more important genera of the Scrophulariæ and Cruciatæ.

The above-mentioned families of the monocotyledons have in general a greater tendency to flowers of the white and yellowish-red series of tints than those of the dicotyledons. Blue flowering species are much rarer among the first than the last, whereas the monocotyledons include a much greater number of odoriferous species. The families of the Lilies, the Hemerocallideæ, the Amaryllideæ, the Scilleæ, and the Irideæ, contain on an average 14.2 per cent. odoriferous species, whereas the families of dicotyledons cited above contain only 9.9 per cent.

Among the already mentioned five families of monocotyledons, the Amaryllideæ contain the largest number of white flowering, and at the same time of agreeably scented species. Of 100 species there are 38 which are white flowering, whereas the blue flowering species seem to be awanting; there are 27.8 per cent. odoriferous species. The Irideæ, on the contrary, have rarely white flowers, and odoriferous species are seldom met with, there being only about 9 to 10 per cent. There are many blue flowering species (19 per cent.), and only 11.8 per cent. having white flowers.

The Rosaceæ are, after the Jasmineæ, the richest among the previously enumerated families of dicotyledons in white flowering and odoriferous plants. There the blue colour is entirely awanting. In 100 species, 36 are white, and 13.1 are odoriferous. The Campanulaceæ, Gentianeæ, and Papaveraceæ, are the poorest of the dicotyledonous families in white and odoriferous species. Among the two first there are many white flowering species, and among the last many violet-flowering species.

To confirm this observation, I may state, that there are only 4.10 species in 100 having white flowers, and hardly 1.2 in the same number possessing a smell. If we arrange the colour relations in a general table, we have the following results :—

Colour of the flowers.	In 4000 species.	Taking the mean in 1000 species.
White,	1193.3 species,	284 species.
Red,	923	220 ....
Violet,	307.5	73 ....
Blue,	594.5	141 ....
Green,	153	36 ....
Yellow,	951.3	226 ....
Orange,	50	12 ....
Brown,	18.5	4 .. ..
Black,	8.5	2 ....

Hence it appears, that white is the most extensively distributed colour; and that among the coloured flowers, red, yellow, and blue are of more frequent occurrence than the three intermediate tints,—violet, green, and orange. Of the three principal colours, yellow is the most abundant, but blue the rarest; while, of the three intermediate colours, violet is the most frequent. When flowers occur having a green colour, the tint is generally not pure, but is rather a dirty yellowish-green; for, indeed, a pure green, in flowers, is an extremely rare phenomenon. It is also remarkable, that brown and black, which do not present themselves in the optical spectrum, are rare in flowering plants.

If we proceed in regard to the relations of smell in plants, in the same manner as in those of colour, there results the following general view, from which it may be remarked, that the few black flowering species can be brought into the calculation only by deducing the general mean.

Colours.	Number of species.	Odoriferous species of the colour.	Taking the mean in 100 species of the colour, there occur,
White,	1193.5	187	15.66 odoriferous.
Red,	923	85.4	9.25 ....
Yellow,	951.3	75.6	7.94 ....
Blue,	594.5	30.9	5.18 ....
Green,	153	12.8	8.36 ....
Violet,	307.5	23.5	7.64 ....
Orange,	50	3	6 ....
Brown,	18.5	1.2	6.48 ....
General mean,	4200	419.3	9.99 ....

It is thus evident, that as the white-flowering species are most numerous, so are they the most generally odoriferous. Among the coloured flowers the red have the greatest tendency and the blue the least to the formation of odoriferous substances. On the average there is only one odoriferous species in ten.

If we further separate the species having an agreeable from those having a disagreeable smell, we obtain the following results:—

Colour of the Flowers.	Number of Species.	Having an agreeable odour.	Having a disagreeable odour.	Of 100 species of this colour there are, taking the mean,	
				Having an agreeable odour.	Having a disagreeable odour.
White,	1193.5	755	12	14.66	1.00
Red,	923	76.1	9.3	8.24	1.01
Yellow,	951.3	61.1	14.5	6.42	1.52
Blue,	595.5	23.3	7.5	3.91	1.26
Violet,	307.5	17.5	6.0	5.68	1.95
Green,	153	10.3	2.5	6.73	1.62
Orange,	50	1.0	2.0	2.00	4.00
Brown,	18.5	0	1.2	...	6.48
Coloured-flowering altogether,	2997.8	189.3	43.0	6.31	1.43

From this table it is apparent that white-flowering plants are much more frequently agreeably perfumed than coloured flowering; for, in 100 white-flowering plants, there are, on an average, 14.6 having an agreeable smell, and only 1 having a disagreeable; whereas, in the same number of coloured-flowering plants, there are 6.3 having an agreeable odour and 1.4 having a disagreeable.

There are therefore among the white-flowering plants a greater number of species having an agreeable smell, than among the coloured-flowering, in the proportion of 63 : 146; on the contrary, among the coloured-flowering there are a greater number of plants having a disagreeable smell than among the white-flowering, in the proportion of 10 : 14.

The individual colours exhibit further the following differences, when the flowering odoriferous species in each colour are reduced to 100 agreeable smelling species; there are, according to the above relations, in the flowers of 100 agreeable smelling species:—

Having a white colour	6.8	having a disagreeable odour.
.... red	12.2	....
.... yellow	23.5	....
.... blue	32.2	....
.... violet	34.2	....
.... green	24.2	....
Of coloured flowers altogether,	22.7	....

The orange and brown flowering plants seem to possess a larger number of disagreeable than of agreeable smelling species. Among 4200 species examined, there are two brown plants, which are odoriferous, viz. the Delphinium triste, L., and the brownish-red flowering Scrophularia aquatica, L., and three odoriferous orange and yellowish-red flowers, the Nicotiana glutinosa, L., Alestris uvaria, L., and Verbascum versiflorum, Schrd.: the last alone has an agreeable smell; the others have a disagreeable odour. It is well known, and not on that account the less remarkable, that the great genus Staphelia, which so frequently exhibits flowers of a yellowish-red or yellowish-brown colour, includes so many species having a disagreeable odour, often like that of carrion; further, that two species distinguished by their peculiarly offensive odour, viz. the Arum divaricatum, W., and the Asarum europæum, should possess a dark brown passing into violet corolla.

We perceive, then, from these details, that white flowers are for the most part and especially sweet smelling; but the family of the Cruciatæ is in this respect an exception, for many of the species have non-odoriferous flowers, whereas they possess as a compensation a transient sharpness, as in the genera Cochlearia, Lepidium, Cardamine, Thlaspi, Sisymbrium, Senebiera, &c. Among the monocotyledons, we observe the same thing in the genus Allium.

After having deduced these results from the species considered collectively, the authors take a general view of the larger genera in regard to the relations of colour and smell, in which they separate the genera of each principal colour into three divisions, according to the different proportions of white in their flowers; they then enumerate together the whole species of each colour; and thus calculate the number of odoriferous species which occur, taking the mean of 100 species.

The genera of each division are again arranged separately, according to their principal colours; the colours next in abundance are added to each principal colour, in order to ascertain the greater or less tendency of the separate species to this or that colour. This will be rendered more distinct by the following tables:—

1. *Red Flowering Genera.*

a. Genera which contain 0—12 per cent. white in their flowers.

Genera.	Principal Colours according to the per centage.						Odoriferous.	No. of species.
	Red.	Yellow.	Blue.	Violet.	Orange.	White.		
Antholyza, .	83	5	...	...	11	...	...	9
Chironia, . .	77	11	11	...	...	...	...	9
Amaryllis, .	70	15	...	...	10	4	...	57
Papaver, . .	68	6	...	4	13	4	...	22
Canna, . . .	61	30	...	...	8	...	...	13
Scrophularia, .	53	17	...	2	9	7	1	22
Erythræa, . .	53	38	...	...	...	...	...	13
Gladiolus, . .	49	22	12	5	...	9	11	91
Altströmeria,	46	28	...	0.7	7	8	...	43
Fritillaria, . .	44	28	...	10	5	10	1	21

Among 300 species there are 17 odoriferous, therefore among 100 a mean of 5.66.

b. Genera which contain 12—70 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Red.	Yellow.	Blue.	Violet.	Orange.	White.		
Pæonia, .	78	...	...	...	7	14	2	14
Brunsvigia,	72	...	...	1	...	22	4	11
Rosa, . .	65	3	...	0.5	...	30	49	199
Hæmanthus,	64	...	...	...	...	35	1	17
Asperula, Lam.	52	9	...	4	...	33	3	21
Anemone, .	47	17	9	...	...	24	0	33
Ipomoea, Lam.	45	8	6	12	2	25	1	89
Phlox, Lam.	44	...	14	14	...	28	5	23
Matthiola, R. Br.	44	14	...	20	...	14	8	20
Lilium, .	41	10	...	...	17	29	11	34
Primula, .	39	23	2	16	...	16	9	43
Ixia, . .	37	24	13	4	...	15	4	80
Convolvulus,	37	8	14	4	3	32	1	83
Exacum, Smith,	36	14	9	18	...	18	...	11
Hesperis, .	36	5	...	28	...	30	4	18
Aloë, . .	33	11	...	1	4	19	...	78
Rubus, .	29	1	...	3	...	65	2	55
Androsace, .	28	5	...	...	...	66	1	21
Cynoglossum,	26	...	24	20	5	20	3	29
Lachenalia,	26	...	...	...	...	14	11	32
Nicotiana, R. Br.	22	15	...	...	5	39	2	18
Clematis, Dec.	21	12	7	12	...	40	5	42

Among 962 species there are 126 odoriferous, and hence taking the mean 13.09 per cent.

c. Genera which contain 70—100 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Red.	Yellow.	Blue.	Violet.	Orange.	White.		
Pyrus,	23	...	...	...	...	77	2	13
Crinum,	23	...	...	...	...	77	27	48
Prunus,	18	...	...	...	...	81	9	22
Spiraea,	15	...	...	...	...	84	2	26
Sanseviera,	11	...	...	...	...	83	3	9
Crataegus,	7	...	...	...	...	93	1	14
Pancratium,	7	...	...	...	...	92	18	27

Among 159 species there are 82 which are odoriferous, and hence taking the mean 38.99 per cent.

2. *Violet flowering genera.*

a. Violet flowering genera which contain 0—12 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Violet.	Red.	Blue.	Yellow.	Orange.	White.		
Roemeria,	100	...	...	...	...	...	...	3
Pulmonaria,	60	20	20	...	...	...	...	10
Pinguicula,	54	18	9	9	...	9	...	11

Of 24 species there is not one that is odoriferous.

b. Violet flowering genera containing 12—70 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Violet.	Red.	Blue.	Yellow.	Orange	White		
Crocus,	46	13	3	20	...	16	3	15
Lycium,	40	25	10	...	...	25	1	20
Solanum,	29	6	20	5	...	38	4	195

Of 230 species there are 8 odoriferous, and hence taking the mean 3.47 per cent.

c. Violet flowering genera, containing 70—100 per cent. white in their flowers.

Genera.	Principal Colours according to per centage,						Odoriferous.	No. of Species.
	Violet.	Red.	Blue.	Yellow.	Orange.	White.		
Iberis,	15	10	...	...	...	75	4	20
Datura,	14	7	7	...	...	71	3	7
Massonia,	7	...	...	...	...	85	3	14

Of 41 species there are 10 odoriferous, and hence taking the mean 24.39 per cent.

3. *Blue Flowering Genera.*

a. Blue flowering genera containing 0—12 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Blue.	Violet.	Red.	Yellow.	Orange.	White.		
Veronica, . .	74	7	9	...	...	9	...	87
Campanula, .	59	24	4	3	...	9	1	120
Scilla, . . .	58	11	...	...	...	9.7	3	36
Delphinium, .	56	15	13	2	...	5	3	45
Phyteuma, .	56	13	13	4	...	9	1	23
Aconitum, .	53	7	3	26	...	9	...	27
Anchusa, . .	52	8	18	15	...	5	...	38
Gentiana, . .	46	11	13	15	1	11	...	79
Aquilegia, .	45	8	33	4	...	...	...	12
Moraea, . .	41	6	4	38	...	9	...	22

Of 489 species there are 8 odoriferous, and hence taking the mean 1.63 per cent.

b Blue flowering genera, containing 12—70 per cent. in their white flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Blue.	Violet.	Red.	Yellow.	Orange.	White.		
Myosotis, .	72	...	...	11	...	16	2	18
Anagallis, .	62	...	25	...	...	13	...	8
Hyacinthus,	52	...	11	...	...	19	4	23
Nigella, . .	45	...	...	30	...	25	...	10
Echium, .	34	17	12	1	...	35	1	59
Viola, . .	29	17	4	91	1	29	9	84
Nymphæa,	22	...	14	...	...	64	7	18

Of 220 species there are 23 odoriferous, and hence taking the mean 10.45 per cent.

c Blue flowering genera, containing 70—100 per cent. white in their flowers. Heliotropium contains 4 odoriferous species in 31; and 13 per cent. blue, 3 red, 3 yellow, 73 white. Hence, taking the mean, there are 12.90 per cent., odoriferous species.

4. *Green Flowering Genera.*

a Green flowering genera, containing 0—12 per cent. white in their flowers, and having a pure green tint do not occur; but perhaps the genus Helleborus might be referred to this division.

b Genera containing 12—70 per cent. white flowers.

Genera.	Principal Colours according to per centage.							Odoriferous.	No. of Species.
	Green.	Blue.	Yellow.	Red.	Orange.	Violet.	White.		
Drimia,	61	...	...	...	...	...	22	...	9
Cissus,	45	...	27	...	...	...	27	...	11
Vitis,	27	...	12	11	...	...	50	3	9
Yucca,	22	...	14	...	9	...	54	1	11

Of 40 species there are 4 odoriferous, and hence 10 per cent.

Green flowering genera, containing 70—100 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.				Odoriferous.	No. of Species.
	Green.	Yellow.	Red.	White.		
Smilacina,	12	12	...	75	2	8
Convallaria,	12	4	...	83	2	12

Of 20 species there are 4 odoriferous, and hence 20 per cent.

5. *Yellow Flowering Genera.*

a Genera containing 0—12 per cent, white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species
	Yellow.	Red.	Blue	Violet.	Orange.	White.		
Potentilla,	85	3	...	...	...	9	...	106
Ranunculus,	84	4	0.7	...	...	10	1	137
Onosma,	76	11	6	...	...	6	...	17
Verbascum,	74	4	...	4	2	11	7	54
Lysimachia,	69	23	...	...	...	4	1	13
Gagea,	62	...	...	...	...	...	...	16
Sisyrinchium,	68	11	19	3	...	...	...	13
Atropa,	54	18	9	9	...	9	1	11
Lisianthus,	34	17	11	14	3	...	...	35
Crucianella,	33	7	15	...	...	1	1	13
Iris,	32	11	28	14	...	10	13	84
Digitalis,	30	26	...	3	25	11	...	16

Of 515 species there are 24 odoriferous, and hence 4.66 per cent.

b Yellow flowering Genera, containing 12—70 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of Species.
	Yellow.	Red.	Blue.	Violet.	Orange.	White		
Erysimum,	81	...	...	...	...	19	3.5	32
Hyoscyamus,	70	14	...	...	...	14	2	14
Physalis,	69	...	4	...	...	23	4	21
Rubia,	63	...	...	...	...	36	1	11
Geum,	61	9	...	...	...	28	...	21
Albuca,	56	...	...	...	...	32	1	17
Narcissus,	54	...	...	...	...	43	29	81
Cheiranthus,	50	13	...	13	...	23	3	15
Utricularia,	50	6	20	3	3	16	...	30
Tulipa,	45	40	...	...	...	15	5	20
Cestrum,	36	7	...	...	...	39	11	28
Thalictrum,	33	13	...	...	...	53	2	15
Lithospermum,	23	3	16	16	...	37	...	30
Galium,	23	11	...	...	...	80	8	88
Ornithogalum,	16	...	...	...	...	68	6	54
Tournefortia,	10	5	5	...	5	68	1	20

Of 497 species 76.5 are odoriferous, and hence 15.39 per cent.

e Yellow flowering genera, containing 70—100 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of species.
	Yellow.	Red.	Blue.	Violet.	Orange.	White.		
Jasminum	14	2	......	...	...	74	14	29
Cordia	13	6	...	...	...	74	1	31
Ehretia	38	7	..	...	...	77	3	13

In 73 species there are 18 odoriferous, and hence 24.65 per cent.

6. *Orange-Red Flowering Genera.*

Genera.	Principal Colours according to per centage.						Odoriferous.	No. of species.
	Orange.	Red.	Yellow.	Violet.	Blue.	White.		
Odonis	44	22	33	...	...	...	...	9
Chrysiphiala	40	21	12	...	...	6	...	10
Aletris	38	11	11	...	...	33	3	9

The two genera with 0—6 per cent. white, contain no odoriferous species; the genus containing 33 per cent. white, contains 3 odoriferous species; hence in the 3 genera of this colour there are 10.71 per cent. odoriferous species.

If we collect the chief results of this arrangement in a general view, we obtain the following relations between colour and smell:—

Intensity of Colour in Flowers.	Mean number of Odoriferous Species according to the prevailing Colour of the Flowers.				
	Red.	Violet.	Blue.	Green.	Yellow.
With 0—12 per cent. white	5.66	...	1.63	...	4.66
With 12—70 per cent. white	13.09	3.47	10.45	10	15.39
With 70—100 per cent. white	38.99	24.39	12.90	20	24.65

The increase of odoriferous species in proportion to the diminution of colouring matter is evident in each of these principal colours, as has been already remarked above. This seems also to be the case in the orange-red colour, but before such a circumstance can be ascertained with certainty, new investigations must be made.

It would, however, hardly have been safe to extend to the whole vegetable kingdom the interesting laws determined and ascertained regarding the 4200 species whose colour and smell were examined. New and extensive investigations were still indispensably requisite, but these have already been partially carried on, and their results published in two essays, by the same able naturalists, viz. "*Investigations regarding the Distribution of Colours and Odours in the families of the Rubiaceæ; by G. Schübler and F. X. Müller,* (*Inaugural Dissertation, Tubingen,* 1831, 8*vo*);" and, "*Investigations on the Distribution of Colours and Odours in the families of the Asperifoliæ, Primulaceæ, Convolvulaceæ, Campanulaceæ, Rosaceæ, Ranunculaceæ, Papaveraceæ, and Nymphæaceæ; by G. Schübler and Fr. Feil.* (*Inaugural Dissertation, Tubingen,* 1831, 8*vo*.)"

We shall here speak particularly of the family of the Rubiaceæ, which includes plants containing extremely powerful substances, that are employed for medicinal purposes, for nourishment, and for technical uses; and also species that are remarkable for their agreeable or disagreeable odours.

Under the great family of the Rubiaceæ are included the following sub-families, viz. the Cinchonaceæ; the Gardeniaceæ, Rich.; the Hedyotideæ, Cham. and Schl.; the Isertieæ, A. Rich.; the Hamelieæ, A. Rich.; the Cordiereæ, Rich.; the Guettardaceæ, Kunth; the Pæderiæ, Dec.; the Coffeaceæ, Dec.; the Spermacoceæ, Cham.; the Anthospermeæ, Cham.; the Stellatæ, Ray and Dec.; and the Opercularieæ, A. Rich.

All these subdivisions contain 708 species of plants, which may be divided, as to colours, in the following manner; and, for the sake of further comparison, are added the results deduced from the mean of several other families, according to the principles already communicated.

Colour of the Flowers.	Of 708 species of the Rubiaceæ.	Taking the mean of 100 species,	
		Of the Rubiaceæ.	Of several other families.
White . .	401.8	56.7	28.4
Red . .	12.9	18.2	22.0
Violet . .	19.0	2.7	7.3
Blue . .	20.3	2.8	14.1
Green . .	20.7	2.9	3.6
Yellow .	96.8	13.6	22.6
Orange .	4.5	0.6	1.2
Brown . .	2.3	0.3	0.4
Black . .	1.0	0.1	0.5

It is hence apparent, that the Rubiaceæ contain, on an average, more white flowers than the previously examined families. Of the three principal colours, the Rubiaceæ have the greatest tendency to the development of red flowers, and the least to that of blue,—a result which seems to be connected with the occurrence of red and reddish-brown colouring matter in their roots and barks, and of vegetable acids in their leaves and fruits; the last are found in the succulent fruits of the *Vangueria edulis*, Vahl; *Morinda citrifòlia*, L.; *Ixora coccinea*, L.; *Ixora alba*, L.; *Gardenia edulis*, Poir.; *Genipa Americana*, L.; *Genipa esculenta*, Lour.; and *Pavetta indica*, L.; in fresh coffee beans; in the leaves and flower-stalks of the *Nauclea orientalis*, Lam., and *Uncaria acida*, Roxb.; in the leaves and stems of *Galium verum* and *græcum*, L.; and in the barks of several species of *Cinchona*. If we now deduce from these and the previously communicated data, a general mean for the distribution of colours in flowers, we obtain the following results:—

Colour of the Flowers.	Of 4771 Species.	Mean of 400 Species.
White . . .	1527.3	320
Red	1030.5	215
Violet . . .	324.5	68
Blue	612.8	128
Green . . .	166.7	34
Yellow . . .	1014.1	212
Orange . . .	54.5	11
Brown . . .	20.3	4.2
Black . . .	8.5	1.7

The 700 more particularly examined Rubiaceæ contain 83 odoriferous species; hence, on an average, 11.5 per cent.; a result differing somewhat from the number previously deduced (100 : 9.9). Nearly all have an agreeable smell.

If we divide the 83 odoriferous species according to the principal colours, we have the following result:—

Colour.	Number of Species.	Odoriferous Species of this Colour.	Taking the mean of 100 Species, there are:
White	10.8	49.6	12.3 odoriferous.
Red	129.0	12.4	9.6 ......
Yellow . . .	96.8	11.2	11.5 ......
Blue	20.3	1.0	4.9 ......
General mean	708	83	11.5 ......

If we examine the intermediate colours, orange, violet, and green, we meet with no odoriferous species, or so few that they cannot be employed for general results. We perceive, again, that white plants have the greatest tendency to be odoriferous, and blue plants the least.

By deducing a general mean from the previously communicated observations, in connection with the results obtained from the Rubiaceæ, we obtain the following division of colours and odours :—

Colours.	Number of Species.	Odoriferous Species of this Colour.	Taking the mean of 100 Species, there are
White . . .	1527.3	226.1	14.8
Red	1030.5	97.3	9.4
Yellow . . .	1014.1	84.4	8.3
Blue . . .	612.8	31.8	5.2
Green . . .	166.7	11.5	8.7
Violet . . .	324.5	23.5	7.2
Orange . . .	54.5	3.0	5.5
Brown . . .	20.3	1.2	5.9
General mean	4771	503.3	10.5

Species having a disagreeable odour are rare in this family, and chiefly in the genus Mephitidia, the colours of whose flowers have, however, not been very particularly ascertained.

In examining more closely the species of this great family, in regard to colour and smell, we find, as to the first, that white also predominates here, except in the Cinchoneæ, in which the red colour is the most abundant, for they contain, taking the mean, 41 red and 38 white flowering species. The red is, after the white, the most prevailing colour in the Gardeniæ and the Hedyotideæ ; the yellow in the Stellatæ and the Guettardaceæ ; the blue in the Spermacoceæ, which also include several species having a disagreeable odour, and which act powerfully on animals. The Coffeaceæ have, next to white, the greatest tendency to red and yellow flowers, although some genera contain also violet flowering species. The Gardeniæ and Cinchoneæ, which, next to white, are chiefly disposed to red tints, contain the largest number of species having an agreeable smell ; and the Spermacoceæ, which, next to white, have the greatest tendency to blue flowers, possess the fewest.

By arranging the great genera of the Rubiaceæ for the calculation of their relations of colour, according to the rules already laid down, we obtain the following tabular views :—

1. *Red-flowering Genera.*

a Red-flowering genera, containing 0—12 per cent. white, do not occur.
b Red-flowering genera, containing 12—70 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odorife-rous.	No. of species.
	Red.	Yellow.	Blue.	Violet.	Brown.	White.		
Manettia........	61	...	15	...	...	23	...	13
Asperula........	52	9	...	4	...	33	3	21
Cinchona........	47	...	...	...	...	50	3	15
Ixora............	45	...	...	3.2	...	51	2	31
Anotis...........	33	...	...	11	5.5	50	...	9
Rondeletia.....	23	20	...	...	8.1	41	4	16

Of 105 species, 12 are odoriferous, hence 11.4 per cent.

c Red-flowering genera, containing 70—100 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.				Odorife-rous.	No. of species.
	Red.	Yellow.	Green.	White.		
Coffea	11	...	...	89	3	14
Randia.............	8.1	6.2	3.3	82	7	16

Of 30 species 10 are odoriferous, thus giving 10 per cent.

2. *Violet-Flowering Genera.*

a Violet-flowering genera, with 0—12 per cent. white, do not occur.
b Violet-flowering genera, with 12—70 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.						Odori-ferous.	No. of Species.
	Violet.	Red.	Blue.	Green.	Orange.	White.		
Coccocypselum	30	20	25	5	...	20	...	10
Cephaëlis......	20	15	15	...	10	40	...	10

Of 20 species there is not one odoriferous.

c Violet-flowering genera, containing 70—100 per cent. white in their flowers. Of such the Rubiaceæ contain only the genus Faramea, which contains 83 per cent. white, and 16 per cent. violet. Of 6 species 1 is odoriferous.

3. *Blue-Flowering Genera.*

a Blue-flowering genera, with 0—12 per cent. white do not occur.
b Blue-flowering genera, with 12—70 per cent. white. To this belongs the genus Spermacoce, which in its flowers contains 21 per cent. white, 23 per cent. blue, 7.7 per cent. red, and 7.7 per cent. violet. We have already mentioned that it contains very few odoriferous species, there being not 1 in 13 plants.

4. *Green-flowering Genera.*

a Genera which contain 0—12 per cent. white do not occur.
b Genera in which we observe 12—70 and 70—100 per cent. white.

Genera.	Principal Colours according to per centage.				Odoriferous.	No. of Species.
	Green.	Blue.	Red.	White.		
Oldenlandia...	50	10	20	65	1	10
Morinda	6	...	...	93	1	3

In the first of these genera 10 per cent. are odoriferous, and in the last 12.5 per cent.

5. *Yellow-flowering Genera.*

a Yellow-flowering genera, with 0—12 per cent. white. Crucianella with 33 per cent. yellow, 7 per cent. red, 31 per cent. green, 15 per cent. blue, 7 per cent. white. Of 13 species 1 is odoriferous, therefore 7.7 per cent.

b Yellow-flowering genera, which contain 12—70 per cent. white in their flowers.

Genera.	Chief Colours according to per centage.						Odoriferous.	No. of Species.
	Yellow.	Red.	Violet	Blue.	Green.	White.		
Rubia	63	...	...	...	...	36	1	11
Nauclea	50	11	...	...	5	22	3	9
Palicourea ...	44	19	10	1.5	2.5	17	2	20
Psychotria ...	23	6.3	2.1	2.1	5.3	60	...	47
Galium	22	11	...	...	3	60	8	98

In 175 species, 14 are odoriferous, = 18 per cent.

c. Yellow flowering genera which contain 7—100 per cent. white in their flowers.

Genera.	Principal Colours according to per centage.				Odoriferous.	No. of Species.
	Yellow.	Orange.	Red.	White.		
Gardenia,.........	9.5	...	2.3	83	16	21
Pavetta,..........	8.0	2.0	6.0	84	2	13

Of thirty-four species, eighteen are odoriferous, equal 52 per cent.

If we collect these principal results in one general view, we have the following table :—

Intensity of colour.	Mean number of Odoriferous Species according to the prevailing colour.				
	Red.	Violet.	Blue.	Green.	Yellow.
In flowers with 0—12 p. c. white.	...	...	...	...	7.7
.... 12—70 p. c. do.	11.4	...	...	10.0	8.0
.... 70—100 p. c. do.	3 .3	16.6	4.2	12.5	52.9

We also observe in this family an increase of odoriferous species as the amount of colouring matter diminishes,—a remark we have several times had occasion to make in the preceding investigations. In the last of the quoted essays notice is particularly taken of the relations of colour and smell in the families which are most abundant in our climates. By including these families in a general view, and arranging them according to the relations of their odoriferous species, these being reduced to a per-centage, we obtain a nearer approximation to the more general distinctions in regard to colour and smell. There flower in the mean of 100 species,

In the family of the	Red.	Violet.	Blue.	Green.	Yellow.	Orange.	White.	No. of odoriferous species p. c.
Nymphæaceæ, .	11	...	14	...	28	...	46	32
Rosaceæ, . .	32.2	0.5	...	...	52.2	...	40	13.1
Primulaceæ, .	41	7	6	1.5	15	97	27	12.3
Asperifoliæ, ,	10	9	28	3	13	0.5	35	5.9.
Convolvulaceæ,	39	10	12	...	7	2.4	27	4.13
Ranunculaceæ,	16	4	15	2	42	0.5	19	4.11
Papaveraceæ, .	38	9	...	...	36	7	7	2 ...
Campanulaceæ,	5	21	58	...	3	0.7	10	1.31

Of the families here enumerated, the Nymphæaceæ and Rosaceæ contain, in proportion, the largest number of white flowering species, and the Papaveraceæ and Campanulaceæ the fewest; the two first include at the same time the largest number of odoriferous species, and the two last by much the smallest, and of these several have disagreeable odours.

The Primulaceæ and Convolvulaceæ are richest in red flowering species. In the first many have yellow flowers, and in the last many have blue. The first are richer than the last in plants having an agreeable smell.

The Campanulaceæ are richest in blue flowers; then follow the Asperifoliæ, which have at the same time a much greater tendency to white and yellow flowers; the last also possess a much larger number of plants having an agreeable odour.

Lastly, the Ranunculaceæ, in the genus Ranunculus, have a great many yellow flowering species; but most of the other genera flower in the tints of the bluish-red colour series; they contain few odoriferous species, and of these many in proportion have disagreeable odours.

Extract of a Letter from the Right Hon. J. H. Frere, written from Malta to Dr Davy, on the subject of a Natural Phenomenon recently discovered in the neighbourhood of the* Pietà.† Communicated by Dr Davy.‡

You may recollect my attempt at forming a kitchen-garden at the Pietà by levelling a piece of rocky ground at the top of the hill; it has led to a discovery which is very extraordinary, and which to every person who has visited it appears unaccountable.

Near the Carruba tree, which you may remember on your right hand at the top of the new flight of steps, a piece of rock had been left untouched for fear of injury to the tree; at length, however, we ventured to remove this last remnant of rock. It was found to rest on a body of clay, about twenty-seven feet in length, and (at the surface) about fifteen in width. As a welcome addition to the scanty collection of soil which had served to cover the rocks and stones, one-half of the length and the whole of the width was excavated to the depth of about twelve feet; but in doing this, stones (one or two of them as big as a man's head) were found imbedded in the clay, evidently rounded by the action of water; others were found of a laminous texture, in which all the crevices and interstices were penetrated by the clay, shewing that this same clay (though it had now become so hard, and dense, and heavy, as

* From the Malta Gazette, 26th July 1836.

† Any persons who on a Sunday or *festa* may wish to visit the premises, will be admitted on applying to the gardener, *Giovanni Moretti, Vico Secondo, No. 2 Molo della Pietà.*

‡ Dear Sir,—I am induced by the interest of the subject to send you an extract of a letter, published in the *Malta Gazette*, which Mr Frere has been pleased to address to me, relating to certain geological appearances recently discovered in Malta. One important point of inquiry to which they seem to lead is, the connection of the traces of human art with indications of great changes in the physical condition of the surface; and associated with other facts relative to Malta, they may possibly warrant the conclusion, that Malta was inhabited by man before the great catastrophe took place to which it owes its present form, and by which it may have been separated from the continent. The bone noticed by Mr Frere in his letter, in the opinion of M. Clift, to whom I have submitted it, is probably a portion of the radius of a ruminating animal—perhaps a goat. I have examined it chemically, and have found it in composition very similar to the bone of the bone-breccia, which occurs in many parts of the shores of the Mediterranean, consisting chiefly of phosphate of lime, without any animal matter, and with a larger proportion of carbonate of lime than exists in recent bone.—*Dr Davy in a letter to the Editor.*

to be with difficulty broken up by a strong man working with a pick-axe) must at one time have been in a fluid state, suspended probably in a body of turbid water.

Moreover, the sides of the rock, forming a sort of irregular funnel in which the clay was contained, exhibited on one side (the side which may be called concave, and which as we descended was found to be vaulted and overhanging) indications distinctly suggesting, even to an unpractised observer, the notion of their having been formed by a rotatory action of water; and that this rotatory action had probably originated in the rush of water to some great cavity below, forming a sort of whirlpool. Indications different in appearance, but equally bearing witness to the violent action of water, were observable on the opposite, or what may be called the convex side, the form of which might be described as resembling a portion of an inclined cylinder, or of a cone; striped, as it was found to be, from top to bottom with deep longitudinal furrows, shewing that the direct downward rush of water must have taken place on this side, while on the opposite and concave side the rotatory action resulting from the contraction of the lower part of the rocky funnel had left its traces in a series of horizontal furrows.

It followed, therefore, as an obvious inference, that the funnel upon which we had entered, would be found to penetrate through the whole depth of the rock. The work, therefore, was continued, partly from curiosity and partly for the chance of finding water, till it was brought down to the level of the sea, a depth of sixty-three feet from the surface; when all further operations were stopped by the influx of water. But the existence of a continued cavity filled with clay, and extending in a downward direction below the surface of the water, was ascertained by the facility with which iron-bars could be thrust down into it, for the water was not found at first, but flowed in gradually as soon as the fissures of the rock were left unobstructed by the removal of the clay.

If my report had ended here, it would hardly have been worth while to trouble you with it; but the only organized substance which was discovered is a fragment of bone, which I send, in the hope that some of your scientific friends may be able to determine the genus or species of animal to which it belonged. It was found (after we had been at work about three weeks) imbedded in the dense and tenacious clay. But a more singular discovery was made a day or two after; a piece of hard and very heavy stone, about four inches in length, and two and a half in width. It was irregularly fractured at the back and at the edges, but on the other and larger side reduced to what may be called a smooth surface; that is to say, smooth with the exception of the traces of the instrument which had been employed for the purpose of giving it an even surface; these traces are very distinctly observable upon it. This stone, like many others which were found imbedded in the same clay, was covered with a black fuliginous varnish, a mark of authenticity which, if I had had any suspicion of the good faith of the workmen, would have been sufficient to remove it. It was entrusted to a lapidary, who has carefully polished one of the edges, the rest of the stone being left in the state in which it was found, with its varnish untouched. He declares it to be what they call a *pietra dura*, of the hardness of a jasper or hone.

Stones exactly of the same quality have been procured for me by favour of the lapidary above mentioned. They were found near St Julian's imbedded in a red earth. Having examined their natural fractures, none of them were found to bear any resemblance to the surface which I supposed to have been produced artificially.

Chalk is nowhere to be traced in the existing strata of the island, but nodules of perfect chalk occurred frequently in the clay; it is singular, however, that no fragment of flint has been found to accompany it. Another circumstance worthy of remark is this; that a slip of the rock is distinctly perceptible, extending from top to bottom, at the extremity of the major axis of the whole cavity; the rock itself being unbroken and perfectly solid till we descend to the level of the sea, where we find it broken and disjoined to such a degree as to have occasioned great difficulty, and made many precautions necessary for the safety of the workmen: this disruption must have been anterior to, or at least cotemporary with, the rush of turbid water in which the clay was suspended, since in nearly all those places where the rock is discovered to be in a broken and shattered state, its interstices are found filled with this hard and tenacious clay. Another circumstance might be mentioned in confirmation of the former conclusion that the whole of this clay had been suspended in a torrent of turbid water. It was found, that in lateral cavities (which would have escaped the general rush and pressure of such a torrent) the clay did not completely fill the whole of such cavities, and was taken out in a loose granulated state. There is one circumstance, which seems to imply a very long continued action of water, or more properly speaking the same action renewed after long intervals. The rounded stones above described, " one or two of them as large as a man's head," must have been brought there by a torrent of water; but it is impossible that they could have remained in the place which they were found to occupy, only twelve feet from the surface, unless the turbid water had, at the time when they were brought there, already deposited a mass of mud firm enough to afford them support, and to prevent them from being borne by their own weight to the bottom of the cavity.

I now come to a circumstance which, except to an actual spectator, might make the statement and inferences above mentioned appear wholly fallacious and incredible. Accordingly, even to an actual spectator, it has usually been the last which I have pointed out. I have said: " You see immediately beneath your feet the straight furrows stretching downwards; you see the horizontal furrows on the side opposite; in neither of them are there any salient parts; but every angle either in a downward or horizontal direction is worn and rounded off: you see further down little niches and cavities worn out by the rebound of the water, and becoming gradually deeper and more marked, as you descend to those parts where the rocky funnel is more straitened, and where the resistance and reaction must have been greatest: In short, all the undoubted traces of a rush of water pouring down the cavity from the side on which we are standing. Now, let us turn round, and look for the higher or equal level from which this rush of water must have proceeded. It has ceased to exist; you can see nothing behind you, but a declivity leading down to a branch of the present harbour."

This, therefore, is one of the local enigmas which are of frequent occurrence in geology, and which are usually (and in the present state of science perhaps justly) overlooked by those observers whose attention is more properly directed to general and comprehensive facts.

The single circumstance, however, of the discovery of the traces of human workmanship in the situation above described, is sufficient to place it in a distinct class. If the frozen elephant of Siberia had been discovered two hundred years ago, it would have given rise to a number of vain and fanciful theories. It now finds its just and proper place; being classed apart, as a separate and (in our present state of knowledge) an unaccountable fact, awaiting its solution from such future discoveries as chance or science may produce, and which it may contribute to confirm or to illustrate. In the same manner the discovery (which I have been endeavouring to describe), though not immediately available for the solution of any question actually in discussion, or even likely to be discussed for some time to come, appears to me so singular and unusual as to deserve at least to be distinctly authenticated and recorded. With this view, wishing that scientific strangers who may happen to pass this way should have an opportunity of visiting the spot while the traces of every thing are fresh and distinct, I hope you will not think that I take an unwarrantable liberty with your name, if what I have written is communicated to this portion of the public in the easiest and most obvious way, being printed with its Italian translation in the *Malta Gazette.*

Some Conjectures regarding the Great Revolutions which have so changed the Surface of Switzerland, and particularly that of the Canton of Vaud, as to give rise to its present Aspect. By. F. de Charpentier.

There was formerly a time when the whole of Switzerland formed part of a vast ocean, which completely enveloped the terrestrial globe. The level of this sea, that is to say, the distance from its surface to the centre of the earth, does not appear to have undergone any sensible change; for we must not attribute the appearance of continents and islands to its lowering, but to a subterranean force acting from below upwards; and this appears evident from the whole tenor of geological observations.*

The portions of the bottom of this sea which are nearest to the canton of Vaud, and which seem to have been the first raised, and laid dry, are the Vosges, with the very small group of the Alps of the Valais and of Savoy, extending from the base of the Dent de Morcles as far as the Tarentaise, in the direction of the valleys of the Trient and of Chamouny, as they exist at the present day.

Several geological facts render it probable, that this formation did not form a continuous mass above the waters; but rather a series of islands, running in a line from north-west to south-east.

At this distant epoch, before the earth was so much cooled as it now is, these new regions must have had nearly the same climate as that which is enjoyed in the present day by the countries situated between the tropics. Thus the vegetation which was quickly established on them, had the character of that now observed on the islands of the Torrid Zone, as is seen by the vegetable impressions preserved in the clay-slates of Erbignon, Salvan Gétroz (valley of the Trient), the Col de Balme, and the Tarentaise; for these impressions are chiefly of ferns which are for the most part arborescent, equisetaceæ, lycopodiaceæ, and monocotyledonous plants, but which differ from the species, and even from the genera of the present day. The considerable thickness of the deposits of anthracite contained in this formation, at Outre Rhône, Servan, Servoz, and in the Tarantaise, indicates that this vegetation was vigorous, and that it lasted a long time; because these carbonaceous beds are evidently the product of that ancient vegetation whose forms have perished. The destruction of these accumulated vegetables was the result of a violent pressure of the rocks deposited on them by later revolutions, and perhaps also of a strong heat, to the action of which this formation seems to have been afterwards exposed.

It appears that this primitive sea, if I may use the expres-

* See the works of Von Buch and Elie de Beaumont on the subject of *Soulèvemens.*

sion, was much shallower in the north and west of the canton than towards the south and east, or in the direction of the Alps. This conjecture is founded on the fact, that the rocks of the Jura contain infinitely more species and individuals of marine testacea than the same rocks in the Alps; and it is well known that molluscous animals diminish in number in proportion to their distance from the shores and shallows, and to the increased depth of the sea. The northern and western shallow, of which we are now treating, is a limestone, generally of a light yellow, disposed in beds, and contains a prodigious quantity of marine remains.

It was also, in its turn, raised and pushed up above the surface of the water. This immense mass of formation, breaking up into long stripes, formed those chains of mountains parallel to each other, of which the whole goes under the name of Jura. *

But this country was by no means elevated all at once to the absolute height at which we now find it above the ocean. The sea still washed the bases of those new mountains; it even entered into several of their valleys, and deposited in them rocks of a new order, known under the name of the *chalk formation.*

At some distance to the south, and shortly before the *soulèvement* of the Jura, or more probably at the same epoch, a pretty considerable formation likewise appeared above the waters. It comprehends the chains of mountains of the Mont Arvel (above Roche), of Naye, the Verraux, and the Moléson. We are entitled to suppose that those two *soulèvemens* are contemporaneous; because the rocks proper to the chalk formation, the deposition of which followed immediately after the soulèvement of the Jura, are not met with on the mountains which we have named, and which were therefore above the waters at the period of that formation.

To this great convulsion there succeeded an interval of repose, during which the shores of the sea, and the dry land, were peopled by a certain number of amphibious animals, of different shapes, some of which were gigantic and of singular forms. An infinite

* According to the researches of M. Elie de Beaumont, the Coté d'Or in Burgundy, and Mount Pilas in Forez, were raised at the same epoch.

number of species of marine animals perished, and were replaced by beings which did not previously exist: among the latter even fishes are met with.

We cannot determine the duration of this period of repose, but every thing leads to the conclusion that it was troubled by a new catastrophe—the *soulèvement* of our calcareous Alps. This powerful convulsion was not limited solely to these last; it reached the Jura, laying it almost completely dry; or in other words, elevating it to a still greater height, so that the sea retired from the valleys which it had hitherto overflowed, and exposed the chalk it had deposited in them.*

At this epoch the chalk formed the bottom of the sea, and as its thickness was not nearly so great as the height of the Alps above their base, this rock forms only the summits of these mountains, whilst the rest belong to the Jurassic limestone, which in its lower beds belongs to the Lias, and in its upper to the Oolitic formation. But, owing to dislocations, ruptures and *bouleversemens*, the chalk is in many places destroyed, whilst at the same time it makes its appearance at very different heights; and in positions where it could not be found if those *soulèvemens* had happened slowly and without violence.

However, neither the Alps nor the Jura had attained by this new catastrophe the height which they were afterwards to reach. The sea did not retire completely from the country; it still extended an arm between the two chains.

It is in this canal or strait that we find a new formation of rocks, and a new creation of genera and species of animals. The rock which the sea deposited at that time is of a sedimentary structure, that is to say, it is extended in beds, and is composed of fragments of pre-existing rocks united together by a cement which is sometimes argillaceous, sometimes calcareous. When the fragments are very small we know it by the name of Molasse; the fragments are generally polyhedral, and the cement argillaceous.

* Chalk which in many localities, but not within the Canton, is white and friable, is with us generally of a deep grey colour, and of sufficient hardness to receive a pretty fine polish. It can only be recognised by the nature of the organic bodies which it contains, and which are the same as those of the white and friable chalk.

When these fragments are larger it becomes the *gompholite* of Brongniart, and the *Nagelfluh* of the Germans. Owing to the size of the fragments, in this instance, their form and nature are easily recognisable. We find that they are rubbed and rounded exactly like the pebbles of our rivers,* that a great number of them belong to rocks which are found *in situ* in our Alps; but that there are also many which have been derived from rocks that would be sought for in vain throughout Switzerland.

This remarkable fact, joined to the arrangement of those conglomerates which are generally found situated at the foot of the Alps, and which only assume the form of Molasse when removed to a certain distance from them, renders it probable that all those materials were furnished by the first *soulèvement* of the Alps themselves. They would in that case be the debris of the rocks which, during that terrible catastrophe, were fractured, broken, rubbed, and triturated in a thousand different ways. Several of them must have been torn from great depths, and from rocks which our valleys have not reached, and which consequently our Alps have not exposed.

Beds of lignite (a species of coal) accompanied by remains of molluscous fresh water animals, and even by some species of Mammalia, shew, by their presence in the interior of the Molasse, that during the epoch of the formation of the latter, the sea retired several times and left this formation dry; and this for a length of time sufficient to permit the formation of fresh water marshes, the establishment of vegetation on them, and an order of things fit for the creation of terrestrial animals. It is impossible to determine whether these retirings of the sea took place in consequence of a lowering of its level, or, as appears more probable to us, were owing to a slight momentary *soulèvement* of the formation, which, sinking down afterwards, was again submerged.

During the epoch of the formation of the Molasse, the portion of Switzerland in which our canton is included formed part of a vast island. This country was bounded on the north and north-west by the southern chain of the Jura; and on the

* M. Studer, in his classical work on the Molasse, has perfectly explained the cause of the difference of form in the large and small fragments.

south by the arm of the sea, that separated it from the Alps, which at this period had not yet attained their entire elevation, and presented none of those great rents and sharp peaks observable at the present day. A long sandy plain extended between the sea and the Jura. As it enjoyed a climate sufficiently mild to produce palms, which is proved by the impressions of Chamærops found in the interior beds of the Molasse at Lausanne and near Vevay; it was inhabited by several species of Mammalia peculiar to warm countries, but different from any which now exist.

All conjecture as to the duration of this state of repose would be completely hypothetical. We only know, by the observation of the geological phenomena of Switzerland, that this tranquillity was followed by a most extraordinary revolution, which caused the sea to disappear entirely from these countries, elevated the Alps to a height infinitely greater than they had previously attained, changed their climate, formed the present valleys, and gave to the country pretty nearly the aspect it exhibits at the present day.

This cataclysm was occasioned by the appearance of the granite. Two vast granitic masses rose at the same time above the waters; the one in the *Haut Valais*, and the other in Savoy. It is especially this last which exercised the greatest influence on Western Switzerland. It comprehends the whole enormous mass of feldspathic rocks, whose highest summit is Mont Blanc, and which reaches our canton near the thermal springs of Lavey.

This granite opened a passage through the gneiss, the mica-slates, and the other talcose and slaty rocks which lay immediately under the limestone of our Alps.* It elevated them all to a height considerably greater than that of the present Alps. The rents and dislocations produced by the *soulèvement* and the rupture of these solid masses, as well as the partial subsidings

* Our most celebrated geologists regard gneiss, mica-slate, and other analogous rocks of a slaty structure, as having been deposited by and in water; but as having afterwards, under the double influence of excessive heat and a considerable pressure, completely changed their nature, and retained nothing of their original condition except the slaty structure. Probably this change took place long before the *soulèvement* of the Alps.

and sinkings of the raised bands of rocks, gave rise to those kinds of crevices and rents in the form of furrows, which we denominate *valleys*. This revolution was the last, up to the present time, which changed the surface of Switzerland. It formed the existing valleys, and, in a certain degree, gave to the mountains the aspect which they now exhibit. It changed the climate, caused the disappearance of the ancient vegetation, and the destruction of the animals which, until that period, had inhabited Switzerland. Finally, it produced the conditions necessary for the existence of the organized beings which now adorn and animate this beautiful country.

Great masses of rocks fell back into the vast crevices, which, having remained open, form our principal valleys. When these detached masses were not completely covered by the alluvium which gradually filled to a certain height the bottom or soil of the fissures, they became those isolated rocks, presenting greater or less escarpments, which we are astonished to see rising up in the centre of some valleys. That of the Rhone presents several striking examples, as at Saint Tryphon, near Ollon, at Mont d'Horge, and at Tourbillon, near Sion.

Moreover, by this same catastrophe, vast portions of rock were sunk to so great a depth as not to allow of the subsequent alluvium filling up the hollows which had resulted from it; these last, being afterwards filled with water, produced those lakes which give a peculiar charm to Switzerland, and of which the most beautiful, if not the most extensive, embellishes our canton.

These partial subsidings, which produced our lakes, and a number of *accidens* and changes of level, either in the plains or in the mountains, were by no means considerable; and, in particular, they were much less important in their effects than the general subsidence, which the whole raised mass seems to have undergone.

For every thing leads to the conclusion, that, at this epoch, not only the Alps, but also the Jura, and the formations which separate those two systems of mountains, were affected by this astonishing revolution, and all raised much higher than they now are. Such a commotion must have caused immense displacements, dislocations, and the formation of hollows and cavities. The raised mass must then have undergone a subsidence, or a sort of *tassement*, until all the parts which were ill supported or ill placed, had taken their proper position, and acquired the solidity and stability which the mass presents at the present day.

The effect of such a *soulèvement* to so great a height above the level of the sea, combined with the diminution of the terrestrial heat, must have effected a great change on the temperature of the climate of these countries. The climate fit for the growth of the chamærops, and other plants of warm countries, became similar to that of the north; the atmosphere was cooled; the Alps were covered with snows, which, descending continually into the valleys, formed immense glaciers. Not only did these glaciers gradually invade all the valleys, but they reached and even covered all the low part of Switzerland, and extended their *moraines* so far as the top of the Jura.

But, in consequence of the general sinking, this vast country having diminished in elevation above the sea, its climate was insensibly ameliorated, by which means it arrived at its present temperature. These enormous glaciers diminished in their turn, retiring according as the surface of the land subsided, and the temperature increased. They left, in the track of their passage, as witnesses of their former existence, those blocks of rocks from the Alps, which are found sometimes isolated, sometimes in a heap (in the form of a dike or rampart), from the summit of the Jura to the summit of the Alps, and they also left those marks of friction and attrition so apparent on the surface of the rocks which bound the valleys, and which rise to a height corresponding to the thickness of those vast primitive glaciers.* Those blocks of alpine rocks, dispersed to such great distances, are known to geologists by the name of Boulders (*Blocs erratiques*), and their mode of transport has long been a subject of investigation; but it is to M. Venetz, engineer in the canton of the Valais, that we owe the knowledge of the true agent alone capable of producing this great phenomenon, and all the *accidens* which accompany it.†

* The great moraines in valleys in Norway, where now no glaciers occur, are here deserving of notice.—EDIT.

† In a Memoir, read to the *Société Helvétique des Sciences Naturelles*, at their meeting at Lucerne, now translated into German in Nos. 3. and 4. of the

We may add, that the greatest glacier which came from the Alps, is that which issued out by the Valley of the Rhone; for it pushed its moraines not only so far as the ridge of the Jura, but on the western side to Geneva, and on the eastern to the environs of Burgdorf, in the canton of Berne. If no other glacier in Switzerland equalled in extent that of the Valley of the Rhone, it is because this valley is the longest in Switzerland, and also especially owing to its situation between the two high chains of the Alps, as well as to the circumstance that, from its origin at the Furca, to where it meets the Lake of Geneva, almost all the valleys which join it come from very high mountains, covered even in the present time with perpetual ice and snow.

Such are the conjectures, authorized by geological facts, on the revolutions which have successively changed the surface of the canton of Vaud. We shall finish this *exposé*, by endeavouring to determine the height to which this country and the Alps were raised by the appearance of the granite, and to calculate the sinking which followed this great catastrophe.

Before the last *soulèvement* of the Alps, the country of the basin of the Rhone, in order to produce the chamærops, must have had a mean temperature of 17°5 Cent. or 64° Fahr. The temperature of the valleys of the Alps, which is fit, not for the formation, but for the preservation of glaciers, is 6° Cent. or 42°8 Fahr. Such is the temperature of the Valley of Chamouny. If we admit that the temperature decreases 1° for every 480 feet (of the canton Vaud) of elevation, the country which enjoyed a mean temperature of 17°5 C. or 64° F., must have been raised 5520 feet (480 + (17.5 — 6)), in order that its mean temperature should be lowered to 6° C. or 42°8 F. But, as the elevation of our lake is 1116 feet, the sinking which

Mittheilungen aus dem Gebiete der theoretischen Erdkunde, by Fröbel and Heer, I have endeavoured to develope the theory of M. Venetz,* and to bring it into accordance with the facts which prove the ancient elevation of temperature, and to apply it to several phenomena of the external configuration of valleys and mountains.

* The Theory of M. Venetz, that the Boulders of Switzerland are the *Moraines* and remains of ancient glaciers, has been recently defended and developed by M. de Charpentier, in a special memoir, inserted in the *Annales des Mines*, vol. 6, Paris, 1636. (Note by the Editor of the *Bibliothéque Universelle de Geneve*.) This article was published in our last Number, p. 210.—Ed. *New Phil. Journ.*

this country has undergone must have been 4404 feet (5520 — 1116 = 4404). Admitting that the Alps have experienced the same lowering, Mont Blanc, whose present height is 14,430 feet, must have possessed an elevation of 18,834 feet, a height which is not attained by the Nevado de Sorata, the Nevado d'Illimani, Chimborazo, the Dhawalagiri, the Jawahir, and several other peaks of the Himalaya.

On the Manufacture of Gun-Flints. By James Mitchell, LL. D., F. G. S. Communicated by the Author.

Brandon in Suffolk is the only place in England in which gun-flints are now made to any considerable extent. During the war, and before the invention of percussion-caps, when the demand for gun-flints was much greater than it is at present, some were made at Lewisham, Maidstone, Purfleet, Greenhithe and Northfleet; but none are made there at present, although the largest flint-merchant in the world resides at the last mentioned place. The gun-flint makers at Brandon say that they have an advantage over every other place in England, in consequence of the material which they obtain in the pits below their heath being better than is to be had any where else. They say, that the flints which they are enabled thereby to make will last longer than other flints, and are most certain in their fire. This, from information elsewhere obtained, I consider to be true. At Brandon they said that the French no longer made gun-flints, and, in fact, that they themselves were now the only makers in the whole world, and yet the seventy or eighty men now employed could barely make a living by their trade; the cessation of war, and the invention of percussion-caps, had so much diminished their business. The masses of flint from which the gun-flints are made at Brandon are obtained from a common about a mile south-east from the town. The chalk is within six feet of the surface. The men sink a shaft down about six feet, then proceed about three feet horizontally, and sink another shaft lower down into the chalk about the same depth of six feet, and sometimes they fall in with a floor of flint within this depth. They proceed again about three feet horizontally, and sink another shaft six feet; and so they proceed, going sometimes to the depth of about thirty feet. By making their shafts only about six feet in depth, they are able to descend, and hand up the stone from one stage to another without the aid of any machinery; and although a windlass, rope, and bucket might save labour, they would require capital, which the poor men who follow this occupation cannot command. They pay a rent of five shillings to the parish for every cart-load, which is as much as three horses can draw, and of this they grievously complain. In the descent of about thirty feet, they generally find three floors of flint, and sometimes as many as four. At every floor of flint which they find they excavate horizontally for several yards, even as far as twenty yards below the chalk. The flint is in large blocks, in form much like the septaria stone. The men break the blocks into moderately-sized pieces, so as to be enabled to hand them up from stage to stage. When engaged in doing this, a man places himself about half-way up between two stages, so as to receive the stone from below, and hand it up to the stage above him. They sometimes sink shafts, and do not fall in with flint to repay their labour.

That the flint of the best quality, and most adapted for the manufacture of gun-flints, is comparatively rare, is shewn by the experience of France as well as England. Dolomieu informs us, that where twenty beds of flint (silex) were found lying one above another, only one or two of these would afford good flint, and very seldom two, generally only one. On the banks of the Cher, he states, that flints were obtained by sinking shafts to the depth of forty or fifty feet, from which horizontal galleries were carried through the only one good stratum which was met with. On the banks of the Seine, in the hills of La Roche Guion, the cliffs present strata of flint (silex), but only one of these, which was six toises from the surface of the chalk, was good material for gun-flint.*

* I have been informed that the gun-flint makers at Maidstone found only one stratum of flint in the quarries in Kent fit for use. This stratum of flint lies under a stratum of green chalk. It is the only stratum of flint which will not decompose. Fragments which have been fifty years exposed to the air, and are known to have been so long exposed, being flakes struck off at the time when the old or English manner of making flints was in use, are still as black as ever. The other strata of flint would do to make flints for exportation. This information was given to me by Mr Jeremiah Simmonds.

The art of making gun-flints appears to be very simple, yet I was informed at Brandon, that it is not more than forty years since the present mode was known there, being introduced from France. The origin of the art is kept in recollection by its being called the French mode, as distinguished from the mode formerly in use, which they called the English mode. One of the men in a shop which I visited recollected the time when it was first made known. According to what is called the English mode, pieces were struck off the edges of a block of flint, and when it happened that they were of such a form as would answer, the edges on the sides were broken off, and they were brought into some shape. Such flints were unshapely in comparison of the present very elegant form of gun-flints; there was a great waste of material, and only a small number could be made in a given time. Accordingly this mode was soon totally abandoned when the French mode was once known. *

This mode I shall now attempt to describe. The workman, technically called a cracker, who is seated on a chair, has a thick piece of leather strapped to his left thigh; and over that piece of leather he straps on a thick piece of iron. He takes a large piece of flint-stone, and breaks it into pieces of manageable size about two pounds each: he then takes one piece in his left hand, and applying it to the plate of iron on his thigh, he strikes out fragments at short distances from each other: he then strikes with his hammer on the parts of the edge of the flint, which are now separated from the rest, and the effect of the blow, together with the reaction on the plate of iron on his thigh, causes a flake of about three or four inches in length to come off, there being on each side a conchoidal fracture. Other flakes are broken off in the same manner. Of the flakes thus obtained from the mass of flint, some are large and others small. The workman has before him three small casks with the upper end open; into one of them he drops the larger flakes; into the second the flakes of a less size; and into the third the flakes of the smallest size. When he has broken off so many flakes that

* Mr Jeremiah Simmonds has informed me, that the first man who introduced the French mode into England was his own grandfather Mr James Woodyer, who resided at Kingsdown, between Maidstone and London. He has been dead now more than fifty years. It is probable that the French mode was not introduced at Brandon until some time after it was in use in Kent.

there is no longer any good flint left, but only the outer white crust, or such parts as are made of greyish matter, he throws the refuse into a fourth cask which is beside them, and it is from time to time carried out of doors, and thrown into a heap of rubbish. The three casks with the flakes are intended each of them for a separate workman, who has to finish them into flints, as musket flints, carbine flints, horse-pistol flints, single-barrel flints, double-barrel flints, and pistol flints. The workmen who divide the flakes into flints, are called nappers, and one cracker is enough to keep three of them employed. A napper has before him a block not unlike a butcher's block, upon which a piece of iron is nailed, from which rises a thin piece of iron three inches in length, and only a sixth of an inch in thickness, and brought to a coarse edge. The napper uses a hammer which is merely a plate of steel, extending two inches on each side of the handle, and an inch in breadth, and not above a sixth of an inch in thickness. He takes into his left hand one of the flakes, and lays it over the little anvil on the block, and with his hammer he breaks it into three or four flints. All that he has to do after that, is to see which edge will be best for the flint, and from the other he breaks a little off, and the whole is complete.

Forty years ago, according to Dolomieu, the making of gun-flints was carried on in the communes of the department Loir-et-Chez, viz. Noyers, Couffy, and Mennes; and in one commune of the Indre, named that of Lye. The inhabitants of these communes employed in this branch of industry are said to have been about 800 in number.*

When we look at a gun-flint, and observe its elegant shape, and consider how admirably it is adapted for the purpose intended, we should be apt to think it had been ground into that shape with great labour and skill. Such, indeed, is the manner in which gun-flints, if we may so call them, are made in Germany from agates and conglomerates; but they are much less efficient, and more expensive.

* He further states, that one workman had emigrated from Mennes, and established himself on the banks of the Siene, at La Roche Guion, where he had been thirty years. He also states, that in some other parts of France the art was practised, though only to a small extent. It was also carried on in the territory of Vicenza, in Italy, and in some of the cantons of Sicily.

At Brandon I was told that, in the present depressed state of the trade, arising from the use of percussion caps, the best musket-flints were sold from 7s. to 8s. a thousand, which at one time, during the war, were sold for two guineas.

On the Geology of Egypt and the Valley of Cosseir. By D. W. Nash, Esq. A. L. S., Assistant Surgeon, Bengal Army. Communicated by the Author.

Egypt, or that portion of the valley of the Nile north of the first cataract, is bounded on the north by the Mediterranean, on the south by Nubia, and on the east and west by two ranges of mountains which run in lines nearly parallel to each other from the first cataract to Cairo, leaving between them a valley of variable width from three to nine miles broad, and separated by these mountain ridges on the eastern side from the Red Sea, and on the western from the great Lybian desert. In this valley flows the river Nile, now hemmed in and confined to a narrow bed by the rocks which close in upon it on either side; now gliding through the rich alluvial plain of which it is the fertile parent.

Geologically, Egypt may be formed into four great districts, according to the nature of the formations presented to us in our course down the Nile, from the first cataract or Assouan to the shores of the Mediterranean. These are the granite, the sandstone, the limestone, and the alluvial formations. The granite formation extends from the mountains of Nubia to Assouan in 24° north latitude, where the river rushes rapidly through the granite rocks which impede its course, and form what is called the first cataract. These cataracts, five or six in number, occur throughout the whole course of the Nile southward of Assouan, as far as Cartoon, where the two branches of the river unite; the branch called the Bahr ul Neel or Blue River (a term which is also applied by the Arabs to the Nile in its entire course from Cartoon to Cairo), coming from the Lake Dembea in Abyssinia; and the Bahr ul Abiad or White River, coming from the south-west through unexplored regions inhabited by savage tribes, and supposed by many to flow past the walls of the mysterious city of Timbuctoo.

The two first cataracts met with in the course of the Nile are in this granite district, but with the exception of the second cataract, that of Wady Halfi, they hardly any of them deserve the term which has been applied to them, being for the most part passable by the boats which commonly trade on the Nile. It is in this granite district that those old quarries are seen, from which were procured the enormous blocks used by the ancient inhabitants of Egypt in the erection of their imperishable monuments; it was from these quarries that the materials were conveyed down the Nile for building a great part of the pyramids of Gizeh, for the temples of Carnac and Luxor, and for the buildings at Memphis. This granite differs very much in character and quality in various parts of the formation; at Assouan it is chiefly of that red or rose-coloured kind which is the real syenite of the ancients, and has derived its name from the locality whence it was procured, Assouan having formerly been called Syene; it is not, however, the rock known by the same name in modern collections. Of this rose-coloured granite, many of the most splendid monuments of Egypt are constructed; the obelisk of Philœ which Belzoni conveyed to England—the great obelisks in front of the northern pylon of Luxor, one of which has been removed by the French—the still more splendid one of Carnac—the statue in the British Museum called the head of the Young Memnon—that which lies overthrown at the Memnonium of Thebes, on the western bank of the Nile, and many others. The two colossal sitting statues in the plain of Thebes are formed of a greyish coloured granite. At Carnac are numerous sitting figures of black basalt, which also belongs to this formation. From Assouan to Esneh, a distance, in a straight line, of about seventy miles, the sandstone formation obtains. At Gibbul Silsileh, or the Mountain of the Chain, are the quarries from which were hewn the sandstone blocks for the building of the great temple at Philœ, for the extensive edifices at Esneh, and the beautiful and well preserved temple of Isis at Dendera. This sandstone is of different kinds; being sometimes very fine, white, and crystalline, sometimes of a yellow colour, and a loose friable texture.

Immediately below Esneh commences the great limestone formation of Egypt, which extends on each side of the river as far as Cairo, where the two limestone ridges diverge, the eastern branch, running off nearly at right angles towards Suez, the western branch taking a north-west direction towards Alexandria, and leaving between them the triangular space called the Delta.

Just at the commencement of the calcareous formation, the hills which had closed in on the river recede on each side, leaving between them and the river on either bank an extensive level area, the great plain of Thebes. On this alluvial plain, so remarkable for its local advantages, was erected the capital of Ancient Egypt, the hundred-gated Thebes, now known under the various names of Luxor, Carnac, Medinet, Abon, and Gournon. It is in this limestone rock that have been excavated those receptacles for the dead, called collectively the Necropolis of Thebes, and those still more magnificent abodes for the mummies of her ancient monarchs, styled the Tombs of the Kings. Excavations of the same kind, and for the same purposes, but on a less imposing scale, may be observed at intervals throughout the whole of this formation, and especially at Benihassen in Middle Egypt.

One feature in this part of the Valley of the Nile is, that, on the western side, the limestone ascends from the plain by a gradual and gentle slope, while on the eastern bank it forms lofty and sometimes precipitous escarpments, the bases of which are washed by the river. Both the eastern and western ridges are traversed by transverse valleys, of which the most important are, that leading to Cosseir on the Red Sea, and the one which opens into the plain of Fayoum. Partaking of the nature of these transverse valleys are those on the west of Cairo in the desert, running nearly east and west; these are two valleys separated by a ridge,—the northern one is called the Natron Valley, and contains six small salt-lakes, the waters of which hold in solution a large quantity of the muriate and carbonate of soda,—the surface of the valley and the central ridge are encrusted with these salts. The southern valley, called the Bahr b'ul Mah, or sea without water, contains no lakes or saline deposits, but has a sandy surface, covered with innumerable fragments of quartz, agate, and jasper, in these respects resembling the transverse valley of Cosseir on the eastern side of the Nile.

At Cairo, as has already been stated, the limestone ridges diverge, leaving the Delta-shaped plain, through which flow the two principal arms of the Nile, as well as several other minor branches. The space included between the Rosetta and Damietta branches is at its widest about 200 miles, and this is the extent of the alluvial formation of Egypt. There are, however, considerable alluvial deposits along the course of the river and in the plain of Fayoum. This alluvium has been deposited over a considerable extent of country, now covered over by the ever encroaching sands of the desert, conveyed by the pernicious west wind, which the ancient Egyptians so figuratively pourtrayed under the symbol of the destroying Typhon. All these alluvial formations derive their origin from the waters of the Nile, which, when swollen by the tropical rains of Nubia and Abyssinia, bring down with them vast quantities of mud and soil. There has been considerable dispute as to whether the entire Delta owes its existence to the waters of the Nile; be this as it may, there can be no doubt that the alluvium annually deposited is very considerable, and that the surface, at least of the soil below Cairo, is covered by this deposit. In fact, throughout all Upper and Middle Egypt, from Assouan to near Cairo, the bed of the Nile is, after the periodical rains in Nubia, little else than the bed of a torrent, with here and there an inconsiderable expansion: such as the plain of Thebes. Its waters rush down to empty themselves into the Mediterranean with great velocity, and the alluvial matter which they hold suspended, must naturally be precipitated, when these waters are spread out into the wide expanse of level ground below Cairo. Bruce has stated that the waters of the Nile contain but a very small quantity of earthy matter; but even long after the inundation has subsided, it is necessary to allow this water to stand for a considerable time in your water-skin before drinking it, in order to allow the mud which it contains to precipitate. But, if the gradual efforts of the river have added a few leagues to the soil of Egypt, it is no less certain that in other parts Egypt has yielded up a portion of her territory to the encroachments of the ocean,—much of what was formerly a fertile plain, being now converted into salt-lakes.

Valley of Cosseir.

Between the Nile and the Red Sea are several ranges of hills, forming, for the most part, one mountain-chain, which has a direction nearly north and south, crossed by several transverse valleys, of which the one best known is the Valley of Cosseir. This valley, running nearly east and west for 120 miles, forms a plain covered with a fine sand composed of quartz and limestone, and having its surface strewed over with fragments of quartz, jasper, agate, and common flints. It is bounded on each side by the hills through which it passes, and which present, in some places, very precipitous escarpments; in others steep slopes, the basis of which are masked by low hills of debris. In this valley, three principal formations are seen; the limestone, the sandstone, and the primitive or plutonian rocks. In its course it presents one natural spring of mineral water; and, where the sandstone prevails, wells have been sunk from which a brackish water is obtained. Its appearance fully justifies the appellation of the Dessert of Cosseir; for, with the exception of two or three stunted acacias, there is no trace of vegetable life.

The town of Cosseir, on the western shore of the Red Sea, in about $24\frac{1}{2}°$ north latitude, is situated at the eastern entrance of this valley. This town is built on an ancient coral reef, now elevated a few feet above the level of the sea. Behind the town is a still more ancient coral reef, raised in some places as much as twenty feet, and containing numerous univalve shells in a very soft and decomposing state. Upon this reef lies an argillaceous marl containing large quantities of gypsum, and above this a layer of rolled pebbles covered with angular fragments of sandstone, quartz, jasper, felspar, and granite, derived from the neighbouring hills. These marls and rolled pebbles mixed with gravel, form low rounded hills which cover the whole plain from immediately behind the town of Cosseir to the eastern debouchements of the valley of the same name.

On leaving Cossier, the traveller passes for the first hour among those low gravel hills, which soon give place to more lofty elevations of limestone and granite. At Ambagi there is in the limestone a mineral spring, exceedingly bitter, so much so as to be refused even by the camels. The granite now appears breaking through the limestone, which rests upon it in highly inclined strata. This granite differs very much in quality in the same rock, being in some places black and very compact, in others red and porphyritic, similar to the granite of Syene. Beyond this the hills diverge on either side, forming a wide amphitheatre, from which many smaller valleys proceed. This amphitheatre extends to Bir Anglaise, where the valley again contracts. The left or southern boundary of this plain is composed entirely of secondary limestone, in highly inclined strata, presenting an almost perpendicular escarpment along its whole length. The dip of these strata is east, and their direction nearly north and south. On the northern face this limestone is seen lying on sandstone in conformable strata. This limestone contains numerous layers and beds of flints, with an inclination conformable to the stratification, and varying in thickness from a single row to beds of six and ten feet deep. These flints are all fossil sponges, alcyoniæ, &c. There are also a few marine shells. The similarity in the appearance of this limestone and its rows of flints to the escarpments of the chalk formation of the south of England is very striking. Just before reaching Bir Anglaise is a bed or dike of fossil oysters, which crosses the plain from the one face of the valley to the other, rising from the surface of the ground at an angle of about 35°, with a dip east, conformable to the limestone, in the centre of which it was once imbedded. This valley has, however, been traversed by a great current of water, which has washed away the soft limestone rock, and left the hard siliceous strata of fossils bare and solitary in the midst of the plain. This dike rises in some places to the height of sixty feet, while in others it is visible only a few inches above the surface.

The sandstone formation next appears, rising very distinctly from beneath the limestone, having the same dip, and the same angle of stratification. This sandstone varies in colour from the deepest red to white, and from a hard, compact stone to a friable and highly quartzose, but granular rock. In one place this sandstone rests on a hill of trap, which has forced its way through it, and has altered the sandstone into a dark, very crystalline rock. There is also a conglomerate of dense and siliceous blocks of sandstone, covered with a smaller pebbly conglomerate, and a stratum of gravel. Beyond this sandstone come the rocks of igneous origin, consisting of trap, granite, serpentine, and mica-slate; the latter rock rises to a great height at the pass of Abou Zeyran.

There is also a breccia of serpentine and granite, and a very beautiful puddingstone of serpentine and porphyry. After passing these gneiss rocks, the sandstone again makes its appearance, and extends almost to the valley of the Nile, where it is again met by the limestone formation, which, on the western bank of the river, rises to a considerable height.

In the remarks upon this valley, three considerations present themselves as worthy of attention. 1. That the igneous eruptions in this country have been active since the formation of the limestone and sandstone deposits, which have been broken through by the trap-rocks. 2. That the coast of the Red Sea has undergone a very recent elevation, and is probably still undergoing a similar change. 3. That the valley of Cosseir has, since the elevation of the limestone, been traversed by some very powerful torrent of water. With regard to the elevation of the coast of the Red Sea, that this is recent, there is abundant proof, both at Cosseir and at Jidda, on the eastern coast of the Red Sea, where the low hills around the latter town contain numerous Echinida, Asterias, and marine shells similar to existing species, and also from the circumstance, that the ancient canal which led from Suez to the now marshy lakes to the northward, the continuation of which to the west, towards Cairo, is now called the Wadi Tomlat, has been obliterated by this very means; the elevation of the land immediately around Suez being necessarily subsequent to the formation of this canal which was once navigable to Suez.

The only point which remains for consideration, is the age and character of the sandstone and limestone formations of Egypt relatively to those of Europe.

The sandstone formation of Egypt is, in its general

Valley of Cosseir and Section of the Valley of the Nile.

character, argillaceous, soft, and friable; abounding, comparatively, in springs of water, which have all a more or less saline impregnation, and situated immediately beneath a secondary limestone. It forms, for the most part, rounded hills of no great elevation, with sloping sides, cut into ravines by numerous watercourses in the Cosseir district, and having their bases covered by hillocks of their accumulated debris. Throughout the Valley of Cosseir, the principal wells are in this sandstone. The limestone formation, which lies directly on the sandstone, is in general of a greyish-white colour, has a conchoidal or splintery fracture, and contains, in the Valley of Cosseir, large quantities of siliceous fossils, of which the principal are, ostrea, cardia, madrepores, and sponges.

That part of the limestone formation which is near Cairo, and is called the Mokattam, contains an abundance of nummulites. In the Valley of Cosseir, I found a turritella and considerable quantities of gypsum. At Siout, and thence to Kenneh and Esneh, where the sandstone commences, the limestone is of the same kind, but there are no nummulites, and it contains vast quantities of rounded flints. Professor Ehrenberg states, that there is dolomitic limestone on the western shore of the Gulf of Suez, and calls the limestone above Siout, which is destitute of nummulites, Jura limestone without fossils; it is, however, full of flints.

Both the limestone and the sandstone are secondary formations; the latter appears to be the same as the new red, or saliniferous sandstone, and the former may perhaps be equivalent to the cretaceous group; but without a more extended knowledge of their organic remains, it is impossible to form a decided opinion.

Some Observations on the Geography and Geology of Northern and Central Turkey. By Dr A. Boué. Communicated by the Author, in a letter to the Editor.*

Dear Sir,—I take the liberty of sending you the chief result of my first excursion through Turkey, a country to the in-

* Less is known of the physical geography and geology of Northern and

vestigation of which I intend devoting several years. I shall start again in April, and extend my observations to Asia Minor. Possibly I may fix my quarters at Constantinople. In my next I shall mention how such a journey may be made easily and pleasantly.*

Although many countries have been lately surveyed and described, we still remain in the same ignorance as ever in regard to the natural configuration and constitution of the Turkish dominions. Christian prejudices and mercantile interests are the chief reasons for the small number of European travellers in Turkey; especially as that country now enjoys the blessings of peace, and the former fanaticism of the inhabitants has disappeared. Seeing a vast field of new facts before me, I determined to devote three or four years to its investigation, and endeavoured to associate with myself in my travels some naturalists who cultivated other branches than geology. This year I was fortunate enough to secure for a portion of my tour the assistance of two French geologists, M. Montalambert and M. Viquenel, together with a Moravian botanist, M. de Friedrichstal, and a Moravian entomologist and zoologist, M. Adolphe Schwab. These gentlemen extended their travels to the Archipelago, and so far as Syria and Egypt.

Part 1st. Geography.

We began our tour in parts of Turkey which are almost quite unknown, but instead of impediments, we everywhere found the people obliging, often anxious to forward our enterprize, with kindness and civil treatment on the part of the Pachas or minor governors of the land, and the Christian chiefs. Prince Milosh, in particular, has every claim to our gratitude for his great politeness, and the facilities he afforded us, not only in Servia, but also in Turkey. The Sau and the Danube, Montenegro, Scutari, Pindus, Olympus, Salonichi, Philipopolis,

Central Turkey than of any other extensive tract in Europe, and we have, therefore, great pleasure in laying before our readers the first of a series of memoirs on these districts, by so able and acute an observer as our friend Dr Boué.—Edit.

* In a second letter, which has just reached us, Dr Boué communicates "Some remarks on the best mode of travelling in Turkey." These useful instructions are published in the subsequent part of this number of the Journal.

and Widdin, form the best known limits of that part of Turkey which I travelled through.

The geological study of Turkey is rendered extremely difficult, owing to the want of proper knowledge as to the geography of the empire. It would be necessary to construct a totally new map before one could delineate the geological features. All the best maps are crowded with false indications; I mean not only false or ill-spelled names, but ill-placed localities. Hills and even large rivers are totally omitted; whilst many parts of the maps on which hills are marked, are merely imaginary representations of the truth. All maps exhibit a central chain of great magnitude; now, in reality, we find that the Hæmus Mountains or Balkans, from Sophia to the Black Sea, are in general only a range of small heights, such as, for instance, the Kahlenberg, near Vienna. It only rises to a greater elevation near Keczanlik, and continues so to Sophia. The central part of the chain may be crossed anywhere in a day, in some parts in less than a day, or even in a few hours. Between Sophia and Uskub we looked in vain for those hills, said to be so high as 9000 or even 11,000 feet; indeed, in some places, *Molasse* Hills occupied the place of these pretended lofty mountains. Even the Alps of Tschardagh or the ancient Skordus, to the west of Uskub, do not attain that elevation.

As examples of rivers omitted, I may mention the great western branch of the Ibar, S. and S. W. of Novibazar. This branch receives the Metrovitza and Semnitza, and is the true original Ibar, not the Metrovitza as it is marked on the maps. Karatova in Macedonia is placed some leagues too much to the west on a wrong river; and the river called the Egridere does not flow like the Braunitzo to Tetip, but joins the Vardar, near Banja and Hankapetan. The Karasu or Strymon runs through no lakes in the upper part of its course. It is only a very winding river with some marshes of inconsiderable extent, and some ground which, from its black colour, would seem to have been formerly of a marshy nature. However, in time of inundation, the Strymon forms here and there a broad sheet of water. Near Radomir it describes a great curve from W. to E., which is omitted in the maps. I think that all maps are very faulty in regard to the position and extent of Mœsia Superior; Sophia, in particular, seems to be too much to the east, and Radomir too much to the north-west of Dubnitza.

The road from Sophia to Nissa is imperfectly marked, which is also the case with many post-roads in Servia. The road from Seres to Dubnitza is wrong, and Libanovo is on the east, not the west bank of the Karasu. The town Tikavech does not exist in Macedonia; it is the name of a district. Negotin should be marked on the spot where Tikavech is indicated. The basin of the White Drina is ill-figured, as it is a vast plain and not a valley. The same is the case with the great Perlepe and Bitoglia tertiary basin. The Perindagh is not correctly laid down. The hilly country marked between Radomir and Scharkoë is a purely ideal representation. The sources of the eastern Morava are ill delineated.

If I pass over the *faults in nomenclature* which are known to me, I may at least be allowed to express a wish, that in future maps the following names may not be marked as localities: *Koliba*, a single small house; *Keny*, or, in Servish, *Celo*, a village; *Tschiflik*, a farm; *Kula*, a tower; *Kale*, a fort; *Hissar*, a fortified place; *Palanka*, a place fortified with palisadoes; *Karaul*, a military post; *Hammam*, a bathing place (in Servish, *Banja*); *Han* or *Ghan*, (and not as travellers or geographers write and pronounce it, *Khan*) an inn; *Monastir*, a convent; *Grad* (Servish), a large town; *Varosh*, a small town; *Maidan*, a mine, &c. All those are useful for travellers if indicated by small signs, but it is absurd to put thirty or forty times on a map, *Keny*, *Karaul*, and the like, with only some variations in the orthography, as *Kei*, *Kioï*, *Koï*, *Karaula*, *Karaoul*, *Karakul*, *Kareul*. The poor geographer, in compiling from the data of others, has not perceived that each traveller had his own orthography for the Kish or Servish names. It is also most singular to find upon a map marked as villages, three inns which are not far distant from each other.

Another incongruity in maps is the partial translation of the following words annexed to names: *Beuk* (Servish, *Veliko*), great; *Kutjuk* (Servish, *Malo*), small; *Gorne*, superior; *Dolne*, inferior, &c. Such words should either be entirely translated, or left in the original language, as also all the following: *Dagh*, *Balkan*, *Planina*, a chain of hills; *Déré* (Servish, *Dolina*), a valley or glen; *Su* or *Sou* (Servish, *Voda, Rieka*), a river, a torrent; *Issor*, a source; *Bunar*, a fountain or well; *Keupri*, a bridge (sometimes written *Köpri*); *Derbend* (sometimes wrongly written *Derwend*), a pass; *Kapu*, a door; *Klissura* (Servish), a pass; *Demirkapu*, an iron door; *Eski*, old; *Jeni* (Servish, *Novo*), new; *Beyaz* (Servish, *Bjelo*), white; *Kara*, (Servish, *Cserno* or *Tscherno*), black; *Tuzlu* (Servish, *Slan*), saltish; *Egri* or *Eyri*, bent; *Potok*, a small rivulet; *Schuma*, a forest; *Mik* (Wallachian), small; *Mare* (Wallachian), great. These words on maps have a meaning in the original language, but when translated this is not the case.

It is also foolish to indicate the inns by their names, as these change with the proprietor for the time being; thus we have *Ibrahim han*, *Marecastino han*, &c., *Bimek tashi han*, near Dubnicza, so named because there is before the inn a stone to assist travellers in getting on horseback.

I think I have given hints sufficient to induce the geographer to travel over Turkey, and to make astronomical as well as geographical observations.

The Russian government is perhaps the only one which has made any attempts of this kind; but the results are still unpublished. I do not know if the Austrian government is in possession of many accurate observations, excepting some parts on the boundaries of that empire.

The principal chains of mountains in Northern and Central Turkey may be enumerated in the following order:—

1. The Tschardagh (*Skordus* of the ancients), a high and extensive chain running about north-east and south-west from the bold conical hill named Liubeten, west of Kacsanik or Katschanik, to Kalkandel (wrongly written Kalkandere on the maps), the Drinas, and the neighbourhood of Alessio or Scutari. It forms the *western* part of the central chain, and, when seen towards the end of June, from the tertiary plains of Albania, or the white Drina, presented the appearance of a formidable alpine range, having occasionally pointed summits, and interspersed with small fields or patches of snow, which remain even during the summer. Under the bare and pointed summits are extensive woods and pastures.

The *Dryas octopetala, Silene acaulis, Narcissus poeticus,* *Cerastium*, *Myosotis*, *Saxifraga*, *Crocus*, &c. are the chief plants which are met with at the greatest elevations, some of which, as is the case with the Skordus of ancient writers, exceed 7000 feet in height; but this last, however, can be crossed in a day.

2. The chain named by geographers Rhodope or Despotodagh, begins between Dubnicza and Dzumaa or Djumaa. This very large chain runs N. W. and S. E., or W. N. W. and E. S. E., diminishing always in height in an easterly direction. It traverses the Sea of Marmora at the island of that name, and continues in Asia Minor till it takes the name of Taurus. The western part of the Rhodope is the highest, and is called Riloplanina and Rilodagh, and farther to the east it takes the names of its great valleys. The name of Despotodagh (Chain of the Ecclesiastics) originated from the convents of Greek monks situated in this chain, and which formerly contained 5000 monks.

The *Perin-dagh*, which lies between Djumaa, Melmik, and Nerro-kup, is only a higher part of the Despotodagh, which extends south of Philippopolis. It is probable that the highest summits of these chains attain an elevation of 7000 feet. When seen from a distance, they have a bold appearance, especially on the northern side, where there are only small alluvial hills at their base; but, on the contrary, they diminish in height as they approach the sea. These hills are much wooded in the central and higher parts, having the oak below, and the larch (*Larix europæa*), together with the fir-tree, higher up; to which succeed the alpine pastures and the bare summits. They form, from Dubnicza to Stanimak, and thence to Seres, the central nucleus of Romelia, a very strong military position. This natural fortress can only be approached, through the defiles or passes: it still includes, as advanced stations, all the hilly country between the lower Strymon and the lower Vardar, and the great extent of wild hills in Karatova, and thus commands the important position and high-road of Egri-Palanka. It is only separated by the Vardar Valley from the chains between the Vardar, the Black Drina, and Castoria. Among these last hills may be mentioned a pretty high one, running nearly E. and W., north of Florina, Vodena, and Monglena, and south of Gafadartzi.

3. The group of hills, almost unknown, which occupies a large

and very wild tract of country between Ipek, Scherkoles, Triguschna, Trebigne, Zenitza, Bielopol, Plava, Klementi, and Detschiani. Like the Rhodope, it has no general name. At Scherkoles it is called Kuriloplanina; behind Ipek Paklen it receives the name of Rosalia Planina; and at Idljb on the Ibar Stari Kolashin, that of Mokra Planina. This chain seems to run north-east and south-west, and probably attains an elevation of above 6000 feet. Nothing is known about its geography, except that it gives rise to twelve considerable rivers and to many torrents, among which are the Drina, White Drina, the Zem, the Moracca, the Drina of Bosnia, the Lini, the Vavatz, the Raschka, the Ibar, &c. This chain, like the former, is much wooded, and also contains vast pastures, with villages. In other parts it is quite uninhabited, as, for example, to the north-west of Detschiani, where there is a wood or wilderness ten leagues in extent.

I may here mention the numerous chains of Bosnia, as it appears that several of them approached the height formerly mentioned, although none seem to equal the Dormitor, a high chain of inconsiderable extent, having the pyramidal naked form of the dolomite peaks in Southern Tyrol, and lying south-east from Mostar in the Herzegovina. Some people have called this chain Komovi, and placed it near Gusie Kasaba in Herzegovina. It attains an elevation of at least 6000 feet. *Saxifraga Diapersioides* is one of the characteristic plants of the higher summits near Ipek.

4. The chain of hills next in importance is that called by the ancients Pindus, extending from Messovo to the north-west beyond the lake of Ochrida, and running north-west and south-east. Its southern extremity is connected by a somewhat lower chain with the Olympus, and separates Thessaly from Macedonia. When seen from a distance, the two chains of the *Pindus* and *Olympus* seem to form an arc of a circle, or two sides of a triangle. The height of the first chain cannot be less than 5000 feet, and some of the summits must attain a still greater elevation.

To these may be added the Suhagor, a group of hills between Bitoglia and the lakes of Ochrida and Castoria, and also the pretty high chain south and west of Tettovo.

Although the chains I have enumerated are under the line of perpetual snow, and without glaciers, yet snow remains during the whole year in greater or less patches. On the southern side the patches are naturally of a smaller extent, at an equal elevation, than on the north side. In European Turkey there is probably no hill which attains an elevation of 9000 feet, or perhaps even 8000 feet. All the other chains in the empire are much lower, and without snow in summer.

5. The true *Balkan*, or *Hæmus*, is divided into *Veliki Balkan* or Great Balkan, between Sophia and Keczanlik, and *Malo Balkan*, or Little Balkan, and forms the *eastern* part of the central chain. If we allow 3000 feet, or very little more, for the elevation of the Great Balkan, and 2000 feet, or less, for the Little Balkan, I think it will not be far from the truth. Small *contreforts*, or hills running parallel to each other, exist only on the northern side between Schumla and Kabrova, the declivity being more abrupt towards the south. A very low chain also extends from the Bosphorus to the north-west, separating the waters which run to the Black Sea, from those of the basin of Adrianople.

6. A mass of rather small hills, forming the *middle* part of the central chain, and running, some N. and S., as near Radomir and between the basin of the white Drina and Pristina; some NW. and SE., as the Karadagh to the east of Uskub; some W.N.W. and E.S.E., as north of Kostendil, occupying the space of country between the chain which lies along the vast ancient channel of Nissa to Tchtiman, and the chains of the Tschardagh and the Ipek Mokra Planina.

Here and there prominences appear in the midst of this undulating high country or *plateau*. The largest and most elevated of these lie to the N.N.E. of Egri-Palanka, and probably exceed 3000 feet in absolute height. The group appears to be the Orbelus of the ancients. All the other hills of this district are often below, and seldom much above, 2000 feet. They are either partly wooded to their tops or base, particularly when they are calcareous or doleritic: some pastures occur on the highest.

The central chain of Turkey is thus composed of the Tschardagh or Skordus to the W., and the Balkans to the E.; between which we find, running from W. to E., the Karadagh, the hills about Vrana, those of Egri-Palanka, the Orbelus, the hills of Radomir and Kostendil, especially the Koniavo. We found that the name of Egri-sudagh, for the hills of Egri-Palanka, was as much unknown there, as that of Argentaro or Szrebernicza for the chain near Ipek.

7. In southern Servia, to the north of the preceding group, are the groups of the Kopannegh, or Kopannik, and the Plocsa Hills; they form a prominent feature between the Ibar, the Toplitza and the Rachina. The hills belonging to them seem to run N.N.W. and S.S.E., and the greatest absolute height they attain is from 4000 to 5000 feet. To the east of these hills, between the great plain of Kruschevacz and the large valley of the Eastern Morava, is situated the Male-Jastrebicza-Planina, a wooded chain of considerable elevation, although lower than the last mentioned.

All the vast forests of both chains are composed almost entirely, as in Servia, of two species of oak, *Quercus Robur* and *Q. pedunculata*; but in the Kopannegh, fir-trees occupy the highest western part. In the high meadows are found the *Gentiana lutea*, *Pedicularis*, *Alchemilla vulgaris*, &c., and higher up, in the bare rocky parts, the *Arbutus Uva-Ursi*, *Gentiana acaulis*, *Crocus*, *Saxifraga diapersioides*, &c., as on the Ipek chain. We may regard the Temnitscha-Planina, between the Morava and Kalenska-Rieka, as a subordinate part of the Jastrebicza. It is, however, much lower, and diminishes in height towards the north, extending further north than Tagodin.

8. Servia contains another pretty high group of hills around Szokol, on the Drina; which, along with those of the neighbouring Bosnia, probably attain an elevation of 3000 feet, and contain many beautiful pasturages. Another lower chain forms the high land of Middle Servia, running N. and S. At its commencement it is nearly covered by the tertiary and alluvial deposits, and makes its appearance at the Avala Hill, in the Kosinai Hills, the Kleschnavicza Hills, in those west of Schabari; and, finally, it forms a pretty large group, called the Hills of Rudnik (Rudnik-planina), between Kragojevacz, Rudnik, and Brusnitza. The last interesting group is the central nucleus of Servia, and a most important military position, owing to its forests and its central si-

tuation. It has served more than once as the last refuge of the Servians in their wars, and as the place from which they again commenced hostilities. The native abode of Prince Milosh is also in this district. The hills are rounded, and thickly wooded to their summits, with meadows interspersed here and there. The height of the two highest, the Great and Small Sturacz, cannot much exceed 2000 feet. To the east of the Rudnik hills a chain as high as these extends between the Kopannik group and that of Szokol, forming the hills of Kosnik, the Gelin, &c.

All the forests in Servia are composed of oaks (*Quercus Robur, Q. pedunculata*), amongst which are observed some ashes (Fraxinus excelsior), one species of *Tilia*, the *Cornus mascula*, a great many wild pear-trees, some apple and cherry trees, and a few hazels. But oaks and pear trees, especially in low situations, are almost the sole forest trees. This vegetation extends so far as to the south of Nissa, and into Mœsia Superior; but, south of Prestina, we find the Macedonian series, consisting of the *Rhamnus paliurus*, the *Dictamnus albus*, the *Salvia horminum*, together with several particular species of oak and willow. In Albania many oaks and chesnut trees, as also the *Acer tataricum*, exist in the forests, the soil of which is dolomitic.

The Grecian vegetation, *Acanthus spinosus, Colutea arborescens*, &c. extends to Castoria; but, in Southern Macedonia, we find a Mediterranean vegetation,—the evergreen oak, cypress, Grenada tree, *Platanus orientalis, Colutea arborescens, Cercis siliquastrum*, the walnut and fig tree, &c. The olive tree is much cultivated only to the south of Salonichi in Thessaly.

9. A most remarkable chain runs nearly north and south through Eastern Servia, between the broad and fertile valley of the Morava, and the Danube, being a continuation of the hills of the Bannat; but, from the heights of Tagodin to Sophia, the chain turns more to the east, so that the direction is nearly NW. and SE. In it is the vast channel through which the Bulgarian Morava, the Nissava, and Isker have their course. This chain is higher than the central hills of Servia, and perhaps attains, or even exceeds 3000 feet in elevation. To the north of Nissa, these hills are thickly wooded with oaks; but, further south, the limestone hills are in many places quite bare of vegetation.

10. *Lastly*, In Western Turkey, viz. Western Bosnia, Herzegowina, Montenegro, and maritime Albania, there is a system of hills running like that of Dalmatia, NW. and SE.

A prominent character of the orography of European Turkey is the presence of vast cavities or high plains at the foot of the chains, and the number of extensive cross fractures in the latter. The *cavities* or *plains* may be regarded for the most part as longitudinal valleys; and I may mention, as instances of this kind, the great valley of the Morava so far as Stolacz, and the valleys of the Nissava and Isker. A very curious and vast channel exists in Central Turkey, to the south of the central chain. It begins at the foot of the Tschardagh, or in the upper alluvial basin of the Vardar, and terminates in the Sea of Marmora, the sole interruptions it experiences being to the west of Strazin, to the east of Egri-Palanka, and the west of Somakow. There are also the upper basin of the Vardar around Kalkendel, the vast tertiary basin of Uskub, crossed by the river of that name, and those proceeding from Komanova and Karatova, a small basin to the east of Strazin, a pretty large basin from Kostendil to Dzumaa, Dubnicza, and the hills of Somakow; then the immense basin which commences at Kostanitz, contains the alluvial plains of Tartar Basardschik and Philippopolis, and extends to the tertiary basin of Adrianople, and even so far as the Sea of Marmora.

It may be remarked, that the northern side of the Hœmus is not so near the flat land as the southern, the plain of Wallachia being separated from that chain by a series of tertiary hills, which are chiefly composed of molasse.

As plains, we may add to those of Philippopolis that between Keuprili and Kratovo, on the Vardar; that of Sophia, ten leagues in breadth and twenty in length; that of the Upper Strymon or of Radomir, which is smaller and irregularly triangular, but not less remarkable, for it appears to have been once the site of a large lake, and afterwards of smaller ones, the recent disappearance of which is still shewn by the occurrence of bogs and black earth. In the upper part of the tributaries of the Ibar lies the remarkable oval plain of Kossova or Pristina, which is three leagues in breadth, and from six to ten in length. This alluvial plain, which is as flat as the hand, is only surrounded by hills of inconsiderable elevation, as it is itself on a pretty high level. To the west of these hills, and especially of the Goliesh, the White Drina forms a vast basin from Ipek to Prisrend, and farther down; though probably it does not form a direct junction with the tertiary basin of Scutari.

Farther south in Turkey, the Kutschuk Karasu constitutes a beautiful and extensive basin from Perlepe to Monastir or Bitoglia, and from Florina to beyond Salugiler. Lastly, I may add, the basin of the Lake of Tenidje or Tenidsche, with its partly saline or marshy soil, near Salonichi, the basin of the Seres and Drama, the alluvial plain of Kruschevatz on the Morava, &c.

