THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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On the Farinaceous Grains and the various kinds of Pulse used in Southern India. BY WALTER ELLIOT, Esq., Wolfelee.*

The specimens on the table exhibit a series of the cereals and pulses of Southern India, used as articles of food. They were taken from the Madras Exhibition of 1857, and number 107 sorts.† It was intended that the series should embrace samples of every kind of grain or pulse exhibited; but unfortunately it was not discovered until after the collection was dispersed, that a large number of the dry grains had been omitted. The series of wet grains is tolerably complete, comprising 107 varieties of paddy or rice, with the husk. The terms *wet* and *dry* grains are employed conformably with their signification in common language in India, the former referring to grain raised by means of irrigation, the latter to such as are cultivated without artificial watering. These distinctions, however, are only to be understood as generally correct. The paddy or rice crop is the principal wet grain, and cannot be raised without a constant supply of water; nevertheless, it is sometimes grown at higher levels than those to which the artificial systems of irrigation convey water. Such crops are called *maniveri* in the south, and depend on the falling rain alone. They, in consequence, often fail, or yield only a scanty and inferior crop. On the other hand, patches

* Read before the Botanical Society of Edinburgh 13th February 1862.

† The specimens have been placed in the Museum at the Botanic Garden, Edinburgh.

of dry grain, such as *rági* (*Eleusine Coracana*, Gærtn.) or *chólam* (*Sorghum*), are raised by water drawn from wells in the hot weather, to serve as fodder for cattle. But these exceptions are too trifling to affect the general accuracy of the conventional terms in common use.

It may be well to premise, that the seasons in India, as in all tropical climates, are but three:—1. "The monsoon, or rainy season," commencing in May or June, and lasting four months; 2. "The cold season," occupying the succeeding four months, to September or October; and the remaining four months constituting, 3. "The hot season." The first is the period of cultivation, and answers to our spring and summer, which, owing to the rapidity of tropical vegetation, are compressed into one; the second is the time of harvest or autumn; and during the last, which answers to our winter, the land has rest, and vegetation is suspended.

Considerable variation occurs in the dates at which these well-marked alternations of season occur, dependent on the phenomena which regulate the course and progress of the monsoons. The greater part of India comes under the influence of the south-west monsoon; and although the north-east monsoon is not without a certain degree of importance, it is only experienced to an appreciable extent on the coast of Coromandel. The theory of the monsoons is well explained by Mountstuart Elphinstone in his account of the embassy to Cabul. He describes the western trade-winds as commencing in the month of May with violent thunderstorms, and bringing with them the heavy clouds surcharged with moisture impending over the Indian Ocean. In their progress to the eastward they strike on the western shores of the continent, where, deflected from their regular course, they follow the mountain system of India, and, travelling gradually northwards from Cape Comorin to the Himalayas, send off detachments in the direction of the various spurs and transverse ranges which cross the peninsula, till they reach the great northern barrier, where they separate finally into two divisions to moisten the arid plains of Bengal and the valleys of Affghanistan. The time occupied by this process is from six weeks to two months. The first clouds break on Cape Comorin about the middle of May. The more distant valleys of Cabul do not receive their supply till July.

The absence of lofty mountains in the Carnatic excludes the lands of the south-east portion of the peninsula from sharing in the benefit of this monsoon, and the want is supplied, but in more scanty measure, by the north-eastern monsoon, which does not begin till October, and is experienced for about two months only. The cause of this partial distribution is apparent at once, from the relative position of the land and sea on the Coromandel, or eastern, and the Malabar, or western coasts. When the east trades begin to blow, they expend their force on the countries lying far south of the Indian peninsula, and deluge the lands of Siam, Burmah, and the Malayan peninsula, so that India gets but the tail as it were of that monsoon. On the