All these plains were once, like the valley of Thessaly, the sites of lakes which must have completely covered the Turkish empire. Only very few now remain, such as those of Ochrida, Castoria, Tanina, and Scutari; and even these are rapidly disappearing and being filled up: that of Castoria is said not to be deeper than fifty feet, which I can scarcely believe, but its shores are partly swampy and covered with reeds. The stream which flows from it passes through a low country. The lake of Ochrida appears to be deeper. All the lakes of Turkey are in the western or south-western part of the empire, and are chiefly surrounded by limestone hills, or they occur on the tops of hills, as in the Olympus.

Northern Turkey contains no lakes, excepting near the lowest part of the course of the Danube.

The *cross fractures* in the chains are for the most part at right angles to their direction; so that, in the chains running N. and S., they extend from W. to E.; and in those running W. and E., or N.W. and S. E., they extend from N. to S., or from N. E. to S. W.

Turkey affords good examples of the first kind, in the course of the Danube, between Panchova and Kladova; in the course of the Servian Morava, from Uschitze to Kruschevatz and Stolacz, and in the course of the Toplitza. Of the second kind are the upper part of the White Drina (*Biela Drina*) bed in the Ipek chain of hills, the course of the Black Drina (*Tscharna Drina*), across the Tschardagh range, particularly between

Ibali and the confluence of the two Drinas; the fractures in the Tschardagh, extending from Kalkandel to Prisrend; the course of the Kutschuk Karasu, in Bitoglia (Erigon), especially from Florina to where it joins the Vardar (the Axius). The course of this last river, particularly between Negotin or Gradiska, and Devrethissar; the course of the Karasu, or Strymon, which runs in true fissures between Kosnitza and the confluence of the river of Dubnitza with the Strymon, then south of Djumaa (Dzumaa), through the Kreshna Hill, then between Vistritza and Skola, north of the plain of Seres, and, lastly, west of Orphano.

The Rhodope, also, presents similar rents, running N. and S. on the Nevrekop, between that place and Kasluk. They are also observable in the course of the Karasu or Mesto, where it flows into the sea opposite the island of Tassos, and in the course of the Maritza or Hebrus from Dimotika to the sea.

I have still to speak of the remarkable rents from N. to S., which cross the middle of the low part of the central chain, between Sophia and Uskub. These fissures are so deep, and the hilly *plateau* so low, in comparison to the more western and southern chains, that travellers scarcely encounter any ascent whatever, when they cross these imaginary Alps of geographers, in passing from Northern into Southern Turkey. These rents not only admit of roads for horses, but even for carriages; or, at least, they could often be made suitable for the latter with very little labour; a fact of great importance as regards geography, as well as commerce and military operations.

In proceeding from the plains of Pristina to Uskub, we found the points from which the waters begin to flow in opposite directions, to the north and south, not on a chain of hills, or even a hillock, but on a very small *plateau* covered with wood and black earth, so as to give it the appearance of having once been a bog. This is in reality only a higher part of the Kossova plain, and is attained by an imperceptible ascent, so that it is probably not eighty feet above the level of the plain. It is situated between Babach and Sessnia, and is only three quarters of a league in breadth. The descent from it leads gradually through vast alluvial deposits, formed from crystalline slaty rocks, talcose gneiss, and protogine, to Kacsanik, where a deep rent, through which flows the Pepentz, conducts the astonished traveller gradually down to the tertiary basin of Uskub. This rent may be termed the Gate of Macedonia. First, There is a picturesque defile, with perpendicular walls of old slaty and limestone rocks, so that, for the formation of the carriage road, it has been necessary to cut a very small gallery through the granular limestone and white dolomite. Afterwards, for a league and a half, the road winds down a woody and undulating deep ravine, resembling the Pass of Killiecrankie. Lower down, there is only a small valley or glen in the crystalline slates, which varies considerably in breadth, the narrower parts being formed by the protrusion of hornblende rocks. In the course of six or seven leagues, one passes from a region where no vines grow, into a lower country, clothed with walnut-trees and excellent vineyards, and then into the warm plain of Uskub. Yet, nevertheless, I do not think I can estimate the descent from Kacsanik to Uskub at more than 500 or 600 feet.

It appears, that between the plain of Pristina and that of Vrana, the water-shed is also formed by very low eminences. The same is the case between the basins of the White Drina and the Mitrovitza. We passed from the one to the other by an imperceptible and very slight ascent, and along a boggy smooth defile, situated to the west of Lapushnik. Even between Vrana and Komanova, the Karadagh chain presents only very low hills, with valleys which tend much to diminish the ascent. Farther to the E., N. W., N. and N. E. of Kostendil, the hills around the Radomir plain, or the Upper Strymon, are very low, as we cannot allow more than 800 feet above the level of the plain for the western hills, and 1500 or 1700 feet for those to the east, as also for the Hill of Koniavo, to the north of Kostendil.

The Kostendil basin is deeper than the Radomir plain, and is only separated from that of Dubnicza by hills whose elevation is generally under 1000 feet; and from that of Sophia by the Wistoska, a hill whose absolute elevation may be estimated at about 2500 feet.

This inconsiderable height of the Radomir Hills, in conjunction with the valleys or glens, facilitates very much the passage from Kostendel, Dubnicza or Radomir, into the Morawa basin.

To the south, between Dubnicza and Radomir, it is only necessary to cross a small *molasse* hill not exceeding 300 feet in height, or we may even go round this hill if we avoid Pobovnol and Tedno, and in that case the carriage road only crosses a small sienite elevation at Dubnicza, and an insignificant smooth tertiary hill to the east of Tedno. To the north of Radomir, on ascending by a scarcely perceptible acclivity, first the smooth valley of the winding Strymon, and then the Gerleskarieka, one arrives at Gerlo (Grlo) almost without being aware of the ascent. At this place a small molasse ridge is crossed, without ascent, by means of a deep defile or rent, running E. and W. and a quarter of a league in length, and after ascending a very little, still on molasse, the point is attained where the water begins to flow to the north. A gradually inclined plane leads through pretty deep cross valleys to Scharkoë or Pirot, in the great valley of the Nissava.

The valleys which form this small inclined plane are Novocelskorieka, running chiefly N.E. and S.W., Nevljanskarieka, running N. and S. and also sometimes E. and W., Lakanitschkarieka, running N.E. and S.W., and Sukova, running E. and W. By means of these it is possible to penetrate from the north into central Turkey with still greater ease than by Kacsanik or Vrana, for carriages may be made use of along the whole line; and from Scharkoë to Belgrade there are only two hills of small extent, on which the passage of large carriages would be somewhat difficult, or which would require some previous preparation, viz. at one league north of Scharkoë, and at two leagues S.E. of Nissa (pronounced Nischa) between Banja and Topolnitzarieka.

Lastly, a very low pass, to the south of Tchtiman at Porta Trajana, separates the plain of Sophia from that of Tatar Basardschik. The plain of Sophia is to be regarded as an upper subordinate portion of the great basin of Bulgaria and Wallachia, with which it is connected by the Iskar Valley, a cross fracture, as also by the bed of the Uraha or Wid.

(The Geology of Turkey, or second part of this Communication, in our next Number).

Notes on the Natural History and Statistics of the Island of Cerigo and its dependencies. By Robert Jameson, Esq. Assistant Surgeon, 10th Regiment of Foot, Corfu.

(Continued from last Number.)

ANIMALS.

Invertebrate Animals.—We shall now make some general remarks on the animal kingdom, as it presents itself in the island and its environs. The invertebrate animals are numerous, more especially those in the lower part of the scale; but their minute examination required more time than was afforded. Among the Zoophyta we met with various genera of polypi, as sertularia, flustra, corallina, gorgonia, madrepora, spongia, &c. Coral of a red and white colour occurs at the Ovo Rock and Dragoneres Islands, and is occasionally fished for in the following manner:—A diver goes down, makes a strong net, something similar to that used for oysters, fast to a coral bed, which, on being dragged along by people on the water's surface, breaks off branches of coral and is brought up when sufficiently weighty; from repeated trials, the longest period those divers have been known to remain under water was two minutes. Sponges, also, of a fine description are met with along the coasts of the island. In the months of July and August a fleet of boats sometimes comes from the Morea to drag for corals and sponges, but of late years the trade has decreased much in value, indeed so much so as to be little profitable. A tolerably good sponge in Cerigo sells for about sixpence, but, like all other commodities where they are produced, scarcely any thing except the dross is to be met with.

In the class Medusaria, various genera occur on the coasts, but more especially after the prevalence of particular winds; and in Echinadermata, the gorgonocephala, echinus, asterias, &c.

Molluscous animals are rare on account of their forming a chief article of food during the long fasts prescribed by the Greek Church. The principal genera met with are, serpula, spirobis, balanus, chiton, patella, pholas, solen, tellina, lucina, cardium, terebratula, mactra, donax, cytherea, venus, spondylus, pectunculus, pecten, pinna, haliotis, helix, pupa, clausilia, trochus, turbo, monodonta, janthina, natica, columbella, cassis, buccinum, fusus, cerithium, murex, cyprina, conus, argonauta. In violent south winds, but more especially SE. or sirocco, many species of animals belonging to this sub-kingdom are driven on shore. Among others, we have the Janthina fragilis, from which the island is said to have derived one of its ancient names. Strabo says that the first name of the island was Porphyra, and Aristotle gives the derivation of the primitive name πορφυροῦσα from the quantity of porphyry the island was supposed to contain; while others maintain that it was not from the Greek word signifying porphyry, but from the word purple, on account of the purple dye which the ancients extracted from the Janthina fragilis, abundant on the Cerigo coasts. Pausanius says (chap. xxi. b. iii.), "The coasts of Laconia abound in shells which yield a purple dye, the best except those of the Sea of Fenicia."

Like the mollusca, the articulata are much prized at certain periods of the year as articles of food. In the class Crustacea, examples of most of the great divisions were noticed, and in the fresh water streams and ponds genera of the order Amphipoda. Of the class Arachnida, the genera tarantula and scorpio are common, occurring sometimes of a very large size. People are sometimes stung by scorpions without greater injury than swelling the part, and producing a smarting pain, to allay which a small quantity of olive oil is used. The genera of the class Insecta are numerous, and require more space than can at present be afforded.

Vertebrate Animals.—The animals of this great division are few in number, but when abundant are periodical.

Fishes.—Migration, a subject of much interest to the philosophical inquirer, is still but imperfectly understood; indeed, the facts on this head are comparatively few, crude, and ill digested. Tribes of the class Pisces migrate regularly every season either on account of want of food or diminished temperature. Some kinds of fish are always to be found, but others only occur in particular seasons, which circumstance the fishermen are well aware of, therefore use different kinds of tackle and bait according to the time of the year. In autumn shoals of the genus Hemiramphus appear on the coasts, and are caught by rod lines trailed along the surface-water; about the same period Mackerel, Crysophris, and Boops abound; they are fished for in the night and taken by long lines thickly set with hooks, made fast to hoops with bells attached, floated by calabashes, for the purpose of informing the fishermen of the situation of their nets. The species frequenting the shores, are taken by different kinds of drag-nets. During winter the genera Smaris, Sargus, Pagrus, and Pagellus appear to abound; and in spring the genera Dentex, Zeus, &c. are of common occurrence. Fish-flesh varies in quality at different periods of the year; some kinds at particular periods become so bad as almost to be considered poisonous, and therefore are rejected by fishermen. The genera and species most frequently met with in the market are Percis, Smaris vulgaris, Sargus, Pagrus vulgaris, Pagellus, Crysophris aurata, Boops, Oblada, Serranus scriba and cabrilla, Trigla lyra and hirundo, Mullus surmuletus and barbatus, Scorpena, Cottus, Trachinus, Zeus faber, Caranx, Cybium, Dentex, Crenilabrus lupina, Labrus trimaculatus, Torpedo, Ophisurus, Pleuronectes, Scyllium, Trygon, Mugil auratus, Hemiramphus, Syngnathus.

Reptiles.—Animals belonging to the class Reptilia, although not very abundant, yet still representatives of the following genera were observed: Testudo græca, Emys europæa, Chelonia caretta, Lacerta agilis, ocellata, viridis, Ascalabotes, Oligodon natrix, Viperium, Coluber berus, Vipera ammodytes, Rana esculenta, Hyla arborea, Bufo communis. Every stream and marsh in spring teems with frogs which make a noise rather grating to the ear; a species (in Corfu) of a large size produces a peculiar sound, somewhat similar to the name given by Aristophanes to the frogs of the river Acheron in Epirus, βρεκεκεκοαξ. Indeed both the ancient and modern Greeks seem to have derived the names of many animals from their cries; at present, in the island, birds are called from the sounds which they emit.

Our attention must next be directed to a class of animals highly interesting in themselves, and important from the part they perform in the economy of nature.

Birds.—In Cerigo stationary birds are few in number, but hosts appear, remaining a longer or shorter period, in spring, on their passage north to spend the summer in more temperate climes, and in autumn on their return. Much has been written on the migrations of the feathered tribes, although even still our data are few and incomplete, or just enough to lull many absurd theories on the subject. I shall now give the genera and species met with, not only in Cerigo, but in the Ionian Islands generally, in different seasons of the year.

Spring:—Vultur fulvus, Falco tinnunculoides, tinnunculus, peregrinus, subbuteo, rufipes, æsalon, Nisus vulgaris, Buteo communis, Circus cyaneus, rufus, Otus communis, Bubo vulgaris, Scops vulgaris, Lanius excubitor, minor, collurio, Muscicapa grisola, albicollis, Turdus merula, musicus, saxatilis, Oriolus galbula, Saxicola rubicola, rubetra, œnanthe, strapasina, Sylvia rubecola, phœnicurus, tythys, Curruca turdoides, atricapilla, vulgaris, cinerea, salicaria, Regulus trochilus, vulgaris, Motacilla alba, cinerea, Budytes flava, Cypselus apus, melba, Hirundo rustica, riparia, rupestris, Alauda cristata, Parus cœruleus, Emberiza melanocephala, miliaria, Fringilla cœlebs, Carduelis vulgaris, Linaria cannabina, spinus, Coccothraustes chloris, Pica vulgaris, Garrulus glandarius, Coracias garrula, Upupa epops, Merops apiaster, Alcedo ispida, Picus medius, Cuculus canorus, Coturnix vulgaris, Columba turtur, livia, Charadrius morinellus, Ardea minuta, garzetta, nycticorax, ralloides, Ibis falcinellus, Numenius arquata, Scolopax gallinago, rusticola, major, gallinula, Rallus crex, porzana, Glareola torquata, Podiceps auratus, minor, Larus ridibundus, melanocephalus, Pelecanus onocrotalus, Anser ferus, Anas rufus, Rhynchaspis clypeata, Tadorna boschas, sponsa, penelope, Sarcella crecca, querquedula, Mergus albellus.

Summer.—Pastor roseus, Oriolus galbula, saxicola rubicola, rubetra, Sylvia palustris, melanocephala, galactotes, Hirundo rustica, rupestris, Caprimulgus europæus, Parus major, cœruleus, Emberiza melanocephala, Pica vulgaris, Garrulus glandarius, Coracias garrula, Upupa epops, Merops apiaster, Alcedo ispida, Yunx torquilla, Pterocles alchata, Ardea cinerea, nycticorax, purpurea, Grus cinerea, Ciconia alba, Ibis falcinellus, Numenius arquata, Totanus glareola, Himantopus melanopterus, Larus marinus, canus, Stoleda vulgaris, Tadorna vulgaris, Sarcella crecca.

Autumn.—Vultur fulvus, Falco tinnunculoides, tinnunculus, subbuteo, æsalon, rufipes, peregrinus, Nisus vulgaris, Bubo communis, Circus cyaneus, rufus, Scops vulgaris, Turdus saxatilis, Oriolus galbula, Saxicola rubecola, rubetra, Sylvia rubecola, phœnicurus, tythys, Motacilla alba, cinerea, Budytes flava, Cypselus apus, melba, Hirundo rustica, riparia, rupestris, Caprimulgus europæus, Garrulus glandarius, Coracias garrula, Upupa epops, Merops apiaster, Alcedo ispida, Yunx torquilla, Cuculus canorus, Coturnix vulgaris, Columba turtur, livia, Charadrius morinellus, Totanus glareola, Œdicnemus crepitans, Vanellus cristatus, Ardea cinerea, minuta, garzetta, nycticorax, ralloides, Ciconia alba, Numenius arquata, Scolopax rusticola, gallinago, Gallinula major, Rallus crex, porzana, Podiceps minor, auratus, Larus canus, marinus.

Winter.—Some of the above Accipitres at intervals: Turdus merula, musicus, pilaris; the Saxicolæ as in spring, also the Curucæ and Reguli; Budytes flava, Alauda cristata, Parus major, cœruleus, Emberiza miliaria, Fringilla cœlebs, carduelis, vulgaris, Linaria cannabina, spinus, Coccothraustes chloris, Picus medius, Ardea nycticorax; Scolopaces as in autumn; Larus ridibundus, melanocephalus, Pelecanus onocrotalus; and Lamellirostres as in spring.

Stationary Birds.—With regard to the Accipitres, I have not yet ascertained whether any of the species are stationary throughout the year. Turdus cyaneus, Pyrgita vulgaris, Corvus corax, monedula? Perdix rufus remain all the year round. There are several others of which I am still uncertain.

On reviewing this list we are struck with the few indigenous species. It shews the route many genera take in performing their migrations, and points out a wider range to some species than hitherto known: the Sylvia gulactoles is only as yet known to occur in Spain, and the Stolida vulgaris, although not common, may be added to the catalogue of European species. A general notice of how the migratory flocks occur may not be uninteresting. As to the period when different species appear, much depends on whether the weather is warm or cold, being early in the former instance, and late in the latter. When the winter is scarcely finished, those birds which appear early in England arrive here, while the latter species and our summer visitants are first observed about the end of spring; again, about the middle of autumn, the summer visitants of this place, or richly plumaged birds, depart, and are succeeded by those with less gaudy tints from the north; but the most sombre of all arrive about the beginning of winter, and are the first to depart in spring.

The flocks of quail which appear here in spring and autumn, are considerably reduced by various destructive means of the inhabitants; but the most singular is that of finding them by dogs, something similar to a lurcher, and then catching them with hand-nets. Two, or a party of three, go sporting in this way; each net has a mouth somewhat oval, stiffened by a rim of wood two or three feet long, attached to which is a net of a proportionate bulk; to this border is fastened at one end a pole, ten to fourteen feet long, and with such a weapon a party of three will secure twenty or thirty couples during the day in the following manner. When the dog makes a point, the party comes up towards the spot in different directions, holding their nets by the ends of the poles, and if the quails lie so close, as they do in bushes, as to allow the party to touch each other's nets, then the dog is driven in to put them up. On rising, each man strikes at a bird with his extended oval-mouthed net, twisting it in the air to entangle his game, and, when expert, seldom misses. On their first arrival, the quails are often so much fatigued as to be taken by the hand, or nets of the simplest construction. In spring they are thin, and scarcely worth the trouble of procuring, while in autumn they are fat, and much prized as delicacies. Great numbers are preserved, and fattened for the table, but unless great care is taken they die quickly; several experiments have been made here in autumn by private individuals, of several hundreds at a time, but they always died off before the cold weather had fairly commenced.

Quadrupeds.—From the preceding description of the islands, we would naturally infer a scarcity of wild mammiferous animals, and their being well adapted, in the milder parts of the year, for pasturage. In former times, that animals of a large size existed in Cerigo in a wild state, we are entitled to infer from the fossil organic remains now existing, and already noticed; indeed, in the time of the ancient Greeks it would appear, that an island on the coast of Greece, at a short distance from Cerigo, took its name from the number of deer it contained. At present, the wild mammiferous animals existing are Canis aureus, Vespertilio murinus, Rhinolophus ferrum-equinum, Mustela foina, Lepus timidus, cuniculus, Mus musculus, rattus. Mustela foina is much dreaded by the peasantry from the havoc it makes amongst their poultry; they have many contrivances for its destruction, which keep its numbers in check. The only locality for the Lepus cuniculus is in the crevices of one of the Dragoneres islands, and it may have been brought thither by the bands of pirates inhabiting it; and, in fact, it was a famous rendezvous in the 17th century. A key as the spot is to the Levant, none could be more favourable to such people. Merchantmen, from the nature of the winds there, could have only escaped them accidentally, and they must have assumed the authority of Cerberi of the then passage of eastern commerce.

Of domestic mammifera sheep are the most abundant. There are scarcely a dozen horses in Cerigo. Mules and asses, on an average for five years, there are annually 871; horned cattle 3132, goats 5524, and sheep 16,809. In Cerigotto, mules and asses 20, horned cattle 153, sheep 303, and goats 806. The oxen are short and stout, usually of a dark brown colour. They are used for agricultural purposes, and the few fed for slaughter are those either useless from age, or purposely imported from Greece. Cabbage and other succulent vegetables, often withered and unboiled, are used for fattening, to which circumstance we may in a certain degree attribute the bad quality of the flesh. More attention than has ever yet been paid here to this subject is much required. Sheep are small, and of a white or grey colour, but sometimes entirely or partly brown or black; there is a large variety with a much broader tail than the others, which seems to have been derived from the African breed. Mutton is better flavoured than usually met with in this part of the globe. The goat is much valued for many reasons. It varies in appearance as to colour, although black with white and brown markings are the most common; a few varieties almost entirely white or brown are generally met with in a large flock. Many shepherds have names for their goats from the forms and colours of the markings. Sheep commence to bring forth in November, and goats somewhat later. Kids' flesh is delicate and well-flavoured, but goats' is coarse and ill-tasted. Cows are never milked, goats and sheep only in spring: from the milk of the latter a dry peculiarly flavoured cheese is made, suited to the native taste, for they will tell you English cheese tastes and smells too strong. Goats' milk having more solid contents than any other kind used by us, is more nutritious, and better adapted for making cheese; on the same account, it keeps longer than other milk, a circumstance well known here among the peasantry. The peasantry are perfectly aware of the difference the kind of pasture produces on goats and sheep; the former are usually led to the higher or less fertile parts of the mountains, and the sheep are kept in the more richly verdured valleys.

The hog is an inmate of every peasant's cottage. Omnivorous as it is, nothing escapes it. During the olive season, however, swine become fattest, and are then slaughtered in considerable numbers. Every part of the carcass is useful in domestic economy, even the very entrails are used as sandal ties. Hog and goat skins are still used for holding oil and wine in transporting them from the country to the market. Again, hog skins, after a rough tanning, are cut up, and made into sandals or common Greek shoes, called *παπυζι*, which are much prized for travelling in a rough country like theirs.

The ass and the mule are the exclusive beasts of burden in Cerigo, and for the uses to which they are put, are certainly preferable to horses.

There are two well-marked varieties of dogs in Cerigo; one of which, imported from Candia, is about the size of our greyhound, with a head similar to it; general shape of body also like, but stouter, and covered by longish dark grey coloured hair: the other is the common dog of the island, which more nearly resembles our shepherd's dog than any other I have seen. Both have good scent and speed, but so remarkable are these qualities in the Candia variety, that nothing can escape it in the shape of game. When talking of quail, it was this kind of dog alluded to, and it is highly prized by the Cerigots.

(To be continued.)

Corfu, *April* 22. 1836.

Biographical Notice of the Mulatto M. Lislet-Geoffroy, Correspondent of the Academy of Sciences for the Section of Geography and Navigation.

JEAN BAPTISTE LISLET-GEOFFROY, a mulatto of the first degree, was born in the Isle of France, on the 23d August 1755. By means of his amiable disposition, great perseverance, and excellent character, he succeeded in overcoming the obstacles which the cupidity and prejudices of the colonists, as well as the influence of custom, had so long unceasingly opposed to the moral and intellectual improvement of men of colour. Lislet-Geoffroy never left the African Archipelago, in which he was born. The just reputation which he had obtained by the age of thirty, extended across the seas, and procured for him, in 1786, the honourable title of Correspondent of the Old Academy of Sciences; an honour which he acquired by means of the almost insignificant resources which the Isle of France could offer to men of study before the revolution of 1789. I believe that M. Lislet is the first of his race on whom Europe has conferred academical honours. This circumstance, however, is not the only one deserving of attention in this case. I observe that at the same meeting of 23d August 1786, when this learned mulatto was nominated, that the Academy likewise enriched its lists of celebrated names with those of Dubuat and Spallanzani, and that it appointed the venerable Duke de la Rochefoucauld to be the immediate correspondent of M. Lislet. In this association of names there would have been enough to overturn completely the notions of the planters, had not the well-known gentleness, virtues, and general knowledge of M. Lislet-Geoffroy long since placed him in a privileged position, before which the most deep rooted prejudices disappeared.

When the academies were abolished in 1793, M. Lislet-Geoffroy, like all the other associates, lost the title of which he was so justly proud. Its renewal, as correspondent of our present section of Geography and Navigation, is dated so late as 7th May 1821; but before this can be imputed as a neglect, it must be added, that the Academy, in spite of the rigorous nature of its rules, did not wait for a vacancy in order to replace him. I will add, that if the name of M. Lislet Geoffroy does not appear among those of the correspondents of the old Academy, which the Mathematical Class of the Institute eagerly attached to it, it is only because the difficulty of communication between the metropolis and the Isle of France, during the wars of the revolution, rendered it impossible to ascertain whether the skilful geographer still lived, when the Institute was established. Whatever may be said of this, there will therefore be no reason to speak of the prepossessions of power, of the *aristocracy of the skin*, nor of prejudices truly unworthy of enlightened men.

A life, however long, passed wholly on a small island in the middle of the Southern Ocean, must necessarily offer few incidents worthy of being remembered. At all events, if any thing wonderful marked the career of M. Lislet, his European correspondents have not been made acquainted with it. We know only that whenever a vessel arrived at the Isle of France, he immediately abandoned his retreat and favourite occupations, and became, by day and night, the willing guide to all who shewed the slightest desire to avail themselves of his knowledge. In 1771, M. Lislet accompanied Commerson in his voyage to the Isle of Bourbon. In remembrance of this excursion, M. Bory de Saint-Vincent has bestowed the name of *Piton-Lislet* on a volcanic mountain of that island, near a remarkable circular depression of the ground known in the country under the name of *Troublanc*. If the necessity of terminating this notice in a short time left me leisure for it, I could extract from the relations of most of our navigators in the southern regions, testimonials of respect as significant and honourable to M. Lislet-Geoffroy as that which I have mentioned.

The following, I believe, are the principal productions entitling M. Lislet to the gratitude of the scientific world :—

Map of the Isles of France and Reunion, drawn up on the observations of Lacaille, and a multitude of particular plans, by the author; published by order of the Minister of Marine in 1797.

The same map, second edition, corrected from new observations; published at Paris in 1802.

Chart of the Sechelles, according to observations made by the author during numerous voyages in the midst of this dangerous archipelago.

Map of Madagascar. This was published by order of the English Government after the Isle of France had ceased to form one of our colonies.

In the map of the Isle of France, which accompanies the *Voyage of M. Bory de Saint-Vincent to the four principal islands of the African seas*, the mountains are designed, as the learned traveller himself declares, according to a plan of M. Lislet-Geoffroy.

Peron has published, in his *Voyage of Discovery to the Southern Lands*, a table of the heaviness and relative strength of many different kinds of wood belonging to the Isle of France, which was communicated to him by M. Lislet-Geoffroy.

The oak of Europe appears in this table as a standard wherewith to compare the results which various natural philosophers have obtained by operating on substances of the old continent. It only occupies the seventeenth place with regard to weight, and the nineteenth in respect of strength!

The almanacs of the Isle of France contained various scientific articles by M. Lislet (one among others on the mountain named *Pitrebot*), which shew all the varied knowledge of their author. The experiments by means of which M. Lislet proved that the shoal known under the name of *Isle Plate*, was formed by the debris of the old crater of a volcano, have been justly appreciated by geologists.

The interesting account of a voyage to Saint-Luce (Isle of Madagascar), made in 1787, is found in the second volume of Malte-Brun's *Annales des Voyages*.

I may affirm, in conclusion, that the most important labour which M. Lislet ever undertook, and on which he never ceased to bestow the most scrupulous care during his long life, and which will enable us to fix definitively the climatic circumstances of the Isle of France, will not be lost to science. I remember, indeed, that M. de Freycinet, who, in 1818, carefully compared the meteorological instruments of the *Urania* with those of M. Lislet, obtained from that natural philosopher a series of tables embracing an interval of more than thirty years. When these tables are properly drawn up and arranged, they will shew with all the necessary precision,

The mean and extreme temperatures of the Isle of France;

The height of the barometer at the level of the sea, at the 20° of south latitude; its diurnal and monthly variation;

The extent of the changes of atmospheric pressure which announce or accompany the dreadful tempests which commit such ravages in tropical regions:

The mean height of the annual fall of rain, and the enormous differences which exist between the dry years and the wet years, whether in regard to the total quantity of water collected, or the number of rainy days, &c. &c.

A note which I have just received from the Isle of France, informs me that M. Lislet continued his observations till the close of the year 1834; they therefore embrace upwards of half a century. Fifty years of observations made by the same person, in the same place and with the same instruments, cannot fail to throw much light on the question now so much agitated respecting the climatic influence of clearing of wood in this long interval; indeed the mania for this has not been less active in the colonies than in Europe.

M. Lislet-Geoffroy died on 8th February 1836, at the age of nearly eighty-one years, with the title of Hydrographical Engineer of the Mauritius. Under the French Government, he was promoted, during the war, to the rank of Captain of Engineers.

Additional Details respecting him by M. Bory de Saint-Vincent.—In the notice given by the Perpetual Secretary, the virtues and merit of the philosopher whom we have just lost have been worthily appreciated. I ask permission of the academy to add something to this notice, in order to make you better acquainted with a man of colour whom I have mentioned in the *Essay on Man* (of which I have the honour to present you with a third edition), for the purpose of demonstrating that one may be a Negro, or nearly so, without being condemned by nature to that degree of intellectual inferiority which, it is pretended, must be the condition of the ulotrique species.

A magnificent map of the island of Mauritius, engraved in England in 1814, and which I have the honour to exhibit to the Academy, is one of the works of M. Lislet-Geoffroy which has been omitted in the catalogue of his scientific works. The general map of the two islands of France and Bourbon, cited in the notice, and in which, it will be recollected, I marked, in regard to the first of these islands, the figure of the mountains, had them indicated only at a very few points, and without any of the details which are so well expressed in this.

The father of Lislet-Geoffroy, as far as I remember the account I have heard of him, was born at Paris, but his relations belonged to Bretagne. Having gone to the Isle of France at some period between 1730 and 1740, he there bought and married, according to all the regular forms, a Caffre negress, whom I remember to have seen when at a great age, and the object of the most affectionate attentions, in the pretty house which their excellent son had built. The latter was then somewhat upwards of forty-five years of age. He related to me, that Commerson and Bernardin de Saint Pierre had successively been guests in his father's house. The former having undertaken to explore Bourbon, or rather Muscareigne, Lislet, who was already acquainted with the country, was chosen as guide; and the correspondent whom you have just lost, then very young, also accompanied them. A valuable and permanent memorial of this scientific excursion remains on the plain of the Caffres, a nearly central plateau, elevated 600 or 800 metres above the level of the sea. Lislet-Geoffroy's father had brought strawberry plants from Europe, which he carefully cultivated in his garden at Port-Louis, but the heat prevented them succeeding. By the advice of Commerson, the impoverished plants were transported by the three travellers to the plain of Caffres, where they prospered to such a degree, that, on my arrival, the heights of the island were entirely covered with them. The plants had in many places entirely occupied the soil, and choked the indigenous vegetation. In the fruit season, I saw, in 1801, spaces which appeared entirely red with them; and I may affirm, without exaggeration, that one could not walk along the ground without staining the feet, even above the ankles, with a kind of marmalade mingled with volcanic ashes.

Further Biographical Details of M. Lislet-Geoffroy, commu-

*nicated by M. Arago.**—" I was born in the Isle of Bourbon 23d August 1775. My mother was a negress of Guinea, named Niama. She was the daughter of Touca Niamba, King of Galam, who was made prisoner in a war, and massacred, along with all the males of his family, according to a practice sufficiently common in these countries.

" My mother, then about nine years of age, was made a slave, and sold to the agents of the company, who sent her to the Isle of France about the year 1730. M. Geoffroy obtained her from M. David, governor of this colony, in order to restore her to liberty. She followed him to Bourbon, where she solaced him with every attention in old age.

" M. Geoffroy took charge of me in my infancy, and educated me himself; he taught me the first principles of drawing and mathematics; and wished likewise to teach me Latin, but in this study I made little progress. As I had no fortune, he made me enter the service at my fifteenth year, and shortly after I went to the Isle of France, where M. le Chevalier de Tromelin, conceiving that he observed in me an inclination for the sea service, employed me at the works of a new bridge which he was building. Having thus his instruments and books at my disposal, I applied myself to the study of mathematics and astronomy. Not being able to procure instructors, M. de Tromelin was very ready to assist me with his advice, and to encourage me. It is to this generous patron that I owe the little knowledge I have acquired, and my advancement in the service. From gratitude, and still more from attachment, I embarked with him at the commencement of the war of 1778 in the capacity of assistant pilot.

" I obtained in 1780 the occupation of draughtsman to the military engineers of the Isle of France.

" On 23d August 1786 I was elected correspondent of the Royal Academy of Sciences of Paris. I have sent to this learned society a series of twelve years' meteorological observations, and a number of experiments on the strength and weight of the woods found in this colony, made by M. Malavois, and which I was engaged to continue after his departure.

* These details are furnished by a letter of M. Lislet-Geoffroy's, written to M. le Baron de Zach, and communicated by M. Wartmann of Geneva.

"In 1787 I was sent by the Governor-General to the Bay of Saint Luce in the south of the island of Madagascar. I drew up the map of this bay, and of the country for fifteen leagues inland, and I likewise visited the thermal waters of the Valley of Amboule, specimens of which I transmitted to M. le Duc de Rochefoucauld at Paris. My journal was printed in the Modern voyages.

"In 1788, I was appointed to draw up the map of a part of the Isle of France; this was sent to the depot at Paris, and procured me the commission of Geographical Engineer. During the disastrous period of the revolution, I was so fortunate as to assist in preserving this colony from the misfortunes and calamities which overturned the rest of our western colonies. True to my principles, I wished to deserve the confidence of my superiors and that of the people of colour at whose meetings I always presided, and we succeeded in escaping the troubles with which we were threatened in 1794.

"At this period M. Geoffroy adopted me, by an authentic act, and I assumed his name, that of Lislet-Geoffroy, which I now bear.

"This same year the Administrators-General sent me on a mission to the Sechelles islands; I there made various observations on the bays, harbours, islands, and dangers of this archipelago. At my return General Malartic appointed me an assistant-officer in the body of military engineers.

Captain-General Decaen, on assuming the command of the Eastern Colonies in 1803, confirmed me in the rank of captain. At the capture of the Isle of France, he named me chief of the commission for the inspection of the place. When this operation, and all others that depended on practical engineering, were completed, it was impossible for me to repair to France according to the terms of capitulation, as I was then fifty-five years old, and had the misfortune to lose my wife in 1804, who left me two children of a tender age, the objects of all my cares and solicitude.

Under the English Government, M. Farquhar, Governor of of the Isle of France, sent a corvette to the coasts of the northern parts of Madagascar, and particularly the bay and harbour of Louiqui. I formed one of the commission appointed for the purpose, and was entrusted with all relating to geography.

This voyage afforded me an opportunity of making many new and very important observations, in correcting the map of this great island, and completing that of the Archipelago on the north-east, at which I had worked for so long a time.

The map of the Isle of France which I drew up with much care, and the accuracy of which I can vouch for, was engraved in England, by order of the Quarter-Master-General. I sent it to the depot at Paris, but it appears that it was intercepted on the voyage in 1808.

On the Composition of Bitumens. By M. Boussingault.

The bitumens which are so abundantly spread over the face of the globe, and whose uses are every day becoming more varied and extensive, have hitherto been little examined. If we except the labours of M. de Saussure upon the naphtha of Amiano, we are nearly in complete ignorance concerning the intimate nature of these bituminous compounds.

It is to this insufficiency of the data supplied by chemistry that we must attribute the confusion into which most mineralogists have fallen in their attempts to classify the different bitumens. A systematic place can easily be assigned to naphtha, idrialine, and mellilite or honey-stone, but when we come to petroleum we get involved in difficulties; this substance usually met with in a liquid state, now becomes viscid, and successively presents all possible degrees of consistence, till we arrive at asphaltum, which is solid and brittle. We are generally led to admit that the bitumens owe their fluidity to naphtha; but the results of the present investigation shew that there is no ground for this supposition. The attention of the author was first directed to the viscid bitumen of the *Departement du Bas-Rhin.* After describing the method in which the bituminous sand is treated, he gives a rapid sketch of the locality of bitumens; and shews that the immense masses of mineral pitch which are found on the banks of the River Magdalena, at Payta, upon the coast of Peru, have a geological position precisely similar to that in which we find bituminous impregnated sands in Europe; that is to say, in formations which we must refer to the supercretaceous group.

The only contradictory fact opposed to this conclusion is that recorded by M. de Humboldt, when he states, that at La Punta d'Araya, in the Gulf of Cariaco, he saw petroleum issuing from mica-slate.

The bitumen of Bechelbronn is viscid, of a very deep brown colour. The uses to which it is applied have procured for it the name of mineral grease.

Heated to 120°, this bitumen does not yield any product; but, on distilling it with water, an oily principle is procured, which is volatile, of a pale yellow colour, and in which analysis shews there is nothing else than carbon and hydrogen. As this carburetted hydrogen appears to constitute the principal liquid of bitumens, the author designates it by the appellation *Petroline.*

Petroline boils at 280° of the mercurial thermometer; its odour is that of bitumen; at 21° its weight is 0.891, even at a cold of 12° it does not lose its fluidity; alcohol dissolves it in small quantity, and it is much more soluble in ether. It contains carbon 0.885, hydrogen 0.115, and is consequently isomeric with the essential oils of turpentine, lemon, and copaiba.

By using the methods employed by M. Dumas, it is found that the density of the vapour of petroline is equal to 9.415, whilst calculation indicates 9.533. This is precisely double the weight of the vapour of the essence of turpentine. If we admit that four volumes of vapour constitute an atom of petroline, its atomic composition will be as follows:—

Carbon, 80 atoms, . .	3060.8
Hydrogen, 64 atoms, . .	400.0
	3460.8

Independent of the petroline, there exists in the bitumen a black solid substance, which is absolutely insoluble in alcohol, and soluble in ether. M. Boussingault names this product *Asphaltine,* because it forms the base of that species of mineral which mineralogists describe under the name of asphaltum.

Asphaltine may be procured by subjecting bitumen purified by ether to the continued action of a temperature of 240° or 250°. Asphaltum is solid, very black and brilliant, its fracture conchoidal; at a temperature of 300° it becomes soft and elastic, and is decomposed before the blowpipe. It contains Carbon, 0.753; Hydrogen, 0.099; Oxygen 0.148, a composition which is represented by the formulary $C.^{80}. H.^{64}. 0^{6}.$ which indicates that asphaltine is the result of the oxidation of petroline.

The bitumen of Bechelbronn, purified by ether, seems to be nothing more than a mixture of petroline and asphaltine. It contains Carbon, 0.870; Hydrogen, 0.112; Oxygen, 0.018.

On the whole, then, it would appear that glutinous bitumens are mixtures, probably in all proportions, of two substances, which we can isolate, and which have each a definite composition. One of these principles is solid and fixed, and in its nature approaches to asphalt; the other liquid, oily, and volatile, resembles petroleum in some of its properties. Hence we may readily conceive how the consistence of bitumens varies in a way we may call indefinite; its degree of fluidity being regulated by the relative proportion of the mixture of its ingredients.

The analogy which exists between the asphaltine and the asphaltum of mineralogists, led me, says the author, to inquire if this analogy is maintained in their composition; I have submitted the asphaltum of Coxitambo (Peru), which may be considered as the type of the species, to analysis. This asphaltum has a fracture which is eminently conchoidal, with a high degree of lustre. The weight is 1.68; it is decomposed before the blowpipe, and when burned leaves 0.0016 residuum. It contains Carbon, 0.750; Hydrogen, 0.095; Oxygen, 0.155.

Memoir on the Chemical Composition of Asses' Milk. By M. E. Peligot.*

These researches have been undertaken for the purpose of ascertaining whether the changes which are produced by asses' milk in the animal economy are owing to the differences in the proportion of the constituent elements of this liquid; and, sup-

* Read to the Academie des Sciences of Paris.

posing this conjecture to be verified, to determine the circumstances which influence the relative qualities of the proximate principles.

The method which M. Pêligot followed consists in submitting a certain quantity of milk, the volume and density of which was noted at the commencement, to the heat of a vapour-bath. When the residuum ceased to lose more by evaporation, it was weighed; it was then treated with a mixture of alcohol and ether, which removed all the fatty matter; it was again subjected to heat and dried, and then weighed, and the difference of the two numbers gives the weight of the butter. Frequent washing with cold water separates the *sugar of milk* from the *caseum,* the quantity of which is then determined in the same way as was the greasy or oily matter.

The density of asses' milk varies from 1030 to 1035, water being 1000. It is very nearly the same as cows' milk, which, however, contains a considerably greater quantity of solid matter. This result, which appears contradictory, is explained by the large quantity of butter in cows' milk compared with the other, which contributes to diminish the density.

Ass-milk differs much from other milks; owing especially to the great proportion of sugar of milk which it contains; and it is to the preponderance of this ingredient, according to M. Peligot, that we are probably to attribute its chief medicinal virtues.

As an average of sixteen analyses, the author finds that 100 parts of ass-milk contains

Solid matter,	9.53	Butter,	1.29
		Sugar of Milk,	6.29
		Caseum,	1.95
Water,	90.47		
	100.00		

The proportion of the solid matter obtained varied from between 7 and 11 per cent. of the milk; it is sometimes, though rarely under 7 per cent.

The composition of asses' milk may, like that of other milk, vary under the influence of different causes, and especially under that of nourishment. For the purpose of manifesting the effects produced by this last cause, the same ass was fed with different kinds of nourishment for a continued time, and at the end of not less than a fortnight of this uniform regimen, its milk was submitted to analysis.

1st Experiment. An ass was fed for a month with carrots freed from their leaves: at the end of this time its milk contained, in every 100 parts,

			Butter,	1.25
Solid matter,	8.89		Sugar of Milk,	6.62
Water,	91.11		Caseum,	1.62
	100.00			8.89

This milk, evaporated to dryness, appeared of an orange colour, and exhaled the smell of carrots. This ass ate 18 kilogrammes weight of carrots a-day, equal to 39 lb. 11 oz. 10 dr.

2d Experiment. The same ass was then furnished with red beet-root; and, at the end of fifteen days its milk shewed the following composition:

			Butter,	1.39
Solid matter,	10.23		Sugar of Milk,	6.51
Water,	89.77		Caseum,	2.33
	100.00			10.23

This is the nourishment which made the milk most rich in solid matter. The ass ate 21 kilogrammes of beet in the day, equal to 46 lb. 5 oz. 9 dr.

3d Experiment. To the same ass was given for a month 7 kilogrammes of bruised oats a-day, equal to 15 lb. 7 oz. 3 dr., and 3 kilogrammes of dry lucern, equal to 6 lb. 9 oz. 15 dr.; its milk, at the end of this time, contained

			Butter,	1.40
Solid matter,	9.37		Sugar of Milk,	6.42
Water,	90.63		Caseum,	1.55
	100.00			9.37

4th Experiment. The same ass was fed for a fortnight on potatoes, and its milk then supplied the following analysis:—

			Butter,	1.39
Solid matters,	9.29		Sugar of Milk,	6.70
Water,	90.71		Caseum,	1.20
	100.00			9.29

From these analyses we are led to conclude, that the beet-root is that nourishment which furnishes milk most rich in solid matter, next succeeds the mixture of lucern and oats, then the potatoes, and lastly the carrots. M. Péligot, moreover, endeavoured to ascertain the different specific gravities of the milk procured under the different kinds of feeding. The weight was found greater according as the quantity of solid matter existing in the milk was greater. Thus there was collected, nine hours after the previous milking: When fed with

Beet, . .	1.500 kil.	= 3 lb.	4 oz.	15.5 dr.	or	3.3 lb.
Oats and Lucern,	1.500 ...	= 3 ...	4 ...	15.5 ...	or	3.3 ...
Potatoes, .	1.250 ...	= 2 ...	12 ...	2.25 ...	or	2.74 ...
Carrots, . . .	1 ...	= 2 ...	3 ...	5 ...	or	2.2 ...

I have mentioned, says M. Péligot, the time which elapsed since the previous milking, because it is one of those circumstances which has a great effect on the quantity of the principles discovered in the milk. That we might be able accurately to measure the influence of this cause, the following experiments were made. The milk of the same ass was collected an hour and a-half after the previous milking, then after six hours had elapsed, and then when twenty-four hours had expired.

	After 1½ hour.	After 6 hours.	After 24 hours.
Butter, . . .	1.55	1.40	1.23
Sugar of Milk, .	6.65	6.40	6.33
Caseum, . .	3.46	1.55	1.01
Solid matter, .	11.66	9.37	8.57
Water, . .	88.34	90.63	91.43
	100.00	100.00	100.00

It will thus be seen that the proportion of solid matter became less, or, in other terms, the milk became less and less rich, in proportion as a long time elapsed after the last milking. As this result is directly contrary to the commonly received opinion, the author was apprehensive it might have been reached through some accidental means, or, perhaps, because the usual and proper limits in which the milk is secreted had been exceeded. He therefore instituted a new set of experiments, taking the milk at an interval of six hours, and twelve hours after the former milking.

	Six hours after former milking.	Twelve hours after.
Butter, . . .	1.73	1.51
Sugar of Milk, .	7.00	6.70
Caseum, . .	1.25	1.10
Solid matter, .	9.98	9.31
Water, . .	90.02	90.69
	100.00	100.00

But not only does the milk vary in its composition according to the greater or shorter time which elapses from the previous milking; the analysis presents, moreover, sensible differences according as it is taken from the early or late drawn portion of the same milking. Thus when the milk drawn without interruption, and of course at the same milking, after an interval of nine hours from the former, is divided into three distinct portions, the following is the result:—

	First Third.	Middle Third.	Last Third.
Butter, . . .	0.96	1.02	1.52
Sugar of Milk, .	6.50	6.48	6.45
Caseum, . .	1.76	1.95	2.95
Solid matter, .	9.22	10.45	10.94
Water, . .	90.78	89.55	89.66
	100.00	100.00	100.00

Thus, in the same milking, the richest is that which is last procured, a fact in accordance with the universal opinion of those conversant with the concerns of the dairy; and also with the experiments of M. Deyeux, and of Parmentier on the proportion of butter contained in the different portions of the milk obtained on the same occasion.

In finishing his labours, M. Péligot endeavoured to ascertain if the introduction of certain mineral substances into the food of the animal passed into the circulation, and affected the milk. For ten days thirty grains of the iodide of potassium was administered to an ass, and its milk was then submitted to analysis. After being evaporated to dryness, the residuum was heated in a platinum crucible: the part which was soluble in water, after being acidified by sulphuric acid, gave, by means of a solution of starch and chlorine, a very sensible tint of blue. This milk, therefore, contained iodide of potassium. Common salt given at the rate of three ounces a-day was recognised in the milk by its flavour, and was also made apparent by analysis. Chlorine given at the rate of five grains a-day, and to the extent of twelve grains, could not be traced in the milk; nor could it be discovered in that of a she-goat, which had taken the same quantities. Thirty grains of the bicarbonate of soda were given for six successive days to an ass. At the end of this time its milk was found highly alkaline the moment it was drawn,—the experiment being made upon fifteen different milks. Usually the new drawn milk of the ass exhibits acid properties.

Farther preliminary Notices regarding Fossil Infusoria. By Professor C. G. Ehrenberg. (Communicated to the Royal Berlin Academy of Sciences.) *

I have already communicated the fact, that the polishing slate (*Polierschiefer*) of Bilin in Bohemia, which is a member of the tertiary formation, consists chiefly of the siliceous shields of the *Gaillonella distans*, and some other infusoria, without any foreign cementing ingredient. The less interesting and newer *Kieselguhr*, and the *Bergmehl* of Santafiora, consisting of the shells of larger infusory animals, are more suited than the polishing slate to prove the existence of such fossil organic beings, and to display them clearly ; for in the latter substance the animals are so minute as to render requisite the use of a powerful and clear magnifying power. Humboldt having visited the Bilin district, during a recent excursion to Teplitz, kindly procured for me two very rich collections of the local mineral productions ; and has, by his exertions in procuring specimens, and also by his communications, afforded me new materials for a continuation of my investigations.†

Before mentioning the important results obtained from the examination of these specimens, I must allude to observations I have made on the polishing slate of Planitz, perfectly authentic fragments of which were procured for me by Professor Weiss from M. Freiesleben of Freiberg. I have now ascertained beyond a doubt, that the Planitz deposit is an accumulation of the shells of infusory animals. The portion examined certainly resembles the *Saugschiefer* of Bilin, and the shells of the Gaillonella distans which it contains are so much mixed with a siliceous cement, that the distinctness of their forms is somewhat destroyed ; but I have seen some of them so clearly, that I am perfectly convinced of the correctness of my assertion. There is probably a more earthy form of this rock, resembling the polishing slate, chiefly composed of the unaltered Gaillonella distans.

* From Poggendorff's Annalen, vol. xxxviii. p. 455 1836.

† According to Klaproth, the *Kieselguhr* of the Isle of France consists of silica 72.0, water 21.0, alumina 2.5, and oxide of iron 2.5 ; and the *Kieselguhr* or *Bergmehl* of Santa Fiora (in the district of Sienna), of silica 79.0, water 12.0, alumina 5.0, and oxide of iron 3.0. *Saugschiefer*, according to Bucholz, is composed of silica 83.5, water 9.0, alumina 4.0, lime 0.5, oxide of iron 1.5.

A highly interesting specimen of polishing slate, from Cassel, was sent me by Carus of Dresden, in which he also had detected the existence of organic forms. From the same locality there are also specimens in the Royal Museum, some of them containing remains of the fish called *Leuciscus papyraceus*, Bronn. Very recently, through the kindness of Mr Keferstein of Halle, I have been enabled to examine other specimens of the Cassel polishing slate from Habichtswalde. This polishing slate of Cassel contains seven different species of loricated infusoria, between whose remains there occurs a loose, chiefly siliceous cement, which cannot be clearly reduced to remains of organic beings. The most remarkable circumstance is, that, while in the Bilin and Planitz polishing slate, most of the forms are those of animals which are extinct, or which have not yet been discovered in a recent condition, and the forms which resemble living species belong to those which are not well characterized, and are hence less fitted for ascertaining the identity; there occur, on the contrary, in the Cassel polishing slate two of the best characterized of the living forms, viz. the *Gaillonella varians,* and *Navicula viridis.* The *Navicula striatula* seems also to occur. The *Gaillonella varians* and the *Navicula viridis* are common to the tertiary formation of Cassel and the *Bergmehl* of Santa Fiora, and both these deposits contain a form analogous to the *Navicula Follis.* Besides 1 *Gaillonella varians,* 2 *Navicula viridis,* 3 *Navicula striatula?*, 4 *Navicula crux* (*N. Follis adulta*); I also found in the Cassel rock, 5 *Navicula fulva juv.?*, 6 *Navicula gracilis?*, and 7 *Navicula Cari,* n. sp.; three species that are less distinctly marked, but of which the last is extremely abundant, and is new to me.

Besides these facts, which have been ascertained regarding the distribution of the *infusory slate* in the form of polishing slate, the valuable collection from Bilin, and the valley of Luschitz, sent by Humboldt, has given rise to some very fortunate investigations. The series of specimens consisted of a small collection of Bilin minerals from Dr Stolz of Bilin, a larger collection from Dr Reuss, besides many fragments obtained by Humboldt himself. A carefully executed sketch by Dr Reuss, explains the arrangement of the rocks.

The Bilin *infusory rock* is about fourteen feet in thickness, and forms the upper layer of a Tripoli hill, which rises to a height of about 300 feet above the surface of the Biela rivulet. This eminence is different from the Kritschelberg, with which it was formerly confounded. It reposes on a stratum of clay, which rests on chalk marl. Under these occurs the gneiss, which there forms the basis of all the rocks. The upper mineral masses to the west of the Tripoli hill, repose on an erupted portion of basalt which forms the Spitalberg, and on whose opposite side (to the west) Grobkalk, containing many well-known fossil remains of marine animals (many Crinoidea) is seen lying on the gneiss.

The more compact masses (*saugschiefer* and semi-opal), occur more in the upper part, the earthy in the lower; the two are frequently mixed irregularly, and the lower layers are nearly horizontal.

The examination of the *saugschiefer* and semi-opal, with their numerous transitions, has already afforded the unexpected result that the latter as well as the former consists of infusory animals, compactly united together. The microscope has proved that the *saugschiefer* is merely a polishing slate, whose infusory shells are cemented together and filled by amorphous siliceous matter, just as we have empty and full fossil shells of molluscous animals. This circumstance causes its greater specific gravity, and all its other characters. We observe, in the gradual passage to the semi-opal, that the cementing material increases at the expense of the infusory shells, while the latter diminish both in number and distinctness.

The semi-opal occurs in concretions in the polishing slate, and the most imperceptible transitions may be remarked from *saugschiefer* to the former. A careful microscopic analysis of the different varieties of semi-opal from Bilin, and the neighbouring valley of Luschitz, has shewn that all of them, even those having the hardness of flint, and giving sparks like steel, are sometimes entirely composed of a slightly transparent siliceous cement of aggregated infusoria, and sometimes also contain larger infusory forms, included like insects in amber. We can often distinctly perceive that the layers of polishing slate have undergone no other alteration during their conversion into *saugschiefer* (a cementing and penetration by amorphous siliceous matter), or their transition into semi-opal, than that some portion of the infusory shells, especially the more delicate, was corroded and dissolved, and that it included, in an unaltered condition, another portion of the infusory animals, and more particularly the larger forms. The slaty structure of the polishing slate has not been obliterated by this process, for it is apparent in the striped character of the semi-opal. The white and less transparent stripes are chiefly layers of well preserved infusoria. A dissolving substance has acted on the siliceous shells like drops of water, or like steam on a mass of flour. The portions in contact have been tranquilly penetrated, and they have partly been gradually dissolved and converted into opal; or the penetrating material that formed the opal, occupying but little space of itself, has assimilated a larger or smaller part of the empty siliceous shells. It is probable that in the true wood-opal, in which the substance of the wood is converted into opal, a particular opaline mass replaced the decayed and dissolved vegetable matter, while the form was still preserved. We cannot so easily conceive a penetration by the opaline matter of the spaces occupied by the siliceous shields of the animals; but the idea seems admissible, that by means of water, or some other solvent, but not fluoric acid, opal was formed like a paste from flour. Unkneaded dough has flour stripes, and in the same manner semi-opal has stripes of infusory animals. Both are hydrates.

In the semi-opal of Bilin, and the valley of Luschitz, we can recognise the following included organic bodies:—1. *Gaillonella distans*; 2. *Gaillonella varians*, especially the larger individuals; 3. *Gaillonella ferruginea*; 4. Siliceous spicula of sponges. The first is for the most part entirely dissolved, but is sometimes contained as the chief part of the mass, somewhat rounded in its outline, although the uniting basis seems quite glassy. The second, also somewhat blunted in its outline, is generally distinctly preserved. The third is sometimes well preserved in the yellow specimens, but, on account of its minuteness, is not one of the best characterized. This last, which probably occurred in moist portions of the already formed polishing slate, is not unimportant in reference to the question of the influence of volcanic agency. When the yellow opal is heated, it becomes red, and comports itself like iron. The red was the thread-like extremities of the Gaillonella. They could not therefore have been heated in the air. The regular horizontal stratification of the polishing slate (probably resulting from a sort of annual, or periodical deposition of tabular masses), is also an argument for Neptunian agency. Moist vapour, arising from neighbouring volcanic action, without actual fire, may have contributed much to the purifying of the mass.

These organic relations, in the semi-opal of Bilin, are placed beyond a doubt. The semi-opal of Champigny, that from the dolerite of Steinheim near Hanau, and that from the serpentine of Kosemitz in Silesia, exhibit included bodies, bearing a strong resemblance to organic forms. The very distinct, microscopic bodies, occurring enclosed in these minerals, and also adhering externally, like white flour, to the semi-opal of Kosemitz, or filling its internal cavities, may belong to the recent genus *Pyxidicula.* They are quite different from the little stalactitic columns exhibited by the round eyes in agates.

It was very natural that I should again examine the chalk-flints which I had so often investigated; and, on the present occasion, I was more successful, from having employed a higher magnifying power. The black, partially transparent flints, present no distinct traces of microscopic organic remains, but many animal forms are to be seen in the opaque white and yellow flints. The rare, horizontally striped varieties, much resemble the striped semi-opals. All frequently contain spindle-shaped or globular bodies, provided with an opening that can hardly be an optical appearance, and enveloped in a transparent siliceous mass. We sometimes observe in the latter, as in the *Gaillonella varians* of Cassel, radiating stripes proceeding from the pierced centre to the circumference, and also a pretty distinctly marked separate shell. The chalky envelope and white covering of flints does not effervesce with acids; it is not chalk but silica, which does not result from decomposition, but is like the skin of a lump of dough, that is, it is that layer of siliceous flour (distinct organized beings) which, during the formation of the flint, was only touched, but not fully penetrated by the dissolving or replacing liquid. It is thus pretty evident, that chalk-flints are formed nearly in the same manner as the semi-opals of the polishing slate. The siliceous portions of the chalk, owing to their specific gravity, are gradually accumulated at particular spots, and form layers of siliceous *bergmehl* in the chalk ; just as, in the different materials composing high perpendicular masses of rubbish, we see substances having the same specific gravity, as mortar, fragments of porcelain, bones, &c., collected together, each by itself, and gradually accumulating in horizontal strata. If, then, these siliceous accumulations were penetrated by a dissolving elastic, or liquid substance, they would form those horizontal strata or nests, which have already attracted so much the special attention of geologists, and of which some possess the form of holothuriæ and corals, whose vast abundance and enormous size, together with their undefined form, have imparted no small difficulty to this explanation. Some other new facts regarding the extremely regular microscopic relations of the chalk and porcelain earth, will be mentioned in a separate notice about to be published. In menilite we can see beautifully the formation of nodules of an infiltrated substance, occupying almost no space, and which does not alter the stratification of the including mass.

Finally, I must here mention my observations on the precious opal of Kaschau. In some fragments of the common serpentine-opal of Kosemitz, and of the precious porphyry-opal of Kaschau, I perceived enclosed round bodies resembling those of flint, but the greater part of the mass was homogeneous. I afterwards examined the matrix of the precious opal, and found that a sort of lithomarge always surrounded the imbedded portions. This lithomarge, under the microscope, resembles much the Gaillonella distans, as it exists in the *saugschiefer* of Bilin. I have frequently repeated, proved, and compared these experiments, on account of the remarkable nature of the phenomena, and I prefer announcing them to remaining silent ; but it is my intention to prosecute my researches with scrutinizing care, to publish the results whenever they shall have attained sufficient maturity.

The more the partly old, partly new saying,

Omnis Calx e vermibus,
Omnis Silex e vermibus,
Omne Ferrum e vermibus,

gains probability, the more necessary it becomes to separate, by strict and severe examination, facts from opinions, a task which is not the work of a few days; and it is also the more necessary to avoid enveloping the facts in mystery, and to limit them, by careful investigation, to the boundaries which may be reached with probability, and which Nature herself has indicated.

We may regard as fully ascertained facts, that the following substances consist, either entirely or in part, of the shells of loricated infusoria, viz.

1. *Bergmehl*, 2. *Kieselguhr*,	Of the newest formation.
3. Polishing slate, 4. *Saugschiefer*, 5. The semi-opals of the polishing slate,	Tertiary substances.

We may consider the following minerals as *very probably* of the same description :—

6. The semi-opal occurring in Dolerite, 7. The precious opal occurring in porphyry, 8. The flints occurring in chalk,	Secondary and primary formations.
9. Yellow earth, 10. Bog iron-ore,	Of the newest formation.
11. Certain kinds of lithomarge.*	

On the Mineral Springs of Iceland. By C. Krug von Nidda.†

After having spent some days in the vicinity of Hecla, and having, on the 3d August 1833, ascended that mountain, I pursued my journey towards the hot springs of Haukadal, under which are included the great Geyser and the Strokr. These

* The examination of a boulder found in the *Mark Brandenburg*, which had been regarded as a floatstone or *Schwimmstein* (Quarz-agathe nectique, H.), has recently proved to me, that its principal mass consists of unattached siliceous spicula of sponges, and of the small globular bodies (infusoria, Pyxidiculis ?) which the flint pebbles of the district contain in great abundance. These bodies occur in the powder of the flinty envelope. The *Schwimmstein*, therefore, bears the same relation to the flint as the polishing slate to the semi-opal, and it is to be referred to the chalk.

† From *Karsten's Archiv.* vol. 9, p. 247.

remarkable springs lie about six geographical miles north-east from Hecla. The great plain, from which rises the slaggy and isolated cone of Hecla, is the south-west opening of a large valley, which is surrounded on both sides by high mountain plateaus, and which traverses the island in its longest direction, that from south-west to north-east. This plain is bounded to the south by the Valley of the Markarfliot, over which is elevated the ice-covered plateau of the Eyafiall-and Torfa-Jökul; to the north by the boundless ice-plains of the Bald and Eiriks-Jökul; and to the south-west the country is open to the sea-shore. A number of broad streams coming from the interior of the island, cut it in a south-western direction. Numerous volcanic cones, chiefly of inconsiderable height, but at one time formidable from the streams of lava which flowed from their summits, rise above the plain. Further in the interior this great plain seems interrupted by some rocky hills, which are arranged in rows; it is divided into several flat valleys, whose prevailing north-eastern direction is that of both the mountain plateaus. Thus, next to Hecla on the north, is placed the broad Valley of Thiorsaae; and then, but separated from this last by low ranges of volcanic tuffa and conglomerate rocks, the valleys, from which proceed the Huitaae and its lateral branches. These separate rocky ranges are so inconsiderable in height and breadth, compared to the two vast mountain plateaus to the south-east and north-west, that they cannot obliterate the general character of one single great longitudinal valley traversing the island through its centre. The position on the summit of Hecla, placed about midway between the two plateaus, has therefore a peculiar interest, as from it the eye can penetrate far into the interior of the island. There we can follow on both sides the long line of lofty ice-covered plateaus; and the great longitudinal valley which they enclose seems only divided into ravines by the small rocky ranges. The Haukadal, so celebrated for its geysers, and the numerous larger and smaller hot springs in its neighbourhood, is the most northern ravine of this description at the base of the Bald-Jökul.

Towards evening, on the 7th August, I arrived at the Haukadal. Already at a great distance, clouds of steam indicated the valley where these vast natural phenomena exist. My expectations were raised to the highest pitch, and the nearer I approached, the more slowly did the time seem to pass, until I actually reached the springs. At length I passed rapidly round a small rocky hill, which seemed torn asunder from the neighbouring mountains, and found myself suddenly in the midst of abundant columns of steam rising from the various openings; I hastened from one spring to another, till I stood at the edge of the great geyser, and saw down into its abyss. The spring was tranquil; but it excites the same feelings with which one walks on the crater of a volcano in a state of repose.

After having in some measure satisfied my curiosity, I began to make the necessary preparations for passing the night. The horses were relieved of their burdens, and turned loose to search for forage in the grassy meadows of the valleys; I pitched my tent at a distance of about sixty paces from the great geyser, in order to observe every movement. In the immediate vicinity there are some Icelandic huts, inhabited by the solitary family of a native. While I conversed on the subject of the geyser with the proprietor, who was a very intelligent man, we heard a dull thunder-like noise under our feet, which soon became louder, and was changed to sounds resembling a series of shots, and following each other in rapid succession. The earth experienced a trembling movement; I hastened out of my tent and saw great masses of steam bursting from the interior of the geyser, and the water of the spring thrown out to a height of fifteen to twenty feet. This agitation of the geyser scarcely lasted a minute, and the usual perfect tranquillity was then restored. I learned from the Icelanders that this outbreak of the geyser was one of the frequent smaller eruptions, that those on a large scale occurred only at intervals of from twenty-four to thirty hours, and that, shortly before my arrival, one of the latter had taken place, so that I must remain more than a day in order to witness a new display. Although this intelligence was very unpleasant, I resolved to remain till I should see the geyser in a state of full activity.

I employed the remainder of the day in examining the geyser itself, and the numerous springs in its vicinity.

The Haukadal is, as already stated, the most northern of the ravines, and is shut in on the north by the projecting flank of the Bald-Jökul, and on its south side by a range of rocks from

600 to 700 feet in height. The valley is about a quarter of a mile broad, and its bottom consists of marshy meadow-ground, through which several rivulets follow serpentine courses, and then, at the mouth of the valley, unite with the Huitaae. So far as the eye can reach to the north, nothing is visible but the indestructible covering of ice which envelopes the plateau of the Bald-Jökul. Towards the north-east the valley contracts, and through a small opening are perceived steep broken-up mountain masses, which are piled up in gigantic groups in the interior of the island. To the south the three snowy peaks of Hecla project above the rocky wall of the valley; to the south-west the great plain commences, that extends to the sea. The rocky walls of the valley consist of layers ranged one above another of tuffas, streams of slag, and slag conglomerates; and also of a mass of rock which belongs to the great trachyte formation, and reposes on the trachyte porphyry as a more or less thick covering, so that the last is almost exclusively found forming the domes of the high plateaus.

A small rocky hill, about 300 feet high, and one-eighth of a mile long, seems to have been violently torn from the steep rocky wall which bounds the valley on the north side. A narrow fissure-like ravine forms the separation. The hill presents a steep declivity opposite to the rocky wall; but on the side next the valley, its slope is gradual. On the last-mentioned side of the hill are scattered the celebrated springs, of which more than fifty can be counted in a small space of a few acres of land. Almost every spring possesses its own characteristic features, by which it is more or less distinguished from the others. An essential separation can only be made between the openings that *are filled with hot pure water*; and those from which especially the *streams of hot gases issue*, and which contain *no water, or very little*, and then only *muddy water* (mud springs). The first deserve the name of *water springs*, and the latter that of *gas springs*.

Both kinds of springs, although in each other's immediate vicinity, nevertheless differ in regard to position; for, while the gas springs rise from the acclivity, and even from the summit of the rocky hill, the water springs occur exclusively on the flat surface at the foot of the hill.

The hot-water springs of this valley always attract first the attention of the traveller, for among them are the great Geyser and the Strokr, whose gigantic eruptions present the most incomparable spectacle.

The Geyser has heaped up a flat cone of siliceous tuffas and sinters, having a height of 25 or 30 feet, and a diameter of 200 feet. At the summit there is an almost round basin, at whose deepest point is the mouth of the funnel-shaped pipe of the spring. The basin measures at its edge sixty feet in diameter, and is six or seven feet in depth. The pipe of the spring has, at its junction with the basin, a diameter of about ten feet, but at the furthest point to which we can see, it contracts to about seven or eight feet. It descends quite perpendicularly to a depth of seventy feet. The side walls of the perpendicular passage consist of siliceous incrustations. The internal surfaces of the basin and of the channel, which are in constant contact with the water of the spring, become so smooth from the friction, that they acquire a polished appearance. But on the exterior of the cone we find the siliceous masses in beautiful crystalline groups, and in bush-like forms, having often a striking resemblance to cauliflower. As this exterior is moistened only from time to time by the water thrown out during the eruptions, or which falls in drops, the silica held in solution is, by the gradual evaporation of the water, placed in such circumstances as to admit of the action of a crystalline power of attraction during its deposition.

Two hours had elapsed since the first small eruption, and not the smallest activity was perceptible in the Geyser. The water filled about half the basin, and was perfectly still. Thin clouds of vapour only were formed on its surface. The thermometer, when placed in the water, indicated 72° R. (194°. F.), and the temperature diminished as the evaporation proceeded. Suddenly I heard a dull sound like thunder under my feet, and immediately there followed five or six violent reports from beneath, during which the earth trembled. The water of the geyser began to boil violently; the basin became filled to overflowing; large bubbles of steam broke forth from the funnel-shaped pipe, and threw the water, by several successive impulses, to a height of about twenty feet. Stillness was restored in a short time. I immediately examined the temperature of the water, and found that it had risen to the boiling point, but that immediately afterwards it sank perceptibly.

I had frequent opportunities of observing these small outbreaks of the Geyser, as they were repeated in a surprising manner, at regular intervals of two hours. The subterranean noise which preceded them, and the concussions of the earth, roused me several times during the night. On every occasion I hastened from my tent, and always saw phenomena similar to those I have described. The same was the case on the following day. In the evening, at half-past six o'clock, the roaring noise resounded from beneath, and I proceeded to the edge of the basin. Twelve to fifteen formidable thundering reports followed, during which the ground was violently agitated by a vibrating movement. I hastened from the edge of the basin, for it threatened to burst asunder under my feet. When I had reached some distance, I stood still and looked back towards the Geyser, when I witnessed that magnificent spectacle which can be produced only by the gigantic powers of subterranean agency. A thick pillar of vapour rose to the clouds with the rapidity of an arrow, and included in its interior a column of water which rose with a wavering movement from the mouth of the Geyser to a height of eighty or ninety feet in the air, but which soon fell to half the altitude. Detached smaller jets ascended much higher, and others were projected in inclined arcs from the envelope of vapour. Soon the vapoury clouds were dispersed, and displayed the column of water, which, separated into innumerable jets, was projected in a straight line upwards, then spread itself out at its summit like a pine tree, and afterwards descended in the form of a fine dust-like rain. The clouds of vapour speedily collected round their nucleus, in order to exhibit it anew in a still more surprising form. Several times the gigantic power seemed worn out, and the column suddenly disappeared; but the earth was anew agitated—dull thunder rolled beneath, and the column of water was elevated into the air by the steam with renewed force. The activity of the spring lasted, including the short periods of repose, about ten minutes. The column of water then sunk back into the mouth of the geyser, and stillness was restored. I approached the basin, and found that the water had fallen to a considerable depth in the pipe, and that it began to rise again, but slowly.

As, according to the testimony of the Icelanders, which was ascertained to be correct, such great eruptions are repeated only at intervals of twenty-four or thirty hours, I had no hope of witnessing again this magnificent spectacle before my departure on the following morning; but shortly afterwards a sight presented itself which is, in some respects, equal to the Geyser in beauty and grandeur, for the Strokr, to my extreme surprise, commenced its wonderful display.

This spring is situated at about 150 paces south-west from the great geyser. It possesses no cauldron-shaped basin like the geyser, but its pipe, which has an average diameter of five feet, and is coated by siliceous incrustations, commences directly from the surface. There is only a small hill four or five feet in height, and consisting of heaped up siliceous sinter, which forms a rim round the opening. The water remains generally at a depth of ten or fourteen feet under the mouth of the pipe, and is always in a state of agitation. The temperature of this spring is constantly at the boiling point.

It was seven o'clock in the evening when the eruption began. A thick column of smoke ascended suddenly to the clouds. The water was projected from the opening with frightful violence, and was converted in the column itself into a fine fog, which rose to an extraordinary height in the atmosphere. From time to time I observed some perpendicular or inclined jets of water forming paths for themselves through the smoke; some attained a height of 100 feet. Large stones which we had previously thrown into the spring were projected to heights that could hardly be reached by the eye; many were so perfectly vertical in their direction, that they fell back again into the pipe and answered the purpose of balls for the sport of the gigantic spring. At the commencement all the water was projected from the mouth, and afterwards the column over the opening consisted only of steam, which left the mouth with a whistling and hissing noise, and rose with incredible velocity towards the clouds. The activity of the spring continued in this manner uninterrupted for three-quarters of an hour, when tranquillity was restored, with the exception of the usual violent boiling of the water.

The eruptions of the Strokr afford a much longer continued, and hence more attractive spectacle, than the Geyser; but I cannot with certainty assert that they occur at fixed intervals of time, as I had an opportunity of observing only one of them. The point has been disputed by several travellers. From the analogy of all other springs which exhibit eruptive phenomena, it seems extremely probable that the Strokr has fixed periods of activity. It is unquestionable that the intervals of time are longer than in any other intermitting spring, even than in the case of the Great Geyser; for, according to the testimony of the natives who live in the neighbourhood, eruptions occur only once in the two or three days. The eruptions of the Strokr do not seem to have the slightest connection with those of the Great Geyser. During the long eruption of the first, the other remained perfectly tranquil, and *vice versa.* Indeed, every one of the numerous springs, which are here crowded together in a small space, seems quite independent of the others. This is also indicated by their remarkable difference in level.

The eruptive phenomena of the Great Geyser and the Strokr are so magnificent, that the entire attention of the observer is directed to them during his stay at this spot; and the other numerous springs in the vicinity are only deemed worthy of a passing glance. And indeed the fact is, that they present no phenomenon which is not exhibited on a much larger scale, by the Geyser and the Strokr. Thus we find between the Geyser and the Strokr, but a little sidewards, and nearer the declivity of the little rocky hill, a considerable opening, from which, at intervals of a few minutes, a large stream of steam issues with a loud noise. This spring was first mentioned by Stanley, and on account of the uninterrupted noise in the interior of the basin, the pipe was named by him the Roaring Geyser. Stanley observed, that at regular intervals of four to five minutes, it projected water with extraordinary violence to a height of thirty or forty feet, so that it was dispersed in the form of the finest spray. During the earthquake of 1789, which agitated this part of the island, the pipe of this spring was broken up, so that the Roaring Geyser now gives out nothing but steam. About 100 yards west from the Strokr, there are several openings of various dimensions, which are all filled with pure transparent water. Some of them are subject to small eruptions at regular periods. The largest, generally called the Small Strokr, breaks out at intervals of from twenty-five to thirty minutes; large masses of vapour then stream from its mouth, and carry the water with them to a height of from eight to ten feet. Such an eruption lasts about thirty seconds, and then perfect tranquillity is restored. There are also very many springs whose surface is never agitated, either by a continued or a sudden evolution of vapour. Their temperature is always more or less under the boiling point.

The regular periods at which the eruptions of the Geyser and of all intermitting springs are repeated, impart to them the character of the action of an artificial machine. We cannot suppose the existence of a system of valves, for Nature always employs the simplest means to produce her most remarkable phenomena. If we group together the phenomena of the Geyser and other intermitting springs, we can deduce some conclusions regarding the development of such immense energy as that exhibited by the Geyser and the Strokr, which may be of importance not only for the theory of all intermitting springs, but also of volcanos. For what are volcanoes but intermitting springs of melted earth? As to the agency which raises the water of the Geyser to so extraordinary a height, no doubt can exist. It is gaseous bodies, chiefly steam, whose expansive power can be immeasurably increased by an elevation of temperature.

The temperature of the thermal springs at their surface cannot exceed 80° R. (212° F.), on account of the continued evaporation under the pressure of the atmosphere. It even sinks considerably in most springs, as in the Geyser, during periods of repose. But that the temperature in the deeper portions of the water-column must be much higher than in the upper, is evident from the evolution which takes place there of steam, whose expansive power stands in equilibrium with the common pressure of the atmosphere, and of the superior portions of the water.*

Warm springs may be divided into three classes:—

1. Those that are *constantly agitated and in a boiling state*—*(permanent thermal springs).*

* We find it stated in a late number of the *Comptes Rendus* of the French Academy of Sciences, that M. Lattin, during a recent expedition to Iceland, ascertained that the temperature of the Great Geyser, at a depth of 60 feet, was 255° Fahr.; and that of the Strokr, at a depth of 40 feet, 233° Fahr.—Ed.

2. Those that are only *agitated at particular periods, and are perfectly tranquil during the remaining time—(intermitting thermal springs).*

3. Those *whose surface is always tranquil, and which are never in an agitated or boiling condition.*

The Icelanders make a similar division, for they term the springs of the first and second classes *Huerer*, that is spouting springs; and those of the third class *Laugar*, that is warm-baths. The springs of the first class have always, at the surface, a temperature equal to that of boiling water under the simple pressure of the atmosphere. The springs of the second class acquire their boiling heat only during their sudden ebullition, and have their temperature considerably lowered, during their periods of repose. The springs of the third class never reach the boiling point.

It is probable that the thermal springs acquire their elevated temperature from the mass of steam which streams from the subterranean warm spring through the column of water. If the steam could always pass freely through the aqueous column, the layers of water must always preserve equably the temperature indicated by the boiling heat, under that pressure, to which each particular layer of water is subjected; at the surface this would of course be 80° R. (212° F.). If, on the contrary, the masses of steam are interrupted by numerous canals during their passage to the surface; if, for example, they are enclosed in hollow spaces; the temperature of the upper layers of water must sink, while owing to the continued evaporation caused by the atmosphere, a large quantity of heat is lost, which is not replaced from beneath. But a circulation of the warm and cold layers of water, according to their specific gravity, seems to be rendered difficult, by the narrowness and the complicated windings of the pipe.

It is doubtless, on such hollow spaces, that the simple mechanism of intermitting springs depends. In them the evolved masses of steam will be detained by the column of water which closes up the canal leading upwards to the mouth; these masses thus necessarily accumulate, and force the water always deeper downwards into the cavity, until at last their expansive power becomes so great, that they open the canal communicating with the external mouth, escape with violence through the column

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of water to the atmosphere, and carry the water upwards along with them. The violent bursting forth of the masses of steam gives rise to the subterranean thundering noise, and the shaking of the ground, which precede every eruption. The first portions of the steam do not penetrate to the surface, but are condensed in the cooler layers of water through which they must pass; the latter thus acquire a temperature sufficient to permit the passage of the succeeding masses of steam. The column of water, once agitated, does not now, as previously, offer such opposition to the pressure of the steam, and this opposition becomes always feebler, as more of the resisting water is projected from the mouth of the spring by the escaping masses of steam. When the reservoirs of steam are so much emptied, that the expansive power yields to the equilibrium established with the column of water in the passage, the latter shuts up the communicating opening, and the previous tranquillity is restored, until enough of new steam is accumulated to produce another emptying of the cavity.

The spouting of the spring hence occurs at intervals depending on the capacity of the reservoir of steam, the pressure of the column of water, and the evolution of heat beneath.

The geyser exhibited, at the time I observed it, two distinct kinds of eruptions. The smaller were repeated regularly at periods of two hours, and the water spouted to a height of only 15–20 feet. The larger occurred at intervals of 24–30 hours; and the masses of steam then rose to the clouds, while the jets of water were elevated to the height of 90 feet. These two sorts of eruptions are to be referred to two different caverns. A smaller cavern is more rapidly filled, and is consequently more frequently emptied; a larger one is more slowly filled, and is more rarely emptied, but with so much the greater force.

The Strokr whose eruptions almost surpass in sublimity those of the great Geyser, has this peculiarity in its structure, that it is both a permanent and an intermitting thermal spring. It is recognised as a permanent thermal spring, by its uninterrupted violent agitation and boiling; and as an intermitting thermal spring, by its gigantic eruptions, which seem to occur at intervals of two or three days. A part of the steam generated beneath, passes through the column of water, and meeting with no obstacle, escapes into the atmosphere. Hence the constant agitation of the spring, and hence its constant boiling temperature. Another portion is arrested in cavities, where it accumulates until it is able to force a passage, and thus produce the eruptions. Among the numerous thermal springs which I had an opportunity of examining in Iceland, the Strokr is, in this respect, a solitary anomaly. No other thermal spring, which exhibits constant agitation and boiling, presents at the same time the phenomena of periodical eruptions. Whatever could produce violent eruptions escapes in continued streams to the atmosphere, without ever being accumulated for the more vigorous displays of power.

We find it mentioned in several books of travels, that eruptions can be produced at pleasure in the Geyser and the Strokr, by throwing stones or other heavy bodies into the pipe. Thus Olafsen relates, that whenever he attempted to sound the depth of the Geyser with the lead, water was vomited forth. Henderson reports, that when the Strokr was in a perfect state of tranquillity, stones thrown into the funnel immediately caused a violent subterranean noise, and that in a few minutes afterwards the column of water was elevated together with the stones.

I can give no opinion as to the accuracy of these statements, for the experiments which I made were not attended by any result. Although I threw many stones into the pipe both of the Geyser and the Strokr, not the slightest degree of activity was excited in either. At the next eruption the stones were again thrown out from below. I am equally unable to decide on the probability of the assertion made by travellers, as well as by natives, that the violence and frequency of the eruptions stand in connection with rainy, stormy weather.

The phenomena of the Geyser, the Strokr, and some of the other more remarkable springs, have undergone a great variety of alterations. Particular canals may be closed by the incrusting power of the water. Caverns may fall in, and new ones may be formed by the frequent shocks with which all the greater eruptions are combined. But the greatest alterations have always been occasioned by the earthquakes, which from time to time have agitated the island. Thus, owing to the earthquake of 1789, there disappeared that spring, which, after the

Geyser, was the largest in this district, and was in 1789 termed, by Stanley, the Roaring Fountain. Whereas, what is termed the New Geyser (Strokr), which, previous to the earthquake of 1789, was quite insignificant, afterwards increased so much, that now, next to the Geyser, it is the most important spring.

The accounts of travellers who have visited the springs from time to time, must hence differ very essentially from one another. The first mention of the Geyser is made by Saxo Grammaticus, in the preface to his History of Denmark, written in the 12th century. The older notices we possess of the Geyser, are not only extremely deficient, but also interwoven with many errors and exaggerations. We cannot even free from this objection the information communicated by Olafsen and Pauelsen, in their Tour through Iceland, written in the last century.

Von Troil* visited the Geyser in the year 1772. He observed, in the course of twelve hours, eleven eruptions of the Great Geyser, which, however, were not of equal intensity. Most of them lasted only a few seconds, and the jets of water ascended to a height of thirty feet. During the last and most violent eruption, which lasted four minutes, the highest jet spouted to a vertical height of 92 feet, according to a measurement made by the quadrant.

Stanley,† who visited the Geyser in 1789, gives the most instructive description of it, and of some of the other more important springs in its vicinity. He observed several eruptions of the Geyser which succeeded each other in comparatively short periods, but which differed much in their violence and duration. The greatest lasted ten to twelve minutes, and the highest jet of water attained an elevation of ninety-six feet. The Strokr is, for the first time, mentioned by Stanley under the name of the New Geyser. He saw one of its eruptions which lasted thirty minutes, and by which columns of water and steam were raised to a height of 132 feet. Stanley further communicates some interesting particulars regarding a spring denominated by him

* Letters regarding a Voyage to Iceland in 1772, by Uno Von Troil. Upsala and Leipzig, 1779.

† An account of the Hot Springs of Iceland. Transact. of the Royal Soc. of Edinburgh.

the Roaring Geyser, and which, at intervals of from four to five minutes, projected its jets of water to a height of from thirty to forty feet.

Olafsen,* who visited the Geyser in the year 1804, observed that the eruptions of the Great Geyser were repeated at intervals of six hours, but that, besides these, smaller eruptions occurred between, which, however, were of trifling intensity and duration, whereas the greater lasted from five to ten minutes—rarely fifteen, and the jets of water were projected to a height of 212 feet. He also witnessed an eruption of the Strokr, which lasted uninterruptedly for two hours and ten minutes, and by which the jets of water were thrown to a height of about 150 feet.

Hooker saw the Geyser in 1809, and estimated the height of the water at upwards of 100 feet.

Mackenzie † visited the Geyser during his tour through Iceland in the summer of the year 1810. He enumerates many eruptions, which, as it appears, were repeated at periods of from two to three hours, and were sometimes very considerable, for they continued several minutes, and the jets of water rose to a height of thirty feet. He seems to have witnessed two of the greater eruptions, so far as can be ascertained from his description, and the time that intervened between them was thirty hours; the highest jet attained an elevation of ninety feet. During his stay in the country he also saw three eruptions of the Strokr (the New Geyser), which occurred at periods of from twelve to fourteen hours, and whose activity was continued uninterruptedly from half an hour to three hours.

In the year 1815, Henderson ‡ visited the Geyser, and found that its greater eruptions took place at intervals of six hours, and the smaller at intervals of from one to one and a half hours. During the great eruptions, the water-column rose to a height of from seventy to eighty feet, and one jet to an elevation of 150 feet. The eruptions of the Strokr were repeated after periods of tranquillity of twenty-four hours, and continued one hour. Henderson caused an eruption by throwing stones into the pipe

* Gilbert's Annalen, vol. xliii.

† Travels in Iceland.

‡ Journal of a Residence in Iceland.

of the Strokr, and, in that case, the water rose to an elevation of 200 feet.

Lastly, in the year 1834, John Barrow * visited the Geyser. After thirty-five hours of fruitless expectation of one of the great eruptions, and after being frequently deceived by the subterranean noises which precede each of the numerous smaller eruptions, this traveller was at last rewarded by the surprising spectacle of one of the great eruptions. He estimated the height of the column of water at from seventy to eighty feet.

The water of the Geyser, the Strokr, and the other neighbouring springs, deposites, during evaporation, in the form of tuffas and sinters, the silica which it contains in such considerable quantity. Over a large tract in the vicinity of these springs the surface consists of a thick crust of these deposits. The basins of all the thermal springs, and the walls of their pipes, are formed of them. The bodies which are moistened by the water of the springs are speedily covered by the siliceous matter, and we find stalks of grass, rushes, turf, leaves, and many other objects included in the tuffa.

Bergman submitted the incrustations of the Geyser to a superficial analysis, and was the first to discover their siliceous nature. We are indebted to Klaproth for a more exact analysis, according to which the sinter consists of silica, with one and a half per cent. alumina, and a half per cent. oxide of iron.

Stanley filled several bottles with the water of the Great Geyser, and of another hot spring near the church of Reikum in Guldbringesyssel, which is precisely similar to that of the Geyser, and sent them to the two chemists Black and Klaproth. Both examined the water, and found that 10,000 parts of the water of the *Reikum-Huer* contain,

According to Klaproth †—

Carbonate of soda,	1.04
Sulphate of soda,	1.73
Muriate of soda,	2.93
Silica,	3.10
	8.80

* A Visit to Iceland in the Summer of 1834. London, 1835.

† Klaproth's Beiträge zur chemischen Kenntniss der Mineral-Körper, vol. ii. p. 99.

According to Black*—

Soda,	0.51
Sulphate of soda,	1.28
Muriate of soda,	2.90
Silica,	3.73
Alumina,	0.05
	8.47

The water of the Geyser was examined by Black only; it contains in 10,000 parts,—

Soda,	0.95
Sulphate of soda,	1.46
Muriate of soda,	2.46
Silica,	5.40
Alumina,	0.48
	10.75

The most important discrepancy between the analyses of the two chemists is, that Black found in both springs a considerable quantity of caustic soda; whereas, according to Klaproth, the soda is combined with carbonic acid.

I was unfortunately prevented from bringing with me water from the springs in order to have it submitted to chemical analysis, and I am therefore unable to decide which of the two chemists is correct; nor can it be determined whether, as Klaproth imagined, Black merely supposed that the soda existed in a caustic state from having assumed that the silica in the springs was chemically combined with the soda.

Barrow sent a small quantity of the Geyser water to Mr Faraday, who examined it with a view to determine the nature of its contents. Faraday, in a letter to Barrow, says, that the water is characterized by containing a peculiar combination of silica and soda: this combination ceases to exist when the water is evaporated, and the silica is then deposited in an insoluble condition; while the alkali, probably by the agency of the carbonic acid of the atmosphere, is set free, and remains dissolved in the water in

* Transactions of the Royal Society of Edinburgh for the year 1789, vol. iii.

† Barrow's Visit to Iceland, p. 209–211.

considerable quantity. The proofs of the existence of such a combination of silica and soda, or of the saturation of the one by the other, are, that the original water of the Geyser does not perceptibly affect turmeric paper, although the alkali is contained in it in such abundance, and that, when the silica is separated and the soluble salts diluted with distilled water in the same degree as in the original water, the turmeric paper is strongly coloured.

Black's opinion of the existence of the soda in a caustic condition is therefore confirmed by these experiments of Faraday.

But even though Klaproth's view should prove to be correct, viz. that the soda exists as a carbonate in the water of the Geyser, yet the quantity of carbonic acid would still be only sufficient to neutralize the soda, and the remarkable phenomenon would still remain, of the presence, in such minute quantity, of an acid which, in other springs, is the prevailing one, and is the solvent of the lime and magnesia.

The solubility of the silica in such considerable quantity in the hot springs of Iceland, remained for a long time a puzzling phenomenon, until that property of silica was discovered which it has in common with phosphoric acid, viz. of forming two isomeric modifications, of which one possesses the property of being insoluble in the moist way, and its combinations are frequently insoluble in the strongest acids. The other modification is, on the contrary, distinguished by the property of being soluble in acids, and even in considerable quantity in water. Afterwards, a larger or smaller quantity of silica was discovered in all mineral waters that were submitted to an accurate analysis; and it was to the alkalies which, combined with sulphuric, muriatic, or carbonic acids, are abundantly contained in the mineral waters, that the power was ascribed of converting the silica from one modification to the other: the presence of the silica and the alkalies was considered as the consequence of a dissolving process produced by the action of the mineral waters on the rocks during their passage to the surface. Experiments in our laboratories do not seem to contradict the opinion, for if we boil finely powdered silica with a solution of carbonate of soda or potash, it is gradually converted into the second modification and is dissolved. We remark a similar dissolving process in the weathering of the mountain-rocks, that consist chiefly of combinations of silica with soda, potash, and alumina; it is distinctly marked in the formation of porcelain earth from felspar. This combination of silica with alkalies, in which the silica performs the part of an electro-negative body, is decomposed by an acid in which, though one of the weakest of the real acids, the electro-negative character is exhibited in a much higher degree than in the silica, viz. by the carbonic acid. This latter, though an accidental constituent of the atmosphere, is yet universally distributed, is combined with the atmospheric water, penetrates through cracks and fissures into masses of rock, and is thus enabled gradually to decompose those silicates of soda and potash. When the alkali quits its previous combination, it dissolves a portion of the silica, and carries it forth in the spring water. But what is accomplished by the long-continued action of weak carbonic acid, is effected in a higher degree by the stronger acids, as sulphuric and muriatic acids, when these occur in mineral waters and come in contact with rocks containing soda or potash.

It would seem, therefore, that it is only requisite for water, impregnated with carbonic acid, to unite with the soda and potash of those rocks which it penetrates by means of clefts and fissures, in order to make its appearance as a mineral spring. We can thus so far follow up the idea that all mineral springs are the result of a mere simple dissolving process: but whence are derived the carbonic, sulphuric, and muriatic acids, which are partly combined with bases, and partly contained in a free state in mineral waters. Can they also be regarded as the products of a simple process of solution? We may perhaps consider deposits of rock-salt as the sources from which the muriate of soda has been derived, though geological facts are in most cases adverse to such a supposition; but we know of no combination either of carbonic or sulphuric acid, from which, without the intervention of other substances, the acid can be separated in order to unite with the water with which it comes in contact. Carbonic acid is so universal a constituent in springs, that there is probably not a single one which does not contain more or less of it. If we suppose that it is in part derived from the atmosphere, and that it unites with the atmospheric water, or that it has resulted from the decomposition of organic substances, and then united with the atmospheric water, still these explanations do not at most account for more than the carbonic acid of ordinary spring water, and by no means for the great disengagements of carbonic acid which are found at many parts of the earth's surface, and in which the gas is either combined with water, or issues from the ground in a free condition.

If we do not regard it as accidental, that all the great disengagements of carbonic acid gas, and further that most mineral waters occur in the vicinity, and in the district of active volcanos, or of such rocks as have undoubtedly been formed by volcanic agency; and as we find that the same ingredients which mineral waters contain in solution predominate in the products of active volcanos; we cannot doubt of the connection in which mineral waters stand with the plutonic processes of our globe. But how these acids of mineral waters were produced in the seats of volcanic fire; whether in their place of origin they were already united with the bases of the salts with which they are combined in the mineral waters; or whether they derived these bases from the rocky masses, that they encountered during their passage to the earth's surface; are questions which can only be answered hypothetically.

If the simple structure of the island of Iceland presents us with a display of the gigantic power, which has elevated the trachyte to lofty and widely extending plateaus, raised enormous trap mountains from the depths of the ocean to vast heights, and torn asunder these mountains by means of fissures of frightful depth and great length; if the eruptions of the volcanos, and the streams of fire from their open summits, which have covered whole districts, and the shocks of earthquakes which shake the island to its very foundations, leave no doubt of the prodigious extent of the subterranean fires; the mineral springs which are the feeblest indications of volcanic activity, afford perhaps the most important information as to the substances contained in the interior of our planet, and as to the processes to which they are subjected.

The analyses of the Geyser water have only informed us of those ingredients which remain as solid component parts after evaporation, but not of those substances which escape in a gaseous form during evaporation. We have said already that the water of the Geyser contains very little carbonic acid. On the other hand, when it comes from the spring, a gas predominates, which is so feebly united with the water, that it leaves it in a gaseous form, almost at the instant the surface is reached, and so much the more easily, because the springs have a very high temperature. This is sulphuretted hydrogen gas, which is contained in all the Icelandic springs that are distinguished by their high temperature, and by their containing a considerable amount of dissolved silica. Its presence is at once rendered evident by the smell of the ascending vapours.

It is this gas also, that, united with steam, issues from those openings, which I have termed gas springs, and which are scattered in great abundance on the declivity of the neighbouring small rocky hill. Most of these gas springs, those, namely, which occupy the higher part of the hill, are entirely free of a rising of water; and only some of the deep-lying openings at the base of the hill contain a small quantity of muddy water. The loose fissured structure of the tuffaceous and slaggy conglomerate composing the hill, prevents the water from accumulating on its summit or declivity, and causes it to flow to the deeper points situated at its base. The small quantity water occurring in some of the deeper openings seems to be deposited by the moist gases which are constantly evolved. This water is not like the pure transparent water of the Geyser or the Strokr, but is variously tinted by the clay which is mechanically suspended in it. The quantity of clay is so great that it forms with the water a pasty moisture, which is constantly kept in an agitated and bubbling condition by the disengagement of the gases.

Besides the sulphureted hydrogen, the gases evolved consist of sulphurous acid, and perhaps sulphur in the state of vapour. The sulphureted hydrogen by contact with the atmospheric air, and the intervention of watery vapour, undergoes a partial decomposition. The hydrogen unites with the oxygen of the air, and the sulphur is separated. The sulphurous acid, also, exercises an oxydizing power on the sulphureted hydrogen, and then the sulphur of both gases is separated. Finally the sulphur of the gaseous sulphur is condensed. The sulphurous acid by acquiring oxygen is converted into sulphuric acid and forms sulphates. In this manner various products are produced, which accumulate at the edges of the gas springs.

As the rocky hill, on whose declivity the gas springs are scattered, consists of loose tuffas and slags, and since the acid vapours penetrate the mass in all directions by innumerable canals, it is not surprizing that we should find the rock completely decomposed, so far at least as the gas springs extend. It is difficult to find a fragment of slag, which has not been converted into a brittle and soft mass of clay. The ground consists of a soft clay, rendered moist by the watery vapours, and presenting yellow, red, blue, or other tints of colour. The water of the lower gas springs is mixed with these clays, and in this way acquires its varied colours.

Round each gas spring, there is a small rim of alternating layers of clay and sulphur, to which are occasionally added some sulphates: as gypsum, alum, and sulphate of iron. The temperature of the evolved gases is always very high. It even sometimes exceeds the boiling heat of water. The surface of the ground is so hot, that one can hardly touch it with the hand.

(To be concluded in our next.)

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*On some Fallacies involved in the Results relating to the Comparative Age of Tertiary Deposits, obtained from the Application of the Test recently introduced by Mr Lyell and M. Deshayes.** By EDWARD CHARLESWORTH, Esq., F. G. S.

DURING the author's investigation of the fossiliferous strata above the London clay in Suffolk and Norfolk, some facts have come under his observation, which appear to him to point out sources of error to a considerable extent in the application of the test recently proposed by M. Deshayes and Mr Lyell, and which is now so generally made use of in the classification of tertiary formations.

The crag has been referred by Mr Lyell to his older *pliocene* or upper tertiary period, on the authority of Deshayes, who identified among the fossil testacea of that deposit, 40 per cent.

* The above is an abstract of the memoir read before the Members of the British Association, at Bristol, August 26. 1836.

with the existing species. The correctness of this result has been called in question by other eminent conchologists, particularly by Dr Beck of Copenhagen, who has examined the crag fossils in the author's collection, and considers that the whole of them are extinct. In this opinion Dr Beck is supported by Mr G. B. Sowerby, who states, that he has only met with two or three crag shells, which may, perhaps, be identified with existing species. Professor Agassiz has inspected an extensive series of ichthyological remains, collected from the crag by the author, and pronounces them all to belong to extinct genera or species; while a precisely similar result has attended Dr Milne Edward's examination of the corals.

Professor Phillips, in his Introduction to Geology, has placed the crag in the *miocene* or the middle tertiary division; while Dr Fleming, who, for more than a quarter of a century, has been an indefatigable collector of British shells, considers that the proportion of recent species in the fossils of that formation has been rather *under* than over-rated by Deshayes; and among the corals of the crag he has detected a large porportion of living forms.

The particular one of Mr Lyell's divisions, to which a geologist will refer any given deposits, must therefore depend upon his own estimate of the characters which constitute specific distinctions, and which is evidently liable to the greatest possible amount of variation. The author next enters upon an inquiry respecting the course which should be adopted in obtaining the relations of analogy, presented by the fossils of different deposits to one another, or to the races in existence at the present period. The effect of the method now made use of is, to class as contemporaneous those deposits which respectively furnish the same per-centage of extinct forms, without the slightest reference to the greater or less degrees of approximation which these forms exhibit, when compared with living types. The conchologists who agree with Dr Beck cannot, by means of the per-centage test, express the difference in the amount of approximation presented by the testacea of the crag and London clay, to those now existing, because they would consider all the fossils of both these formations extinct, and, consequently, refer them both to the *eocene* or oldest tertiary division.

In this instance, the relation of analogy can only be obtained by a general estimate of the amount of resemblance borne to existing species, by the entire series of crag or London clay-fossils taken collectively. This mode of procedure may, at first, offer only a different adaptation of the numerical plan of Mr Lyell. It will, however, be found an important modification of his principle; for, when applied to the fossils of those formations, which, from the presence of living species, can also be subjected to the per-centage test, it will, under some circumstances, furnish results that clearly establish a fallacy in one of the two methods. For instance, the red and coralline crag are supposed by Deshayes to contain the same number of extinct species; and by the per-centage test, they therefore present an equal approximation to the existing organization. But, if the shells, which Deshayes thinks he can identify with those now inhabiting the German Ocean, are rejected, and the extinct testacea alone compared with living types, the forms most remote from existing species will be found to occur in that series which has been derived from the coralline crag.

The author then changes his line of argument, and assuming that there is a general agreement among conchologists, as to the characters which should be depended upon in discriminating species, and also that the per-centage test is the true method of obtaining relations of analogy, he proceeds to inquire whether the association of organic remains in fossiliferous deposits implies their previous contemporaneous existence? The evidence drawn from this source, appears to the author to be by no means so conclusive as it has been generally considered; and his opinions have been formed principally from an attention to the causes now in operation upon the earth's surface.

The small part of this island occupied by the crag formation, is intersected, in one spot, with several estuaries, which have completely removed this generally superficial fossiliferous stratum, the bed of the estuary being formed in an older formation. Along the banks of the Deben, which flows through a part of the coralline crag, in some spots, the fossil shells line the shore in greater numbers than the recent testacea; and, during the period in which this estuary has been formed, prodigious numbers of these fossils must have been swept down into the German Ocean, and there indiscriminately mingled with the *reliquiæ* of existing species of mollusca. It is not merely the extent of surface at present occupied by these estuaries which has thus been denuded of the crag; but considerable tracts of marsh land formerly connected with them, but from which the water has since been shut out, have also lost this original covering. Within a very short distance of the Deben, another estuary, the Stour, flows through a lacustrine deposit belonging to the *newer pliocene* or uppermost tertiary *period;* and here, in addition to the shells, is a considerable stratum of mammalian remains, which, at one period, evidently extended as far as the opposite bank of the river, a distance of about a mile and a half, or two miles.

I must look forward some few thousand years, and anticipate the time when, by the recession of the sea or the elevation of the land, the deposits forming at the mouths of these estuaries has become accessible, and is made the subject of geological investigation. I must also assume, that the geologists of that remote period have followed the same course of induction that has recently been pursued, and have arrived at similar conclusions respecting the course to be adopted in ascertaining the relative antiquity of tertiary deposits. The age of the formation in question, then, is about to be tested by comparing its organic remains with the then existing species. Of what will these fossils consist, and whence will they originally have been derived? The bones of such animals as are now drifted down the rivers Deben and Stour will be mingled with those of the extinct mammalia of the uppermost or *newer pliocene* period. The living species of mollusca now inhabiting the German Ocean, will be found associated with the extinct testacea of the *newer pliocene*, *older pliocene*, and perhaps even with the *miocene* or middle *epoch*. Yet this deposit, in which the organized beings of different geological periods shall be found thus indiscriminately mingled, will be one exhibiting every appearance of regular stratification,—a deposit in which a large portion of testacea will be found naturally grouped, and in which there will be the clearest evidence of their having become entombed on the spot which they had long previously inhabited. That the influences of causes now in operation is really producing such an effect as the one now described, admits of almost actual demonstration; for the fossil shells of the crag are thrown up along various parts of the Suffolk coast, several miles from the spots in which they have been carried down.

"It may be said that these older shells, entering into the new deposits, carry with them evidence of the stratum from which they have been derived; or that, at all events, their worn appearance would distinguish them from the more recent mollusca with which they are associated. This is so far from being the case, that considerably finer and more perfect specimens of the Volùta Lamberti can be picked up on the sea shore, where they have been dashed by the waves upon a shingly beach, than can even be obtained from the beds of the crag formation itself. In fact, this gradual process of degradation appears, in many instances, to be of all others the most favourable for detaching organic remains from the matrix in which they are imbedded; and with respect to the evidence that might possibly be supposed to arise from a difference in lithological character, it should be remembered, that even if such indications did exist by the time these new deposits become accessible, every vestige of the crag will have disappeared. There will, consequently, be nothing to excite the slightest suspicion that the crag species are not contemporaneous with all the organic remains associated with them. In adopting this line of argument, I am of course supposing that the geologists of a future epoch have the same amount of information respecting the history of the tertiary deposits of those days that we have of our own, and not that a geological record of events has been continued up to that period.

"To a certain amount, then, this admixture of fossil with recent shells, even in regular stratified deposits, cannot be denied; but it may be urged that it takes place only under peculiar circumstances, and to such a limited extent as would never interfere with the accuracy of general inductions founded upon extended research and careful practical observation.

"If, however, we enlarge our field of observation, we shall find that a process has been going forward attended with similar results, over a tract the superficial extent of which far exceeds that occupied by the whole of the crag formation. The bed of the ocean, all along the coast of Norfolk, Suffolk, and Essex, and probably as far as Kent on the one side, and Yorkshire on the other, is strewed with multitudes of the bones of extinct mammalia. These remains have been taken up twenty miles from the shore; and, in dredging for oysters, the fishermen have suffered considerable inconvenience from the number of elephants' bones and teeth which become entangled in their nets. Mr Woodward supposes that the grinders of at least 500 elephants have been fished up off the oyster-bed at Happisburgh; * and, from the numbers which I have seen, I have no reason to think this calculation is exaggerated. I do not now propose inquiring whence this prodigious accumulation of fossils has been derived, or to what geological epoch they should be referred; it is sufficient for my present purpose to feel satisfied that they are the remains of beings belonging to a remote era, which are becoming entombed, covered with the balani and zoophytes that now inhabit the German Ocean. These are facts which, I presume, will not be disputed, and yet so entirely has the operation of existing causes in this respect been overlooked, that Mr Lyell fully concurs in the assumption, that, in undisturbed stratified deposits, the embedded remains must necessarily have existed contemporaneously; and upon this evidence solely, important conclusions have been drawn respecting the bones of elephants associated with the shells of existing species of mollusca in a deposit in Yorkshire."†

The next point adverted to in the paper is the presence of *secondary* fossils in the *upper* or *red crag*. During the formation of this deposit, causes similar to those now in existence appear to have been in operation, and effects have there been produced which exactly correspond with the author's deductions as to the nature of the formations at this time in progress round some parts of the British coast. This introduction of secondary shells in the tertiary deposits of Norfolk and Suffolk has been detected solely by an attention to lithological characters; and the evidence derived from this source is no longer available when there is reason to suspect an admixture of organic remains belonging *exclusively* to rocks of the supracretaceous series.

* A village on the Norfolk coast, between Cromer and Winterton.

† That these quadrupeds, and the indigenous species of testacea associated with them, were all contemporary inhabitants of Yorkshire (a fact of the greatest importance in geology) has been established by unequivocal proofs by the Rev. W. V. Harcourt, who caused a pit to be sunk to the depth of more than 200 feet through undisturbed strata, in which the remains of the mammoth were found imbedded together with the shells, in a deposit which had evidently resulted from tranquil water.—*Lyell's Geology*, vol. i. p. 96, edit. 1.

The species which are *common* in the chalk and red crag are very few when compared with those which are common to the *red crag* and to the subsequent *tertiary* strata. In the latter case, however, we have no means of ascertaining whether those individual species which occur in separate formations existed throughout distinct periods, or, like the fossils of the chalk, were, by the natural process of degradation, removed from their original matrix, to be again entombed with the races of a more recent epoch. Unless this difficult problem is solved, it is clear that the application of the per-centage test may be attended with the most fallacious results. To what extent erroneous conclusions may have already been formed, from the neglect of those considerations so obviously necessary in the examination of the crag, must be a subject for future investigation.—*Records of General Science*, No. xxiv. vol. iv. p. 465.

On the Unity of Structure in the Animal Kingdom. By MARTIN BARRY, M. D., F. R. S. E., M. W. S., late President of the Royal Medical Society of Edinburgh. (Communicated by the Author.)

ALL finite existences presuppose design. This is a position which, happily in the present day, we may assume.

It has been usual to regard organic structure as manifesting design, because it shews adaptation to the function to be performed. It has also been suggested, that function may be equally well considered as the result of structure. And, truly so it may. Yet perhaps we are not required to shew the claim of either to priority; but may consider both structure and function,—harmonizing, as they always do,—as having been simultaneously contemplated in the same design.

The object of the present essay, is to offer a few considerations on structure only; but the subject is so vast, and our limits are so circumscribed, that these considerations must be of the most general character. Yet some details on development will be found indispensable.

The expression "organic structure," includes of course the structure of what we call animals and plants. But, while both are comprehended as beings contemplated in the same original design;—while the metamorphoses presented in a realization of this design, and the remarks that may be made on development in general, will apply equally to both;—it is intended to restrict the further prosecution of the subject to animals alone.

The terms "lower" and "higher" animals, will be throughout this paper strenuously avoided, because they are calculated to mislead. Should they occur, it will be as forming part of a quotation. Such terms, if used in regard to the organs of relation only, are, to say the least of them, ambiguous; because we do not know what parts of structure may not contribute to constitute these organs. If they be used to describe differences in the *degree* of elaboration only, such application of them presupposes a simply "ascending" or "descending" scale of structure, differing in *degree* alone,—a thing, the existence of which, it is in part the object of this paper to question, and then acknowledge or deny. We therefore disuse them, substituting the expressions general and special,—simpler and more complex,—diffused and concentrated,—homogeneous and heterogeneous,—less or more elaborate,—less or more developed.

It is important to appreciate exactly, the difference in meaning between the terms "individual" and "individuality." An element, or a set of elements, acquires a separate or distinct existence, *i. e.* an individuality, and there is thus constituted an individual.*

The constituent parts of an individual perform certain functions, in the sum of which consists its life. These functions are reducible to changes of condition, and of relative position, —to dismissal and renewal,—of the elements of which the individual is composed; which changes are not identical in any two individuals. The effect of these continued changes, up to a certain period of life, is a more and more elaborate and special structure, performing more and more diversified and special functions.

Now, as the elements of an individual cease, in turn, to be constituent parts of the same, the identity of that *individual*

* "I exhort you to be particularly on your guard against loose and indefinite expressions; they are the bane of all science, and have been remarkably injurious in the different departments of our own."—*Lawrence's* two Lectures; being an Introduction to Comparative Anatomy and Physiology. 1826. P. 118.

must be continually changing,—can exist, indeed, at no two periods of time; inasmuch as new elements are continually entering into its constitution, while old ones are departing. But the same separate or distinct existence—the same *individuality*—continues.*

A law, not less vast in its importance, than it seems to be general in its application, may be supposed to direct structure in the animal kingdom. This law requires that a heterogeneous or special structure, shall arise only out of one more homogeneous or general; and this by a gradual change. The importance of this law appears to have been insisted on chiefly by Von Bär, who arrived at it by long and attentive observation of development.

Let us then inquire, in the first place, what analogy there is in the states of germs in general, at the earliest period of observation; and whether they have in common, a homogeneous or general structure.

In animals presenting the most simple manifestations of life, —" in which, every point of the creature is, as it were, an epitome of the whole, without any relation to, or dependence on, the rest; and capable, therefore, when separated from the rest, of an independent existence,"†—maturity alone appears sufficient to produce offspring, and simple separation sufficient to constitute a new being. Such is the case with many zoophytes.

Reproduction becomes less simple, as vitality grows complex; because now, " each point of the creature has a more close relation to, and dependence on, the rest, than before."‡ When something like ova begin to be discernible, they consist of a half-fluid, throughout homogeneous, more or less granulous mass. This is the state of bodies regarded as ova, in some Infusoria, some Polypes, and many other Zoophytes. Bodies of this kind have been called " Germinal Granules." Such imperfect ova

* Cessation of the changes spoken of, constitutes death. The state of being subsequently, forms a subject, of which it would here be out of place to treat. It is sufficient that revelation makes us acquainted with the fact, that *human* existences continue, after they have ceased to be represented by combinations of elements, performing functions, the sum of which is called life.

† *Dick*, in the Trans. of Prov. Med. and Surg. Assoc., vol. iv. p. 344.

‡ *Dick*, l. c. p. 344.

seem to hold a middle place between "Shoots," on the one hand, and "Germinal Vesicles," on the other.*

The ovum of more elaborate structures,—perhaps of all the rest of the animal kingdom,—is a sac, containing a sort of Yolk, —the Germinal Vesicle,—and a Layer of granules. (Fig. 1. p. 120.)

The *Yolk* of ova generally, is very much the same in essential character; but performing a more important part in some animals than in others, it differs much in quantity.

The *Germinal Vesicle* is an exceedingly delicate, transparent sac; measuring in diameter sometimes less than $\frac{1}{100}$th of a line,† and containing a pellucid fluid. On the internal surface of the Germinal Vesicle, there has lately been discovered an opacity,—the *Germinal Spot* (*Macula germinativa*), consisting of extremely minute granules, more or less spherical in form. With a magnifying power of eight hundred diameters,—that is to say, magnified 640,000 times,—this spot has not yet been found to consist of other than homogeneous parts.‡ It has been already said, that it is contained within the Germinal Vesicle; the latter measuring in diameter sometimes less than $\frac{1}{100}$th of a line.

In some Infusoria, the contents of the Germinal Vesicle are rather a mass of granules, than a fluid and a spot; perhaps corresponding parts, in a less concentrated state. Indeed, may not "Shoots," "Germinal Granules," and the contents of the Germinal Vesicle, be, all of them, corresponding parts, in different states of concentration?

The *Layer of Granules (Germinal layer)*, containing perhaps, in part, the rudiments of the future Germinal Membrane, lies immediately on the internal surface of the Primary Membrane that contains the Germ and Yolk. This layer is more or less circumscribed,—often indistinct, because of its periphery coalescing with the Yolk. The Germinal Vesicle is found lying in the centre of this layer of granules, on the surface of the Yolk; though there are reasons for supposing that, originally, the Germinal Vesicle is situated in the centre of the Yolk.

* *Purkinje,* in Berlinerwörterbuch, Band x. S. 109.

† *Wagner,* in Ed. Med. and Surg. Journ. 1836. No. 127.

‡ *Wagner,* l. c.

We have then—

1stly, "Shoots;" as in many Zoophytes.

2dly, "Germinal Granules;" a half-fluid granulous mass, as in some Infusoria, some Polypes, and many other Zoophytes.

3dly, The ova of some Infusoria, in which the Germinal Vesicle contains a mass of granules.

4thly, Perfect ova, of more elaborate animals, viz.—

Fig. 1.

a Germinal Spot.
b Fluid contained in Germinal Vesicle.
c Germinal Vesicle.
d Layer of granules, having the Germinal Vesicle in its centre.
e Yolk.
f Primary membrane, enclosing the Germ and Yolk.

5thly, Superadded, in Mammals and in Man, there are the Graafian Vesicle, and its fluid,* viz.—

* In Mammals, and in Man, the part corresponding to the ovum of other animals, is called the *ovulum*.

For the discovery of the latter,—an epoch in the history of development,—we are indebted to the illustrious *Von Bär*. Von Bär was once a pupil of Döllinger, the head of the Würzburg School; who having expressed to the former a wish, that some young naturalist should, under his own superintendence, thoroughly investigate the development of the common fowl, Von Bär would most gladly have undertaken it, but for circumstances that required for a time his estrangement from the subject. Von Bär mentioned it, however, to his friend *Pander*, who had come to Würzburg, at his suggestion, to be a fellow-pupil of Döllinger. Pander undertook those researches; and hence his discovery of the primary separation of the Germinal Membrane into layers. *Von Bär* returned with renewed ardour to the subject, and discovered the Ovulum of Mammals; *Purkinje* having in the mean time found the Germinal Vesicle of Birds. *Valentin* next discovered the Germinal Vesicle in Mammals; and *Wagner* afterwards found the Germinal Spot. The last-mentioned author justly asks, Is this spot also to present some contained part?

For a particular account and drawings of these minute bodies, see *Von Bär*, "de Ovi Mammalium et Hominis genesi;" also the Ed. Med. and Surg. Journ. Nos. 127 and 128; and Müller's Archiv, 1836, Heft ii.; likewise a paper by *Purkinje*, "Symbolæ ad Ovi Avium historiam ante incubationem;" and one by *Bernhardt*, "Symbolæ ad Ovi Mammalium historiam ante prægnationem."

Dr Allen Thomson, one of the very few in this country who have attended to the subject of development, has given an epitomized but very comprehensive account of the changes in the Germinal Membrane of Vertebrated Animals, so far as ascertained up to the time when he wrote (1830), adding observations of his own. (See vols. ix. and x. of this Journal.)

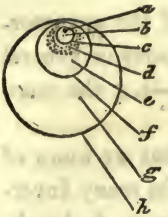


Fig. 2.

a, b, c, d, e, f, as above.
g Fluid contained in the Graafian Vesicle.
h Graafian Vesicle.

The following table * shews how generally, the more difficult to discover of these parts, have already been met with in the animal kingdom.

	Germinal		
	Vesicle.	Spot.	Layer.
Vertebrata.			
Mammalia, including Man,	—	—	—
Aves, . .	—	—	—
Reptilia, . .	—	—	—
Pisces, . .	—	—	—
Mollusca, .	—	—	—
Articulata.			
Annelida, . .	—	—	
Crustacea, .	—	—	—
Arachnida, .	—	—	—
Insecta, . .	—	—	—
Zoophyta, . .			
Entozoa, . .	—		—
Infusoria, . .		—	

It is then fair to presume,—since this table contains "both ends," as they have been termed, of the animal world,—viz. Infusoria and Man,—that wherever there exists what is called a perfect ovum, all the above parts are present.

There are reasons for supposing that the Germinal Vesicle is formed before the Yolk,—one of which is afforded by its relatively greater size; † and, if so, the Germinal Vesicle, with its contents, constitute the primitive portion of the ovum, which in all animals, where found, appears to be essentially the same. ‡

It has thus been shewn, that in all classes of animals, from Infusoria to Man, germs at their origin are *essentially the same in character;* and that they have in common a homogeneous or general structure.

* Compiled from various sources.

† The Germinal Vesicle is met with in those ova only, that are not quite ready for impregnation; as it bursts on the latter taking place, and pours its contents among the granules of the Germinal layer, by which it is surrounded.

‡ *Purkinje,* in Berlinerwörterbuch, Band x. S. 111.

It appears also, that essentially, the *manner* of the metamorphosis, or metamorphoses, from a more homogeneous or general structure, to one more heterogeneous and special,—*i. e.* the *manner* of development,—*is universally the same.*

Such a proposition seems deducible from what we know of development, not only in all the Vertebrata, but in many Invertebrated animals; such as the Insecta, * Crustacea, † Arachnida, ‡ and even Mollusca; § and Von Bär seems to have meant the observation to apply to animals in general, when he spoke of development proceeding by "a continued elaboration of the animal body, through growing histological and morphological separation." || Zoophytes themselves, so far as their development extends, may also be included, as subject to the same law.

To the *manner* of development, we shall presently return.

The Layer of granules, already spoken of, as having in its centre the Germinal Vesicle (fig. 1. p. 120), appears, on the bursting of the latter, to contribute to the formation of the Germinal Membrane (Plate I. fig. 3): though the central and most important part of the latter is perhaps constituted, by the contents of the Germinal Vesicle.

The Germinal Membrane in some of the Vertebrata, is at first a more or less circumscribed disk, covering only a part of the Yolk, and afterwards extending itself to surround and enclose the whole of it; in others, it encloses the whole of the Yolk from the first. This membrane in the Invertebrata, presents differences in this respect, regarding which physiologists are not quite agreed.¶

In most vertebrated animals, the Embryo is at first nothing more than the exuberant growth of a part of this Germinal Membrane, *near its centre*, (see Plate I. fig. 3.); *i. e. in the*

* See *Burmeister's* Entomology, translated by Shuckard, 1836, 8vo.

† *Rathke*, über die Bildung und Entwickelung des Flusskrebses, 1829, fol.

‡ *Herold*, Untersuchungen über die Bildungsgeschichte der Wirbellosen Thiere im Eie, 1824, fol. Also *Rathke*, in Burdach's Physiologie als Erfahrungswissenschaft.

§ See *Von Bär's* observations on the development of Snails, in his "Entwickelungsgeschichte der Thiere," &c., 1836, 4to.

|| l. c. p. 231.

¶ See *Valentin*, Entwickelungsgeschichte des Menschen, &c. pp. 144 and 602–3. Also *Herold*, l. c.; and *Rathke*, l. c.

Fig. 3.

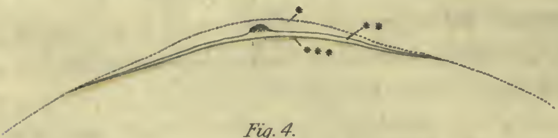


Fig. 4.

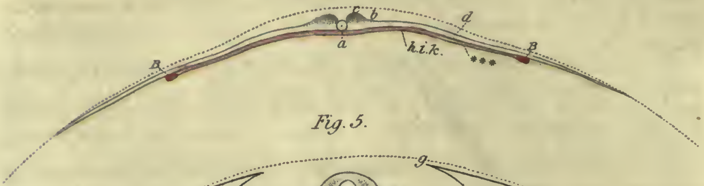


Fig. 5.

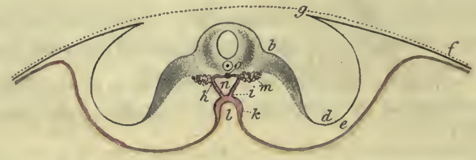


Fig. 6.

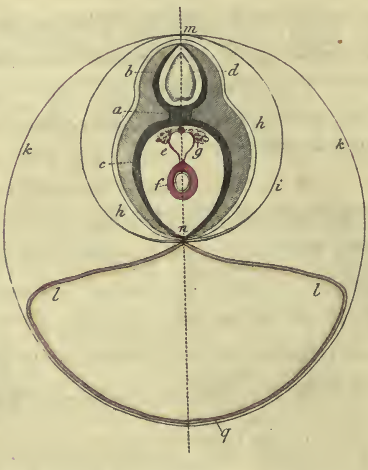
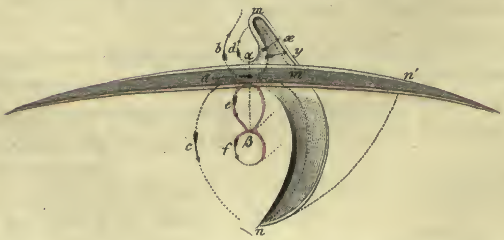


Fig. 7.



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situation occupied by the Germinal Vesicle, before the bursting of the latter; the part exuberant, projecting, but not being distinguishable from the rest, by a well-defined border. The projecting portion becomes more and more distinct, until its growing independence is manifested, in a tendency to withdraw itself from the remainder. (See Plate I. fig. 5.)

This separation of the central part of the Germinal Membrane from its periphery and from the yolk, gives rise eventually to the appended *Umbilical Vesicle* in Man and other Mammals. In Birds, the corresponding part is taken into the abdomen. In Frogs, the embryo occupies, from the first, so large a portion of the Germinal Membrane, and the latter so nearly surrounds the yolk, that the yolk becomes contained in the embryo, before the independence of the latter has time to manifest itself by a tendency to withdrawal.

Explanation of Plate I.*

Fig. 3. Transverse section of the Germinal Membrane and incipient Embryo of the Common Fowl.

Fig. 4. Ditto, more advanced.

Fig. 5. Transverse section of an Embryo of the Common Fowl.

- * Primary membrane enclosing the Germ and Yolk.
- ** Serous, or Animal layer.
- *** Mucous, or Vegetative layer.
- B Sinus or Vein, bounding the Vascular Area.
- *a* Chorda vertebralis.
- *b* Outer margin of the Lamina dorsalis.
- *c* Upper margin of the same; afterwards the Mesial Line of the back.
- *bc* Lamina dorsalis.
- *d* Outer (and afterwards under) margin of the Lamina ventralis.
- *bd* Lamina ventralis.
- *e* Flexure of the serous lamina.
- *de* Membranous portion of the abdominal paries.
- *f* Margin of the lateral envelope.
- *g* Lateral part of the fold of the Amnion; afterwards, the closing-point of the Amnion.
- *deg* Amnion.
- *h* Upper angle of the mesenteric lamina.
- *i* Under angle of the mesenteric lamina; afterwards the suture of the Mesentery.
- *hi* The mesenteric lamina.
- *k* The vascular lamina on the Intestine.
- *l* Mucous lamina of the Intestine.
- *m* Corpora Wolffiana.
- *n* Mesenteric space.
- *o* Aorta.

Fig. 6. Ideal transverse section of the Embryo of a Vertebrated Animal.

- *a* Stem of the vertebral column.
- *b* Laminæ dorsales—their union forms the upper or dorsal Tube.
- *c* Laminæ ventrales—their union forms the under or ventral Tube.
- *d* Central portion of the Nervous System or nervous Tube.
- *e* Vascular Tube.
- *f* Mucous Tube.
- *g* Corpora Wolffiana.

* Containing *transverse* sections only: selected from *Von Bar.*

h Skin.
i Amnion.
k Serous covering, resulting from the closing of the amnion at *m*. (See also *g* of Fig. 3.)
l Yolk-bag.
m n Central line, common to all the Fundamental organs.
q Vascular lamina, on the Yolk-bag.

Fig. 7. Formation of the Germinal Membrane into the Embryo of a Vertebrated Animal.

α β Central line, common to all the Fundamental organs.
a Chorda vertebralis.
b Formation-arc of the Laminæ dorsales.
c Formation-arc of the Laminæ ventrales.
d Formation-arc of the Nervous Tube.
e Formation-arc of the Vascular Tube.
f Formation-arc of the Mucous Tube.
m Ridge of the Lamina dorsalis.
m′ That place in the Germinal Membrane out of which the ridge (*m*) arises.
n Ridge of the Lamina ventralis.
n′ That place in the Germinal Membrane out of which the ridge (*n*) arises.
x Perforating formation-arc of the Eye.
y Perforating formation-arc of the Ear.

The *manner* of development seems to be as follows:—*

The Germinal Membrane separates into two disjoined layers; viz. into a Mucous or Vegetative (Plate I. Fig. 3, ***), and a Serous or Animal layer (same Fig. **); the latter being in contact with the Primary Membrane (same Fig. *), enclosing the Germ and Yolk; the former lying immediately upon the Yolk itself. The Vegetative layer is afterwards seen to be composed of two intimately united laminæ; viz. the proper Mucous (Fig. 4, ***), and the Vascular (Figs. 4 and 5, *h*, *i*, *k*). The Animal layer also, in the embryo at least, divides itself into two laminæ, viz. into the Skin, on the one hand (Fig. 6, *h*), and into a mass containing the Fleshy layer, as well as, in vertebrated animals, the Osseous, and the Nervous layers, on the other (Fig. 6, *a*, *b*, *c*, *d*). This division into layers, is the "*primary*" separation. During the course of this separation, the layers become tubes, or Fundamental organs. (See Plate I, Fig. 7.)

There occurs, at the same time, a separation of textures, in the substance of the layers or tubes; cartilaginous, nervous, and muscular substance, separating from each other; while a part of the mass becomes fluid. Some of the elementary textures also, assume the form of laminæ, which are subordinate to the original layers; the latter therefore, (now tubes), become the

* We here present, in a very condensed form, Von Bär's observations on the Vertebrata, as contained in his work "Entwickelungsgeschichte der Thiere," &c. 1828, pp. 153-159, &c.:—so modified, however, as to make the description applicable to invertebrated animals also.

central portions of systems. This separation into textures, is the "*histological*" separation.

Besides the above, there arise differences in outward shape; single sections of the tubes being developed into distinct forms or organs, destined to perform particular functions; which functions are subordinate members of the function of the whole tube; but differ from the functions of other sections of the latter. For example, the mucous tube divides itself into the mouth, œsophagus, stomach, intestine, respiratory apparatus, liver, urinary bladder, &c.; the peculiarity in the development being connected with either an increased or diminished growth. This is the "*morphological*" separation.

Thus, by a threefold division, the mass becomes heterogeneous; and the further back we go, the more do we find, not single organs only, but histological elements united.

"Fresh parts are acquired, not by *new*, but by *trans*formation. When, for example, the foundation of a cartilage forms, there was not previously a vacancy in the place it occupies, but a homogeneous mass; the *change* in which, consists in the appearance of an assemblage of opaque granules, and a surrounding pellucid fluid. This is the *manner* of histological separation; calling forth, as it were, antitheses."

"No part is formed, that was not previously in connexion with some part, earlier formed; no part has an isolated origin, then adding itself to the rest. Nothing swims freely around, annexing itself here or there, as formerly was said of the whole embryo, and even lately, has been conceived and taught of the spinal cord.* Each organ is a modified part of a more general organ;" and development proceeds from the centre towards the periphery. This is the *manner* of morphological separation.

It was to uniformity in the *manner* of the *primary*, of the *histological*, and of the *morphological* separations, just described, that we referred in the proposition, that essentially the *manner* of the metamorphosis, or metamorphoses—*i. e.* the *manner* of development—from a more homogeneous or general, to a more

* Such is the doctrine of Serres. See his "Anatomie Comparée du Cerveau;" also his "Recherches d'Anatomie Transcendante et Pathologique." 4to, 1832.

heterogeneous or special structure, is universally the same; and we have already mentioned researches, which seem to warrant this conclusion.

The *direction* taken by development, is, however, not the same precisely, in any two animals; and in different Classes, the direction (type) differs very widely. But of *direction*, or *type*, we shall treat more particularly hereafter.

It has then been shewn,—that *germs* from Infusoria to Man, are essentially the same,—and we know that there are some structural characters, common to all animals in a *perfect* state,—especially to those of the same Class, as, for example, the Vertebrata: there are besides, resemblances between some of the more elaborate structures, in certain of their embryonal phases, and many less wrought out structures, in their permanent conditions; which resemblances are observable, not only between animals included in the same great Class, but also, though more remotely, between animals belonging to different Classes.

To sum up these important facts: If the structure of germs has been found in animals at "both ends" of the animal kingdom, as well as in the intermediate classes, to be essentially the same;—if between the homogeneous masses, forming germinal membranes, there is found no essential difference;—if the primary separation of this membrane into layers (the vegetative layer being always directed towards the yolk), and the subdivisions of these layers—incipient in the membranal, and completed in the embryonal states—are the same in character;—if the formation, not of textures only, but of organs also, proceed in the manner just described;—and, above all, if permanent structures, among many of the less elaborate animals, resemble most obviously, different degrees of histological and morphological separation, as presented in the embryonal phases of an individual destined to be more wrought out;—are we not entitled to conclude, not only that a heterogeneous or special structure arises only out of one more homogeneous or general; but also that, essentially, the *manner* of the metamorphosis, or metamorphoses,—the *manner* of development,—from the latter to the former state, is universally the same?

And are we not then led fairly to the conclusion, *that all the* *varieties of structure in the animal kingdom, are but modifications of, essentially, one and the same fundamental form?**

Now, seeing that not only the Vertebrata, but all Classes of animals, in their development, must pass *thus gradually* from a merely *animal* form, to the most special forms they respectively attain; further, that the *manner* of development may be considered as essentially the same in all;—is it surprising that there are resemblances between some of the embryonal phases of very different animals; and that some of the stages in embryonal life of the more elaborate structures, resemble perfect states of those that are less wrought out? Could it, indeed, have been otherwise?

Let us inquire a little more particularly into the development, firstly, of the Vertebrata; and, secondly, of some Invertebrated animals.

Firstly—Of the Vertebrata.

The layers into which the germinal membrane separates, become, as already said, tubes. (See Plate I. fig. 6.) These tubes are more or less bent towards the yolk, at each extremity; but extend the whole length of the animal, including its head and tail. Therefore, out of the upper tube,—constituted by a union of the laminæ dorsales (fig. 6, *b.*),—are formed, the arches of the caudal, lumbar, dorsal, and cervical vertebræ, the arched cranial bones, and the soft parts covering all of these; together with the central portion of the nervous system. While out of the under tube,—constituted by a union of the laminæ ventrales, (*c*)—are formed, the ribs, the soft parts of the thorax and abdomen, the hyoid bone, and all that portion of the neck, anterior (or inferior) to the vertebræ, the lower jaw, and some other parts, both osseous and fleshy, of the face. The bodies of the vertebræ, and the base of the cranium, are formed out of a portion of the animal layer of the germinal membrane, common to the upper and the under tube (fig. 6, *a.*)

The central portion of the nervous system in different animals, may, in its ultimate elaboration, produce very different struc-

* Whether this fundamental form is vesicular, as it has been supposed,—and in favour of which opinion, several facts might be brought forward,—we cannot now inquire.

tures; all grades between the splendid cerebral hemispheres in Man, and the mere rudiments of hemispheres in Fishes. The nervous portions of the organs of sense are, in all the Vertebrata, processes of the central portion of the nervous system, through the Laminæ dorsales (Fig. 7. *x. y.*); so that, though so varied in different animals, not only all parts of the central portion of the nervous system, but all processes from the latter,—with a common origin, and the same *manner* of development,—may well bear a general resemblance to each other, in the perfect states of the less, and the embryonal states of the more, elaborate animals.*

(The nervous ganglia of the Cuttle, and perhaps of many other invertebrated animals, seem to correspond, not with the sympathetic, but with the spinal ganglia of the Vertebrata; a spinal cord and brain not being present.† It is remarkable, that in the Cuttle, there occur cartilaginous rudiments of vertebræ, under which the ganglia lie.)

The muscles of the trunks in different animals of the Class Vertebrata, are but modifications of the fleshy portions of the Laminæ dorsales and ventrales; and the muscles of their extremities, are only similar metamorphoses of those portions of the latter, that are carried out with the osseous (or at first cartilaginous) foundation of the extremities themselves. (See fig. 8, below.)

All the resemblances in the vascular system of different animals, are, in like manner, referrible to a common origin, and the same *manner* of development; and its varieties, to various modifications in *direction* (or *type*) and *degree*.

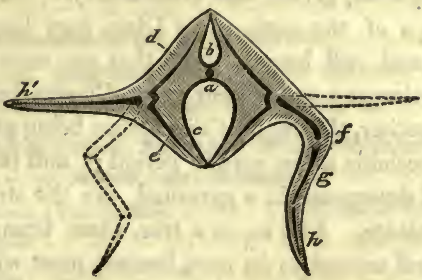
The Mucous tube originates, as processes, the mouth, œsophagus, stomach, respiratory apparatus, liver, urinary bladder, and other organs; in part also, and in conjunction with the Vascular tube, the genital organs: which parts, in all their varieties, bear a general resemblance to corresponding parts in different animals.

* It has been said that the spinal cord originates the brain. This is most untrue; the spinal cord does not exist before the brain; but there exists a central portion of the nervous system, out of which arise both brain and spinal cord.

† The term "brain" is here limited to the enlargement at one extremity of a mass, of which the other forms a spinal cord. (Von Bär, l. c.)

Fig. 8.

Ideal Transverse Section of a Vertebrated Animal, to shew the Type of the Extremities.



a Stem of the vertebral column.
b Arches of the Vertebræ.
c Ribs.
d Dorsal, *e* Ventral } radical portion. } of an Extremity, &c.
f Upper, *g* Under } middle portion. } of an Extremity, &c.
h Terminal portion. } of an Extremity, &c.
h' Terminal portion as a Fin.

(This fig. is taken from Von Bär.)

In the substance of the fleshy portion of the Lamina dorsalis and ventralis of each side, there is formed a series of osseous arcs (fig 8, *d e*), constituting the radical portion of the extremities, of the superior maxillæ, &c.; and from a point near the middle of each arc, there issues a process corresponding to the middle (*f g*) and terminal (*h*) members of the latter. Now, it is obvious, that with this common origin, and the same manner of development, corresponding parts in different animals of the Class Vertebrata,—whether arms, legs, wings, fins, maxillæ, &c.—are likely to retain a general resemblance; though the absence of the middle members, or modification of the whole extremity, &c. may render them very dissimilar in their details.

Corresponding parts of structure may, however, in different animals, perform very different functions. Thus, besides the extremities just mentioned, many other examples might be given; such as a fact pointed out by Geoffroy St Hilaire, that certain parts of the hyoid bone in the Cat, correspond to the styloid processes of the temporal bone in Man; and the different functions of the generative organs in the two sexes, afford a still more remarkable example.

It has thus been shewn, why corresponding organs may resemble each other in different animals of the Class Vertebrata. Of Invertebrated animals, we shall presently speak.

In development, germs, and even embryos, belonging to different groups of the same great Class, may long be indistinguishable; and still longer, those that are more nearly allied. But those belonging to different great Classes, begin to diverge sooner; or rather, the angle of divergence being greater, a difference is appreciable at an earlier period;* and in proportion to the angle of divergence in a germinal, are the structures unlike in a perfect state. Just as, in a tree, those branches that have been given off nearest to its root, become most widely separated in their terminating twigs.

In different Classes, development, though it proceeds in the same *manner*, yet taking thus different *directions*, attains, with materials perhaps essentially the same in primordial structure, very different ends (*types*).

Thus it proceeds in the Vertebrata or Osteozoa, with especial reference to the central portion of the nervous system; in the Arthrozoa (which include, besides the Articulata, some Zoophytes), having for its chief object, the organs of locomotion. In both of these Classes, therefore, it is the Serous or Animal layer of the Germinal Membrane, that is seen first advancing; and out of this, in these two Classes, there is thus produced, a very different system of organs.

In the Gastrozoa (*i. e.* the Mollusca and most Zoophytes), on the other hand, the organs of nutrition are especially the object; and in them, therefore, development proceeds chiefly in the Mucous or Vegetative layer.

To these priorities in development, and to the important influence they have on the direction which development takes in other parts of the system, are referrible the leading characters of Classes.† Yet it is in *direction* only, that development can

* The *primitive trace* is very different in Invertebrated animals,—for example, the Crustacea,—from what it is in the Vertebrata; and even among some of the Vertebrata, there are observable, in this respect, no small differences; as between the primitive trace of Batrachian reptiles, and that Birds,—(*Valentin*, Entwickelungsgeschichte, &c.)

† Hence we cannot compare animals, belonging to different Classes, in regard to what is called their "rank," unless we keep in view, not the *degree* alone, but also the *direction* of development. For the same reason, it is absurd to say, that one Class of animals can pass into another; such, for exam-

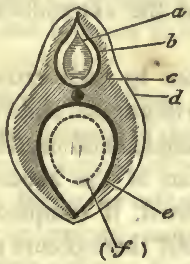
be said to differ in different animals; in *manner*, it remains the same.*

Secondly,—Of some of the Invertebrata.

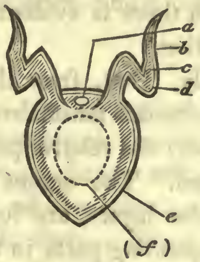
The following diagrams will illustrate different *directions* of development, though the *manner* be the same.

Ideal Transverse Sections, shewing the Structures formed out of the Animal layer, respectively,

Of the Osteozoa (Vertebrata).
Fig. 9.



Of the Arthrozoa.
Fig. 10.



Upper tube—

a, Central portion of the nervous system; situated in the *upper* part of the Animal layer.

b, Arches of the vertebræ, some of the cranial bones, &c. (part of the internal skeleton.)

c, Fleshy layer.

d, Skin.

Under tube—

e, Ribs, lower jaw, &c. (part of the internal skeleton); the other parts of this tube, as c and *d* of the upper tube.

(*f*, Mucous tube.)

Upper tube, incomplete, viz.

a, Situation of what there is, corresponding to the central portion of a nervous system: situated in the *lower* part of the Animal layer.

b, External skeleton, secreted from the skin, } forming an Extremity, a Mandible, &c.
c, Fleshy layer, such as it is, }
d, Skin, }

Under tube—

e, External skeleton, secreted from the skin; the other parts of this tube, as *c* and *d* of the upper tube.

(*f*, Mucous tube.)

The Vascular tube is not shewn in the above figures.

ple, as the Cephalopoda of the Class Mollusca, or the Crustacea of the Class Articulata, into Fishes of the Class Vertebrata. As well might it be said, that branches divergent at a tree's root, because they retain some characters in common, can be coincident in their terminal localities.

* There are, however, certain systems of organs more or less common to all beings. Among these are especially the nutritive or appropriative organs; resemblances between which, therefore, in corresponding stages of development, may be conceived to extend to existences of almost every kind. It has been justly said by Burmeister, that Osteozoa (Vertebrata), uniting in

It is obvious from the above,

1stly, That in the Osteozoa, the *central portion of the Nervous System*; in the Arthrozoa, the *organs of locomotion, mandibles*, &c., are the especial objects, in the early stages of development.

2dly, That the central part of the Animal layer is appropriated accordingly. Thus it may, perhaps, be said, that parts corresponding to the Laminæ dorsales of the Osteozoa, go to form the Extremities chiefly, in the Arthrozoa.

3dly, That the upper tube in the Arthrozoa is imperfect, though there is evidently a tendency in the extremities to its formation.*

4thly, That, from the direction taken by their extremities, the Arthrozoa must move about, with the thorax and abdomen uppermost; the relative position of the Fundamental organs being reversed. The organs also, formed out of the Mucous and Vascular layers, are found to be inverted, if compared with corresponding parts in the Osteozoa; but there occurs such an adjustment in the situation of the external parts,—as, for example, in that of the mouth and organs of sense; and, as what in the Osteozoa is the extensor, becomes in the Arthrozoa the flexor side of the body;—that, so far as these are concerned, it cannot be said that the Arthrozoa move about on their backs. Rather may it be affirmed, with Valentin, that "they have no true back, but only the tendency to form one."† But their thorax and abdomen are certainly inverted.

5thly, That the situation of what these animals have of the central portion of a Nervous System, is a part of the body corresponding very nearly to that occupied by the central portion of the Nervous System in the Osteozoa; viz., it is in the former (Arthrozoa) situated in the *under*—in the latter (Osteozoa) in the *upper* part of the animal layer,—supposing each of these Classes of animals to be situated *above* the yolk.

6thly, That the term "dorsal" vessel, is calculated to mislead;

themselves, in no small degree, ventral as well as locomotive properties, exhibit formal approximations to both Gastrozoa and Arthrozoa in their development. (Burmeister, l. c. p. 419.)

* Such is the idea of Valentin, l. c. p. 608.

† Loco citato, p. 607.

the part so called, obviously corresponding to the aorta in other animals; and, according to the above diagram, having a truly thoracic and abdominal locality.*

Of the development of molluscous animals, we know very little: enough, however, to render it quite safe for us to extend to them the laws already laid down; viz. of the heterogeneous arising only out of the homogeneous, and of identity in the *manner* of histological and morphological separation (the *manner* of development),† whatever may be the *direction* which the latter takes, and however limited its *degree*.

Even to Zoophytes, the same laws may be applied. The Germinal Granule of the Polype—a homogeneous, shapeless mass —separates into a softer portion, on the one hand; and a more rigid, a horny, or calcareous substance, on the other; and assumes its proper, more or less special, form. Even shoots themselves—those, for example, of the Hydra ‡ —are at firs simple swellings, then cone-like, afterwards somewhat cylindrical, and gradually become funnel-shaped, like the parent: processes then appearing wart-like, at the circumference of the common cavity, and these by degrees elongating into arms.§

The whole animal kingdom then, (perhaps all organized beings?), may be considered as directed in development by the above laws; and all animals present besides, the antithesis of an

* The Germinal Membrane separates, as well in invertebrated, as in vertebrated animals, primarily into a Serous or Animal, and a Mucous or Vegetative lamina; between which, sooner or later, there is found a third, the Vascular lamina (Valentin, l, c, p. 605).

The above figure (10.) is not intended to present the *form* of any of the Arthrozoa. The form, indeed, of an *Osteozoon*, has been as far as possible adopted, in order to admit of an easy comparison of corresponding parts; the only purpose here, being to shew the appropriation of the Animal layer of the germinal membrane in the two Classes. We do not at present enter into any comparison in *form*, of parts of the external skeleton of the Arthrozoa, with the osseous system of Vertebrated animals (Osteozoa).

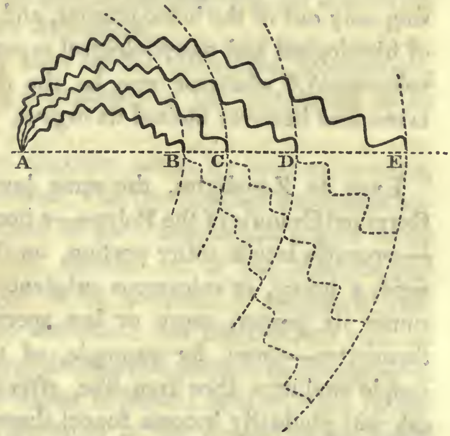
† See *Von Bär's* researches on Snails, already mentioned; also those of *Stiebel* and *Carus*, alluded to by *Burdach*, Physiologie als Erfahrungswissenschaft, Band ii. S. 179–180.

‡ *Carus*, plate i. fig. 1. § Burdach, l. c. p. 164–165.

internal or vegetative, and an external or animal portion of the body.

The following diagram is intended to illustrate fundamental unity, and the causes of subsequent variety in structure; the latter being acquired in development, and development being represented by curves.

Fig. 11.



Let the point A, represent the supposed coincidence in fundamental form, of four germs of the Class Vertebrata.

The curves drawn from the point A, to the points B, C, D, E, represent, respectively, the development of Fishes, Reptiles, Birds, and Mammals.

The identity of the curves, in curvature, corresponds to identity in the *manner* of development (*i. e.* in the *manner* of histological and morphological separation).

The *lengths* of the curves, together with the *degrees of undulation*, measure the *degree of aggregate elaboration* attained by each of the above, in the course of its development.*

The dotted *continuations* of the curves, measure the *differences* in the degree of elaboration.

The different *directions* of the curves, both general and particular, represent the different *directions* taken in development; *i. e.* modifications of the type of the Vertebrata; and serve to shew, that while there exist *resemblances*, *identities* are impossible.

The amount of *divergence*, measures the difference in *structure*, arising from the different *directions* taken in development, (difference in *kind*).

* This illustration is, however, a very coarse one. We cannot, for instance, represent the fact, that certain parts of structure in birds, are more wrought out, than corresponding parts in mammals. The term *aggregate* elaboration, has therefore been employed.

The *cross lines* (arcs) indicate, at the points where they cut the curves, *corresponding stages* of development. It is in corresponding stages of development that resemblances occur.

By the above diagram (Fig. 11.), resemblances between organized structures, admitting of comparison, are seen to be in the inverse ratio of the age,—the curves having a tendency to coincide, in proportion as they approach the point A ; and the causes of variety, are seen to be resolvable into differences in *direction* and *degree* of development.

There are many purposes to which it may be applied, such as a comparison of the development of the primary divisions of the animal or vegetable kingdom (Classes), or of any of their subdivisions; of corresponding layers of the Germinal Membrane; of systems of organs or single organs, in different animals, or in different plants; or of systems of organs or single organs, originating in the same Fundamental organ, of the same animal or the same plant.

Perhaps the chief use of this diagram consists, firstly, in assisting the *understanding*, by affording something like an object, to which descriptions may be referred; and, therefore, secondly, in assisting the *memory*, by means of association.

Let us, for example, refer to it a fact mentioned by Oken,* and since by Burmeister,† that certain Insects, differing in the degree of elaboration in the *perfect* state, differ in a corresponding manner as *larvæ* also. Suppose that at the point A, four germs of different Insects coincide essentially in fundamental form. Let the curves represent their development in larval (*i.e.* a part of embryonal) life; and let the germs be those respectively of one of the Diptera, Hymenoptera, Coleoptera, and Lepidoptera. The larvæ of the Diptera (gnat, house-fly), whose development is represented by the curve A B, resemble the footless and headless Leech; those of the Hymenoptera (bee, wasp, ant) A C, may be compared to Nais, in which there is a distinct head, but the feet are wanting; those of the Coleoptera (May and caddis-flies), A D, are comparable to a third grade of the Annulata, " residing in tubes, and furnished with large bundles of gills."

* " Allgemeine Naturgeschichte für alle Stände," 8vo, Band iv. s. 469–470.
† Loco citato, pp. 419, 420.

Lastly, in the larval development of the Lepidoptera (butterfly, moth), curve A E, there is a resemblance to another grade of the Annulata—among which the Aphrodite—having, " besides a distinct head, many feet on the ventral side of the segments."

Now from this example it is obvious, that not only the four Families of perfect Insects, as well as their larval states,—but also those animals with which the latter, respectively, have been compared,—will be, as it were, all *located* in the diagram; and this in the order of their respective degrees of elaboration. The latter, therefore, will be easily remembered. Thus, in the curve of least elaboration, are located not only the gnat and house-fly, but also the leech. In the curve of most complete development, not the butterfly and the moth alone, but the Aphrodite, and others of the same grade in the Annulata. So also of the two other curves.

It seems as if, with the original design to create organized beings, there had arisen a scheme of more or less complete division and subdivision, continued down to species, and including in the latter, all individual forms.*

One of the supposed grand divisions may have included *animals*;† one of the first subdivisions, the type of the Vertebrata; subordinate to which, and co-ordinate to each other, we have the types of Fishes, Reptiles, Birds, and Mammals. Each of these groups presents its families,—each family, genera,—each genus, species,—and every species has its individual forms. So would the other Classes admit of being referred to subdivisions of the supposed scheme.

In thus speaking of Classes and other divisions of the animal kingdom, however, we by no means acknowledge the present arrangement to be perfect. The only sure basis for classification is—not structure, as met with in the perfect state, when func-

* Of the *order* in which the various beings were called into existence, we do not pretend to speak.

† Another of the supposed grand divisions may have comprehended *plants*; and this would explain why the resemblance should be so great, between the simplest forms of both. It is obvious, that an inappreciable shade of difference, between two general and crude structures, might occasion divergence to an almost immeasurable distance, in proceeding to the most highly organized and special states.

tion tends to embarrass, but—the *history of development*, at that period when structure presents itself alone ; and, as Von Bär has justly said, this will perhaps " one day become the ground for nomenclature," * as it can be the only one on which to form a correct estimate of parts, in different animal forms.

Certain elements, proceeding from the elements of an individual, or from the elements of two individuals, constitute, by a separate or distinct existence, another individual, a germ ; destined, like its parent or parents, to undergo, by a succession of elements, continued changes in its component parts ; and, by degrees, to attain a state of being, represented by a form, belonging to the parent-type.

These elements, while they constituted part of the parent or parents, shared the state of being, peculiar to the latter. It is then easily conceivable, that, having themselves acquired a separate or distinct existence, the new being they constitute, should contain within itself, properties analogous to those of its parent or parents ; and that therefore, in its progress towards its destined state of being, it should undergo similar changes ; that it should attain the parent-type, and also more or less of individual resemblance to its parent or parents.

The elements of every germ must have innate susceptibilities of a certain definite arrangement ; so that, on the application of stimuli, there results a certain structure.† These we shall in future call, innate susceptibilities of structure, or innate (plastic) properties. All innate properties are of course derived from the parent or parents. If the germ be animal, its leading properties are those characterizing *animals* in general. But it has others, common respectively to the class, order, family, genus, species, variety, and sex, to which the germ belongs. Lastly, it has properties that were previously characteristic of its parent or parents ; in which, indeed, all the others are included. But no innate properties, except those merely *animal*, are at first, to our senses at least, apparent in the structure of the germ.

The sum of these innate (plastic) properties, determines the

* l. c. p. 233.

† The stimuli are those circumstances that produce development ; such as nourishment, a peculiar ambient medium, and a certain degree of warmth.

direction taken in development; determines, therefore, the structure of the new being.

The *general* direction taken in the development of all the individuals of a species, is the same; but there is a *particular* direction, proper to the development of each individual, and therefore a particular structure, not identical with any other; for in no two individuals, is the sum of the innate (plastic) properties in all respects the same.

It has been already said, that as the elements of an individual cease, in turn, to be constituent parts of the same, the identity of that individual must be continually changing—can exist, indeed, at no two periods of time; inasmuch as new elements are continually entering into its constitution, while old ones are departing.

Hence, individual peculiarities in structure must, in their turn, become hereditary to succeeding sets of elements; continually renewed, as we have just asserted these elements to be. There must, besides, continually present themselves, fresh peculiarities; and in their turn, these also must be inherited by sets of elements succeeding.

For the same reasons, the first set of elements, constituting a germ,—proceeding, as already said, from the elements of a parent or of parents,—must possess properties that were characteristic of the latter, at the moment when their separation took place; and can indeed possess no others, since the elements of the parents, and therefore the properties, are continually changing.

Hence it is, that the sum of the innate (plastic) properties can be in no two individuals the same; hence the *particular* direction of development proper to each *individual*; * and hence *individual* peculiarities of structure.

Strictly speaking, therefore, no two individuals of different births can have the same parentage; for though the *individuality* of the parent, or of each parent, does not change, yet, as *individuals*, the parents are continually changing.

The more nearly *cotemporaneous* separation of their elements, and the cotemporaneous derivation of nourishment from the maternal fluids, during fœtal life,—but especially the former,—are perhaps the causes why twins are sometimes so much alike in

* One *general* direction, as said before, being common to a *species*.

individual structure; and *super*-fœtation may be, in part at least, the cause why this is not always the case.*

The innate (plastic) properties include, as already said, some that are characteristic of animals generally, and others common to all the animals contained in that division of the animal kingdom, to which the species is subordinate. Now, the properties characteristic of the parent or parents, at the time of the separation of the germ, must include all of those transmitted to the latter.

This assists us to understand, why properties of the same kind should all, in a modified form, re-appear in the development of the offspring (see second paragraph of p. 137): and, indeed, since it is plain that "every step in development is possible only through the condition preceding,"† that "becoming depends upon having become,"‡ we see why those properties can re-appear in a certain order only; viz. in the order of their generality in the animal kingdom.

Thus, in development, the structure characteristic of the Vertebrata only, cannot manifest itself until there has been assumed, essentially, a structure common to ***animals***,§ of which the Vertebrata are but a part, and to whose type, the type of the Vertebrata is subordinate. In like manner, structures subordinate to the type of the Vertebrata, cannot manifest themselves until after a modified appearance of the *general type*, of which they are but partial metamorphoses. More and more special forms are thus in succession reached, until the one most special is at length attained. ||

* There is, however, another cause why individuals, even of the same birth, should differ: viz. the different periods, at which the maternal portion of the germs may have been first secreted in the Ovary: for, though continually renewed, they must have, in consequence, a more or less peculiar state of being.

† Von Bär, l. c. ‡ Burmeister, l. c.

§ The necessary appearance, first, of a structure common to *animals* generally, affords indeed a principal reason for *supposing that there is essentially but one fundamental form.*

|| *Valentin*, an excellent German author, already quoted, says, "the development of the animal kingdom, and of the individual animal, are in the original idea, throughout, one and the same; but in the realization of single beings, perfectly different, and elaborated in different directions." The latter he conceives to take place in obedience to "metamorphoses" (a becoming more and more special) "of the original idea." Whether such is the case, we do not now inquire; but it is due to him, to acknowledge, that if there be

To the law, requiring that a more fundamental type shall uniformly manifest itself before the appearance of one more subordinate, is perhaps referrible, the formation of parts that seem to answer no other purpose than the fulfilment of this law; viz. parts that either continue rudimentary through life, or not being used, disappear.

An example of the first, occurs in the appendix vermiformis of the caput cœcum coli, in the human subject; of the second, in the embryonal gills of land and air-vertebrata, which latter, having at no period an aquatic respiration, can never use gills.* Development proceeds to a certain point—though this point may differ in different animals—in obedience to the law, requiring that a more fundamental type shall uniformly manifest itself, before the appearance of one more subordinate; so that the special purpose to create Birds, Quadrupeds, and even Man himself, is, as it were, subordinate to the more general purpose, to create a Vertebrated animal. This explanation will perhaps apply to all parts present in a rudimentary state alone. †

any thing like probability in what we have proposed as an explanation of the re-appearance of general characters in individual development, it has, in some degree, resulted from reflection on the contents of his admirable work. —See the last 100 pages of his "Entwickelungsgeschichte," entitled, "Fragmente zu einer künftigen Gesetzlehre der individuellen Entwickelung."

* *Rathke* (Meckel's Archiv, 1827, p. 556.) and *Von Bär*, have described gills, in embryos of Mammals and of Man; *Huschke* (Oken's Isis, 1828, Heft I. p. 2.) in very small embryos of Birds.

† There are, however, certain parts of structure, that arise and disappear, not rudimentarily, for the fulfilment of this law; but to serve purposes required by the temporary relations of germinal and embryonal life. Such are the yolk, and umbilical vesicle, the amnion, chorion, and placenta, or corresponding parts; the gills, fins, and tail in the tadpole, or fœtus of the frog; to which examples, there might be added a host of others.

The metamorphosis of insects, furnishes a beautiful instance of the temporary presence of certain parts of structure, during embryonal life. Instead of an appended yolk, over which the Mucous or Vegetative layer, of the Germinal Membrane, is spread, to imbibe nourishment; that layer, in the larval state, becomes speedily a huge intestine, into which food is taken in prodigious quantity by the mouth. The vegetative process is, in this condition, the main object. But, as the pupal state is gradually attained, growth yields to transformation; and, as Burmeister has well shewn,* the intestine is, in part, metamorphosed into generative organs; which, in the Imago, or perfect insect, give origin to germs, destined to undergo like changes.

* l. c.

It has thus been shewn,

1*stly*, That a heterogeneous or special structure, arises only out of one more homogeneous or general, and this by a *gradual* change.

2*dly*, That the *manner* of the change, is probably the same throughout the animal kingdom, however much

3*dly*, The *direction* (or *type*) and *degree* of development may differ, and thus produce variety in structure; which however, there is good reason to believe, is

4*thly*, In essential character, *fundamentally the same.*

5*thly*, That no two individuals can have precisely the same innate susceptibilities of structure, or plastic properties; and therefore,

6*thly*, That though all the individuals of a *species*, may take, in their development, the same *general* direction,—there is a *particular* direction in development, proper to each *individual.*

7*thly*, That structures common to a whole Class must, in a modified form, re-appear in individual development; and,

Lastly, That they can re-appear in a certain order only; viz. in the order of their generality in the animal kingdom.

It has been our endeavour, throughout this paper, to limit the idea of fundamental unity of structure, to *essential* character alone; specific, and even individual peculiarities,—however inappreciable,—forbidding more. Each germ, even when presenting the merely *animal* type, must do so in a modified and peculiar form; on which the nature of its future metamorphoses depends: and if in the course of embryonal life, there occur resemblances in certain parts of structure, to corresponding parts in other animals, they are no more than *resemblances;* since individualities cannot be laid aside.

There is a danger in the present day, of generalizing too freely;* of carrying transcendental speculation much too far; of being so captivated by " the idea of a subjective unity, that real variety may be lost sight of;—as bright sunbeams veil myriads of worlds, that might shew to mortal man, what they are, compared with his world, and how little he is in the latter." †

* See an excellent chapter on the " Unity of Design" by *Dr Roget:* Bridgewater Treatise; vol. ii. p. 625.

† *Valentin,* Fragmente zu einer Künftigen Gesetzlehre der individuellen Entwickelung, in his Entwickelungsgeschichte, &c. S. 566,

Some Remarks on the Mode of Travelling in Turkey. By Dr A. Boué. (Communicated by the Author.)

There are three kinds of passports in use in Turkey, the *teskeré*, a simple passport; the *bigranti*, of a somewhat higher class; and the *firman*, which is obtained through the traveller's ambassador from the Sultan, and is called great firman. The firman gives the right to have a Tartar as travelling companion and protector. These Tartars are employed to carry the letters and orders, &c. of the government; they have a particular dress, consisting of a dark, violet-coloured short coat, a kind of short petticoat open before, blue Turkish trousers, large boots, partly covered on the upper part with ornamented woollen stockings, and the red high Turkish cap. They form a particular corporation, which is much respected, and they are all inscribed in a book, and distributed over the whole empire, at the residence of every pacha. There they live in a house set apart for themselves, called Tartar-han. As they are thoroughly acquainted with European Turkey, they find friends wherever they go; and their being armed with pistols, and a long hanger, always insures them respect, so that the traveller may rely on them with confidence.

They are in general a good sort of people; and though drinking a good deal of brandy, are always sober when on the road, and only intemperate when arrived at the end of their journey, or when they have plenty of money, and are in a large town.

Their pay is pretty high, being 10 francs a-day; besides which, the traveller has to pay for their return, and for post-horses, at the rate of 1 piastre, or 5 French sous for every hour; but as a post-boy, called *surudju*, is required for bringing back the horses, the traveller has in reality to pay for two horses; a third is taken *gratis*, in case one should die on the road. The Tartar, when on duty, is always galloping, with his whip in his hand, ready to strike the horse of the *surudju*, or that person himself if lazy.

As the Tartars are sober, and live chiefly on onions, garlic, eggs, fowls, lamb, and milk, nobody, I think, before the inexperienced Quin,* was foolish enough to conclude a bargain with

* Quin, author of a Voyage down the Danube.

one for travelling, and the eating on the road. What would a naturalist do with a Tartar, always galloping, and travelling at night. If you make a proper bargain, then, the Tartar is like one of your own servants, and does what you wish, although he never mixes with the servants, and dines alone, to shew that he is greater than they. His title is Tartara, a diminutive of Tartaraga, or Mr Tartar. In several pachaliks they may be hired at a lower rate, even for four or five francs a-day, especially when they are old, or out of service.

The great firman has another advantage, in giving the right to be put into private lodgings by the Turkish commanders in villages, as well as in towns. Now in Turkey there exist a great number of isolated inns, called *han*, or when in small villages *meyhane*. In such inns the traveller generally finds every possible comfort, if he can adapt himself to oriental custom, and is travelling during summer. They have large open galleries, which may be used as drawing-room and sleeping-room, and sometimes apartments clean enough to please even a European, together with the necessary provisions. In the towns and large villages, the inns are often crowded with people; they have no court-yard or garden, and even, sometimes, no large gallery; so that the traveller is obliged to eat and sleep in the same room with others; and it is, therefore, of great consequence to get a private lodging. The traveller, on arriving, either goes at once to the pacha or Turkish commander, or sends his Tartar to him, and is immediately lodged in a house, which generally belongs to a Christian. The Christians are so much accustomed to this regulation, that many have a part of their residence allotted expressly for foreigners, to prevent them seeing their families or wives. There, the traveller orders what he likes, and pays, as at an inn, or if the people are rich, gives the women a present of some pieces of money. Also if he calls on the pacha as a mark of civility, the latter will perhaps have the politeness to send him a dinner from his own kitchen, or hay for the horses, or defray the expense of the post-horses. At all events, he will order one of his inferior officers to conduct the foreigner wherever he chooses, and to watch over his safety. In a very short time the whole city becomes aware that the stranger is a friend of the pacha, and, far from annoying him, all treat him with every possible respect. In getting a private lodging, one should take care that the house be inhabited; for sometimes rich Christians, who dislike such visits, go away from their houses, and leave the traveller without any assistance for making the necessary arrangements for dinner or supper. When this happens, a second call on the pacha, or his *kiaya* or alterego, or sometimes even a civil word to the officer in attendance, will be sufficient to attain the object.

Lastly, as the great firman specifies the object of the traveller, which is not the case with the *teskeré*, it inspires the Turks with perfect confidence. The foreigner goes to the pacha, Musselim or Ayan commanding in the city, takes with him his tartar, and presents his firman to the pacha, who receives it with respect, or even kisses it, and reads it over in a low tone of voice, after which comes the coffee, and the *tschibuk* or pipe; and then is the time for the traveller to ask the pacha for what he wants to forward his journey; horses, guards, hay, barley, or information about the road. Physical instruments, the collecting of plants and minerals, and even drawing, are things which are quite new to the Turks, as well as to the Christian Turks, so that it is necessary to shew in the firman to the people, the strongest proofs that one does nothing contrary to the laws of the Sultan. We should also take care to hide nothing from the people. Every experiment or piece of business must be done openly, and one must always be ready to answer questions. The plants and minerals should be for medical purposes, and for discovering mines, the physical instruments for determining the nature of the climate and the like. No drawing should be made of a Turk when in presence of the foreigner, without his express permission. The secluding one's-self in a room or endeavouring to lock it up, only tends to excite suspicion. In Turkey, the traveller must not pay any attention to people who come into his room from curiosity; the less he attends to them the sooner they will go away. Besides, it is not the fashion to lock up doors as in Europe, and nobody would dare to take the least thing belonging to a traveller, especially to one with a Tartar. Excepting in the great maritime towns and the Greek towns, small robberies are unknown in

Turkey. When the Turks do rob, it is with arms in their hand, on the highway; indeed, it cannot be otherwise in a country where the doors do not shut, and the windows are of paper, with wooden frames. Even the shops are locked in a very miserable manner, and the shopkeeper often goes away, leaving nobody to watch his goods, as the peasant leaves his house with the door open. Bankers have their money in trunks, which are not fastened to the floors or walls, and in wooden houses which could be very easily broken into. The only things which are apt to bring the traveller into scrapes, are, disliking to answer questions, treating people, especially Turks, with contempt or haughtiness, exciting their jealousy, or giving vent to angry feelings. The Turk talks little; it is difficult to make him angry; but when he is so, he is very passionate.

In Turkey many roads are impracticable for carriages; and only a few are good enough for European carriages; it is therefore the custom to travel on horseback, the ladies occasionally travelling alone in bad waggons. The trunks of the traveller are put on a second horse, furnished with a *sèmèr*, or pack saddle, made of wood, with knobs to which ropes are attached. I found short leather trunks the most convenient; and ropes with iron hooks at the ends would probably render the packing more expeditious. The chief difficulty is to distribute the luggage, so that there may be an equal weight on each side of the saddle. Where this cannot be done, the people sometimes use stones as a counterpoise; but this contrivance is apt to spoil the trunks. The price of horses in Turkey is from 80 to 100 or 125 francs; for which last sum a good riding horse may be bought. Their keep costs per day from 10 to 13 sous, and in large towns from 15 to 16 sous.

The horses are fed chiefly on barley; and the pack horses retain their pack-saddle night and day. The horses often lie out in the open air. It is necessary to have for each a woollen cloth, and a bag made of horse-hair, from which they may eat their barley. It is also necessary to have a servant for each pack-horse, or at least two servants for three horses, especially at the beginning of a journey, as otherwise, the horses not being accustomed to each other, the caravan is apt to get into disorder. Servants are not expensive in Turkey, and for that reason every traveller has some. The Servish, or Turkish servants are probably the best, but the traveller must always remember that those people are not accustomed to such activity as our servants. They live far worse, but work less. The usual monthly wages of a servant are 25, 30, or 40 francs; if he has his own horse he is paid 40 or 50 francs; if not, the traveller must get a horse for him, or hire post-horses.

The first plan is preferable, as horses are always easily sold for at least half-price; and, in coming from the north, they will sell in the south for their original price. A servant's living may be estimated at less than one franc a-day. It is essential that one of the servants should know something of cookery; and also all, or nearly all, should speak the Turkish, Servian, or Bulgarian languages. In visiting Greece, a Greek servant becomes necessary. If a number of servants are taken, I would recommend a German or Hungarian one, as, knowing the mode of living of European gentlemen, he would be useful in directing the others. Old German soldiers, accustomed to a hard life, would also be found of service, but fashionable servants should never be taken. If the traveller does not understand oriental languages he must have an interpreter, or, at least, use one of his servants as such. Such men are easily to be found at Constantinople, Bucharest, Belgrade, Salonichi, &c.

In regard to the *money* to be taken,—Austrian money, even the paper-money, will do for the whole of Servia; but in Turkey one loses on the Austrian money, and it is therefore necessary to take golden tkosars of the value of five francs, or the large Turkish talaris, which is only half that value, or five piastres. I need scarcely recommend prudence as regards carrying too much money, or shewing it openly. The best plan is to have circular letters of credit on all the chief mercantile towns; and these should be written, not only in an European language, but also in Greek and Servian.

The traveller must have as little *luggage* as possible. The first thing requisite is a bed, consisting simply of a strong and thick carpet, or a Hungarian *bunda* (furred robe), or, what is still better, a small mattress made of horse-hair, with a small pillow and a woollen cover; the whole capable of being rolled up and put into a linen bag, after having been bound with leather strings. To these may also be added two bed-sheets, or two sheets fitted together like a sack. In winter time the furred robe may be advantageous, but in summer insects are apt to take up their abode in it. Straw, and particularly hay, are found in most places, so that, with that addition, one sleeps very comfortably on such a bed as I have described; and, if the weather is cold, the traveller may add his horse's woollen cloth. A small iron bed-stead appears to me to be quite useless. As Turkish etiquette requires but little attention as to dress, a traveller should take care not to overload himself with clothing. The riding-coat is the common dress for every purpose; and the dress-coat is scarcely necessary, unless in the maritime large towns. I would also recommend warm, as well as light, trousers and vests, and a warm riding-coat, because the temperature is variable in the hilly parts, and the medium temperature is often not so high as one would expect in such latitudes. The north-east wind is very cold, and marks well its origin. I found, in summer, a light short jacket a most comfortable dress on horseback; and it is also much used in cities during the plague. The best defence against rain is a larger waterproof cloak, or, if one prefers it, one of the heavy, thick, woollen cloths which are used by the Turks. The green pale colour, which is peculiar to the Turkish priests, is to be avoided, either in dress, or for umbrellas. If one wishes always to have clean shoes, it is necessary to carry shoe-blacking, as it is still unknown in most places. Duplicates should be taken of all kinds of physical instruments, spectacles, pencils, colours, &c., as few of these can be replaced or repaired in Turkey. In all Macedonia I could not even find spirit-of-wine for my hygrometer. It is convenient to carry a small tin pot for making coffee or tea, an iron kettle for making soup and boiling meat, a small iron frying-pan, a large spoon, a pocket apparatus, with spoon, knife, and fork, and a pocket leather-cup; for although all such things, excepting the knife and fork, are generally to be found in the Turkish inns, they are sometimes awanting, or other people may already have used them; besides which, one is thus enabled to cook in a more cleanly manner. A fire apparatus, with some wax candles and a candlestick, is also useful; for people often use, instead of candles, resinous wood, or even kindled hay, which gives very little light.

Europeans may find it easy to dispense with chairs, and to employ instead of them their bed, a stone, a square piece of Wallachian salt, or low Turkish stools; but this is not the case in regard to a table when one is obliged to write. I should therefore recommend the traveller to take along with him a small portable iron table, consisting of five iron rods, four being fitted together, two by two, in the manner of an inclined cross, and the fifth serving to attach together both the crosses. Such an apparatus is easily fitted to every Turkish round table or *sofra*, which is never more than four or five inches high. Some towels are also necessary, as well as a small provision of tea, coffee, rice, sugar, raisins, and the like. In this way the traveller can find something to eat everywhere, and he can establish his *bivouac* wherever he likes. It is a good precaution always to secure before departing the meat necessary for the next dinner or supper, such as fowls, lamb, &c. then, by sending it on with one of the servants, or the Tartar, to the inn, so that he may reach it an hour or two before the rest of the party, they enjoy the pleasure of finding their dinner ready, and are not obliged to wait till the meat is sought for and cooked.

The Turks eat at eleven in the morning, and at six or seven in the evening. The common meats are, all kinds of poultry, lamb, either roasted or cooked as a *ragout*, or made into a soup with rice; sometimes it is roasted whole, with rice, hashed meat, or liver, and red Spanish pepper in its inside; the *pillaw*, or rice with butter, fat, or milk; a kind of cake or tart of herbs and eggs called *pita*, salad, raisins, grapes, excellent acidulous milk or *jaghur*, &c. Good milk is found nearly everywhere; but as the Turks take coffee without milk, you must always order, the previous evening, the milk for the next morning's breakfast, as otherwise it would be made into cheese or *jaghur*. There are still various *hachés* or *ragouts* prepared with butter, jaghur, or Spanish pepper, *hachés* of the leaves of plants, the *sarma*, and many sweet dishes, such as eggs and milk mixed together, and fried; the *halva*, a kind of glutinous food with honey, stewed fruits, good comfits, and various fruits, amongst which the melons, water melons, and grapes, are the only ones which are better than in other parts of Europe. They have some vegetables which are unknown in Germany and France. It is easier to live well with the Turks than with the Christians, for those of the Greek religion often have fast-days, or even weeks; however, Europeans should not care about this strictness, but, even in convents, should, like the Turks, order meat, and other necessary things, especially as they do not know how to cook salt or fresh fish properly. Excellent red wine, not at all sour, like Quin's pretended Hungarian wine, is found everywhere.

The best months to travel in Turkey are from April to October; for, in winter, the roads are bad in many places, and sleeping in rooms with paper windows is unpleasant. In the Archipelago it may perhaps be different. As for the plague, it is less prevalent in winter and in spring than in autumn; it seems to be always at Constantinople, although not at the neighbouring towns where Christians live. In Macedonia, it is said to happen rarely, only once in twenty-five years, as is alleged. This year it was there, and in various towns. The Turks are still ignorant of the proper means to extirpate this disease, which, like the cholera, attacks chiefly the lower class of people, those who are dirty or intemperate. We saw two towns, Köprili and Tenishe-Vardar, surrounded, by order of the Sultan, with a military cordon, so that nobody could either go in or out; rather a singular way of preserving the lives of those who had not yet been attacked by the disease. The consequence was, that in other towns, the people took great care that the governor should not know of any of the cases of plague which occurred in them. The plague was at Dubnicza in August, owing to the clothes of a Tartar, who had died there, being sold to the Jews. Yet travellers must not fear this disease; it is customary to go round about and avoid infected places; and the cholera is worse, from being liable to attack one anywhere. It is therefore advisable to carry proper medicines for these and other violent diseases. In Turkey one finds very few medical men; the pachas have generally some Jew or Turk, who is rather a *charlatan* than a *hekim* or doctor. Indeed, there is no opening for a physician in Turkey, as the sick call them in only for old chronic diseases, whilst for dangerous maladies they only take the advice of women or quacks, and too often die without any advice at all. Surgeons are still rarely to be met with; even in Servia there is a great want of medical men, and the government have ordered many *kreis doctors* (physicians for a district of country), and surgeons, but the individuals are still awanting to fill these offices. In Turkey good physicians are only to be found in the chief cities, Smyrna, Salonichi, Bucharest, Constantinople, Belgrade. A medical school in Turkey, as well as in Servia, would be a most useful institution. At present the army physicians in Turkey are chiefly European gentlemen. Sending Turks or Servians to European schools will never be of the same benefit as medical schools in those countries themselves.

The European, on arriving in a town where European consuls are residing, should put himself under the protection of the consul of his own nation; so that, if he remains for some time, he may be exempted from tribute. The post is still in a very imperfect state throughout Turkey, and the Vienna post is the only regular communication between Germany and Turkey, so that the consuls' houses are the places where the traveller will be likely to find news from home.

Lastly, I may speak of the robbers who are said to infest Turkey. I do not know how it was formerly, but now there are almost none, or, where there are suspected to be any, stations of soldiers or *gendarmes* are placed, although these, perhaps, should sometimes be stronger. The only parts where one is likely to be robbed at present in Turkey, are, the north-west part of Bosnia, where the new regulations of the Sultan, the new military dress, &c. find many enemies; also the limits of Thessaly and Greece, where Grecian robbers are said to infest both sides. But even in these last countries, as in the Olympus, it is possible to travel with a good escort, and the advice of well-inclined pachas. In other parts of Turkey where I was told there were robbers, as in Albania, I suspect they were only men exasperated by bad treatment, and not able to get justice, or governed contrary to their customs, who revenged themselves by killing the soldiers of the pacha, although they did not, on that account, attack peaceable travellers.

In some parts of Albania, where the pacha's officers said that the pacha's authority was very little respected, I heard the people say that the *Ghiaurs* or Christians had now the power, and that it was necessary to submit to them. Servia, through the admirable strictness of Prince Milosch, has been rendered as secure as any civilized country; and one may travel day and night through the vast forests of that country, without any danger. I must add that Turkey is far from being, like Spain, favourable to robbers; for if in Spain one finds many towns or large villages, and few isolated farm-houses, the contrary is the case in Turkey. Besides, the slave population in Servia and Bulgaria, are a good race, and well disposed to European travellers. The Turks also, are the same, although less communicative. The Albanese are wilder, but yet not at all a bad people, especially when one knows their language. The Greeks, however, are cunning, and often employ their cunning for bad purposes.

By following my advice, and taking proper precautions, one may be assured of making a pleasant and comfortable journey in Turkey, without the least danger, at the rate of twelve francs a-day; but if one hurries into that country in the same foolish manner as Quin, without servants or interpreter, and ignorant of the language; if he will not live like the Turks, but ask for tables, beds, potatoes (which are scarcely known in Turkey), and veal (which is not used there); if he feel himself only happy in London and Paris, he will bring from Turkey very singular fancies, like our friend Quin,* and it would be better that he had remained at home with his tea and toasted bread. I should be happy if these lines should induce some Englishmen

* I was much amused with the political views of Quin on the regeneration of the Turks, and his idea that the Roman Catholic religion would soon prevail in Turkey, and the like. But his fancy of a canal being cut from Panchova to Cladova, through the hills of Servia, to avoid the rapids of the Danube, reminds me of the Frenchman who was travelling in Switzerland, and who, being annoyed by the number of mountains, asked why the Swiss did not entirely level their hills! His fear of walking alone near Moldawa, because the dress of the Wallachians was unknown to him, is a sure proof of his ignorance; for that country is as safe as the neighbourhood of London, or more so, and even the umbrella was not necessary, Quin's work owes its success to the novelty of the voyage, and some good descriptions of the customs and dress of the Turkish people.

or naturalists to follow my steps, and assist me to throw, at last, some light upon the topography and natural history of that beautiful empire, European and Asiatic Turkey, to the investigation of which I have devoted the remaining best days of my life.

A Lecture on the Phenomena of Metalliferous Veins; delivered at the Penzance Institution, on Tuesday the 10*th of November* 1836. By W. J. Henwood, F. G. S. London and Paris, Assay Master of Tin in H. M. Duchy of Cornwall.

The Chairman, Dr Boase, Secretary of the Royal Geological Society of Cornwall, opened the proceedings by stating, that, having himself given a lecture on Geology generally, it was intended to take the various departments in detail. In course, it would have been his object to have described the primary, or non-fossilliferous rocks, leaving the subject which would form the present evening's lecture to follow it. But the question of the origin of veins, had been recently taken up by Mr Fox, and having deservedly attracted so much attention, it had been thought advisable to follow it up whilst the impression remained. Mr Henwood had, for several years, been engaged on the subject, and had inspected most of the mines in this and the adjoining county; the results of his labours were in a state of forwardness, and would shortly be before the public, in the fifth volume of the Royal Cornwall Geological Society's Transactions.

The Lecturer said that it had been originally his intention to have refrained from publishing any of his observations, or the views to which he had been led by them, until he could do so in a connected form; and in this determination he had for some years persevered. Finding, however, that views from which he almost entirely dissented, were before the public, on the high authority of a gentleman for whom he had the greatest respect, and to whom he felt himself much obliged, he had thought it might not be improper to give an outline of them; and he felt the more satisfaction in doing so, as he believed they were in unison with the opinions of almost all the practical men of this county.

Before, however (he continued), we proceed to inquire into the origin of mineral veins, it may not be out of place to inquire "what a mineral vein is?"

"Veins or lodes," says Mr Burr, "must be understood to be the contents of what have been originally *cracks* or *fissures*, traversing rocks longitudinally, and descending into them at various angles with the horizon, but usually much inclined."

Mr Carne says, "By a *true vein*, I understand *the mineral contents of a vertical or inclined fissure, nearly straight, and of indefinite length and depth.* These contents are generally, but not always, different from the strata, or the rocks which the vein intersects. *True veins* have usually regular walls, and sometimes a thin layer of clay, between the wall and the vein; small branches are also frequently found to diverge from them on both sides. *Contemporaneous veins* have been usually distinguished from *true veins* by their shortness, crookedness, and irregularity of size, as well as by the similarity of the constituent parts of the substances which they contain, to those of the adjoining rocks, with which they are generally so closely connected, as to appear a part of the same mass. When these veins meet each other in a cross direction, they do not exhibit the heaves or interruptions of *true veins*, but usually unite. When they meet *true veins* they are always traversed by them."

Mr Burr remarks, "*Contemporaneous veins*, or veins of *segregation*, which appear to have resulted from a chemical separation of certain mineral and metallic particles from the mass of the enclosing rocks, while yet in a soft or fluid state, and the determination of these particles to particular local situations.

Playfair, the great illustrator of the Huttonian theory, observes, "veins are of various kinds, and may in general be defined separations in the continuity of a rock of a determinate width, but extending indefinitely in length and depth, and filled with mineral substances different from the rock itself. The mineral veins, strictly so called, are those filled with sparry or crystallized substances, and containing the metallic ores."

Werner defines veins to be "particular mineral repositories of a flat or tabular shape, which in general traverse the strata of mountains, and are filled with mineral matter, differing more or less from the nature of the rocks in which they occur." He adds, "all *true veins* were originally and of necessity rents open in their *upper* part, which have been afterwards filled up from *above;*" he continues, "the vein, *after its first formation*, may have been *again opened* up," and he considers the parallel layers, of which veins sometimes consist, as the deposites after such successive openings.*

Professor Sedgwick says, "In all the crystalline granitoid rocks of Cornwall, there are also many masses and *veins of segregation.* Such are the great and contemporaneous masses and veins of schorl-rock; and some of these are metalliferous. The decomposing granite of St Austell Moor is traversed, and sometimes entirely made up of innumerable veins of this description. Upon these lines of schorl-rock there is often aggregated a certain quantity of oxide of tin, which diffuses itself laterally into the substance of the contiguous granite." After having examined it, he "left it with the conviction that several of the neighbouring tin-works were not opened upon *true lodes*, but upon veins of segregation."

In my own opinion, however, the best description of the *veins of this county* (and of these alone unless the contrary, he expressly said, I beg to be understood as speaking) is given by Dr Boase, in his valuable memoir on the geology of Cornwall, in the fourth volume of the Cornwall Geological Society's Transactions. I concur most fully in every one of his statements; and the nature of the relations between the veins and their containing rocks, are so well described, that were I to attempt one of my own, it would be but a repetition of the same ideas.

"The veins of Cornwall have no determinate size, being sometimes very narrow, or exceeding several fathoms in width, extending sometimes to a great length and depth, or terminating after a short course in either direction. As regards their form, they are occasionally, though rarely, contained within parallel and regularly inclined sides or *walls;* but are continually varying in width, both on the line of their course and of their inclination, partaking often of the same undulating, and even curved, form of the rocks which they traverse; moreover, they are accompanied on either side by innumerable branches,

* *Vide* Dr Anderson's translation of Werner's classical work on Veins, 8vo, pp. 259. Edinburgh, 1809.

which extend in various directions. And, lastly, a parallel series of veins frequently meets a cross vein, either on the line of its course or of its depth; some of these veins continue their direction on either side of the cross-vein, whilst others on the opposite side of the cross-vein abruptly disappear, on the line of their original course, and are often found at some distance therefrom, but running in a parallel direction.

"On a small scale, as in the granite of Carclaze, and in the slate of St Agnes, these branched and intersected veins are beautifully illustrated, parallel ramifications may be seen departing from either side of the veins, and in the case of intersected veins they sometimes preserve the same course on both sides of the cross-vein, but often exhibit the peculiar arrangement called by the miner *a heave*.

"Veins vary very much in their composition; in general they consist entirely of earthy minerals, which, indeed, even when the veins are metalliferous, constitute the greater part thereof, the ores seldom being continuous for any considerable distance, but being scattered and disseminated throughout the matrix in short irregular veins, layers, bunches, granules, crystals, and smaller forms; sometimes, indeed, but rarely, except in very small veins, the ore entirely prevails."

The prevalent idea of Cornish *lodes* is, I believe, rather imperfect, and those who suppose veins to have regular walls, and to have been derived from fissures, would not recognise as such layers of schorl-rock, of porphyry, of hornstone, and even of granite itself; but these are called lodes by the miners (Mr Carne states, that in Huel Unity, the *elvan* is so rich in tin, that it is considered as the *tin lode*) when they abound in metallic minerals. Even the most regular tin and copper *lodes* are very complex in their composition, quartz generally prevails in their matrix, but is always more or less blended or mixed with a substance similar to the adjoining rock; indeed, the latter often occurs in distinct forms, as nodules, angular pieces, and even masses of considerable size, which are independent of the main rock, being completely enveloped in the quartzose part of the lode. These are of such common occurrence as to have been named by the miners *horses of killas*. Sometimes the schist so abounds in the *lode* that the quartzose part altogether disappears, or is only continued in minute strings; in this case the *lode* is said to have *dwindled away*, or to have been *wrung out*. It also frequently happens that both these principal parts (the rock and the quartz) are intimately united, producing a siliceous layer of rock, which is still metalliferous, and is commonly called the *capel;* hence the courses of schorl-rock, porphyry, and some anomalous rocks, which have been called by the miners *elvans*, have been properly considered by them to be analogous to *lodes*, for they are in fact veins on a larger scale.

"It has been already stated that the *elvans* pass by gradual transitions into the adjoining rocks; and it may be mentioned, that the same intimate connection which subsists between the quartzose part of veins and the included portions of slate (*horses* of killas) also obtains between the veins and the main rock. I have invariably found that this phenomenon is common to the metalliferous veins of Cornwall. This fact appears to explain why the matrix of lodes bears a relation to the containing rock; and why the metallic contents of *lodes*, in like manner, vary both in their nature and quantity.

From the same authority, in his valuable "Treatise on Primary Geology," we learn that large metalliferous veins, like the lesser ones, which are confined to rock concretions, though they may sometimes appear to have walls or way-boards, yet these are not essentially necessary, being often only found in certain parts of the veins, and may therefore be attributed to accidental circumstances, such as the peculiar manner in which the substance of the lode was aggregated; the occurrence of a smaller vein of a different mineral, parallel and sometimes coincident to the sides of the larger, but far more frequently to the subsequent formation of seams or fissures, by the alternation of the rock at the junction of the veins resulting from decomposition, the effects of the percolation of water, or of the action of the elements. How can we otherwise account for the fact, that many parts of those veins, exhibiting what have been called regular walls, are intimately connected with the adjacent rock, not only as it were by a mechanical union, but often by a transition of mineral composition, so that in granite the union is generally effected by the rock becoming gradually more and more quartzose, and in the slate it is also accomplished by the latter undergoing a like change? Sometimes, indeed, the vein itself, at these points of union, appears to partake of the nature of the containing rock; but much more commonly it entirely includes portions of the rock of various dimensions, according to the size of the vein.

These *horses* are of the same nature as the contiguous rock, being slaty when the *walls* of the vein are slate, and granitic when they are of granite.

As a general fact, though, with many exceptions, it may be said that tin ore prevails in the granite, and copper ores in the slate; notwithstanding it may, perhaps, be true, that the largest *single* masses may have been found in the opposite rock, of tin ore in slate, at Wheal Vor, and of copper in the granite, at Tresavean; for example, a pretty fact of the prevalence of different ores in various rocks, I noticed in Botallack. There were two or three alternations of granite and slate of no great extent; the *lode*, when in the granite, contained tin-ore, and when in the slate, copper. Indeed, it is a very well known fact, that the same vein is seldom productive in two different rocks; thus the immense mass of tin-ore, I believe more than a million sterling worth, in Wheal Vor, was in slate, whilst the same vein is entirely unproductive in the granite. The adjoining mine of Great Work gives all its tin-ore in granite, and is poor in the slate. Again, the *lode* of Tresavean yields its copper-ores in the granite, being worthless in the slate; whilst the neighbouring mines have given almost the whole of their copper in the latter. These respectively are on parallel veins. There is a prevailing proverb of "ore against ore," meaning that in the same neighbourhood there is a greater probability of it in parallel veins, near the same north and south line, than eastward or westward, even on the same vein.

It has been already quoted, that even the richest metalliferous veins contain, compared with their total mass, but a small proportion of ore, and that this is irregularly distributed. These masses are called *shuts* or *shoots*, and appear by their dip in the vein as if obedient to some influence of the granitic masses in their vicinity, always dipping *from* and seldom *to-*

wards them; indeed, I have not met with an instance of the latter.

It is also one of the most generally recognised facts, that veins of copper or tin ore, are more productive when perpendicular than when inclined, and that when a change of dip takes place, it is almost immediately succeeded by an alteration in the contents of the lode.

I am disposed to suspect that grey (vitreous) copper-ore occurs more generally in granite and massive slate-rocks than in the schistose rocks; and that the copper-pyrites is most abundant in the latter. I am, however, aware, that there are many and considerable exceptions.

It is by no means uncommon to find masses of ore close to cross-courses.

But the *elvan courses*, of which I have already spoken, are supposed to play no insignificant part in the economy of the metalliferous districts. They are frequently several fathoms in breadth, and are chiefly composed of a basis of felspar and quartz, containing imbedded crystals of both these minerals, and frequently of many others. As a general rule, they are intersected by the metalliferous veins, cross-courses, &c., but they are seldom *heaved;* a case, however, of an elvan course *heaved* by a flucan, occurs at Swan-pool, near Falmouth, and has been well figured and described by Mr Thomas; whilst at Polgooth the *elvans heave* some of the *lodes*. In the vicinity of these veins, many of our mines have been very productive; of tin, at Polgooth, Wheal Vor, and the Wherry; and of copper, at the Consolidated and United Mines, Ting Tang, Treskerby, Dolcoath, Wheal Alfred, Wheal Fortune, &c. At the Battery Rocks here (Penzance), at Swan-pool, before mentioned, and at St Agnes, the *elvans* are beautifully shewn on the coasts.

Having now briefly described the contents of the lodes, and the composition of the elvans, which vary too in their composition, whether they occur in slate or granite, we have to see of what the *cross-courses* consist. They are generally of quartz, which is often of a peculiar radiated structure, with abundance of clay; and when the latter prevails, they are called *flucans*. *Cross-courses* and *flucans* change their character very frequently; depending also on the nature of the rock they traverse. *Slides* are often veins of clay only; but they often also become quartzose, and sometimes, as in some at St Agnes, they are metalliferous.

The *directions* or bearing of the greater number of *metalliferous veins* in this county, are within a few degrees of magnetic east and west; of the *slides* nearly the same; the *elvans* are generally rather more to the south of west and north of east than the *lodes;* whilst the *cross-courses* and *flucans* bear within a few degrees of north and south. There is, however, a metalliferous series of veins, the *contra or counter lodes*, which have a direction of about north-west and south-east; whilst the *lodes* of the parish of Saint Just are about north and south, and the *cross-courses* or *guides* about north-east and south-west.

It is a general fact, that there are seldom or never *in the same district* two metalliferous series at right angles to each other.

The rocks, too, are traversed by lines of symmetrical structure, the (queres), which have a kind of rough approximation to the directions of the veins; one of the principal sets bearing about north and south, whilst a second stands about east and west, and a third is nearly north-west and south-east.

This coincidence, so far as I know, was first alluded to by Dr Boase, who says, " it has often struck me that the large veins correspond with the seams of the layers of rocks, and the smaller ones with those of the component blocks and laminæ of these layers; I have repeatedly detected this coincidence." The subject has recently attracted the attention of Professor Phillips, Professor Sedgwick, and Mr Hopkins, and all these excellent observers have given details of great value.

Whether these be synchronous with the rocks themselves, or of posterior origin, has lately been discussed by Dr Boase and Mr Hopkins; the former maintaining the affirmative, the latter the reverse. It is well known that these lines traverse, often without interruption, the granite, slate, elvans, and veins; although sometimes the same want of coincidence, which, in the case of *lodes*, is called a *heave*, is observed. It is, I think, clear that, if produced in the slate by any dislocating elevation, the *lodes* must have been contemporaneous with that movement, if not anterior to it; for it is scarcely possible to think that any which had existed in the rocks previously to the formation of the veins, would have been prolonged from each side through the latter with such exactness. It cannot be doubted that the contemporaneity of veins very much simplifies any idea of their origin.

When two veins, having different directions, meet *horizontally*, one often intersects the other, the portions of that cut through, not being found exactly opposite each other, on the different sides of the traversing vein, but by turning either to the *right* or to the *left* hand. The *right* and *left* hands are familiarly employed by practical men in preference to the points of the compass, as, on whichever of the divided portions we approach the intersecting vein, the *heaved* segment will be found on the same hand.

When veins intersect vertically in *descent*, this want of coincidence is called a *slide;* a few of these occur in many parts of the county, but they are most common in St Agnes and Gwennap; whilst the *heave* is of almost universal occurrence, being found of greater or smaller extent in every mining district of Cornwall.

A little consideration of the phenomena will shew that the latter may occur *alone*, if the veins have a horizontal parallelism, and the former *only* if *horizontally* at right angles; whilst, if there be any intermediate directions, at certain points in their extent, one, and at others, the other of them will obtain.

A great point in dispute is, were these opposite portions ever united? it being an axiom of Werner's, which has been adopted by all the advocates of these originating in mechanical disturbance, "*that a vein which is intersected or traversed by another vein*," "is older than the vein by which it is traversed."

In this investigation we are not to consider that the phenomena in question are their own explanations, or that the fact of an intersection is *a proof* that they were ever united; it is evidence of an independent nature we require.

My distinguished friend Professor Phillips says, "How can the geologists of Cornwall doubt the reality of those angular movements, which have left such clear evidence as the fine slickensides of some of their veins or fissures?"—If this acute observer had enjoyed such facilities for examining these as I have, he would have remarked that, polished as they are, they are very irregular, and that the depressions are equally bright with the elevations; the striæ, too, are seldom parallel, and on opposite sides of a vein they have often reverse dips; it is by no means unusual to see them curved, contorted, and irregular as a piece of crumpled paper, intersecting each other in all directions. I think it will be allowed that this is not "clear evidence," or if so, at all events not in favour of motion. The earthy contents of *lodes* and *cross-courses* present the same glittering and striated faces, and with like complications, with still greater frequency.

Following the idea of intersection being an index of the ages of veins, Mr Carne, some years since, attempted a classification of Cornish veins, of which he made eight different ages,—older and newer tin lodes; old, newer, and newest copper lodes; cross-courses, cross-flucans, and slides: the exceptions given in his instructive publication are, however, as numerous as the cases on which the subdivision is founded.

The great argument in favour of the mechanical displacement is supposed to be derived from the accordance of facts, with what would obtain were an *elevation* of the *one side* of the traversing vein to take place. This ingenious idea, so far as I am conversant with its history, was first propounded by a German geologist (the late Herr Schmidt), and was long since submitted to mathematical analysis by Zimmermann, in his publication "Gänge, Lager, and Flötze;"* and lately Mr Hopkins, in his "Researches in Physical Geology," has placed it in an English dress. So long ago as 1831, I submitted an outline of it to the Geological Society of London, which, I believe, was little noticed; I shall again speak of the contents of the paper in which it was inserted.

It is not easy to explain, unless at great length, by words alone, or even with diagrams, the results of motions on given planes of systems of lines not coincident; but models of Herr Schmidt's contrivance have been constructed, which beautifully and simply illustrate his theory. We will suppose two *lodes*

* The precise title is "Die Wiederausrichtung verworfener Gänge, Lager & Flötze. Von Dr Ch. Zimmermann." 8vo, pp. 204, with six plates. Leipzig, 1828.

nearly parallel in direction, but having opposite dips towards each other in descent, giving a large V on the end view; fractured nearly at right angles to their direction, and the portion on one side of the fissure to be elevated vertically. It is plain that the *lower and narrower part of the* V *on the elevated side, will be brought opposite the upper and wider portion of the letter on the unmoved side.* Let us then imagine all the portion elevated above the former surface to be removed, and take a view of the horizontal plan presented, we have the fissure representing a *cross-course,* and one of the fractured veins will be *heaved* to the *right,* and the other to the *left.* If both veins had dipped the same way, it is obvious they would have been heaved the same way; whilst, if the line of elevation, instead of being vertical, had been coincident with the dip of one of the veins, and the two were not parallel in dip, one vein would be merely intersected, whilst the other would be *heaved.*

This beautiful and ingenious illustration exhibits very satisfactorily that, if the dip be irregular, so, in proportion, will be the distance of the *heave.*

It is also evident that these *are not only possible, but* INEVITABLE *results;* and that, if two veins having opposite dips be displaced by the same vertical motion, it is "*physically impossible*" that they can be heaved otherwise than towards *different* hands. The object of my already-named communication to the Geological Society was to shew that this county afforded instances inexplicable on any one simple motion assumed; but, for reasons with which I was never made acquainted, this paper was kept by the officers about a year, before it was read to the Society. Professor Phillips says, "Several remarkable cases which occur in the mines of Cornwall have been simply explained by Mr Lonsdale." I presume those I gave are intended; but it would have been desirable to have known what number of them was left unexplained. Moreover, we are, I think, restricted rather within the limits of bare possibility, and tied to probability too; are the motions required for simple explanation likely? Is there any evidence of their occurrence but their convenience? For, if allowed to assume motions of any masses, by any forces, to any distances, and in any times required, our limits will be indeed extensive.

We will now see how nearly this most beautiful theory coincides with the facts. In Cardrew Downs, Wheal Trenwith, and Wheal Bolton, parallel *lodes with different underlies are heaved the same way, by the same cross-course.* Such things, with a vertical motion, are *totally at variance with it.* But let us see if oblique motion will help us: At Dolcoath (a beautiful fact kindly pointed out to me by Captain Petherick) an *elvan* course and two veins dip northward; all three are traversed by a *cross-course,* the two veins are *heaved different distances but both to the right; and one of them is heaved from the killas into the elvan, whilst the elvan itself is not heaved;* whilst still continuing northward *the same cross-course is itself heaved by an east aud west vein.* It is clear that an oblique motion on the line of the dip of the unheaved vein *(the elvan)* will not satisfy all the conditions.

In the same mine the same intelligent gentleman describes a case recorded by Mr Fox, where one *lode heaves* another at one depth, whilst, at a different one, it is itself intersected by the same vein which it had *hove.*

Slides are supposed to be the results of similar movements shewn on a transverse section, and *primâ facié,* the want of coincidence is far more striking. But have we any greater evidence of *mechanical* disturbance than in the preceding case? In the well known section of Wheal Peever we have one case of the vein in the hanging wall being the *lower,* and two of the same wall being the *higher.* In Mr Carne's section of Treskerby, the hanging wall, in four cases, seems the higher; whilst in Trevannance (from the same authority) we have five cases of the contrary. In Herland there is a fine case of the *foot* wall being the lower, and in South Wheal Towan, where the contrary obtains, the *slide* in one spot is split into two, and a portion of the vein is contained between them; whilst, above and below, these unite and form one vein only. There appears no greater harmony here than in the cases of *heaves.*

Professor Phillips well remarks, "It is, besides, no argument for one theory that another is beset by difficulties which are left unexplained in both." Having, however, stated these objections to the prevailing theory, it is not the point at issue for its advocates to shew that any hypothesis I may have, if I have one, is equally objectionable; but it is for them either to shew how their theory applies to any facts; or, if a theory we must still have, to modify the existing one so as to embrace them.

We know, however, as was well stated by Mr Grylls, at Redruth, in remarking on Mr Fox's excellent lecture, that the same phenomena are exhibited in hand specimens, the same apparent *heaves and slides*, is it contended that these are also mechanical disturbances?

I must conclude this brief notice of the phenomena, with expressing my inability to lay down, or to concur in any diagnostic characters of the small veins of this county, which are not equally applicable to our great metalliferous systems.

We now come to the consideration of the theories which have been propounded for the explanation of the *origin* of mineral veins, and here I hope I may be permitted to pay my humble tribute of admiration and respect for the illustrious *Werner*. His views of the origin of many rocks have been rejected, his opinions of the filling of veins have in many cases been abandoned, but his idea of the veins having originated in fissures has been adopted by all his successors. Strictly speaking, I believe the notion of cracks had its origin as far back as Agricola; but Werner in geology, like Newton in physical astronomy, combined and collected all the beautiful fragments elaborated by his predecessors into a structure, objectionable, perhaps, in some of its arrangements, but in the department of which I am now speaking, so far beyond any thing that I believe, without his labours, even the present day would erect, that whether our veins be large or small; of sudden or progressive formation, of *horses* and their supports, all the leading views, and all the principal phenomena described by him, have been adopted by successive theorists.

Fissures being, then, the common postulata of all the theories, excepting of that of the practical men of this county, and which supposes the contemporaneity of the rocks and veins, let us proceed to an examination of the grounds for the assumption.

Werner, imagining all rocks to have been originally deposited from aqueous solutions, says, " the shrinking of the mass of a mountain produced by desiccation, and still more by earthquakes and other similar causes, may have contributed to the formation of veins." Hutton thought that elevatory forces acting from beneath, originating in paroxysmal protrusions of liquefied matter in the interior of the earth might have caused them. It has also been supposed that the earth may have been originally in a state of igneous fusion, and that as its temperature diminished, the external crust would crack during its cooling. Mr Hopkins has investigated mathematically the results which would obtain in a homogeneous mass acted on by an elevatory force, and concludes that it would induce "two systems of fissures with a certain general approximation, subject to certain modifications to rectilinearity, and perpendicular to each other." Those at intermediate angles must therefore have originated at different times. Were each system to have been completed at one paroxysm—we should have many such; but where we have, as in the metalliferous districts of this county, veins in every direction, which both Mr Hopkins and Mr Fox think may have opened "gradually or at intervals;" many of them many times "opened up" the elevatory forces, must have been almost continually at work on one system or another. But Mr Hopkins has shewn that *parallel* systems of fissures *must inevitably* have been synchronous. Now, in many of our mining districts the *lodes* form no inconsiderable portion of the whole mass of the earth;—often, indeed, between two, the rock is not very many times wider than one of them; what would have kept open these thin masses of rock, usually much inclined "and of indefinite length and depth?" The *horses* (in the north they are called *riders*), replies the advocate of fissures. Why, then, I reply, do we find no portion of the upper rock (killas) fallen into the subjacent granite? and why are the *horses* entirely surrounded by the vein; for until the substance of the vein was deposited what supported it? Werner, Mr Hopkins, or Mr Fox replies, at first it was a mere crack or narrow fissure kept open by the rubbish falling. I rejoin, if we must have a crack and props to keep it open, is it more difficult to keep abroad a wide than a narrow fissure? If we must support the same weight, may it not be as well kept a yard as an inch apart? Mr Fox has said, "veins are often divided into branches, which unite again at considerable depth, including between them vast portions of rock, perfectly insulated by the ore or vein stones from the general mass; these, it is evident, could not have existed as fissures for a moment."

I select Mr Hopkin's excellent results as tending to bring the theory of fissures within the dominion of exact science; rather than the equally ingenious opinions of some other gentlemen, not based on such unexceptionable investigations as his mathematics.

We now approach the last division of our subject, *the filling of the fissures*, and here we again meet Werner, Hutton, Professor Sedgwick, and Mr Fox.

It has been already seen that Werner thought veins were filled from above; his proofs may be all comprised in the occurrence of masses of the contiguous rocks, and of round stones in the veins. It has been seen that these contained masses always resemble the rock *at that spot* in contact with the vein and not of *superior* rocks. In this county the well known Relistian *lode* has been often quoted. But whoever will examine the *walls* of this vein, will see that a very similar structure prevails in the rock itself. Nothing is much more common than a spheroidal concretionary form; in the *elvans* it is frequently very well shewn on decomposition. I have seen some of the best cases at Tresamble, in Gwennap. In the granite, too, we observe similar nodular concretions," of dark colour, and fine grained, and which, " indeed, if sufficiently abundant to predominate over the containing rock, would exhibit a conglomerated structure. In the globular granite of Corsica, however, we have a noted example, in which the constituent minerals are arranged around certain centres, in concentric laminæ." We see therefore that *rock masses*, which, by the common consent of geologists of all opinions, are attributed to no derivative origin, possess the same conglomerated structure. I know of but one case in this county in which I should consider the filling up of a vein to have been mechanical, this is the Badger *lode*, in the Herland Mines, and where we have rounded and angular pieces of granite, slate and elvan, imbedded in the same felspar clay. In the secondary rocks, however, which Werner studied, it is not uncommon to find even organic remains in the veins; that these are of posterior date, admits, I think, of no doubt.

The theories of *injection* and *sublimation* appear both to have been formed from a consideration of volcanic phenomena alone. Here injected veins are of frequent occurrence, and the fissures and rents are doubtless often lined with crystals which may have been sublimed. But will the generalization which has been thus hastily drawn of the analogy of these phenomena to those of metalliferous districts, honestly hold good in the cases before us? In the *universally* recognised volcanic rocks, the veins are of very nearly homogeneous texture, whatever be the containing rocks; and, supplied from a common source, it is natural to expect that they would be so. In our *lodes*, on the contrary, the contents of the vein change with a change of rock. Mixed, too, as are the ores of copper, zinc, tin, and lead indiscriminately in our veins, with innumerable earthy minerals; if they were ever presented to each other in a state of fusion, would they not chemically combine? We find, however, no such compounds in our veins.

The same objections equally apply to the theory of *sublimation*, for the very idea involves a mode of escape. Why, then, have not the volatile mineralizing substances, sulphur, &c. been dissipated? One would have expected that they would, and if deposited in the veins that they would have separately occupied one portion, the metals, &c. in a pure state, another, and perhaps different situations would have been filled by silica (quartz) and other substances, with which the veins abound. This is certainly as unlike our *lodes* as it is possible to imagine anything.

We now approach the *segregation* of Professor Sedgwick, and with this, I rather think, I tolerably coincide, presuming that Mr Burr truly interprets it; for I believe we shall all subscribe to the truth of the oxide of tin being deposited on the contemporaneous masses and veins of schorl-rock—we find tin-ore very generally accompanying schorl. Indeed, it appears to me little other than the contemporaneity of the veins and rocks. But the Professor considers that he can draw a line of distinction between veins of *segration* and true veins;—he has not, however, done so, and I must confess I doubt his ability to do so in a manner which shall be unobjectionable; for I have already said I believe the phenomena of the large and the small veins to be identical, and it has been seen that Dr Boase has already published the same view of the subject.

We come now to the theory recently propounded by Mr Fox, that veins have originally been fissures gradually opened, and that they have been filled by electric action taking place between the rock masses. The idea of progressive enlargement of fissures has been already considered when speaking of Werner and Mr Hopkins. The idea of electric filling up was first given by Professor Sedgwick, who says, " after the important experiments of Mr Fox, there can, I think, be no doubt that the great vertical dykes of metallic ore, which rake through so many portions of the county, owe their existence, at least in part, to some grand development of electro-chemical power." The artificial production of *crystallized metallic* substances from solutions by the electric action of the solutions alone on each other, was first discovered in France by M. Becquerel, as long ago as 1827, and his experiments anticipate nearly all that has been hitherto done in this country; his list of crystalline metallic substances far exceeds Mr Crosse's, and they were produced by far more simple means; some account of these ingenious and important discoveries appeared in an English Journal early in 1830, but they have only recently attracted the general notice their importance should have at once commanded. I may briefly offer my objections to Mr Fox's theory, with a hope that the great resources of his powerful mind, may obviate them, if worthy of his notice, or the theory to embrace them if they be valid. I have in the discussion of fissures stated my objection to their existence, whether suddenly or progressively formed; and I see no better explanation of the *horses* on the one than the other assumption.

The salts contained in our mine water, have not been shewn to differ much in the same neighbourhood, and Mr Fox (although in one case he found 92 grains) says that they are not generally more than from one to five grains in a pint. Beside, *we have yet to learn that these solutions, or any others, will develope electricity in rock masses;* Mr Fox's beautiful discovery of electric currents *in veins,* being confined to the *veins alone,* for neither in his experiments (yet published) nor my own, *have we ever detected electric currents in the rocks or in the earthy* *contents of the veins*, the experiments shewing nothing but the existence of electricity of the present contents of veins, in their present places. An *experiment* should have *shewn* this, or it is nothing but an assumption; a probable one, perhaps, but still nothing more.

Again, it is truly said, that electric currents will pass more readily at right angles, than parallel to the magnetic meridian, and that this explains why the ores are deposited in the east and west veins. But the lodes and cross-courses are all of the same age, and filled at the same periods, says Mr Fox. We have seen that the lodes in St Just bear about north and south. Here, then, we have the same agent, doing the same work, at the same time, in two different modes. For if the more ready transmission in one direction than another, *be the cause of the deposit* of the *ores*, *why, in one case, is it so formed in harmony with that fact, and in another in direct opposition to it*;—and this in both *at the same time?* When, too, we have the assumption of synchronous fissures (forming a considerable angle with the meridian, and through which the transmission would be far easier) which are not metalliferous. Why, too, is some portion of the quartz deposited in the east and west, and others in the north and south fissures by the same agent at the same time?

I offer these objections respectfully to Mr Fox's consideration, and no one will be more rejoiced than I shall be if he can resolve them. There are many others of equal force, which I reserve, as I fear I have already trespassed too far on your patience.

Let me add that the fact of parallel *lodes* in the same district, producing similar ores in different rocks, as of tin in slate of Wheal Vor, and in granite at Great Work, and of copper in the one at Consols, and in the other at Tresavean, does not bear out the conclusion that they were deposited by the agency of electricity—the rocks being in opposite states. If so, which is the positive and which the negative formation? and why do similar causes, under apparently like circumstances, produce opposite results?

The facts and observations which I have thus attempted to bring together lead me to conclude:—

1. That the phenomena of our metalliferous districts are not consistent with the idea of the veins having originated in fissures.

2. That the appearances and positions of the *horses* do not countenance the assumption of their having ever supported the bounding planes of *empty spaces.*

3. That the contents of veins varying in different rocks is inconsistent with any theory of their having been filled from *above*, or by *injection*, or *sublimation* from *beneath.*

4. That the metallic contents of parallel veins in the same district being similar in different rocks; and also in veins in different districts not far apart, at right angles to each other, is irreconcilable with their being filled at the same period by electric agency.

5. That we have no *experimental* knowledge that rocks now are, or ever were, in opposite electrical states; our real knowledge extending to the existence of electric currents in the present *metalliferous* contents of veins, in their present places *only.*

6. That the *heaves* and *slides* are inexplicable on any yet assumed direction of mechanical disturbance, which is consistent with the general simplicity of natural causes; and that synchronous fissures exhibiting these phenomena are irreconcilable unless of contemporaneous origin with the containing mass.

7. That there is no line of distinctions to be drawn between the intersections of small veins found in hand specimens—and the larger ones occurring in what have been called *true veins*, *contemporaneous* veins, and *veins of segregation.*

8. That the only theory yet propounded which agrees with the phenomena is that of *segregation*, and that so far only as it admits the contemporaneity of the veins and their disturbances with the rocks in which they occur.

In submitting the foregoing views, I feel I am only exhibiting the opinions which *practical* men in this country have long generally entertained; and I shall be more than amply recompensed for some years of labour I have bestowed on the subject, if I shall succeed in inducing but *one* of them to record the results of his daily experience for the benefit of his successors.*

* Professor Jameson, in March 1808, read a paper on contemporaneous veins before the Wernerian Society, which was published in the first volume of the Society's Memoirs; afterwards, in 1818, a memoir on the same subject, printed in second volume of the Wernerian Memoirs; and we understand papers on the contemporaneous origin of many veins, by Professor Jameson, have appeared in the Annals of Philosophy and elsewhere.

Observations upon the Fossil Polypi of the Genus Eschara, (*Millepora*, Lin.) By M. H. Milne Edwards.

At the meeting of the *Academie des Sciences* of Paris, on Monday the 21st of November last, M. Milne Edward read an interesting paper on this subject, of which the following is the substance.

The stony, or rather the bony, texture of the external tunic of the *Eschara* affords very favourable conditions for the preservation of the remains of these polypi in the slimy deposits which have successively invaded their abode, so that, in spite of their extreme delicacy, they are frequently encountered in a fossil state; and at the present moment the number of extinct species, whose existence is regarded as established, greatly exceeds that of the recent species detected by zoologists in our present seas. The examination of these fossils has nevertheless been for long neglected, and the list of the authors who have treated of them is very short. M. Desmarest has directed the attention of naturalists to several species; Faujas de Saint Fond and Lamouroux have also discovered some; but it is chiefly in the work of M. Goldfuss that we must look for that precise and minute information which will be truly useful.

At the same time, it must be confessed that the study of these polypidoms is attended with considerable difficulty, inasmuch as it requires a minute examination of the conformation of the almost microscopic cells of which they are formed; and in order that the drawings which are taken may be satisfactory, it is necessary that the objects should be magnified at least twenty times, and that the relative sizes of the different parts should be maintained. But that which principally diminishes the value of the labour which has previously been bestowed on this department of natural history, is the ignorance which prevailed concerning the modifications of the forms which were induced by age on the polypus in each cell; for, in the want of the knowledge of this fact, inquirers were naturally led to be content with the examination of a few well-preserved cellules in each polypidom, and thus proceeding, were liable, on the one hand, to multiply species without sufficient ground, and, on the other, to confound species which were really different, but whose distinctive characters disappeared in old age. But, in fact, the changes which we have detected in the external conformation of the tegumentary cellules of the living Eschara we have examined at different ages, occur also in the fossil remains of these polypi; and before we can pronounce on the specific identity or distinction of these, it is often necessary that we should compare them in different periods of their existence, a comparison which cannot always be accomplished, as the fragments found are often so small that they do not contain cellules of different periods of life.

Almost all the species of fossil Eschara of which good descriptions or intelligible figures have hitherto been published, belong to a very remote geological epoch, as they, for the most part, belong to the chalk formation. These strata, however, are far from being the richest in polypidoms of this genus, and it is particularly in much more recent strata of the crust of the earth that they are found in abundance. In certain strata, whose formation is subsequent to that of the most recent tertiary strata of the Paris formation, the number of Escharæ is so very considerable that, at the corresponding geological epoch, these zoophytes appear to have contributed in our high latitudes to the formation of immense banks in the same manner, as at the present day, we see other polypi, creating reefs and islands, in tropical seas.

The combined observations of geologists and zoologists have led to the conclusion, that in the creation of organized beings the general tendency of nature has been to advance from the simple to the more complicated. In the series of vertebrated animals we regard this progress as indisputable; it is probably not so evident as it regards the series of the class mollusca, and as yet we know too little of the articulata of the ancient world to decide if the same law held good in this great class of animated nature; but, be that as it may, the same tendency appears to exhibit itself in a very striking way in the structure of the various polypi which have appeared at the surface of the globe.

In truth all our researches demonstrate that the Eschara and neighbouring genera are of more complicated organization than any other known polypi. But, amongst the numerous zoophytes which inhabit the seas in which the transition limestones were formed, we know of no well established example of a polypidom belonging to that family; it is even probable, that at that remote period very few polypi of the order *Bryozoaires* existed, whilst Alcyoniæ and *Zoanthaircs*, whose structure is much more simple, abounded. The Escharæ are rare in the Jura formation, but in the chalk and tertiary limestones their number is proportionally greatly increased; and in the more recent series, by some geologists denominated quaternary or pliocene strata, the quantity of the remains of these polypi much exceeds that of those fossils belonging to less elevated orders, such as the *Zoanthaires* and Alcyonæ.

The Eschara, properly so called, first appear to have existed about the time of the formation of the Jura limestone of Caën; and Lamouroux has in fact found in this deposit a fossil which undoubtedly belongs to this genus; and Desmarest has shewn that there is a second. In the chalk of Maestricht these polypidoms are by no means rare; and the number of species figured by M. Goldfuss, as belonging to this geological formation, amounts to ten; but, as will presently be seen, all the fossils arranged by this author under the name of Eschara do not appear to have a legitimate claim to remain in this group; and it also appears highly probable that simple modifications dependent upon age have, in more cases than one, been regarded as constituting specific differences, and so have led to the improper multiplication of species. In consequence of this, his list of the Eschara of the chalk formation will be very considerably reduced; but, on the other hand, it will be augmented by new species which I mean to propose at the close of this memoir. The tertiary strata about Paris and those of Westphalia, have likewise furnished Messrs Desmarest and Goldfuss many Escharæ, but unfortunately few of these fossils have been represented in such a way as to allow us to come to any satisfactory conclusion. We, too, have met with some species which belonged to this geological epoch, and which appear to us to be new; but it is especially in the English Crag and the analogous deposits in the basin of the Loire, that we have found the greatest variety of these polypidoms: up to the present moment no naturalist has described one of these, and the number we now proceed to describe, will almost double the total amount of the species already discovered in all the other marine deposits of the crust of the globe.

Many fossil Escharæ differ greatly from the species now existing, whilst others, on the contrary, very much resemble them; but up to the present moment we have not been able to establish the specific identity of any one of these polypidoms with the recent species; and it is therefore probable that the polypi of this genus, which inhabited the ancient seas, were all destroyed previous to the creation of those which are existing at the present time.

The concluding portion of the memoir is occupied with the description of eighteen species, seventeen of which, according to M. Edwards, are entirely new.

At the next meeting of the Academy, on Monday the 28th of November, M. Dujardin presented a communication, of which we give the following extract:—

"The memoir of M. Milne Edwards, read at the last meeting of the Academy, on the 21st November, makes it necessary that I should request the Academy to accept at my hand the five first plates of a work which I have been preparing for a long time upon the fossil polypidoms of the chalk formation; so that it may clearly appear, when my treatise is published, which I expect will be in a few months, that my researches are not posterior to those of Mr Edwards.

"These plates represent twenty-two species of foraminated polypidoms of the chalk of Touraine; the three other plates, which are nearly finished, will complete a series which comprehends the foraminated polypidoms of that locality, and of many analogous cretaceous formations.

"A simple inspection of these plates will prove that I have no more neglected, than M. Edwards has done, the changes which are produced by age in the Eschara, and that I have moreover extended this observation to two other groups of the Millepora and Retepora. This has enabled me considerably to reduce the number of species, and to explain the mode in which the testaceous matter is deposited and increased in thickness. In fact I have found in the living animals of many of the neighbouring genera, numerous filiform tentacula which traverse the pores or spiracles of the surface, and produce the incrustation externally, and not internally, as in shells. In some polypidoms these pores are placed on the anterior surface, whilst in others, as in the Retipora, they are on the posterior side.

"Another observation, which, so far as I know, has not previously been made, is the discovery of pores of communication between the cellules, and which pores establish the commonalty of life in all the porous polypidoms, and at the same time promote the propagation by *gemmation*, or the emission of the *gemmules*,* which develope themselves at the free edge and extremity of the polypidom, and promote its increase; whilst the eggs which are destined for the reproduction of the species in another part are found in particular capsules above the opening of the cellule. These communications, which I have discovered in all living polypidoms, where they are sometimes formed by a cribriform plate, may be observed in the fossil polypidoms which I have represented when the crustaceous matter has been worn down on either side; and I have been solicitous to represent them in both aspects.

"It follows from this fact, that we cannot admit an isolated life to the Eschara, or the other cellular polypi, at any period of their development. And it is especially on this account that I wish to mark a date, by presenting these plates to the Academy."

The Magnetic Variation near Edinburgh, and in Berwickshire. By Captain Milne, R. N., F. R. S. E. Communicated by the Author.

The amount of the magnetic variation at different stations, will, after an interval of several years, necessarily be a subject of scientific interest, not only from its connexion with navigation, but more particularly from its being illustrative of the still unknown laws of magnetism. The following observations have been made, and are now published, with the view of af-

* These corpuscules differ from true ova and seeds, inasmuch as the substance of which the new being is formed is not inclosed in a special envelope, and its formation is owing to the active substance of the reproductive corpuscule.—Tiedemann's Comp. Phy. 42.

fording data, for estimating at some future period the progressive change in this country, which is known to be going on in the magnetic intensity.

The instrument employed was a magnetic bar, capable of being reversed on its axis, and which played over an arc placed on a distant wall;—the true bearing of the zero having been accurately determined by repeated transits of the sun. The instrument used was a simple magnetic bar of considerable length, —which was found to give decidedly more accurate results, and to be free from sources of error to which smaller instruments are liable. Care was taken to free the instrument from any local cause of attraction, by having the pedestal at a distance from accumulated masses of iron (which exist in all houses), or volcanic rocks whose attraction likewise exerts considerable influence on the needle; and for this reason it may not be advisable to compare the present observations with those made at Edinburgh some years ago, where even at short distances between the stations very different results were deduced.*

There is also another subject to be considered in deducing the mean variation, viz. the *diurnal variation*. From several series of observations continued at different periods with a needle, delicately suspended by a silk fibre, it was found, that the hour of the needle's mean position was $10^h\ 3^m$ A. M., that the needle's north pole then advanced progressively westward until $12^h\ 50^m$ P. M.; and then again receded to its mean place at $4^h\ 35^m$ P. M. The total amount of arc passed over east and west of the mean position from this cause was 12′. To compensate this error, each series of observations was reduced to the mean hour. A mean of these gave the following results, as the mean magnetic variation for August 1836, at—

Inveresk, six miles east of Edinburgh, Lat. 55° 56′ 20″ N., Long. 3° 2′ 40″ W.	= 26° 33′ 40″ W.
Milnegraden Berwickshire, Lat. 55° 41′ 20″ N., Long. 2° 11′ 41″ W.	= 26° 13′ 25″ W.

* Mr Bain, in his valuable Essay on the Variation of the Compass, gives the following from his observations in 1814 at Edinburgh:—

	variation.	
At the Observatory, ...	27° 50′ 10″ W.	(120 obs.)
... Grange's Park, West Church, . .	27 36 2 ...	(30 ...)
... a Garden south side of Castle draw-bridge,	27 41 35 ..	(40 ...)

Table of Heights ascertained barometrically in the Department of the Hautes-Pyrénées. By M. le Comte de Raffetot. Communicated by Professor Forbes in a Letter to the Editor.

My Dear Sir,—The accompanying Table of Heights I think you will consider worthy of publication on two accounts: First, as enlarging our knowledge of the figure of the earth's surface; and, secondly, as affording an excellent example of a method by which many individuals without scientific pretensions, may usefully employ and dignify their leisure, and increase the stock of human knowledge.

The annexed results were obtained by a French gentleman of fortune, the Count de Raffetot, whose acquaintance I had the good fortune to make last year amongst the Pyrenees. Both residing at the same inn in the village of Luz, the accident of our both possessing barometers by Bunten of Paris, was the origin of our acquaintance; and it is a fair testimony to the character of that excellent artist to add, that we were equally surprized and pleased, on comparing our instruments, to find them agree within *one-tenth of a millemetre.* M. de Raffetot employed his leisure in ascertaining the elevation of the chief surrounding points of the valley in which we resided: and if we reflect upon the additional knowledge in physical geography which such well-directed and pleasant labour would produce, if undertaken by the frequenters of every watering-place in Europe, we cannot but consider the lesson as a valuable one. Some remoter and more elevated points were determined from my observations, M. de Raffetot making the corresponding ones at Luz. Such observations are marked with an asterisk, amongst which I have added one or two wholly my own.

When I add that these observations have been chiefly reduced by the tables in the French *Annuaire*, and that they have been converted into English measure by my friend and pupil, Mr Thomas Anderson, I believe that I have stated all that needs to be known respecting this little contribution.

Believe me most sincerely yours,

10*th December* 1836. JAMES D. FORBES.

Height of the Principal Points of the Valley of Barèges (Hautes Pyrenees), above the level of Luz (the chief town of the valley) and also above the Level of the Sea.*

NOTE.—We have given here the height of all the "chefs-lieux des communes," of some of the hamlets and of some uninhabited places, which will give room for some interesting observations. In calculating the height of these different points above the level of the sea, we have supposed, according to the excellent observations of MM. Rebonz and Vidal, that the church of Luz is situated 739 metres = 379 toises, or 2424½ English feet above the level of the sea. The height of all the "communes" and hamlets mentioned, have been taken from the level of the church of each place, except the villages of Barèges, Gavarnie, and Gèdres.†

Height of the "Chefs-lieux de Communes."

Name.	Above Luz.		Above the Sea.		
	Metres.	Toises.	Metres.	Toises.	Feet.
Betpouey	272	139.5	1011	518.5	3317
Biella	88	45	827	424.5	2713
Chèze	52	26.5	791	405.5	2595
Esquièze	12	6	751	385	2464
Esterre	46.5	24	785.5	403	2577
Grust	261	134	1000	513	3281
Saligos	33	17	706	362	2316
Sassiz	68	35	671	344	2201
Sazos	118	61.5	857	439.5	2812
Sère	0	0	739	379	2424
Sers	405	208	1144	587	3622
Viey	254	130.5	993	509.5	3258
Villenave	66	34	805	413	2641
Viscos	138	71	877	450	2877
Visos	116	59.5	855	438.5	2805

* Barèges, far from being the principal place of the valley which bears this name, is merely a hamlet which during the greater part of the year does not contain above 100 inhabitants. During the season of the baths, viz. from 1st June to 1st October, it is visited by a considerable number of strangers.

† It is absolutely necessary to mention precisely the station at which the observations were made; unfortunately, however, this is generally omitted in tables of heights; in the Annuaire of the French Board of Longitude, the points of observation are not specified except in a very few cases. This want of precision takes from the results of these observations some of their merit, having the great disadvantage of preventing their use as a basis for other calculations.

Height of the Principal Hamlets of the "Commune of Luz."

Name.	Above Luz.		Above the Sea.		
	Metres.	Toises.	Metres.	Toises.	Feet.
*Gavarnie,† first floor of inn	629	322	1368	701	4498
Gèdre, (the bridge) .	281	144.5	1020	523.5	3356
Héas‡ . . .	791	406	1530	785	5020
Pragnères . .	193	99	932	478	1568
St Sauveur, (terrace of the baths) . .	22	11	761	390	2497

Height of some uninhabited points.

Name.	Above Luz.		Above the Sea.		
	Metres.	Toises.	Metres.	Toises.	Feet.
*Breche de Roland .	2065	1059.5	2804	1438.5	9209§
Cirque de Gavarnie, (a little plain situated at its lower part) .	889	456	1628	835	5341
Lac d' Escoubouz .	1202	616.5	1941	995	6368
Lac de la Glaire .	1254	643.5	1993	1022.5	6569
Lac de Portanet .	1654	848	2393	1227.5	7851
Lac de Troumouse .	1356	696	2095	1075	6873
*Sommet du Pic du Midi (of Bigorre) .	2173	1115	2912	1494	9553‖
*Pic de Bergons, near Luz	...	...	...	...	6117¶
*Col d'Oleon, between Luz and Cauteretz	...	...	...	...	6660**

† The Annuaire gives the height of three inhabited places of the valley of Bareges above the level of the sea, especially that of Gavarnie, its height (1444 metres), differs considerably from that given by us. But to what part of the village does the height refer? Certainly not to the inn (the point of which we have given the height on account of its being the head-quarters of those who visit the principal branch of the valley, nor to the church, as we have determined along with Mr Forbes, Professor of Natural Philosophy in the University of Edinburgh.

‡ Here, too, there is a considerable difference between our height and that of the Annuaire (1465 metres). But to what point does the height given refer?

§ I believe that there is some mistake regarding the calculation of the height of the Breche. In a private letter, M. de Raffetot mentions that he calculated it from my observations, and he communicated to me his corresponding ones at Luz. Calculating by the tables in the *Annuaire*, I find the height above the inn at Luz 2117 metres, or 6944 English feet. If to this we add the height of the inn at Luz (only eight feet below the church), which is 2416 feet, we obtain 9360 for the height of the *floor* of the Breche above the sea. According to Charpentier, it is 9337 English feet.—*J. D. F.*

‖ The height of the Pic du Midi agrees within eight feet with that given by Reboul and Vidal.—*J. D. F.*

¶ 6930. Ramond.—*J. D. F.*

** To this I may add the elevation of Cauteretz, although it belongs to a different valley. The principal street is 680 feet above Luz, or 3096 above the sea.—*J. D. F.*

Height of Barèges, a Hamlet of the "Commune of Betpouey."

Name.	Above Luz.		Above the Sea.		
	Metres.	Toises.	Metres.	Toises.	Feet.
Barèges, (court of the baths) . .	532	272.5	1274	653.5	4180

Extract of a Letter from Mrs Somerville to M. Arago, detailing some Experiments concerning the Transmission of the Chemical Rays of the Solar Spectrum through different Media.

In the account of the meeting of *L'Academie des Sciences* on the 21st of December 1835 (Compte Rendu, p. 508), it is stated that M. Arago, after having repeated what was most essential in those experiments by which M. Melloni proves that the solar rays, while preserving all their luminous properties, may be deprived of their calorific power, remarked, that there was another point of view in which the subject might be investigated. He said it would be important to inquire if the means employed by M. Melloni, or other analogous ones, would not enable us to deprive the solar rays of their chemical properties also; or, in other words, if, of the three properties which light possesses when it reaches us from the sun,—1st, That of illuminating; 2d, That of heating; and, 3d, That of destroying or exciting chemical combination, we could not separate the latter two, and retain its simple illuminating power. This experiment, remarked M. Arago, would probably lead to curious results, and I last week almost yielded to the temptation of undertaking the investigation. But, as possibly M. Melloni may have himself thought of it, though quite silent about it in his memoir, I think I had better not prosecute the subjects till after consulting the learned Italian philosopher.

The motives which I had in 1835, said M. Arago, at the meeting of the Academy on the 17th of October 1836, not to interfere in researches which so directly conducted M. Melloni to these beautiful discoveries, still subsist. I shall, therefore, abstain from stating some results to which I have arrived concerning the absorption or interception of the chemical rays. Every one, however, will understand that the same reserve cannot be imposed upon Mrs Somerville; and I cannot, therefore, withhold the interesting experiments of this illustrious lady from the Academy, and the public.

In my experiments, she remarks, I employ the chloride of silver, which Mr Faraday was so kind as to prepare for me, and which, accordingly, was perfectly pure and white. It was liquid, and might be uniformly spread over paper. Although this substance is exceedingly sensible to the action of the chemical rays; yet as we have no precise means of appreciating the changes of colour produced by their action, some uncertainty as to the result might remain were we to compare only those tints which differ but little from each other; but the results which I shall furnish on this occasion shall be chosen from among those which were in no degree doubtful.

A piece of glass, of a light pale green colour, which was perfectly transparent, and less than $\frac{1}{20}$th of an inch in thickness, did not permit any of the chemical rays to pass; after exposure for half an hour to a very hot sun, the chloride of silver behind the glass exhibited no change of colour whatever.

I have repeated this experiment with many pieces of green glass, which differed both in their tint and thickness, and I have always found that they were all nearly impervious so far as the chemical rays were concerned, and even after they had been subjected for a much longer period than that above stated to the solar influence. As M. Melloni has already found that glass of this colour arrests the most refrangible calorific rays, by associating his results with mine, we are led to conclude, that glass of this colour has the power of wholly intercepting the most refrangible portion of the solar spectrum.

Laminæ of mica, of a deep green colour, are also nearly impervious to the chemical rays; however, when they are very thin, and the solar action is continued for a very long time, then it appears that they do not completely arrest these rays. I fixed, with a little wax, to a sheet of paper which was covered over with the chloride of silver, a sheet of pale green mica from Vesuvius, the thickness of which was not more than the thirtieth of an inch, and I exposed the whole to the rays of a powerful sun; after a time the sheet of mica being removed, it was found that that part of the paper which it covered retained all its original whiteness, whilst the rest was wholly of a deep brown colour.

The same experiment has been tried with fine sheets of white mica. Six sheets of common white mica placed on each other did not intercept the chemical rays; the chloride of silver which they covered, at the end of an hour's exposure to the sun, had become quite brown. The same result was obtained after using a single plate of mica, which, however, was still thicker than all the others put together. This substance does not appear to present any obstacle to the transmission of the calorific rays.

These experiments led me at first to suppose that all green substances possessed this property: but I very soon found that this would be drawing too hasty a conclusion; for, having shortly afterwards tried the experiment with a very large emerald, the green of which was very beautiful, though not very deep, and the thickness of which was at least 0.35 of an inch, I found that it readily transmitted the chemical rays. Thus, the matter which imparts the colour to the green emerald has no action on the chemical rays, whilst that which imparts the same colour to glass and mica has great influence over them.

Rock-salt, as might be expected, possesses in a high degree the faculty of transmitting the chemical rays. Glass, too, coloured violet with manganese, and very deep blue glass, such as is common in finger-glasses, likewise very readily transmit these rays. The alteration in the colour of the chloride of silver very speedily takes place in spite of the interposition of a plate of blue glass of the deepest tint, and nearly a quarter of an inch thick.

Among the various substances which I have tried in these experiments, rock-salt and white glass, as also the blue and violet-coloured glasses, are those which afford the maximum of permeability to the chemical rays; whilst the green shades of glass and mica present the minimum. Other bodies possess this property in intermediate degrees, and sometimes vary considerably, though the colour is nearly the same. Thus glass of a deep red colour allows very few of the chemical rays to pass, whilst garnet, of an equally deep colour, allows nearly the whole of them to pass. The white topaz, as well the blue, the blue pale beryl, the cyanite, the heavy spar, the amethyst, and various other substances, transmit the chemical rays with great facility; whilst the yellow beryl does not, so to speak, transmit them at all, and the brown tourmaline as well as the green, have the property in so slight a degree, that I have failed in my attempts to polarize the rays under these circumstances, though I believe it might not be impossible, if thinner plates were used than I had it in my power to employ. In concluding, I may observe, that I purpose shortly to resume the prosecution of the subject.

Observations regarding Fossil Infusoria, communicated to the Royal Academy of Sciences of Berlin, by Professor Ehrenberg, on the 27th and 30th June 1836.*

The proprietor of the porcelain manufactory at Pirkenhammer, near Carlsbad, observed that the substance occurring in the peat-bog, near Franzensbad, in Bohemia, and resembling the Kieselguhr (a siliceous deposit), "is almost entirely composed of the coverings of some species of *navicula*, and seems to be the product of the action of subterranean heat on the ancient submarine land." Mr Fischer accompanied this notice with a specimen 2 inches long, 1 inch broad, and ¾ of an inch high, of the siliceous mass, together with some specimens of the peat, requesting me to determine the animal form, and to publish the result. A microscopic investigation has confirmed the discovery of Mr Fischer; the Kieselguhr of Franzensbad is almost entirely composed of extremely well preserved *naviculæ*, with which are also mixed some other Bacillariæ; and the great transparency together with the purity from organic matter, of all the siliceous shields, renders it probable that they have been purified and heaped together by an unusual degree of heat. It is not probable that they belonged to the bottom of the sea, for the great majority of the forms, as well according to the numerical relations as the striping, are identical with the *Navicula viridis*, a species found so abundantly in all the fresh water near Berlin. *Naviculæ* can also be recognised in the specimens of the turf; and although for the most part different from those of the *Kieselguhr*, have nevertheless the forms of living species. An examination of original specimens of the *Kieselguhr* from the Isle of France and Santa Fiora, in Tuscany, similar to those ana-

† From Wiegmann's Archiv fur Naturgeschichte, Zweiter Jahrgang. Viertes Heft. 1836.

lyzed by Klaproth, has shewn, that they also consist almost exclusively of the shells of infusory animals of several genera of Bacillariæ chiefly of species still living, and also of a few siliceous spicula of sea and fresh-water sponges; but without any uniting basis. Thus the discovery of Kützing, that the coverings of Bacillariæ consist of silica, receives new confirmation.

Several years ago, the author discovered that the ochre-yellow slimy substance, which sometimes covers the soil in marshy rivulets and ditches, and seems often to be regarded as a deposition of oxide of iron, is a very delicate form of the Bacillariæ, which, when heated, becomes red, like the oxide of iron, and is very ferruginous; but which neither loses its form by ignition, nor by the action of acids, and therefore must possess a siliceous covering, that approaches most nearly the genus *Gaillonella.* Hence, this form was, during the previous year, figured as the *Gaillonella ferruginea* in plate 10. of the work on Infusoria, which is about to appear. All the ochre surrounding bog iron-ore exhibits siliceous filiform members, as the residue after the removal of the iron. The above appearances render it extremely probable that the Gaillonella ferruginea performs a very important part in the formation of bog iron-ore, whether it be by the direct addition of the iron contained in itself, or by attracting that belonging to neighbouring foreign substances. The species of fossil infusory animals occurring in the above mentioned substances, are the following:—

1. In the *Kieselguhr* of Franzensbad:—1. *Navicula viridis,* as the principal mass; of various dimensions, the largest being $\frac{1}{9}'''$; 2. *Navicula gibba;* 3. *Navicula fulva;* 4. *Navicula Librile;* 5. *Navicula striatula;* 6. *Navicula viridula.* (The two last belong to salt water; all the others to fresh water). 7. *Gomphonema paradoxum;* 8. *Gomphonema clavatum;* 9. *Gaillonella varians?* all fresh-water animals. None of these can be distinguished from the recent species.

2. In the peat-bog of Franzensbad;—1. *Navicula granulata,* the most abundant, and hitherto an unknown form; 2. *Navicula viridis,* rare; 3. *Bacillaria vulgaris?* 4. *Gomphonema paradoxum;* 5. *Cocconeïs undulata,* all living forms; the last in the salt water of the East Sea.

3. In the *Bergmehl* of Santa Fiora:—1. *Synedra capitata,* a new species forming the principal mass; 2. *Synedra ulna;*

3. *Navicula Librile;* 4. *Navicula gibba;* 5. *Navicula viridis;* 6. *Navicula capitata;* 7. *Navicula zebra;* 8. *Navicula phœnicenteron;* 9. *Navicula inæqualis,* all identical with living fresh-water species; 10. *Navicula viridula,* a living salt-water species; 11. *Navicula granulata;* 12. *Navicula follis,* both new species; 13. *Gomphonema clavatum;* 14. *Gomphonema paradoxum;* 15. *Gomphonema acuminatum,* all species living in fresh water at the present day; 16. *Cocconema cymbiforme,* identical with the recent fresh-water species; 17. *Cocconeïs undulata,* a recent marine species; 18. *Gaillonella italica,* n. sp. 19. Siliceous spicula of a *Spongia* or *Spongilla.*

4. Klaproth's *Kieselguhr* of the Isle of France contains, 1. *Bacillaria vulgaris?* as the principal mass; this species occurs in a recent state in all our seas; 2. *Bacillaria major,* a new species; 3. *Navicula gibba,* a recent species living both in fresh and in salt water; 4. *Navicula,* species not determined; 5. *Navicula bifrons.* None of these organic beings are so well preserved as the species occurring in the other mineral substances, and seem, with exception of the last, to be marine species.

The great majority of these fossil infusory animals still live; and most of them occur near Berlin, and on the East Sea near Wismar. Most of them are so well preserved, that they can be minutely investigated. Thus, besides the numerous ribs, we can recognise the six openings of the hard coverings of the *Navicula viridis;* the four openings of the *Gaillonella;* the two openings of the *Gomphonema,* &c. It is only the rock from the Isle of France, that seems to contain a preponderating number of marine animals. We are entitled to suppose that the few new forms are undiscovered living species.

The great predominance of particular species is extremely remarkable. Thus the *Navicula viridis* characterizes by its extreme abundance the *Kieselguhr* of Franzensbad; the *Bacillaria vulgaris* that of the Isle of France; and the *Synedra capitata* the *Bergmehl* of Santa Fiora. The recent species are more mixed, and live only around and on the vegetables by which they are nourished.

The slaty Tripoli of commerce also consists almost entirely of infusory animals. The polishing slate of Bilin, in Bohemia, which forms whole strata, consists almost entirely of a minute infusory animal, which can be referred to the genus *Gaillonella*

(*Gaillonella distans*). The *Podosphenia nana*, n. sp., *Navicula scalprum?* and *Bacillaria vulgaris* (the two last are recent marine species) occur singly between the individuals of the prevailing species, and the first only can sometimes be compared to the Gaillonella for abundance. In the same polishing slate there occur impressions of plants and one species of fish, the *Leuciscus papyraceus* of Bronn, according to Agassiz. In the adhesive slate of Menilmontant, some indistinct traces were found of the *Gaillonella distans*. An individual of this animal, which, almost without any uniting basis, constitutes the polishing slate of Bilin, is $\frac{1}{288}$ of a line in size ; many are smaller ; there are consequently forty-one thousand millions of these animals in one cubic inch of that substance.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Upon a new Thermometer which will indicate Mean Temperatures. In a Letter from M. Jules Jürgensen to M. Arago.*—Our common thermometers indicate the temperature at the time that we make our observation ; and there are others which supply the *maximum* and *minimum* temperatures from the time we have made one observation till the time when we again examine them. Up to the present day, no thermometer has been constructed which would indicate with precision the mean temperature of a day, or month, or year. This, however, is the design which M. Jules Jürgensen, a celebrated watchmaker at Copenhagen, undertook to accomplish, and which he has succeeded in fulfilling. The balance-wheel of a common watch increases in size when the temperature increases, and, on the contrary, contracts when the temperature diminishes. An augmentation in the dimensions of the balance-wheel leads inevitably to an increase of the duration of its oscillations, and consequently to the watch going slower, whilst its contraction makes it go quicker. To meet these inconveniences, watchmakers have long been in the habit of substituting for simple balance-wheels, which are formed of four radii and a continuous ring all of one metal, others which are compound.

Of these latter a tolerably accurate idea may be formed, by conceiving two rectangular rods of the same metal, at the four extremities of which four distinct arcs are attached, each of which is formed of two metals unequally dilatable, riveted at their extremities. These bi-metallic arcs must necessarily change their curve, and consequently their position, on a variation of temperature. It is equally evident that the movement of the free extremity of each arc will be towards the metal which is least dilatable when the temperature increases, and in the opposite direction when the temperature diminishes. Hence it results, that at the same time when in the way of dilatation consequent on the augmentation of temperature, the radii of the balance-wheel separate from their point of intersection or axis of rotation the extremities of the arcs which are attached to them, the other extremities of these same arcs, or their free extremities, will, on the contrary, be borne towards the centre, *if the most dilatable metal is the more external.* When the more dilatable metal is more central or *within*, the play of these compound bi-metallic arcs, far from diminishing or entirely compensating the effects of the dilatation of the radii, would considerably increase them. After these statements, it will be very manifest, that when we wish to give a watch the power of indicating the smallest variations of temperature, the relative position which it was necessary for M. Jürgensen to assign to the bi-metallic arc was the reverse of that which is adopted in our common chronometers, and the most dilatable metal of the compound arcs must be put the most internal. But the artist has done more; the free extremity of each of the four arcs has been selected as the point of attachment of another entirely similar arc, the variations of the curve of which increase the effects of the analogous changes of the other. The watch-thermometer which M. Jüngensen has made, according to these principles, is of the same size as a common watch. The outer arc of the bi-metal balance-wheel is made of platina, the inner one of brass. The variation in its going is *very nearly 32″ in the twenty-four hours* for every *single degree* of temperature. When this instrument is put in an exposed situation, it will evidently go quicker or slower, according as the atmospheric temperature diminishes or increases. When, then, it has once been determined experimentally at what precise temperature the watch is regulated, that is to say, at what degree the seconds' hand beats exactly 86.400 times in the twenty-four hours, the difference between 86.400 beats and the real number of oscillations which it makes during the twenty-four hours of any given day will afford the data for calculating its mean temperature, whatever may have been its variations throughout the several periods of which the day is composed. Each temperature, in truth, having acted according to its intensity and duration, will be expressed in the beats of the seconds' hand in the total result, and may form the expression in an exact arithmetical calculation of the mean temperature, just as if the elements of that temperature had been known. All, then, that will be required will be for the observer, twice in the twenty-four hours, to note the difference of the strokes of the pendulum of a well regulated chronometer and the thermometer-watch, and this will furnish the daily acceleration or retardation of the latter. Astronomers will be aware that the uncertainty in these comparisons will be only to the extent of a very small fraction of the oscillation. It will be easy experimentally to construct a table which will convert the quicker or slower movement of the watch into the degrees of the common thermometer. For the purpose of rendering this watch more generally useful, M. Jürgensen has connected with it, and without sensibly augmenting its size, a metallic thermometer which gives the actual temperature; and, with the aid of two floats, the maximum and minimum temperatures that occur during the twenty-four hours. The idea of employing an uncompensated pendulum to measure the annulative effect of temperature was suggested by Brewster many years ago, and more lately in Germany by Grassmann.

2. *Extract of a Letter from M. ——— to M. Arago, upon the Shooting Stars of the year* 1695.—After having read your article upon *Shooting* or *Falling Stars* in the Annuaire of the present year, I met, in the course of my reading, with a fact which goes to support the statement you advance, that the shooting stars have been especially observed in the months of April and November. I was then reading Wilkin's work, in which he has supplied the learned world with the best history we possess of Crusades. In giving an account of several phe-

nomena which preceded these astonishing migrations, and which the people interpreted into favourable prognostics sent of God to encourage them in the execution of the enterprize, the author says (I translate from the German), "Previous to the Council of Claremont the stars of heaven had announced the movement of Christendom, for they were beheld by numbers in France, on the 25th of April, to fall as thick as hail." This passage is nearly a copy from the Latin Chronicle of Baldric, p. 88. As I have not met it in the examples which you cite, I take the liberty of supplying you with it, for the fact is the more valuable, as being at so remote a period.

3. *Shooting Stars on the Night of the* 11*th*–12*th November* 1833, *Letter from M. Gaimard to M. de Freycinet.*—I have received from M. Méquet the following communication "On the night between the 11th and 12th November 1833, M. Müller, Director of the Danish Commercial Establishment of Frederikshaab, and M. Kauffelat, Assistant at Gothaab, a district farther north on the same coast, witnessed a shower of fire in a western direction, which lasted for a quarter of an hour. The Esquimaux, who were terrified at the spectacle, ran with the greatest precipitation to rouse the gentlemen named above." This observation will necessarily be highly interesting to M. Arago. In the *Annuaire du Bureau des Longitudes* for the present year, he mentions a shower of shooting stars which occurred in America in the night of the 12th–13th of November, and he requests that all mariners will attentively watch the celestial phenomena between the 10th and 15th of November.

4. *Temperature of Space.*—At Fort Reliance, north latitude 62° 46½′, west longitude 100° 0′ 39″, Captain Back observed the spirit-of-wine thermometer to sink so low as — 70° Fahr. If this observation is correct, M. Arago concludes that the temperature of space must be under — 70° 6′. Poisson, however, does not admit this conclusion, for, according to him, the temperature of the upper stratum of air is considerably lower than that of space.

5. *The Ancient Temperature on Mount Taurus.—M. Libri* has lately given to the *Academie des Sciences* an account of the last voyage of *M. Texier*, who, after having traversed the whole of Asia Minor, had lately arrived at Trebisond. M. Texier

had made large geological and mineralogical collections. But we more especially remark, that he had crossed the chain of the Taurus with an engineer officer, who had taken the heights of many spots. M. Libri attaches great importance to these observations, and conceives they will be much valued by philosophers. For, if it has been demonstrated by the invariability of the length of the day that the mean temperature of the earth has not varied during 2000 years, the constancy of the temperature at the surface, and especially the maxima and minima of temperature, are very far from having been demonstrated. Moreover, those ancient observations, which are at all fitted for establishing comparisons, are very rare, and the problem still remains unsolved, on account of the want of the necessary elements. Now, these observations of which M. Texier speaks, will enable any one to discuss those which Xenophon made in the same localities, during the retreat of the ten thousand. Xenophon speaks of perpetual snows, of the wine freezing in their leathern bottles, and of the symptoms of somnolency and of asphyxia, similar to those which Solander and his companions experienced in their voyage to the southern regions. According to the remarks of M. Texier and his travelling companion, the height of Taurus being determined, it can be ascertained whether the same phenomena are reproduced in the present day in seasons corresponding with those in which Xenophon crossed this chain.

6. *Researches on Living Barometers, by M. D'Hombres Firmas.*—The author, in a memoir on this subject, proposes to prove, that man in a state of health can support, without inconvenience, great variations in the atmospheric pressure, provided these variations are not too sudden and rapid. Even in those cases in which the change is effected in a very short period, as when the traveller ascends from the bottom to the top of a mountain, the effects are far from being the same in different individuals; in truth, whilst some experience very annoying and even very painful sensations, others are but slightly affected, and others not at all. This is the general result of a great number of observations which have been collected by the author, and which perfectly harmonize with his own. He likewise thinks that the disagreeable effects which are experienced by some

travellers do not depend solely on the diminution of the pressure on the surface of the body, and on the rarification of the air interfering with the perfect accomplishment of the act of respiration, but are likewise caused by fatigue, by the effects of cold, and even by the apprehension of the danger with which these excursions are almost always accompanied. The effects resulting from the augmentation of atmospheric pressure may, in like manner, be complicated by the effects resulting from accessory circumstances. Thus, formerly we referred almost exclusively to this cause the symptoms experienced by workers in the diving bell, whilst a portion of the resulting accidents was owing to commencing asphyxia; and they have ceased to manifest themselves since means have been devised to renovate the air which is vitiated by respiration. It is, moreover, true respecting the augmentation of the pressure, or of its diminution, that its influence varies in different individuals, in some it is scarcely marked, whilst in others it will produce swooning. In general, this sensibility to change of atmospheric pressure most strongly exhibits itself in persons of a feeble constitution, of great nervous excitability, in those whose respiration is not quite healthy, or who are the victims of rheumatism, or have suffered from bad wounds. In some we observe a state of discomfort, or of pain more or less acute, appear under the influence of the different causes which act upon the barometer, the hygrometer, or the electrometer; and these indications, like those of the instruments we have just named, mark beforehand the occurrence of certain meteorological changes. It is these individuals that M. d'Hombres Firmas regards as living barmometers.

7. *Luminous Appearance at Sea off the Shetland Isles.*—A curious luminous appearance at sea is mentioned in the following abstract from a letter to Robert Stevenson, Esq. Engineer, by the Light-house Keeper on Sumburgh Head in Shetland: "*Monday, September* 19. 1836—*Sumburgh Head Light-house*—The herring-boats went out through the night—there came on a severe gale of wind from the north-east, which drove them from their nets, and scarcely any one of them got into their own harbours. Mr Hay's fishermen lost 180 nets, Mr Bruce of Whalsey lost 114 nets, and a great many of the poor men lost the whole of their nets. The fishermen also in-

formed me, that upon the same night, there appeared to them a light which greatly annoyed them. It appeared like a furnace standing in the water, and the beams of the light stood to a great height. It became fainter on the approach of day, and at length vanished away by day-light. It continued for two nights. It stood so near some of the boats that the men thought of cutting from their lines to get out of its way."

8. *Tropical Nights.*—By the by, I travelled by night, to avoid the heat of the mid-day vertical sun, and I now, from experience, advise my friends never to follow my example. No evaporation takes place, you perspire copiously, with which, and the excessive dew, your clothes get saturated, hanging on you like wet leather, impeding every motion, and thus increasing your fatigue. Your breathing is less free, and you get an occasional puff of cold damp air, which, instead of refreshing, only adds to your discomfort; in short, you become completely oppressed. But in the sun, what a change; evaporation rapidly progresses, your dress acts like a wine-cooler, you get rid of the oppressive sense of heat, become stimulated, and march on excessively relieved. One point, however, must never be neglected, to keep a considerable thickness of clothing upon your head; you may then bid defiance to mere heat. On this subject of tropical nights, it occurs to me that there is a rather singular affection to which the human frame is subject; and several medical gentlemen to whom I have spoken, seem to me to entertain rather erroneous views as to its origin. I allude to what is vulgarly called being moon-struck. Dr Wells, in his admirable Essay on Dew, has shewn that a mutual interchange of radiated heat takes place, in ordinary circumstances, between all bodies, and that on this depends the preservation of temperature. On brilliant moon-light and other cloudless nights, however, all exposed bodies do not receive a quantity equal to that which they shed forth. The want of clouds prevents them receiving that vast quantity which would otherwise be shot back from the sky; in consequence, equality of temperature is not maintained. All those bodies which lie favourably, some more than others, become much cooled down, and, among other effects, moisture is deposited from the little portion of air, cooled by contact, in the immediate vicinity of the bodies. The human body, when ex-

posed, offers no exception to the law; and if the circumstances of the case are such as to preclude the generation copiously of animal heat, the consequences are very serious; persons who incautiously sleep, sentries on duty, &c. become occasionally even victims. When attentively examined in this state, they seem like icicles, cold and wet, shrunk and livid; all the blood has left the superficial vessels, and become engorged in the large venous trunks; congestion takes place in the brain, producing a state precisely similar to that form of apoplexy which occurs in persons perishing in snow-storms, and I have known cases when this apoplectic condition has terminated in paralysis either of the face or of the limbs, and in one instance in death. When interrogated, those who have suffered slightly from it, state the consciousness of extreme cold against which they could not make head, then insensibility to cold, and afterwards a drowsiness which gradually overpowered them;—a description which tallies exactly with that of Banks and Solander in relation to their suffering from excessive cold in South America, and to which the latter nearly fell a victim. The means, also, of recovering them is precisely similar,—a gradual approach to natural temperature, with a cautious use of stimulants. Officers on night duty in India, leaving their warm quarters, on pickets, have sometimes suffered similarly from the carrying power of the damp air, in which they have been forced to remain for some time, serious illnesses having been entailed on them. May this be looked upon as a primary, or at least an auxiliary agent in the production of agues, from its tendency to lower the animal powers?

ANIMAL ELECTRICITY.

9. *Experiments of M. Matteucci upon the Torpedo.*—M. Donné has sent to the Academy of Sciences at Paris, the extract of a letter, in which M. Matteucci gives the conclusions to which he has come from experiments upon thirty-six torpedoes. 1*st*, The electrical discharge of the torpedo is obtained, although the skin covering the organ has been removed, and although slices of the electrical apparatus itself have been cut out. 2*d*, When the torpedo does not of its own will emit a discharge, it is impossible to obtain, in the interior of the organ, try what part

you will, the slightest trace of electricity either by the galvanometer or the condenser. 3*d*, The intensity of the discharge diminishes in proportion as you reduce the number of the nerves which go to the organ. 4*th*, In the act of the discharge, the electrical current is found to be invariably directed from the back to the pelvis; and this whether exteriorly, or in the inside of the organ, or in examining the nerves and the brain, it always proceeds by the nerves to the pelvis. 5*th*, Three grains of the hydrochlorate of morphine introduced into the stomach of a torpedo, kills it in ten minutes; but death is attended with stronger discharges than usual, and with convulsions. 6*th*, When the torpedo has ceased to supply, though irritated, any additional discharge of electricity, if its brain be exposed, and if we touch, at first gently, the posterior lobe of the brain, which supplies nerves to the organ, three or four discharges more violent than common take place, and which have the usual direction from the back to the pelvis. But if, instead of simply touching the surface of the brain, it is deeply and rudely wounded, then very violent discharges are renewed, *but without the same constancy in the direction of the current.* I have observed three, one immediately after the other, proceed from the pelvis to the back, and all without any manifest law. These facts, and especially the last, continues M. Matteucci, suffice to demonstrate, that the electricity of the torpedo is not produced in the organs it possesses on each side of the brain, that this current receives its direction from the brain, and that the electricity in the peculiar apparatus is only condensed there, as in a Leyden bottle, or in a secondary pile. He adds, I am far from thinking that the study of the torpedo is concluded; there is still much to do; but it appears not a little interesting, that it has been demonstrated that electricity in the torpedo is nothing more than condensed by the organs: and, if we do not find the traces of electricity in other animals, it is only because they have not such condensing organs, and that their electricity is continually disappearing in the discharge of their numerous functions.

CHEMISTRY.

10. *On solid Carbonic Acid.*—Letter from M. Thilorier to the

Academie des Sciences of Paris.—" I have the honour of now announcing to the Academy that I have just finished a second memoir upon liquid carbonic acid, in which, after having successfully examined the different parts of this body, its *specific gravity*, which is so variable that, from 32° to 86° Fahr., it successively runs through the whole scale of densities from water to that of ethers; its *dilatability*, which is four times greater than that of air itself; its *pressure* and the *weight* of its vapour; its *capillarity*, and especially its *compressibility*, which is a thousand-fold greater than that of water, I have succeeded in determining in the most exact manner, the uniform and constant law which regulates all these phenomena, which at first view appear altogether independent of each other. The Academy will without doubt learn with interest, that, by means of a very simple apparatus, I have succeeded in instantly producing, and economically, masses of solid carbonic acid weighing an ounce and an ounce and a quarter, and which the experimental chemist may beneficially employ. My first experiments on cold, which I have already presented to the Academy, were made by directing a stream of liquid carbonic acid upon the bulb of a thermometer, or on tubes which enclosed the different substances upon which the action of the cold was tried. This method had the serious inconvenience of wasting a great quantity of the liquid, and of leaving some uncertainty upon the maximum of the cold produced. The facility and abundance with which I now obtain the solid carbonic acid has supplied me with a method of experimenting which is infinitely preferable. The bulb of the thermometer having been introduced into the centre of a small mass of solid carbonic acid, at the end of one or two minutes the thermometer became stationary and stood at —194° Fahr. Some drops of ether and of alcohol poured upon the solid mass did not produce any appreciable difference less or more on the temperature. Ether forms a mixture which is half liquid, and of the consistence of melting snow; but alcohol, in combining with solid carbonic acid, congeals, and produces a hard, brilliant, and semi-transparent ice. This freezing of anhydrous alcohol only takes place in the act of mixture; when isolated, as in a silver tube, in the midst of a mass of solid carbonic acid, the alcohol undergoes no change whatever. The mixture of alcohol and solid carbonic acid begins to melt at —185° Fahr., and starting at this point, the temperature does not vary any more. Thus we can obtain from this extreme limit a point as fixed as is supplied by that of melting ice. If, after having formed *a small coppel* of solid carbonic acid, we pour into it three or four drachms of mercury, it is seen to congeal in a few seconds, and to remain in this new condition so long as an atom of solid carbonic acid remains, that is to say, for twenty or thirty minutes when the weight of the coppel is from two to three drachms. I have already said that the addition of ether or alcohol did not augment the real degree of the cold, but, by giving the solid carbonic acid the power of moistening bodies, and of adhering more intimately to their surface, these substances much increase the frigerating effects. A piece of solid carbonic acid, on which some drops of ether or alcohol are poured, becomes capable of congealing fifteen or twenty times its weight of mercury. The promptitude with which it is converted into the solid state, the mass in which it is effected, and which may easily exceed half a pound, and its continuance in this new condition, which may be maintained as long as you like, with the single precaution of placing the metallic mass upon a base of solid carbonic acid, leads me to believe that this method of freezing mercury will henceforward be substituted for all those which have been previously employed."

11. *Mode of preventing Beer from becoming acid.*—A patent has been taken out in America, for preserving beer from becoming acid in hot weather, or between the temperatures of 74° and 94°. To every 174 gallons of liquor, the patentee Mr Storewell directs the use of one pound of raisins, in the following manner:—"Put the raisins into a linen or cotton bag, and then put the bag containing the raisins into the liquor before fermentation; the liquor may then be let down at 65° or as high as 70°. The bag containing the raisins must remain in the vat until the process of fermentation has so far advanced as to produce a white appearance or scum all over the surface of the liquor, which will probably take place in about twenty-four hours. The bag containing the raisins must then be taken out, and the liquor left until fermentation ceases. The degree of heat in the place where the working vat is situated, should not exceed 66° nor be less than 60°." To prevent *distillers' wash* from becoming acid,

two pounds of raisins should be put into 150 gallons of the wash, the raisins being chopped and put in without a bag, and 106 of hops should be put into the wash vat for every eight bushels of malt at the time of washing, and ¾ of a pound of hops for every bushel of malt brewed, to be boiled on in the liquor in the copper. —*Journal of the Franklin Institute of America. Sept.* 1. 1836.

12. *Note on the Manufacture of Platinum*, by M. Pelouze.—The method of Wollaston in the fabrication of platinum is only followed by those who make this metal an article of commerce. Chemists do not prepare malleable platinum for the requirements of their laboratories, and in their public lectures its preparation is never exhibited. M. Liebig is, I believe, the only one who manufactures it during his course. Although the method he follows is precisely that of Wollaston, and therefore presents nothing new in a scientific point of view, yet it may be alike useful and agreeable to chemists to retrace the steps of a process which is too much neglected and so easy of execution, that we may say there is no operation whatever more simple or expeditious than that of the manufacture of malleable platinum, made in the simple apparatus described below.—It is a hollow cylinder slightly conical, one of the extremities of which is closed by a small but very thick metallic plate. After having decomposed at as low a temperature as possible the muriate of platinum and ammonia, the *froth* which is produced is separated by a piece of wood; with this and a little water a clear paste is to be made, and introduced into the cylinder: An iron piston is then introduced into the cylinder, and after having pressed it at first very gently for a minute or two, it is then compressed with the greatest possible force. An iron ring, by which the base of the cylinder is supported, being struck with a hammer, affords us facilities for getting at the piece of platinum which is thus formed. The platinum taken from the cylinder has already a high density, and a brilliant metallic lustre. It is dried with a gentle heat; and, after having been exposed for a quarter of an hour to a white heat, it is rapidly withdrawn from the crucible, and receives a single blow of the hammer. It is then again exposed in the fire four or five times, and the number of the strokes from the hammer are only gradually increased. In less than half an hour the whole operation is finished; and it is so easy that the

result is always certain. I now exhibit to the Academy a spatula and the blade of a knife of platinum, which I myself saw prepared in a few minutes at Giesen in M. Liebig's laboratory.

ZOOLOGY.

13. *On the Specific Characters of the larger Cetacea, as deduced from the Conformation of the Bones of the Ear*, by M. VANBENEDEN.—It is often very difficult, M. Vanbeneden remarks, to distinguish between the different species of whales, if you have not an opportunity of examining the specimens in a fresh state, or of comparing their crania. But in the arrangement of the bones of the ear an equally important character is found, although it has not hitherto been noticed, notwithstanding that its application might be often most useful. A voyager would have much less difficulty to give an account of the bones of the ear of a whale, than of its whole cranium, and might in this way as effectually obtain all the necessary information for determining the species. In this way we may speedily have in all the Museums a series of preparations of Comparative Anatomy, which, for this order of the mammalia, will be the representation of the various genera and species, as in the other orders, there is a series which exhibits the formulary of the dental apparatus. The genus Rorqual, which is clearly distinguished by external marks, is not less so by those afforded by the examination of the ear, and this is also true of the several species of the genus. From this source, then, we may obtain valuable data for ascertaining the geographic distribution of these animals. Thus, it is not now known how far the rorqual which is distinguished as the Mediterranean species, penetrates towards the North Pole; but the bones of the ear which were last year described by MM. Quoy and Gaimard, during their voyage to Iceland, demonstrates that this species penetrates much farther in that direction than was previously supposed. This character is also important in the determination of fossil species. Thus a bone of the ear, found by M. Vanbeneben in the province of Anvers, has been recognised to belong to a Rorqual; but of a species different from those which are known as existing at the present time.

14. *Fossil Saurian in the Lias of the Isle of Skye.*—" On the

eastern side of the northern wing of the Island of Skye, below the farm of Lanfern, I found a petrified turtle, of large size. It rested on a wacke rock, and had been part of a shattery bed of limestone, which occupied the sea beach behind, but which the sea had washed from around it. Its shell preserved its natural yellowish-green colour only a little blanched; and all its septaria were perfectly distinct. Its neck extended from its body in a curvature like that of a swan, and had all its conical rings overlapping each other. Its eye was perfectly distinct, and only its mouth was a little bruised. Internally it consisted of dark-blue limestone, intersected by the animal membranes of snowy whiteness." This notice we extract from a published lecture on geology by the late Reverend James Headrick, bearing date 1828, Montrose. The fossil may belong to the genus Plesiosaurus.

15. *Infusory Animals of the Springs of Carlsbad.*—The researches which had been made by Ehrenberg respecting the infusoria which are found in the mineral waters of Carlsbad, had previously demonstrated that there were to be found among those animals forms which were very peculiar, and which had not previously been observed except among marine animals. But, besides this, these waters, with the exception of those of Tessel, and the common fresh-water springs, are now found to contain a considerable number of forms which are altogether new, which M. Ehrenberg had not previously observed in fresh-water, and which probably, therefore, belong either to the waters of the ocean, or to salt springs; or, finally, are altogether peculiar to the waters of Carlsbad.

ANTHROPOLOGY.

16. *Use of Horse Flesh as an article of Food in Paris.*—"We must now," says the Editor of the Athenæum, in his notice of Parent Duchatelet's work on Public Health, "entertain our readers with the history of horse-flesh as a part of the dietary of our good neighbours the Parisians. The impurities of the knacker's yard, and the choice of his subjects, are too well known to require detail here; yet it is through this channel that the 'cheap and nasty' eating-houses for the humbler classes were accustomed (clandestinely) to obtain their supply

of animal food for their customers. Omitting the earlier notices of the practice, which are contained in the work before us, we shall take the matter up in the year 1825, when 'the Board of Health, having acquired proof that the horse-flesh sold for the dogs was habitually also used by the poorer classes; and considering the article to be well-tasted and nutritious—that the workmen of Montfaucon throve upon it, and that military men have often been glad enough to get it,—proposed to regularise the sale by open permission, and the establishment of horse-butcheries, where sound animals alone should be slaughtered.' This proposition was not approved, and the subject was for that time dropped. In 1822, and from thenceforward to 1830, an individual having obtained the permission to introduce horse-flesh into Paris, for the use of the wild beasts at the Jardin des Plantes, sold enormous quantities to the poor in the Faubourg St Marcel. Accordingly, in the distress which followed the Revolution of 1830, the project of an open and lawful sale of the article was again brought forward; but it was considered that society having by common consent refused the flesh of this animal, there must be something inherently disgusting in its use; and the idea was again rejected. The author, however, adds: 'I have, notwithstanding, myself acquired a perfect proof, that a larger quantity of horse-flesh was never consumed than during the last winter. The workmen out of employment were in the habit of going to the knacker's yard, where it was given to them in any quantity they desired, without their troubling themselves with inquiries into the causes of the animal's death. It was sufficient that the meat *looked* well, in order to be put aside for distribution. The Commissary of Police for the quarter of Saint Martin declared, that horse-flesh was notoriously sold, at several restaurateurs, at four *sous* per lb.; and that, when it could not be brought into town during the day, it was, during the night, and at an appointed time and place, thrown over the walls in large quantities, and immediately taken away.' This, he adds, is practised every day.—To complete this sketch, we have only to repeat the Doctor's assertion, that 'he never attended the depot for knacking the dead dogs and cats of Paris, without finding some of both species prepared for the spit; and (he asks) are these intended for the use of the workmen themselves, or are they sold in the city?' The question of legalizing horse-flesh seems to have occupied the attention of the French authorities very deeply. M. Duchatelet, who is a vehement advocate for the practice, insists upon two points; first, the perfect fitness of the article for the purpose of food; and, secondly, the impossibility of preventing its clandestine sale. If, he contends, the sale be permitted, every guarantee can be obtained for the wholesome and cleanly preparation of the meat, which cannot otherwise be insured; and the public would not risk purchasing it disguised under another appellation, at the higher price of the other more esteemed species of meat.—The state of things to be inferred from these details, does not augur well for the general condition of the working classes in Paris; and it is probably but too true, that however comfortable may be the mode of living of those above the lowest, yet that the utter unskilled labourers are for the most part accustomed to the greatest hardships. A Londoner of the lowest class would suffer much and long privation before he would tolerate the bare idea of feeding upon any unaccustomed article of diet; but if such an article came from a source so disgusting and suspicious, mere starvation alone would compel him to adopt it. On the point of clandestine consumption, there is perhaps greater equality between the two capitals than the public is aware of. Considering the enormous size of London, and the avidity of its speculators, it can hardly be doubted that much dressed food is sold within its precincts, whose origin and preparation would not bear too rigid scrutiny. Fortunately, 'what the eye sees not,' &c.; and it is well if no material less really unwholesome than horse-flesh is selected for the purpose."—*Athenæum*, Nov. 12. 1836.

17. *The Illyrian Dwarf.*—M. Geoffroy St Hilaire gave *L'Academie des Sciences* at Paris, some details respecting this remarkable dwarf, who is distinguished by the exact proportion of the several parts of his body. This individual, whose name is Mathias Gullia, was born in Illyricum, at Breda, a village not far from Trieste. He is now twenty-two years of age; and his height is not more than (one metre) three feet three inches. Until the age of five years, his physical development exhibited nothing particular; but after that time he

ceased to grow. His intellectual development, on the other hand, does not appear to have been arrested; and his parents, who accompany him, declare that he speaks with facility the Italian, French, and German languages, besides the Illyrian, and another dialect which are common on the shores of the Adriatic. The members of the Medical Section of the Academy were requested more particularly to examine him.

ANATOMY AND PHYSIOLOGY.

18. *Researches on the Structure of the Teeth. Extract of a letter from M. Retzius to M. Flourens.*—Messrs Retzius and Purkinje, have been engaged much about the same time, but unknown to each other, in microscopic researches on the teeth. The observations of the latter anatomist have been published in the Inaugural Theses of two of his pupils, viz. those of Messrs Frankel and Raschow; and M. Retzius has published his in the last volume of the Memoirs of the Academy of Stockholm, which will speedily appear. M. Purkinje, says the author of the letter, has carried farther than I have done his researches upon the enamel; and I believe that I on the other hand have pushed my investigations further on the structure of the osseous portion. The two preparations which I transmit along with this letter, will enable you to verify the accuracy of my conclusions. Both M. Purkinje and myself have recognised that the osseous substance is principally composed of waving fibres, and of hollow cylindrical canals, which extend from the cavity of the pulp or lining membrane in a radiating manner towards the surface; I have observed that they are ramified with great regularity, and but rarely communicate with each other. Under the microscope they appear like vessels which are filled with a white substance. I may add that the same structure is witnessed in the teeth of all the vertebrata. Since these observations were published, I find that Leuwenhoeck had made similar ones, but they had entirely been lost sight of. The two preparations I send you are prepared from human teeth, and on both a groove may be found, the one running vertically, the other horizontally, and in the centre of the crown. We have both discovered the cortical substance of Tenon, which surrounds the root of the human teeth. This substance, according to our

observations, very much resembles in structure that of the bones; it has the same small cavities, and undulating canals, but it appears to have no bloodvessels, or cylindrical tubes, or radiated canals.

19. *Microscopic Researches on the Structure of the Teeth, by M. F. Dujardin.*—The author having detailed the recent labours of Messrs Purkinje and Retzius (as stated above) remarks that Malpighi had, as early as 1667, observed the structure of the enamel, and that Leuwenhoeck in 1687 announced that the bony portion is composed of a union of small tubes in which he could perceive infiltrations, the result of capillary attraction. M. Dujardin then points out his method of observation, which consists in removing, by means of the small chissel of the engraver, laminæ of extreme fineness, either parallel to the exterior surface, or in the direction of the natural fissures, or perpendicular to the axis. The laminæ thus procured without roughness, which, be it observed, is not a little difficult, are exposed under water, placed between two fine plates of polished glass, and introduced into the microscope, varying the mode of illumination, and augmenting the power of the light by means of lenses placed underneath. The parallel laminæ of the surface exhibit in all teeth of mammalia, holes or pores of from $\frac{1}{1100}$ to $\frac{1}{1500}$ part of a line in size, and spaces $\frac{1}{300}$ of a line, so that there are from 380 to 500 in the length of a line. This is nearly the number indicated by Leuwenhoeck, but the observations of Mr Purkinje differ, inasmuch as this observer has found intervals five or six times as great as the pores or tubes. These pores are sometimes round or oval, but they are irregular, and elongated, and even appear to arise from the unity of several pores. This irregularity alone is sufficient to indicate that they are not the orifices of tubes or vessels; and besides it is impossible to recognise in the fine laminæ any difference of density, forming a concentric circle round the pores, which would have been the case if they were the sections of tubes or vessels; and moreover the rupture of these laminæ does not exhibit that they have proper parietes, which are more resisting. The pores especially in the long teeth, such as the canine, assume a somewhat regular disposition in a longitudinal direction, and it is in this direction also that the fissures

are most easily produced, because at each pore there is a corresponding elongated gap, or a small canal proceeding from the axis. If one of the laminæ is raised from the surface of these fissures, we see very distinctly the small canals, which are all nearly parallel, with a diameter nearly equal, proceeding from the centre towards the surface; but the irregularity in their calibre, and their intercommunications with each other, also go to prove that they are gaps left in the bony substance at the time it is secreted by the dentary pulp, and not pre-existing tubes, which would assume a very different kind of uniformity. M. Dujardin, moreover, has not been able to perceive the regular ramifications attributed by M. Retzius to the canals, nor the waving fibres which this anatomist states to be distinct from the cylindrical hollow tubes. He concludes by pointing out the difference which the structure of the teeth of fishes exhibits from that of the mammalia. As an example, he takes that of the pike, and at once found that it split, as did the others, with most ease in the direction of its length, whilst on the whole it is much softer. Their centre is composed of a fibrous bundle, as Malpighi had previously announced, and here he found irregular shut lacunæ of a considerable size. The cortical part, which is about $\frac{1}{15}$ of a line thick, separated from the central portion by a circle of compressed lacunæ, is composed of laminæ or fibres of a particular structure, bent outwards, and wholly different from the enamel or bony substance of other teeth.

20. *Summary of Researches upon the Anatomy of the Pelvis, by Mr Alexander Thomson.*—The author states that these researches are connected with a great work upon Hernia, and that it is chiefly for the purpose of elucidating this part of surgical pathology, that they have been undertaken. He points out successively the general arrangement of the different fibrous laminæ, which occur in the parietes of the abdomen, and the neighbouring parts, and thus determinates the number of curvings which such hernia ought to have, according to the region in which it occurs. From these statements he deduces many remarks, on the application of bandages, and operations, and the various manifestations which in certain cases may supersede the necessity of the scalpel: finally, in those

cases in which it must be employed, he points out those parts in which incision is superfluous; as for example, in the operation of crural hernia, he discusses the propriety of the divison of Gimbernat ligaments, and avails himself of this opportunity to point out the minute structure of this ligament: Far from being so simple as is usually supposed, according to him, it is formed by the superpositions of many fibrous laminæ, which are the prolongations of the tendinous extremities of different muscles. The author in concluding this summary insists on an anatomical point which he has already displayed in several memoirs which have been read to the Academie des Sciences, viz. upon the crossing of these tendinous fibres, and their interlacement upon the mesial line of the abdomen.

NEW PUBLICATIONS.

1. *Levy's Work on Mineralogy.*

We have the pleasure of announcing that the printing of an important work, which the scientific world owes to the liberality of Mr H. Hewland of London, is now nearly finished, and that early next year it will appear in three volumes octavo, with a volume of 83 plates, representing crystals, with descriptions drawn up by the late celebrated Abbé Hauy, under the title, "*Description d'une Collection de Mineraux, appartenant à Monsieur Charles Hampden Turner, formé par Mr Henri Heuland, et décrite par Mr Armand Levy*, en 3 vols. 8vo, avec 1 volume de 83 planches, &c."

2. *Micographia: containing Practical Essays on Reflecting Solar, Oxy-Hydrogen Gas Microscopes, Micrometers, Eye-Pieces, &c.* By C. R. Goring and Andrew Pritchard, Esqrs., 1 vol. 8vo, pp. 231. London, Whittaker and Company.

In this Journal we have frequently directed the attention of naturalists to the important and beautiful discoveries made in our time by means of the microscope. The investigations of Ehrenberg on the Infusoria and on fossil organic remains; the new researches on the organic elements, and intimate structure of animal bodies, by G. R. Treviranus; the discoveries of Von Baer, Rathke, Purkinje, Wagner, Valentine, Müller, Retzius, Dujardin, Brown, Bauer, and other distinguished explorers of the minuter arrangements in the organic kingdom; and the curious observations of

Nicol on the structure of fossil vegetables, we owe to the powers of the microscope. We can, indeed, have little hesitation in affirming, that the admirable investigations now so auspiciously commenced by means of the microscope, are opening up to us an entirely new world. Observers are indebted to the authors of the Micographia for various valuable contributions to microscopical science ; and the present volume we particularly recommend as a manual on this subject.

3. *History of British Fishes.* By WILLIAM YARRELL, Esq., Vice-President of the Zoological Society of London, &c. &c. Illustrated by nearly 400 wood-cuts. 2 vols. 8vo. John van Voorst, London.

Before the appearance of this valuable work, the subject of British fishes had engaged the attention of a good many observers, and much curious information had been collected. To Mr Yarrell, so long advantageously known to naturalists, has been reserved the agreeable though difficult undertaking of bringing together, in an accurate form, all that is at present known on this important subject. That he has succeeded, is evinced by the universal testimony in favour of the " History of British Fishes," expressed by our best naturalists. The enterprising publisher, Mr Van Voorst, has been fortunate in securing for his work on British zoology the talents and practical knowledge of such naturalists as Yarrell and Bell.

Proceedings of the Society for the Encouragement of the Useful Arts in Scotland.

THE Society for the Encouragement of the Useful Arts held its first meeting for session 1836–37, in the Royal Institution, on Wednesday the 9th November 1836, at 8 o'clock, P. M. EDWARD SANG, Esq. V. P. in the Chair.

The following communications were laid before the Society :—

1. Specimen of a *New Method of combining Letter-press with Lithography ;* by facilitating the introduction of *Diagrams, &c. for Books of Science, &c.* By Mr John Graham, Printer, 124 Trongate, Melville Place, Glasgow.

The specimen produced is the Second Edition of the Pharmacopœia of the Glasgow Royal Infirmary 1835.

2. On an Improvement in the formation of the common *Inside Chasing Tool.* By Edward Sang, Esq. F. R. S. E.—V. P. Soc. Arts.

3. Donation. *Researches on Heat.* Second Series. From the Transactions of the Royal Society of Edinburgh. 2d May 1836. By Professor Forbes, F. R. S. L. & E., V. P. Soc. Arts, &c. From the Author.

3. Donation. *On the Mathematical Form of the Gothic Pendant.* With a Plate. By Professor Forbes. From the Author.

Nov. 23.—Edward Sang, Esq. V. P., in the Chair. The following communications were laid before the Society :—

1. Mr Robison exhibited and described a *Table Lamp* (Argand burner) *calculated for being used with Cocoa-nut Oil.* Communicated by Sir George Mackenzie of Coull, Bart., M. S. A.

This lamp gives a powerful light at a considerably smaller expense than those do in which it is necessary to burn Spermaceti oil.

2. Description of an *Improved Turnip Cutter.* By George William Hay, Esq. 2 Duncan Street, Newington.

A model was exhibited, as also one on the old construction.

3. Remarks on Mr James Gall junior's *System of Musical Notation by Figures—for the use of the Blind.* By John Thomson, Esq. Professor of Music, Edinburgh, M. S. A.

4. Donation. Statements of the Education, Employment, and Internal Arrangements adopted at the *Asylum for the Blind, Glasgow, &c.* and Ninth Annual Report by the Directors, with Lithographic Illustrations. Presented by John Alston, Esq. the Author. Printed at Glasgow, June 1836.

5. Donation. First Specimen of *Printing for the Blind,* executed at the Glasgow Asylum; under the direction of James Alston, Esq. From Mr Alston.

The following candidates were admitted as ordinary members :—

1. Mr Robert Hume, Plumber, 21 West Register Street. 2. Mr Alexander Kirkwood, Die-Cutter, Meuse Lane, St Andrew Street.

Dec. 7.—Mr Professor Forbes, V. P., in the Chair. The following communications were laid before the Society :

1. Part First of the Annual Report on the State of the Useful Arts, ordered by the Society. By Edward Sang, Esq. F.R.S.E., V. P. Soc. Arts, teacher of Mathematics, and lecturer on Natural Philosophy, Edinburgh.

In this part of his report, Mr Sang brought under notice the more recent improvements in the Turning and Planing Machines.

2. On the Erroneous Geographical Position of many Points on the Frith of Clyde. By William Galbraith, Esq. teacher of Mathematics, Edinburgh, M. S. A.

In this paper Mr Galbraith shewed, from actual observation, that several points in the entrance to the Frith of Clyde, such as Pladda Light and the south end of Arran, are erroneously laid down even on the best maps, to the extent of an error of five miles in latitude; the longitude being also very erroneous. He concluded by suggesting the propriety of memoralizing Government to allot a tenth part of the men employed on the Trigonometrical Survey of Ireland, to complete the Survey of Scotland.

3. Two Models of Snow-Ploughs, invented by Mr Thomas White, wright, Straton, were exhibited.

4. Drawing and Description of a Tenoring and Sash-making Machine. By Mr John Kirkwood junior, wright, Glasgow.

5. W. Austin and Company's Family-Mangle, which obtained the Silver Medal in 1834, was exhibited in an improved form.

This mangle has been simplified, and iron frames have been substituted for wooden ones. Mr Wilshere of 9 Waterloo Place, the maker, exhibited this mangle.

6. The Committee on M. Dembour's (of Metz) Metallic Ectypography, or Method of Engraving in Relief, reported. Mr Gellatly, convener.

7. The Report of Committee on Mr R. Adie's New Anemometer, was read.

8. The List of Prizes offered by the Society for the current Session, 1836–37, were distributed.

9. The following Report of the Prize Committee awarding the Prizes for Session 1835–36, was read, and the Prizes were delivered to the successful Candidates, by the Vice-President, with appropriate addresses:—

1. To Edward Sang, Esq. teacher of Mathematics, and lecturer on Natural Philosophy, Vice-Pres. Soc. of Arts,—for his Improvement in the Construction of Wollaston's Goniometer; read and exhibited 13th April 1836.—The Society's Honorary Silver Medal.

2. To Mr John Sang, land-surveyor, Kirkaldy, M. S. A.,—for his Systematic Method of Measuring Surface and Solidity; read 13th April 1836.—The Society's Honorary Silver Medal.

3. To Mr James Gall junior, printer, Edinburgh,—for his specimens of Embossed Maps for the Blind; exhibited 9th March 1836.—The Society's Honorary Silver Medal.

4. To Messrs John Macpherson (of Smith's Heirs), Blair Street,

Edinburgh, and Charles Hope Smith, garden-architect, Edinburgh, —for their New Mode of Heating a Bath by means of a Portable Boiler; read, and exhibited in operation, 17th February 1836.—The Society's Honorary Silver Medal.

5. To Mr R. Adie, optician, Liverpool,—for his New Anemometer, by which the most minute Changes in the Force or Velocity of the Wind or Current of Air may be measured; read 25th May 1836.—The Society's Honorary Silver Medal.

6. To William Galbraith, Esq. teacher of Mathematics, Edinburgh, M.S.A.,—for his New Pocket Box Circle for making Observations at Sea or on Land; read and exhibited 13th April 1836.—The Society's Silver Medal, value Ten Sovereigns.

7. To Messrs Maclure and Macdonald, lithographers, 190 Trongate, Glasgow,—for Nine Specimens of Transfer Lithographic Drawing and Printing; exhibited 27th April 1836.—The Society's Silver Medal, value Eight Sovereigns.

8. To Mr James Whitelaw, 18 Russell Street, Glasgow,—for his Additions to the Turning-Lathe, for facilitating Slow Turning where only a small portion of the body is meant to be turned; read and exhibited 18th November 1835 and 13th January 1836.—The Society's Silver Medal, value Five Sovereigns.

9. To Mr James Gall junior, printer, Edinburgh, M. S. A.,—for his Guide for Teaching the Blind to write a common Current hand; and for his Pin Notation for enabling the Blind to perform Arithmetical Calculations, and to form Geometrical Figures, &c.; read and exhibited 30th March 1836.—Five Sovereigns.

10. To Mr J. Kirkwood junior, wright, Glasgow,—for a Machine for cutting Mortises in Joiner Work, introduced by him into this country from America; read and exhibited 27th April 1836. —Three Sovereigns.

11. To Mr John St Clair, teacher of Music, 59 South Bridge Street, Edinburgh (himself blind),—for his Simple Plan for enabling Blind persons to write to their seeing Friends by means of a Writing Board; read and exhibited 13th April 1836.—Three Sovereigns.

12. To Mr Duncan Macgregor, smith, Comrie,—for his Model, and the ingenuity displayed by him in his New Escapement; read and exhibited 27th January 1836.—Three Sovereigns.

There was no competition for the following prizes:—

1st Prize, Keith Gold Medal of Twenty Sovereigns. 2d Prize, Second Lithographic Prize from Chalk Drawings, Eight Sovereigns.

The special thanks of the Society were given to the following gentlemen for their respective communications, viz.—

1. To Mr Morris Leon, sealing-wax manufacturer, 7 Ingliston Street, Edinburgh,—for his Method whereby, with five given Weights, any number of pounds may be weighed from 1 lb. to 112 lb. inclusive; read 13th January 1836.

2. To Mr Samuel Leith, lithographer, late of Banff, now of Leith and Smith, lithographers, Hanover Street, Edinburgh, Assoc. Soc. Arts,—for his Twelve Specimens of Lithographic Drawing and Printing; exhibited 27th April 1836. These specimens are so nearly of equal merit with those of Messrs Maclure and Macdonald, No. 7., that it was with difficulty and hesitation the Committee decided between them.

3. To Dr Andrew Fyffe, lecturer on Chemistry, Edinburgh, M. S. A.,—for his Experiments on the Use of Steam in the Economizing of Fuel; read 13th April 1836. The Society have requested Dr Fyffe to continue his experiments on this interesting subject.

4. To David Stevenson, Esq. resident engineer for Granton Harbour,—for his Observations on the Dublin and Kingston Railway; read 8th March 1836.

5. To Edward Sang, teacher of Mathematics, Edinburgh, Vice-Pres. Soc. Arts,—for his Suggestion of a New Experiment, whereby the Rotation of the Earth may be demonstrated; read 9th March 1836.

The following candidates were admitted ordinary members, viz.—

James Ballantyne, Esq. of Holylee, 13 Castle Street; Robert Wright junior, Esq. architect, 8 Fettes Row; Mr John Ranken, glass-manufacturer, Leith Walk.

The Society elected their office-bearers for the ensuing year, viz.—

President.—The Most Noble the Marquis of Tweeddale, K. T.

Vice-President.—Sir John Graham Dalyell, Kt. F. A. S.; Robert Bald, Esq. F.R.S.E.

Secretary.—James Tod, Esq. 21 Dublin Street.

Foreign Secretary.—Alexander Adie, Esq. F.R.S.E.

Treasurer.—Robert Horsburgh, Esq. 1 Fettes Row.

Curator.—Mr Dunn, 50 Hanover Street.

Ordinary Councillors.—Dr D. B. Reid, Mungo Ponton, Lieut.-Col. Macdonald, John S. More, William Fraser, Wilk. Steele, George Swinton, John S. Russell, James Milne, Edward Sang, Richard Whytock, James Slight.

List of Patents granted in Scotland from 20th September to 17th December 1836.

1. To Elisha Haydon Collier of East India Cottage, City Road, in the county of Middlesex, formerly of Boston in the State of Massachussetts, America, Civil-Engineer, for an invention of "an improvement or improvements in steam-boilers."—Sealed 20th September 1836.

2. To William Barnett of Brighton in the county of Sussex, founder, for an invention of "certain improvements in apparatus for generating and purifying gas for the purposes of illumination."—21st September 1836.

3. To Francis Coffin of Russel Square, in the parish of Saint George, Bloomsbury, and county of Middlesex, gentleman, for an invention, communicated by a foreigner residing abroad, of "certain improvements in the construction of printing machinery or presses."—24th September 1836.

4. To Matthew Hawthornthwaite of Kendal, in the county of Westmoreland, weaver, for an invention of "a new mode of producing certain patterns in certain woven goods."—4th October 1836.

5. John Isaac Hawkins of Chase Cottage, Hampstead Road, in the county of Middlesex, Civil-Engineer, for an invention, communicated by a foreigner residing abroad, of "an improvement in the blowing-pipe of blast furnaces and forges."—4th October 1836.

6. To George Richard Elkington of Birmingham, in the county of Warwick, gilt-toy maker, for an invention, of "an improved method of gilding copper, brass, and other metals or alloy of metals."—4th October 1836.

7. To William Hinkes Cox of Bedminster, near Bristol, tanner, for an invention of "an improvement or improvements in tanning."—14th October 1836.

8. To John Pickersgill of Colman Street, in the city of London, merchant, for an invention, communicated by a foreigner residing abroad, of "improvements in preparing and in applying India rubber (caoutchouc) to fabrics."—14th October 1836.

9. To Thomas John Fuller of the Commercial Road, Limehouse, in the county of Middlesex, Civil-Engineer, for an invention of "a new or improved screen for intercepting or stopping the radiant heat arising or proceeding from the boilers or cylinders of steam-engines."—18th October 1836.

10. To George, Marquis of Tweeddale, for an invention of "an improved method of making tiles for draining soles, house tiles, and flat roofing tiles, and bricks," the word "bricks" having been omitted in former patent of 25th May last.—19th October 1836.

11. To William Hale of Crooms Hill, Greenwich, in the county of Kent, civil-engineer, for an invention of "certain improvements on machinery applicable to vessels propelled by steam and other power, which improvements, or parts thereof, are applicable to other useful purposes."—22d October 1836.

12. To Thomas Grahame of Nantes, in the kingdom of France, but now of St James's Street, in the county of Middlesex, gentleman, for an invention of "certain improvements in passing boats and other bodies from one level to another."—25th October 1836.

13. William Brindley of Caroline Street, Birmingham, in the county of Warwick, paper-manufacturer, for an invention "of improvements in the manufacture of tea-tray and other japanned ware, and in the board or material used therein, and for other purposes."—26th October 1836.

14. Michael Linning, clerk to his Majesty's Signet in Scotland, for an invention of "certain improvements in converting mosses into fuel, and in preparing and drying the said mosses, and for making and extracting certain colouring matter or paint, and tar, gas, oil, ammonia, varnish, and other properties from the same."—29th October 1836.

15. George Sullivan of Morley's Hotel, Charingcross, in the county of Middlesex, gentleman, for an invention, communicated by a foreigner residing

abroad, and invention by himself, of "improvements in machinery for measuring fluids."—18th November 1836.

16. To Robert Walter Swinburne of South Shields, in the county of Durham, agent, for an invention of "certain improvements in the manufacture of plate-glass."—18th November 1836.

17. Augustus Applegath of Crayford, in the county of Kent, calico-printer, for an invention of "certain improvements in printing calico and other fabrics."—18th November 1836.

18. John Yule of Sauchiehall Street, Glasgow, practical engineer, for an invention of "improvements in rotatory engines, or an improved rotatory engine."—18th November 1836.

19. Joseph Whitworth of Manchester, in the County Palatine of Lancaster, engineer, for an invention of "certain improvements in machinery, tools, or apparatus for turning, boring, planing, and cutting metals and other materials.—24th November 1836.

20. William Watson of Liverpool, in the County Palatine of Lancaster, merchant, for an invention, communicated by parties residing abroad, of "certain improvements in the manufacturing of sugars from beet-root and other substances."—3d December 1836.

21. Henry Huntly Mohun of Walworth, in the county of Surrey, doctor of medicine, for an invention of "improvements in the manufacturing of fuel."—5th December 1836.

22. To Robert Copland of Courland, Wandsworth Road, in the county of Surrey, engineer, for an invention of "combinations of apparatus for gaining power."—5th December 1836.

23. William Sneath of Ison Green, in the county of Nottingham, lace-maker, for an invention of "certain improvements in machinery, by aid of which improvements thread-work ornaments of certain kinds can be formed in net or lace, made by certain machinery commonly called bobbin-net machinery, and on other fabrics."—9th December 1836.

24. To Thomas Henry Russell of Handsworth, near Birmingham, tube-maker, for an invention of "improvements in making or manufacturing welded iron tubes."—9th December 1836.

25. To John Buchanan of Ramsbottom, in the county of Lancaster, mill-wright, for an invention of "an improved apparatus for the purpose of dyeing and performing similar operations."—9th December 1836.

26. To Luke Hebert of Paternoster-Row, in the city of London, civil-engineer, for an invention of "certain improvements in mills or machines for grinding and sifting farinaceous and other substances."—9th December 1836.

27. To John Gordon Campbell of the city of Glasgow, in the county of Lanark, merchant, and John Gibson of the same city and county, throwster, for an invention of "a new or improved process or manufacture of silk, and silk in combination with certain other fibrous substances."—9th December 1836.

28. To Joseph Hanson of Hinchley, in the county of Leicester, architect, for an invention of "an improved vehicle for the conveyance of various kinds of loads upon common and other roads."—9th December 1836.

29. To Daniel Chambers of Carey Street, Lincoln's Inn, water-closet manufacturer, and Joseph Hall, plumber, of Margaret Street, Cavendish Square, both of the county of Middlesex, for an invention of "an improvement in pumps."—17th December 1836.

30. To James Elnathan Smith of Liverpool, in the county of Lancaster, merchant, for an invention, communicated by a foreigner residing abroad, of "certain improvements on railways, and on locomotive carriages to work on such railways."—17th December 1836.

31. To George Guynne of Holborn, in the county of Middlesex, gentleman, and James Young of Brick Lane, in the same county, brewer, for an invention of "improvements in the manufacture of sugar."—17th December 1836.

PRINTED BY NEILL & CO. OLD FISHMARKET.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Account of an Improvement in the Construction of Wollaston's Goniometer. By EDWARD SANG, Esq., F. R. S. E., Vice-Pres. Soc. Arts, Teacher of Mathematics, &c. Edinburgh. *

THE science of crystallography has now become, on account of its connection with the new subject of polarized light, a most important branch of stereometry. Almost the only instrument

* Read before the Society of Arts for Scotland, 13th April 1836,—the Society's Honorary Silver Medal awarded 7th December 1836.

Report on Mr Sang's Improved Form of Wollaston's Goniometer.

Your committee have examined carefully Mr Sang's addition to the goniometer, which consists of a plane mirror capable of being adjusted, so that the plane of reflection shall be perpendicular to the axis of the instrument.

Instead of bringing the image of an object (such as the bar of a window) reflected from the surface of the crystal whose angle is to be measured, to coincide in direction with a second object (such as a window bar parallel to the first), Mr Sang proposes to employ the reflection of a single object from a plane mirror attached to the instrument.

This modification, though very simple, affords great facility of practical application. In using the instrument in its usual form, the image of the first object (A), reflected from the crystal, can only be brought to coincide in direction with the second object (B), seen by direct vision, whilst the instrument remains perfectly at rest: and this however distant either object. Alter the position of the goniometer, and the crystal attached to it by the smallest employed in crystallographic researches, is the reflecting goniometer contrived by Wollaston; but that instrument, in its ordinary form, is of troublesome and uncertain application. It is, in fact, an incomplete instrument, inasmuch as it does not contain, in its own construction, all the elements from which the determinations are to be made. Before it can be applied to the measurement of the inclination of two faces of a crystal, a pair of parallel lines must be traced at a considerable distance from the table or stand on which the instrument is placed, and exactly at equal distances from the axis of its motion. The axis has also to be rendered parallel to these lines; and all this is preparatory to the adjustment of the crystal. The goniometer in this form is much inferior to the spindle of the turning lathe. It is, for accurate purposes, as completely a fixture as the lathe, and at the same time wants its steadiness and dimensions. I long employed the head of my lathe as a goniometer, and, having obtained a graduation to single minutes from Mr Adie, I continue to employ it whenever the objects are of considerable dimensions. By measuring the height of the reflecting surface above the centre, as given by the tool of the slide-rest, the argument of the parallax is readily obtained, and thus nothing more is left to be desired than portability. By a very simple contrivance, even the repetition of the angle can be obtained, and

quantity, and the reflected image of A will be displaced from its apparent coincidence in direction with B, by twice the angle through which the reflecting surface of the crystal has been shifted. The result is, that the slightest unsteadiness of the hand or the instrument produces some uncertainty in making the coincidence. By using a *permanent* reflecting surface attached to the instrument itself, to afford a second image of A to answer the end of the object B, any displacement or tremor of the instrument affecting both surfaces equally, does not impair the accuracy of the adjustment, so that the instrument in its improved form may be as accurately used in the hand (like the reflecting circle or sextant) as when clamped to the firmest table. If the distance of the object A be considerable, the adjustment amounts simply to making the reflecting plane of the crystal parallel to the permanent reflecting plane secured to the instrument.

Your committee are persuaded, from actual experiment, that this addition to the reflecting goniometer, although so simple, is one of great practical consequence; and the reporter desires to add, from his personal knowledge, that, although only now presented to the Society, Mr Sang has employed this principle in practice for several years past.

James D. Forbes (*Reporter*)

25*th May* 1836.

any error in dividing or centering the graduated limb corrected; this addition, however, I have not found it necessary to adopt.

As it may be useful to those members who have turning-lathes, to know how these may be converted into accurate angular instruments, I shall detail the necessary modifications.

The first requisite is a *slow motion* or *tangent screw* for the spindle. That usually adopted in the theodolite answers very well; still better would be that employed by Robinson in his small astronomical circles. No turner of any standing can feel the least difficulty in constructing this for himself. The next thing is to obtain an accurately graduated circle. For this a circle of brass should be accurately fitted to some part of the spindle or pulley, and made so carefully that it may be removed and replaced with certainty. This must be sent to the dividing engine to receive the graduations. The limb on my lathe is 6.9 inches in diameter, and is graduated in thirds of degrees; the subdivision into single minutes being effected by means of a vernier. As soon however as possible, I mean to construct a micrometer for the same purpose, because by its help the position of the eye in reading off may be rendered more convenient; and also because the edge to which the vernier applies has become considerably rounded.

From this addition, the lathe receives a great augmentation of power. It can be employed as a graduating instrument, particularly in cases where the graduations are to be unequal, as in logarithmic circles, &c.; or it is competent to the construction of orrery wheels, when the deviation from the mean motions are to be shewn; it is also useful, in conjunction with the graduations of the slide rest, for placing a series of points on a piece of work by means of their polar co-ordinates. I find no difficulty in guiding my tool by such means, within the thousandth part of an inch of the required place.

To use the turning lathe thus fitted up as a reflecting goniometer, we have only to provide an adjusting chuck which may enable us to adjust the position of the crystal attached to it. The plan I adopted is this. Being already in possession of a cylindric chuck, with eight adjusting screws, which I used for turning pivots accurately, I took a square bar of iron and placing it in the chuck, well centred, turned a portion of the end conical: to this cone I fitted a small piece of brass with a flat face, on which to cement the crystal or prism whose inclination is wanted.—By means of the adjusting screws, four of which work on one end, and four on the other end of the square bar—the faces of the crystal can be rendered parallel to the axis of the lathe. The first approximation can be readily obtained by causing the reflected image of one side of the shear, agree with the direct image of the other. To obtain the final and accurate adjustment, the following process is adopted. On the opposite wall of the room is fastened a paper scale with divisions marked so strongly as to be perceived readily from the lathe; and near the floor on the same wall is placed a small black circular mark. The image of the scale is then brought to coincide with the circular spot, and the division which culminates it is noted. Turning the lathe head half round, the reflection of the spot is brought in contact with the scale, and if the same division be again read off no farther adjustment of that face of the crystal is needed; if any difference exist, one-half of it is to be corrected by means of the screws in the chuck. To save time in after adjustments, there is then placed a distinguishing mark at the mean of the two readings, and this mark is ever afterwards compared with that at the bottom of the wall; at least if the position of the lathe be not changed. If the two marks be placed at the same distance from the axis of the lathe, the two readings on the graduated limb will not differ from each other exactly by 180°; but by that + or — twice the parallax arising from the face of the crystal not passing actually along the axis of the spindle. Half the sum of the two readings then will be freed from the influence of parallax. The analogous half sum obtained from the other face of the crystal will also be freed from parallax, and thus the difference between the two half sums will give exactly the inclination wanted.

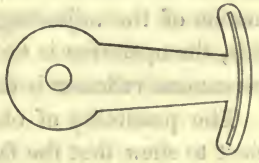
To repeat the measurements on another part of the limb, we have only to turn the piece of brass round on the cone to which it is fitted: but as the axis of the cone is not coincident with that of the spindle, unless by chance, a new adjustment of the crystal is then needed. The repetition is, however, scarcely called for, as the readings have always been taken on opposite sides of the limb, so as to eliminate the error in centering, while no errors need now-a-days be feared in a graduation to minutes.

This apparatus is, as many trials have convinced me, quite sufficient to give the inclination of two reflecting surfaces to the nearest minute; nor does it seem to me that, in order to render it still more precise, any thing else is required than the addition of the telescope, and the use of more delicate graduations. Although a very convenient appendage to the workroom, it is by no means adapted for the general purposes of the crystallographer, who requires a portable and manageable tool.

The manipulation of the common reflecting goniometer resembles that above described in every thing but the steadiness and certainty of the operations; one source of inaccuracy so exceeds all the rest, that it may serve at once to characterise the instrument; I mean the instability of the frame which carries the reader: this results from the goniometer being detached from the two parallel lines or objects of comparison, and from its extreme lightness. Any change in position which occurs during the observations induces an error in the results; and unless particular precautions, such as fastening the instrument to the table, be taken, the measurements can never be entirely depended on.

It is by no means difficult to obviate this inconvenience, and to give at the same time a compact and completely portable form to the common goniometer.

For this purpose, I fix upon the sole of the instrument a small plate of brass, by means of two screws, one of them working in a round, and the other in an elongated opening; so that the brass may have a limited motion round the first, and may be clamped in any required position by the second screw. To this I attach a small stage with its



upper face incled about 45°, the particular inclination being of no moment, and on that face I lay a piece of good thin plate glass.

Instead of bringing the reflected light of an object to coincide with the direct light of some other object, I cause it to coincide with that reflected from the plate glass. When this coincidence is obtained, the one reflecting surface is parallel to the other, at least if we neglect the parallax. The next coincidence will place the second plane in the same situation, and thus the inclination will be at once obtained, provided the parallaxes in the two cases are alike.

By means of the permanent reflector, we can make all our observations on images of one object, which we can take as distant as convenient; the coincidences will thus be more easily observed than those of one object with another. The parallax can always be rendered so small as not to influence the results; indeed, by using an object at the distance of half a mile, it will be entirely avoided. But, even although circumstances should compel us to use a proximate object, the parallax can be readily and advantageously eliminated from the observations; before, however, any observations are made, the permanent reflector must have its plane rendered parallel to the axis of the instrument. The limited motion of the brass arm enables us to make this adjustment. A substance with a pretty extensive and well-polished face is cemented to the goniometer, and the image of a distant object in it is made to coincide with that seen in the permanent reflector. The limb of the goniometer is then turned half round, when, unless the adjustment happen to have been hit at first, the instrument, when *used as a sextant*, by receiving the direct light from the object and the twice-reflected light from it at the same time, will not exhibit again that coincidence. The two images will appear in a plane passing along the axis of the motion, and, by the motion of the permanent reflector, one-half of the distance must be corrected; the other half by the motion of the adjusting apparatus on the goniometer. After this, the operation is to be repeated until no error appear; the permanent reflector is then placed parallel to the axis.

The possibility of obtaining a coincidence will now be sufficient to shew that the face of a crystal is placed properly on the goniometer. During all these operations the instrument may be held in the hand like a reflecting circle, the coincidences being entirely independent of the absolute, and depending only on the relative positions of the parts. Indeed, if the observer were provided with a silvered mirror attachable to the axis, the instrument would become an efficient reflecting circle.

If all the observations be made on one object, that part of the parallax which depends on the distance of the axis from the point at which the reflection takes place on the permanent reflector will be constant, and will influence all the readings in the same way, it may therefore be entirely neglected; only that, when the object is very near, care must be taken to use the same part of the surface, or to direct the eye in a fixed way in regard to the parts of the goniometer: this, however, only when the distance is a few feet. The parallax, depending on the distance from the axis of the instrument to the face of the crystal, must, however, be attended to. In the direct observation this parallax will affect the reading in one way; in the back observation the same parallax has the opposite effect, so the amount of the two readings is freed from its influence; and thus half the difference between the sum of the readings in the one face and the sum of the readings in the other face of the crystal will be their inclination. By using this process, the error of centering is entirely corrected; it is, however, troublesome when the crystal is minute, and the repetition of the measurement by the direct method is preferable, the object being taken at some considerable distance.

The surface of the permanent reflector must not be too bright, otherwise the light from it will be too strong, and prevent the distinct vision of the other image. By moving the eye a little backwards and forwards a position can be found which will give to both images the like brightness, and thus facilitate the estimation of the coincidences.

In conclusion, I remark, that the stops affixed to the instrument, as ordinarily made, impede very much the work; on which account I would recommend their removal from it even in its usual state.

On the Mineral Springs of Iceland. By C. Krug von Nidda. (Concluded from p. 110.)

Part II. On the distribution of Mineral Springs in Iceland.

The occurrence of the larger and more remarkable mineral springs, is intimately connected with the geognostical structure of the island. As the volcanic eruptions are limited to the district of the trachyte, so likewise the larger mineral springs are met with only in that formation; hence it is apparent, that it is one and the same volcanic process which manifests itself, but in a different manner, in the two phenomena.

The great band of trachyte, which traverses the interior of Iceland from the south-west to the north-east coast, consists of two parallel mountain plateaus, which enclose a large longitudinal valley. This valley is known only at its two openings, viz. on the south-west coast, and on the north-east coast. However much the diversified volcanic phenomena of these two opposite points of the coast may have excited the desire of travellers to investigate the interior of the island, all such attempts have hitherto been frustrated by insurmountable difficulties.

The south-western opening of the valley forms the great plain, which extends between the Eyafiell and the Bald-Jökul. It may be compared to a flat surface, which is much and variously pierced, from whose openings there issue, occasionally, streams of burning liquid lava, and, constantly, hot water and gas springs. Among the numerous cones of eruption, the Hecla holds the highest rank; and of the numerous mineral springs the Geyser is the most important.

Around Skalholt there are several hot springs whose temperature reaches the boiling point.

In the vicinity of the lake Apa-vatn, columns of smoke may be observed at many points, rising from warm springs. Several of these exhibit eruptions of considerable extent, which are repeated at certain intervals.

To the south of the Tingvalla lake, the Kirche Reikum is situated in a deep narrow valley, enclosed on both sides by precipitous rocky walls, which are composed of alternate layers of tuffas, streams of slag, and conglomerates. In the bottom of this valley there is a long line of hot springs, amounting to at least 100 in number. Most of them are so insignificant, that they would hardly be noticeable were it not for their clouds of vapour; but there are some which, after the Geyser and Strokr in the Haukadal, are probably the most considerable in Iceland. The springs of this valley have a great similarity to those of the Haukadal, and may in like manner be divided into water and gas springs. The water springs are filled with the clearest water, which contains the same constituents as the water of the Geyser. The incrustations consist of siliceous masses. Many of these springs have periodical eruptions; in the largest, the periods of repose last five or six minutes, and the eruptions one minute; the jets of water rise to a height of from twenty to thirty feet.

The soil on which the gas springs are scattered, consists of variously coloured clays. Sulphuretted hydrogen is the prevailing gas evolved by the openings. At their edges we find sulphur and some sulphuric salts.

The tuffa and slaggy conglomerate mountains of the Guldbringesyssel, rise to the south of the Thingvalla lake, and, including the middle of the tongue of land, form a steep rugged chain to the west south-west. At Krisuvig, a deep transverse valley cuts this chain. Beyond it the mountain range again rises, but only to form a small ridge, which is again terminated by a valley parallel to that of Krisuvig; on the other side of the second valley there is a ridge exactly similar to that between the two valleys. There, however, the chain ends, and in its line of continuation towards Cape Reikianaes, there are only isolated rocky masses of the most peculiar forms.

The valley of Krisuvig is important on account of its numerous sulphurous springs, which are distributed over a considerable flat tract, on its western rocky acclivity. So far as these springs occur, the soil consists of clays of various tints. Only a few of the openings are filled with muddy water. From all of them there issue copious streams of steam mixed with sulphuretted hydrogen. The deposit of sulphur round these springs is not inconsiderable; it is from time to time collected, and conveyed as an article of commerce to Reikiavig. Besides sulphur, gypsum, alum and sulphate of iron are the most common products.

In the neighbourhood of Cape Reikianaes there are several water and gas springs; but none particularly remarkable.

The other opening of the great longitudinal valley is not less interesting. The Myvatn lake is to be regarded as the centre of the volcanic phenomena of this district. Among the numerous cones of eruption scattered round it, the most remarkable are the Leirhnukur, and the Krabla, on the north-east side of the lake; and the Haedubreid on the south side. Large streams of lava cover the district.

In the Myvatn lake there are several hot springs, which are recognised by the great clouds of vapour rising from various points on the surface of the water.

The celebrated Namar or Sulphur mountains, lie to the north-east of the Myvatn lake, between it and the Leirhnukur and Krabla. They are about one mile long, and a quarter of a mile broad. The soil consists of variously tinted clays. Innumerable little hillocks, three to four feet in height, rise from the surface, and the hot gaseous streams burst through their summits. It is not altogether safe to walk on the Namar. The clay, constantly moistened by the watery vapours, is so slippery and soft, that at every instant one is afraid of sinking in the mass. It is only necessary to pierce with a stick the upper and somewhat cooled clayey crust, in order to ascertain how high a temperature prevails in the deeper layers; for immediately a hot stream of gases escapes from such an aperture. Sublimed sulphur occurs everywhere, and being collected by the inhabitants, forms rather an important article of traffic.

Henderson* gives a remarkable and interesting description of the hot mud springs which he saw in the crater of the Krabla. This traveller, when he reached the base of the Krabla, descried a vast volume of smoke, rising to a considerable height, at regular periods, from a break about two-thirds up the south-west side of the mountain. With much difficulty he ascended the acclivity, which was covered with loose masses of tuffa and pumice. At length he gained the edge of a deep gulley, at the bottom of which was situated a circular pool of black liquid

* Journal of a Residence in Iceland, vol. i. p. 170.

matter, at least three hundred feet in circumference. From the middle of this pool there was erupted, at certain intervals, and with a loud thundering noise, a vast column of the same black liquid, which was enveloped in thick clouds of smoke. From all the circumstances connected with the hollow in which this pool is placed, Henderson, with much probability, regarded it as the shattered remains of the crater of Krabla. The surface of the pool was about 700 feet below what appeared to be the highest peak of Krabla, and about 200 feet below the opposite height on which the traveller stood. Henderson descended to the margin of the pool, and found that the neighbouring soil was composed of coloured clays and sulphur. Nearly about the centre of the pool was the funnel-shaped descending pipe; the eruptions took place every five minutes, and lasted two minutes and a half; the jets reached a height of thirty feet. Besides this great opening, there was in the pool another jetter, which also exhibited eruptions, though on a smaller scale, and was evidently connected with it, as there was a continual bubbling in a direct line between them.

There are, to the north of the Myvatn lake, but nearer the coast, some other points where sulphur springs occur, but these are by no means so considerable as the Namar.

Among the most remarkable spouting springs (*huerer*) of this district are those of Reikiadal, situated a few miles to the south of the commercial village of Husevig; they consist of the Nordurhuer, the Oxahuer, and the Sydsterhuer, which are placed near to one another, in a direct line from north to south. The pure boiling water of these springs contains silica in solution, and thus possesses an encrusting power. The basins and pipes are of a large size; the eruptions are repeated at short intervals, but are of trifling magnitude.

Between the two trachytic plateaus of the Eriks and Hofs-Jökul, lie the interesting springs of Huerevalle. In this case also, the water and gas springs occur near one another. Some of the water springs are in a constant state of agitation, others are tranquil, and a third class exhibit periodical eruptions. But the most singular spring of the valley is a gas spring, which issues from the summit of a hillock of clay about four feet in height. The gaseous stream escapes from the opening with incredible violence, and produces a roaring noise, which, at the distance of a mile, resembles the dull sound of a lofty waterfall. When stones are thrown into the opening, they are immediately projected to a considerable height.

The Sneefield-Syssel forms a long narrow tongue of land, which stretches far out into the sea, on the west coast of the island. Its geognostical constitution is similar to that of the promontory of the Guldbringesyssel. In its centre there is a mountain chain composed of tuffas and slag conglomerates. Numerous cones of eruption are placed on the summit as well as at the base of this ridge, and from them have issued considerable streams of lava. Along the south coast of the tongue of land there is a long line of mineral springs, that are completely different from the greater number of the other mineral springs which are dispersed over the trachytic region of Iceland. They have a comparatively much lower temperature, are rich in carbonic acid in a pure and combined state, and contain, especially, carbonates of soda and lime, together with the muriate and sulphate of soda. On the other hand, silica and sulphuretted hydrogen occur only in extremely minute quantities. The inhabitants of Iceland term the springs *olkilder*, that is, beer-springs, owing to the somewhat intoxicating power communicated to them by the quantity of carbonic acid they contain.

Mackenzie * carried away water from several of these springs, and sent it to Thomson for examination. The most remarkable springs of the series are the following:—

Near Stadehraun there is a spring which rises from a stream of lava; it is very rich in carbonic acid, and contains little else but carbonate of lime.

At Rudemelr there is situated, among the volcanic cones of eruption, a mineral spring, whose temperature is 6° R. (45½° F.), which exhales much carbonic acid gas, and contains carbonate of lime as a chief constituent ingredient.

The spring at Lisiehuls has a temperature of 28° R. (95° F.). The carbonic acid gas which is evolved by it in great abundance, is certainly mixed with a trace of sulphuretted hydrogen gas. It contains in solution, carbonate of soda, carbonate of lime, muriate of soda, and a trace of sulphate of soda.

* Travels in Iceland, p. 398.

The spring of Buderstadt has a temperature of 6° R. ($45\frac{1}{2}$° F.), and in composition resembles extremely the preceding.

The springs which are so unusually frequent in Iceland, viz. those characterized by a high temperature, by their containing silica in solution, and by their giving out sulphuretted hydrogen gas, are entirely awanting in the volcanic promontory of the Sneefield-Syssel. This is certainly a remarkable circumstance, as we meet with this description of mineral waters everywhere in those portions of the island, where volcanic activity has manifested itself until a modern epoch by the eruptions of the volcanic chimneys. The promontory of the Sneefield-Syssel is one of these districts, for it presents numerous volcanic cones, some of which have been in a state of activity in modern times. The fact is, that this volcanic promontory did possess hot springs which contained dissolved silica. We find at many points siliceous incrustations, in the form of tuffs and sinters. The spring of Lisiehuls occupies the place of one of those siliceous springs; but its present deposits are only calcareous, and are entirely different from the deeper lying siliceous incrustations.

Are we to regard these carbonic acid mineral springs as the weak remains of the more powerful displays of volcanic activity of earlier periods?

It would lead us too far to enumerate the remaining mineral springs which are dispersed over the trap district. They may be the more easily omitted, as they are of insignificant magnitude, and are not in any degree to be compared with the gigantic aqueous eruptions, occurring in such abundance in the trachytic volcanic district. There are some isolated weak siliceous springs in the deep valleys and fiords of the north coast, but in the trap hills of the east coast they are entirely awanting.

One portion only of the trap region must be instanced, from its containing so large a number of springs as to entitle it in this respect to be compared with the trachytic district. It is that flat portion of the island traversed by several parallel valleys, which is bounded on the south by the mountains of Skardsheide, on the north by the chain of the Sneefield-Syssel, and on the west by the Borgar-fiord. The valleys of this plain, separated from one another by low rocky ridges consisting of layers of trap rocks, extend in a direction from east to west, and are parallel to the volcanic line of the Sneefield-Syssel. The most northern of these valleys is that of Norduraae, and then follow to the south those of Thuraae, Huitaae, and Reikoltsdal. All these valleys indicate by their parallelism a similar origin; and the cause which produced them is probably to be found in the volcanic trachytic mountain chain of the Sneefield-Syssel. In the Nonduraae valley, which lies farthest to the north-east, we are not a little surprised by finding a volcanic cone of eruption, from which a stream of lava has flowed, for in all other places the trap rocks exhibit no volcanic eruptions. Probably this is the only point in the whole island where a volcanic chimney is to be found among trap hills.

The southern valleys do not possess an inferior degree of interest, from the numerous hot springs to which they give rise. The Reikholtsdal is the most important, and owes its name to the pillars of smoke which it evolves. At its bottom there is a long line of hot springs, stretching over a space of two miles. Many of them exhibit periodical eruptions, and project the water to considerable heights. All the springs contain silica in solution, and give out sulphuretted hydrogen mixed with the vapour. Silica forms incrustations round their edges.

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*A New Pocket-Box Circle.** By William Galbraith, Esq., M. A. Teacher of Mathematics, Edinburgh, M. S. A.

In the early ages of the world, the instruments for making astronomical observations being very rude, the results obtained by them were far from accurate. In the days of Hevelius and Flamsteed, large sectors of many feet radius were employed; and, though divided to a very great degree of precision, yet being only parts of the circle, did not possess that accuracy which might have been obtained by employing the whole circle. At a much later period, quadrants were used at Greenwich, Oxford, and in most of the continental observatories; and, from the accuracy of their construction by Graham, Bird, Ramsden, and Troughton, important results for the advance-

* Read before the Society of Arts for Scotland, 26th March 1836. The Silver Medal, value ten sovereigns, awarded 7th December 1836.

ment of astronomy were derived from the labours of those astronomers to whom they were entrusted.

The first meridian transit circle, so far as we know, was that of Horrebow, constructed about the year 1735. The next, that of Mr Francis Wollaston in 1793, made by the late Mr Cary, though Ramsden had made the Palermo altitude and azimuth circle in 1789, and the Dublin circle some years afterwards, both of which have rendered essential services to astronomy. These were all of great size, and fitted for fixed observatories only. A smaller, and more portable circle, was still required to supply the wants of amateur astronomers and scientific travellers. Mayer of Göttingen first contrived an instrument by which he could diminish the errors arising from *bad dividing*, by the principle of repeating the measurement of an angle over the whole, or, at least, a great part of the circumference. Shortly afterwards, Borda invented his celebrated repeating astronomical circle and his repeating reflecting circle, of which so much use has been made on the Continent, and to which such extravagant eulogiums have been paid by the Continental observers. Undoubtedly, the results obtained by means of these instruments, particularly the former, are in many instances remarkable for their accuracy, considering their moderate dimensions. In fact, all the operations, astronomical and geodetical, required in the determination of the French arc of the meridian, were made by Borda's repeating circles of about *eight inches radius ;* while in the British trigonometrical survey, the astronomical observations were chiefly taken by a zenith sector of *eight feet* radius, and the terrestrial by a theodolite of *eighteen inches radius ;* and it is at this moment difficult to say, notwithstanding the disparity of the dimensions of these two classes of instruments, which of those two grand operations have been executed with the greater accuracy. Instruments of moderate dimensions, capable of repeating the observations frequently in a short space of time, seem by these, and other instances that might be produced, to approach the accuracy of the larger instruments much more nearly than might have been anticipated.

A reflecting circle was constructed by Bird for Admiral Campbell, chiefly from the description of one invented by

Mayer, contained in his Tabulæ Solis et Lunæ, published at London in 1770. This was the first *reflecting circle* to which the repeating principle was applied. It was also the opinion of the inventor that a circle could not be divided at that time to a greater accuracy than *three minutes*, the dividing engine not being then in existence, and for these reasons *sixteen inches* was fixed upon as the diameter of this circle, which Bird, in the actual construction, exceeded by an *inch and a half*. The consequence was, that the circle became far too heavy to be used in the hand, either at sea or land.

This circle was divided as usual into 360°, and therefore it was necessary to double the angle read off from the instrument, as required by the principles of optics, on account of the double reflection at the index and horizon glasses. To avoid the trouble of doubling, these instruments have, for many years, been divided into 720°, or the space on the arc equal really to half a degree, is now reckoned a whole degree.

Admiral Campbell having found the instrument, on account of its weight, unmanageable at sea as a repeating instrument, confined his observations to a part of the limb that was found to be most perfectly divided. This gave rise to the construction of the sextant, which was lighter and more easily managed. These advantages, however, were gained at the expense of superior accuracy. From the principles of construction, a circle with three verniers has the errors of centering, division, reading, glasses, &c. all either exactly, or nearly corrected; while in the sextant the accuracy depends almost entirely upon the abilities of the artist. Now, we think it cannot be doubted that the principle of correcting errors by mechanical means is much to be preferred to trusting to the character and abilities of the artist, however excellent both may be. For this purpose, even Troughton himself, with all his skill and ability as an artist, contrived a somewhat large reflecting circle of about eight or ten inches in diameter, and the same thing has been done by Dollond, Borda, Mendoza Rios, Hassler, &c. For many purposes these are too large and heavy, especially for travellers, surveyors, &c. who have generally had recourse to the pocket-box sextant, which is subject to the same errors as the larger sextants already alluded to; and to avoid these, I, many years ago, proposed to Troughton, the idea of forming a small pocket-box circle, similar to the one which I now produce, and in which very little of the diameter is lost in forming the radii to which the verniers are attached. Indeed, had the circular box been formed into a sextant instead of a circle, having an index carrying a single vernier, the length of that index would not have greatly exceeded those of the circle, on account of the space required for centering, and the segment cut off by the divided arc, and consequently little advantage would by that means be gained from greater length of radius.

Being unable to induce Troughton to enter into my views, I then attempted to get the late Captain Kater to patronize it, but without effect. I admit the good qualities of Troughton and Dollond's circles for many purposes, though I am also aware that their bulk, weight, and high price, are to many insuperable objections. I am also willing to grant to Kater's small portable circle all its merits as a travelling instrument at land, and I at this time possess one of the very best that Robinson has hitherto constructed, having both its horizontal and vertical circles six inches diameter, with three verniers, each showing 10″, and from the experience I have had, it promises to give, when properly managed, very accurate results. My object, however, was, by means of the new pocket-box circle, to furnish observers with a very convenient small portable instrument that might answer every useful practical purpose at sea as well as on land, when accompanied by one of the simplest and most convenient artificial horizons.

By the able assistance of Mr John Adie, I believe I have succeeded in constructing this little circle in a satisfactory manner, though in some of the minor details it may yet be simplified and improved, and I shall feel much pleasure should it meet with the good opinion of this Society, and shall gratefully adopt any suggestions of its intelligent members for accomplishing its future improvement, and bringing it more nearly to such a degree of perfection as it may be susceptible of. The three verniers read each to minutes only, but as observations must always be taken, from the nature of its construction, twice —once forward and once backward—a mean of six readings will be obtained, giving a probable error not exceeding 20″ or so, for each double observation. By repeating these two or three times when thought necessary, it is obvious a much greater degree of accuracy will be obtained, than, from the small size of the instrument, might naturally be expected. Its convenient form, the ease with which it may be used, and the accuracy of its results, will, it is hoped, recommend it to a numerous class of observers, while its moderate price will enable many to become purchasers.

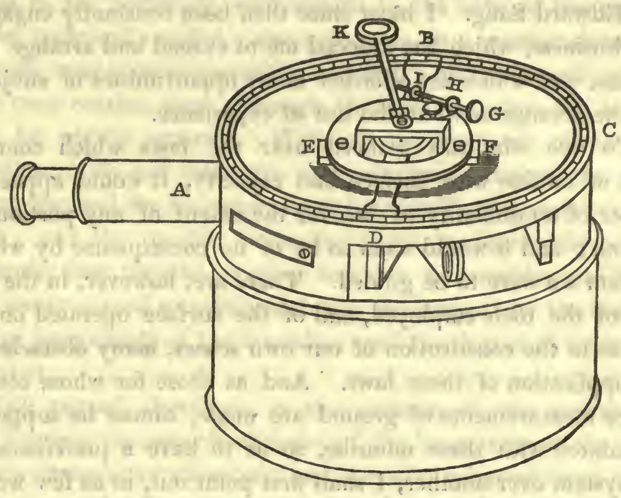
My remarks relative to the advantages derived from the use of two or three microscopes or verniers, are derived chiefly from an excellent analysis of the errors to which astronomical circles are liable, in a paper by Dr Robinson of Armagh, read before the Royal Irish Academy in 1825, and, if I am not mistaken, published subsequently in a separate pamphlet, so that it appeared to me unnecessary *now* to enter upon another discussion on this subject.

The learned author shews that "two microscopes will correct for eccentricity, or for any other error varying by a similar law; as also for all errors which are as the odd powers of the sine or cosine, but that *three* verniers are still better, failing only where the number expressing the order of the error is divisible by *three*."

In the original circle exhibited to the Society of Arts for Scotland, there are three verniers, but in the figure given here there are only two, though either mode may be followed by the maker when desired. In this figure A B C D is the circle divided into 720°, A the telescope, B, D, the two opposite verniers reading to minutes, or half minutes, if thought necessary, K the reading microscope or lens, G I the tangent screw fixed at any required position on the elevated circle E F H by a clamping screw near H. From this description, the method of making and using the circle will readily occur to those acquainted with the sextant.

54. South Bridge. WILLIAM GALBRAITH.

Galbraith's New Pocket Box Circle.



On a Systematic Method of Measuring Surface and Solidity. By Mr John Sang, Land-Surveyor, Kirkaldy.*

In most of the transactions relating to land, it is essential that its extent be ascertained, and that its boundaries be defined by permanent descriptions or representations. On correct estimations of the extent, depend the security of the fortunes of those engaged in transfers, and the success of many useful agricultural speculations. If the estimations be false, they may continue to mislead the agriculturist, and to injure the fortunes of the occupiers or proprietors for a series of years; for, when once made, they cannot be verified without complete re-measurements, which are expensive, even when conducted in the best manner. It is, therefore, of great consequence that the surveyor's operations be conducted with accuracy and ease. The object of this paper is to detail an improvement which increases the accuracy, while it makes apparent the limit of the errors, and also materially lessens the expense and labour of surveying.

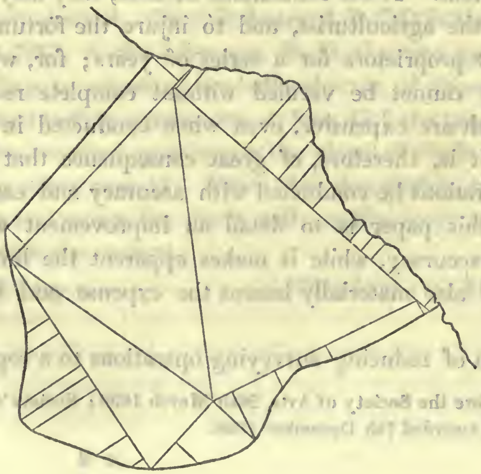
The idea of reducing surveying operations to a regular sys-

* Read before the Society of Arts, 26th March 1836; Society's Honorary Silver Medal awarded 7th December 1836.

tem, was communicated to me many years ago by my brother Mr Edward Sang. I have since then been constantly engaged in a business, which has induced me to extend and arrange the system, and which has afforded many opportunities of subjecting the arrangements to the test of experience.

To one who has glanced over the laws which connect form of outline with surface and capacity, it would appear a matter of no difficulty to discover the extent of any portion of ground; and it would seem to be of no consequence by which of them we were to be guided. There are, however, in the nature of the tools employed, and of the surface operated on, as well as in the constitution of our own senses, many obstacles to the application of these laws. And as those for whose convenience measurements of ground are made, cannot be supposed acquainted with these minutiæ, so as to have a preference to one system over another, I shall first point out, in as few words as possible, the common methods, and their defects.

Ground is usually measured by dividing it into trigons and trapezoids, whose dimensions are ascertained by a chain alone, or by a chain accompanied by an instrument for measuring angles. The trigons always occupy the interior and larger part of the ground, while the trapezoids are arranged on the outskirts, and fill up the surface between the trigons and the boundary of the ground, in a manner similar to that in the annexed figure. The parallel sides of the trapezoids are technically



called offsets, and they determine the position of a series of points in the boundary, with regard to the side of the larger figure, technically called a surveying line, in a manner theoretically the most accurate possible, and which also practically gives very true results, even although the surveying line and boundary be widely separate. With the management of offsets, therefore, I do not interfere. The distance between the surveying line and the boundary must be actually traversed at each offset; and the trouble of moving from one line to the other, demands that they be as close together as possible, and that they never exceed a certain distance, determined by the curvature or irregularity of the boundary, and the degree of accuracy aimed at.

With regard, therefore, to the position of the surveying lines forming the outer boundaries of the large trigons, the surveyor's choice is very limited; and it is also apparent from their connexion with offsets, that their lengths must be actually measured. The choice of the forms of the trigons is therefore also limited by these circumstances, as well as by the nature of the surface of the ground.

In order to obtain data for the interior trigons, either their sides or their angles must be measured, or a mixture of both. The measuring of lines on the ground by the common chain is well known to give only an approximation to the truth. The errors are occasioned by the roughness of the surface, by the elongation or contraction of the chain, from the force employed, or from the variation of heat; but, above all, by the difficulty of applying its end to the exact spot formerly occupied by its beginning. Since the data obtained in the field are thus erroneous, the trigons should be of that form which is least altered by a slight variation of the sides or angles. But this arrangement, from the causes already mentioned, is scarcely ever practicable, and many of the trigons are unavoidably of such a shape that the errors in measurement are likely to produce greater errors in the plans, and in the calculated extent.

The area of the trigons is arrived at, by its relation to their three sides, to two sides, and the sine of the contained angle, or to the sines of the two angles and the interjacent side. When these quantities are at once discovered from the field operations, the calculations are simple; but in the greater number of cases where angular measurement is employed, an intricate and laborious process must be first undergone. So tedious are the operations, that, in fact, in nine cases out of ten, the artist cuts them short, by drawing out a plan of the ground from the data obtained in the field, and remeasuring from the paper others more convenient. This method is even recommended in respectable treatises on land-surveying.

The errors acquired in the field are of no moment compared with those consequent to transferring the data to paper, in the shape of a plan. It is true, one source of error, that of repeating the measuring instrument, is much lessened, for the scale which corresponds to the chain can conveniently be of such a length as to embrace the longest line required, and thus leave only an error in both its terminations. The scale also may be made of a material whose rate of expansion is very small, and from the precision to which the art of dividing has arrived, its divisions may be conceived to be perfect. The instruments called protractors, for marking out angles on the paper, may also be as well divided as the theodolite, or other angular instrument employed in the field. But to counterbalance these advantages, there are the diminished size of the figures, and the expansion of the paper on which they are traced.

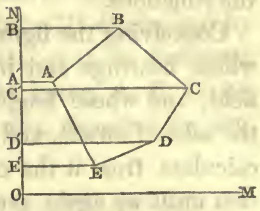
The eye cannot be applied, for a few hours, to a traverse scale with eighty divisions in the inch, without much pain. The smallest scale in use for the naked eye has sixty divisions to the inch. The fifth part of a division of this scale by means of a sliding index and needle, may be transferred to paper; or, we may lay down a line in that particular manner, without the aid of a microscope, and by estimating the fraction of the division by the eye alone, to the accuracy of the $\frac{1}{300}$th part of an inch. But the method is only applicable to a few of the lines, and I believe I am far within the truth, in estimating the utmost accuracy with which distances, lying in all the accidental directions of a survey, can be transferred to paper in the common way, by means of a scale and needle, or by compasses, to be the $\frac{1}{100}$th part of an inch. The transferring of circular divisions to paper is liable to a greater risk. In the field there is the chance of an error in placing the theodolite over the apex of the angle to be measured. In drawing out the plan, either the same risk is to be encountered, or the risk of the line transferring the angle not being truly parallel. From observations, I find that in a multitude of angles transferred to paper, with the various scattered apices required by surveyors, that the accuracy of each cannot be depended on to within less than four or five minutes. Supposing the scale used to be 200 links to an inch, the average length of the lines to be 500 links, and the trigons to be of the best possible shape, this error would be about one link in every line, and, combined with the risk of error in laying off the lengths, it would give three links in every line, or six links in the thousand. The common and unavoidable changes in the heat and moisture of the air of a room cause considerable contractions and expansions in paper, the rate depending on its texture. Experiments induce me to estimate the change of size at one in two hundred. We have thus in protracting and remeasuring a series of figures, a total risk of error of 17 links in the thousand, or 34 acres in the thousand. These errors are supposed to be in lines, forming the best possible shape of trigons. If we were to regard the increased risk from the shapes being unavoidably bad, the estimate would be doubled. And there can be no doubt, that double or treble this error is frequently made in consequence of following the slovenly, and in truth tedious practice of making the estimations of area depend on the accuracy of the plan.

A rectilineal figure is given, when all its sides and angles except three are known. If all the sides and angles, except two or one, be given, the data are checked, or we can discover by calculation, whether they be possible, or consistent with each other. If, in a rectilineal figure, formed by surveying lines, there be an inconsistency, arising from the causes already mentioned, we may conceive that we will make a nearer approximation to the truth, by dividing the error among all the constituent parts of the figure, so as to make the smallest alteration in each. To such a subdivision of the error it is barely possible to approximate in the form of the parts when protracted. It is very difficult to make the subdivision of error on the original data, for the sides and angles depend on one another in a very complex manner. Yet if corrections be not made, the error increases and accumulates in every new step of the operations, until it becomes altogether unmanageable. By employing the method I am going to describe, the errors are easily corrected, and accumulation is rendered impossible.

The chief features of the method are,—that the interior surface is not divided into trigons, but is considered solely as a polygon, the number of its sides being of no consequence to the accuracy of the result, and, that the field measurements are made so that all the terminations of the surveying lines can be readily co-ordinated to three assumed planes. To understand the principles of the system no exertion is required. They are developed by the collation of a few simple facts, resulting in a simple and very beautiful law.

Three perpendiculars falling from a point upon three planes mutually intersecting one another at right angles, are called the rectangular co-ordinates of that point, and their lengths determine its position with regard to the planes. And it is evident, that the co-ordinates of a series of points to the same plane will determine the positions of these points in relation to one another. For the sake of convenience, I will designate the co-ordinates severally by the names of Altitude, Latitude, and Longitude. The altitude is defined as the distance of a point from an assumed horizontal plane situated below it, as the continuation of the surface of the sea; the latitude as the distance northwards from a vertical plane stretching east and west; and the longitude as the distance eastward from another vertical plane stretching north and south. And I shall suppose all the co-ordinates to lie on these sides of the planes, in order to avoid the contemplation of negative quantities. I shall designate by the term Inclination, the angle which a line forms with its projection on the horizontal plane, and which may be either negative or positive, according as the line tends upwards or downwards; and by the term bearing, the angle which the horizontal projection of a line makes with the north line. The bearing shall be read from left to right, and shall be conceived always to increase in that direction.

Let ABCDE represent any rectilineal figure; the plane of the paper being the horizontal plane, and the lines ON, OM the intersections of the vertical planes. If the co-ordinates of any point A are assumed, and if the bearings, lengths and inclinations of the sides, are given, the co-ordinates of the other points are determined in the following manner.



The altitude of B is equal to the altitude of A added to the distance AB, into the sine of the inclination of AB. The latitude of B is the latitude of A added to the distance AB into the sine of the bearing of AB into the cosine of the inclination of AB; and the longitude of B is the longitude of A added to the distance AB, into the cosine of the bearing of AB into the cosine of its inclination. In the same manner, with the other points. The co-ordinates of the several points, therefore, may be calculated with facility. If a common table, giving the functions of an arc to 90^0 only, be used, 90^0, 180^0, and 270^0 must be deducted from the bearings, as they lie respectively in the second, third, or fourth quadrant, and attention must be paid to the change, under these circumstances, of the sine into the cosine, and the cosine into the sine, which, together with the change of signs omitted in these tables are thus exhibited.

If the bearing be between	Latitude is equal to	Longitude is equal to
0° and 90°	$+ L \cos b$	$+ L \sin b$
90 and 180	$- L \sin (b - 90^\circ)$	$+ L \cos (b - 90^\circ)$
180 and 270	$- L \cos (b - 180)$	$- L \sin (b - 180)$
270 and 360	$+ L \sin (b - 270)$	$- L \cos (b - 270)$
$L =$ length, $b =$ bearing.		

It is, however, far more convenient for these, as for all other trigonometrical calculations, to use a table titled with the de-

* See Davidson's Mathematics, new Edition, 1832, p. 280.

grees and minutes all round the circle, and giving the signs of the functions.

Conceiving the figure to represent a series of surveying-lines, whose bearings and inclinations have been ascertained in the field, and whose lengths have been necessarily measured for the sake of offsets, and that we assume co-ordinates for A, and calculate from it the co-ordinates of all the points in succession until we again arrive at A, we will have before us a clear view of the accuracy of the field operations. For it is apparent that the co-ordinates of A thus calculated should be the same as those assumed at first. Or, which is the same thing, the sum of all the differences between each two points of altitude, latitude, and longitude respectively, should amount to nothing. If these sums be much more, or less than nothing, there has been a blunder in the survey, for which there is no other remedy than to revise the field operations; but if there should be a slight excess or defect from zero, we may safely assume that it is composed of an accumulation of minute errors in the co-ordinates of each point, contracted in the measurement of the lines and bearings, from the unavoidable causes already mentioned. And from this assumption it follows, that a nearer approximation to the truth would be the calculated co-ordinates collated with a proportion of the error depending on the distances of the points from one another in order, and the functions of the respective bearings of the lines. Such a subdivision of error would, in a practical point of view, produce quantities differing very little from the quantity given by dividing the whole error by the number of points. If we therefore divide the error by the number of points, and apply one part to each, we will arrive at a very near approximation to their true places; at any rate, we will effectually prevent those accumulations of error so troublesome in the old methods. By using the same process in every one of the polygons of which a survey consist, we will thus either have the errors entirely corrected, or minutely subdivided among all the points, according as our assumption applies or not to the circumstances, in either case, by a simple operation, rendering the whole survey infinitely more accurate than one conducted with equal care in the old method.

Referring to the same figure, and conceiving it now to be entirely in the horizontal plane, we perceive that its area is equivalent to the sum of the trapezoids BC, CD diminished by the sum of the trapezoids BA, AE, ED; or if we designate the latitudes of the several points by the letters A, B, C, &c and the longitudes by the small letters *abc*, &c., and the surface by S, we obtain this equation,

$$2\,S = (b+c)(B-C) + (c+d)(C-D) - (e+d)(E-D) - (a+e)(A-E - (b+a)(B-A)$$

which being simplified, becomes

$$2\,S = A(b-e) + B(c-a) + C(d-b) + D(e-c) + E(a-d)$$

Or, in words, twice the area of a polygon is equivalent to the latitude of each point, multiplied by the longitude of the point before, minus the longitude of the point after it. And the area will be a positive or negative quantity, according to the direction in which we proceed. To determine the area of any polygon, we thus require no more multiplications than the number of its sides; or, since the differences, not the absolute lengths of the co-ordinates, are considered, we can subtract from all the latitudes the latitude of the most southerly point, and thus have one fewer multiplication. It may also be noticed, that the formula simplifies itself when applied to the tetragon, so as to require only two multiplications. It is true that these formulæ are not well adapted for logarithmic calculation; but the whole sum of the products is readily obtained by the use of a table of quarter squares. For example, let the co-ordinates of the points of a polygon be as follows:

	Lat.	Long.
A	3089	14566
B	3527	14846
C	2682	15793
D	2478	15660
E	1753	15156
F	2997	14643

Subtracting 1753 from the latitudes, to save a multiplication, we have twice the area, equal to

1336 (+ 203) =	+ 271208		
1774 (+ 1227) =	+ 2176698		
929 (+ 814) =	+ 756206		
725 (— 637) =		—	461825
0 (— 1017) =		—	
1244 (— 590) =		—	733960
or to	+ 3204112	—	1195785
	— 1195785		
or to	2008327		
therefore area =	10.04163		

But each of these products is also equal to the quarter square of the sum of its factors, diminished by the quarter square of the difference of its factors, and consequently twice the area of the polygon will be simply equivalent to the algebraic sum of these quarter squares; hence the calculation may stand thus:

	Sum.	Diff.	Q. S.	Q. S.
1336 (+ 203)	1539	1133	592130	320922
1774 (+ 1227)	3001	547	2251500	74802
929 (+ 814)	1743	115	759512	3306
725 (— 637)	88	1362	1936	463761
0 (—1017)	——	——		
1244 (— 590)	654	1834	106929	840889
			3712007	1703680
			1703680	
			2008327	
and the area as before =			10.04163	

By throwing the corrections into the formula already given, we can easily approximate to the error in area of any polygon occasioned by the errors in measurement. For, in the same figure let the co-ordinates assumed for A, be A and a, and let the calculated co-ordinates be for the other points:

$$\left.\begin{array}{r} \text{B and } b \\ \text{C and } c \\ \text{D and } d \\ \text{E and } e \\ \text{A} + 5n \text{ and } a + 5m \end{array}\right\} \begin{array}{c} \text{The corrected} \\ \text{co-ordinates} \\ \text{would be} \end{array} \left\{\begin{array}{l} (\text{B} - n) \text{ and } (b - m) \\ (\text{C} - 2n) \text{ and } (c - 2m) \\ (\text{D} - 3n) \text{ and } (d - 3m) \\ (\text{E} - 4n) \text{ and } (e - 4m) \\ \text{A} \quad\quad \text{ and } \ a \end{array}\right.$$

In the first series, the whole error may be conceived to rest on the point A, in the second, to be equally divided among all the points. Let the area of the first be S, and the second s. We have

$$2s - 2\text{S} = m(3\text{A} + 3\text{B} - 2\text{C} - 2\text{D} - 2\text{E}) + n(-3a - 3b + 2c + 2d + 2e).$$

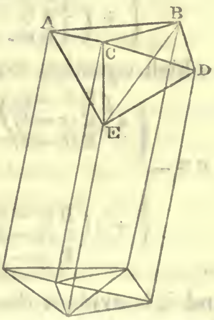
And in the same manner, if all the errors were placed on B we would have

$$2s - 2S = m(-2A + 3B + 3C - 2D - 2E) + n(2a - 3b - 3c + 2d + 2e).$$

Similar formulæ are easily deduced from this for other polygons. Supposing all the error to be on A, and using the same notation, we have

$$\begin{aligned}
&\text{in 3 gon } 2(s - S) = m(A + B - 2C) \;\ldots\ldots\; + n(-a - b + 2c) \\
&\text{in 4 gon} \quad = m(2A + 2B - 2C - 2D) \;\ldots\; + \\
&\qquad\qquad + n(-2a - 2b + 2c + 2d) \\
&\text{in 5 gon} \quad = m(3A + 3B - 2C - 2D - 2E) + \\
&\qquad\qquad + n(-3a - 3b + 2c + 2d + 2e) \\
&\text{in 6 gon} \quad = m(4A + 4B - 2C - 2D - 2E - 2F) + \\
&\qquad\qquad + n(-4a - 4b - 2c + 2d + 2e + 2f) \\
&\qquad\qquad \&c. \quad \&c.
\end{aligned}$$

In order to investigate a formula for solidity, we must suppose that the co-ordinates are determined of so many points in the surface, that the spaces included by joining them in threes are planes, and that the field-book indicates which of the points are to be thus connected. If two of these adjacent trigons are in different planes, their common side, in strict language, is a side of the solid; but, for the sake of convenience, I shall define the term, side of the solid, to mean the line forming the common base of a pair of trigons, although they be in the same plane; every one of the lines joining the points indicated in the field-book, will thus be a side of the solid. A point will also be understood to be in the upper or under surface of the solid, according as a perpendicular from it to the horizon passes through the solid, or does not pass through it.



It is evident, that the lines ordinating the apices of any solid to the horizontal plane, must divide the space between the upper surface and that plane into as many triangular prismoids as there are trigons in that surface; and the space between the under surface and the same plane into as many triangular prismoids as there are trigons in the under surface; and that the capacity of the solid is equivalent to the sum of one set of these prismoids subtracted from the sum of the other set. But the solidity of any of these prismoids is equivalent to its base, multiplied by the third part of the sum of its parallel sides. The base itself is equivalent to half the latitude of each point, multiplied by the longitude of the point before, minus the longitude of the point after it. Again, this base is a negative or positive quantity, according to the direction in which we proceed around its boundary; and if we conceive ourselves to be placed on the *outside* of each face of the solid, and to proceed always in one direction, say from left to right, the signs of the areas of the faces in the upper surface will be contrary to the signs of the areas in the under surface. Therefore, if the solid is regarded as composed of two sets of prismoids, whose bases are determined by the law of co-ordinates, and taken always in the same direction, its capacity will be simply equivalent to the algebraic sum of these prismoids.

Assuming a specific solid, as the hexahedron A B C D E, and indicating the latitudes of each point by the large letters A, B, C, &c.; the longitudes by the small letters a, b, c, &c.; the altitudes by the letters α, β, γ, &c.; and the solidity by S, we will have,

$$6\,S = \left\{ \begin{array}{l} \left(\left\{ \begin{matrix} A\,(b-c) \\ B\,(c-a) \\ C\,(a-b) \end{matrix} \right\} (\alpha+\beta+\gamma) \right) + \left(\left\{ \begin{matrix} C\,(b-d) \\ B\,(d-c) \\ D\,(c-b) \end{matrix} \right\} (\gamma+\beta+\delta) \right) \\ + \left(\left\{ \begin{matrix} C\,(d-e) \\ D\,(e-c) \\ E\,(c-d) \end{matrix} \right\} (\gamma+\delta+\varepsilon) \right) \\ + \left(\left\{ \begin{matrix} A\,(c-e) \\ C\,(e-a) \\ E\,(a-c) \end{matrix} \right\} \alpha+\gamma+\varepsilon \right) + \left(a \left\{ \begin{matrix} D\,(b-e) \\ B\,(e-d) \\ B\,(d-b) \end{matrix} \right\} (\delta+\beta+\varepsilon) \right) \\ + \left(\left\{ \begin{matrix} B\,(a-e) \\ A\,(e-b) \\ E\,(b-a) \end{matrix} \right\} (\beta+\alpha+\varepsilon) \right) \end{array} \right.$$

which equation expanded and simplified becomes,

$$6\,S = \left\{ \begin{array}{l} \alpha \begin{pmatrix} B\,(c-e) \\ C\,(e-b) \\ E\,(b-c) \end{pmatrix} + \beta \begin{pmatrix} A\,(e-c) \\ B\,(a-d) \\ D\,(c-e) \\ E\,(d-a) \end{pmatrix} + \gamma \begin{pmatrix} A\,(b-e) \\ B\,(d-a) \\ D\,(e-b) \\ E\,(a-d) \end{pmatrix} \\ + \delta \begin{pmatrix} B\,(e-c) \\ C\,(b-e) \\ E\,(c-b) \end{pmatrix} + \varepsilon \begin{pmatrix} A\,(c-b) \\ B\,(a-d) \\ C\,(d-a) \\ D\,(b-e) \end{pmatrix} \end{array} \right\}$$

And it is evident that the formula may be applied to any rectilinear body in these words, six times the solidity of any rectilinear mass is equivalent to the altitude of each apex, multiplied respectively by the product of the latitude of each apex connected with it by a side, into the longitude of the apex before minus, the longitude of the apex after it in the order of their connexion with the first by a side.

The co-ordinates of all the points in the survey (except points determined by offsets) are thus calculated, in order to examine the accuracy of the work, to perform the necessary corrections, and to calculate the area, but they present another important advantage in the facility which they afford by protracting either plans or models. This is performed by means of two graduated slips of ivory or brass, the one adjusted so as to slide on the other at right angles, and called T scales, or offset scales; the lines which determine every point are previously corrected, and they cease, with regard to the drawing or model, to have any dependence on one another, so that in the representation there can be no accumulation of errors.

The formula for the area of a polygon, given above, differs in a practical point of view from that of M. Lexel of Petersburgh, which is in this shape.

$$2\,S = \begin{cases} A \,.\, B \,.\, \sin\,(480° - a) \\ A \,.\, C \,.\, \sin\,(360° - a - b) \\ A \,.\, D \,.\, \sin\,(540° - a - b - e) \\ A \,.\, E \,\sin\,(720° - a - b - c - d) \\ B \,.\, C \,\sin\,(180° - b) \\ B \,.\, D \,\sin\,(360° \; b - c) \\ \quad \&c. \quad \&c. \quad \&c. \end{cases}$$

in so far, that the number of members may be always one less than the number of sides, while in this the members are more complex, and their number increases with the number of ways in which the sides, except one, can be collated together in pairs.

The full advantages of the system are not apparent until its application to the field operations is examined. In a polygon determined by the measurement of all its sides and their bearings, there is absolutely no form which produces, from a given error in measurement, a minimum alteration of shape; the square of the error in position being in every case equivalent to the square of the error in length, *plus* the square of the length into the square of the error in bearing. And the error in area is a minimum only when the area itself is a maximum, the perimiter remaining the same, or when the figure becomes a circle. From these reasons the surveyor has unlimited scope for adapting his lines to the offsets. And, indeed, to this object is his chief attention to be directed, as he never requires to measure lines on which offsets are not to be raised. There are, however, a few easily obtained circumstances desirable in the arrangement of the lines. I shall point them out, and the mode of ordering the field operations when it differs from the usual practice.

The most convenient zero for the bearings, at least in a large survey, is the north line. If the theodolite be placed at the commencement of a surveying-line, so that when the telescope points north the vernier indicates zero, the indication of the vernier, when the telescope points along the surveying line will give its bearing; and when the theodolite is removed to the other end of the surveying line, and so placed that the vernier indicates when the telescope is again directed along the line, the former bearing plus or minus 180°, it will be situated, with regard to the north, as it was at first, or the telescope will again point north when the vernier indicates zero. When the theodolite is in this second position it is said to be set back to the line, and it is ready to measure any other bearing as it did the first. If we measure in this manner a series of bearings until we arrive at a point whose bearing is already measured from the first station, we will be able to examine the accuracy of the work, for the counter-bearing should be equal to the other plus or minus 180°. When a bearing is thus twice measured, it is said to be a closing bearing. An error in the measurement of the angles is thus known, at each close, from the simple inspection of the field-book. Since there is some difficulty in placing the theodolite exactly over the hole made by the signal stave, there may be a small error in the second measured bearing, independent of the perfection of the angular instrument. On the third bearing there is a risk of greater error, and so on. This circumstance demands that none of the surveying-lines be very short, and that there be as many closing bearings as possible; or, what is the same thing, that from each station the bearings of all the other stations within sight be observed. This risk of error is not greater than that from want of centering in the old methods, but it is infallibly brought under the surveyor's notice.

In a survey of 10,000 or 12,000 acres, in order to prevent the possibility of an accumulation of errors, it is sufficient to group the stations by laying off the first bearing, by means of a powerful instrument, from a conspicuous point in the middle of the ground, and communicating it to a number of other conspicuous points scattered over the ground, chosen rather from their prominence and command of a good view, than from their fitness to be the termination of surveying-lines. From each of these conspicuous points the bearings of the termination of the surveying-lines within sight are again grouped, and finally the bearings of the lines themselves are determined ; the object in view being to derive every bearing from the first by the fewest possible removes. If the first bearing has been the true north, the position of the instrument may also be verified at any point by again observing the direction of the pole-star while in the meridian, or by taking equal altitudes of the sun. This bearing, however, before comparison with the first, must be corrected for the inclination of the meridians to one another. The correction in minutes is equal to the distance between the two meridians in imperial links multiplied by the tangent of the geometric latitude, and divided by 9206. By attending to these precautions, the error caused by defective centering becomes very small, and entirely unworthy of notice compared with the unavoidable small errors in the length.

In a survey of such a size as we have been contemplating, no skeleton-work of triangulation is required. The result of the whole, indeed, because of the corrections, may be supposed to be derived from the continuous measurement of a base line constantly verified. In the first extensive survey to which I applied the system of co-ordinates, the ground was covered in preparation by a series of large trigons, deduced at considerable expense from a base line measured with much more care than the payment for common surveying work allows of being used in ordinary lines. The positions of the stations were first calculated by the usual trigonometrical formulæ, and they were afterwards reduced to the notation of co-ordinates for the sake of convenient comparison with the subsequent work. The position of the points in the two surveys differed from one another, but the difference on being analyzed, was found to be nearly in a constant ratio to the distance of the points from the first station in the systematic survey. In fact, had the base line been conceived to be a little longer than it actually was, the points in both surveys would have coincided so nearly, that for practical purposes it would have been unnecessary to alter them.

A convenient arrangement for avoiding parallax in the inclination is to have all the signal staves of the height of $7\frac{1}{2}$ links, and divided from the top downwards into alternate white and black spaces of one link each, leaving the remaining third for being pushed into the ground. When observing the inclination, the height of the instrument is measured, and the telescope is directed to a point at the same height on the signal stave; there is consequently no other correction required, except in long lines, for the curvature of the earth. By this simple arrangement some tedious work is saved; and the depression at one end of the line can be compared, on the ground, with the elevation at the other. If landed proprietors were aware how small an additional expense is incurred in measuring, along with the ordinary subjects of a survey, the height of every station above the sea or other conspicuous level, they would seldom omit having it done. The closes in altitude seldom require correction. This evidently proceeds from the inclinations being always small, and from their being referred to the same zero at each station.

The method of co-ordinates allows the whole attention to be devoted to having the surveying-lines convenient for offsets, and over even ground, except that they must also be as long as possible. They should be over even ground to avoid errors in length, and the too frequent use of the instrument for horizontal reduction. If possible, they should be so arranged, that the inclination can be measured from one termination, or, at most, from both terminations at the same time with the bearing. The calculations already described render certain the detection of any blunder in the measurement; and the very trouble of dividing the *small* errors, and the satisfaction derived from perfect closes, induce great care in the manipulation of the chain. The surveyor is also forced to verify his chain frequently, for the slightest elongation is detected in the bad closing of the new with the old work.

The twisting and hauling of the chain, so as to measure offsets, is one great cause of the alteration in its length. The accuracy, and also the speed of the work, is increased, by measuring the offsets by a tape line carried along with the chain. Such an instrument should be 200 links long, and be contained in a light box, eight inches diameter, capable of being fastened by belts to a person's right side. The line should be fastened to a cylinder of wood five inches diameter, and be received into a groove formed of tin-plate inside the box, and turning with the cylinder. By this means it is quickly wound up, and its margins are prevented rubbing on the sides of the box. The aperture through which the line enters the box should be in hardened steel. If the tape, immediately after being drawn through the linseed oil varnish, be stretched as tight as possible between posts in the open air freely exposed to wind, and thus kept till dry, it will retain its length after being divided, and never require adjustment. When receiving the divisions, it should be kept in tension by a weight of from ten to twelve pounds.

The measurements admit of being written in the field-book in a uniform manner. The book is ruled in the usual way, with three columns,—the middle column for the lengths of the surveying lines and the positions of the offsets, the two outer columns for the offsets to the right or to the left. The stations are all designated by numbers; and, beginning with the first at the bottom of the page and writing upwards, every subsequent measurement has its place in a continuous order. It is thus impossible to neglect any of the dimensions in the calculations or plan, for in them, the lines, with their bearings and offsets, are taken in the same continuous order.

In most surveys it is economical to measure all the lines and offsets before the bearings; and thus weeks, or even months, may intervene between the two operations. For the stations, marks are thus required, which can be easily identified, and which also may remain in the ground for a considerable time. For this purpose, pins of soft fir-wood, about three inches long, do very well. If much longer, when inserted into the holes made by the signal staves, they protrude above ground, and are thus liable to be removed by accident or design. If shorter, they drop too far into the holes, and cannot be easily extracted. The names of the stations are marked on these pins by notches, as shewn in Loudon's Encyclopædia of Gardening.

To recapitulate; the advantages afforded by the method of co-ordinates are as follows:—The errors acquired in the field operations are all corrected, and the amount of error in every polygon is made apparent in the form of a simple quantity. The area is deduced from corrected data, and the plans are also protracted from corrected data; and the positions of the points being determined by independent quantities, there can be no accumulation of error in them. It is impossible that a blunder in the field-work pass into the subsequent operations. From the uniformity and simplicity of the notation, all the calculations, as well as the measurements, can be referred to, and examined at any subsequent period. Besides, the scheming of the field operations is more easy, and the time occupied in them and in the house work is less than by the old methods.

KIRKALDY, 17*th March* 1836.

On the Erroneous Geographical Position of many Points in the Frith of Clyde. By WILLIAM GALBRAITH, Esq. M. A. Teacher of Mathematics, Edinburgh, M. S. A. *

THERE are few branches of knowledge more generally interesting than the sciences of Geography, Astronomy, and Navigation. From the combined progress of these departments of human knowledge, many new and interesting discoveries in distant portions of the earth's surface have of late years been made, and their exact position determined with considerable precision. When this is admitted with regard to the more distant countries of the globe, it is naturally to be expected that the

* Read before the Society of Arts for Scotland 7th December 1836.

exact position of the various important points, and the true conformation of our own shores, would be accurately known.

This, in many instances at least, is far from being the case, and that, too, in the track of the most extensive shipping trade in Scotland; I mean the river, and more especially the Frith of Clyde.

My attention was drawn to this point lately, when I resided a short time in the island of Arran. During the month of August last my friend Mr George Atkin and I examined a considerable portion of the sea-coast of that romantic island, with regard to its geological structure, and its botanical productions; while at the same time it was thought that latitudes, longitudes, and elevations of the more prominent mountain ranges above the mean level of the sea (subjects which should always, if possible, be combined) would also contribute to render any account of our joint labours a little more interesting and satisfactory. Indeed, if the relative positions are not well fixed, any geological survey of Scotland, as that proposed by the Highland and Agricultural Society, will not be very satisfactory, as it is difficult to trace the directions of the strata correctly across the country without being misled, or drawing, perhaps, erroneous conclusions, as I found by experience some years ago in an attempt to trace a section across the country from Inverary through the mountains about Glencroe, Benlomond, Aberfoyle, &c. towards Stiring. This I intended to carry across the country from sea to sea, though I have not as yet had either leisure or opportunity, but may perhaps resume it on some future period. Indeed the expense attending such operations is, in my case at least, one of the greatest obstructions. The Highland Society no doubt offer a premium of about L. 50 for a geological survey of any part of Scotland of about 200 square miles, that is, a country of about 14 miles square, or about 20 long by 10 broad. Such a reward may be very good for an independent gentleman, who has leisure and inclination to pursue such researches, or for one whose professional pursuits are likely to direct his attention that way, but for any other, I am afraid, the temptation will not be sufficient. It appears to me that there is no reason it should. I have lately learned, on authority which I think may be trusted, that M.

H. J. De La Beche, the author of several excellent works on geology, is now employed on the southern counties of England. He has, I have been informed, completed a geological survey of Devonshire, and that of Cornwall is considerably advanced. These counties have, many years ago, been surveyed trigonometrically, by the Board of Ordnance, at the public expense, and this survey, too, and the engraved maps, are also corrected to the present time, at the expense to the country of about *one thousand pounds annually.*

Again, there are, I believe, about 1200 men now employed on a survey of Ireland at the public expense. The great triangles were all completed some time ago, and the subordinate ones, together with a complete survey with the chain, are now in progress. Some of the engraved maps are already finished and on sale, and those of the whole country, in the course of a few years, will be completed.

Is it fair and equitable that the claims of Scotland alone should be entirely overlooked? Was there no friend, no representative of the interest of Scotland connected with the Goverment, to urge her claims when the trigonometrical survey of this country, was postponed, and the surveyors transferred to Ireland?

That these are not exaggerated assertions, I now shall attempt to prove by the state of our maps, charts, atlasses, and the recorded latitudes and longitudes of some of the most important points of the sea coasts of our country.

In Headrick's View of the Mineralogy, &c. of the island of Arran, its distance from the nearest point of the island of Bute is said to be about *twelve miles.* In Mr John Paterson's account of Arran, published among the Prize Essays of the Highland Society, this distance is stated at about *nine miles.* In Thomson's County Atlas of Scotland it will measure above *six miles,* while in the Scottish Tourist's Guide, the same is given at *four* miles; that is, the same distance is given at twelve miles, nine miles, six miles, and four miles!!!

The following is a specimen of the varieties in the latitude and longitude of Pladda Light, near the southern shore of Arran:—

Norie's Navigation,	1835,	Lat. 55°	32′	0″ N.	Long. 5°	4′	0″ W.
Lynn's Nautical Tables,	1825,	55	30	0	5	4	0
Vidal's Chart,	. . .	55	26	10	5	6	48
While the true are,	1836,	55	25	33	5	7	0

The difference of the extremes of latitude vary from 27″ to 6′ 27″, and those of longitude vary from 12″ to 3′.

The following are a few of the positions of Ailsa Craig:—

Norie,	1835, Lat.	55°	17′	0″ N.	Long.	5°	8	0″ W.
Lynn,	1825,	55	16	0		5	0	0
Mackay,	1804,	55	15	0		5	5	0
True,	1836,	55	15	13		5	7	0

Here the differences of latitude vary from about 1′ to 2′, and the difference of longitude from 1′ to 7′. It is clear, too, that the true distance of Pladda Light, *due north* from Ailsa Craig, is 10′ 20″, while some of these positions give 15′ N. and 3′ of longitude E., &c. From these few comparisons, therefore, it is manifest, that, in *thick weather during the day*, vessels making for the Clyde are in no little danger, especially towards the evening, in the winter season, when the days are short, and *just before* the light-houses are lit up; because ships may be close in shore while they expect to be five or six miles from it. Before they discover their mistake by the light-houses, especially in blowing weather, it may be too late often to avoid the danger. New surveys of the coasts are therefore more necessary than additional light-houses.

The large map of Scotland by Arrowsmith, from Dr MacCulloch's observations, coloured to shew the geological character of Arran, along with the rest of the country, and sold at L. 5, 5s. partakes of the same errors here, and is therefore totally unfit to trace the connexion of the geological features of Arran with the opposite coast of Ayrshire, Bute, and Cantire. In the recently published map of the basin of the Clyde by Mr Knox, the same erroneous positions in the Island of Arran are obviously followed, while a dotted line, drawn directly south from about Kilmory, instead of from Pladda Light, indicates the course and distance 16′ to Ailsa Craig. In some of the recently published maps, several of the more glaring errors are corrected, though much is yet required to make them perfect.

During the short time, previously alluded to, which I spent in Arran, I made a few observations with a six inch astronomical circle of Kater's construction, made by Robinson, with some improvements suggested by myself. It has three verniers, each reading to 10″, a level whose divisions indicate 3″, and a half, or a third of each division, may be readily estimated. It is also provided with a telescope having magnifying powers of about twenty and thirty times. To this I had added a chronometer kindly lent me by Mr Robert Bryson, which performed very satisfactorily.*

The chronometer was compared with the observatory clock at Edinburgh on the 1st August 1836, and was exactly one minute fast of mean time at noon, with a daily rate of three seconds *gaining;* consequently, the error was 1 minute 12 seconds fast for Edinburgh time, on Friday the 5th of August, the day on which observations were first taken to obtain the latitude and longitude of Broddick Bridge near Jameson's inn in Arran.

The mean latitude by several series of observations both to the north and south of the zenith, was	55°	35′	27″	N.
Longitude by chronometer, 20′ 43.6″ in time, or .	5	10	54	W.
The position of Broddick Castle, the seat of the Duke of Hamilton in Arran, inferred from these, will be nearly in latitude	55	35	45	N.
Longitude, 20′ 42.8″ in time, or . .	5	10	42	W.
In like manner, the position of Lamlash church was determined to be in latitude	55	31	56	N.
Longitude in time 20′ 31.5″	2	8	7.5	W.

These were all the points I had an opportunity of determining by observation directly, and the final results are probably within a few seconds of the truth, both in latitude and longitude.

By the existing maps, such as they are, and a few angles taken by a pocket sextant, the position of Pladda Light and Kilmory school were inferred from these.

Pladda light,	Lat. 55° 25′ 34″.	North Long.	5° 7′ 9″ W.
Kilmory school .	55 26 40.	North	5 14 0 W.

The former agrees very closely with the true position already given, and it is probable the latter is not far from the truth.

The following are a few heights determined geometrically by the circle above the mean level of the sea :—

Goatfell	2863 feet
Benoosh	2598 —
Muildoun	1138 —

* It was with the same chronometer that I made the observations on the solar eclipse which happened on the 15th of May last.

These are a few of the observations which I was enabled to make during my short stay in Arran, as far as regards position. The others must be deferred to some future opportunity.

I may add, however, that from a paragraph which I sent to some of the Glasgow newspapers on my return, stating a few of these glaring blunders, I have the satisfaction to learn that on a petition or memorial afterwards prepared from those interested in the prosperity of the trade of the river Clyde, Government have engaged to send a competent engineer to survey the Frith of Clyde and part of the adjacent lochs, and I should be happy if these remarks would draw the attention of men of influence connected with Scotland to memorialize Government to induce it to grant a *tenth part* of those employed on the Irish survey, that is, 120 men and officers, to continue the survey of Scotland, under the able superintendence of Colonel Colby, where it might be thought most advantageous for the prosperity of the country, and beneficial to its maritime interests.

54 South Bridge. W. GALBRAITH.

On the Geography and Geology of Northern and Central Turkey. Part II. Geology. By Dr A. Boue'. Continued from page 61.

The crystalline slaty rocks occupy an immense tract of country in European Turkey, as they form the following chains, viz. the great ranges of the Tschardagh and Despotodagh; the Perindagh, with the chains north of Seres, and east of Istip; those of the Chaladian promontory; those between the Kutschuk Karasu or Perlepe-Bitoglia basin, and the lakes of Ochrida and Castoria; the Pindus; the Olympus; in Servia, the Jastrebacz, the Temnitscha-Planina, and the western borders of the Morava valley higher than Tagodin; and in Wallachia the chain separating that country from Transylvania and the Bannat. These rocks also, chiefly under the form of mica or talc slates, occupy considerable tracts between the Timok valleys and the defile of the Danube; then west of the Pristina plain; around Kacsanik; in the Karadagh; around Egri-Palanka; between that town and Karatova; south of Kostendil; in the hills between the basin of Bitoglia and the Tscherna; and, lastly, at Kezanlik in the Hæmus, and probably farther to the east on the southern side of that chain.

Those primary rocks, called by some authors transition rocks (see my *Guide du Geologue Voyageur*), occupy still greater space in European Turkey than the crystalline slates, so that the Turkish peninsula is, like the Iberic one, chiefly composed of old formations, and may be described as a group of very ancient islands. Among the transition rocks, there are two sets which it is not always easy to distinguish; the one older, and composed of slates with quartzose rocks, some micaceous, talcose, and arenaceous rocks, and a few compact or semi-granular limestone beds; the other newer, and composed of greywacke, greywacke-slate, sandstone, conglomerate slate, and limestone in the compact state, and more fossiliferous.

This last formation constitutes the whole mass of hills in central Servia north of the Servian Morava, as also the Gelin, the Kosnik hills, the Kopaunik group, a part of the Novibazar district in Bosnia; the hill Vrenie between Novibazar and the Ibar; a part of the hilly district to the east of the basin of Pristina; and, lastly, it appears in the Balkans. The other, or older transition rocks, are to be found in the north-west portion of Servia; in the hills of Goliesh between the Mitrovitza and the White Drina (the Goliesh); in the district of Kolaschin, near Pristina; in some parts of Mœsia Superior; in the hills west of Gafadartzi in Macedonia; and probably also in the Balkans.

These last rocks, having only experienced some slight igneous changes in the neighbourhood of plutonic masses, establish a kind of transition from the true recent greywacke to the talcose and micaceous crystalline slates like those of the Tschardagh. In the subordinate limestone beds I found only encrinites and indistinct polypiers, as at Rabocsevo, south of Belgrade; yet the limestone masses are sometimes very large, as on the road from Uskub to Kalkandel, or on the road between Gafadartzi and Perlepe. Three or four leagues from Gafadartzi, a blackish or greyish compact limestone forms a small chain running N.—S. (the beds running N.—S. and dipping at a high angle to the E.), and crossed by a deep fissure from E. to W. At Uskub there is a greyish compact limestone; and at the distance of four leagues from that city the road to

Kalkande passes through a defile, running E.—W., and situated in a small granular whitish limestone. This reminds one of the geology of Greece.

On the Nevljanska-Rieka, between Radomir and Scharkoë, I also observed masses of what I should be inclined to consider as the same limestone and slate; but the vicinity of secondary limestone seems to make it sometimes as difficult there, as in S.E. Carinthia and Carniola, to classify with precision all the limestone masses the travelier may meet with. One might perhaps also unite with these the compact limestone associated with slate and quartzose conglomerate, in the Kosnai hills in northern Servia; and that of the Maidan-pek district, which is traversed and altered by sienite and sienitic-porphyry dykes, were it not that these slates, &c., like the same rocks in the Bannat, have too much of a crystalline, slaty, and talcose structure.

These deposits possibly correspond with some of the oldest members of Murchison's silurian system. The greywacke formation (classed by me among the newer primary rocks) occasionally contains a limestone filled with petrifactions, and is probably of the same age as the rocks of the Eifel. The greywacke is, like that of the Harz and the South of Scotland, composed of a basis of clay-slate, which includes fragments of clay-slate and quartz and scales of mica. A good example of its limestone is found at Divostin, and in the valley S.W. from the convent of Vratschka (Vracsa), 2½ leagues from Kragojevacz in Servia. Its colours are grey, blue, red, and brown, and it contains encrinites, caryophylleæ, astreæ, fungites, and other kinds of polypiers or corals, as well as some indistinct bivalves, a turritella, and a small patella, or a univalve of some genus of Lamarck bordering on the patella. M. Viquenel found an *echinoderme* in the limestone slate. At Kosnik, in S. W. Servia, the same limestone presents itself, with many madreporic-like fossils and encrinites. The greywacke also includes some limestone breccia, as near the convent of Vratschefnitza at the eastern end of the Rudnik Hills, and near Verbovnitz not far from Dubnicza.

I am inclined to regard those old and new primary deposits as the masses which, for the most part, have been altered by subterranean heat and plutonic agency, so as to give rise to the greatest portion of the crystalline slaty rocks of Turkey. In the first place, it is a remarkable fact, that all those last contain limestone beds, generally of a granular texture, or in the form of dolomites; and, even as in Greece, these nodular shaped masses are of considerable extent; as, for instance, in the Karschiaka hill, near Uskub, between that city and Kalkandel, and along the whole range of hills between Trojak and Perlepe. Now, in this last range, a beautiful white dolomite, forming the hill of Kosak and other eminences, is contained in a green talcose mica-slate, with a slight admixture of felspar, and this St Gothard-like dolomite is in intimate connection with other similar masses of blackish or whitish compact or semigranular limestone, which are associated with clay-slate to the east and west of this dolomitic deposit. The greatest plutonic action has been upon this last and the neighbouring slates.

In the Tschardagh range the same thing is observed. Vast masses of argillaceous slates, as well as chloritic or talcose rocks more or less decomposed, and even sometimes altered and discoloured by acid vapours, or mixed up with ferruginous matter, envelope or include bed-like ovoidal masses of limestone, which is partly granular, partly compact. These last seem to form the summits of many hills, as the Kobelitza near Kalkandel, and present the greatest analogy with the position of many of the limestones of the Pyrenees. I have no doubt that future observers may find in these limestones, in the vicinity of erupted masses, some crystallized minerals like those of the Pyrenees. The quartzose conglomerates have been occasionally changed into quartzite, and those chloritic or talcose rocks, which contain little quartz, have been converted into varieties of talcose gneiss, or at least something resembling it.

In the Karadagh and the hills of Kacsanik, some *cipolin* or micaceous limestone beds, are to be seen; and we have already mentioned the occurrence of a great mass or bed of white granular limestone and dolomite in micaceous slates, quartzites, and clay-slates at Kacsanik.

Granular limestone also occurs in the more altered primary rocks; those which have been converted into gneiss and micaceous and felspathic slates: for instance, between Tagodin or Stiple and Kukurovacz or Kragojevacz, in the Perin-dagh south of Djumaa, or more properly above Siribin, in the Rilo-planina, a quarter of a league, and three-fourths of a league to the east of the large and beautiful convent of Rilo. Crystallized minerals occur in most of these limestones; the plutonic action having been complete, varieties of hornblende and augite, tremolite, actinolite, green augite, garnet, idocrase, &c., have been produced, as I shall afterwards mention more fully in speaking of the granites.

Turkey lies in the Mediterranean zone of Europe, so that we could not expect to find there either the old coal deposit, or the secondary series of rocks which characterize the middle and N. W. part of Europe. Indeed, I only found my *great alpine and Mediterranean reddish arenaceous and calcareous formation.* The rocks consist of reddish or greyish, very micaceous slates, sandstones like many of the *trias*, some conglomerates chiefly of the quartzose kind, rarely with fragments of slates or older rocks, and compact or somewhat fetid limestone, which occurs in three or four thick beds. I had occasion to observe this formation on both sides of that vast *dos d'âne*, formed by central Servia, Mœsia Superior, and central Macedonia; but I could not discover any fossils in it. Between Novibazar and Ipek, after having passed the clay-slates of Vrenie, in the upper part of the Ibar and Kolaschin, we begin to find quartzose conglomerate, and reddish or arenaceous slate, between Kaludra, Meleja, and Petzkij. At last, before commencing the descent of the plain of the White Drina, the slate is distinctly seen covered by compact limestone, then by quartzose conglomerate, and afterwards by an immense deposit of compact limestone, which constitutes the Kurilo-planina above Scherkoles and to the east of the plain of the White Drina, as also the high picturesque hills above Shetskevok and the high summits to the east of Breniatz; in short, the greatest part of the group of hills N. and W. of Ipek. The alternation of this limestone with conglomerate, reminded me of a similar one in the valley of the Enns near Lientz in Upper Styria.

At Castoria, subordinate to a vast deposite of greyish compact or semi-crystalline and dolomitic limestone, there occurs an alternation of greyish-black and reddish slates, with quartzose conglomerates. I do not know if these arenaceous rocks are to be referred to our old secondary formation, as they seemed to me to be more connected with the greywacke. They form the northern side of the lake of Castoria, as well as the neck of the peninsula on which that town is beautifully situated.

In south-eastern Servia, and the district of Nissa, my "*reddish old secondary formation*" is best exposed: it extends from Banja some leagues in a northerly direction, forming the lowest part of all the hills on the eastern side of the Nissa basin. Thence it is known to extend at least as far north as the Slatova hill on the Ressava, but it is only visible occasionally, as between Krivivir and the convent called Svetapetka, where it forms a *plateau*, covered with a thick forest. In other places it is concealed by the alluvial soil, or the secondary limestone. I also found it in the Bannat on the Danube, extending to Steuerdorf, near Oravitza; but *there* it is associated with true *todtliegendes*, quartziferous porphyry (Islas), and even with an old coaly deposite, which furnishes an excellent caking coal at Steuerdorf.

The superposition of secondary limestone on my reddish old secondary formation is best seen at 2½ leagues east of Nissa, on the ascent of a hill over which the road to Sophia passes, and where there are two *Karaul*, or stations for *gens d'armes.* The beds incline to the E. and S.E. at an angle of 45°, and dip under the compact limestone, which forms the upper parts of some hills in the vicinity. Two beds of compact fetid limestone occur in the lower part of this series of slaty and quartzose sandstones, some of which are not unlike the *trias* rocks of Germany.

The *lias and Jurassic limestones* are represented in Turkey only by a great deposit of compact whitish, greyish, yellowish, and reddish limestone, as is the case in the whole Mediterranean zone of Europe: the best examples which occur to me, are those on the road from Sophia to Tagodin. This formation constitutes the whole of that vast and singular cavity through which flow the Nissava, and its tributaries the Sukava, the Nevljanska-rieka, the Lukanitschka-rieka, &c. It also forms the hills separating that part of the Morava valley between Nissa and Kopri from the valley of the Timok, particularly the Rtan, three leagues to the north of the Servish Banja. Farther north it forms the great Omelijska-Planina, and bounds the tertiary molasse of Timok and its tributary torrents to the east, as well as to the west and south, by forming the Vratarnicza-Planina, which extends to the pass of the same name on the north of Gorguschevatz.

In these countries, the limestone does not vary much in its texture or colour, which is chiefly greyish or whitish, seldom reddish or yellowish, but it exhibits some variety in its fossils. Sometimes it is distinctly oolitic. Although the compactness of the rock often prevents the organic remains being visible, yet, at other times, indistinct traces of them are very common, and in particular beds the fossils are well preserved, but difficult to extract from the rock. Two leagues south of Scharkoe, on the Sukava, the whitish limestone is full of encrinites, and bivalve and univalve shells in fragments: this rock is probably only a prolongation of the beds observed to the south, alternating with some slaty rocks upon the Lukanitscha-rieka and Nevljanska-rieka. The position of these last limestone rocks is rather doubtful: they are sometimes oolitic, and full of encrinites, various corallines, terebratulæ, &c. Some spots seem to be still more rich in fossils. In crossing from Nissa to Gorguschevatz, I observed between the inn of Male Timok and the highest part of the *plateau* to be crossed to the north, that the limestone contained so many Encrinites, as well as the *Ostrea cristata*, and species of *Astrea*, *Cariophyllia*, *Cardium*, *Trochus*, *Echinodermes*, &c. that it was not unlike some of the rocks belonging to the coral rag. I searched in vain for belemnites; but I hope to be able next year to make a more extensive collection of Turkish Jurassic fossils.

In Western Turkey the whole group of hills between Bosnia, Novibazar, Ipek, and Montenegro is calcareous, and composed of a limestone which is greyish or whitish, seldom reddish, and much like that of the secondary Alps. Some marly slates are interstratified here and there; but I have not heard of gypsum or salt being found in it. Fossils seem very rare; yet in ascending from Ipek the Peklen hill, we meet at no great height a bed full of a species of *Isocardia* not unlike my *I. Carinthiaca* (See Mem. de la Soc. Geol. de France, vol. 2, part 1,

. 47). It is most probable that this formation extends far into Bosnia, forming, in particular, the chains between the Bosna and the Verbas; as it makes its appearance in Croatia, and as the chains have all the same direction N. W.—S. E., it must cross the whole of Bosnia. It is even possible that the Szokol plumbiferous limestone in Western Servia, if it be not a transition rock, may also belong to this extensive formation.

In South-western Macedonia there are a great number of chains of compact limestone, which may also possibly belong to the secondary rocks; as around Castoria, between Castoria and the Pindus, to the south of Castoria, between Florina, Vodena, and Sarigöl, and probably still more to the south in Southern Albania. In Turkey, as in Carniola and Southern Styria, the vicinity of primary (transition) rocks to great limestone masses, as well as also to the Jurassic limestone, renders it difficult to distinguish between them, and for that reason I am unwilling to assign a precise age to those compact limestones. I observed them west of Radomir, in the Wistoka hill, west of Sophia, in the Koniavo hill north of Kostendil, in a hillock isolated in the midst of tertiary molasse between Kosnitza and the Dubnicza vineyards, as also near Niemele on the road from Gerlo to Scharkoë. In this latter place, as well as in the Upper Nevljanska-rieka, the limestone is associated with slates resembling greywacke or even clay-slates, as also with arenaceous slates of a greyish or reddish colour, and sandstones. These limestones, like the Jurassic, occasionally form singularly shaped hills and small défiles, and contain caverns. Small caverns are also to be seen between Sophia and Nissa; and in the Ipek chain in Albania, large bodies of water sometimes issue out of the caverns.

The *great chalk formation of Southern Europe* is also found in Turkey; it is already known that the hippurite and nummulite limestone, together with compact limestone, as also dolomite, and sandstone or marls, constitute, not only Dalmatia, but also a considerable portion of Western Bosnia, Montenegro, and Western Albania. We saw this formation extending from the Scutari hills to the middle of the White Drina basin near Drsenik, and thence to the east as far as Iglareva, forming small *plateaus* covered with oaks, or as barren as those of Dalmatia and Istria.

In the very ancient basin of Novibazar, we meet with a vast deposit of greyish marly sandstones with coaly fragments of vegetables, and interstratified with grey marls more or less indurated. It appeared to us that these slightly inclined masses, situated to the N. and N.W. of Novibazar, belonged to the lower cretaceous formation or green sand, and were distinct from the transition-slates and greywackes of the lower part of the Raschka and Ibar. We were confirmed in this idea by the discovery made at Mekinie, one and a-half leagues S.W. of Novibazar, of hippurite limestone with a great many cll-preserved hippurites, chiefly of two species, (H. cornu pastoris, H. vaccinum), identical with those found in the Alps of Salzburg. It appears difficult to account for the presence of this deposit at Novibazar, otherwise than by considering it as a local one overlying older formations; for, as the surrounding hills are very high, I cannot see how it could extend thence into Western Bosnia.

In crossing rapidly the limestone hills between Kalguilar and Telovo, in Southern Macedonia, I found limestone rocks with various coralline bodies, which I thought might be hippuritic limestone. A league to the west of lake Telovo, I met with calcareous conglomerate, and black slaty fetid marls like those of the lowest cretaceous system. But as my journey was unfortunately too rapid, I only give this as an indication for future travellers, and shall pay it proper attention on a later occasion.

For the same reason, I shall not assign an age to the secondary dolomite and compact limestone between Kalgiular and Ostrovo, and at Kösele. Near Belgrade, 1½ leagues from that city at the entry of the valley of Toprad, I found a patch of compact hippurite limestone, with smooth and striated terebratulae, encrinites, and polypiers; but here the hippurites were broken, and not in their original situation as at Novibazar. This small deposit, together with some similar ones in Southern Styria and Carinthia, leads to the presumption that Hungary, perhaps even Sclavonia and northern Bosnia, may contain some of the same kind. Indeed, it would be remarkable if, in Hungary, a country containing so much cretaceous nummulitic limestone, as in the Bakonywald and near Pest, hippurites should be entirely awanting. I also saw in Belgrade a reddish coarse marble like the Italian Scaglia, and the well-known marble of Dotis in Hungary. I was told that it came from Eastern Servia,—Can it also be a chalky rock?

Next year I shall visit the secondary limestones of Gallipoli and the Dardanelles, the age of which my travelling companions have perhaps already determined.

A very large portion of European Turkey consists of the tertiary series. The greatest basin is *that of Wallachia and Bulgaria*, which is filled up with marls partly saliferous (slatina), molasse sands, and some limestones with shells. In lower Bulgaria and the Dobrutscha, a vast deposit of this kind seems to predominate, which in many places renders the country hilly to the banks of the Danube. This formation extends to all the great annexed basins, as those of the Wid, the Isker, the Timok, &c. In this last I found, near Gorguschevatz, argillaceous marls with bivalve shells, as also inclined molasse beds. Tertiary shelly limestone occurs near Negotin.

I was very anxious to determine if the tertiary sea had extended from the Bulgarian basin to that of Servia. The most likely place I could find for this supposed connection, is between Nissa and Gorguschevatz, being the lowest part of the chain from the Danube to Sophia. Indeed to the N. E. of Nissa, the limits of both basins come very near each other for some miles. Yet I could not find the molasse beds extending from one side of the secondary limestone ridge to the other, although the sandstones were to be seen at a slight elevation below the low pass at Grenada. Farther to the north I twice crossed the chain, but found an ancient communication to have been quite impossible, the ridges of secondary limestone being too high. I therefore conclude, that, if no connexion existed, the Servian Sea was separated from the Bulgarian one, only by a very small ridge in the neighbourhood of Nissa.

The *basin of Sophia* is another great subordinate portion of the Bulgarian-Wallachian tertiary basin, and was only separated by a pretty narrow ridge of limestone and other old rocks from the great tertiary basins of Kostendil and Dubnicza, and Tatar-Basardschik. Alluvium forms its bottom, and molasse with bituminous wood is found in it.

The *greatest part of Servia* north of the Morava is tertiary, the country consisting of small, smooth, wooded hillocks, and fertile valleys or plains near the Danube. The primary rocks (*transition* of authors) are only seen in the highest hills. We can distinguish the tertiary formation of Servia in the following localities, viz. the lowest region of the Drina, the great tertiary gulf of the Kolubara, Lipla, and Turia; the other gulf of the Morava from Saemendria to Stolacy, and extending far to the west in the direction of the Tessawa, Limovaty, river of Kragojevacz, Levazna, and Kalenska-rieka, as also to the east by the Pek, the Mlava, Ressawa, and Ravenatz. All these gulfs were once parts of the great Hungarian tertiary sea, in which there appeared as southern promontories, the hills between Maidan-Pek and Ressawa, the Avala hills, with the Kosinai and Palkovitz, &c. To the south, the Morava is separated only by a short defile of a league in length, cut in gneiss between Stolacz and Jassica, from the somewhat higher alluvial and tertiary *basin or plain of Kruschevatz.* This last extends to Tschatschak, but diminishes considerably in breadth. It is also connected with a still higher basin, *that of the Raschina*, which is pretty extensive, and filled up chiefly with marls and calcareous rocks, with or without fresh-water shells and lacustrine deposits, as at Osretze, Riberia, and Bruss. At Bobota we observed impressions of plants in the marls. This deposit overlies greywacke.

Another considerable basin, also higher than that of the Morava, extends from Turkish Banja, near Nissa, to Bulovan, and along a part of the course of the Morava and Toplitza. South of Nissa it is alluvial as well as tertiary, having marls and molasse with sands above, and lastly alluvial loam or löss. The Nissava cavity, with its two natural dykes, the one south of Banja, the other 1½ league north of Scharkoë, is only filled up with alluvial matter. At Mustapha-Palanka it forms a vast triangular plain.

The composition of the northern Servian tertiary basin is identical with that of Southern Hungary and the Bannat. The inferior rocks are argillaceous marls, or molasse with sandy marls, then sands and sandy marls, with some conglomerate and calcareous beds containing fossils, such as Cerithium, Cardium, Venus, Concheria, Trochus, &c. I may mention as examples, the sections at Vischnitza, Grotzka, E. and S. of Belgrade, Rakovitza, Raila, Schabari, Kragojevacz. Coralline limestones, like those of Syrmia and the Leithagebirge near Vienna, are also to be met with, particularly in those parts bordering on the Danube, as at Vischnitza, Belgrade, and south of Sau. In the upper part of the basins, where the influx of fresh water must have been greater than elsewhere, one sometimes observes whitish or greyish marls containing *Cypris*, *Planorbis*, *Paludina*, *Lymnea*, and *Concheria* (*C. spathulata*), as at Relnitza, and on the shores of the Mutnitschka-rieka, near the monastery of Svetapetka, W. of Parakin-Palanka. To the SW. of Kragojevacz I also found marls with *Cypris*, and in the sandy marl a whitish coarse limestone, with many impressions of the *Concheria triangularis* (Partsch). Lignites are met with near Semendria and Miliova, at which latter place Planorbes occur.

The *Kossova-Pristina basin* is situated pretty high, and is evidently the site of an old lake, of which the bottom is now alluvial, and the sides are covered here and there with marls and a conglomerate having a calcareous cement like that of many fresh-water limestones.

The *Kostendil, Dubnicza, Radomir*, and *Dzumaa basins* contain only molasse and marls. These arenaceous rocks form considerable ridges between Dubnicza and the Radomir and Kostendil plains. One of the ridges between Kosnitza and Verbonitz surrounds or covers old compact limestone hills, and the Strymon flows through a rent running N—S. in this molasse, from Kosnitza to the confluence of the Dubnicza river with the Strymon.

The molasse is inclined to the S.E., and some coarse conglomerates are seen on the sienitic rocks near Kosnitza, and between that place and Shetirtza. These last are partly horizontal. In the middle part of that basin I found, north of Pobovdol, three thick beds of bituminous wood, interstratified with the marly sandstones which are there of a granitic appearance, and somewhat resemble the granite of Kostendil and Rilo. Dicotyledonous wood and some boggy gramineous plants are found in it. One peculiarity of this molasse is, that it reaches to considerable heights. M. Viquenel found it at the top of the Koniavo hill N. of Kostendil, and I saw it forming the hills N. of Pobovdol, then those to the E., NW., and W. of Dubnicza, and extending to the vicinity of Dzumaa. We cannot say if the elevation, which amounts to from 1500 to 2000 feet, is the original one, or whether the deposits were elevated at the epoch of the appearance of the neighbouring trachytes.

The fact is, that varieties of molasse or tertiary marls are associated at a high level with trachytic conglomerates, between the plain of Kostendil and the valley of the Egredere.

Marls are very abundant near Dubnicza, where they form the soil of beautiful vineyards. In the basin of Radomir there are calcareous conglomerates and travertines, with some lacustrine limestone, including Helices and Planorbes, as around the town of Radomir. I consider these to have been deposited from a mineral spring which formerly issued from the adjacent limestone hill. This hill still affords large springs of excellent fresh water. Alluvial loam or löss also occurs there in the hollows, and on the banks of the Strymon.

In the basin of Dubnicza the alluvial deposits acquire a great thickness and height; they envelope the ridges of limestone north of Dubnicza and Kostendil, and extend all along the base of the crystalline schistose Rilo-Planina, as also along the Perin-Dagh. A small *platform* is thus formed all round the northern and western part of the Rilo-Planina and Eastern Karatova hills. This old alluvial formation is merely the result of the continued erosive action which took place at the end of the tertiary epoch; for, at the entrance of the principal longitudinal valleys of the Rilo-Planina, we find, behind the village of Rilo, a very thick mass of recent tertiary conglomerate in horizontal beds, and attaining an elevation of at least 100 feet above the torrent of the defile.

Lastly, this basin contains the vast level alluvial plains of Radomir and Kostendil, and it must have been separated from that of Sophia only by a very small stripe of land during the tertiary epoch.

The *great Vardar tertiary basin* extends from W. of Uskub to Negotin, Istip, Komanova, and the valley of Shinnie (to the E. of the last town), and includes small patches of rocks along the Pepentz to 1½ leagues S. of Kacsanik. Marls, molasse, quartzose micaceous sand, and sandstones, are the chief constituent parts of its deposits; but the molasse with some conglomerate predominates. On the Pepentz we saw, reposing on mica slate, a patch of tertiary argillaceous marl, with traces of lignite and impressions of leaves of trees; it was in beds dipping to the N.E. under an angle of 45°, this high inclination being owing to some accidental cause. Near Nagoritsch and Vinitza, sand and sandstones are also inclined to the W. at an angle of 15°; but here the vicinity of doleritic rocks fully accounts for this position, which is also observable farther to the E. of Vinitza in sandstones and limestone conglomerates, which dip to the E. under an angle of 20°. Near Uskub at the Karschiaka hill, there is a calcareous conglomerate having an inclination of from 20° to 35°.

In the southern part of the basin, the molasse often forms a very hilly country, as between Pepelischta and Istip, where red marls, along with calcareous marls and some conglomerates, are seen amongst these rocks, always without fossils as elsewhere. Deposits, apparently of fresh water origin, occasionally occur in the marls. We likewise observed between Gigantitz and Istip, and at that last town, the molasse associated, as in S.W. France, along the Lot, with whitish or reddish compact calcareous marls, sometimes having a concretionary or pisolitic structure. At Istip these beds have an inclination of from 5° to 10°; this inclination is also seen at other places, as they cover a very undulating surface of older sienitic or primary crystalline rocks.

The Vardar at Negotin is surrounded by horizontal beds of calcareous marls, with many impressions of aquatic marshy plants. It appeared to me that these rocks were subordinate to the molasse formation which constitutes a portion of the base of the hills on the right bank of the Vardar; indeed, we found molasse on the road from Gafadartzi to Perlepe, between Vosagé and Trojak, where it, in conjunction with conglomerate, forms pretty considerable heights, some of which are upwards of 1000 feet. The molasse also forms the *Col*, which it is necessary to pass before descending into the Trojak basin; and it is covered with freshwater limestone, which forms a thick deposit throughout the whole extent of that picturesque and wild valley. The inferior part of the valley is completely filled up with this limestone, and a stream of water has cut a deep bed for itself in it. This basin does not seem to have communicated with that of Perlepe and Bitoglia, for the defile between the basins, which is of considerable height, contains no tertiary rocks, and tertiary conglomerate is only found on the descent to Perlepe.

The same freshwater limestone deposit is seen at Vosagé, and on the small hill W. and S.W. of Gafadartzi, in some places overlying greyish tertiary marl. We had also occasion to observe it in the form of travertine, and associated with calcareous conglomerate, at a pretty large hill near the beautiful dolomitic rocks to the W. of Uskub on the road to Kalkandel. Lacustrine limestone, containing planorbes and other shells, also occurs near Komanova, and I saw patches of travertine at Aratschina (1½ leagues E. of Uskub). This country, as well as the base of the Karadagh, is skirted by a range of small hills composed of greyish tertiary marls, and tertiary conglomerate with fragments of slate, jasper, quartz, &c., in beds inclined at an angle of 20° or 30°; the same rocks, however, are nearly horizontal at Istip on the banks of the Vardar.

The Vardar basin contains a vast quantity of old alluvium, which forms the plain S. of Uskub, and also the upper Vardar basin to the E. and W. of Kalkandel. Some calcareous pudding-stones belong to this epoch, as those on the old limestone hills of Dobrotan, those to the S. of Kalkandel, and 1½ leagues from Kacsanik on the Pepentz.

The beautiful *basin of Perlepe and Bitoglia* has, likewise, along the base of the hills which border it, deposits of molasse and marls, with a rich vegetable soil of lacustrine origin. Old alluvial conglomerates are occasionally met with, as, for instance, between Sarigol and Kalguilar. Similar deposits exist around the lake of Telovo and below Vodena. Moreover, from Telovo to within half a league S. of Vodena, the valley is completely incrusted with a very thick deposit of travertine. This rock presents itself in all possible forms, as calcareous tufa, pulverulent matter, calc-sinter, and freshwater limestone, which is either compact or concretionary. Its beds are very irregular. Two very thick masses occur, the one under the village of Telovo, the other below Vodena, which are easily accounted for, on the supposition that the river Telovo formerly fell in the form of cascades at those places, nearly in the same way as it does at present. At Telovo the cascades are three in number, and the height of the highest is at least fifty feet. At Vodena, immediately below the town, there is a double set of cascades; the first set, consisting of five, falls down a height of from seventy to eighty feet; the second set is less high but broader. Nothing in all Macedonia is more beautiful than these cascades; and we may here mention that they have been figured by Cousinery. The white stream of water, surrounded by a most luxuriant Mediterranean vegetation, the large *Platanus orientalis*, *Cercis siliquastrum*, immense fig-trees, mulberry, almond, pomegranate, and peach trees, remind one of Tivoli, near Rome; but I think the scenery at Vodena is finer and on a larger scale.

The *bottom of the Vistritza and lower Vardar basin* is also tertiary; and the argillaceous soil or *löss* is impregnated with nitre and covered with marshes. The village of Allah-Kilissia, which is nearly on the site of the ancient Pella, is built on a pretty large smooth hill extending N.—S., and composed of calcareous conglomerate, travertine, and lacustrine limestone; this last has probably been deposited by a mineral spring, as we still find a most abundant spring of excellent water taking its rise from the hill, and making its appearance in the middle of the sterile plain which surrounds it. The interior of a ruined edifice, probably a temple, serves as a reservoir for the water; and six beautiful and very large palms afford shade to the traveller who comes thither to refresh himself.

The *Seres* basin has nearly a similar constitution with the last, and contains a vast deposit of travertine at the entrance of the first defile of the Strymon (N. of Seres), near Skala. It is a porous rock, which seems to have been deposited by streams of acidulated water flowing down the hills for a succession of ages. The soil of the Seres basin contains much nitre in many places.

I had also occasion to examine some molasse deposits near *Karatova* to the N.W. of that city, and I travelled through the molasse *basin of Melnik and Libanovo.* Small hills of molasse and alluvial matter extend along the Strymon valley, at some distance from the river, particularly in an easterly direction. They commence at Vistritza and finish at Schenadidere. Libanovo, on the left bank of the Strymon (and not on the right as indicated in maps), is situated in a basin of molasse and greyish marls. To the S. of the inn called Marecastino-han, there are very good sections of the quartzose tertiary sands, sandstones and conglomerates, all lying in horizontal beds, and without fossils. Old alluvial granitic masses are accumulated, forming pretty high ridges along the last *contreforts* of the Perin-Dagh and the Kreshna hill, as S. of Schenadidere. Some small blocks of granite and granular limestone are occasionally seen in the beds of the torrents; but the great phenomenon of dispersed erratic blocks seems to be foreign to Central Turkey. A very small basin of molasse, dipping to the E. at an angle of 15°, along with alluvium, exists around Sirbin, between the Kreshna hill and the pass of Dzumaa.

I have now to mention the *White Drina tertiary basin* in Albania, which appears to be similarly constituted with the Hungarian and Austrian basins; having marls below, and some fossils in the upper sandy parts; as at Drsenik, where there is a mixture of freshwater and saltwater shells, consisting of *Congeria triangularis* (Partsch), a large *Paludina* with marked ridges on the spire, a Buccinum (*B. baccatum*), found in Austria and at Bordeaux. Above these marls occur sand and sandstones, with superimposed beds of greyish yellow marl, and freshwater limestone with Planorbis, Paludina, Lymnea, and Physa, as we observed at the foot of the hills of the Kurilo-planina E. of Schkerkoles. In short, this basin, as well as that of Scutari, would probably furnish fossils to the amateur of paleontology.

The *Haliacmon or Nazlitza and Karasu basin* in Southern Macedonia, is probably similar to the Vardar basin. On the other side of the Olympus is the *Thessalian tertiary basin.* Lastly, the *great tertiary basin of Adrianople* seems to be connected with that vast extent of high land which forms the central part of Asia Minor between the Taurus to the S., and the group of hills between Amastrah and Bafra, to the N. Major Hauslab is right in the idea which he has formed of the course of the rivers, and the position of the salt lakes. Trachytic and other igneous eruptions occur in this basin, particularly on the Bosphorus and in Asia Minor.

(To be concluded in next Number.)

On the Electric Currents observed in some Metalliferous Veins.

By W. J. Henwood, Esq. F. G. S. London and Paris Hon. M. Y. P. S., Assay Master of Tin in H. M. Duchy of Cornwall *.

It is my object, in the following pages, to describe briefly the geological features of the district (Cornwall) in which most of the experiments on this subject have been made, the method of observing which has been pursued, the results obtained, to enquire into the probable causes of the currents observed, and to examine whether the theories which have been erected on them be well founded.

The discovery of electric currents in some of the metalliferous veins of Cornwall, is well known to have been made by Mr Fox (*Phil. Trans.* 1830, p. 399); it was soon followed by a beautiful experiment of Mr Barlow's, in which the phenomena of the dip of the magnetic needle were well approximated, by suspending a magnetized bar over various parts of a hollow globe, around which voltaic electricity circulated through wires of copper placed in the parallels of latitude (*Phil. Trans.* 1831, p. 99). These discoveries must have been regarded as very

* This paper is altered and amended by the author from the edition which has just appeared in Mr Sturgeon's interesting Annals of Electricity.

confirmatory of M. Ampere's theory of the electric origin of terrestrial magnetism.

The Mineral Veins of Cornwall traverse both the granite and slate rocks (and often the *Elvan courses*, which rake through both the granite and slate) without interruption; they are highly inclined tabular masses of great extent; on a small scale, exhibiting numerous curves and irregularities, both in direction and dip, with very variable breadths; but on a large view having an approximation to rectilinearity. Their composition is chiefly quartz, but, with other earthy minerals, in many places mixed with metallic substances, viz. copper and iron pyrites, vitreous copper ore, oxide of tin, blende, galena, with admixtures of small quantities of other minerals; as native copper, red oxide, and the carbonates of copper, salts of lead, &c.; all frequently so intimately and indiscriminately mixed (mechanically) with the rock-contents of the vein, that their separation is among the most difficult and expensive of our mining operations.

These irregularly distributed masses, veins, granules, crystals, and other forms of the ores, have usually a prevailing dip longitudinally through the vein itself *(shuts or shoots)*; and this is almost universally *from the granite and towards the slate*, whichever of them may be the containing rock. It is also most commonly the case, that the vitreous copper-ore occurs in those parts of veins which are in the granite, and in the massive slate rocks (greenstones) contiguous to it; whilst the copper pyrites more usually occur in the *lodes* when in the shistose members of the slate series; not, however, without many exceptions to both.

Tin ores abound more in the granite than in the slate districts, notwithstanding very large quantities of it have occurred in the latter. It is a generally recognised fact, that although the most perpendicular veins are not always the richest, yet the most productive parts of a given *lode* are those nearest to perpendicularity.

It is also true, but with many exceptions, that in parallel *lodes* the ores generally occur near the same N. and S. line. The same vein is, however, seldom productive in both granite and slate; notwithstanding, parallel veins are often rich in similar ores in different rocks; thus the veins of Wheal Vor and of the Great Work mines, are worked in both granite and slate; but the former is productive in the last mentioned rock, and the latter mine in the first named. Again, the copper-ore at Tresavean is all in granite, whilst in the parallel veins of the adjacent United, Wheal Squire, and Ting Tang mines, it is entirely in slate.

The general *direction* of the principal metalliferous veins is about E. and W. (magnetic), but there is second series, the *contra lodes*, bearing about N. W. and S. E. Both these systems are usually intersected, and often dislocated *(heaved)* by a third series, the *cross courses*, which strike about N. and S. The *dip* will, of course, in either case, be at right angles to the direction, but sometimes to one side, and at others to the other; the *lodes*, for example, sometimes dipping to the N. sometimes to the S. The directions more or less coincide with the lines of symmetrical structure, by which both series of rocks are divided.

There is, however, one rather extensive district (that of Saint Just) in Cornwall, in which the metalliferous veins bear about N. and S., and the *cross courses* (guides) about N.E. and S.W.

The extensive mining operations in this county afford excellent opportunities for examining the *subterranean temperature*. From an extensive series of observations, I have satisfied myself, that, at all depths yet attained here, the slate rocks are on an average from two to three degrees warmer than the granite at the same level. *Records of General Science*, Sept. 1836; and *Edinburgh New Philosophical Journal*, vol. xxi. p. 376.

Of the mineral contents of the water from some of the mines, Mr Fox says (*Cornwall Geol. Trans.* vol. iii. p. 323), "I have examined the water from the bottom of several deep mines, and find it generally to contain very little foreign matter, not exceeding one to five or six grains in a pint. Its relative purity seems to have no reference to the temperature, nor to the depth of the mines; for instance, the deposit from the water, taken from the two deepest in this county (each nearly 250 fathoms deep), Dolcoath and Huel Abraham, after evaporation, did not, in either case, exceed two grains from a pint. On the other hand, the water from the Consolidated mines, when evaporated, left 10 grains of residuum from a pint; from Huel Unity 16 grains; from one shaft of Poldice 19 grains; and from another 92 grains from the same quantity.

"The muriatic salts, especially of lime, were most abundant; but in some instances I have detected common salt, particularly in the water from the bottom of the United Mines, the Consolidated Mines, Huel Unity, and Poldice. Out of the 92 grains of residuum from the latter, as mentioned above, 24 grains proved to be muriate of soda, 52 grains of the muriate of lime and magnesia, and the remainder muriatic acid with iron and sulphate of lime. The water from another part of the same mine contained 5.5 grains of common salt. All these mines are in killas, or primitive slate, and several miles distant from the sea" (excepting Dolcoath and Huel Unity, which are worked both in granite and slate).

This terminates the brief notice of the geological features of the district, and other subterranean phenomena which bear on our investigations.

The mode of experiment pursued was by pressing plates of sheet copper, of about 18 or 20 inches long, and from 3 to 4 inches wide, closely against such portions of the metallic contents of the vein as were thought proper for examination. To each of these plates a copper wire of 0.05 inch in diameter was connected by closely twisting it round; the opposite ends of each wire being connected in the usual manner with a galvanometer. In some cases but a few feet of wire were required to connect the stations; in others many (in one instance six hundred) fathoms were employed. In many instances the points were situated at the same depth, and on a continuous vein; in others, still at an uniform depth, and on the same vein, but on opposite sides of a *cross-course* dislocating *(heaving)* the vein; in some, too, the stations were at the same level but on different veins; whilst there were many occasions in which the same vein, and others in which different veins at different depths, were connected through the galvanometer. The experiments have been made on metalliferous veins bearing E. and W., N. E. and S. W., and N. and S.

The results obtained were much the same, whatever were the directions of the veins. In all those producing *tin-ore* alone, in many which afford copper, and in most cases where there was a continuous mass of copper-ore between the points examined, no electricity was detected. In some instances, however, where all the intervening space consisted of rich copper-ore, most energetic action was detected. The general fact, however, appeared to be, that in such cases the currents were most feeble; and where the continuity of a mass of ore was broken either by an unproductive part of the *lode* itself, or by a *cross-course*, the currents were strongest. Copper pyrites, vitreous copper-ore, black copper-ore, galena, and blende, were among the contents of the veins in which the largest development of electricity obtained. But it is in the *metallic parts* of the veins *alone in which these currents have been detected*; for, *notwithstanding the same means were employed* both *on the earthy contents of the lodes and* ON THE ROCKS THEMSELVES (as in the tin veins), *no trace of electricity has in any one case been discovered in either of them.*

The *lead veins* in the carboniferous limestone of North Wales were also found by Mr Fox (*Cornwall Geol. Trans.* IV. 23.) destitute of electric currents. Herr Von Strombeck has repeated the experiments in some E. and W. veins, traversing the clay-slate and greywacke-slate near St Goar on the Rhine; the contents of one vein were copper pyrites, grey copper-ore, and galena; and of the other, carbonate and phosphate of lead, grey copper-ore, brown iron-ore, and a little blende, spathose iron, and galena. In neither case, however, could he detect traces of electricity. (*Archiv für Mineralogie, &c. Von Karsten*, VI. 431; *and Bulletin de la Societé Geologique de France*, V. 53.)

In his announcement of the discovery, Mr Fox said (*Phil. Trans.* 1830, p. 399), " the direction of the positive electricity was in some cases from east to west, and in others from west to east; and when parallel veins were compared, its general tendency was, I think, from north to south, though in several instances it was the reverse. In veins having an underlie towards the north, the east was commonly positive with respect to the west; but in veins dipping towards the south the contrary was observed, with one exception only, and that under unusual circumstances. In comparing the relative states of veins at different depths, the lower stations appeared to be negative to the upper; but exceptions sometimes occurred when a cross vein of quartz or clay intervened between the plates, and the higher one was on the negative side with respect to horizontal currents."

I had the honour to assist Mr Fox in the first experiments instituted, and, as he mentions, of making many of those detailed in his first paper on the subject; I have subsequently extended them to mines in all parts of Cornwall, making in all fifty-seven different series of observations, of which forty-five were either altogether or in part conducted by me, and the following is a brief generalization of many of the results.

Direction of the Vein.	Dip.	Direction of Electric Current and No. of Observations.	
East and West	North	East to West	18
Ditto	Ditto	West to East	6
Ditto	South	East to West	1
Ditto	Ditto	West to East	35
North-west and South-east	South-west *	North-west and South-east	1
Ditto	Ditto	South-east to North-west	8
North and South	East	North to South	1
Ditto	Ditto	South to North	3
Ditto	West	North to South	1

When points at different depths were connected, in thirteen cases the currents were *upward;* and in thirty-five *downward.*

In thirty-six experiments the direction has been *towards*, and twenty-one *from*, the granite.

The causes exciting the currents will be our next object of inquiry.

In the Reports of the British Association (III. p. 118) Mr Christie has made an objection to the conclusions drawn by Mr Fox, which I had previously often urged on that gentleman, viz. that the wires employed might, by contact with the ores, have generated the currents observed. Mr Fox has, however, entirely obviated it by a very well contrived experiment, in which the copper plates were sometimes alternately employed with others of zinc, and in some instances zinc alone were used: the direction of the currents were the same whatever the positions and arrangements of the plates. (*Reports, Brit. Assoc.*, IV. 572).

But two opinions have, so far as I know, been yet formed as to the origin of these currents, one, that they are *thermo-electric;*

* There have been no observations on any of this class having a north-easterly dip.

the other, *voltaic.* Both these were alluded to by Mr Fox, who, however, *now* seems to prefer the latter, and this also appears to be the opinion of Strombeck. If *voltaic*, they must of course be accompanied by chemical decompositions ; What substances, then, undergo these changes under ground ? Our iron pyrites is a bisulphuret, and very little liable to decompose under ordinary circumstances ; and if oxygen were obtained for the purpose, we would still have an excess of sulphur to dispose of, of which we found no traces in our veins. The ores of copper, zinc, &c., it may be said, are changing their forms ; why then, when broken out of the lodes, are they so constantly " unsullied and bright ?" We should have expected that decompositions generating such enormous quantities of electricity, would have produced a more visible effect on their surfaces.

But we have seen that sulphuric salts have not been detected in the mineral waters of Cornwall ; and no one who has descended into the mines has ever been struck by the chemical changes going on ; the sulphate of copper which in such a case should have been an abundant product, is scarcely ever met with. It is true that atmospheric influence, aided by the percolating water, and a rather elevated temperature, would have been expected to induce many chemical changes, but where is the evidence of their progress ?

As a greater development of voltaic electricity would accompany an elevation of temperature,* and as the heat increases as we descend, it would follow that the most deeply seated currents should be the most energetic, but nothing of the kind occurs.

We have no reason to believe that there is any *constant* difference in the mineral contents of the water in different rocks, and it certainly appears that no general law regulating their existence and nature, has yet been discovered.

It has, however, been shewn, that the various ores of copper are commonly contained in rocks of different characters, and this would indicate the probability of electric currents being excited, even if the liquid be the same in both cases.

All metals and many ores, among the latter the sulphurets of

* Faraday, 3d series, Phil. Mag. IV., 414.

copper, lead, and iron, when unequally heated, are traversed by currents of electricity of very low intensity, although in considerable quantity.

In a communication to the Royal Geological Society of Cornwall, in 1834, Mr Fox states, that when heated, copper pyrites was positive both to purple and vitreous copper-ore, to galena, and to iron pyrites; also that elevation of temperature induces *positive* electricity in the sulphurets of copper and lead, but *negative* in iron pyrites.

It is well known that "foreign metals brought into contact with a homogeneous circuit near the point of heat, participate in the action, and tend to determine the current." (*Prideaux, Phil. Mag.*, 3*d series*, 1833, III. p. 272.) Seeing the complicated results, obtaining when a *few metals only* are employed, could we expect simplicity where so many more elements enter our circuit?

We have seen that the contents of our veins consist of several ores of many metals: who would venture to predict the direction of a thermo-electric current excited in such a mass; the elements varying in the numbers, magnitudes, and directions of their masses; in some places connected, in others disjoined; here mixed, there separate; in one spot coincident, in another opposing; parallel in some situations, transverse in others? It is obvious that the higher temperature of the slate than of the granite, and of masses of ore dipping from the latter towards the former are highly favourable conditions for the development of *thermo-electricity;* and in order to see how it accords with facts, we will *assume* a case which shall involve them all.

Suppose a mass of copper-ore originating near the surface in slate, to be prolonged in extent towards, or into the granite, the upper portion would probably be in general copper-pyrites, the lower vitreous copper-ore. On a given *horizontal* line, we shall then have the *positive* ore (the pyrites) in the *warmer* rock, and the *negative* (vitreous) in the *colder;* and the same result will obtain, whether each ore singly had been *unequally* heated, or whether *both* are in contact at the *same* temperature. In either case a current would be determined *towards* the granite.

If, however, we take a *vertical line*, our conditions are different; for here, if the points be distant, the *higher temperature* *of the vitreous* copper-ore may render it positive to the copper-pyrites. In some cases, it is obvious, differences of depth may compensate for the natural inequality of temperature between the granite and slate, and thus currents may be excited in contrary directions to those which would obtain, if both ores were *equally* heated in contact, or if the pyrites were warmer than the vitreous copper. It is evident too, that in many cases "foreign ores" may determine the directions of the currents, and that minor circuits may neutralize each other.

I think it is hopeless to search for any relation between the directions of the currents and the points of experiments; for these, although partaking of the natural temperature of the spot, are constantly modified by the combustion of candles and gunpowder, the presence of workmen, and the circulation of air from other parts of the excavations, to all which influences the outer film of ore must be very obedient.

The *exciting* differences of temperature must be sought in the *mean* temperatures of the *sums of the masses* under experiment; and to them our observations being but *approximations*, can be but imperfect indices.

The last division of our subject relates to the opinions which are supposed to be supported by these experiments, and the theory which has been founded on them.

Taken in conjunction with the beautiful experiment of Mr Barlow, they would, *prima facie*, be thought confirmatory of the opinion that terrestrial magnetism is of electric origin. But it has been shewn that these currents have no uniformity of direction, even in parallel veins; and that they exist of equal force in veins bearing N. W. and S. E. and N. and S. as in those having an E. and W. direction; remembering, too, that we are entitled to speak with but little certainty of Cornwall, whilst of all other parts of the world we can yet but guess.

If the electrical currents yet discovered have any effect on a magnetized bar freely suspended, they would of course subtend an angle to each other; in the mines of St Just, however, the currents are *parallel* to the magnetic meridian.

But the discovery of electric currents in the *present contents* of our veins has been made use of as a foundation for a theory of the *origin* of the veins themselves. Professor Sedgwick, in one of his addresses to the Geological Society, says, "After the important experiments of Mr Fox, there can, I think, be no doubt that the great vertical dikes of metallic ore which rake through so many portions of the county, owe their existence, at least in part, to some grand development of electro-chemical power."

I confess I see nothing in the experiments to bear up such an opinion, which would surely derive much stronger support from the observations of M. Becquerel, which had then been some years before the world.

This most original and ingenious experimenter, by the use of a curved glass tube, divided at the turned part by a bit of moist clay, and filling each leg of it with a solution of a different substance, which he connected by a piece of wire, obtained *crystals* of metallic copper, red oxide of copper, and vitreous copper; metallic silver, sulphuret of silver, galena, sulphuret of antimony, and many other substances, which frequently could not be distinguished from *natural* minerals, the agency being *the electricity developed by the solutions alone.*

The theory which Mr Fox has recently brought forward, assumes the previous existence of fissures in the strata, which are subsequently gradually opened; the contents of the fissures he imagines to have been deposited by electric currents generated by the action of saline solutions on the rock masses.

The opinion of a gradual opening on the line of previously existing fissures, was propounded by Werner (*Theory of Mineral Veins*, translated by Dr Charles Anderson of Leith, 68); and I purpose the task of examining whether it is consonant with the phenomena of this county in another place; at present we have only to deal with the electric part of the theory.

The discovery of electric currents in the *present contents* of veins, appears to me to have no necessary connection with the mode of their original deposition; and if it had, there are not only *no currents in the tin lodes*, but many of the *lead* and *copper mines are equally destitute* of them.

It is admitted that currents will most *readily pass at right angles* to the magnetic meridian, and this *facility* is made the *reason* for the E. and W. and N.W. and S.E. veins being so filled in preference to those bearing N. and S., but still all the metalliferous deposits are supposed to be synchronous, notwithstanding the *lodes* of St Just are *parallel* to the magnetic meridian, whilst the *cross veins* of the same district bear N.E. and S.W.

Beside this, it must not be forgotten that the magnetic *variation* is a fluctuating quantity; and that, therefore, that which is *now coincident with it*, was not so *some time since*, and will not be so *a little time hence*.

One rock is assumed to be positive and the other negative, (Mr Fox has not said which he supposes in either state), and thus one ore is deposited in the granite, another in the slate.

We have seen that in the contiguous mines of Huel Vor, and Great-work, worked on parallel veins, all the tin ore in one mine is in slate, and all the like ore in the other, is in the granite; also that in Tresavean, the copper-ores are *all in the granite*, whilst in the parallel veins of United Mines, Wheal Squire, and Ting Tang, they *are entirely in slate*.

But we are told by Mr Fox, that different saline solutions, existing " in the rocks, are capable of exciting voltaic action, and giving rise to voltaic currents, even if there were no other cause sufficient to produce them."—*(Report of a Lecture delivered at Redruth, West Briton, Nov.* 4. 1836.)

I have already stated, that the currents detected in veins, have been *confined to their metallic portions;* and that, notwithstanding the *same means were applied to the* ROCKS, *and the* EARTHY CONTENTS OF THE VEINS, NOT A TRACE OF ELECTRICITY HAS YET BEEN FOUND IN EITHER.

Mr Fox does not allude to the original locality of the metals thus supposed to be deposited by the currents; this is, however, a very necessary point of inquiry, for they may have been beyond the reach of electricity. If, however, they are supposed to have been in solution, it is but an obvious application of M. Becquerel's experiments; where, however, are the solvents now? If the currents be assumed to have acted IN the *fissures* only, what force *collected* the matter which was not originally *contained in them?*

If the force acted *beyond* the fissures, why were not the ores deposited *out of them?*

It may not be out of place to observe, that Mr Fox has spoken of the *conversion* of copper-pyrites *into purple copper-ore;* now this *conversion* is certainly not analogous to *deposition.* I have, however, a series of experiments in progress, which, I think, will shew that *no change takes place in the pyrites,* the appearances being occasioned by a PRECIPITATION OF PURPLE COPPER THEREON. This (if confirmed by more extended experience) will at once reduce the fact to a mere repetition of M. Becquerel's experiments; with such modifications only as render it less like the simplicity of nature.

I regard these currents as merely local, originating probably in inequalities of temperature prevailing among *different ores,* in *various rocks,* at different depths; possibly also in voltaic combinations of various metallic substances. These may be adequate to the induction of chemical changes within certain limits; but that they perform any more important function in the economy of nature I do not believe. I have the honour to remain, Sir, your very faithful humble servant,

W. J. HENWOOD.

To WILLIAM STURGEON, Esq.

P. S.—It is still an object to be determined by experiment, whether these currents have any decomposing or heating power, or whether they will yield a spark. I have long contemplated making the examination, but have been hitherto prevented by more pressing occupations.

4. CLARENCE STREET, PENZANCE,
December 6. 1836.

Analysis of Fossil Scales from the Old Red Sandstone, Clashbennie, Perthshire. By A. CONNELL, Esq. F. R. S. E. Communicated by the Author.

THE following analysis may be added to those of fossil scales from other formations, formerly published.* For the scales now examined, I have to thank Mr Robison, Secretary of the Royal Society, who found them at the above-mentioned place, and sent them to me for analysis.

They presented quite a different appearance from all those

* New Edin. Phil. Journal, October 1835.

formerly examined. Instead of the fine lustre exhibited by the Burdiehouse, Craighall, and Tilgate scales, those of Clashbennie had a quite dull aspect, and all the appearance of dried or calcined bone. Their colour was white, with occasional transfused portions of the red sandstone matrix in which they were imbedded. Their hardness inconsiderable. Their shape was in general imperfectly preserved, but the portion analysed appeared to have been a fragment of a rhomboidal scale. Mr Robison informs me, that the scales sent to me were exactly similar to those which have been found in the same place actually covering a portion of a fossil fish.

Fragments were selected for analysis as free as possible from any intermixture of the matter of the matrix. They were parts of a scale an inch long, by half an inch broad, and an eighth thick, which appeared, however, to have been a portion of a larger one.

The result obtained by the same process as formerly was as follows :

Phosphate of Lime, with a little Fluoride of Calcium,	91.42
Carbonate of Lime, ...	7.05
Chloride of Potassium, ...	0.27
Water, ...	0.97
Sandstone matrix, ...	2.38
Phosphate of Magnesia, trace.	
Animal matter, trace.	
	102.09

Thus these scales did not differ more from those formerly examined in external appearance, than in chemical constitution. Whilst in all the latter, the perishable animal matter appeared to have been more or less replaced by siliceous or calcareous matter, in the present instance there seems to have been no substitution at all. The animal matter is gone, but nothing has come in its place, the permanent bone-earth alone remaining. But this is merely a difference in the state of preservation, depending on the circumstances under which the fossils have been preserved. A more important distinction is found in the relative proportions of the phosphate and carbonate of lime. There was reason to believe that this proportion had been originally nearly the same in the three different fossil scales formerly examined, and that all of them had borne a strong analogy in this and other respects to the recent scales of the Lepisosteus analysed by Chevreul. In regard to the Burdiehouse scales, this was hardly a matter of any doubt, because the animal matter was indubitably represented by a fine siliceous skeleton, and the relative proportions of the three constituents, phosphate of lime, carbonate of lime, and animal matter, plainly approached very nearly in the recent and fossil scales. But, in the present instance, the ratio of the phosphate to the carbonate of lime, is quite different, being nearly as 13 to 1, instead of as formerly about 4 to 1. Now, it is singular that two of the three analyses of recent fish-scales which Chevreul has given us, present nearly this ratio of 13 to 1. His analyses are,—

	Perca labrax.	Chætodon.
Phosphate of Lime,	37.80	42
Carbonate of Lime,	3.06	3.68
Gelatinous Animal Matter,	55.	51.42
Phosphate of Magnesia,	.90	.90
Fatty matter,	.40	1.
Carbonate of Soda,	.90	1.
	98.06	100

Now, all recent fish-scales which have been examined, contain a large proportion of perishable animal matter, usually about half their weight; and in the case of the Burdiehouse fossil scales, there is plain evidence, from the substituted siliceous matter, of an original constitution similar in this respect. Let us suppose that those at present under examination had originally contained, like those of the Perch and Chætodon, with which they agree in the relative proportions of phosphate and carbonate, a little more than half their weight of animal matter, which has disappeared without substitution. On this view, their original composition would have been nearly as follows, retaining the present proportions between phosphate and carbonate:—

Phosphate of Lime,	41.6
Carbonate of Lime,	3.2
Animal Matter,	55.2
Phosphate of Magnesia and Chlorides, small quantities.	
	100

This constitution would therefore have been entirely analogous to that of the scales of the two recent fishes referred to.

I by no means intend to argue from this, that the ancient fish of the old red sandstone must necessarily have been analogous to one or other of these recent fishes. That is a point I leave to M. Agassiz, and other naturalists qualified for the task. Indeed, whilst the Perch, and perhaps the Chætodon, belong to the Ctenoidean class of Agassiz, we should probably, I suppose, look for so ancient a member of the finny tribes as an existing occupant of the old red sandstone, in one or other of the two older classes, although the dull aspect of the fossil scales, as well as their chemical composition, would seem to exclude their possessor from the Ganoideans. But these are points for others to resolve. All I feel entitled to state with comparative confidence is, that there appear to be reasonable grounds for holding, that the external covering of the fossil fish in question had an analogous chemical constitution to that of the two recent Acanthopterygeans referred to, whether it was allied to them in other respects or not.

In a recently published popular work by a scientific author, we are told, that " horny scales of fishes, and dermal bones of crocodilean animals, are preserved in the same lias with the bones of Ichthyosauri."* Notwithstanding the high authority due to statements coming from such a quarter, it is much to be regretted that the above statement was not accompanied by some farther explanation. Numerous recent and fossil fish-scales have been examined by Mr Hatchett, M. Chevreul, the late lamented Dr Turner, and myself, comprehending a considerable variety of genera or species, such as the Salmon, Carp, Shark, Lepisosteus, Perch, Chætodon, and Sturgeon, amongst recent fishes, and the Megalichthys, Dapedium politum, &c. amongst fossil fishes, and in all of these, without a single exception, the quantity of bone-earth was found to be considerable; and I am not acquainted with any other special examination of fish scales than those referred to. It is therefore hardly to be expected that such a general statement, as that " horny scales of fishes,"—understanding that expression to have a similar meaning with another in the same passage, " horny scales of lizards,"—are found in the lias, should be admitted without some account of the methods and results of chemical examination. The occurrence of even *recent*

* Geological Bridgewater Treatise, II. 22.

horny fish-scales in this sense would, so far as my knowledge extends, be a fact well worthy of special details; and still more remarkable would be *fossil* fish-scales of that nature. I am much more prepared for the other statement in the above passage, that "dermal bones of crocodilean animals" are found in the lias, understanding that these *dermal* bones were also *dorsal*, as stated with respect to crocodilean dermal bones in the previous part of the same passage. In the former paper on fossil scales, I made a distinction between the flat scales on the belly and sides of crocodiles, and the carinated scales on the back of those animals, conceiving the former to consist of perishable animal matter, and therefore not likely to exist in a fossil state, unless in virtue of substituted mineral matter,* whilst the latter might very probably contain, as I partly, indeed, found by analysis, more or less bone-earth; and reference was made to the passage in the Ossemens Fossiles, in which notice is taken of a "a very prominent bony crest" on the fossil saurian scales of Argenton. Still, however, farther details respecting the form and chemical composition of the crocodilean bones of the lias would have been highly interesting, and, we may hope, will still be afforded. †

Remarks on the origin of Meteoric Stones, and more especially on the views entertained on the subject by Berzelius. By K. E. A. Von Hoff. ‡

Various hypotheses have been proposed to account for the origin of meteoric stones, and of these there are three which deserve particular attention.

The *first* was brought forward by Chladni, and supposes,

* The horny or other highly azotized animal substance, of which the lower flat scales of crocodiles consist, fusing by heat, and burning with flame, and strong animal smell, is evidently much less likely to be present in its natural state, than such a substance as chitine, of which it is supposed the curiously preserved covering of the fossil scorpion from the Bohemian coal-field is composed.

† I wish to take this opportunity of mentioning, that Professor Jameson informs me, that Wardie was the locality of the coprolite analyzed by Messrs Gregory and Walker, Edin. New Phil. Journ. Jan. 1835, and there stated to have been from Burdiehouse.

‡ Poggendorff's Annalen der Physik und Chemie, Band xxxvi. p. 161.

that they are of *cosmical origin*; and hence that they are either the fragments of shattered planets; or themselves small planetary bodies, which, floating and revolving in space, descend to the earth's surface when they come within the reach of the attraction of our globe; or, finally, that they are accumulations of loose matter (the original material from which the planets were formed).

The *second:* that they are *masses ejected from the moon*, was advanced by Baron Von Ende, after the possibility of such an origin had been mathematically demonstrated by Laplace and Olbers; and has been recently defended by Benzenberg and Berzelius.

The *third:* that they are of atmospheric origin, that is, that they have been formed in the earth's atmosphere from gaseous substances belonging to itself, has been adopted by several authors, and recently by Egen and Butler.

Some other more or less paradoxical opinions, such as, that meteoric stones are terrestrial stony masses altered by lightning, or masses ejected by the volcanos of the earth, or even portions of the poles, have all been proved to have so little foundation, that they are unworthy of farther consideration.

Butler's essay induced me to publish formerly some observations on the origin of meteoric stones,* but at that time the investigations of Berzelius had not been made known. That great chemist has declared himself an advocate for the *lunar origin* of meteoric stones, on grounds which he finds in the chemical constitution and oryctognostical characters of these bodies; thus affording new support to Ende, Benzenberg, and the other partisans of an hypothesis which had been partly raised on a mathematical basis.

The views of Berzelius had great attractions for me, but some doubts which I entertained on the subject, have induced me to place in as clear a light as possible all the circumstances connected with the remarkable phenomenon of the fall of meteoric stones. I now venture to offer my observations on the question, and I do so the more willingly, because it may possibly have been imagined (though incorrectly), from the tenor of my former remarks on Butler's hypothesis, that I assumed to my-

* Poggendorff's Annalen, vol. xxxiv. p. 351.

self the merit of having originated the theory of the atmospheric origin of meteoric stones.

The following are the chief arguments adduced by Berzelius in favour of the lunar origin of meteoric stones.*

1. Meteoric masses contain *metallic* iron, or are entirely composed of it. All iron penetrated by water containing air, becomes rusted (oxidised); and this invariably takes place on the earth's surface. *Metallic* iron must therefore come from a place where there is no water; in the moon, as we must conjecture, there is no water; there alone, therefore, can iron remain in a metallic (unoxidised) state; consequently meteoric stones may be derived from the moon.

2. Most meteoric stones are as similar in their constituent parts as if they were derived from one mountain; only a few have been found with a different composition. On the earth there is a variety of mineral compounds occurring at different places. This may also be the case in other heavenly bodies, and in the moon; hence we may suppose that various mineral mixtures would come from the moon, if they were derived from different portions of its surface.

3. Masses ejected by the moon, would most easily reach the earth's surface, when thrown out from the centre (or at least some point near the centre) of the side of the moon turned towards our globe. The species of rock which predominates there, would hence afford the largest number of meteoric stones, and thus most of them resemble one another. Ejected masses from other parts of the moon do not proceed in such direct lines towards the earth; hence they more rarely come within the influence of the earth's attraction, and these are probably those stones which have a different composition from the majority. Can perhaps, says Berzelius, the quantity of nickeliferous iron, on this side of the moon, be the cause that the latter always turns the same side to the earth; owing to the magnetic attractive power of the earth acting chiefly on this side, and less or not at all on the other, which probably contains no nickeliferous iron?

4. When we examine meteoric stones as mountain rocks, we find that they are extremely different from those of the earth. The abundance of magnesia, the rarity of silica, and the incon-

* A more detailed account of the opinion of Berzelius on the origin of meteoric stones is given in the beginning of this volume of the Journal.

siderable quantity of silicates of alumina and the alkalies, characterise meteoric mineral masses. On the earth the case is reversed; here the silica predominates, and silicates of alumina and the alkalies are every where the chief component ingredients: magnesia occurs rarely.

5. Meteoric stones do not seem, like our terrestrial volcanic products, to have been ejected in a melted condition, but to have been quietly and slowly formed; for they appear to have been fractured, and to have had the fissures so produced filled in some places with a dark coloured mineral substance.

6. Berzelius does not think that olivine is a volcanic product, on account of its difficult fusibility; but regards it as a pre-existing mineral which was only enveloped in the liquid lava.

7. The meteoric stone of *Alais* is a rock which has been weathered and decomposed in its place of origin.

8. The meteoric stones of *Stannern*, *Jonzac*, and *Juvenas*, were derived from a different part of the moon from the others, and possess very distinct characters. They contain no native iron, and are aggregates of easily distinguishable minerals; magnesia occurs in them in very inconsiderable quantity. But on the other hand, besides a little sulphuret of iron, silicates of lime, alumina, and oxide of iron, they contain also chrome, &c.

The chemical investigations of Berzelius are of such extreme value, that, even to praise them, would, in me at least, be unpardonable presumption.

But the question may be asked, Whether the composition and constitution of meteoric stones as ascertained by chemical examination; whether further their oryctognostical characters and physical properties; whether, finally, the phenomena accompanying their descent to the earth, furnish a ground for believing them to be derived from the moon; or render it necessary for us to adopt such an opinion, and at the same time to reject every other view of the question.

The component parts of meteoric stones exhibited as well by their empirical and physical characters, as by the analysis of their simple chemical constituents, are not exclusively peculiar to them, but all occur in the masses of which the crust of the earth is composed.

The *metallic* iron is the only exception, for it has not yet been found in any hitherto examined portion of the globe.

Magnesia occurs in abundance in many mountain rocks, and silica is awanting in others, as well as the silicates of alumina and of the alkalis.

The oryctognostical character of the meteoric mineral compound, when the latter is regarded as a mountain rock, is certainly different from all the rocks hitherto found on the earth. But the structure exhibited by meteoric stones, the masses of native iron excepted, is the same as that presented by many terrestrial rocks, viz. the *granular-crystalline.* But the same mixture of the same simple minerals has not yet been observed on the earth.

We find, therefore, in meteoric stones resemblances to inorganic terrestrial masses, and also differences from them. The *similarity* consists in all the simple ingredients, and some of the mineral species resulting from their combination, being the same in meteoric stones as those we find in the crust of the earth. The *difference* is, that in meteoric stones the mineralogically simple substances, resulting from the union of chemically simple ingredients, form a compound which does not occur on the earth; that in this mixture iron occurs in a metallic condition, and that many meteoric masses entirely consist of such iron, while the earth does not afford any example of metallic iron.

The difference of meteoric from terrestrial masses certainly points to the conjecture, that meteoric stones *previous to their descent, have not belonged to the earth.* But, as their characters are not only those of a mineral, as in the masses of native iron, but also of a mountain rock, as in meteoric stones, the conjecture is admissible, nay natural, that formerly they belonged to bodies constituted essentially like the solid portion of our globe.

The moon is the nearest heavenly body to the earth to which we can ascribe a composition of such materials.

That a certain given power could project bodies so far from the moon—that they should be more powerfully attracted by the earth than by the moon—has been mathematically demonstrated from physical laws.

That in the moon volcanic action does occur, to whose agency such a projectile power may be ascribed, is at least not improbable, nay even indicated by some phenomena.

The idea conceived by Berzelius is extremely ingenious, viz. that most of the meteoric masses reaching the earth—that is, supposing them to be derived from the moon—must come from a region lying near the centre of that side of the moon turned towards us, therefore from a limited space, in which one single kind of rock may predominate; and that it is on this account the majority of the meteoric stones hitherto found consist of a very similar mineralogical compound; that, on the contrary, those from a district considerably removed from the centre of the side of the moon next us, and therefore belonging to a different rock formation, do not proceed in a direct line towards the earth, hence reach us more rarely; and that it is for this reason we find so few meteoric stones differing in their characters from the majority. We must not, however, leave unnoticed the following consideration. The greatest support of the lunar hypothesis is undoubtedly the mathematically demonstrated possibility of bodies being projected from the moon to a region within the range of attraction of the earth. But the calculation by which this is proved is formed on the supposition that the earth and moon remain stationary. This, however, is not the case; and the movement of the moon round the earth and round the sun is communicated to the masses ejected by the first. Hence these will describe an elliptical path round the earth, in which they can reach the earth itself only in that case when their perigeum touches the earth, or at least its atmosphere. As this, however, can, in all probability, be the case with only a small portion, only very few of the masses ejected by the moon reach the earth. But as the occurrence of meteoric stones is so common, the moon, if it is their place of origin, must gradually lose much of its mass.*

It is not to be denied, that, notwithstanding this last observation, all the circumstances mentioned in the preceding remarks favour the hypothesis that meteoric stones, and the masses of native iron which fall from the air, *can* be derived from the moon. But, in order to judge if it be necessary to ascribe to the moon alone the origin of these masses, and to reject every other view of their origin, we must examine more attentively the circumstances which, among those employed to support the opinion, are still hypothetical. In this light I consider the following:—

Iron, says the hypothesis, can occur in a *native* state only in the moon, since it is not oxidised there, owing to the moon pos-

* Vide Olbers in "*Von Zach's Monatliche Correspondenz,*" vol. vii. p. 159.

sessing no atmosphere and no water from which the iron could absorb oxygen. Now it is not fully proved that the moon is destitute of an atmosphere resembling that of the earth, or that water does not exist in the moon in a similar way as on the earth. We have no evidence that the moon does not contain water under its solid covering, or on the side which is constantly turned away from us. We find further, that in the component parts of those meteoric masses which do not consist entirely of meteoric iron, the process of oxidation has taken place. If, then, these bodies have been derived from the moon, the process of oxidation must have gone on there, consequently an absorption of oxygen must have occurred there, and consequently oxygen must exist there. There remains, besides, much that is unexplained in the occurrence of native iron in the moon; and if to this part of the hypothesis we should oppose the theory, that perhaps in the earth itself, but at a depth not yet reached by man, native iron may be found, such a conjecture could not be regarded as a very rash one.

Further, the possibility of bodies being projected from the moon with the force necessary to bring them within the range of attraction of the earth, is not only not to be disputed, but even mathematically demonstrated. But that such a power is actually exerted on the moon, is not an ascertained fact, but only an hypothesis. The circumstance that volcanic formations of considerable magnitude are to be observed on the moon's surface certainly supports the idea; but the proof on this head is not quite conclusive.

Granting, however, that the chemical and physical constitution of meteoric stones and masses of iron which have fallen from the air, and granting that all the other circumstances we have hitherto adduced favour the notion of the lunar origin of these masses, granting also, that the doubts started against the hypothesis are to be regarded as insignificant; there still remains the question to be investigated if the phenomena accompanying the fall of meteoric stones support in a similar manner this opinion.

According to the conjecture in question, meteoric stones are the mountain rocks of the moon, which have been separated from their original beds, and hurled away as solid masses. Hence they may either fall in their original condition on the earth, as a cannon-ball reaches its destination in the same state in which it was discharged from the cannon; or they may undergo some change during their transit through the space between the moon and the earth.

The condition of meteoric stones, when we regard them as fragments of mountain rocks, affords us no grounds for believing, that, during their passage, they have suffered any other change than a sort of slight melting of the surface, which is made known by the black crust with which they are enveloped. This crust is extremely thin, and penetrates to a certain extent the interior of the meteoric stone, only where there are fissures. The interior has so completely the aspect of a granular compound mountain rock, and the iron of the masses of iron is so perfectly compact, that when we assume that these masses have been torn from the moon, constituted as we find them, we must also admit that, during their passage, they have suffered no other alteration than the very slight one operated on their external surface, by which a thin crust has been produced; and sometimes the breaking up of the mass into several pieces. Berzelius seems to entertain the same view on this point.

When we consider that a discharged cannon-ball does not become red-hot during its passage through the lowest and densest portion of the air; and that a rifle-ball, composed of easily fusible lead, penetrates wood of ordinary hardness, without losing its roundness, thus shewing that it has not become soft during its passage, we can understand that masses ejected by the moon, notwithstanding the much greater rapidity of their motion than that of cannon-balls, cannot be altered to any depth in their interior, or melted, merely by friction in the atmosphere, whose denser portion they reach only at the end of their course. It is therefore difficult to explain, according to the lunar hypothesis, the phenomena which always accompany the fall of meteoric masses, and which can be produced with extreme difficulty during the passage, however rapid, of a difficultly fusible solid body through the atmospheric air.

The phenomena of this description are the following: *The evolution of light*, which can only be perceived at night, lasts but a short time, and enables us to follow the course of the falling body. The luminous body generally appears as a more or less round ball of fire, which often drags a luminous tail after it, and sometimes emits sparks. If we assume that the meteoric mass already formed was projected from the moon in a solid condition, we must explain the continued evolution of light for a certain time, by supposing either that it was ejected in a red-hot condition, or that it was heated to the red-hot state, or to that of fusion, by friction in the medium through which it pursued its course. It would also be necessary to explain by this high degree of heating, the flying off of separate fragments, thus giving rise to sparks, and likewise the fiery tail in so far as it is not to be regarded as an optical deception.

But there are several circumstances which are opposed to this assumption. *Firstly*, An ejected mass from the moon would pursue by much the greater part of its course towards the earth, through a medium so extremely rare, that one can with difficulty admit an elevation of temperature caused by the friction of the moving body. At all events, so powerful a friction or compression (as Chladni afterwards assumed, instead of the mere friction, as the cause of the increase of temperature) could only begin in the lowest, densest, but also least considerable portion of the earth's atmosphere. But that such is not the case in this lower region, is proved by the circumstance, that the evolution of light has always ceased when the meteoric mass arrives at the lower part of the atmosphere, and also by our perceiving this phenomenon of light and fire in the falling bodies at the height of some miles from the earth's surface.

Secondly, The falling meteoric mass arrives at the earth's surface in a compact state, not melted, not softened, not even, or at least only extremely rarely, red hot; for its form acquires, by its fall on the ground, no such alteration as would be the consequence of the violent concussion of a soft body against a hard one; and we have almost no instance of meteoric stones inflaming, or even burning much, the substances on which they had fallen. Chladni,* among several cases in which damage was caused by meteoric stones, instances only a few in which the injury was produced by the objects being set on fire by such bodies; and in some of these few examples it is doubtful if the meteoric phenomenon was an aerolite or an ordinary stroke of lightning. If the elevated temperature of meteoric masses

* "Feuermeteore," p. 77-80.

be caused by friction in the air, or by the compression of the air, the greatest degree of heat must be attained in the lowest part of the atmosphere; and from the high degree of temperature which we may assume is proper to the falling bodies at the greatest height where the fiery phenomenon is visible, this degree of heat ought to be so increased at the time the stone reaches the earth, that the mass should no longer retain its solid form. It is true that traces are said to have been found of partial melting or softening in fallen meteoric masses, such as impressions of stones, attached or imbedded stones, &c.* but such cases seem to be of extremely rare occurrence, and the traces themselves very indistinct. On the other hand, most of the meteorolites, even the masses of iron, as, for example, that of Agram, and that of Ellbogen, known by the appellation of the "*Verwünschter Burggraf,*" have arrived at the earth's surface as massive and thick lumps, or have penetrated the earth like solid balls from cannons.† They must therefore have acquired their solid form, and become hard, at considerable heights above the earth. If they had reached the earth in a melted condition, they would have formed a broad, thin mass, like tin or flattened lead.

Thirdly, Meteoric masses (with the exception of masses of native iron) have the characters of crystalline primitive rocks. If we assume that these are fragments of such rocks belonging to the moon, we must suppose that, during their passage, they have undergone no change in their interior, at least no change caused by fusion. The product of such an operation would not be a granular mixture of several mineralogically simple and crystalline substances. But the extremely thin shaggy crust which generally surrounds meteoric stones, shews that probably two distinct operations have taken place, of which one has not affected the interior, but only the exterior. The masses of native iron, in particular, have that remarkable crystalline internal structure (*the Wittmannstadt figures*), which is not produced by fusion, but points to the original formation of the mass.

From all these circumstances, it seems to me to follow, that the operation of the medium through which meteoric stones

* Chladni's "Feuermeteore," p. 41.

† Schreiber's "Beiträge," p. 7.

have passed, or friction of the masses in the atmosphere, or the compression of the latter caused by the falling bodies, can exercise extremely little, or perhaps no influence whatever, on the internal and essential constitution of aerolites; and that it still remains even doubtful if the luminous phenomena exhibited by the fallen meteoric stone is to be attributed to friction in the atmosphere and compression of the air.

In the case of meteoric stones, which have fallen by day, a feeble display of light only has been observed; but, on the other hand, a small cloud frequently accompanies the falling bodies, or precedes the descent. As this cloud probably consists of vapours which are intimately connected with the luminous phenomenon, all that has been said of the latter applies equally to the former.

Fourthly, Besides the luminous phenomenon which accompanies the fall of meteoric stones, and lasts but a short time, fire and smoke occur as still more transient, almost momentary phenomena, which are of the highest importance in explaining the origin of the phenomenon.

In every fall of a meteoric stone, and at the time when the falling body is still at an extremely considerable height above the surface—a height amounting probably to many miles—a very loud momentary explosion is heard, like a report or peal of thunder, or crackling noise, and which is very distinctly audible at great distances.

This momentary explosion is least easily explained by the idea of the lunar origin of meteoric stones. If such a mass as a detached fragment of rock from the moon fell towards the earth, what could produce on it a momentary violent effect in a region where the earth's atmosphere—if, indeed, it extends so far—must be so attenuated, that it may almost be compared to empty space? Why should there ensue an apparently tremendous explosion in that region, and not rather in the densest portion of the atmosphere, where the reaction of the latter on the penetrating solid bodies must be the most powerful? That the explosion really occurs at such considerable heights is demonstrated partly by observations made on the parallaxes of such meteors, and partly by the time which intervenes, in falls of stones, between the occurrence of the phenomenon of light and clouds, and the hearing the report.

A *fifth* circumstance deserves particular consideration. The meteoric stones and masses of iron which are found on the earth after the occurrence of the phenomenon, are remarkably small masses in comparison with the size of the fire-balls which have produced them, and which, at a great height above the earth, appear very much larger than they could appear, if the fallen masses had at that height only the same dimensions which they possess when found on the earth, and if they had exhibited their luminous appearance only from an elevation of temperature, or from their being red hot. The difference between the size of the fire-balls and that of the solid masses which have fallen from them, amounts to perhaps a hundred thousand times.

Sixthly, An amorphous, dull mass of light, occupying, however, greater space than the ball itself, sometimes precedes the formation of a round fire-ball, as when occasionally a luminous cloud presents itself, or parallel stripes are seen in the heavens, which afterwards are blended together in a fire-ball.

All these parts of the phenomenon, viz. the momentary explosion, as well as the temporary display of light, together with the last mentioned phenomena which precede, and prepare for the principal occurrence; further, and chiefly, the considerable difference in size between the fire-ball and its product which falls to the earth, cannot be explained by the passage of a solid body through the space above and in the atmosphere. At the foundation of all these phenomena, there must be a peculiar, instantaneously-effected, physico-chemical process, regarding whose exact nature all the observations hitherto made leave us still in the dark; hence it seems too soon to endeavour to explain it by the laws of nature, which have become known to us, or which we think we have ascertained to exist.

But there is one conjecture which seems to me perfectly natural, and which it is necessary to bring forward, viz. *that, at the time when the explosion and evolution of light occur in a falling meteor, a great chemico-physical operation takes place, which is not merely the accompaniment of the fall of a solid body, or the effect of that fall; but which forms a new body from the original* *elements ; and that this new body is actually the falling meteoric stone.*

Chladni assumed, that the space between the great heavenly bodies is filled with masses of an original matter, in an incoherent form, from which solid planetary bodies can be produced; and perhaps also with already formed, but extremely small planet-like bodies, endowed with the same revolving motion as the larger. He believed that revolving accumulations of this loose matter, when they came within the power of attraction of the earth, could descend to its surface, and thus produce meteoric stones, or that the phenomenon of aerolites might be caused, by the arrival within the region of the earth's attraction, of one of the small satellites assumed by Chladni to exist, and to which he gave the jocular appellation of world-chips (*Weltspäne*). Nevertheless, he gave the preference to the idea of the formation of meteoric masses from loose elementary matter, probably from the consideration, that the theory of the descent of *Weltspäne* is involved in the same difficulties as the lunar hypothesis.

But, it appears to me, that the notion of the descent of a mass of loose original matter to the earth, its meeting with the atmosphere, and its passage through the latter, is not *of itself* sufficient to explain the phenomena which have been enumerated above, as accompanying the fall of meteoric stones. I might be inclined to support the proposition which forms the basis of the view, viz. that there exists an original matter in space (and probably also in the earth's atmosphere); but, it seems to me, that, in order to produce the appearances described, some other process must take place in relation to this matter than its mere entering into the earth's atmosphere.

The opinion, that the substances from which planets are formed, are dispersed in space, is by no means unnatural; and the same may be said of the idea, that the formation of solid bodies from such substances is constantly being effected by the agency of some physico-chemical process, of whose nature we are ignorant. This last view has been adopted by Herschel, * certainly a very competent authority. It thus appears to me, that all the circumstances accompanying the fall of meteoric

* Gilbert's Annalen, vol. lxxv. p. 250.

stones, are extremely favourable to the thought, that the phenomenon is caused by a process which produces solid bodies from the loose matter already mentioned.

If we adopt this view, we find that it explains many of the phenomena of meteoric stones, much more easily than the other hypothesis; that the difficulties which are opposed to the adoption of the latter do not affect it; and that it leaves unassailed the results of chemical investigation.

The suddenness of the phenomenon, the momentary explosion, the light diffused by the falling body, the circumstance of the stone being cooled on arriving at the earth, its solidity at that moment, its internal crystalline structure, the enormous extent of the fiery mass when at a great height compared with the small volume of its solid product, the fact, that the commencement of the phenomena has sometimes presented a small luminous cloud, at other times parallel luminous stripes, which gradually unite to form a fire-ball; all these appearances are much more easily reconciled to the theory, that, in the fall of a meteoric stone, a new body has been formed, than to the other, that a perfectly formed solid body from another planet, or from some other quarter, has fallen to the earth simply from its specific gravity. I presume it to be well known, that, in great chemical combinations and decompositions, violent and sudden phenomena occur, such as evolutions of heat, light, &c.

There is another circumstance which seems to favour more the theory of the new formation of a solid mass from original elements, than that of the ejection of a fragment of a larger mass of rock, and this is, the trace of a *regular form* produced by crystallization of the whole mass which is observable in some meteoric stones.* Although the approximation to a regular form is only a slight one in the cases alluded to, yet it is not to be denied that observations of this kind deserve attention.†

* Chladni's Feuermeteore, p. 49.

† In King's work on Meteoric Stones (1796), afterwards mentioned in the present memoir, we find the following curious passage regarding the form of meteoric stones. He says, "I have received from Sir Charles Blagden a present of one of the very small stones that are affirmed to have fallen in Tuscany, and which has very lately been brought carefully from Italy. Its figure plainly indicates, that in the instant of its formation, there was a strong effort towards crystallization. For it is an irregular quadrilateral pyramid,—whose

The same view is countenanced by the nature of the *slaggy crust* which would seem to be the product of an instantaneous process, * perhaps of the last step of the great principal operation, and is intimately connected with the breaking up of the mass into pieces, for all the fracture surfaces are coated by this crust.

Even the planetary rapidity of motion which has been noticed in the progress of fire-balls and meteoric stones, corresponds better with the idea now under consideration, than with that of a mere descent of a solid body, in which latter case so great a rapidity could not be produced.†

If this hypothesis should be considered too daring, and too little supported by other better known phenomena, or by ascertained physico-chemical laws, I must freely confess that I cannot bring forward any farther proof of a positive description, and that I must chiefly appeal to the fact, that, of all the theories, it affords the greatest facility for the explanation of nearly the whole of the phenomena presented by meteoric stones. I have also to request the attention of my readers to the following facts: Planets exist of extreme variety in regard to their volume. They must at one period have been formed by a process conformable to the laws of nature. We have no grounds for considering that the formation of planetary and other similar bodies has ceased. Ascertained phenomena in the region of the fixed stars, permit, nay favour the conjecture, that extremely large heavenly bodies are still being formed, while, probably, also others are dissolved. *Great* and *small* are expressions which ought not to have any influence in deciding such a question. The Sun, Jupiter, Uranus, and Vesta are heavenly bodies having a similar nature. The diameter of Vesta is upwards of 3000 times less than that of the Sun; and a body whose diameter should bear the same relation to that of Vesta, as the diameter of Vesta does to that of the Sun, would have a diameter of

base, an imperfect kind of square, has two of its adjoining sides about six-tenths of an inch long each, and the other two each about five-tenths; whilst two of the triangular sides of the pyramid are about six-tenths on every side of each triangle, all of which are a little curved; and the other two triangular sides are only five-tenths on the sides where these two last join," p. 32.—Edit.

* Chladni's "Feuermeteore," p. 49.

† Mayer in "Voigt's Magazin," vol. v. p. 15; also Bessel and Benzenberg.

a little more than 400 feet. Hence a meteoric stone whose diameter to that of the assumed body stood in similar relations as that body to Vesta, would belong to the class of aerolites of the smallest size. For chemically produced inorganic bodies, nature has only a measure of the relations of their component parts, but no measure for the masses regarded as a whole.

It is extremely probable that the elementary ingredients from which heavenly bodies are formed, are analogous or similar to one another, since the laws of nature, which produce regularly the greatest phenomena of the heavens, act with such uniformity. It is, on this account, also probable that the substances resulting from the union of the elementary ingredients, and of which the planetary bodies consist, are extremely similar to one another; still, however, as is self-evident, without prejudice to that predominating variety in the detail that seems to be observed so universally by nature, and which we also perceive in the otherwise extremely uniformly arranged solid structures of our globe.

We find that the lowest portions known to us of the crust of our earth consist of crystalline, granular, compound mineral masses. Although this known part of the crust is so small, yet the information we thus possess is by no means without importance for obtaining an idea of the internal constitution of the earth. Since all the mineral substances brought to the surface by the agency of volcanos, and some of them probably from a very great depth, seem to belong to such rocks, we may assume, at least, that the same compounds—without going so far as to believe that they actually extend to the centre—still form an essential and important constituent part of our planet.

If such rocks are essential component parts of the earth, they, or at least similar structures, may hold a prominent place in other planets; nay, from the above mentioned uniformity of the laws and operations of nature, it is even probable that granular crystalline mineral structures, of various kinds, are essential component parts of all planetary bodies; that, therefore, in the formation of these bodies, such mineral compounds are produced from elementary substances; and that, even now, when original matter is united in space to constitute solid bodies, this takes place by the formation of granular crystalline mineral substances. An especially important part seems to have been assigned to iron in the economy of nature: that it forms a large and important part of our earth is well known, and that it probably exists in extremely large masses in the interior of the globe, seems to be indicated by magnetic phenomena. It is hence quite possible, that, in the distribution of elementary matter existing in space, the matter from which iron is formed * may occur in such predominating quantity, that the obscure process of the formation of solid bodies when it reached those portions of original matter, would give rise to masses of native iron instead of compound meteoric stones.

Since the defenders of the lunar hypothesis support their opinion by the fact, that meteoric stones are granular rocks, and since they thus assent to the supposition that the materials of the two distinct heavenly bodies can be of similar or very analogous constitution, which may also be the case with several heavenly bodies, perhaps even, though with important differences in the medium compactness of the mixed principal constituents, with all the bodies belonging to one solar system,—they cannot deny, that, in the formation of *new* heavenly bodies, in the same system, a material very similar to the mass of the others may, nay, reasoning on the uniformity of operating forces of nature, must, be produced.

If, then, creative nature is not limited in the scale of its operations, it will continually bring forth bodies of all sizes, formed from the inexhaustible supply existing in space of the elementary matter which is constantly renewed by decompositions. Perhaps within the limits of separate solar systems only smaller bodies, such as subordinate planets, revolving fragments, shooting-stars, and meteoric stones are produced; while in the vast spaces between the solar systems, the formation proceeds of larger—infinitely larger—heavenly bodies, of whose existence we are only made aware by their becoming now and then visible, at immense distances, in the form of new stars.

It will be remarked, that I have here enumerated shooting or falling stars. Many of the appearances included by us under this name, and which do not all belong to one and the same phenomenon,† and also the small moveable luminous points that

* Iron belongs to *our so-called* simple bodies.

† Olbers has expressed the opinion that falling stars exhibit essential differences among themselves. Vide "*Von Zach's Monatliche Correspondenz*," vol. vii. p. 159.

are sometimes seen through telescopes, may partly be ejected masses, partly such newly formed bodies as we have mentioned, none of which reach the earth. But regarding such speculations I do not wish to proceed beyond reasonable limits. It now only remains for me to recapitulate briefly the result of the preceding considerations, and to express concisely the view which I have formed on this subject.

The hypothesis of the formation of meteoric stones *within* the limits of the atmosphere, and by the *sole* agency of that *terrestrial atmosphere*, and the matter contained in it, seems to me to be unsatisfactory. But, whether the earth's atmosphere has not some share in the production of these bodies; whether the finding solid matter in rain, and the atmosphere, indicates a connection by means of that matter between the earth, the region of the atmosphere, and space, a connection which admits of a reciprocal operation of phenomena, extending upwards to a great height; these are questions which I cannot directly answer in the negative.

It appears to me that *all* the phenomena of meteoric stones are not sufficiently explained by the hypothesis which regards them as of *lunar* origin.

From the information we at present possess, I am much more inclined to regard, as in some degree sufficient to explain the phenomena satisfactorily, or at least tolerably well, that hypothesis, according to which, meteoric masses are not originally solid fragments, which have been torn away and violently projected from their rocky beds; but *bodies which, at the instant of the occurrence of the meteoric phenomena of the light and the explosion, are, by the agency of a great physico-chemical process, newly formed from incoherent, and probably gaseous materials, and by the same cause solidified,* and which descend to the earth's surface when this, still to us obscure process, takes place within the sphere of attraction of our globe.

In conclusion, I cannot refrain from adding a few remarks on the historical sketch given by Berzelius, of the views which have at different periods prevailed regarding the phenomena of aerolites.

Berzelius says, "It is only since the commencement of the present century, that the occasional descent to the earth of larger or smaller masses of stone, has been regarded as scientifically proved." This is perfectly correct; but, he continues, "the certain knowledge which we at present believe ourselves to possess, was originally grounded on the duly accredited fall of a stone, on the 13th December 1795, in England, viz. at Woodcottage in Yorkshire. Howard, who, a few years afterwards, undertook the examination of this, and several other presumed meteoric stones, found that they agreed in appearance and composition, but that they differed distinctly from minerals of terrestrial derivation." Further, "Howard communicated the results of his investigation, in the year 1802, to the Royal Society of London. They excited universal attention," &c.

This is also at least substantially correct; but Berzelius has passed over in silence the following facts relative to the early history of the subject.

In the year 1794, at the Easter Leipzig Fair,—therefore at a time when this great phenomenon attracted the attention of no one, was to many altogether unknown, and by those who possessed information on the matter was regarded as a fable or a superstition,—at that period appeared Chladni's well-known tract, on the origin of the mass of iron found by Pallas, and of other similar bodies, &c.

In that essay Chladni endeavoured to prove that stony masses might fall from the air, and that the well-known phenomenon of fire-balls was identical with such falls of stones. He adduced many accounts, which had previously been regarded as fabulous, of falls of stones whose products were still preserved in collections; and he asserted that the Pallas iron was such a mass, an opinion which corresponded with the prevailing tradition among the inhabitants of the Ural. Among the examples brought forward by Chladni, in which the period of the fall of the mass was known, and the products still preserved, the most remarkable were the falls of *Eichstadt* and of *Agram*, while the most modern were those of *Alboreto*, in the year 1766, and of *Luzé* on the 13th September 1768.

No other philosopher had, at that time, dedicated his attention to this phenomenon, and Chladni was not able to quote any more recent falls. That distinguished man, endowed with all the requisite attainments for the investigation of the question, was the *first* who combined the then existing data in one entirely new, and soon afterwards thoroughly proved view, and even then, in his first memoir, indicated the leading features of the hypothesis he formed, and which he subsequently steadily maintained.

It was not until several months after the appearance of Chladni's publication, that, on the 16th June 1794, there occurred the fall of stones near Siena, and then in the following year, in 1795, on the 13th December, that of Woodcottage in Yorkshire. The attention of the English was first directed to the phenomenon by Chladni's essay, and by the two examples of aerolites just mentioned, which occurred a considerable time after the date of the publication of that essay. It was not, however, Howard, but King, who was the first to turn his attention to meteoric stones. The latter published an extract from Chladni's work, and enlarged the notice there given, of accounts of falls of stones.* Howard did not come forward with his observations till after the great fall at Benares, which took place on the 8th March 1796.

Contributions to the Botanical Geography of Southern Europe. By Professor Link.†

The flora of a country is one of its distinguishing features; it determines its character. To ask a reason for a plant being found in one station and in no other, is like inquiring why the domestic fowl is not provided with peacock's feathers.

It is not an easy matter to find plants which characterise a country in reference to its latitude, as well as to its longitude and its height. We must select plants which are extensively distributed; we must select plants which are not easily propagated by means of seed, because these are easily transmitted accidentally from one country to another; and we must select plants which do not grow among grain. On one occasion I found, in Portugal, the beautiful corn blue-bottle (*Centaurea cyanus*), which ornaments our northern fields. But even when

* E. King's Remarks concerning Stones said to have fallen from the clouds in these days, and in ancient times. London, 1796.

† From Wiegmann's *Archiv für Naturgeschichte.* 1836.

we have made a good choice, we must remain long in a country to be enabled to determine the limits of the distribution of a plant.

It is well known that many, not all, plants of the northern plain occur also on the mountains in the south; and although such plants are very convenient for marking the relations of the climate of the mountains, yet they are not so well suited for the determination of the relations of the climate of the plains from which we started. These plants also ascend the mountains gradually, and do not make wonderful leaps like the buck-thorn (*Hippophäe Rhamnoides*), which the traveller from the island of Rügen to Geneva will not meet with any where else but at these two points. It is fortunate also when the characteristic plant is universally known, so that minute botanical knowledge may not be required for making the desired determinations. A plant well adapted for determining the elevation of the ground is the bilberry or whortleberry (*Vaccinium myrtillus*). It grows in northern Germany, also near Berlin, in the wooded parts of the plains. It then gradually ascends: occurs near Freyburg in Baden, but only on the higher mountains; in Switzerland it grows in the woods of the lower Alps, then reappears for the first time on the high *Alpe di Caporagheno,* above Fivizzano, where it flourishes in the meadows along with the *Colchicum autumnale.* There it was also met with by my friend the late Professor Hoffman, shortly after my visit to the place. Finally, it is afterwards to be sought for only on the high Majella, in the Abruzzi.

Let us return to the plains, and afterwards consider the lines of separation of the plants of Southern Europe. After we have completely left the Alps, there very soon makes its appearance a universally known plant, the lavender (*Lavandula spica*). It occurs on the sunny hills around Verona; it is particularly abundant behind Coni, towards the Col di Tenda, constantly following the mountain chain; then extends to the south of France and Spain, and is still abundant in Aragon, but further in the interior and in the plains of Castile it is not found; and it is no where met with in Portugal. It also ceases in the direction towards Rome, and only makes its appearance among the high mountains which border the Adriatic Sea. The lavender is not an eastern plant; in Istria we find in its place the clary (*Salvia officinalis*), which there follows the Monte Maggiore, but in Italy only grows on the high mountains of the Abruzzi.

The plain of Lombardy is a garden, where we hardly find a wild vegetable production, and none which can be regarded as characteristic. In the same manner hilly Istria is entirely covered with planted olive trees, and it is only between them that we can remark the commencement of the myrtle region. The myrtle covers whole districts in Portugal, and is there a particularly beautiful shrub on the banks of streams. It is distributed over the centre and south of Spain, and the southern provinces of France, and extends to the Riviere of Genoa. It is to be found every where in the States of the Church, and around Naples; and occurs throughout the whole of Istria, to the very base of the Monte Maggiore. It extends a little farther to the south, but becomes rarer and rarer; and only separate individuals grow in the north of Italy.

Proceeding in a southerly direction from the region of myrtles, we arrive at the land of the rosemary, or what may be better and more definitely denominated the land of the oleander or rose-bay. That shrub commences at Merida in Spain, follows the course of the Guadiana to Ayamonte, where, on one occasion, the good King Gargatai reposed in a rose-bay bush. It then adorns the valleys of Algarve with its beautiful flowers, while the *Serra de Monchique* displays the lovely blossoms of the *Rhododendron ponticum.* We find it only in the warm valleys of Calabria and Sicily. In the Morea, after proceeding for many hours along the road leading to ancient Troezene, over bare and arid mountains, and exposed to the scorching sun, from which but a scanty shelter is afforded by a few scattered diminutive wild cherry trees (*Pyrus cuneifolia*), there appears in the distance a long stripe of oleanders, winding, with some projecting sycamores, among the mountains,—a most welcome sight to the thirsty and fatigued traveller; for he is sure to find a streamlet in the thicket, and the sycamores give promise of an agreeable shade.

We have now indicated the three botanical regions of Southern

Europe from north to south. Let us next consider the separating lines of vegetation from west to east. Here it is not difficult to find plants which determine the limits, for the firs and oaks are extremely characteristic.

Our park fir (" Thiergarten-Tanne") (*Pinus sylvestris*), for I will so term it, owing to the numerous botanical doubts involved in the names, does not cross the crest of the Alps towards the south, nor the Rhine towards the west, that is to say, in a wild state; it is proved historically that it has been often enough planted in France. The foliage of a large and beautiful tree replaces its greyish-green leaves. The pinaster (*Pinus pinaster*, Lam., *P. maritima*, Cand.) forms the great wood of Leiria in Portugal, which Don Diniz caused to be planted, but from native seed. It has quite a different mode of growth from our fir, presenting a pyramid instead of a crown; the branches form nearly right angles with the stem, and the needle-shaped leaves are very long, and of a dark green colour. Throughout the whole of Spain and the south of France, this tree stretches along, in the vicinity of the Mediterranean Sea, till it reaches Genoa, where it occurs on the Riviera, both to the east and west of the town. We can recognise the form by its stretched out branches, which make it resemble a chandelier. But the pinaster soon ceases, and there appears in its place the fir of Aleppo (*Pinus halepensis*), for so it is termed by botanists, who have established it as a rule never to alter a name, however improperly it may have been given. Its long, extremely fine needle-shaped leaves, render this lofty, picturesque tree sufficiently well known. It belongs to the plains of Italy; while a beautiful fir is proper to the mountains, and has not been long known to us. It is the *Laricio* (*Pinus Laricio*) which grows on the mountains of Corsica, in Calabria, and on Etna; and has much the habit and height of the red-fir (*Picea excelsa*). It flourished formerly on the low mountains of Italy, as on the Riviera of Genoa; for Strabo says, that there wood was cut down for masts, and was exported by the inhabitants, who received in exchange oil, an article which was wanting at Genoa. The case is now entirely reversed. A few years ago, when the foundation of the Theatre of Carlos was laid at Genoa, some fir-cones were found, which were afterwards shewn me by Viviani; and they were precisely similar to the fir-cones I had brought with me from Etna.

Further to the east we meet with the Greek fir (*Pinus maritima*), a tree of inconsiderable height, but having a beautiful crown, and long light-green needle-shaped leaves, which, by their peculiar tint, at once distinguish this species from all the other firs. I found it in a wild state in no other country but Greece. It enlivens exceedingly the gloomy mountains of that country, and is particularly abundant in ancient Attica. From the Acropolis, there is visible in the distance, on the sacred path leading to Eleusis, a wood composed of the *Pinus maritima*. Also on Hymettus, and on the promontory of Sunium, we find woods of this cheerful looking tree. When we leave the hilly plain of Megara, the road suddenly ascends towards the Isthmus; a wood of these firs is then entered, rocks appear to the right, and the mountains round which the path winds become more lofty and more precipitous. The narrow arm of the sea, with its bay, is almost completely shut up by the now deserted island of Salamis, which there elevates its innumerable mountain summits. A precipice overhanging the sea is now to be passed, and might cause giddiness in the traveller, were it not for a friendly thicket of mastick, which protects him from danger, and permits him to enjoy undisturbed the extreme loveliness of the scene. Traces are still perceptible of walls, and of tracks of wheels on the rock. Here, in remote antiquity, was the abode of the robber Pityokampos, who bound his victims between two fir trees bent together, and thus cruelly murdered them. This he might easily do with the small Greek fir, but it would have been impossible with our species.

In the Morea the tree is not abundant, and is almost confined to the northern coast. It ornaments the valleys of Epidauros and the mountains of Ægina. At the foot of the lofty Cyllene, towards the sea, it is found in perfection; and it grows with a beautiful and wide-spreading crown on the rugged banks of the river Xylocastro, which descends with violence from the mountains. On the southern coast of the Morea it is rare, and on the western coast we meet with the Aleppo fir (*Pinus halepensis*).

The three firs we have now enumerated, viz. the pinaster, the Aleppo fir, and the Greek sea-fir, characterise three regions of southern Europe from east to west. In like manner we have three oaks. In Spain and Portugal there is one species of oak with edible fruit, which was well known to the ancients. Desfontaines discovered it again on the mountains of Algiers, and named it the *Quercus Ballota;* and the Count Von Hoffmannsegg and myself have to inform botanists, that it grows in Portugal and Spain, but that, on account of its fruit, it is cultivated as a forest tree at Portalegre in Portugal; at the gates of Madrid it is roasted and sold along with chestnuts. In Italy, another oak having edible fruit makes its appearance, and one which Tenore curiously enough regards as a variety of our oak (*Quercus pedunculata*). Finally, in Greece, we have the *Quercus Ægilops*, the high, slender, and beautiful *Vellanida*, the Arcadian oak, whose fruit was eaten by the ancient Arcadians, (the βαλανόφαγοι ἄνδρες of Pythia), and of which the cups are imported by us under the name of "*Knopper*," and used in tanning. The oak which furnishes the gall-apples (*Quercus infectoria*) occurs on the eastern coast of Greece, but is not abundant till we arrive in Natolia.

Description of a new Anemometer, by which the most minute changes in the force or velocity of the Wind or current of Air may be measured. Invented and constructed by Mr R. Adie, Optician, Liverpool; read and described to the Society of Arts for Scotland, by Mr John Adie, 25th May 1836.*

In no department of the science of Meteorology is the want of a correct and sensitive instrument more felt than in the determination of the force and velocity of the wind. A great variety of suggestions have been made by scientific men of all nations for supplying this deficiency, but no method has yet been found generally useful, from the want of the means of comparing the results obtained from one instrument with those obtained from another; and also from their want of sensibility to small

* The Society's Honorary Silver Medal awarded to Mr R. Adie for this communication, 7th December 1836.

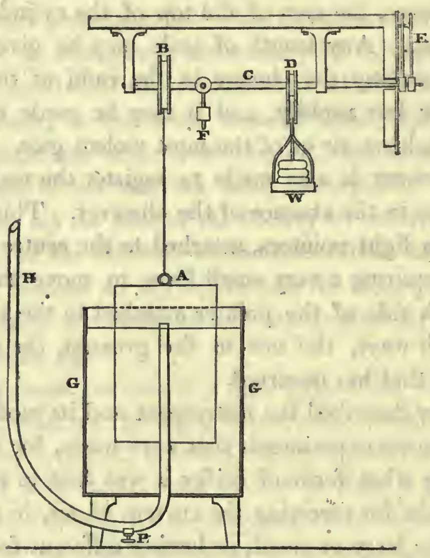
changes. Most anemometers hitherto constructed measure the velocity of the wind by its mechanical effects; on the principal of exposing a surface of known extent, or sails moving on an axis, to its action, the force or pressure on the surface being measured by the compression of a spring or air bag, by raising a column of fluid, or by the elevation of a weight round an axis acting on the arm of a variable lever; thereby balancing, and consequently measuring, the force of the wind. But to all of these methods there are objections. To the spring, which is the most simple, from its change of strength by change of temperature, and from the change of elasticity by frequent compression, and to all from the difficulty of maintaining the surface at all times perpendicular to the direction of the wind. The anemometer, or wind-gauge invented by Dr Lind, and by which the greatest number of observations with which I am acquainted have been made, is free from most of those objections, but in this instrument the scale is so minute, that small changes or light currents of air are not easily perceptible. I shall not, however, take up the time of the Society by entering farther into the merits of the different anemometers that have been proposed, but proceed to lay before you the description of an instrument which was designed and constructed by Mr R. Adie about two years ago.

The instrument consists of a light cylindrical vessel, made of thin copper, close and air-tight at one end, the other being open. This cylinder is placed, inverted, within another of greater diameter, filled with water; one end of a tube is made to pass through the bottom of the outer cylinder, and to terminate above the surface of the water, the other is carried into a free and exposed situation; on the top of this tube is placed a chamber, having a funnel-mouth, moveable round the tube, and it is made air-tight by a mercury valve. The opening is kept exposed to the perpendicular action of the wind by means of a vane placed opposite and attached to it. Over the end of the tube which passes through the water, the inner cylinder is suspended by a cord passing over a wheel, placed on an axis above, its open end passing into the water. If now a current of air be allowed to pass down the tube its effect will be to force up the cylinder out of the water, and the measurement of the force with which it acts is accomplished in the following manner:—To the axis having the wheel on it, over which the cord suspending the cylinder passes, is fixed a spiral of variable diameter, in the form of the fuse of a watch; from this spiral is suspended a weight which, when acting on the largest radius, counterbalances the weight of the cylinder suspended in the water when no compression of air is allowed to exist within it; this point is marked zero on the scale or dial-plate, placed at one end of the axis. The dial-plate is divided into parts, shewing the force with which the wind is pressing up the cylinder. The scale is formed from actual experiment, by applying weights to the cord passing over the variable lever, the area of the top of the cylinder being accurately known. Any length of scale may be given to the instrument by making the change in the radii of the spiral increase more or less rapidly, and it may be made to mark the force of the lightest air or of the most violent gale.

The instrument is also made to register the maximum and minimum force in the absence of the observer. This is done by means of two light pointers, attached to the centre of the dial-plate, and requiring a very small force to move them: one is placed on each side of the pointer attached to the axes, and by it pushed both ways, the one to the greatest, the other to the least pressure that has occurred.

Having now described the instrument and its mode of action, I may notice some experiments that were made, for the purpose of determining what form of orifice it was best to apply to the end of the tube for receiving the current of air, in order to ascertain whether large or small, or having different forms of orifice, would cause any difference in the results. Three kinds were tried; one, a piece of tube the same as the long tube communicating with the cylinder, another with an oblong opening, and a third a funnel. These were made so that they might be shipped off and on without loss of time, and the morning being fine, with a gentle and steady breeze, I could discern no difference in the amount of pressure with the different mouths, but I thought the funnel kept its head most steadily to the wind, and consequently the hand did not vibrate so much.

In order that the construction of this instrument may be more perfectly understood, I have given a section of the different parts. A is the inner cylinder, suspended by a cord passing over the wheel B. C is the axis on which the wheel B is fixed. D the spiral fixed on the same axis over which the weight W passes, counterbalancing the cylinder A. E is the index marking the forces on the dial-plate. F counterpoise weights to balance the index and spiral. G the outer cylinder filled with water, into which the cylinder A passes. H the pipe through which the current of air passes into the cylinder A. P a plug to let off any water that may get into the curve of the tube.



Report of the Committee on Mr R. Adie's (of Liverpool's) Anemometer. (*Read* 25*th May* 1836.)

Your Committee having examined the drawing and description of the anemometer, and inspected the instrument itself, beg to report :—

That this instrument is admirably calculated for exhibiting minute variations in the elasticity of gaseous bodies; and that it is more properly to be regarded as a pressure gauge than as an anemometer, the application to the measurement of the pressure of the wind being only one of the numerous uses to which it may be applied. In the gas-works it would be a much more delicate indicator of the progress of the operations than the pressure gauge usually employed there.

In its general construction it resembles that of the floating gas-holder; but it differs from it in this particular, that the elasticity of the air in the gas-holder is kept as nearly as possible the same, whatever quantity may be inside; while in Mr Adie's instrument, the load is regularly increased with the elevation of the instrument, so that that elevation becomes a measure of the excess of the elasticity of the included air over that of the atmosphere, or of the difference of level between the outer and inner fluid.

From a minute examination of a beautiful specimen of the instrument in Mr Adie's own possession at Liverpool, one of your Committee is quite satisfied that the construction is susceptible of great precision and of extreme delicacy.

Your Committee, therefore, gladly recommend this instrument to the favourable notice of the Society.

EDWARD SANG.
JAMES TOD.

Edinburgh, 16*th November* 1836.

Account of some Meteorological Instruments. (With a Plate.)

THE importance of obtaining simple Meteorological Instruments, which are capable of indicating the *maxima and minima* of atmospheric changes, during the absence of the observer, has always been acknowledged. The following descriptions of three instruments of this kind, contrived by Professor Traill, have not, we believe, yet appeared in an English publication, though they were exhibited and explained by him several years ago, when he lectured in the public institutions of Liverpool, and though he read a short description of them to the meeting of German Philosophers at Hamburg, in 1830; as appears by the account which Oken has given in the Isis for 1831. The instruments are simple in their principle, and seem well suited for the intended purpose.

I. *Register Anemoscope*.—The indications of the direction of the winds are generally given in a very imperfect manner in meteorological journals; it is rare to find more than a single point of the compass noted for each day; and even this is seldom given with tolerable precision. It is obvious, however, that if we hope ever to arrive at any knowledge of the causes that influence the direction of *local winds*, it must be founded on more accurate means of directing the variations to which they are perpetually liable, that we may be enabled to compare these variations with other meteorological phenomena; and this desideratum seems to be supplied by Dr Traill's Anemoscope.

This instrument, in its simplest and original form, is represented in Fig. 1, where *a* represents a light but firm rod of brass, supported, in a vertical position, by circular apertures in brass cramps fixed in a wall, when the rod is short; or moving between friction rollers, when it is of considerable length, in the manner usually adopted in the vanes on public buildings. The lower end of the rod is shod with a blunt cone of steel; and, to unite cheapness of construction, with freedom of motion, the socket consists of a flint, selected for one of those smooth, natural round cavities, which are so often observed in that mineral.

This socket is firmly fixed in the centre of a polished circular plate of common writing-slate, on the exterior margin of which the rhombs of the compass, and degrees of a circle, are engraved. The vane *b* is firmly attached to the rod, and carries the rod along with it, when acted on by the wind. Four inches above the slate, the square brass-arm *c* is jointed to the rod, so as to have a slight vertical motion, but to be carried around with the rod. On the horizontal arm slides a spring tube *d*, intended to carry a piece of slate pencil; the point of which may trace the progress of the vane round the circle. The spring-tube may be fixed at any distance from the centre by means of a small nut-screw *f*; and the due pressure of the pencil on the slate is secured by the ball *e*, which moves on the arm by means of a screw, formed on its outer extremity. It is obvious, that in this manner the whole variations in the direction of the wind, capable of moving the vane, may be read off even to degrees of the circle, during a complete revolution of the instrument. As it was found inconvenient, in some situations, to place the *index-plate* or slate horizontally, Dr Traill afterwards altered the apparatus, as represented in *Fig.* 2.

Two equal bevelled wheels were added: one, *e*, was fixed horizontally on the rod; the other, *c*, was attached vertically to the axis of the index *f*. The wheels have the same number of teeth; and the motions of the index correspond in extent to those of the vane; for the only effect of the introduction of the wheels thus arranged, is to convert a horizontal into a vertical motion. The whole of this subsidiary apparatus is included in a box of brass; and to prevent the entrance of dust, a small inverted cone of copper is cemented at *d*, so as to cover the aperture for the rod, without impeding its motion. This is represented detached at *h*.

For the writing-slate Dr Traill substituted a surface of polished porcelain, and fastened, by a small spring, a black-lead pencil in the index *f*. The movements of this pencil on the porcelain-plate are remarkably smooth, and the line is beautifully traced with very little friction. But more lately, the inventor finding that the wearing of the pencil gave the necessity of frequently replacing it, has rendered the instrument more easy of management, by substituting two light indices *g g*, which are fitted to the central hole in the index-plate, with just sufficient friction to remain in the position to which they are moved by a stud on the prime index *f*. The indices *g g* have a curve at half their length, which allows their being brought together, just below the prime index, when the instrument is adjusted for a fresh observation. The principle of this modification of the anemoscope is so obvious, and its construction so simple, that we conceive no farther description requisite.

Should it be considered desirable to have an instrument to indicate more than a single revolution of the vane, a modification of *Fig.* 2. will produce it; and Dr Traill exhibited to the Royal Society of Edinburgh, an anemoscope, which marked four revolutions of the vane. In Fig. 2. the bevelled wheels had each forty-two teeth; these were retained; a pinion of twenty-one leaves was fixed on the axis of the vertical bevelled wheel *c*, to give motion to a small wheel with forty-two teeth, having on its axis another pinion of twenty-one leaves, which moves a second small vertical wheel, also with forty-two teeth; the axis of this last is hollow (to allow the passage of the axis of the vertical bevelled wheel *c*), and it gives motion to a *stud-arm* moving round the index-plate, by these combinations, *once*, while the prime index makes *four* entire revolutions. This stud-arm moves the indices.

Dr Traill finds that this apparatus moves pretty freely, and will certainly register all the probable variations of the wind during twenty-four hours. He considers it, however, unnecessary to provide for contingencies so rare, and believes that every useful purpose may be served by the form of the instrument in Fig. 2, especially if the meteorologist, during very variable weather, would make two instead of a single daily observation.

II. *Register Barometer.*—The philosophic world is well acquainted with the ingenious contrivance of Mr Keith for registering the variations of the barometer; but the means employed by Dr Traill have the advantage of simplicity, and, while the instrument is kept at rest, of not being liable to derangement from slight causes. He employs two barometric tubes, arranged as in Fig. 3, and attached to a board C. A is a common diagonal barometer into which is introduced, before the upper part of the tube is bent, a smooth cylinder of iron-wire, half an inch in length and nearly equal in diameter to the tube. The tube is filled in the usual manner; and on placing the tube, as in the figure, a slight manipulation disengages the cylinder from the mercury, and it remains in the void space of the tube. When the barometer rises, the mercurial column pushes the cylinder before it; and when the barometer sinks, this index is left behind; and therefore its lower end marks the *maximum height* of the barometric column.

B is nearly on the principle of what is termed the rectangular barometer. The cistern is placed above, and the aperture is on the other extremity of the tube; which in order to give both indices similar resistance to the movements of the column, is inclined in a degree equal to the diagonal portion of the tube A. An iron-wire index is slipt into the open end of B, after it has been filled with mercury, and is fixed in the position represented at B in the figure. As the atmosphere becomes lighter, the mercury descends from the cistern, pushes the index before it; and the *minimum* of the mercurial column is obtained by the position of the index.

Having remarked that the entrance of dust was apt to impede the free motion of the index, Dr Traill obviates this inconvenience by contracting the open end of the tube, and bending it slightly downwards, after the introduction of the index.

Both indices are adjusted, for a fresh observation, by bringing them into contact with the mercury, by means of a small magnet.

III. *Register Thermometer.*—It has been objected to *Rutherford's* thermometers, that the *maxima* and *minima* are obtained by means of fluids of very unequal expansibilities; and that, therefore, they require a nice adjustment, or a calculation to make their scales correspond. The principal objection to *Six's* thermometer is, that the *index-springs*, however constructed, are very liable to alterations in their resistance to the mercurial column, and frequently impede, in a serious degree, the free motion of the indices; so as to unfit the instrument for delicate observations.

To obviate these inconveniences, Dr Traill contrived a single register thermometer (described in the *Library of Useful Knowledge*), in which the two indices moved in a horizontal tube, and therefore required no springs to retain them in their positions; but that instrument being found liable to derangement from slight movements, he has constructed a modification of the instrument, which is represented in Fig. 4.

In fact, it consists of his thermometer with the tube bent in the middle, so that the legs make with each other an angle of 120°. This form renders the mercurial column less liable to separate; and the inclination of the arms of the tube is just sufficient to prevent the indices slipping down when the mercury retires from them.

In this register thermometer, as in Six's, the thermometric indications are obtained from the expansions and contractions of alcohol; the indices are moved by a short mercurial column, which is itself acted on by the changes in the bulk of the spirit; there is a portion of spirit also in the limb *a* of the instrument, as in Six's thermometer; the slight inclination of its arms allows the indices to rest whenever they have been propelled by the mercury, and renders any kind of spring unnecessary. The indices are iron wires enclosed in slender tubes of coloured glass; their extremities next the mercurial column give the *maxima* and *minima*; and they are adjusted for each observation by means of a small magnet.

Report upon a Letter addressed by M. le Baron de Humboldt to His Royal Highness the President of the Royal Society, and communicated by His Royal Highness to the Council.

To His Royal Highness the President and Council of the Royal Society.*

Previously to offering any opinion on the important communication on which we have been called upon to report, we feel that

* This report is taken from the Athenæum of March 1837.

Fig. 3.

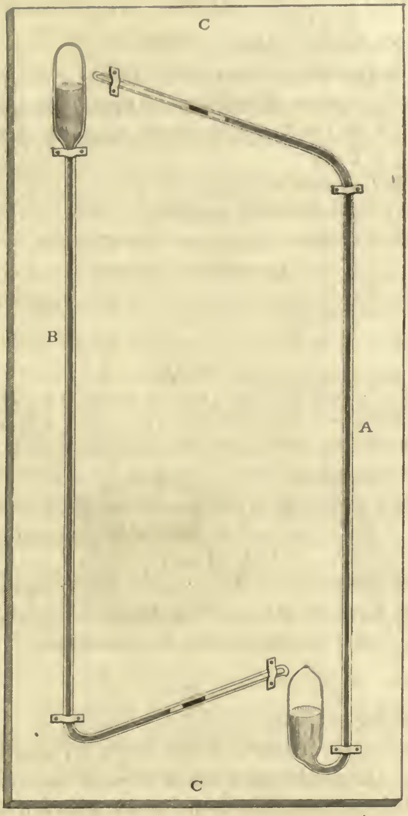


Fig. 1.

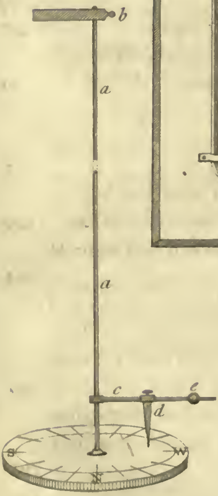
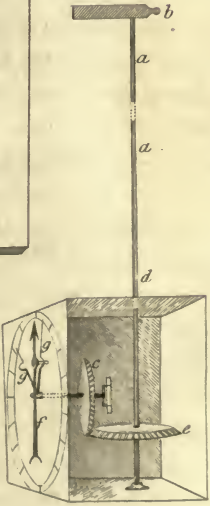


Fig. 2.



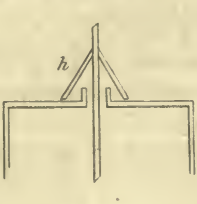
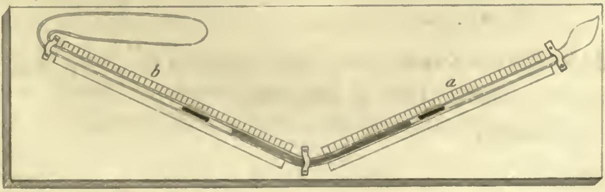


Fig. 4.



Dr. Trail's Meteorological Instruments.

E. Mitchell. Sc.

it will be proper to lay before the Council a full account of the communication itself. In this letter M. de Humboldt developes a plan for the observation of the Phenomena of Terrestrial Magnetism worthy of the great and philosophic mind whence it has emanated, and one from which may be anticipated the establishment of the theory of these phenomena.

After his return from the equinoctial regions of America, M. de Humboldt, in the years 1806 and 1807, entered upon a careful and minute examination of the course of the diurnal variation of the needle. He was struck, he informs us, in verifying the ordinary regularity of the nocturnal period, with the frequency of perturbations, and, above all, of those oscillations, exceeding the divisions of his scale, which were repeated frequently at the same hours before sunrise. These eccentricities of the needle, of which a certain periodicity has been confirmed by M. Kupffer, appeared to M. de Humboldt to be the effect of a reaction from the interior towards the surface of the globe—he ventures to say of "*magnetic storms*"—which indicated a rapid change of tension. From that time he was anxious to establish to the east and to the west of the meridian of Berlin, apparatus similar to his own, in order to obtain corresponding observations made at great distances at the same hours, but was for a long period prevented putting his plan into execution by the disturbed state of Germany and his departure for France.

The Baron de Humboldt and MM. Arago and Kupffer having, by the co-operation of many zealous observers, succeeded in establishing permanent magnetic stations extending from Paris to China, M. de Humboldt solicits, through his Royal Highness the President, the powerful influence of the Royal Society in extending the plan, by the establishment of new stations. The plan which he proposes, and which has been successfully carried into execution over a large portion of the north-eastern continent, is, that magnetical observations, whether of the direction of the horizontal and inclined needles, or for the determination of the variations of the magnetic force, should be made simultaneously at all stations, at short intervals of time, for a certain number of hours and at fixed periods of the year, precisely similar to the plan which has been recommended and adopted by Sir

John Herschel, with reference to observations of the barometer and thermometer.

Referring in terms of commendation to the magnetical observations which have originated in this country, M. de Humboldt expresses his wish that such observations may, by the adoption of an uniform plan, and by connecting them with the observations now in progress on the continent of Europe and of Northern Asia, be rendered more proper for the manifestation of great physical laws. He then enters into an historical detail of the establishment of stations for magnetical observations, stating the important results obtained by MM. Arago and Kupffer by means of simultaneous observations, which appear to establish the isochronism of the perturbations of the needle at Paris and Kasan, stations separated by 47° of longitude. Under the patronage of the Governments of France, of Prussia, of Denmark, and of Russia, magnetical observatories have been established at Paris, at Berlin, in the mines of Freyberg, at Copenhagen, in Iceland, at St Petersburgh, Kasan, Moscow, Barnoul at the foot of the Altai Chain, Nertschintk near the frontiers of China, even at Pekin, and at Nicolajeff in the Crimea.

M. de Humboldt states that the lines representing the horary variations at Berlin, Freyberg, Petersburgh, and Nicolajeff affect parallelism, notwithstanding the great separation of the stations and the influence of extraordinary perturbations; that this, however, is not invariable, since even at small distances, for example, at Berlin and in the mines of Freyberg, one of the needles may shew considerable perturbations, while the other continues that regular course which is a function of the solar time of the place.

The epochs at which it had been proposed that simultaneous observations should be made at all stations were,

20th and 21st of March,	From 4 o'clock in the morning of the first day, until midnight of the second, observing, at least hourly, night and day, at each magnetic station.
4th and 5th of May,	
21st and 22d of June,	
6th and 7th of August,	
23d and 24th of September,	
5th and 6th of November,	
21st and 22d of December,	

But as many observers have considered these as too near to each other, the observations most to be insisted upon are those at the times of the solstices and equinoxes.

England, from the times of Gilbert, Graham, and Halley to the present, observes M. de Humboldt, has afforded a copious collection of materials, adapted to the discovery of the physical laws which govern the changes of the variation, whether at the same place, according to the hours of the day and the seasons of the year, or at different distances from the magnetic equator, and from the lines of no variation. After adverting to the continued observations of Gilpin and of Beaufoy, omitting, however, to mention the important ones by Canton, he observes that the arctic expeditions have furnished a rich harvest of observations to Captains Sabine, Franklin, Parry, Foster, Beechey, and James Ross, and Lieutenant Hood;* and that thus physical geography is indebted to the attempts which have been made to discover the north-west passage, and also to the explorations of the icy coast of Asia, by Wrangel Lutke, and Anjou, for a considerable accession of knowledge on terrestrial magnetism and meteorology. Excited, he observes, by the great discoveries of Oersted, Arago, Ampere, Seebeck, and Faraday; MM. Hansteen, Due, and Adolphe Erman have explored, in the whole of the immense extent of Northern Asia, the course of the isoclinal, isogonal, and isodynamic curves; and M. Adolphe Erman has had the advantage during a long voyage from Kamtschatka round Cape Horn to Europe, of observing the three manifestations of terrestrial magnetism on the surface of the earth, with the same instruments, and by the same methods which he had employed from Berlin to the mouth of the Obi, and thence to the Sea of Okhotsh.

M. de Humboldt remarks that our epoch, marked by great discoveries in optics, electricity, and magnetism, is characterized by the possibility of connecting phenomena by the generalization of empirical laws, and by the mutual assistance rendered by sciences which had long remained isolated. Now, he observes, simple observations of horary variation or of magnetic intensity made at places far distant from each other, reveal to us what passes at great depths in the interior of our planet or in the upper regions of our atmosphere: those luminous emanations, those polar explosions which accompany the "*magnetic*

* To this long list we may now add the name of Captain Bach; nor ought the name of Mr Fisher to be omitted.

storm" appear to succeed the changes which the mean or ordinary tension of terrestrial magnetism undergoes.

M. de Humboldt considers that it deeply interests the advancement of mathematical and physical sciences that, under the auspices of His Royal Highness the President, the Royal Society should exert its influence in extending the line of simultaneous observations, and in establishing permanent magnetic stations in the tropical regions on both sides of the magnetic equator, in high southern latitudes, and in Canada. He proposes this last station because the observations of horary variation in the vast extent of the United States are yet extremely rare. Those at Salem, calculated by Mr Bowdich, and compared by Arago with the observations of Cassini, Gilpin, and Beaufoy, may, he remarks, guide the observers in Canada, in examining whether there, contrary to what takes place in Western Europe, the (diurnal ?) variation does not decrease in the interval between the vernal equinox and the summer solstice.

In a memoir published five years ago, M. de Humboldt states that he has indicated as stations extremely favourable for the advancement of our knowledge, New Holland, Ceylon, the Mauritius, the Cape of Good Hope, the island of St Helena, some point on the eastern coast of South America, and Quebec. In order, he observes, to advance rapidly the theory of the phenomena of terrestrial magnetism, or at least to establish with more precision empirical laws, we ought to extend, and at the same time to vary, the lines of corresponding observations; to distinguish, in the observations, of the horary variations, what is due to the influence of the seasons, to a clear or a cloudy atmosphere, to abundant rains, to the hour of the day or night, solar time; that is, to the influence of the sun, and what is isochronous under different meridians: we ought, in addition to these observations of the horary variation, to observe the annual course of the absolute variation of the inclination of the needle, and of the intensity of the magnetic forces, of which the increase from the magnetic equator to the poles is unequal in the American or Western, and in the Asiatic or Eastern hemispheres. All these data, the indispensable basis of a future theory, can acquire certainty and importance only by means of fixed establishments, which are permanent for a great number of years, observatories in which are repeated at settled intervals and with similar instruments, observations for the determination of numerical elements.

Travellers, remarks M. de Humboldt, who traverse a country in a single direction and at a single epoch, furnish only the first preparations for labours which ought to embrace the complete course of the lines of no variation; the progressive displacement of the nodes of the magnetic and terrestrial equators; the changes in the forms of the isogonal and isodynamic lines; and the influence which, unquestionably, the configuration and articulation of the continents exert upon the slow or rapid march of these curves. He will, he considers, be fortunate if the isolated attempts of travellers, whose cause he has to plead, have contributed to vivify a species of research which must be the work of centuries, and which requires at once the co-operation of many observers, distributed in accordance with a well-digested plan, and a direction emanating from many great scientific centres of Europe; this direction, however, not being for ever restricted by the same instructions, but varying them according to the progressive state of physical knowledge and the improvements which may have been made in instruments and the methods of observation.

In begging His Royal Highness the President to communicate this letter to the Royal Society, the Baron de Humboldt disclaims any intention of examining which are the magnetic stations that at the present time deserve the preference, and which local circumstances may admit of being established. It is sufficient that he has solicited the co-operation of the Royal Society to give new life to a useful undertaking in which he has for many years been engaged. Should the proposition meet with their concurrence, he begs that the Royal Society will enter into direct communication with the Royal Society of Göttingen, the Royal Institute of France, and the Imperial Academy of Russia, to adopt the most proper measures to combine what is proposed to be established with what already exists; and adds, that, perhaps, they would also previously concert upon the mode of publication of partial observations and of mean results.

M. de Humboldt finally refers to the labours and accurate observations of M. Gauss at the Observatory of Göttingen. The methods, however, adopted by M. Gauss being already before the Royal Society, in a memoir which has been communicated by him, renders it unnecessary here to enter into the explanation given of them by M. de Humboldt. He has referred to them in order that those members of the Royal Society who have most advanced the study of terrestrial magnetism, and who are acquainted with the localities of colonial establishments, may take into consideration, whether, in the new stations to be established, a bar of great weight furnished with a mirror should be employed, or whether Gambey's needle should be used: his wish is only to see the lines of magnetic stations extended, by whatever means the precision of the observations may be attained.

M. de Humboldt concludes by begging His Royal Highness to excuse the extent of his communication. He considered it would be advantageous to unite under a single point of view what has been done or prepared in different countries towards attaining the object of great simultaneous operations for the discovery of the laws of terrestrial magnetism.

Having very fully laid before the Council the contents of M. de Humboldt's letter, we have now to offer our opinion upon the subject it embraces. There can, we consider, be no question of the importance of the plan of observation which is here proposed for the investigation of the phenomena of terrestrial magnetism, or of the prospect which such a plan holds out of the ultimate discovery of the laws by which those phenomena are governed. Although the most striking of these phenomena have now been known for two centuries, although careful observations of them have within that period been made, and that still more care and attention have been bestowed upon those more recently discovered, yet the accessions to our knowledge, not only regarding the cause of the phenomena, but even with respect to the laws which connect them, bears a very small proportion to the mass of observations which have been made. This has arisen in a great measure, if not wholly, from the imperfection of the data from which attempts have been made to draw conclusions. Whatever theories may have been advanced in explanation of these phenomena, or attempts made to connect them by empirical laws; still, whenever comparisons have been instituted between the results of observation and such theories or laws, it has, in general, been doubtful whether the discrepancies which have been found might not as justly be attributed to errors in the observations, as to fallacies in the theory or incorrectness in the laws. Under these circumstances, the Royal Society, as a society for the promotion of natural knowledge, cannot but hail with satisfaction a proposition for carrying on observations of phenomena most interesting in their nature and most obscure in their laws, in a manner that shall not only give greater precision to the observations, but at the same time render all the results strictly comparative.

There are, however, other grounds on which such a proposition as that made by M. de Humboldt should be most cordially received by the Royal Society. This society is here called upon, as a member of a great confederation, to co-operate with several other members, already in active co-operation, for the attainment of an object which ought to be common to all; and to such a call the Royal Society can never be deaf. Those who know best what has been done by co-operation on a well-digested system, and what remains undone in many departments of science for the want of it, can best appreciate the benefits that would accrue to science by the adoption of the extensive plan of co-operation advocated by M. de Humboldt. Independently of our acquiring a knowledge of the laws which govern the phenomena here proposed to be observed, we ought to look to the effect which the adoption of such a plan may have on other branches of science. The example being thus once set of extensive co-operation in a single department of science, we may anticipate that it would be eagerly adopted in others, where, although our knowledge may be in a much more advanced state than it is regarding the phenomena of terrestrial magnetism, still much remains to be accomplished, which can scarcely be effected by any other means. We might thus hope to see the united efforts of all the scientific societies in Europe directed to the prosecution of inquiry, in each department of science, according to the plan of co-operation best adapted for its development.

We must now, after these remarks on the general bearing of M. de Humboldt's communication, go somewhat into detail on points connected with it. One point of view in which we consider the proposed plan of great importance, and to which M.

de Humboldt has not expressly referred, is this:—However defective ordinary dipping instruments may be considered to be, there are few persons who have had opportunities either of making observations with the ordinary instruments for determining the variation of the needle, or of comparing those made by others by the usual methods with such instruments, who will not admit that these instruments and methods are fully as defective—possibly much more so. Thus, however we may multiply the points on the earth's surface at which such observations may be made, still great uncertainty must always rest upon such determinations of these two important elements; and in all comparisons of such observations with laws, whether empirical or deduced from theory, it will ever be doubtful whether the discordances which may be found are due to errors of observation, or are indicative of the fallacy of these laws. This source of uncertainty must, in a great measure, if not wholly, be obviated by observations made at fixed stations, with instruments of similar construction, which have been carefully compared with each other. And we have no hesitation in stating our opinion that more would be done in determining the positions of the poles of convergence and of verticity on the earth's surface, and other points most important towards the establishment of any thing like a theory of terrestrial magnetism, by simultaneous observations made at a few well-chosen fixed stations, than by an almost indefinite multiplication of observations by the ordinary methods.

That a magnetic chart that should correctly exhibit the several lines of equal variation, Humboldt's "Isogonal Lines," would be of the greatest advantage to navigation, those who are best qualified to judge are most ready to admit. If to these lines were added the isoclinal lines, or lines of equal dip, the value of such a chart would, for the purposes of navigation in particular, be greatly enhanced. Whatever may be the magnitude of the influence of the iron in a ship on its compass needle, the extent of the deviation of the horizontal needle due to that influence, on any bearing of the ship's head, is a function of that bearing and of the dip of the needle at the place of observation. The extent, therefore, of the horizontal deviations, in various bearings of the ship's head, having been ascertained at any port where the dip of the needle is known, their extent at any other place, however distant, at which the dip is also known, may readily be calculated. Consequently, a chart which should correctly exhibit the isoclinal, in conjunction with the isogonal lines, would readily furnish the means of obtaining the correction to be applied to the ship's course by compass, both for the variation of the needle and for the deviation due to the ship's influence upon its compass. Whatever charts of this description may have already been constructed, and whatever materials may exist for the construction of more accurate ones, it is well known that great discrepancies exist among the data requisite for such constructions. And it appears to us that such a careful inquiry into the whole of the phenomena of terrestrial magnetism as is proposed by M. de Humboldt, is the means best adapted to insure the accuracy which would be of such inestimable advantage in this most useful application of scientific knowledge.

Although our views with regard to the stations proper to be selected for permanent magnetical observatories in general accord with those expressed by M. de Humboldt, we shall, we consider, be only conforming to his wishes, if we point out those stations which, from particular circumstances of position, appear most desirable. We consider that it would be of the greatest advantage if two or more permanent magnetical observatories were established in the high latitudes of North America, on account of the proximity of stations so situated at the northern magnetic poles of convergence and verticity, whether these poles are two different points, or one and the same; indeed, continued observations at such stations would go far to decide this question, highly important in a theoretical point of view. M. de Humboldt has mentioned Quebec as a desirable station. To this place, and also to Montreal, we conceive that an objection exists, of which possibly M. de Humboldt is not aware; many of the houses in those cities are roofed with tinned iron. This objection may not, however, exist in some of the establishments in the vicinity of either of these cities. We consider that the most advantageous positions would be, one near the most northerly establishments in Hudson's Bay, and another at or near to Fort Resolution on Great Slave Lake. As, however, observers in such positions would be placed almost beyond the pale of civilization, we fear that, for some time at least, it would be found quite impracticable to obtain regular observations at these important stations. It would likewise be desirable that there should be a station in Nova Scotia or Newfoundland; the latter would be the preferable position.

If the government of the United States were to gi e their cordial co-operation to M. de Humboldt's plan, by the establishment of three or more permanent magnetical observatories, in different longitudes, these, with what we may expect to be undertaken by Russia in the extreme north-west, and our own establishments, would afford the means of obtaining a mass of more interesting magnetical observations than could perhaps be derived from any other portion of the earth's surface.

M. de Humboldt mentions New Holland, Ceylon, the Mauritius, the Cape of Good Hope, St Helena, and a point on the east coast of South America, as desirable stations, and we fully concur in the propriety of the selection. Although Van Diemen's Land, from its greater proximity to the southern magnetic pole, would be a more advantageous position for magnetical observations than Paramatta, yet the circumstance alone of there being an astronomical observatory established at Paramatta, renders it peculiarly adapted for a magnetical station. Possibly circumstances may hereafter admit of magnetical observations being also made at Hobart Town, in conformity with the general plan which may be adopted.

The Island of Ascension, from its proximity to the magnetic equator, would possess peculiar advantages for a magnetical station; but these must, in a great degree, be counterbalanced by the nature of its soil, which, being wholly volcanic, would exert an influence on the needle that would render observations made there of a doubtful character; indeed, the same objection applies to St Helena and most of the islands of the Atlantic. Some recent observations, those of Lieut. Allen, R. N., in the expedition up the Niger, would point to the Bight of Benin as a desirable station; but the insalubrity of the climate and other circumstances prevent our recommending its adoption.

M. de Humboldt has not referred to any station in our West Indian colonies, but we consider that circumstances point to Jamaica as a station where it is very desirable that accurate magnetical observations should be made. It is generally considered that the variation there has, for a very long period, undergone but little change; and, on this account alone, it would be very desirable to ascertain, with precision, the amount of the variation, so that hereafter the nature of the changes it may undergo may be accurately determined. Its position also, with reference to the magnetic equator, is one which would recommend it as a magnetical station.*

Although M. de Humboldt has not adverted to any other point besides Ceylon in our Indian possessions, yet no doubt he would, with us, consider it desirable that observatories should be established at different points on the continent of India; and it appears to us that Calcutta and Agra are in positions well adapted for the purpose. As, however, there is an Astronomical Observatory established at Madras, there would be greater facility in obtaining magnetical observations there than at places where no such establishment exists. We feel assured that the East India Company, which has shewn so much zeal and liberality in the promotion of scientific inquiry, and such a desire for the advancement of scientific knowledge in the extensive possessions under its controul, would afford its powerful assistance in the establishment of observatories for the investigation and determination of the laws of phenomena intimately connected with navigation, and, consequently, with the commercial prosperity of our country.

We consider, also, that Gibraltar and some one of the Ionian Islands are very desirable stations for the establishment of permanent magnetical observatories; and, to come nearer home, that such observatories should be established in the north of Scotland and in the west of Ireland.

* Mr Pentland, who has been appointed Consul-General to the Republic of Bolivia, having, since the Baron de Humboldt's letter was referred to us, offered his earnest co-operation in the objects contemplated in that letter, we cannot hesitate, now that this has been communicated to us, to recommend that an offer so liberal should be made available to science. If accurate magnetical observations were made at some station on the elevated table-land of Mexico, and simultaneously at another not very distant station, nearly at the level of the sea, we consider that they would determine points relative to the influence of elevation on the diurnal variation, the dip and intensity, respecting which our information is at present, to say the least, extremely deficient.

M. de Humboldt adverts to another very interesting class of magnetical observations, those in the mines of Freyberg. The mines of Cornwall from their great depth, some being 1200 feet below the level of the sea, are peculiarly well adapted for observations of this description; and, from the spirit with which philosophical inquiry has been carried on in that part of England, we do not anticipate that much difficulty would occur in the establishment of a magnetical station in one of these mines.

Having enumerated the stations which by their position appear best adapted to furnish valuable results, and having likewise pointed out the facilities which some afford for the execution of this plan of observation, immediately that the nature of the instruments to be employed has been determined upon, and that such instruments can be provided, it may be proper to advert to stations where, although the same facilities do not exist, we consider that zealous and able observers might be obtained without much difficulty. We conceive that such is the case in Newfoundland, in Canada, at Halifax, Gibraltar, in the Ionian Islands, at St Helena, and Ceylon; and we have authority for stating that there would be no difficulty in obtaining observers, in the Mauritius, and even at the Colony on the Swan River, the latter being a most desirable station. We have not alluded to the observatory at the Cape of Good Hope; if, however, no such establishment existed, the presence of Sir John Herschel would ensure co-operation there, in any plan calculated to advance scientific knowledge. Thus, altogether, there might be formed a most extensive spread of stations, in which the principal expense would consist in the purchase of the requisite instruments; and the means of establishing stations where the same facilities do not exist might afterwards be taken into consideration. As it would be necessary that, at all the stations, observations of the barometer, thermometer, and of atmospheric phenomena, should be made simultaneously with the magnetical observations, these would altogether form a mass of valuable meteorological information which it would be scarcely possible to collect by any other means.

There is one point in M. de Humboldt's communication on which we have not yet touched: the nature of the instruments best calculated to attain the objects in view by the establishment of magnetical observatories. This is a subject on which it will be most proper to enter fully when their establishment has been determined upon; and we would recommend that then the Committee should be appointed to investigate the subject, and that this Committee should report to the Council of the Royal Society what instruments they consider it would be most advisable to adopt at all the stations, and, at the same time, give in an estimate of the expense that must be incurred for one complete set of such instruments. We may, however, in the mean time, offer a remark on one apparatus referred to by M. de Humboldt, that of M. Gauss. However well we may consider this apparatus to be adapted for the determination of the course of the regular diurnal variation, yet we apprehend that the great weight of the needles employed would prevent their recording the sudden and extraordinary changes in the direction of the magnetic forces, which are, probably, due to atmospheric changes. Another, and we conceive a very serious objection to this apparatus is, that bars of the magnitude employed must have an influence so widely extended, that there would be great risk of the interference of one of these heavy needles with the direction of another, especially in places where the horizontal directive force is greatly diminished, unless the rooms for observation were placed at inconvenient distances from each other.

By referring to M. de Humboldt's letter, it will be seen that the plan of observation so comprehensively conceived by him, has been most powerfully and liberally patronized by the Governments of France, of Prussia, of Hanover, of Denmark, and of Russia: indeed, it is quite manifest that a plan so extensive in its nature must be far beyond the means of individuals, and even of scientific societies unaided by the governments under which they flourish. To suppose, even without the example thus held out, that the Government of this, the first maritime and commercial nation of the globe, should hesitate to patronize an undertaking, which, independently of the accessions it must bring to science, is intimately connected with navigation, would imply that our Government is not alive either to the interests or to the scientific character of the country, and would show that we had little attended to the history, even in our times, of scientific research, which has been so liberally promoted by the Government. Although the investigation of the phenomena of terrestrial magnetism was not the primary object of the expeditions which have now, almost uninterruptedly, for twenty years been fitted out by Government,—another of which, and one of the highest interest, is on the point of departure,—yet a greater accession of observations of those phenomena has been derived from these expeditions than from any other source in the same period. We therefore feel assured that, when it shall have been represented to the Government, that the plan of observation advocated by the Baron de Humboldt is eminently calculated to advance our knowledge of the laws which govern some of the most interesting phenomena in physical science; that it appears to be perhaps the only one by which we can hope ultimately to discover the cause of these phenomena; and that, from it, results highly important to navigation may be anticipated; the patronage to the undertaking which is so essential to its prosecution will be most readily accorded. We beg, therefore, most respectfully, but at the same time most earnestly, to recommend to His Royal Highness the President, and to the Council, that such a representation be made to the Government, in order that means may be ensured for the establishment, in the first instance, of magnetical observatories in those places which, from local or other causes, afford the greatest facilities for the early commencement of these observations.

S. HUNTER CHRISTIE.
9th June 1836. G. B. AIRY.

On the Organized Bodies found in the Seminal Fluid of Animals, and their analogy to the Pollen of Plants. By G. R. Treviranus.*

The following interesting paper is taken from the fifth volume of Tiedemann and Treviranus's Physiological Journal. Like every thing coming from its illustrious author, it bears abundant marks of accurate observation and deep reflection; and we

* We are indebted for this important paper to the Dublin Journal of Medical Science.

have very little doubt that Treviranus will ultimately succeed in establishing the very curious and remarkable analogy which he has been the first to observe and investigate.

"Although the beings termed seminal animalcules, have been frequently made the subject of observation for the last hundred and fifty years, the question as to their peculiar nature has never yet been satisfactorily answered. Since the abandonment of the opinions of Leeuwenhoek, who maintained that they were the germs of the embryos, they have been generally looked upon as belonging to that class of animals which are generated in all infusions of organized substances. To the latter, it is true, they bear an external resemblance. But even in the case of infusory animalcules, our knowledge of all the individuals of this denomination is not sufficiently accurate to authorize us to place the whole in one and the same class. Ehrenberg discovered in many of these animals a more complicated internal structure than had been previously assigned to them: in many, for instance, he found a real mouth and intestinal canal. But many of them appeared, even under the best magnifying glasses, not more perfect in their interior than various hydatids and other secondary products of the formative organic powers. Among the latter products, the most noted are generally observed as excrescences from solid parts, and without any manifestations of motion. This, however, is not always the case. In man and other animals, hydatids are occasionally generated, which contain only a watery fluid enclosed in a vesicular membrane, and which have no connexion either with each other, or with the walls of the cavity in which they lie. Similar formations may be also very naturally produced in fluids situated in the interior or on the surface of organized bodies, may grow by the absorption of certain constituents of these fluids, and in consequence of the attraction they have towards some, and the repulsion towards other particles of matter, may be capable of exhibiting motions. Beings of this description cannot be ranged in the same division with the true infusory animalcules. Those which are met with in animal or vegetable secretions may form important constituents of the same, and contain a substance which may have a principal share in the functions of these fluids. Among beings of this kind we may, perhaps, place the seminal animalcula.

These inmates of the fructifying animal secretion have been for a considerable time the subject of my observations. I have already made known in some of my earlier publications, two of the results obtained by my investigations: the accuracy of these results I have repeatedly tested within the last few years, whenever I had an opportunity of procuring fresh semen from animals recently killed, and I have found them verified in every instance. One of these is, *that the motions of these bodies occur either solely in the seminal fluid of animals in heat; or that they are observed to be much more lively during the period of heat than at any other time.* The physiologist may easily satisfy himself as to the truth of this assertion, by examining the semen of moles, frogs, and fishes, during the season of copulation, and beyond that period. During the former, the semen is full of organized parts, which exhibit a lively motion through each other. After the period of copulation is over, we cannot discover any vital movement. In moles, whose testicles and seminal vesicles I examined about the last days of July, I could not discover any semen; and the few drops of fluid which I obtained from those parts, exhibited no trace of seminal animalcules, or of motion. Many similar observations had been previously made by Buffon, Daubenton, and Needham, without attempting to draw from this fact the deductions which it affords. From being unacquainted with, or from not having observed this influence of heat on the constitution of semen, physiologists have occasionally denied the existence of seminal animalcules in the semen of many animals; in which, however, they are undoubtedly present during the season of heat. Thus, Prevost and Dumas state, in one of their earlier essays, that these animals are not contained in the seminal fluid of fishes. In a later publication, M. Prevost mentions that he had found them in the semen of the *Mullus gobio*, but does not give any explanation as to the cause of the discrepance between this and his former experiments;—a discrepance which can only be attributed to the difference of the seasons at which he made the seminal fluid the subject of his observations. I examined the semen of various insects during many summers, without finding in it, except very rarely, any parts exhibiting traces of motion. As my examinations had been made during the pairing-season of these animals, this result appeared to me at first extremely remarkable. Dissection afterwards revealed the cause of this apparent anomaly. Among animals of this kind, whose lives last only for a single summer, and particularly among butterflies, it by no means happens that all individuals possess the power of procreation. This is most strikingly seen in the females, many of which, even in autumn, have ovaries containing immature ova. Still the motions observable in the seminal fluid of invertebrate animals are never so lively as those observed in the semen of the vertebrate. Had I not occasionally seen, in the case of the former, these organized bodies change their forms by evident contractions and extensions, I should certainly think they were without any motion dependent on internal causes. I have observed these changes of form particularly in the organized parts of the male semen of the *Cantharis livida*, which I had killed during copulation, and then immediately opened. This observation of mine on the microscopic bodies observed in semen, is supported by the observations made by earlier writers,—that the semen of very young, of very old, and of hybrid animals, as, for instance, the mule, does not contain any seminal animalcules.

"The second of my observations is, that *although the organized parts of semen possess a proper motion, they are also carried onwards by currents which take place in the fluid portion of the semen.* The same observation was also made before me by Von Gleichen, but did not attract any notice, notwithstanding its strong claims to attention. This motion occurs only at the period of heat. I have seen the most striking examples of it in the semen of frogs, which I had opened shortly after awaking from the state of hybernation. It is consequently not entirely peculiar to the seminal fluid of warm-blooded animals, in which it was noticed by Von Gleichen. It exhibits itself but feebly in undiluted semen; this, however, arises from the viscid nature of that fluid. Still the seminal animalcules manifest even in feeble motions, but the latter become exceedingly energetic the moment a small quantity of water is added to a drop of semen placed on the pôrte-objêt of the microscope; they continue, however, only a short time.

"To these earlier observations I can now only add a third, which appears to me deserving of attention. I think I have discovered *that the organized parts of semen are not in reality* animals, but bodies *analogous to the pollen of plants*; *that these bodies form on the internal surface of the vessels engaged in the secretion of the seminal fluid*; *that in many animals they are furnished with peduncles*; *that for peduncles they have the filaments of a layer of extremely delicate fibres with which the surface of the secreting vessels is covered; that at the period of their maturity they detach themselves from these surfaces, sometimes with and sometimes without the peduncles; that they appear to contain the proper fructifying matter, and that in some animals they discharge their contents within the testicle, and in others not until they have escaped from that organ.* The facts on which these propositions are based have been verified only in animals of the lower classes; but all circumstances lead to the conclusion, that they are equally true with reference to man and the higher animals.

"It is well known that at the posterior end of the abdominal cavity in snails, and connected with the liver, there is a gland composed of roundish sacculi, and from which a winding duct extends to the uterus. In a former essay I have termed this gland the racemiform organ, and expressed my suspicions that it was a testicle as well as an ovary. I subsequently, however, found in the organ which I termed the maternal gland, and of the peculiar function of which I was then uncertain, bodies which had the appearance of ova. I therefore look upon the racemiform organ at present as the testicle, and the maternal gland as the ovary; and for the future I shall understand the former under the name of the testicle. Through the excretory duct of this testicle, a thick milk-white secretion flows, which, when examined by a glass capable of magnifying three hundred diameters, is observed to contain long hair-like fibres, which contract into serpentine folds on the addition of water, and also bodies having the appearance of round discs, consisting of very minute vesicles enveloped in a common external covering, and about 0,02 of a millimeter in diameter. I shall call these bodies for the future by the name of discs, in order to distinguish them from the vesicles they contain, although I cannot say whether they are in all cases actually flattened on both sides. The vesicles form within them a round mass, which is often smaller than the space enclosed by the external membrane. Under such circumstances, the discs appear as if surrounded by a transparent ring, which encompasses a circular space covered with minute globules lying close together. The sacculi of the testicle are also filled with a whitish secretion, more fluid in general than the former, and in which the peduncles or filaments, before described, are seen swimming; it also contains a much larger quantity of discs. The discs are partly attached to the filaments, and partly separated from them. On examining more closely the latter fluid, and the sacculi in which it is contained, the following circumstances are observed:—The filaments at their origin lie parallel and close together, and form a species of fibrous membrane, which covers the internal surface of the sacculi before mentioned. The ends of the filaments project into the fluid, and form an annulus which encloses a disk. The fibres gradually separate from the surrounding parts, and the discs from them. The ends of those which have lost their discs bend backwards, and twist themselves in a spiral form round their own stems. These, as well as the filaments, escape with the secretion of the testicle into the excretory duct. But as the number of discs found in the latter is much smaller than in the testicle, and yet there is no accumulation of discs observed in the testicle, we are obliged to conclude that they discharge their contents in their passage into the excretory duct, and that their external covering is then dissolved.

"These observations were made chiefly on the *Limax ater* and *Helix nemoralis.* If the seminal fluid of these animals be examined at different periods of the year, the proportion of the discs to the vesicles and peduncles is found to differ very much on many occasions. Sometimes one perceives only a few quite transparent discs; but, on the other hand, a great many vesicles and peduncles separated from their discs: at other times, only a few vesicles are observable, but we see a great many discs filled with a dark matter, partly resting on their peduncles, partly detached from them. Occasionally, one can see nothing but vesicles and peduncles without discs. Thus, in two wood-snails which I opened on the 13th of May, the organized parts of the seminal fluid, magnified three hundred times, presented the following appearances :—A drop of the secretion of the testicle, diluted with water, was observed to contain merely discs and vesicles. The discs were quite empty, and the vesicles appeared like points. A drop of the secretion found in the excretory duct of the testicle, when submitted to the same process, presented very different phenomena; it contained only peduncles, which had separated from the discs, and of which the ends were disengaged and bent back towards their stems. On the other hand, in a wood-snail which I examined on the 1st June, neither the secretion of the testicle, nor that found in its excretory duct, contained any discs, but merely peduncles and vesicles, the former only in the secretion of the testicle, the latter in the secretion found in the excretory duct. In other respects, both the fluids are white and opaque, and the latter is generally thicker than the former ; but in this instance the first was of a milky appearance, the latter clear and semitransparent. The causes of these differences can depend only on the circumstance that the discs separate from their peduncles, sometimes at an earlier, sometimes at a later period, and at one time expel the vesicles contained within them in the testicle, at another time not until they have got into the excretory duct.

"In the sacculi of the dew-worm, which lie between the ovaries at their base, opening into the excretory ducts of the latter, and containing a thick yellowish secretion, I have also discovered long filaments of this description, contracting into a serpentine form when the secretion is mixed with water, and resembling those met with in the *Limax ater* and *Helix nemoralis.* In this animal also, they cover the inner surface of the sacculi in layers, like tufts of hair. The seminal secretion, however, only contains globules of a smaller size unconnected with the filaments, and which I have always found devoid of motion. On the other hand, in the secretion of four sacculi which lie at both sides of the ovaries, I observed very fine streaks and globules, in both of which lively and continued motions occurred on adding water to the secretion.

"In the medicinal leech (*Hirudo medicinalis*), and the horseleech (*Hirudo gulo*), the fructifying secretion is found in two organs composed of small twisted cul-de-sacs, situated at each side of the reservoir of the penis. These organs were formerly regarded as a kind of epididymis, or as seminal vesicles. The secretion is full of bodies, which consist of small vesicles, having an irregular form, and exhibiting only very slow motions. Between these, short and tolerably thick peduncles are seen, instead of long thin filaments.

"The animals referred to in the foregoing observations are hermaphrodites; and it may certainly be urged, that the results obtained from an examination of the productive secretion, which in them is the male semen, do not authorise us to draw any direct conclusions with reference to the seminal fluid of these animals, among which the different parts of generation are possessed by different individuals. But the observations which I have made on the organized parts of the semen of winged insects, agree very closely with what I have discovered in snails. I made these observations chiefly on the *Cantharis livida*, which pairs through the whole month of July, and can be collected in great numbers. This beetle has two testicles, each of which is composed of an extremely delicate vessel, covered with brownish-red vesicles, and emptying itself into a muscular seminal reservoir. Viewed through a glass of a magnifying power of 300, round figures are seen on the internal surface of the secreting vessel; and, on tearing the latter, a whitish fluid escapes, which contains round disciform bodies, along with a mass of very minute vesicles. These discs bear a strong resemblance to those found in the secretion of the testicles in snails; but they are smaller, being only 0,006 of a millimetre in diameter. Many of them possess, like those of the snail, a border consisting of a transparent ring, and a filamentary attachment, which, however, is shorter and not so rigid as that found in connection with the discs observed in the seminal fluid of snails. Their internal composition cannot be distinctly ascertained, even with the assistance of a glass capable of magnifying about 500 times. They move but slowly; they change their forms, however, from time to time by contractions, and occasionally turn round in such a manner as to exhibit their small sides, on which they appear of a lenticular shape. On detached portions of the secreting vessel they are sometimes seen in congregated masses, resting on their filiform attachments like whorls on their peduncles. The minute vesicles above mentioned can be regarded only as the contents of the discs, part of which have burst. They lie between the discs, and seem to be the contents of those which have emptied themselves.

"In females of this species of cantharis, which I killed during copulation, a large quantity of clear fluid gushed out when the abdomen was opened. This fluid coagulated into a gelatinous mass in water. From the vagina I obtained a whitish secretion, which contained the same vesicles found in the vicinity of the discs in the seminal fluid of the male, but no discs. On mixing this secretion with water, weak currents were observed, which appeared to be independent of any mechanical cause.

"I have found much larger discs, and bearing a closer resemblance to those observed in snails, about the end of May, in the secretion of the seminal vessels of the May beetle, although not caught during the time of pairing. Some of them were surrounded by a small annulus like those of the snail, and full of dark molecules in the anterior. Some of them had a vesicular nucleus in the centre. Between them lay scattered particles, which appeared to be fragments of the lining membrane of the secreting vessels, and from which short straight filaments projected.

"I also found, on the 9th of August, in the round testicle of the Papilio Brassicæ, which is covered with a brown pellicle, tufts of hair-like filaments, and discs exactly resembling those observed in the secretion of the testicle in snails. The filaments, however, were finer, and the discs somewhat smaller than those of the latter. No trace of motion could be seen in them. The testicle of a Papilio Io, which I opened on the 6th of August, contained a greyish secretion, in which I found discs, and vesicles exhibiting a slow motion like the molecules of Brown. Mos of the discs had discharged their contents, and contained only a small nucleus, which in many of them appeared like a mere point. The vesicles also looked only like dark points when magnified three hundred times.

"If these observations of mine be compared with the description and plates which Von Gleichen, the most accurate of modern observers in this department, has given of the organized parts of the seminal fluid of man, the dog, ass, horse, bull, goat, hare, and frog, a partial difference of form will certainly be observed between the latter and those which I have discovered in the invertebrate animals already mentioned; in other respects, however, the former as well as the latter are furnished with peduncles, from which they detach themselves on the admixture of water with the semen, and they do not possess such an internal organization as would authorize us to place them in the class of self-existent animals. The organized parts in the semen of the fish differ still more widely from the organized products found in the seminal fluid of the invertebrate animals. These have always appeared to me merely as simple non-pedunculated vesicles, from 0,0011 to 0,1600 of a millimeter in diameter. In undiluted semen, they often lie so close together that they cannot be distinguished from each other. In this instance, the vesicles which constitute the most important part of the semen, which in all the other classes of animals are combined together in masses covered by a common integument, and escape singly from this envelope only at a certain period, appear to have been contained in the fluid portion of the semen from the very commencement.

"Hitherto, the motions exhibited by the organized parts of male semen, have been looked upon as analogous to those of the true infusory animalcules. From these, however, they differ very much. The infusory animalcules, it is true, exhibit continued motions; but from time to time they pause, in general, however, only for a moment, for the purpose of taking nutriment. But we never observe these interruptions of motion from internal causes in the bodies found in the semen. Those met with in the semen of the feræ and birds, swing back and forwards like a lifeless pendulum, as long as they remain attached to their peduncles. When detached, they range continually over the field of the microscope, without stopping anywhere. The long peduncles of the discs, in the seminal fluid of the snail, twist and bend themselves; still, merely in the same way as dead elastic filaments, which attract water, which pass from a state of dryness to a state of moisture, and vice versa. The motions of the vesicles in the semen of fishes resemble the molecular motion described by Brown, except that in matured semen it is much more lively than in the atoms of lifeless bodies. In the seminal fluid of a bream, which I examined in May, I saw these vesicles attract and repel each other, on diluting the semen with water.

"From the observations which I have now communicated, the reader will not fail to recognise a strong analogy between the organized parts of animal semen and the pollen of plants. The latter, just like the former, is composed of an aggregate of vesicles surrounded by a common integument, and containing the proper fructifying matter; and which, when moistened by the fluid that exudes from the stigma and nectaries at the period of their maturity, quit their investment. The pollen globules of many plants, particularly in the unripe state, are so like the bodies found in the seminal fluid of the snail, that any one who saw one or the other under the microscope, without knowing whence they were taken, could not say whether they were of animal or vegetable origin. I found this resemblance to the bodies already described among others in the unripe pollen of the larch.

"On the other hand, there are undoubtedly points of dissimilarity between the organized parts of animal and vegetable semen. The differences, however, are unimportant. In the first place, there is an absence of all motion in the pollen. We have seen, however, that, in the seminal fluid of many of the lower animals, only feeble motions are observable. Again, the globules of pollen are without peduncles. Although Turpin and Decandolle suspected that they were always connected to the anthers by filaments during the first stage of their formation, and although, in the Clarkia pulchella, I have myself found many of them attached to filaments which proceeded from the fibrous coats of the anther, still, I have not been able to discover a connexion of this kind in any other plant which I examined, even during the first stage of the origin of these globules. I dissected the rudiments of the following year's flowers of a Daphne Mezereon in the middle of October. The anthers had, even then, a yellow colour, and had nearly attained their full size. The pollen globules contained within them lay in a yellow firm matter, but were almost destitute of colour. From their transparency, I was able to distinguish in them the external integument, which consisted of cells arranged in a reticular manner. There was no trace of peduncles to be seen in them. I also found the anthers of the female flowers of the hazel filled with pollen globules as early as the commencement of October. Their contents consisted of a semitransparent uniform substance, lying in a fluid matter, and having no connection at any point with the walls of the anther. But although, in the animal kingdom, the connection of the seminal corpuscles with the internal surface of the testicle is very frequently by means of a peduncle, still, this mode of connexion, even in them, is not so universal that we should look upon it as something essential.

" The pollen globules of plants do not swim in a fluid while they remain in the anthers. The semen of animals also is originally composed almost entirely of organized parts, which are contained in a quantity of mucus, small in proportion to their mass. It is chiefly in its transit through the excretory ducts, that it is diluted by the fluids which are mixed with it in these canals. Fluids of this description are also effused on vegetable semen. In many plants the stigma secretes a watery substance, causing the pollen globules which lie on it to open. In others, a considerable quantity of this kind of fluid is secreted by the nectaries; while from the stigma a viscid juice exudes in smaller quantity. The latter occurs in the Iris tribe and the Asclepiadeæ.

" In what way the seminal bodies of animals discharge their contents, has not yet been observed. It is not probable that the same occurrence takes place in them as in the pollen globules of many plants, viz. the escape of their contents from the investing membrane in the form of a long filiform cylinder. I have, however, observed this mode of exit only in a small number of plants. The reason why the matter contained in the pollen globules of such plants is discharged in this way is, because it is enveloped in a considerable mass of viscid mucus, which, when forced through a narrow opening in the membrane, by the contraction of the external coat of the globule, is drawn out into a filament. I have never found it, like an offshoot, proceeding from the globule, a point of view in which the filament has been regarded by A. Brongniart and Amici. Neither have I been able to convince myself of the truth of an opinion advanced by these and other phytologists, that these pretended offshoots from the pollen globules penetrate through the stigma and style into the ovary, notwithstanding the great importance I attribute to other observations of many of these naturalists.

"The following are the results of the numerous investigations which I have made on this phenomenon for the last three years:—As soon as the pollen globules have discharged their contents upon the stigma, and fructification is accomplished, the papillæ of the stigma begin to separate from each other. The papillæ are terminated by a bundle of long capillary fibres, passing from the ovary through the style to reach the stigma. These fibres are always accompanied by elongated cylindrical cells, and usually, but not in the grasses, by spiral vessels; and are distinguished from the sap fibres by their greater length and delicacy. Frequently, the ends of the filaments which proceed from the pollen globules are attached to the ends of these capillary fibres, between the papillæ of the stigma, in such a manner, that the filaments seem to be continued into the fibres; and the connexion appears to be the principal cause which has given rise to the opinion already noticed. But we find many filaments connected with the papillæ by means of the viscid secretion of the stigma, as well as with the fibres. This viscid secretion also frequently contracts, particularly on the withering stigma, into long thin filaments, which swell up in water. Many of the fibres become distended at this period, and contain a dark matter, frequently connected with the pollen globules, and resembling the substance found in the latter. But I have observed a similar distention in the fibres of the style, and a similar substance in these fibres, as well as in the cells of the style and stigma of flowers that had not been fructified.

"Another circumstance also which may, and very probably has given rise to deception in this matter, is this: in some plants the papillæ of the stigma are of a globular shape, and immediately connected with the fibres before described. In others we find, under the cells of which the stigma is composed, globular cells, in which the fibres of the style terminate. The former is the case in the Hypericum perforatum, the latter in the Cypripedium calceolus. When the stigma and style in these plants have dropped off, the round cells, with the fibres attached to them, might be mistaken for globules of pollen, with their offshoots forcing their way through the style.

"To illustrate these remarks, I communicate here some detached observations on the state in which I found the stigma, style, and pollen of different plants after the parts of the flower had withered, in cases where fructification had been accomplished, and where this process had not taken place. What I shall say with respect to the Iris pseudacorus will, at the same time, serve to determine more accurately the mode of fructification in these plants, and to rectify the earlier observations which I made on this point in vol. ii. sect. 2, of my work on the Phenomena and Laws of Organic Life.

"Treviranus then proceeds to describe the phenomena of fructification in the Hemerocallis flava, Iris pseudacorus, Cypripedium calceolus, Tellima grandiflora, and Hypericum perforatum; and concludes by observing, that the last result of his comparison of animal and vegetable semen is, that externally there is no essential difference between them. He thinks, therefore, that the term, 'animal pollen,' would be a more appropriate name for the organised parts of animal semen than the appellation seminal animalcula, by which they have been hitherto designated."

In two papers on the same subject in Muller's Archiv für Anatomie et Physiologie, No. iii. and iv., by Professor Wagner and Dr Rudolphi, the statements do not exactly correspond with those of Treviranus. Professor Wagner describes the semen of the Emeriza citronella as an homogeneous fluid, containing two sorts of bodies, *first*, linear or hare-shaped bodies, having one of their ends twisted spirally like a corkscrew; and, *secondly*, globules of various sizes, and vesicles containing granular globules. The first kind of bodies, which he regards as the true seminal animalcules, are generally found in the seminal fluid of the testicle, collected in bundles, and enclosed in a delicate sac, one end of which gradually disappears, and some time afterwards the other end bursts, leaving the linear bodies without any envelope. In the vas deferens, these bodies are mostly seen in close tangled masses, intermixed with the smaller kind of globules. Here also, according to Professor Wagner, they exhibit very remarkable vibratory movements, although he could not discover any trace of vital motion in them while in the testicle.

In Dr Rudolphi's account of the spermatozoa of the Paludina vivipara, we find two kinds of animalcules described. First, worm-shaped, transparent bodies, one end of which terminates in a point; the other is furnished with a tuft of delicate fibres. The movements of these bodies, which are very active within the testicle, are oscillatory or undulating; but they appear to be incapable of locomotion. Secondly, linear or hair-shaped bodies, with spiral ends, very like those described by Professor Wagner, and exhibiting a peculiar vibratory motion within the testicle as well as in the vas deferens. Both these bodies, when mixed with water, exhibit alterations in shape, which consist, according to Dr Rudolphi, in the sudden appearance of vesicles and perforations, or loops, at some certain part of the body. The globules, or vesicles, he represents as occurring in different forms, and under different circumstances. Sometimes they are in aggregated masses without peduncles; frequently they are seen collected in clusters with their peduncles attached to a tenacious mass. In other instances they are elongated, and present an anterior delicate peduncle in addition to that which attaches them to the common tuft.

On the whole, however, these observers do not differ much from Treviranus; nor does there appear any thing in their descriptions calculated to invalidate his statements. The tufts of Treviranus are described both by Wagner and Rudolph, with this exception, that they have not taken any notice of their adhesion to the sides of the secreting vessel. Professor Wagner describes these tufts as originally enclosed in a membranous vesicle. This, however, has not been noticed by any other observer, and very probably depended on an optical illusion. It will be perceived that Wagner corresponds very closely with Treviranus in his account of the globular bodies; and I may add, that in the figures of these bodies, as delineated in their plates, there is a very remarkable similitude. There are also very obvious points of resemblance between the descriptions of the pedunculated vesicles given by Rudolph and Treviranus. It would appear that the chief sources of difference are referable to the means of examination employed, and to the existence of preconceived opinions. The instruments used by Dr Rudolph and Professor Wagner seem to be greatly inferior in power to those employed by Treviranus. Again, the two former regard the linear or hair-shaped bodies alone as the true seminal animalcula; while Treviranus looks upon them as probably nothing more than mere peduncles or fibres of attachment for the vesicles, which contain the most important and essential constituent of the seminal fluid.

The seminal animalcula were first observed in the early part of the year 1677, by Louis Hamme, a German student, who was at that time on a visit with Leeuwenhoek, to whom he communicated his discovery. This indefatigable observer immediately occupied himself with the subject, and in the month of November 1677, transmitted to London an account of the discovery, with a description of the spermatozoa, in a letter to Viscount Bruncker, which was afterwards published in the 142d No. of the Philosophical Transactions. This communication was received with great applause; and the facts were shewn to Charles II. and many scientific individuals. They were subsequently examined and admitted by Hartsoeker (who also claimed the discovery), Asche, Huygens, Spallanzani, Haller, Bonnet, Morgagni, and several others; and engrossed a considerable share of the attention of physiologists about the latter end of the 17th century. These investigations subsequently fell into neglect; but appear about to be revived again in Germany, and in the hands of such men as Treviranus, Ehrenberg, and Purkinje, may ultimately tend to throw some light on one of the most obscure and interesting subjects in physiology.

Further Observations on the Unity of Structure in the Animal Kingdom, and on Congenital Anomalies, including "Hermaphrodites;" with some Remarks on Embryology, as facilitating Animal Nomenclature, Classification, and the study of Comparative Anatomy. By Martin Barry, M.D., F.R.S.E., M.W.S. Communicated by the Author.

In a former memoir on this subject,* certain conclusions were arrived at, which, to save reference, it may be proper to repeat, viz.

1*stly,* That a heterogeneous or special structure arises only out of one more homogeneous or general, and this by a *gradual* change. 2*dly,* That the *man-*

* See the last Number of this Journal, p. 141.

ner of the change, is probably the same throughout the animal kingdom, however much, *3dly*, The *direction* (or *type*) and *degree* of development may differ, and thus produce variety in structure; which, however, there is good reason to believe, is, *4thly*, In essential character, *fundamentally the same.* Yet, *5thly*, That no two individuals can have *precisely* the same innate susceptibilities of structure, or plastic properties; and therefore, *6thly*, That though all the individuals of a species, may take, in their development, the same *general* direction, there is a *particular* direction in development,—and, therefore, a *particular* structure,—proper to each individual. *7thly*, That structures common to a whole class must, *in a modified form*, re-appear in individual development; and, *lastly*, That they can re-appear in a *certain order only;* viz. in the order of their generality in the animal kingdom.

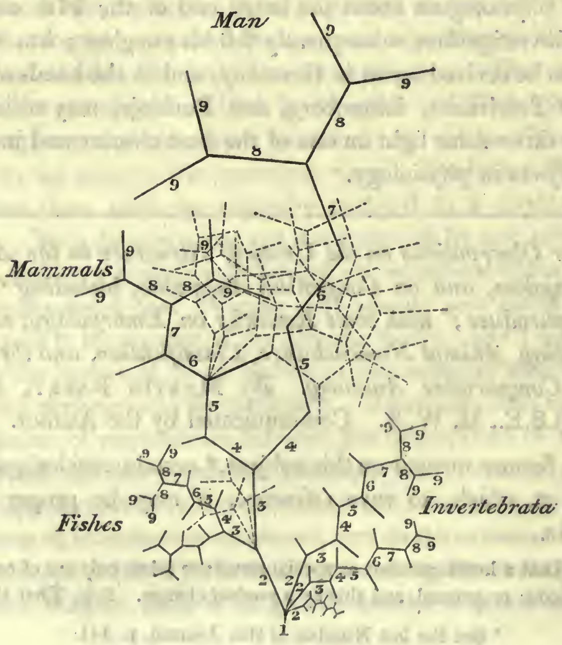
These conclusions, especially the two last, with the reasoning from which they are derived, sufficiently explain why, in the embryonal life of the more elaborate animals, there occur temporary resemblances in certain parts of structure, to the permanent states of corresponding parts, in animals less wrought out.

A Diagram will serve to illustrate some of these conclusions.

The Tree of Animal Development;

Shewing fundamental Unity in Structure, and the causes of variety; the latter consisting in *Direction* and *Degree* of development.

Fig. 12.



The whole figure represents the development of the entire Animal Kingdom.*

Any one of the primary divisions may rudely illustrate the development of a single organism, viz.—

Explanation—to be read from below upwards.

9. The *Individual* character in its most special form.
8. The *Sexual* character obvious, but the *Individual* character obscure.
7. The *Variety* obvious, but *Sexual* difference scarcely apparent.
6. The *Species* manifest, but the *Variety* unpronounced.
5. The *Genus* obvious, but not the *Species*.
4. The *Family* manifest, but the *Genus* not known.
3. The *Order* obvious, but not the *Family*.
2. The *Class* manifest, but the *Order* not distinguishable.
1. No *appreciable* difference in the Germs of all *animals* (Fundamental Unity?)

This illustration is but a coarse one, since it does not shew the *particular* direction, proper to the development of each individual germ.

It is not unusual, however, to hear of the "higher" animals *repeating* or *passing through* in their development, the structure of the "lower:" and though this is said in reference, of course, to no more than single organs, it is a mode of speaking calculated to mislead.

Such expressions might not be improper, did there exist in the animal kingdom a scale of structure differing in *degree* alone. But there is no such scale. We must "distinguish between the degree of elaboration and the type of structure."† Each class, order, family, genus, species, and variety of animals,—each sex and each individual,—has a structure peculiar to itself; nay, every organ also, must, from the first, be constituted with reference to the most special structure it is destined to attain. "The Blastema (germ) of the new being, must be already peculiarly organized, to produce, under requisite, favouring circumstances, this or that individual. A formless material, as the foundation of, and susceptible of constituting, any individuality you please, is

* The lower *dotted* branches, indicate directions for the development of Birds and Reptiles; the following out of which, would have rendered the diagram complicated and obscure.

To avoid complication, only binary divisions have been used, but *dotted* branches (the *upper* ones) are introduced, to shew that *all* the *remote* divisions admit of such addition, except those that indicate the development of sex.

The distance between the root and the extremities of the last twigs, shews the degree of aggregate elaboration or development.

† Von Bär.

merely an abstract notion of the mind, and exists nowhere in Nature; where there are only concrete realities,—more or less characteristic individualities, contained in a higher whole." *

Strictly speaking, therefore, no animal absolutely *repeats* in its development, the structure of any part of any other animal; and not only is the human embryo at all periods of its existence a human embryo, but the human heart and brain, closely as they resemble corresponding organs in other Vertebrata at certain periods of development, are never any thing else than the heart and brain of Man. If the young frog, the tadpole, resembles in some respects a fish, and spends a portion of its existence in the water, is it to be said that the tadpole *is* a fish? Would a highly developed fish constitute a frog? Besides, as said by Valentin,† a passage by the embryo of the so-called "higher" animals through the "lower" grades, would imply the possibility of an individual, at certain periods, laying down its individuality, and assuming that of another animal; which would abolish its existence as a determinate concrete reality.

No structure peculiarly *characterizing* any one set of animals in the perfect state, makes its appearance even in the embryonal life of any other.‡ Thus the perfect gills of fishes, and the air-sacs distributed through the body and the bones of birds, relating as these organs do, to the elements respectively, in which fishes and birds have their abode, are found in them alone, which could not be the case, did the so-called "higher" animals pass through the perfect states of those said to be "lower."

Besides which, as Von Bär has truly said,§ were it a law of nature, that individual development should *consist* in passing through permanent but less elaborate forms, there is not a feature in embryonal life, nor a part then present, that we should not expect to find, somewhere at least, in the animal kingdom. Yet in what direction are we to look for an animal carrying about its food, as the embryo the yolk, or a pendant portion of

* Valentin, Fragmente zu einer Künftigen Gesetzlehre der individuellen Entwickelung, in his Entwickelungsgeschichte des Menschen, &c. S. 591.

† l. c. p. 592.

‡ Valentin, l. c. p. 596.

§ Ueber Entwickelungsgeschichte der Thiere, Beobachtung und Reflexion. Königsberg, 1828. S. 204.

intestine, like the vesicula umbilicalis? In Mammals, the incisors are the teeth which first appear; but no animals have permanently fore-teeth alone.

The same author has well remarked, that inasmuch as embryonal relations produce forms that are present in no grown animal, such as the pendant intestinal sac, just mentioned; it is also impossible that any embryo can repeat the state of many groups of animals. All embryos are surrounded with fluid; and consequently incapable of immediately respiring air. The real character of insects, therefore,—a lively relation to the air,—can never be repeated in an embryo. For the same reason, the embryo of mammals can never resemble perfect birds.*

Besides these arguments, there are others; but it is by no means needful to bring forward more. We briefly recapitulate those now advanced.

1*stly*, There does not exist a scale of structure, differing in *degree* alone. 2*dly*, Individualities cannot be laid aside. 3*dly*, There exist permanent structures among the so-called "lower" animals, not met with in the embryonal phases of any of the "higher." 4*thly*, There are many phases of the "higher" animals, corresponding to which, we do not find any permanent structures among the "lower." 5*thly*, No structure peculiarly characterizing any one set of animals in the perfect state, makes its appearance even in the embryonal life of any other. *Lastly*, The sum of the innate susceptibilities of structure is not the same in any two germs.

It has been said,† that "the assertion is nothing more than that Man, as Man, has once in the progress of his development, been upon that grade upon which the several classes beneath him remain stationary in the progressive development of the entire animal kingdom." But even thus qualified, it is by no means true. Man, in the progress of his development, is not upon that grade on which any other animals remain stationary, unless the latter belong to the same *type* as man: ‡ and even then, the resemblance would relate to certain parts only, because each order, family, genus, species, variety, sex, and individual, has its own peculiarities, which are repeated in the structure of no other animal.

* l. c. p. 204.

† Burmeister's Entomology, translated by Shuckard, 8vo, 1836, p. 419.

‡ We admit, indeed, that the whole animal kingdom has essentially the same fundamental or merely *animal* form; but from this there is an immediate *divergence*. (See Fig. 12, p. 346.)

When the great Meckel said, "the higher animal in its development, passes through *essentially* the lower and permanent grades; by which periodical differences, and differences between classes, may be brought together;"* he evidently meant no more, than that there occurred in the development of a single organism, a *modified* reappearance of structures common to other animals; and further, that he did not intend to say that *all* the structures of *all* "lower" animals reappear in the development of each of the "higher,"—is evident from a remark he uses in reply to one of the objections made by Feiler;† on which occasion, Meckel says, "It is perfectly indifferent, whether the human embryo passes through all, or only some of the grades of formation; if certainly ascertained facts demonstrate that it passes through *many*,—that it *always* passes through them,—and therefore that the analogies in question are not accidental."‡

It may not be improper, by a few of the facts on which Meckel's proposition appears to have been grounded, to exemplify some of the conclusions at which we arrived when last on this subject; and by quoting which, we commenced the present paper.

The uniform appearance first, in the osseous system of the Vertebrata, of what are called the arches of the vertebræ, is referrible at once to the law determining the *order* in which structures essentially the same in a whole class of animals, manifest themselves in individual development; and to the law of uniformity in the *manner* of development. If in the Cephalopoda, there is permanently no more than the trace of a spinal column, corresponding to the arches of the vertebræ,§ it shews that the last degree of development in these animals, is sufficient to produce no more than an approximation to the Vertebrata; but that, so far as they do go, they proceed, in this respect at least, by nearly the same road.

If the ilium is the first pelvic bone that becomes ossified in animals possessing a pelvis,‖ and if there be an animal in which this is the only portion of the pelvis present; this shews unde-

* System der Vergleichenden Anatomie; erster Theil, S. 396. Halle, 1821.

† Ueber angeborne menschliche Misbildungen im Allgemeinen und Hermaphroditen insbesondere. Landshut, 1820.

‡ L. c. p. 411, 412. § Meckel, l. c. p. 399.

‖ Meckel, l. c. p. 400.

viating fulfilment of the same laws, though but a rudimental structure be produced.

The absence of the sternum and the costal cartilages in most Fishes and the "lower" Reptiles,* proves that these parts are not necessary to the general type of the Vertebrata; further evidence of which, is given in the late acquirement of them by those animals in which they are present.

In Man the encephalon is small in comparison with the spinal cord and the rest of the nervous system; the cerebellum is small compared with the medulla oblongata; and the corpora quadrigemina are enormous in proportion to all the other parts of the encephalon.† Corresponding states are found through life in many animals. Now, this is just what we should expect. For certain parts of the cerebro-spinal axis, such as the spinal cord, the medulla oblongata, and corpora quadrigemina, must, in fulfilment of the law determining the *order* in which structures common, essentially, to a whole class, reappear modified in the development of an individual organism, precede, in their appearance, those that are of a more specific character, such as the large volume of the hemispheres in Man.

Having seen why, in corresponding stages of development, parts of the human organism should resemble, in their structure, corresponding parts in many perfect but less elaborate animals; it is obvious, that if human development be arrested in any of those stages, the resemblances become permanent. Hence malformations of *defect.* But sometimes the development of certain parts proceeds beyond the normal limits; and hence malformations of *excess.*‡

Examples occur especially in the vascular system. Thus, the human heart with a single cavity, is somewhat analogous, in its simplicity, to the heart of the Insecta, Crustacea, and Brachiopoda. A single auricle and a single ventricle, afford some resemblance to what we find the normal state in most molluscous animals and Fishes. The Batrachians have two auricles and a ventricle; the incomplete state of the interventricular septum, being analogous to what is regular in the more elaborate Reptiles. Anomalies in the pulmonary artery and the aorta, afford examples of the same kind of resemblance; as do also

* Meckel, l. c. p. 400. † Ibid. p. 401.

‡ J. F. Meckel was the first who satisfactorily explained congenital anomalies. Handbuch der Pathologischen Anatomie. Leipzig, 1812.

the subclavian, brachial, cœliac, and renal arteries; and the inferior cava vein. Malformations occur also, though less frequently, in the nervous system. Many are afforded by the osseous system, as well as by the digestive, respiratory, urinary, and generative organs, the organs of sense, &c.

Meckel attributes the greater tendency in certain parts of the body to malformation, than other parts, to the circumstance, that parts in the "animal series" corresponding to the former, present normally more numerous varieties than others.* Thus, for example, the anterior or superior extremities are more liable to deviations than the posterior or inferior. This explanation is no doubt the true one. We would add to it only, a reference to the law determining the *order* in which structures common to a whole class reappear modified in individual development; for in proportion to the generality of the latter in the animal kingdom, will their individual reappearance be early and established, and *vice versa*. As a further proof of this, it may be added, also, that the liability of parts to malformation, is in the direct ratio of their lateness in appearing†.

The nervous system, as said before, is subject to fewer anomalies than the vascular, and also than the digestive, generative, and urinary organs; corresponding to the relative degree of normal variety in these parts in the animal kingdom. This affords a further illustration of the foregoing; and it may be added, as a proof of the greater universality of the same essential structure in the nervous system of the Vertebrata, that its development is much more pronounced than that of other parts, at an early period of development.‡

The coincidence between the presence of ovaria or testes, on the one hand, and of a certain habitus, as well as other circumstances in various parts of the body, on the other, is sufficiently well ascertained. It is known too, that castration has the effect of neutralizing this genital influence; rendering males, in general

* l. c. p. 427.

† Hence if a fundamental and early-formed part be not developed, parts dependent on, and subordinate to it, do not appear. Thus, if the vertebræ be not developed, the ribs do not appear; and if the ribs are not formed, the sternum also is wanting. Again the lateral portions of the vertebræ appear before their spines; therefore the latter are never present without the former.

‡ See the third paragraph of page 139, in our former paper.

circumstance, less masculine, females less feminine; that is to say, it brings the sexes nearer to a mean state. Age, or the natural termination of the reproductive faculty, produces in degree the same effect. This is observable in the human species, as well as in other animals.*

The fact, that malformations of the genitals occur most frequently in the organs of excitation and copulation,†—parts of subordinate importance, and not formed until a comparatively late period,—affords an example of the fulfilment of the law, determining the *order* in which innate formative properties are manifested. The co-existence of testes, on the one hand, and of ovaria on the other, with a male or female habitus; formed, as those organs are, long before the external, less important, genitals; such co-existence is recognisable in the fact observed by Sömmering, that the sexes may be distinguished in general appearance, before a difference in the external genitals themselves proclaims them.‡ In cases, too, of malformed genitals, it rarely happens that the real sex is not decidedly pronounced in the general habitus; shewing further, the early operation of the latter law.

Another proposition of J. F. Meckel is as follows, viz. "That sexual differences, at least according to their origin, and periodical differences, may likewise be brought together; §" in other words, that sexual differences may be compared to differences caused by the phases of life. It is not easy to suppose that Meckel intended to represent the sexes as differing in *degree* alone; and yet it is added afterwards, that "the inferior animals are purely females.¶"

The circumstance, that what are called "neuter" Hymenoptera, particularly bees—those born for workers—by being conditioned in a certain way, may be converted into females or queen bees, leads obviously to the conclusion, that the so-called "neuter" bees, *are* really females, in an imperfectly developed

* Old female birds acquire a plumage more or less similar to those of males; as well as spurs, combs, and even in degree, male instincts also.—Meckel, l. c. p. 446.

† Meckel, l. c. p. 447.

‡ Valentin, l. c. p. 595.

§ L. c. p. 396.

¶ L. c. p. 425.

state. But does it warrant the conclusion, which Meckel seems to draw, that females are scarcely more than imperfectly developed males? Female bees may rest in an imperfect stage, so that their sex is not obvious: by treatment, they become proclaimed as females: but, we ask, would any further treatment make them *males?*

Yet it is not easy to conceive that Meckel intended the expressions used, for literal acceptation. Perhaps this proposition is to be regarded as not less susceptible of a modified application, than the one alluded to before.

Sexual characters bespeak properties that are innate; though, from being nearly the last that make their appearance in development, they are among the least established, and *therefore* very liable to vary. The sexual character has been said to stand between the character of the species, and the special or particular character of the individual being.* This is true, in as far as specific characters *manifest* themselves prior to those of sex, and those of sex prior to the last touches, stamping the individual character; yet it must not be forgotten, that throughout development, *all innate properties,* from those common to animals in general, down to those distinguishing the species and the sex, are modified in their individual reappearance by individuality.

Now, just as parts of structure common to the *class* are, in essential character, fundamentally the same; so are those common to an *order*, *family*, *genus*, and *species*.† The *sexual* organs, also, are in both the sexes of a species, in essential character fundamentally the same;‡ just as *vertebræ* are fundamentally the same in all the Vertebrata. Male and female organs

* Valentin, l. c. p. 594.

† It is only *individual* peculiarities, that are shared with no other being.

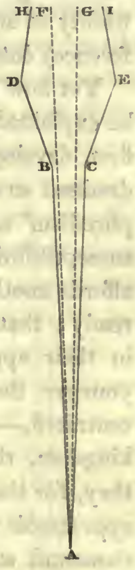
‡ An interesting proof of this occurs in the Order Marsupialia. Males have not, of course, a marsupium or pouch, unless in a rudimental form; but they have the marsupial bones. We need not, however, go for illustrations beyond the human race; in which the males have rudimental mammæ.

These examples will serve further to illustrate an explanation offered in the former memoir, regarding another branch of our subject (p. 140), viz. that rudimental structures seem to answer no other purpose than the fulfilment of the law, requiring that a fundamental or general type shall uniformly manifest itself before the appearance of one subordinate thereto, and special.

have a common origin as processes, and take the same *general* direction, out of corresponding laminæ of the germinal membrane or tubes, and they have the same *manner* of development; but, just as parts of structure, at first common essentially to the *class*, become afterwards transformed, so do the *sexual* organs, which, essentially, are at first common to the *species;* and a difference in function follows. But from the first, as said before, development proceeds according to the *sum* of the innate formative properties, *sexual* properties being included in this sum; though their influence on development be not at first appreciable.

Let the point A, Fig. 13, represent the supposed fundamental form, essentially the same in all animals, so long as a merely *animal* structure is manifested. Two germs belonging to the same species, but of different sexes, start in their development from this point A. Their divergence in development is small, because occasioned by two influences only; one of which is sex, the other, individuality. At the points BC, sexual peculiarities,—local as well as general,—exercise more sensibly their sway; and further development takes them, respectively, to the points DE. Here, if castration terminate the reproductive faculty in both, the result is,—not indeed the attainment of, for that is now impossible, but,—an approximation to, the mean state, FG, which these individuals, respectively, would have reached, had development been influenced,—not by sex, but,—by individuality alone; the points H I being now attained. This we conceive may serve rudely to illustrate, what really takes place in nature.

Fig. 13.



It follows from the above, that we cannot adopt the theory proposed in the Edinburgh Journal of Science for 1829–30;—that "there are, fundamentally, male and female organs in the same being, or originally in all embryos, elementary yet distinct parts, out of which both sets of organs may be formed by development." It is the *sum* of the innate susceptibilities of structure, that determines the direction taken in the development of every germ. Development must therefore from the first, have reference to the sex, as well as to the variety, species, genus, family, order, and class: nay more, development must from the first, have reference to the *individual* structure,—more special still than that of sex. Since, therefore, no properties can exist in an absolutely latent state,—*i. e.* without exercising their influence on development,—both male and female organs cannot be present, even in an elementary state, in the same being, *if those of one sex only, are to be developed.**

That the presence of both male and female organs in the same being, is not *incompatible*, most plants and certain animals demonstrate;† where normal and true hermaphrodism exhibits parts, performing in an individual, both male and female functions. In such cases, there are of course, "fundamentally male and female organs in the same being,"—or at least there is the susceptibility of acquiring them; but then (and herein consists the difference) *both are developed.*

Yet how then, is *anomalous* "hermaphrodism" (so called) to be explained? To be consistent, we must admit that from the first, development has, here as elsewhere, reference to a certain destined structure; ergo, that in cases of anomalous "hermaphrodism" at least, there are fundamentally the elements, or the susceptibilities, out of which it has arisen.‡ Be it so; this but affords another proof of what has been so much insisted on already; that in development, *general* structures must precede, in their appearance, the more *special.* In an organism, the younger the embryo, the more alike,—because the less concentrated,—are its several parts or organs. In the animal kingdom, the younger any two embryos, the more alike are they, for the same reason. But, as already said, there is no *appreciable* difference between male and female organs in fundamental structure, as well in the animal kingdom at large, as in two individuals of the same species: though this by

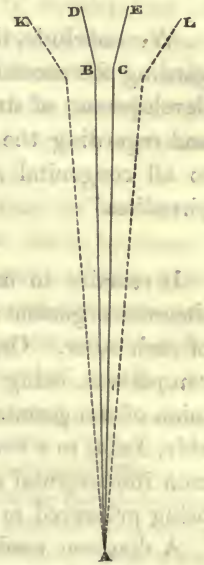
* Supposing the organs of both sexes present in the germ, and those of one sex only, to be developed;—what becomes of the other set? Because, occasionally, parts similar to those in other animals, have appeared in the human structure, may it not as well be said, that, fundamentally, there are the rudiments of *all other animals* in man? (!)

† Helix pomatia,—the garden snail,—affords a well-known example of the latter.

‡ Into the subject of casualties, happening during embryonal life, we do not enter.

no means amounts to the assertion, that *either* male or female organs may be formed out of the same elements. Now, certain of the sexual organs, because of *deficiency* in their elements, or in susceptibility of structure, may advance *less* than is normal, towards concentration: certain of them, because of a *surplus* in their elements, or in susceptibility, may advance *further* than is normal: certain of them may take in development a *male* direction, certain others may proclaim themselves as *female*, because the male and female elements (or susceptibilities), respectively, *of these parts*, existed in the same germ. If the *surplus* relate to the chief organs and to the system generally, there is an *excessive* development of the sexual character: if the *deficiency* relate to the chief organs and to the system generally, males are *less* masculine, females *less* feminine, than is normal;— in other words, there is, in the latter case, an approach to the mean state spoken of before. (See at p. 355 the remarks on fig. 13.) What we have said of surplus or deficiency, and of the presence of both male and female elements or susceptibilities, may relate to one side of the body, or to both sides; to single organs on one side, or on both sides; all of which varieties are known.* The innate *cause* of such anomalies, we may perhaps never know; but the *manner* of their development, it does not seem difficult to understand.

Fig. 14.



In further proof of the justness of this reasoning, may be adduced the fact mentioned by Meckel,† that hermaphrodism is frequent and complete, in proportion as the genital organs are simple, and in proportion as they resemble each other in the normal state; of which Fishes afford the best example. Now this is just what we should expect.

For, with a modification of the last figure (13),—let DE (Fig. 14), represent, respec-

* For an account of "hermaphrodites" in detail, see the late work of Isidore Geoffroy St Hilaire. 8vo, 1836.

† l. c. p. 457.

tively, the points reached in the development of a male and female of a species, in which the sexual organs are very simple, and in which, therefore, the sexual difference is very small. It is plain, that a deviation here, would be more appreciable, —because relatively greater,—than if development had produced complicated structures, and carried the sexes further apart,—as, for example, to the points KL: in other words —the less the angle of divergence, the more appreciable is a deviation, and therefore the more "*complete*" is the hermaphrodism.

But, "in proportion as the genital organs are simple, and in proportion as they resemble each other in the normal state," when perfect,—the less pronounced must be the reference to them throughout development; the later therefore do they manifest themselves. Now, as already said, the liability of parts to malformation, is in the direct ratio of their lateness in development. Hence, in such cases, the more "*frequent*" is hermaphrodism.

We conclude, then, that the explanation before offered, regarding the necessity of a modified re-appearance in individual development, of structures common to a whole class of animals, and regarding the *order* of such re-appearance, is applicable to all congenital anomalies, including those called "hermaphrodites."

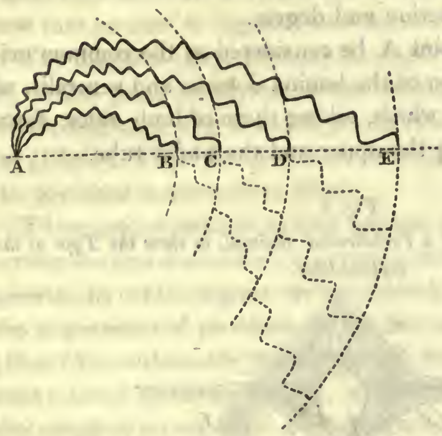
It remains to notice unity of plan, as obvious in organs of the same organism; various parts appearing like modified copies of each other. Organs of the same organism that admit of such comparison, being among those that originate in the same lamina of the germinal membrane or tube, analogies appear referable, 1*stly*, to a common origin,—and therefore 2*dly*, to a common fundamental and general form,—some resemblance, 3*dly*, being preserved in proceeding towards the special.

A diagram used in our former memoir being required here, we again introduce it, to save reference.* Let the point A,

* For a more detailed application of the elements of this diagram, see pages 135, 136, of the last number of this Journal.

Fig. 11, represent the common origin,—the homogeneous nature,—and therefore the coincidence, essentially, in fundamental form,—of various parts arising out of the serous lamina of the germinal membrane of Man (Plate I, Fig. 3, * *):† and *firstly*, of those parts proceeding, respectively, from the laminæ dorsales and ventrales; constituting as the latter do, an *upper* and an *under* tube, (Plate I, Fig. 6, *a. b. c.*)

Fig. 11.



The curves, differing in *direction* and in *length*, may illustrate differences in *direction* and in *degree* of development of the vertebræ; including as well the development of those constituting the coccyx,—curve A B,—as that of those which, vastly more wrought out, enter into the formation of the cranial bones,—curve A E; the development of the intermediate vertebræ being represented by the intervening curves.‡

The development of the ribs being exhibited by one curve, that of the hyoid bone, lower jaw, &c. may be shewn by others.

If the curve A B, represent the development of the spinal cord,—A E may serve to shew that of the most elaborate portion of the hemispheres; and the intervening curves, the development of intermediate parts of the cerebro-spinal axis.§ All

† The Plate here referred to, is contained in the last number of this Journal.

‡ In our former paper (p. 135) we stated the applicability of the above diagram, in a comparison of systems of organs or single organs in different animals. Thus to apply it here; the curve A, E, representing the development of the cranial bones in Man,—A, C, and A, D, may illustrate coresponding parts in osseous Fishes or other Vertebrata, less removed from vertebræ both in direction and degree.

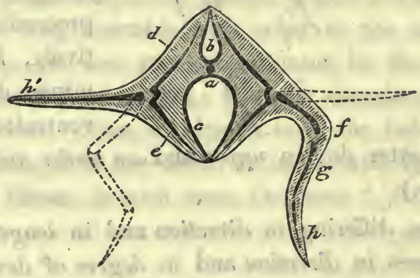
§ Referring to the preceding note, we have again an instance in which the curves A C and A D, may illustrate the development of the hemispheres in animals whose brains are less removed from their primitive simplicity than the brain of Man.

the nerves connected with the latter, may be illustrated in the same manner;—they seem, as it were, rude copies of each other,—differing only in direction and degree.

Secondly, Let the point A be considered as the common origin, in the fleshy portion of the lamina dorsalis and ventralis, of a series of osseous arcs, which, taking those of both sides, form an *outer* tube, including the upper and the under tube.

Fig. 8.

Ideal Transverse Section of a Vertebrated Animal, to shew the Type of the Extremities.



a Stem of the vertebral column.
b Arches of the Vertebræ.
c Ribs.
d Dorsal } radical portion. } of an Extremity, &c.
e Ventral
f Upper } middle portion.
g Under
h Terminal portion.
h' Terminal portion as a Fin.

(This fig. is taken from Von Bär.*)

The curves may now illustrate the development of the radical portion of either an extremity, viz. of the scapula and clavicle, on the one hand, and of the outer portion of the os innominatum,† on the other, or that part of the base of the cranium, which,—formed by one of those osseous arcs, and having coalesced with the cranial vertebræ,—serves to articulate the upper jaw.‡

* This figure also, was exhibited in our last paper. Its re-appearance is needful for the reason before given regarding Fig. 11.

† The inner portion of this bone being probably, as Von Bär supposes, analogous to ribs, derived from the under tube, and coalescing with a section of the outer, to constitute the pelvis.

‡ Von Bär.

Again, if A represent a point near the middle of each arc, the curves shew the development of a process originating there, now into an arm or leg, and now into an upper jaw.*

The diagram (Fig. 11) may be applied also in a comparison of various parts arising out of the mucus (Plate I. Figs. 3 and 4 ***, Fig. 5, *l*, Fig. 6 and 7, *f*), in close union with the vascular (Plate I. Figs. 4 and 5, *h*, *i*, *k*, Figs. 6 and 7, *e*) lamina of the germinal membrane of Man.

These united laminæ having become a tube, there occurs in certain sections diminished, in certain others increased growth, by which organs are originated, presenting the appearance of processes, in the one case *towards* (Fig. 15), in the other *from* (Fig. 16) the axis of the tube; these processes having, as their base, either the whole or a part only, of its circumference.

Fig. 15.

Fig. 16.

Some of these processes are in no small degree analogous to each other, and, as is the case with all other organs of a series,—with all animals indeed,—the more alike, the nearer to the period of their origin we view them.

Thus the lungs have been compared to the urinary organs, and the genitals to portions of the alimentary canal.† But having proposed to enter upon general considerations only, we cannot go into the details of comparison.

With this common origin, and therefore coincidence in fundamental and general form, it is not surprising that organs should present analogies. Besides which, there seems, however, unity of plan in proceeding from the general to the special,—a tendency, as said before, to repetition of parts in the several sections of the same tube. Development appears to take the same

* Or in some of the Vertebrata, into a wing, a fin, &c.

In Fig. 10, p. 131 of the former memoir, there was given an ideal transverse section, shewing the structures formed out of the serous lamina of the germinal membrane in the Arthrozoa. There is a remarkable tendency to repetition in the segments of their dermo-skeleton, including that portion of the latter that enters into the formation of the head; and in certain of them the legs insensibly pass into maxillæ. No doubt the same tendency to repetition is universal in the animal kingdom.

† The resemblance is very striking in animals of simple structure, as well, indeed, as in many of the Vertebrata; in which, for example, the oviducts are scarcely distinguishable from parts of the intestine.

general direction in the several sections, with various *particular* directions, according to various particular and proper functions, in their subdivisions.

It appears, then, that unity of plan, which we have seen to direct *general* structure in the animal kingdom as a whole, extends to the *general* structure of an individual organism. Thus particular organs originating in the same lamina of the germinal membrane or tube, of the same organism, may perhaps be compared to individuals of different sexes in the same species.

A great deal of labour seems to have been lost, in endeavouring to find out corresponding parts,—as well in different organisms as in the same organism,—because directed to the examination of *perfect* structures. How much of this labour,—perhaps, too, some octavos,—might have been spared, had due regard been paid to the *fundamental similarity* in structure, and to the identity that exists in the *manner* of development, of two germinal membranes. To a few general and easily understood principles, are referable all analogies,—whether in the same organism, or in different organisms,—as well as all congenital anomalies.

The same remarks are applicable to Classification; which, as already said,* can have no sure basis in structure, as met with in the *perfect* state; when *different* functions, performed by *corresponding* parts of structure, tend to embarrass and mislead. Nomenclature also, depending thus on data that are uncertain, must be fraught with error.

The fact is, that naturalists have begun, just where they should have ended. They have attended to details, but neglected general principles. Instead of analyzing, their process has been one of synthesis. Their attention has been directed to the grouping of the *twigs*,—as if thus they were to find their natural connections, without even looking for assistance towards the branches, or the trunk that gave them forth. But the simile is inadequate; the labour lost, has been greater than even this supposes. For in the *grown tree* of *animal* structure, parts, once essentially the same, not only have diverged in their development, and become elaborated into very different forms,—but, as

* Page 136 of the last Number of this Journal.

said before, perform *very different functions* also. Hence a *positive*, in addition to a negative source of error.

But what other course *could* naturalists have taken? Truly none: their "circumstance" allowed no other. It is only now that a way is beginning to be opened, by which it may by and by be possible to proceed in an opposite direction; viz. from trunk to branches and to twigs.

This, if ever accomplished, must be by means of the *History of Development* or *Embryology*, both human and comparative; a science almost new, and regarding which, there prevails in this country the profoundest ignorance and indifference. The French are in advance of us; but it is to *German* enterprise, industry, and perseverance, that we are indebted for almost every fact known to us on this subject; at least of those brought to light in recent times.* It is to be hoped, however, that ere long this science will begin to obtain, even among ourselves, some degree of the attention which its importance claims.†

If these remarks are not uncalled for, in reference to nomenclature and classification,—they will not perhaps be deemed unworthy of consideration, when applied to a science, in the study of which, nomenclature and classification are but *means*. But independently of these, does it require much penetration to discern, whether it is easier, in the study of *any* science, first to commit to memory isolated facts, and then proceed to arrange them;—or, having first become acquainted with general principles, to trace their applications? In other words, having first

* When St Hilaire proclaimed in France the principle, that zoological research can have no solid basis but in *anatomy*,—and that it is not the organs of the functions in their totality, but the materials constituting these organs, between which, resemblances are to be sought for,—he advanced a most essential step: yet there was still wanting, more regard to *Embryology*.

† Dr Allen Thomson's excellent paper (see vol. ix. and x. of this Journal) we have already noticed.

The recent appearance, too, of a "Sketch of the Comparative Anatomy of the Nervous System, with Remarks on its Development in the Human Embryo"—by John Anderson, M.E.S., 4to, 1837,—shews that there are grounds for such an expectation as is expressed above. We have only just glanced the volume through, but seen enough to say, that it contains many valuable and well-arranged facts, admirably calculated to illustrate the doctrines of the great Meckel and others, published in Germany so many years ago. Had we read this essay before writing the present memoir, some of the facts it contains might have been adduced by way of illustration.

studied structure in its unity,* to follow it out in development, and find the causes of variety to be resolvable into *direction* and *degree*? If the latter method be the easier, *Embryology would incalculably facilitate the study of Comparative Anatomy.*

On the Development of the Decapodes. By H. Rathke. (Communicated in a letter to Prof. Müller.) †

A prize question having last year been proposed by the Natural History Society of Harlem, relating to the development of the ten-footed crustacea, and more especially the crabs, I am induced to offer a few remarks on the subject.

As is already known to you, I formerly endeavoured to prove, in my account of the river-crab, that this animal, when it leaves the egg, is so far perfected in its form, that it has to undergo no farther important metamorphosis until it reaches maturity. Some years afterwards, Thompson advanced the opinion that the *Decapodes* living in the sea, as, for examples, the crabs and even the lobster, leave the egg in a very imperfect state, and that they then present a strong resemblance in this respect to the Zoëa; thus leading to the inference that, if my observations regarding the river-crab were correct, the latter would present a great anomaly among the *Decapodes.* In consequence of this, the Harlem Society, much to the satisfaction of all those who have taken an interest in the history of the development of animals, have been induced to offer a prize for the best account of the circumstances relating to development which are presented by crabs after their departure from the egg. In this state of matters, I wish to say a few words, which may assist in an examination of Thompson's view, and perhaps also furnish hints as to the points that more especially demand attention in the determination of the question.

About three years ago, during my residence, for a spring and a summer, on the shores of the Black Sea, I examined the development of about fourteen species of Crustacea belonging to very different orders; and among others the Eriphia spinifrons, a new species of Palæmon, and a new species of Crangon. During the present year, I continued my investigations at Dantzic by examining the Palæmon squilla. I hope to be able in a few weeks to present to the public the work in which an account is given of all my observations. I found, in regard to all the above-mentioned *Decapodes*, that, at the last period of their uterine life, they possessed just as many tentaculæ—parts of the dentary apparatus—and bones, as the old individuals of the same species; further, that all these organs present the same relative positions, at least in regard to their attachment; and that all these have the same combination and similar forms as in the old individuals. It is only the proportions which, in those parts,

* It is not intended that *human* structure should be thus first learned: an acquaintance with it, obtained in the usual manner, is here presupposed.

† From "*Müller's Archiv für Anatomie, Physiologie, und Wissenschaftliche Medicin.*" 1836.

present not inconsiderable differences in the more advanced embryo and the old individual. Thus, for example, in the Eriphia spinifrons, when it is about to leave the egg, the antennæ are in proportion longer, but the claws shorter and much more slender, than when the animal is grown. Also the tail and the eyes, considered as a whole, are formed long before these crustacea leave the egg, and are similar to the same organs in the fully grown animal—differing only in their proportions. The eyes are in proportion much larger, especially in the Eriphia, in which, during the last half of its uterine life, they attain an enormous size; but, of the two principal parts which can be distinguished in them, it is the outer half or the real eye that is particularly remarkable for its size; as to the tail, it consists, in the more advanced embryo, of just as many segments as in the grown animal, and is provided with a fan, not only in the species mentioned as having long tails, but even in the Eriphia. I cannot distinctly state the number of parts composing the fans of the Eriphia; but in the embryo of the Palæmon squilla the fan consists of five leaf-like portions. With regard to the relations of the dimensions, it appears, as Cavolini formerly remarked of another crab, that the tail of the more advanced embryo, of the Eriphia spinifrons, is much longer than in the grown animal, but still very small, and nearly equally broad, and similarly formed, as in the long-tailed *Decapodes*. In the mere advanced embryo of the Palæmon and Crangon, on the contrary, the tail is comparatively not so thick and fleshy as in the full grown crab of the same species, but still in other respects it is similar. The shield also which, in the full grown individuals, covers the head and the thorax, already exists in the more advanced embryo, and forms on each side a projection which probably covers the gills. I have not, so far as I remember, distinctly seen gills in any embryo of the animals in question—probably because these organs are extremely minute.

Of the internal parts, I have found a heart quite similar to that of the full grown animal in the more advanced embryo of all the above-mentioned crustacea; but a liver, a ganglionic chain, and an intestinal canal, I have seen distinctly, only in the embryo of the Palæmon squilla, for it is only this embryo that can be extracted uninjured from the egg; but still, on account of their small size, I have not been able to examine the parts satisfactorily.

From this description, which, however, is merely to be considered as a rough sketch, you may be able to judge for yourself if the *Decapodes* inhabiting the sea, actually leave the egg in so extremely imperfect a condition as has been represented by Thompson? I do not wish to speak of the internal organs, for of their development I know too little; but as to what concerns the external organs, I must confess that, in my opinion, an Eriphia or a Palæmon leaves the egg in a condition not much less imperfect—that is, in relation to its parents—than a bird. For such a crustaceous animal has, with the exception of the male parts of generation, just as many external organs; and these organs, considered separately, are composed of just as many essential portions, and occur as a whole, and, in their separate parts, in the same relative positions as in the old individual. The form also of each part is of such a description, that in it we can recognise distinctly enough a certain portion of the perfect animal. Probably, however, there is no animal formed in an egg, whose individual externally observable organs, when it leaves the egg, present collectively and separately the same proportions, as they possess in their matured condition.

Slight, or only moderately great deviations in the proportions of the separate external organs, like those (excluding the eyes) occurring in the newly born *Decapodes*, can afford no grounds for our forming such an opinion regarding them as that expressed by Thompson. In perfect specimens of the Astacus Leptodactylus, the tentaculæ of the male in proportion to the body are at least twice as great as in the female, without our concluding that the female is much less perfect than the male. How completely different, on the other hand, are the relations of many lower crustacea in their perfect and in their imperfect condition! All the *Isopodes*, with whose development I am acquainted, come into the world with fewer bones than they exhibit in their state of maturity—the Bopyrus squillarum has three pair less; the *Cyclopes* have no bones when they come out of the egg, and some parts of the dentary apparatus are also awanting; the Lepas and Balani resemble their parents just as little as the *Cyclopes* do when they come out of the egg. These are animals which we can say with justice and reason enter the world in an extremely imperfect condition; but, as to the *Decapodes*, so far as I have examined their development, I must deny such an assertion, and of them I can say nothing less than at the end of their existence in the egg they have exactly the same aspect, and are as fully developed, as the full-grown individuals. No physiologist would make a similar assertion regarding a newly born bird or quadruped.

We certainly remark a considerable difference between the animal when it leaves the egg and an old individual, in reference to the form of the whole body; but this arises from the circumstance of the young one carrying away a considerable quantity of yolk from the egg. The yolk fills up a large, perhaps the largest, portion of the cavities of the body. Hence the greater breadth of the thorax in the matured embryo of the Palæmon and the Crangon; hence the greater thickness of that part of the body in the matured embryo, not merely of the Crustacea, but also of the Eriphia; hence also the circumstance, that in all of them the middle portion of the shield, in proportion to the lateral portions, is very much larger, and relatively also much thinner, than afterwards when the creature attains its full maturity. But birds also take with them from the egg a portion of the yolk, and many of them after creeping out have still a very large belly, yet nevertheless no one would assert that birds come into the world in a very imperfect condition.

The stomach and the liver may perhaps be but little developed when the crab leaves the egg, and the organs of generation may perhaps be entirely awanting; but I cannot believe that Thompson founded his assertion on these organs; for I have seen specimens of five or six species of crabs which carried eggs; but none of the eggs, so far as I remember, were larger than poppy seeds. In newly born young ones of these animals, it would, therefore, have been a difficult task to investigate the relations of the internal organs mentioned above, and which were partly covered with yolk.

In conclusion, I must remark, that I have not been able to procure a sight of the original paper by Thompson; and that I have only seen the abstract of its more important contents which was published in the Isis. Perhaps, therefore, much of what I have stated in this letter is not applicable to the memoir in question; and it may perchance turn out, that, like Don Quixote, I have been fighting against a windmill.

METEOROLOGICAL TABLES,

Shewing the Temperature and Pressure at Clunie Manse, Perthshire, from the Year 1833 *to* 1836, *inclusive.* By the Rev. WILLIAM MACRITCHIE, and Mr GEORGE MACRITCHIE.

1833.	Monthly medium temperature at 10 A. M. adding the columns.	Monthly medium temperature at 10 P. M. adding the columns.	Monthly medium pressure at noon, adding the columns.	Monthly medium temp. at 10 A. M. taking the two extremes.	Monthly medium temp. at 10 P. M. taking the two extremes.	Monthly medium pressure at noon, taking the two extremes.
	°	°	In. L.	°	°	In. L.
January	33	32¾	30.10	31¾	33	29.96
February	39½	37¾	29.25	39	37¾	29.28
March	42	37½	29.83	41¾	38¼	29.57
April	48¾	41¾	29.58	50½	43¼	29.52
May	59	51¾	29.94	58½	52	29.67
June	60¾	53	29.62	60	52½	29.67
July	63¾	55¼	29.88	64½	55¼	29.82
August	61¼	51¾	29.81	61	51	29.78
September	56½	50¼	29.78	58	51	29.67
October	50½	46¼	29.64	50¼	45¾	29.49
November	42	40¼	29.58	39¼	38¼	29.37
December	38¼	36¾	29.33	38	36¼	29.41
Yearly average	49½	44½	29.69	49¼	44½	29.60
1834.						
January	40¼	38½	29.37	40½	39½	29.46
February	40½	38½	29.78	41½	40¼	29.72
March	45½	41	29.90	45½	42½	29.72
April	49¼	42¾	30.11	51	41¾	29.90
May	58¼	49½	29.89	58½	50	29.83
June	61¾	53½	29.78	60¼	54¼	29.77
July	65½	57¾	29.91	66¼	56¼	29.87
August	62¼	55¼	29.74	63¼	53¼	29.77
September	57	50½	29.94	57¾	51	29.87
October	50½	46¾	29.79	49	46	29.75
November	42¾	40¾	29.76	42	39½	29.50
December	39¾	39¼	30.06	38¾	40¾	29.60
Yearly average	51	46¼	29.84	51¼	46¼	29.73
1835.						
January	36½	36	29.81	38¾	36¼	29.74
February	42	38¾	29.42	44	41	29.39
March	44¼	38¼	29.72	45	39¾	29.73
April	49½	43½	29.95	47¼	42¼	29.93
May	53¾	46	29.72	52¾	46¼	29.68
June	62¾	52¾	29.96	63¾	52¾	29.78
July	63	54¼	29.87	63¾	55¼	29.88
August	64	56½	29.90	64	58½	29.80
September	55¾	50	29.49	54¼	48¼	29.56
October	47¼	43	29.58	46½	43	29.43
November	42¾	41½	29.76	43	40¾	29.70
December	38	37¼	29.97	38½	36¾	29.73
Yearly average	50	44¾	29.76	50	45	29.70

TABLE—*continued.*

1836.	Monthly medium temp at 10 A. M. adding the columns.	Monthly medium temp. at 10 P. M. adding the columns.	Monthly medium pressure at noon, adding the columns.	Monthly medium *daily* temp. adding the columns.	Monthly medium temp. at 10 A. M. taking the two extremes.	Monthly medium temp. at 10 P. M. taking the two extremes.	Monthly medium pressure at noon, taking the two extremes.	Monthly medium *daily* temp. taking the two extremes.
	°	°	In. L.		°	°	In. L.	°
Jan.	38	37¼	29.57	36½	38¼	37	29.40	37
Feb.	38¼	36¼	29.63	36	40¼	37¼	29.49	38¼
March	42½	38	29.20	38¾	43¾	40¼	29.25	41
April	47½	40¼	29.68	43	47¼	40¼	29.66	43½
May	59½	48¼	30.22	52¾	60	49¾	30.18	52¾
June	60	52½	29.68	57½	61½	53¼	29.68	57¼
July	60¾	53	29.73	58¼	60½	55¼	29.73	59
August	59½	51¾	29.87	56½	59¼	49½	29.83	55½
Sept.	53½	46¾	29.73	50½	53	45	29.70	49¾
Oct.	47¼	43½	29.61	44¼	43¼	40¾	29.44	41
Nov.	38¾	37¾	29.34	37	40¾	34½	29.34	37
Dec.	38	37½	29.56	36¼	41	36¾	29.47	36¾
Yearly average	48½	43½	29.65	45½	49	43¼	29.60	45¾

Average for the four years.

Years.	Medium temperature per annum, at 10 A. M adding the columns.	Medium temperature per annum, at 10 P. M. adding the columns.	Medium pressure per annum at noon, adding the columns.	Medium temperature per annum, at 10 A. M. taking the two extremes.	Medium temperature per annum, at 10 P. M. taking the two extremes.	Medium pressure per annum at noon, taking the two extremes.
	°	°	In. L.	°	°	In. L.
1833	49½	44½	29.69	49¼	44½	29.60
1834	51	46¼	29.84	51¼	46¼	29.73
1835	50	44¾	29.76	50	45	29.70
1836	48½	43½	29.65	49	43¼	29.60
Average for the four years	49¾	44¾	29.73	49¾	44¾	29.66

Table denoting the Course of the Winds, and the number of Days in which each prevailed.

Years.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1833	16	34	44	38	19	104	46	64
1834	11	33	28	39	28	134	28	64
1835	11	38	42	29	11	113	54	67
1836	23	36	27	22	24	119	61	54
Average number of days	15¼	35¼	35¼	32	20½	117½	47¼	62¼

N.B.—Under N.E. are included all the days upon which the wind blew from any intermediate point between N. and E.; and the same is to be noted with regard to the S.E., S.W., and N.W. columns of the Table.

Table shewing the Quantity of Rain and Snow fallen.

1834.	Fall of rain in inches.	Fall of snow in inches.	1835.	Fall of rain in inches.	Fall of snow in inches.	1836.	Fall of rain in inches.	Fall of snow in inches.
Jan.	4.660	5¼	Jan.	.831	4½	Jan.	2.907	11¼
Feb.	1.712	2¾	Feb.	2.773	3	Feb.	2.239	5¼
March	1.739		March	1.419	6	March	4.387	1¼
April	.831		April	.834		April	1.550	
May	1.378		May	4.395		May	.608	
June	3.812		June	1.067		June	2.438	
July	2.476		July	1.265		July	3.649	
August	2.124		August	2.759		August	1.579	
Sept.	3.410		Sept.	5.145		Sept.	4.847	
Oct.	1.694		Oct.	2.758		Oct.	3.178	3½
Nov.	2.131		Nov.	3.610	¼	Nov.	3.904	
Dec.	3.217	1½	Dec.	1.654	2½	D .	2.780	5¼
Yearly average	29.184	9¾	Yearly average	28.510	16¼	Yearly average	34.066	26½
Average for the three years, .				Rain 30.587		Snow 17½		

N.B.—The quantity of snow which fell in the year 1833 was 9¼ inches;—viz. in January, 1¼; in February, 4; and in December, 4 inches.

Table indicating the General State of the Weather, with the observed Atmospheric Phenomena.

Years.	Sunny days.	Fair days.	Days in which any rain or snow fell.	Solar Halos.	Lunar Halos.	Bright Aurora Borealis.	Remarkable Meteors.	Parhelia.	Lunar Rainbow.	Mock Moons.	Hurricanes.	Remarks.
1833	150	133	232	11	9	7	2	2			2	A very bright meteor on the 3d Aug., at 11 P. M. The *aurora* remarkable on the 12th Oct.
1834	139	148	217	18	6	4		2	1		4	The lunar rainbow on the 12th Oct., at 9 P. M. A fine aurora on the 22d December.
1835	131	151	214	9	6	4		1		1	3	The mock moon on the 10th Oct. at 10 P. M. *Halley's comet* visible this month and Nov.
1836	150	130	236	6	9	15	1	6			5	Remarkable *aurora* in the spring and autumn of this year, particularly on the 22d Feb. and 11th Aug. *Annular* solar eclipse 15th May. Singular mark, sun *above* the sun, 11th Oct., at 3 P. M. A fine meteor, 4th Dec. at 6 P. M. A snow storm, 28th and 29th Oct., not known since 1782.
Average for four years	142½	140½	224¾									

N.B.—These years were remarkable for cold, wet, and tempestuous weather, particularly the last, which was extraordinary for the *lateness* of the season. There was *rime* by the 23d of August. An appearance of aurora borealis was always followed by a continuance of rain and high wind. The thermometer reached 83½° on the 9th June 1835; and the barometer fell to 28.22 at midnight on the 2d February 1833 (it was uncommonly variable in the spring and end of autumn of that year). These were the *extremes* in the four years. It is to be observed that May 1836 was a very dry and sunny month, and that the solar eclipse was seen *without cloud* throughout. The mortality in this neighbourhood during 1836 much beyond an average; the prevalent diseases typhus fever, putrid sore throat, and influenza,—the latter became general towards the end of December. The lowest temperature, 17th January 1835, 18°; the highest pressure, 3d January 1835, 30.58.

Kinfauns Meteorological Table for 1836.

Extracted from the Register kept at Kinfauns Castle, North Britain.
Lat. 56° 23′ 30″.—Above the level of the Sea 150 feet.

1836.	Morning, ½ past 9. Mean height of		Evening, ½ past 8. Mean height of		Mean Temp. by Six's Therm.	Depth of Rain in Garden.	No. of Days	
	Barom.	Therm.	Barom.	Therm.			Rain or Snow.	Fair.
January .	29.465	38.452	29.436	37.226	37.322	3.40	21	10
February	29.500	36.621	29.496	35.448	36.655	1.60	12	17
March .	29.044	40.323	29.066	38.290	39.129	4.35	20	11
April . .	29.533	45.000	29.549	41.033	43.033	1.50	15	15
May . .	30.034	54.613	30.038	50.000	50.516	.88	4	27
June . .	29.495	57.367	29.490	54.200	54.600	3.30	16	14
July . .	29.547	57.774	29.547	53.806	55.839	3.65	19	12
August .	29.665	57.290	29.673	53.806	54.935	1.65	8	23
September	29.531	51.467	29.510	49.133	49.667	4.05	16	14
October .	29.395	45.935	29.419	44.258	45.193	3.60	16	15
November	29.207	40.333	29.191	39.633	39.667	3.50	17	13
December	29.415	39.742	29.416	38.806	38.548	2.40	15	16
Average of the year	29.486	47.076	29.486	44.636	45.425	33.88	179	187

ANNUAL RESULTS.

MORNING.

Barometer. Observations.		Wind.		Thermometer.	Wind.	
Highest,	14th May,......	S.W.	30.28	14th August,......	E.	... 66°
Lowest,	23d Jan.	W.	28.30	31st October,...	N.W.	... 27°

EVENING.

Highest,	31st Dec.	N.	30.31	5th July, ...	E.	... 63°
Lowest,	13th Dec.	S.W.	28.32	26th Feb.......	N.W.	... 23°

Weather.	Days.	Wind.	Times
Fair, ...	187	N. and N.E. . .	42
Rain or snow, . . .	179	E. and S.E. . .	64
		S. and S.W. . .	142
	366	W. and N.W. . .	118
			366

Extreme Cold and Heat by Six's Thermometer.

Coldest, . .	31st October, ...	Wind W.	19°
Hottest, . . .	17th May,................	Do. E.	73°
Mean temperature for the year 1836,		. . . .	45°425

Results of Two Rain Gauges.

	In 100ths.
1. Centre of Kinfauns Garden, about 20 feet above the level of the sea,	33.88
2. Square Tower, Kinfauns Castle, 180 feet, ...	33.17

Abstract of a Meteorological Journal for the Year 1836, *kept at the Elgin Institution.* By Mr Allan, Master.

1836.	9 o'clock A. M.			3 o'clock P. M.			9 o'clock A. M.	Number of days the wind blew, at 9 o'clock, A. M., in each direction, every month throughout the year.												
	Barom.	Thermom.		Barom.	Thermom.															
		Inner.	Outer.		Inner.	Outer.	Rain Gauge.	N.	N.NE.	N.E.	E.	E.SE.	SE.	S.SE.	S.	S.SW.	SW.	W.	NW.	N.NW.
January	29.396	40.3	36.9	29.392	40.9	38.2	2.545	...	...	...	...	...	3	7	9	...	7	2	1	2
February	29.471	39.0	36.1	29.458	39.8	38.5	1.670	...	...	...	...	...	...	2	...	3	13	...	2	9
March	29.006	41.6	39.7	29.064	42.6	42.2	2.085	...	...	...	1	...	...	7	...	3	14	4	1	1
April	29.533	46.1	45.6	29.544	47.2	45.5	2.675	...	...	3	...	...	...	5	2	1	11	2	4	2
May	30.066	54.8	55.3	30.025	55.9	54.7	0.600	...	1	3	1	1	...	...	...	...	5	3	9	8
June	29.548	60.6	61.1	29.490	61.2	61.2	1.230	1	...	2	1	...	1	5	7	...	7	1	2	3
July	29.563	59.3	61.6	29.589	59.7	62.0	2.785	...	1	...	...	...	...	4	3	...	12	2	6	3
August	29.697	57.7	60.8	29.719	58.4	57.5	2.265	...	2	...	...	...	...	2	4	1	10	6	4	2
September	29.609	50.4	51.5	29.563	52.6	53.3	3.480	...	...	...	1	...	...	4	4	...	12	1	1	7
October	29.476	47.9	45.4	29.408	48.8	48.5	4.260	...	...	...	...	...	...	6	3	2	8	3	1	8
November	29.268	41.0	37.0	29.270	41.3	39.5	2.655	...	...	...	...	...	3	...	2	5	16	4	...	...
December	29.455	38.9	36.2	29.483	41.2	37.5	2.870	1	...	...	...	...	1	...	4	2	9	4	10	...
Mean,	29.507	48.1	47.2	29.500	49.1	48.2	29.120 (Sum)	2	4	8	4	1	8	42	38	17	124	32	41	45

The *Barometer*, the *Inner* and *Outer Thermometers*, used for the foregoing Journal of the Weather, are situated in a window fronting the north; and the observations are always taken at times when the sun's rays cannot affect them directly. The *Rain-Gauge* is raised about seven feet above the foundation of the building, and is at such a distance from it, that the rain is not impeded from falling into it from whatever quarter it comes. On inspecting the portion of the Journal allotted to the Register of the Wind, it will be observed that, during the last year, there has been an increase of 23 days above the year 1835 from the SW., the warmest quarter from which the wind blows in this country, making rather more than a third of the whole year. By this it is not intended to maintain, that the weather during last year was more temperate than during the preceding year, or that it is to be regarded as a mild year compared with the generality of years; for it very frequently happened, that the wind, which was in the SW. at nine o'clock in the morning, would before night have been blowing from all the points of the compass. One thing, however, is quite evident, that it is owing to the tendency of the wind to blow from the SW., that our climate is blander than that in the surrounding counties, more especially Banff and Aberdeen.

The mean pressure of the atmosphere is found to be for the last year 29.503. The mean temperature in the shade by two daily observations 48.1. The mean monthly depth of rain 2.426. There is an increase of 5 inches of rain above the former year's amount.

State of the Barometer, Thermometer, &c. in Whitehaven for the Year 1836.

1836.	Barometer.				Thermometer.						Pluviameter.		Prevailing Winds.	No. of Rainy Days.	No. of Snowy Days.	No. of Stormy Days.	Thunder and Lightning.
	Max.	Min.	Mean.	Range.	Max.	Min.	Mean.	Range.	Mean Increase of Temperature.	Mean Decrease of Temperature.	Rain.	Snow.					
	Inches.	Inches.	Inches.	Inches.							Inches.	Inches.					
January	30.35	28.76	29.631	1.59	49.0°	20.8°	38.843°	28.2°		1.245°	3.589	0.544	W.SW.	27	5	12	3
February	30.26	28.76	29.638	1.50	48.7	23.5	37.775	25.2		1.068	1.503	2.123	SW.	17	5	4	3
March	29.96	28.74	29.243	1.22	55.5	30.0	40.611	25.5	2.836°		4.673	1.069	SW.	26	5	13	2
April	30.23	28.99	29.690	1.24	55.5	30.2	44.203	25.3	3.592		2.939	...	NE. & SW.	18	0	3	0
May	30.38	29.80	30.101	.58	70.0	33.5	51.493	36.5	7.290			0.010	NE.	1	0	2	0
June	30.12	29.25	29.698	.87	75.7	46.0	57.551	29.7	6.058		6.642		SW.	19	0	1	2
July	30.15	29.25	29.757	.90	79.5	49.0	58.981	30.5	1.430		7.146		SW.	22	0	2	1
August	30.16	29.34	29.833	.82	74.5	40.5	57.172	34.0		1.809	5.886		NW.	14	0	3	1
September	30.11	29.18	29.745	.93	66.0	37.5	53.041	28.5		4.131	6.399		NE.	18	0	0	1
October	30.23	28.75	29.606	1.48	63.5	26.0	50.808	37.5		2.133	3.985	0.064	S. & SW.	20	2	7	0
November	29.85	28.87	29.384	.98	52.3	28.0	42.473	24.3		8.335	6.150		SW. & W.	26	0	7	0
December	30.35	28.82	29.603	1.53	52.0	15.2	38.896	36.3		3.577	6.036	0.217	SW. & NE.	22	7	6	0
Means, &c.	30.179	29.042	29.661	1.13	61.85	31.68	47.653	30.16			54.948	4.027	SW.	230	24	60	13
											4.027						
											58.975	Total quantity of Rain and Snow in 1836.					

The atmospheric pressure in the above Table is found by means of observations made three times each day, namely, at 9 A. M., 2 P. M., and 10 P. M. The temperature is observed by a good Six's thermometer, freely exposed to the air in a northern aspect, about six feet from the ground, and protected from direct radiation. The temperature was noted three times each day, but the mean is calculated from the two daily extremes. The diameter of the Pluviameter is eight inches, and each day is accounted rainy in which the 1–1000 part of an inch has fallen. With respect to the wind, the prevailing point for the day is taken.

Description of several New or Rare Plants which have lately Flowered in the Neighbourhood of Edinburgh, chiefly in the Royal Botanic Garden. By Dr Graham, Prof. of Botany.

March 10. 1837.

Begonia platanifolia.

B. *platanifolia;* fruticosa; foliis subæqualiter reniformibus, lobatis serrulato-denticulatis, utrinque hispidis, subtus purpurascentibus, lobis acutis; stipulis ovatis, acutis, rigidis, demum marcescentibus.

Begonia platanifolia, *Schott.—Sprengel,* Syst. Veget. c. p. p. 407.

Description.—*Stem* erect, robust, of rapid growth (in our specimens from 2½ to 5½ feet high) round, joints slightly swollen, and marked with rings from whence the stipules fell, slightly spotted, glabrous, shewing little disposition to develop branches, unless the top be injured. *Leaves* (8–10 inches across the greatest diameter) alternate, petiolate, reniform, nearly equal at the base, lobed, hispid on both sides, dark green above, paler and becoming purplish below, especially on the ribs, which are strong and prominent; lobes acute, contorted, serrulato-denticulate, and in the interstices between the teeth crenulate aud ciliated; petioles (2–3 inches long) nearly round, slightly flattened above, erect; stipules opposite, intrafoliaceous, ovate, acute, involute, herbaceous, rigid, marcescent. *Cymes* axillary, on peduncles as long as the petioles, dichotomous, bearing always a flower in the cleft, fully developed only after the leaf from the axil of which it springs drops, branches slightly hairy, spreading like a fan. *Male flowers* (there are no others on the only two specimens which have flowered with us) 4-petalous, nearly white, very large (2 inches across); petals very unequal, the larger rotundato-ovate, the smaller spathulato-linear. *Stamens* numerous, connected only at the base, filaments slender, connective thick and clavate, anther-cells small, on the outside of the connective, and towards its edges. I am much inclined to think that this is a diœcious species, and that the male plant only is in cultivation.

We received this large and handsome species at Edinburgh from Berlin in 1834, but the plants did not grow vigorously, nor flower till the end of last year, when our increased accommodation at the Botanic Garden enabled us to give them greater stove heat.

Clianthus puniceus.

C. *puniceus;* fruticosus, diffusus, glaber; foliolis alternis, oblongis, subemarginatis; racemis pendulis multifloris; calyce 5-dentato; legumine glabro.

Clianthus puniceus, *Soland.* MS. in Mus. Britt.—*All. Cunningham,* in Hort. Trans. vol. i. N. S. p. 521. t. 22.—Bot. Reg. 1775.

Donia punicea, *Don's* Gen. Syst. of Gardening, 2. 468.

Description.—*Stem* shrubby, round. *Bark* cracked, but otherwise smooth. *Branches* diffused, green, glabrous, slightly angled. *Leaves* alternate, pinnated with an odd leafet; common footstalk, round, with slender furrow above, tapering to the apex; pinnæ 10–12 pairs, subsessile, alternate towards the apex of the leaf, subopposite below, largest in the middle, oblong, subemarginate, minutely mucronate, opaque green and glabrous above, paler and with minute adpressed pubescence below, edges slightly revolute, middle rib channelled above, prominent and rounded below. *Racemes* axillary, pendulous, many-flowered; lower flowers expanded first, flexuose common peduncle and pedicels green, and slightly pubescent, each pedicel springing from the axil of a small green ovato-lanceolate spreading bractea, and with two subopposite bracteolæ in the middle. *Calyx* campanulate, green, its mouth somewhat oblique, with five subequal deltoideo-subulate adpressed teeth. *Corolla* of nearly uniform red, and becoming livid in fading, very handsome, but the whole raceme is less so than it otherwise would be, in consequence of the gradual elongation of the pedicels, being disproportionately greater than the rachis, by which the whole forms a dense and confused ovate mass. Vexillum ovato-acuminate, reflected from near its base, slightly striped with white near its centre, somewhat callous at the claw. Alæ about half as long, narrow, oblongo-sickle-shaped, with a callous colourless curved claw, and a tooth on its upper edge of nearly similar texture, but shorter. Carina as long as the vexillum, nearly colourless on its inside in the lower half, monopetalous, with colourless undivided claw, and short blunt tooth on the edge on each side, acuminate, curved forwards. *Stamens* 10, diadelphous, filament colourless; anthers uniform, oblong, yellow; pollen granules minute, golden coloured, shining, round. *Pistil* green, as long as the keel, and closely wrapped up in it; germen glabrous, furrowed along its upper edge; style covered with long simple white hairs in a line along its upper side, and extending nearly to its middle; stigma small, terminal, capitate. *Ovules* numerous, crowded. " The flowers are succeeded by brownish-black *pods*, 2½ inches long, seated on a slender stipe, and convex on the upper instead of the lower edge; so that unless attention be given to the manner of growth, it would seem as if the seeds grew to the lower instead of the upper edge. They are covered all over with a delicate cottony down, in which lie the small kidney-shaped seeds, of a dull yellowish-ochre colour, mottled with small dark brown blotches and speckles."—*Hort. Trans.* l. c.

We received at the Botanic Garden, Edinburgh, this very handsome plant from Mr Low of Clapton-nursery in 1835. It has been cultivated both in the open ground and in the greenhouse. In the former it lives, but unfortunately does not thrive, and will never be ornamental, unless perhaps on a good wall, and well protected in winter. In the latter situation it is most luxuriant, but has produced no fruit. It flowered first in February 1837, and will probably produce a long succession of blossoms.

Datura guayaquilensis.

D. *guayaquilensis;* herbacea; foliis ovatis, subacutis, basi inæqualibus, integerrimis, obsolete sinuatis, utrinque glanduloso-pubescentibus; corolla infundibuliformi, lobis quinque dentibus hamatis alternantibus; capsulis muricato-spinosis, pendulis.

Datura guayaquilensis, *Kunth*, Synopsis Pl. Æquinoct. 2. 151.—*Spreng.* Syst. Veget. i. 627.—*Loiseleur Deslonchamps,* in Dict. des Sciences Nat. 12. 531.

Description.—*Root* annual. *Stem* (3 feet high) herbaceous, erect, round, unequally dichotomous, slightly reddened, densely covered with soft glandular pubescence of unequal length. *Leaves* (9 inches long, 4½ broad) petiolate, ovate, obscurely sinuate, very unequal at the base, one or two of the lower ones only, and those on the young plant, being generally equal, subacute, glanduloso-pubescent on both sides, bright green above, paler below, strongly veined, the veins prominent behind; petioles round, with a groove above, half as long as the leaves. *Flowers* in the clefts of the stem, erect, peduncled; peduncle (1 inch long) round, stout, erect, becoming cernuous as soon as the flower fades. *Calyx* (3 inches long) green, covered with pubescence similar to that on the leaves, 5-toothed, the teeth unequal, acute. *Corolla* twice as long as the calyx, funnel-shaped, with minute glandular pubescence, white in the upper half, green in the lower, plicate; tube strongly ribbed; limb erect, 5-lobed, lobes subacute, at the bottom of each of the shallow sinuses between the lobes a rib is projected in form of a tooth, green, and hooked inwards. *Stamens* as long as the tube; filaments adherent to about two-thirds of the tube, glabrous; anthers erect, white; pollen cream-coloured, granules minute, spherical. *Pistil* shorter than the stamens, colourless;

style filiform, glabrous; stigma spathulate; germen densely muricated, seated on a 5-lobed, white, glabrous *disk*. *Fruit* pendulous.

This species grows abundantly in moist places on the shores of the Pacific near Guayaquil, where it blossoms in February and March. It was raised by Dr Neill in his garden at Canonmills, near Edinburgh, from Peruvian seeds sent by Mr Tweedie, and flowered in his stove in October 1836.

Lopezia hirsuta.

L. *hirsuta;* caule fruticoso, piloso, subtereti; foliis ovatis, sparsim dentato-serratis, pilosiusculis.

Lopezia hirsuta, *Jacq.* Coll. 5. p. 5. t. 15. f. 4.—*Vahl,* Enumer. 1. 3.—*Willd.* Enumer. 7.—*Roem. et Sch.* 1. 34.—*Spreng.* Syst. Veget. 1. 16.—*DC.* Prodr. 3. 62.
Lopezia Mexicana β hirsuta, *Willd.* Spec. Pl. 1. 18.
Lopezia racemosa β hirsuta, *Pers.* Synops. 1. 4.
Lopezia pubescens ? *Kunth.* Synops. 3. 390.

Description.—*Stem* erect, shrubby, hairy; bark brown, green on the twigs. *Branches* numerous, spreading at right angles to the stem, decussated. *Leaves* petiolate, ovate or ovato-lanceolate, of lively green, with slight pubescence, chiefly on the veins below, distantly tooth-serrated, towards the flowers rather more entire. *Flowers* solitary, axillary, in pseudo-spikes towards the extremities of the branches. *Peduncles* longer than the petioles, spreading, filiform, pubescent. *Calyx* segments linear, reflected, reddish-brown, greenish on the outside and at the apex. *Petals* pale, orange-red, brighter and darker towards the middle, spathulate, the outer broader, and somewhat falcate, the inner geniculate. *Fertile stamen* projecting from the centre of the flower, shorter than the petals; filament dilated in the lower half, and concave; anther oblong, cleft below; *barren stamen* petal-like, reflected, emarginate, its sides folded forwards, more orange-coloured than the petals. *Pistil* shorter than the fertile stamen; germen green, globular, style clavate; stigma terminal.

We received this plant from Berlin in 1836, under the name of *Lopezia frutescens*, from which, however, it differs in its very hairy stem. Fearful of adding unnecessarily to specific names, I have considered it the same as the *L. hirsuta* of Jacquin; though its decidedly shrubby stem, certainly not annual root, its spathulate, not linear, central petals, and its much less hairy leaves than those represented in Jacquin's figure, leave me in some doubt as to its identity. It possesses little beauty, and will probably require protection in the greenhouse, where it flowered with us in February 1837.

The *L. hirsuta* is said to have been introduced into cultivation in Britain, in 1796, and is called in our catalogues biennial. I have not observed it in any collection.

Proceedings of the Royal Society of Edinburgh.

1836, *December* 5.—Sir Thomas M. Brisbane, Bart., President, in the Chair. The following Communications were read:—

1. On an Arrangement of the Planets and Satellites, according to their Distances and Masses. By John Paterson, Esq. Schoolmaster of Douglas.

The author has suggested an empirical law, which seems to him to regulate the arrangement of the planets and satellites. Bode long ago proposed an empirical law, which he thought regulated the distances of the planets from the sun; namely, that their distances form a series, increasing by the successive powers of the number 2. Mr Paterson has propounded another similar law, in regard to their sizes; namely, that throughout the planetary system there is a regular alternating increase and decrease in size, as the planets increase in distance from the sun, or the satellites from the planets they accompany: that there is a progressive increase from the first to the third, a decrease from the third to the fifth, an increase, again, from the fifth to the seventh, and again a decrease from the seventh to the ninth. He illustrates this supposed law by referring to the respective masses of the planets, and of the satellites of Jupiter and Saturn; and he observes, that, in order to bring the whole solar system under the law, it is necessary that two new planets be still discovered between Mars and Jupiter.

The law thus conceived to exist, is deduced empirically alone; no reason is assigned why it ought to be observed in the constitution of the solar system.

2. Notice regarding the Composition and Properties of certain Concrete Juices, resembling Gamboge. By Dr Christison.

This notice is intended as a supplement to the observations read last session by the author, on the composition and sources of the different kinds of Gamboge. It is well known that Linnæus referred gamboge to the *Garcinia cambogia*, Willd.; and others have supposed that a kind of gamboge is also produced by the *Xanthochymus pictorius*. Both are natives of Ceylon, where, as appears from the former investigations of the author, a substance is produced almost or absolutely identical with Siam gamboge. It appeared, however, from the inquiries of Dr Graham, read before the Society last session, that this Ceylon gamboge is produced by an undescribed species of tree, and not by either of the species just mentioned.

Dr Christison has now been enabled to add to this investigation an account of the composition and properties of the concrete juices of the *Garcinia cambogia* and *Xanthochymus pictorius*, which were transmitted from Colombo by Mrs Colonel Walker. These concrete juices, which were sent attached to the barks that produced them, differ from gamboge in having a much paler yellow colour, and not being at all emulsive. That of the *Garcinia cambogia* also differs in not being at all purgative, at least in doses three or four times as great as the customary doses of gamboge; and its colouring resin possesses only a tenth part of the intensity of the colour of true gamboge resin. Farther, both the concrete juices in question differ essentially from gamboge in composition, in so far as both contain proportionally less gum, and one of them contains some volatile oil. Their composition was found to be as follows:—

Resin	66.0	76.5
Arabin	14.0	17.6
Volatile oil . . .	12.0	0.0
Accidental fibre . .	5.0	5.9
Loss, probably volatile oil,	3.0	0.0
	100.0	100.0

The author farther announced that Dr Graham had been lately enabled to determine, with the assistance of Dr Brown, certain points which he had left undecided in his paper of the previous session, on the botanical source of true Ceylon gamboge. It now appears, that the specimen from which Murray of Göttingen established his *Stalagmitis gambogioides*, and which is still preserved in the Banksian Herbarium, is in reality a patched one, consisting, probably, of the *Xanthochymus ovalifolius* and of the true plant. Dr Graham has therefore felt no hesitation in attaching to Mrs Colonel Walker's specimens a new generic name, derived from the dehiscence of the anthers, namely, *Hebradendron*. He has retained the old specific name *Gambogioides;* and he has been enabled to add to the new genus a second species, *H. ellipticum*, found by Dr Wallich in Sylhet, and supposed by that botanist to be a *Garcinia*.

3. Farther account of indications of Changes in the relative Levels of the Sea and Land. By James Smith, Esq. of Jordanhill.

The new localities in which the author has found alluvial deposits containing marine remains, occur on both sides of the river Clyde, in Loch Ryan, in the island of Skye, and on the east and west coast of Ireland. Near Glasgow, and in the county of Limerick, sea-shells were found about 80 feet above the level of high water. In the vicinity of Dublin the marine deposit was upwards of 200 feet above the sea. Mr Smith considers that indications of this change of level will be found on every part of the coasts of the British islands. The deposit belongs to the newer pliocene of Lyell. The shells, of which about seventy different species have been collected, agree in general with those now existing in the

British seas. There are, however, some of them which appear to have become extinct, or at least are not known upon our coasts.

December 19.—Dr HOPE, Vice-President, in the Chair. The following Communications were read :—

1. Observations on Terrestrial Magnetism made in different parts of Europe, especially with reference to the influence of Height. By Professor Forbes.

These observations have reference chiefly to the intensity of the earth's magnetism, and were made for the most part with Hansteen's apparatus, in the possession of the society.

The *first* section of the paper refers to the method of making the observations, which is nearly that of Professor Hansteen.

The *second* refers to the corrections applied. These are—1. for the rate of the chronometer; 2. for reduction of the vibrations of the intensity needles to infinitely small arcs; 3. for the effect of temperature in diminishing the magnetism of the needles, which was determined for each by direct experiment; 4. for changes in the earth's magnetism; 5. for progressive changes in the needle's magnetism, which were considerable for one of the Hansteen needles, but for the other very small.

The *third* section contains tabular views of the results obtained from different series of observations, but particularly from one series made in the central chain of Alps in 1832, and another in the Pyrenees in 1835. The horizontal intensities at several detached points, as Edinburgh, Brussels, and Paris, were also ascertained; that at Edinburgh is expressed by .840, Paris being 1.000.

In the *fourth* section, the results are grouped and analyzed, the Alpine series being first taken, and the relations of the intensities determined with respect to latitude, longitude, and height. The same was done for the Pyrenean observations; the results being not merely graphically deduced, but actually calculated from as many equations of condition as there were stations, by the method of least squares. The following numbers were obtained :—

	ALPS. By Needle No. 1.	ALPS. By "Flat" Needle.	PYRENEES. Both Needles.
Variation of intensity for 1′ of latitude, N increasing, .	—.000364	—.000505	—.000210
Variation of intensity for 1′ of longitude, E increasing,	+.000055	+.000106	—.000100
Variation of intensity for 100 of height, . . .	—.000033	—.000027	—.000053

Of these results, those obtained in the Alps, and by needle No. 1, are the most trust-worthy. From the variation due to latitude and longitude, the direction of the isodynamic lines is easily found. In the Alps, they form an angle of about 78° with the meridian, to the E. of north, nearly coinciding with the geological axis of that part of the chain. The results in the Pyrenees are of a more doubtful character, the observations having been made over a very small area of country, and exhibiting some anomalies. They would appear to indicate a direction from N. of W. to S. of E., which coincides with the mineralogical axis, and does not agree with Hansteen's map.

With regard to the effect of height, the author first considers the evidence already brought to bear on the subject, which he considers as almost quite inconclusive, from the imperfect nature of the data, and the limited extent of the induction. The result at which he has arrived as the most probable, from the combination of all his experiments, is a diminution of $\frac{1}{1000}$th part of the intensity for 3000 feet of ascent; a quantity so small, that it can only be expected to be discovered by combining a great many observations. The sum of the heights of the stations to which he has carried the Hansteen apparatus, amounts to above 160,000 feet, or 30 vertical miles.

In the *fifth* and last section of his paper, the author quotes his observations on magnetic dip, which he has determined (with a small instrument) at a considerable number of points; and by combining the results in the same manner as before, he has endeavoured to approximate to the position of the lines of equal dip in the Alps.

2. Notice respecting a New Reflecting Microscope. By Mr Guthrie.

Mr Guthrie modifies Amici's microscope, by removing altogether the plane speculum, and placing the object to be viewed in the axis of the tube. This arrangement is to the microscope what Sir W. Herschel's is to the reflecting telescope. In order that the object may be properly illuminated, the part of the tube next the mirror is wholly removed, and three pillars substituted for it, to one of which the stage for the object is attached, and regulated by an adjusting screw.

Some observations were made by Dr Martin Barry on Unity of Structure in the Animal Kingdom.

1837, *January* 2.—Dr Abercrombie, Vice-President, in the Chair. The following communications were read:

1. On Tea Oil. By Robert D. Thomson, M.D.

A species of fixed oil, familiarly used in China for the same economical purposes for which olive oil is employed in Europe, has been ascertained by recent travellers in China to be produced in all probability by the tea-plant, or another species of the same natural family. The author assigns reasons for believing that it either is, or may be, obtained from the seeds of various species of the two genera *Thea* and *Camellia*. It has been hitherto almost unknown in Europe. It is when fresh quite free of smell, of a pale yellow tint, without any sediment when long kept. It resists a cold of 40° F., but at 39° becomes like an emulsion. Its density is 927. It is insoluble in alcohol, sparingly soluble in ether. It burns with a remarkably clear white flame. It consists of 75 parts of elaine, and 25 of stearine; whence the author infers its elementary composition to be, oxygen 9.853, carbon 78.619, hydrogen 11.527. He is inclined to think that this oil might prove an important article of commerce in the East, because in its properties it is superior to cocoa-nut oil, and the various other oils prevalently used for burning, or as oleaginous condiments, in Asiatic countries.

2. Observations on a New Species of British Gurnard, and on a New Species of Sole. By Richard Parnell, M.D.

3. On Aplanatic Telescopes, a posthumous paper by the late Archibald Blair, Esq.

January 16.—Sir Thomas M. Brisbane, President, in the Chair. The following Communications were read:

1. On the Condition of the Earth, as it is first described in the Mosaic Account of the Creation. By Mungo Ponton, Esq.

In this paper, the author confined his attention principally to those words of the original, which, in the received translation, are rendered "without form and void." He considered that, in a philological point of view, the most correct translation is "vastness and emptiness," or, in the adjective form, "immeasurable and imponderable."

The bearing of the most recent philosophical discoveries, and of the opinions of natural philosophers and geologists, upon the interpretation of this passage, formed the next subject of inquiry. It was stated that there are three prevailing opinions in regard to the Mosaic account of creation, arising out of three different views with respect to the period when those strata were formed which contain organic remains. One opinion is, that these strata were formed at a period altogether antecedent to the events described in the second and succeeding verses of Genesis. A second opinion is, that the strata were formed during the very epoch embraced in the Mosaic narrative; and a third, that they were formed subsequent to that epoch. In both of the latter views, the description of the state of the earth is considered as applicable to its original condition when first created. The author seems to lean to the second opinion, and infers that the primitive condition of the earth was probably gaseous.

2. On the Result of Experiments on the Weight, Height, and Strength, of above 800 individuals. By Professor Forbes.

These experiments were made upon students in the University of Edinburgh, chiefly between the ages of 14 and 25, and were intended to illustrate the general inquiry as to the law of physical development with age, but more particularly to afford data for instituting comparisons between different nations. For this purpose, throughout these experiments, natives of Scotland, England, and Ireland, were distinguished; and though the numbers belonging to the two latter countries were comparatively small, still the general coincidence of results, as to the three elements of weight, height, and strength, gives some confidence even in that part of the inquiry.

The weights were expressed in pounds including clothes; the heights in inches, including shoes; the strength was determined in pounds by Regnier's dynamometer.

All these data for different ages were expressed by projection upon ruled paper, and interpolating curves used to deduce the mean results, which were then tabulated. A comparison was instituted with M. Quetelet's conclusions, from experiments on a similar class of individuals in Belgium. The following deductions were made:

1. That, in respect of weight, height, and strength, there is a general coincidence in the form of the curves with those of M. Quetelet.

2. In Britain, the progress towards maturity seems greater in

the earlier years (14 to 17) than in Belgium, and slower afterwards. This seems more strongly indicated in the English than in the Scotch curves.

3. The superior physical development of natives of this country above the Belgians is very marked. In strength it is greatest ($\frac{1}{5}$th of the whole); in height least.

4. So far as the English and Irish curves can be considered as correct, they indicate that the English are the least developed of the natives of Britain at a given age, the Irish most, the Scotch retaining an intermediate place.

5. The maximum height is barely attained at the age of 25.

6. All the developments increase during the period of observation (14 to 26 years of age), and all increase *more* slowly as age increases. Hence the curves are all convex upwards, (the abscissæ or ages being projected horizontally).

3. Description of a Single Achromatic Eye-Glass. By Edward Sang, Esq.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Solar Radiation.*—Sir John Herschel, in a communication to M. Arago, says, that the solar radiation is greater in tropical than in temperate countries. Thus, that, by means of his actninometer, he found the solar radiation at the Cape of Good Hope to be 48$\frac{3}{4}$°, while in Europe the maximum of the direct solar radiation does not exceed 29$\frac{1}{2}$°.

2. *Lunar Halo.*—I started one night in December from Port Louis to walk across to the military post at Flacq, and my path lay for several miles through a very wild district, along what had originally been a road, but the rapidity of tropical vegetation, and a *coup de vent*, had made it in several parts difficult to be recognised, and especially on the night in question, as the moon was not high, and the trees, occasionally of magnificent dimensions, spread a deep shade around for several yards. I was picking my way along a space rather less inclosed than that through which I had already come, endeavouring to keep the beaten track, that my boots, already nearly saturated, might imbibe as little as possible of the dew, and listening, because I

could not help it, to the Cicada, which sent forth a note that seemed to leave no cranny unexplored, when I was startled by catching, at a side glance, a brilliant halo of light surrounding the shadow of my head. I turned quickly round to examine it, and found that it proceeded from the moon's light reflected by the dew-drops, clustering thickly on every blade of grass. It appeared to me singularly interesting. I felt continually disposed to watch it, and regretted, when I struck into the great road, that it and I had parted company. It seemed to me too, as I walked along, that I occasionally got a glimpse of a much larger and fainter circle, concentric with the other, but this only for a few paces, and it appeared to me plainer when not looked directly at. Since my return to England, I looked, but looked in vain, for this companion of my walk; there wants the clear brilliancy of tropic moonlight, and the vast copiousness of dew in this less favoured climate.—*Communication.*

3. *Connection between Meteorology and Vegetation.*—M. Boussingault has addressed a note to the *Academie des Sciences* of Paris, which is entitled, *Comparative examination of the Meteorological circumstances under which our common grains (the Cerealia), Turkey-wheat (Maize), and potatoes, vegetate at the Equator, and in the Temperate Zone.*—In this examination the author has first made investigations into the time which elapses between the first springing of the plant and its full maturity. He then determined the temperature of the space of time which separates these two extreme epochs of vegetable life. By comparing these data concerning any given plant which is cultivated both in Europe and America, he arrives at this curious result: That the number of days that separates the commencement of vegetation from its maturity, is more considerable in proportion as the mean temperature, under the influence of which the plant grows, is less; the duration of the vegetation will be equal, however different the climate may be, if this temperature is identical in the two places; and it will be shorter or longer according as the mean heat of the period of time necessary for the accomplishment of the vegetation, is itself greater or less; in other words, the duration of the vegetation appears to be in the inverse ratio of the mean temperatures. So that if you multiply the number of days during which any given plant vegetates in these distinct climates, by the mean temperature of

the actual period of its vegetation, you will obtain numbers which are very nearly equal. This result is not only remarkable, inasmuch as it seems to indicate that, under all climates, the same annual plant receives, in the course of its existence, an equal quantity of heat; but it leads also to a direct practical result in enabling us to decide upon the possibility of introducing any particular vegetable into a country, as soon as we know the mean temperature of the months there.

4. *Climate of Scandinavia.*—Mr Forsell, in his very valuable work on the Statistics of Sweden, gives a short but interesting view of its physical characters. Nature, says the Athenæum, in many regions holds despotic sway, compelling man to remain a savage; even where human industry has broken this bondage, and civilization has reached its greatest height, it is surprising to what an extent the character of the people derives its peculiar form and complexion, from the natural circumstances in which they are placed. The Scandinavian peninsula, comprising Sweden and Norway, has an extent of 6652 Swedish (or 292,700 English) square miles, inhabited by little more than four millions of people. Of that extent the larger share, or 170,240 square miles, belongs to Sweden, the remainder to Norway. In the form of its relief, the peninsula resembles a huge billow, rising gradually from the east, and then, having formed a crest, falling precipitously towards the west. The crest and abrupt aspect of the rocky wave, therefore, lie almost wholly in the Norwegian territory. More than a third of the peninsula has an elevation exceeding 2000 feet above the sea, and 3696 English square miles of its surface are above the limits of perpetual snow, but the greater part of this snowy region (nearly 3000 square miles) is in Norway. In Sweden, on the other hand, one-third of the country has a less absolute elevation than 300 feet, while little more than a twentieth part of its surface lies at a height exceeding 2000 feet above the sea. Thus Sweden, contrasted with Norway, or considered merely in respect to its superficial configuration, seems favoured by nature; but stretching as it does from Lat. 54° N., through sixteen degrees of latitude (1100 miles) northwards, far within the polar circle, the greater part of the kingdom lies too near the confines of perpetual winter. Between North Cape, where the winds are so violent that the inhabitants are obliged

to construct their humble dwellings in pits dug on purpose, and Schonen, or the southernmost district of the peninsula, there is a great diversity of climate; but in the most favoured situations, as at Lund in Schonen, the mean temperature of the year does not exceed 45° Fahr.; while at North Cape, on the sea-shore, it is at the freezing point; and at places distant from the ocean, as at Enontekis, 150 miles farther south than North Cape, and 1470 feet above the sea, the mean temperature of the year is four or five degrees below the point of congelation. The extreme cold of winter is modified throughout the peninsula by the proximity of the sea and the elevation of the place, in each instance, as much as by the latitude. In Stockholm, which, owing to its insular situation, enjoys a comparatively mild climate, the thermometer frequently descends in winter to 28° below zero. A hundred miles north of that city (or beyond the 60th parallel), the mercury in winter freezes in the tube of the thermometer, indicating a degree of cold exceeding —40°. We must altogether pass over the interesting details furnished by Forsell, illustrative of the dependence of temperature on latitude and elevation, and content ourselves with a hasty glance at the zones of vegetation observed in the Scandinavian peninsula. At North Cape, Lat. 71°, potatoes, broccoli, and gooseberries, are reared with some difficulty. One degree farther south, at Alten (70°), a little barley makes its appearance. At Enontekis (68° 30′) the crops barley and bear yield a remunerating harvest, on an average, once in three years. Rye and hemp cannot be successfully cultivated beyond the 66th, nor oats beyond the 64th parallel. This latter is also the general limits of garden cultivation. The cherry-tree, alder, and maple, cease to thrive beyond the 63d, the ash and the willow at the 66th, the elm, lime, and oak, at the 61st parallel. The natural beech-woods of Sweden do not extend beyond Lat. 57°. Finally, the mulberry, the chestnut, and the walnut, arrive at perfection in Schonen (54°), at the southern extremity of the peninsula. On the coasts of Norway, vegetation is less curbed by the rigours of winter than in corresponding parallels on the shores of the Baltic; and, according to Mr Laing, pears, plums, and sometimes even chestnuts, ripen in the neighbourhood of Molde, 62° 47′ north latitude.

5. *On the Temperature of Greenland.*—During the eleven years M. Müller has resided in Greenland, he has only twice heard the sound of thunder, which, repeated by the echoes of the mountains produced, according to him, a most extraordinary and unusual noise. At Frederikshaab the temperature of the only spring which existed in the neighbourhood, and which is about half a mile east from the establishment, is 37° Fahr., whilst that of the atmosphere is 41°. This spring, which is on all sides surrounded with snow, forms a nearly circular basin, from nine to ten feet in circumference, and is about two feet deep. The temperature of the Greenland huts, during summer, varies from 47° to 54° Fahr., according to the number of inmates, and as the lamp is lit or otherwise. The temperature in the open air was 43°. The height of one of the highest ice-mountains or islands seen by the *Recherche*, was found by calculation to be 167 feet: it probably had a double base.

6. *Rapid Fall of the Barometer during the late violent gale on Monday the 19th February 1837 at Edinburgh.*—The following results seem to be remarkable for this latitude.

A. M.	Barom.	Exter. Ther.	Wind.	
9h.	29.13	38	S. W.	Moderate breeze; rain.
10h. 20′	28.86	40	S.	Violent gale which began 10′ ago.
10h. 35	28.80		S.	Still violent gale.
11h. 5	28.70	41	S.	Do. do.
11h. 45	28.75		S.	Violent squall, with sleet.
P. M.				
12h. 40	28.72	40	S.W.	Wind somewhat fallen.
1h. 40	28.69	46	S.W.	Do. do., but still brisk gale.
11h. 30	28.9			Loud peal of thunder and flash of lightning about 11 P.M.; ground partially white from snow or hail.

Thus in the first hour and quarter the barometer fell .27 of an inch; in the next quarter of an hour .06; and in two hours and three quarters from nine o'clock the fall was .43. The barometer observed is about seventy feet above the level of the sea by barometric measurement.—*A. Connell.*

7. *Red-coloured Sea.*—On the 12th of March (to the north of Cape Pilaris, in South America), precisely at noon, we were not a little alarmed by a considerable noise upon deck, and by the order immediately to lie-to. The dirty red colour of the sea had produc-

ed the very reasonable suspicion that we were upon a shoal. However, upon sounding, there was no bottom with 130 fathoms. From the topmast, the sea appeared, as far as the eye could reach, of a dark red colour, and this in a streak, the breadth of which was estimated at six English miles, and which here and there spread into short side branches. As we sailed slowly along, we found that the colour changed into a brilliant purple, so that even the foam, which is always seen at the stern of a ship under sail, was of a rose colour. The sight was very striking, because this purple stream was marked by a very distinct line from the blue waters of the sea; a circumstance which we the more easily observed, because our course lay directly through the midst of this streak, which extended from south-east to north-west. The water, taken up into a bucket, appeared indeed quite transparent; but a faint purple tinge was visible when a few drops were placed upon a piece of white china, and moved rapidly backwards and forwards in the sunshine. A moderate magnifying glass proved that these little red dots, which, with great attention, could be perceived with the naked eye, consisted of *infusoria*, which were of a spherical form, entirely destitute of all external organs of motion. Their very lively motions were only upward and downward, and always in spiral lines. The want of a powerful microscope precluded a more minute examination; and all attempts to preserve some of the animals, by drying a drop of water on paper, failed, as they seemed to dissolve away. They were extremely sensible to the effect of nitric acid; for a single drop, mixed in a glass of this animated water, put an end, almost instantaneously, to the life of the millions that it contained. We sailed for four hours, at a mean rate of six English miles an hour, through this streak, which was seven miles broad, before we reached the end of it; and its superficies must therefore have been about 168 English square miles. If we add, that these animals may have been equally distributed in the upper stratum of the water, to the depth of six feet, we must confess that their numbers infinitely surpassed the conception of the human understanding." —*Poeppig's Travels.*

8. *Questions respecting the Effects of Clearing Land. A Letter addressed by the French Minister of Finance to the Se-*

cretary of the Academie des Sciences in Paris.—Sir,—The Commission appointed by the Ordonnance of the King on the 29th of March 1836, to examine if there be any grounds to report upon, or modify the terms of the 219th section of the chapter concerning forests, so far as it respects the clearing of the woods of private individuals, was occupied in its sederunt of the 11th of last June, with various particulars referring to statistics, meteorology, and law, upon which it thought that information might probably be demanded from the different ministers and public officers, as well as from the *Préfets* and the Academy of Sciences. The minute of this sederunt, which is now before me, contains the proposal to request from the Academy the solution of the following meteorological questions: 1st, Have thermometrical observations been made in France, or can it be otherwise deduced that the temperature has remained constant, or, on the contrary, has it varied? Does the snow remain on the summits of the mountains as long as it was wont to do? 2d, Within the period of historical records, has the time of harvest, the ripening of the fruits and that of the vintage, been changed; has it been in some particular places? Have the rains become less and less abundant? 3d, Does as much snow fall now as there did during the last century? Has there been any decrease of the springs which may be attributed to the clearing away of wood? 4th, Are those cantons which used to be free from hail now more exposed to its ravages? 5th, Has it been observed that the destruction of the forests has made storms more frequent? 6th, Are the floodings of rivers more considerable and sudden than they used to be previous to the Revolution? 7th, Is the direction of the prevailing winds altered since the clearing of the country, and are they become more violent and injurious? 8th, Finally, is the bed of the rivers notably elevated? And if so, to what extent is the annual elevation?—I shall be obliged, Sir, if you will have the kindness to submit these different questions to the examination of the Academy, and of its correspondents in the Departments, and to acquaint me with the results of the inquiry." This letter was sent to a Commission elected for the express purpose, and composed of MM. Dulong, Arago, Gay-Lussac, Silvestre, Girard, Mirbel, and Cortaz.

9. *Observations made on the occasion of two Hail-Storms which occurred at Toulouse and Jouzac. The former occurred on 8th of July* 1834. By Mr Prof. Boisgeraud.—The form and the structure of these hail-stones, says the author, was very remarkable. All that I examined, without exception, had an interior nucleus. These nuclei were generally roundish, although I also remarked some which were flat. Their diameter was usually about two-fifths of an inch, though I found some equal to three-fifths. In the majority of these nuclei, the centre was occupied by a small opaque white ball, like snow. This little ball was sometimes reduced to a white point; to which succeeded concentric layers, alternately limpid and translucent. When these nuclei were divided into two, and polished on a plain surface, having a temperature superior to the freezing point, the section presented the appearance of some polygonal agates. It certainly did not appear to me that these layers were formed by successive additions of matter, and that it was possible to effect their separation: the very reverse appeared to be the truth—the whole hailstone appeared to be formed at a single instant, and I found it quite impossible, notwithstanding all my endeavours, to succeed in discovering any natural divisions between these different layers, by which to separate them. It is quite apparent to me that such divisions do not exist, and that the formation of the layers was not consecutive. By breaking these nuclei with the teeth, the interior exhibited a texture which was radiated from the centre quite to the external surface. This arrangement, which could also be perceived in the entire hailstone, seems also to be opposed to the idea of their increase by the successive deposition of layers. The snowy layers of the hailstone frequently enclosed minute air-bubbles, which were visible to the naked eye: they were of different volumes, and sometimes very small and very numerous. Some portions formed very minute laminæ, and then the hailstones were iridescent. When the air-bubbles were considerable in number and size, the hailstone was friable. The exterior of the hailstones was very angular; and many of their acute points were eight-tenths of an inch long, and some even more than an inch. These transparent points were in every respect an integral part of the hailstone: it was impossible to break them off

without rupturing them. Although these points were acute, and their faces were united by sharp edges, I found it impossible to recognise any thing like true crystals. The size of these acute (*diedres*) angles varied upon the same edge, and the number of sides on these kinds of pyramids were likewise very variable. They melted rapidly by fusion, and the hailstone then appeared mammillary; it even appeared to be irregularly broken, when, more completely melted, it rested on the ground, or on the fragments of stone, on which it disappeared. One fact which appeared very remarkable, was the existence of small snowy nuclei, about the tenth of an inch in diameter, and similar to the central portion of the principal hailstone, which were encased to some depth in the exterior and transparent part of the hailstone. They seemed to have penetrated into it in the same manner that a hot body sinks into any mass on which it falls. I succeeded in extracting many of these small white balls, which consequently were not very intimately united with the part into which they certainly had penetrated. I also remarked some hailstones which had two, and even a greater number of nuclei, but there was no kind of division between them, by which they might be separated into so many distinct hailstones. The hailstones on which these observations were made, were far from being hard. They all floated on the surface of water, and were consequently specifically lighter. In a very few of them I found a greyish powdery matter, which was quite in the interior. After all the irregularity which has been pointed out, it would not be easy accurately to state the size of these hailstones; but I can, without any hesitation, state that, after being freed of their affinities, the largest were nearly the size of a pullet's egg, and had the same elongated form. The smallest were decidedly spherical, and were about an inch in diameter. In falling, their descent was not very rapid, nor was it equally so with them all. Their direction was generally very nearly from the north; but it occasionally varied a little, both towards the east and the west. The temperature of the external atmosphere was not under 61° Fahr. during the fall of the hail. The maximum of the temperature, from the previous evening, had been in the shade, and with a northern exposure 87°, and the minimum during the night 64° Fahr. Having collected a considerable quantity of these hailstones, they were washed first in pure spring water, to remove the soil with which they were covered, and then successively, at two different times, in distilled water. By this process, they were reduced to the size of a hazel-nut. It was in the interior of one of those thus treated, that I observed the powdery matter above alluded to. After their liquefaction, the water which remained was not perfectly limpid; and next day there was found a very light greyish deposit at the bottom of the vessel in which it was contained. This water exhibited, with the numerous reagents with which I tried it, all the characters of pure water. The sub-acetate of lead alone threw down a white precipitate, which a slight excess of acid made to disappear. This precipitate did not appear to be owing to carbonic acid gas, which would have affected any water with lime or barytes in it. I attributed it rather to some organized matter.—The second hail-storm, of which the author speaks, occurred on the 15th of September of the same year (1834), in the district of Jonzac (Charante Inferieure). The hailstones, of an elongated form, were in general of the size of a large nut, and otherwise entirely resembled those examined at Toulouse. But in connection with this storm, the author dwells upon an attendant and peculiar noise, which was not that of thunder, and which was very distinctly heard both before and during the descent of the hail. But we shall allow him to speak for himself:—" At six in the evening, a cloud which at first was inconsiderable, and which insensibly melted away in the skies, made its appearance in the south; its colour was not deep; it rose very slowly towards the zenith, and appeared at the same time to enlarge in all dimensions. It then became very dark. At about a quarter after six o'clock, a noise which was the precursor of the hail began to be very distinctly heard; but it appeared to me as if the noise proceeded from the surface of the earth, and not from the cloud which was now near the zenith. For a time I even thought it might be proceeding from a water-spout, so unconnected did it appear with the cloud itself. The noise increased and somewhat changed its character as it approached. There was not the slightest breath of wind to be felt at the surface of the earth, and the slow progress of the cloud likewise proves that it was equally calm in the upper regions of the atmosphere. At twenty minutes before seven o'clock, I saw the hail begin to fall, and the dull sound which had preceded it then ceased. This murmuring noise, which accompanied the stormy cloud, was heard at the distance of about six miles. I at first thought that it might be attributed entirely to the *fall*—and not at all to the *motions*—of the hailstones in the cloud, as the observations made above might induce us to think; but some individuals who were directly under the cloud, near the situation where it appeared to form, and where no hail had as yet commenced to fall from it, have assured me that they then heard this kind of murmuring noise."

CHEMISTRY.

10. *Researches made on the Bouquet of Wines, by Messrs Liebig and Peluze.*—It has been long suspected that wine contained a peculiar principle which is the cause of the agreeable odour generally known as the bouquet of wines, which principle seems hitherto to have eluded all the attempts which have been made to detect it. "We have now," however, remark the authors of this extract, "the honour of presenting to the Academy certain experiments which we have made on an essential oil, which was sent us by M. Deleschamps of Paris, and which, from all its properties, appears to be the principle so long sought after. This substance has an exact resemblance to the essences, and was given to us as such; its odour is completely that of old wine, with the exception of its intensity. Its chemical properties remove it from the class of essential oils, and regarding its constitution it sheds a new light on organic chemistry, in supplying the first well established example of the existence of a true ether, which is produced in the act of fermentation, and without the aid of the chemist. This ether is composed of an atom of sulphuric ether, and an atom of a new acid which we propose to designate *œnanthic* acid, and which is formed of $C^{14}\ H^{26}\ O^2$. The condensation of its vapour is that of formic and acetic ethers. The oil presents itself under the form of a greasy oil which crystallizes at 56° Fahr. In its free state it contains one atom of water, which it loses by distillation. By combining it with sulphuric ether, we can easily reproduce *œnanthic ether.* We have deemed it necessary, for the purpose of establishing the compo-

sition of one of the most remarkable of these acids, viz. the *melitic acid*, to make some analytic investigations concerning its combination with oxide of silver. We believe that this acid may be regarded as a hydrous acid, and our experiments on this point confirm the views of M. Dulong respecting oxalic acid. The melitate of silver dried in vacuo, by the side of sulphuric acid, contains some hydrogen, which it loses only at the temperature of 356° Fahr. under the form of water, and with change of colour. There is not one other salt of silver which exhibits the same result; all the others are anhydrous. In this particular instance, the formation of water appears to be the consequence of the reduction of the oxid, and not a simple volatilization of water which had pre-existed in the salt. According to all known analyses, the militic acid contains three atoms of oxygen. We have reason to think it contains four, and besides two atoms of hydrogen; and that this hydrogen enters into the constitution of all the melitates except into that of silver heated to 356°, so that this last represents a combination of metallic silver, with the radicle of hydrous acid."

11. *On the Proportions of Nitrogen in different varieties of Wheat, by M. Payen.*—The Philomathic Society of Paris having been consulted by the Agricultural Society of La Marne concerning the quality of four kinds of wheat which are cultivated in the same manner and on the same lands, M. Payen explained to the Society that he had discovered very considerable differences in the proportions of the nitrogenious matter, as well as in the distribution of that substance in relation to the mass of *perisperm* or the integument of the seed. The maximum of gluten and of two other nitrogenious matters in the varieties which were of moderate hardness, is concentrated in the parts which adhere to the integument, or which approach it the most; whilst in the centre of the grain the nitrogenious substances are in the smallest proportion. The author has also determined the relation between the weight of the external integument, and that of the mass of the grain; and finally, he has ascertained that between the most nitrogenious grains, and those which are least so, the proportion of nitrogen varies from 0,022 to 0,029. The varieties thus experimented upon were the *Polish* wheat, the *March* wheat, the

wheat *de la Trinité* and *de pays*. M. Payen being desirous of investigating if still greater differences could be found in the hardest corns, and in those which are the softest, subjected to analysis, the wheat of Taganrock, of Odessa, and of Poland, on the one hand, and the whitest wheats that are employed in La Mennerie of Paris on the other; and he found that the former contained from 0.029 to 0.031 of nitrogen, whilst the others only gave from 0.019 to 0.020. M. Payen adds, that he means to continue these researches on the maxima and minima of nitrogen by procuring samples of the hardest corns of southern countries, and the softest that are raised in the northern regions.

ZOOLOGY.

12. *Influence of Light and Darkness on the Human Body.*—Dr Allen, in his work on the influence of the atmosphere on the human frame, adduces, among others, the following examples as proofs. He says, that A. Von Humboldt was acquainted with a Countess who at sunset invariably lost her voice, and did not again recover it till sunrise. Aristotle mentions the case of an innkeeper who lost her understanding every evening at sunset, but recovered it next day. Baillou relates an account of a female who was deprived of her mental powers at sunset, but had them restored the following morning. But these examples are more connected with the influence of light and darkness than with that of the atmosphere. Nothing proves this influence better than an experiment that is often made, and which is easily repeated. When an individual has taken too much wine he becomes much more conscious of the influence of the wine on his brain, and of over-excitement, when the light is removed and he is suddenly left in darkness. He is then no longer able to stand, and the chair on which he is sitting, or the bed on which he is reposing, seems to him to make rapid revolutions. When he is again placed under the influence of light all these phenomena cease. In early life, says a German physician, I made a curious experiment of this kind on myself. At a merry breakfast party, I drank a few glasses too many of Malaga wine. It was not till about twelve hours afterwards that, when lying in bed I extinguished my candle, the effect of the wine on my brain became perceptible. Every thing seemed then to move round me in a

circle, heat and feeling of uneasiness came on, and I found it necessary to spring out of my bed. As soon as a light was brought every thing became again stationary, and the disagreeable sensations vanished. During the whole day, while under the influence of light, I had been able to follow my usual avocations, without perceiving the slightest symptoms of an unhealthy over-excitement.

13. *Ehrenberg on Masses of Polyparia without Animals.*—"The sponges and alcyons," he remarks, "are not polypiferous masses deprived of their polypi, because, at no epoch of their growth do they shew a structure which indicates the presence of animal bodies; and, besides, the marine sponges have reproductive granules, and consequently are true plants. When studying, eight months ago, at Berlin, the *Sertularia dichotoma* of the Northern Ocean (a polypiferous mass which M. Cavolini had never succeeded in preserving alive in vessels filled with sea-water), he distinctly observed the death or periodical decay of all the animal corals (corolles), and also the formation of new buds after a certain time. The branchy twig was thus then, during a certain time (fourteen days to a month), entirely deprived of living animals, although it was itself alive. This phenomenon, however, did not exhibit itself except in those twigs in which a part of the animals now dead had previously retired into the central and hollow part of the stalk. The minute examination of this internal part demonstrated to me, that it contained many systems of animal bodies, of intestinal canals, also granular masses (were they the male seminal glands?), and longitudinal and transversal muscular threads, endowed with contractility." He presumed that the other organs of the bodies of the polypi also existed in the mass, though the great difficulty of the examination prevented him from making the direct discovery. The polypiferous masses, thus deprived of their living inhabitants, who, so to speak, according to Cavolini, hybernate, though they still periodically produce polypi, are not simple animal substances individually developing themselves, but animated masses which possess as a whole, and, in their integrity, the sum of the animal organs of a complete system, and which completely perish when these come to be altered. It is the same method of reproduction, though differing in some slight particulars, as takes place

in the hydropolypi, or in the mutilated limaçons, or even in the salamanders. This singular mutilation, this death, affects only those parts which are not necessary to the exercise of life. It is the exercise of the functions of the root, where there is an absence of all the organs of the roots of plants.

14. *On the Distinctive Characters between Plants and Animals.*—M. Ehrenberg also communicated the following note upon *the power of division*, as a distinctive character, between equivocal plants and animals:—"Every animal which can be subjected to examination is distinguished from every plant by being a homogeneous compact *whole* of organic systems; but all animals cannot easily be subjected to examination, and hence there are forms which still remain doubtful and problematical. The introduction of solid aliment into internal cavities is a character which is very extensively possessed by animals; but all animal matters are not perceptible to the eye; many animals obtain their nourishment from substances which are transparent, colourless, and gelatinous, such as happens in the case of entozoariæ and many of the infusoriæ. There are even fishes which we can never discover seizing their prey, although, like others, they are possessed of a mouth and intestinal canal. It is for such varieties of animal life as these that the naturalist requires another distinguishing character. I do not know either a plant, or any portion of a plant, not even a cell of the cellular tissue, which, in growing, divides itself. The development of all plants is always made by their lengthening themselves, and by the formation of a bud. True vegetables do not exhibit in any part of their organization the power of spontaneous division (dicothomaire); whilst, on the contrary, this power is a method of reproduction which is common in many beings which very conspicuously possess all the characters of animal life. The whole class of somatomes (naidina), as also that of corals (anthozoa), of turbinated worms (turbellaria), and of the polygastrica, are distinguished by a generation which proceeds both from an egg (ovule) and a bud. Struck with this additional character, it occurred to me that I ought to employ it in ascertaining that the great family of the bacillariæ, which still remains doubtful, does not belong to the vegetable world, or should not be considered as forming an intermediate series; and

starting from my previous labours relative to the characters of animals, to demonstrate that they are not algæ but true animals, which ought to be arranged near the polygastric infusoriæ, where M. O. F. Muller had already placed them, an opinion which appeared to me to be founded upon the laws of nature, to be conformable to those of physiology."

15. *Concerning an African Species of the Genus Canis, an inhabitant of the Sahara Desert, and some of the Valleys of the Atlas.*—M. Bodichon supplies some details concerning the form and habits of one of the genus *Canis*, which he regards as belonging to the subgenus of foxes *(Vulpes)*, although it exhibits marked differences from the different species which have hitherto been described by zoologists. It presents the following characters. The cranium is flattened superiorly; the head is elongated; and the anterio-posterior diameter is much longer than the transverse diameter; the ears are placed high as in the jackal, and are much longer; the neck is slender and long; and the hind quarters somewhat more elevated than the fore. The legs are longer, and the body more slender than in the common fox; the coat is fallow coloured in the upper and external portions, grey on the under and internal parts, whilst the throat, lips, and point of the tail are pure white. The animal does not exhale any bad smell. He lives in numerous troops, amounting sometimes to more than fifty individuals, which hunt in common, and attack the gazelles, sheep, and calves. This is the testimony of the Arabs, though M. Bodichon has never himself seen more than six or seven together at a time. They are not found in the mountainous districts, nor in that portion of the French possessions which is designated by the name of Alger. They are sometimes met with in the plain of Métidja, and more frequently behind the first chain of the Atlas range; but it is especially in the desert of Sahara that they abound, and here they are found in prodigious numbers. In the plains they are stronger than the jackals, who cannot approach their pack with impunity, whilst in the mountains, on the contrary, they yield them the preference, and scrupulously avoid them.

16. *Geographic Distribution of the Crustacea.*—Mr Milne-Edwards has lately communicated to the Philomathic Society of Paris, the result of his researches concerning the *geographic*

distribution of Crustacea, which we shall now present to the consideration of our readers. According to the views which are laid down in the most highly esteemed works on this subject, such as those of Fabricius, Latreille, Lamark, Desmarest, &c., it would appear that a great number of these animals are scattered over immense distances on the surface of the globe, and inhabit equally our own coasts, and the seas of America, as well as the Indian ocean ; but an attentive examination of the crustacea which are brought from these distant localities, and which hitherto have been regarded as identical species, has convinced M. M. Edwards that the habitat of these animals is much more circumscribed than has been generally imagined. He has determined, that with the exception of some of the crustacea of the wide sea, which for the most part repose on floating fuci, or live as parasites upon fish, all the American species are distinct from those of the European seas, and that these again are all different from those of the Indian ocean. " So far as the crustacea are concerned, remarks M. Edward, many zoological regions exist, having each a particular population which is partly composed of organic types, whose analogues are not found elsewhere, and another part consists of the representatives of species which also exist in other regions. Thus our river crawfish does not exist in America, but is there replaced by a neighbouring species of the same genus ; Southern Africa possesses a third species of the same animal, and this organic type is also found in New Holland, but with distinct specific characters. Results altogether analogous are presented by the Palemon, Langoustes, Pagures, Lupées, &c. M. Edwards also remarked that each of these great regions is the head-quarters, so to speak, of certain organic types, some representatives of which, however, are found in other seas. Thus the *portuni* properly so called belonging almost exclusively to the seas of Europe ; though some have been found even on the coasts of New Holland ; and in the seas of Asia and America these crustacea are to a certain extent replaced by the *Thalamites* and the *Lupées.* These great regions, which are completely distinct from each other, are nevertheless in close proximity : thus the northern coasts of Africa belong to the European region, whilst the Red Sea constitutes a portion of the region of the Indian ocean. Finally, each of these regions is subdivided into zoological provinces which are characterized by the existence of peculiar species. M. Milne-Edwards terminates his communication by announcing that he hopes speedily to finish the work he has undertaken upon this subject; and that he is at the same time occupied with analogous researches relating to the geographic distribution of polypi. His observations on this latter subject lead him not less to believe that there is also a very general misconception regarding these animals, in admitting that identical species are equally spread in the waters of the two hemispheres; and his results, though far from complete, demonstrate a tendency to an arrangement altogether analogous to what is exhibited by the crustacea.

PHYSIOLOGY.

17. *Experiments upon the Mechanism of the Motion or Beat of Arteries, by M. Flourens.*—The question concerning the movement of the arteries naturally divides itself into two inquiries, the former of which relates to the cause which produces this movement, and the latter to the mode in which it operates. M. Flourens deems it best to canvass these questions separately, and commences with the one which refers to the *cause* of the movement. As is generally known, the cause which Galen assigned was " a pulse-giving power," which was derived from the heart, and possessed by the coats of the arteries; but the author demonstrates, that the experiment upon which Galen grounded this hypothesis is incorrect, and that consequently his pretended pulse-giving power is only an empty name. He then shows, by means of experiments he has performed upon dogs and rabbits, that the true cause, a physical one,—the immediate and direct cause of the movement of the arteries is the impelling power of the blood, forced forward by the contractions of the ventricles of the heart,—a power which had long ago been recognised and demonstrated by Harvey. As to the question regarding the *mode* in which the arteries move, the author remarks, that it is by no means so simple as that which relates to the physical cause of the motion. He observes, "This important question, taken as a whole, has appeared to me to be nothing more than the experimental deter-

mination of the different elements which concur in effecting the whole movement of the artery, such as the dilatation, locomotion, &c. and consequently I have made it my first object to ascertain the number and the nature of these elements. 1st, *The dilatation of Arteries.*—He then addresses himself to the determination of the point, If an artery alternately dilates and contracts during its motion? He holds that the experiments which are detailed in the memoir prove this double movement; whence the author concludes that dilatation is an attendant phenomenon, and one of the elements in the movements of the artery. 2d, *The locomotion of the Artery.*—As the result of his experiments, the author moreover holds that the locomotive movement of arteries strengthens, elevates, straightens, abases, changes, and effaces the curves of arteries; and hence he infers that this locomotive movement is a second element in the movement of the artery. 3d, *The throb and elongation of the Artery.* To these movements of dilatation and locomotion M. Flourens has observed that there is added a shock or jerking motion, which, by turns, carries the vessel from behind forwards, and from before backwards, and this is the third element of the total movement or *beat* of the artery. " These, then, he continues, the dilatation, the locomotion, and the shock, are the three primitive, constituent, and true elements of the whole movements of the artery, as demonstrated by experiment. And when, in physiology, we have, on the one hand, the constituent elements of a phenomenon, and, on the other, the organ which executes this phenomenon, all that we can moreover do, is to connect the elements of the phenomenon with the physical qualities of the organ. Now, the physical quality which is the most essential one of the arteries, in connection with the point under review, is undoubtedly their elasticity. As a result of this elasticity the artery can be distended in capacity, hence its *dilatation;* likewise in length, whence its *elongation* and *throb;* it can also be bent, straightened, displaced, &c., and hence its *locomotion;* and if we moreover remark, that in all these cases it returns to its previous state, and by its own inherent power, we have the whole variety of these motions reversed and alternated; and from all these together, proceeds the total movement or the beat of the artery. The beat then, or total movement of the artery is a *one*, though complex, phenomenon, a movement which results from all those which are derived from its elasticity, and more particularly from its dilatation, its locomotion and elongation. As to the strength or impulse of the artery, it depends either on the dilatation alone, or on the dilatation complicated with the effort of the blood against the parietes of the vessel which are at the time depressed by the finger which is imposed on it. According to Galen and Harvey, the *pulse*, that is to say the stroke which is felt by the finger which is applied to the artery which beats, is the shock produced by the dilated parietes of the artery. According to Weibrecht, the pulse is the result of the shock produced by the whole displaced artery, and not solely by the dilatation of its parietes. And, according to Arthaud, who denies there is any dilatation, and who nevertheless discovers the pulse in the arteries themselves, which, according to him, have no locomotion, the pulse is the simple effect of the impetus of the blood against the parietes of the artery, which is at the moment depressed by the effort of the finger. After all that has been said, it will be seen, that in those arteries whose course is straight, and whose locomotion is but small, the pulse is produced chiefly by the dilatation; that in arteries which are tortuous, and whose locomotion is great, the pulse is produced chiefly by that locomotion; and, finally, that when the finger does not merely touch the artery, or rather is merely touched by it, but presses upon and depresses it, the pulse is chiefly owing to the impetus of the blood in its parietes. Upon the whole, the pulse is nothing more than the beat felt by the finger; and is composed of all the elements, and all the circumstances which compose or influence, or complicate that beat.

GEOLOGY AND MINERALOGY.

18. *Reduction of Silver, Lead, and Copper.*—M. Becquerel, on presenting some electro-chemical apparatus to the Académie Royale des Sciences of Paris, by the aid of which he had been able to effect the immediate reduction of silver, lead, and copper, stated that, without the intervention of mercury, by constructing an electro-chemical apparatus with iron, a saturated solution of common salt, and an ore of silver, properly prepared,

he had extracted from the latter the silver which it contained, under the form of crystals. The minerals on which the experiments were made were the ores raised in Columbia and the ore of Allemont. The same method has also been successfully employed to extract from the copper-pyrites of Chessy, near Lyons, the silver which it contains, without affecting the copper. It is only from the argentiferous galenas that it is difficult to extract the silver. When a mineral like that of Allemont contains many metals, as lead, copper, &c., each of these metals is separately reduced, and at different times, so that the separation is easily affected. From this it results that the ores of lead and copper may be treated in the same manner as those of silver, but with much less facility, because of the different degrees of oxidation which they acquire, and the compounds which they form during roasting. M. Becquerel is at present occupied with further researches on the extraction of metals, but deemed it proper, for the interest of science, to make known to the Academy the principles by means of which he has been able to extract some metals, particularly silver, from their respective ores.

19. *On the Results of Mr Fox's Experiments on the production of Artificial Crystals by voltaic action.*—We have alluded, in page 83 of the last number of this Journal, in reference to a paper by M. Becquerel, in the third part of the "Scientific Memoirs," to the communications of Mr Fox and Mr Crosse, at the Bristol Meeting of the British Association relative to the production of artificial crystals by voltaic action. We are now enabled, by the kindness of Mr Fox, in sending specimens of the altered ores for examination, to give a more exact account of the results of his experiments than we could otherwise have done. Mr Fox's own statement is as follows:—"The experiment referred to was performed in the following manner:—An earthenware trough was divided by a partition of moistened clay into cells, into one of which was put a piece of the yellow sulphuret of copper, the cell being filled with a solution of the sulphate of copper, and into the other a piece of zinc, and the cell filled with water, either pure or slightly acidulated by sulphuric acid. The zinc was then connected with the copper-ore by means of a copper wire passing over the wall of clay. This simple voltaic arrangement soon rendered

the surface of the copper-ore highly iridescent, then purple, and in the course of a few days grey, the grey crust being covered with metallic copper, deposited in brilliant crystals, and with a slightly greenish soluble salt. This crust resembled grey sulphuret of copper, and increased in thickness after the operation had been continued several weeks." The crust on the specimens received from Mr Fox was thin, and the quantity so small, that an exact analysis of it could not be made. But the result of the examination to which it was subjected, approached so nearly to that of the Cornish sulphuret as to warrant the conclusion of its being the same chemical compound. The soluble salt was found to be a sulphate of copper and iron, which accounts for the iron that the yellow copper-ore had lost during its conversion into sulphuret. Mr Fox considers that, assuming the grey crust to be the sulphuret of copper, as it turns out to be, those results explain why metallic copper occurs in our mines in contact with grey and black copper-ore, and not with the yellow sulphuret of that metal, and likewise why the former is generally found nearer the surface than the latter, and also near cross courses, and in situations where it is most exposed to the action of water, the expelled ferruginous matter being indicated by the " gossan." This usually consists of quartz as well as iron-ochre, &c., and it abounds in copper veins, but not in those of tin.—*Phil. Mag. 3d series*, No. 60, p. 171.

20. *Jamesonite from Estremadura, analyzed by Count F. Schaffgotsch.*—The specimens analyzed were readily cleavable in a direction perpendicular to the axis of the crystals, and with some difficulty in several directions parallel to the axes of the crystals; Lustre metallic; Colour dark lead-grey; Streak blackish-grey; Hardness a little greater than that of rock-salt. Specific gravity = 5.616 at 19° cent. Lead 39.971, Antimony 32.616, Sulphur 21·785, Iron 3.627, Bismuth 1.055, Zinc 0.121; = 99.475.—*Phil. Mag. 3d series*, No. 60. p. 237.

21. *On the Fossil Bones of the Tertiary Formation of Simorre, Sansan, &c. in the department of Gers, and on the recent discovery of a Jaw of a Fossil Monkey.*—An extremely interesting accumulation of fossil bones was discovered about two years ago by M. Lartet in the department of Gers, in the south-west of

France. Very lately, new and more extensive researches have been carried on by the same gentleman; and the results already obtained possess a high degree of importance for the science of Paleontology. Farther discoveries may still be anticipated, for, at the suggestion of Messrs Arago, Blainville, and other distinguished members of the French Academy of Sciences, assistance has been offered by the Academy to enable M. Lartet to prosecute his investigations. The fossil bones, which belong to no less than thirty species of mammiferous animals, have been chiefly found in two deposits, viz. in the *sands* and *sandstone* of the upper tertiary formation of Simorre, Tournon, Lombez, &c., and in the *lacustrine deposit* of Sansan. The remains obtained from these two deposits form two groups, differing materially from each other. In the *Simorre* deposit there have been found two species of Dinotherium, probably similar to the species determined by M. Kaup under the names D. giganteum and D. secundarium; several species of Mastodon, amounting probably to five in number, and of which one is new; three species of rhinoceros; a small Pachydermatous animal; a small deer; and, finally, a large ruminating animal, which must have measured six feet in height to the shoulder. We must give a somewhat more detailed account of the other group of remains, or that occurring at *Sansan.* The Dinotherium does not occur; mastodons are rare; rhinoceroses are found abundantly, but not of the same species as at Simorre. The rhinoceroses of Sansan belong to three species, and would seem to have had no horns. One Palæotherium occurs, and is larger than the P. medium of Montmartre, resembling rather the P. aurelianense. The extremities of this palæotherium are very like those of the horse. With this animal there lived a large anoplotherium, not inferior in size to our rhinoceros. There are also remains of another small Pachydermatous animal, whose molar teeth approach somewhat in form those of the anthracotherium. Bones of ruminating animals abound at Sansan, and belong to three species of deer, an antelope, and another very small species. M. Lartet has also found in the same deposit a gigantic carnivorous animal, a true dog, a large cat, and an animal like a weasel, a small hare, and a very large Edentate quadruped. But the most important of M Lartet's discoveries was that of a jaw, of which the following is a description:—It presented 4 incisor teeth, 2 canine, 4 false molars, and 6 true molar teeth; *in all*, 16 *teeth in a continuous series*; that is, *the dentary formula of man, and of some monkeys*. The incisors differ little from those of man. They are a little more inclined anteriorly, thus resembling more the arrangement in the monkey tribe. The canine teeth are sharp and prominent, less so, however, than in most of the quadrumana. The first false molar tooth has only one strong tubercle; in man it has two. The second false molar has two tubercles as in man. The three true molars are equally similar to those in man except the last, which extends a little farther from before backwards. These molars are, like those of man, divided into four tubercles by two furrows, which cross at right angles in the middle of the tooth. In their state of detrition, one would believe that he was looking at the molars of a man of forty years of age, reduced to about half their natural size. This jaw, and the phalange which seems to belong to it, were found at Sansan in a layer of marl, which is covered by a regular bed of compact limestone, and they were mixed in a confused manner with bones of various species of deer, of the Anoplotherium, the Palæotherium, &c. Here, then, we have an example of a mammiferous animal of the monkey tribe, which, judging from the jaw, must have been about three feet in height, contemporaneous with the Palæotherium, Anoplotherium, and other extinct genera that have long been regarded as the oldest mammiferous inhabitants of our continents.

22. *New Expression for determining the various circumstances connected with the Dip, &c. of Stratified Rocks.*—Dr Anderson of Perth communicates the following new expression, which he has deduced for determining the various circumstances connected with the dip, &c. of stratified rocks. Let A and B be two stations, whose difference of level is denoted by h, positive when B is above A, and negative when otherwise; and let d represent the horizontal distance between them. Also let D denote the angle of the dip of the stratum observed at A; I the horizontal angle formed by the plane of the dip, and a vertical plane passing through A and B; and lastly, let E denote the angle of elevation of B with respect to A, when that angle can be measured by the two stations being visible from each other.

Then if H denote the vertical line from B to the plane of the stratum passing through A, we have

$$H = h + d\ (\tan D. \cos I)\ ;$$

$$\text{or } H = d\ (\cot E + \tan D. \cos I), \quad . \quad . \quad (1.)$$

If t denote the perpendicular thickness of a bed of the same stratified rock, so that the parallel plains passing through A and B are on the opposite sides of the seam, or stratum ; then

$$t = H \cos D = d\ (\cos D \cot E + \tan D \cos I)$$

$$\text{or } t = d\ (\cos D \cot E + \sin D \cos I). \quad . \quad . \quad (2)$$

When $t = o$, that is, when A and B are in the same plane of a face of the stratum, the formula (2) may be expressed entirely in circular functions, and becomes

$$- \cot E \cos D = \sin D \cos I$$

$$\text{or } - \cot E = \tan D. \cos I \quad . \quad . \quad . \quad (3)$$

This expression may be applied to determine whether two points, in a disjoined stratified rock, of the same character, belong to the same layer of the bed, when these points are separated by an extensive ravine or valley. The expression (1) may be of considerable use to miners and practical engineers.

23. *Analysis of Steatite and Algalmatolite.*—Mr Lychnell communicates in Poggendorf's Journal, B. xxxviii. the following analysis of steatite or soap-stone. I. *From Caunegou:* Silica, 66.70 ; magnesia, 34.23 ; oxide of iron, 2.41 ; =99.34. II. *From Sala*: Silica, 63.13 ; maguesia, 34.30 ; oxide of iron, 2.27 ; = 99.70. III. *From Scotland:* Silica, 64.53 ; magnesia, 27.70; oxide of iron, 6.85 = 99.08. IV. *From China :* Silica, 66.53 ; magnesia, 33.42 ; oxide of iron, a trace; = 99.98. V. *From Bayreuth* : Silica, 65.64 ; magnesia, 30.80 ; oxide of iron, 3.61 ; = 100.05. Mr Lychnell also communicates the following analysis of algalmatolite : Silica, 72.10 ; alumina, 24.54 ; oxide of iron. 2.85 ; trace of magnesia.

24. *Analysis of Radiated Zinc-Blende.*—Mr Lowe, in Poggendorf, gives the following analysis of radiated blende : Sulphur, 32.75 ; cadmium, 1.78 ; iron, 2.20 ; zinc, 62.62 ;= 99.35.

25. *Analysis of Plagionite.*—Lead, 40.98 ; antimony, 37.53 ; sulphur, 21.19 ; = 100.00. It results from this analysis that the plagionite is a peculiar chemical compound.—*Kudernatsch* in Poggendorf, B. xxxvii.

List of Patents granted in Scotland from 17th December 1836 to 14th March 1837.

1. To JAMES ELNATHAN SMITH, of Liverpool, in the county of Lancaster, merchant, in consequence of a communication made to him by a certain foreigner residing abroad, for an invention of "certain improvements on railways, and on locomotive carriages to work on such railways."—Sealed at Edinburgh 17th December 1836.

2. To DANIEL CHAMBERS, of Carey Street, Lincoln's Inn, water-closet manufacturer, and JOSEPH HALL, plumber, of Margaret Street, Cavendish Square, both in the county of Middlesex, for an invention of "an improvement in pumps."—17th December 1836.

3. To GEORGE GUYNNE, of Holborn, in the county of Middlesex, gentleman, and JAMES YOUNG, of Bricklane, in the same county, brewer, for an invention of "improvements in the manufacture of sugars."—17th December 1836.

4. To JOHN BURNS SMITH, of Salford, in the county of Lancaster, cotton-spinner, for an invention of "certain improvements in the machinery for roving, spinning, and twisting cotton, and other fibrous substances."—24th December 1836.

5. To JOHN ROBERTS, of Prestolle, in the parish of Preswick, and county of Lancaster, calico-printer, for an invention of "certain improvements in the art of block printing."—28th December 1835.

6. To WILLIAM NEALE CLAY, of West Bromwich, in the county of Stafford, manufacturing chemist, for an invention of "improvements in the manufacture of sulphate of soda."—28th December 1836.

7. To JAMES WHITE, of Lambeth, in the county of Surrey, engineer, for an invention of certain improvements on railways."—31st December 1836.

8. To BARON HENRY DE BODE, Major-General in the Russian Service, of the Edgeware Road, in the county of Middlesex, for an invention of "improvements in capstans."—31st December 1836.

9. To WILLIAM SHARPE, of the city of Glasgow, in North Britain, merchant, for an invention of "a certain improvement in the treatment of cotton wool in preparation for manufacturing the same into yarn and thread."—4th January 1837.

10. To WILLIAM COOPER, glass merchant and stained-glass manufacturer, of Picardy Place, in the city of Edinburgh, in Scotland, for an invention of "an improved method of executing ornaments, devices, colours, or stains, on glass."—12th January 1837.

11. To HAMER STANSFELD, of Leeds, in the county of York, merchant, in consequence of a communication received by him from CHRISTIAN WILLIAM SCHONHERR, of Schneeberg, in the kingdom of Saxony, for an invention of "certain improvements in machinery for weaving, one of which improvements is applicable to other purposes."—13th January 1837.

12. To THOMAS VAUX, of Woodford Bridge, in the parish of Woodford, in the county of Essex, land-surveyor, for an invention of "a certain mode of constructing and applying a revolving harrow for agricultural purposes."—14th January 1837.

13. To CHARLES THORNTON COATHUPE, of Wraxall, in the county of Somerset, glass-manufacturer, for an invention of "certain improvements in the manufacture of certain descriptions of glass."—18th January 1837.

14. To JOHN RUTHVEN, of Edinburgh, for an invention of "an improvement in the formation of rails or rods for making railways, and in the methods of fixing or joining them."—20th January 1837.

15. To GEORGE GOODLET, of Leith, in the county of Edinburgh, merchant, for an invention of "a new and improved mode of distilling spirits from wash and other articles, also applicable to general purposes of rectifying, boiling, and evaporating, or concentrating.—25th January 1837.

16. To CHARLES WHEATSTONE, of Conduit Street, in the county of Middlesex, musical-instrument manufacturer, and JOHN GREEN, of Soho Square, in the same county, musical-instrument manufacturer, for an invention of

" a new method or methods of forming musical instruments in which continuous sounds are produced from strings, wires, or springs."—31st January 1837.

17. To Peter Spence, of Henry Street, Commercial Road, in the county of Middlesex, chemist, for an invention of " certain improvements in the manufacture of Prussian blue, prussiate of potash, and plaster of Paris."—10th February 1837.

18. To Miles Berry, of the Office for Patents, 66 Chancery Lane, in the county of Middlesex, patent agent and mechanical draftsman, in consequence of a communication from a foreigner residing abroad, of " an improved apparatus for torrefying, baking, and roasting vegetable substances, which, with certain modifications and additions, is also applicable to the evaporation and concentration of saccharine juices and other liquids."—15th February 1837.

19. To John Gemmell, of Stockwell Street, in the city of Glasgow, and county of Lanark, merchant, for an invention of " certain improvements in steam or other boats or vessels which are partly applicable to other purposes." —16th February 1837.

20. To Moses Poole, of the Patent Office, Lincoln's Inn, in the county of Middlesex, gentleman, in consequence of a communication made to him by a certain foreigner residing abroad, for an invention of " improvements in anchors, and in friction-rollers to facilitate the lowering and raising such and other anchors, which friction-rollers are applicable to other purposes."—20th February 1837.

21. To James Cook, of Birmingham, in the county of Warwick, gun manufacturer, for an invention of " improvements in gas-burners."—22d February 1837.

22. To Francois de Fausch, of Percy Street, Bedford Square, in the county of Middlesex, military-engineer to the King of Bavaria, for an invention of " improvements in apparatus or machinery for propelling of vessels for raising water, and for various other purposes."—24th February 1837.

23. To John Isaac Hawkins, of Chase Cottage, Hampstead Road, civil-engineer, in consequence of a communication made to him by a certain foreigner residing abroad, for an invention of " certain improvements in the application of the products of combustion in generating and in aiding of steam for giving motion to steam-engines."—4th March 1837.

24. To William Wright, of Salford, in the county of Lancaster, machine-maker, for an invention of " certain improvements in twisting machinery used in the preparation, spinning or twisting of cotton, flax, silk, wool, hemp, and other fibrous substances."—6th March 1837.

25. To Peter Ascanius Tealdi, formerly of Moindoir, in Piedmont, but now residing in Manchester, in the county of Lancaster, merchant, in consequence of a communication made to him by a certain foreigner residing abroad, for an invention of " a new extract or vegetable acid, obtained from substances not hitherto used for that purpose, which may be employed in various processes of manufacture, and in culinary or other useful purposes, together with the process of obtaining the same."—6th March 1837.

26. To John Burns Smith, of Salford, in the county of Lancaster, spinner, and John Smith, of Halifax, in the county of York, dyer, for an invention of " a certain method or methods of tentering, stretching, or keeping out cloth to its width (made either of cotton, silk, wool, or any other fibrous substances) by machinery."—6th March 1837.

27. To Edmund Shaw, of Fenchurch Street, in the city of London, stationer, in consequence of a communication made to him by a certain foreigner, residing abroad, for an invention " of an improvement in the manufacture of paper."—8th March 1837.

28. To John Shaw, of Rishworth, in the parish of Halifax, in the county of York, book-keeper, for an invention of " improved machinery in preparing wool, and also in preparing the waste of cotton wool for spinning."—9th March 1837.

29. To George Bertie Paterson, of Peacock Street, in the parish of St Mary, Newington, in the county of Surrey, engineer, for an invention of " certain improvements in the construction of meters, or apparatus for measuring gas or liquids."—14th March 1837.

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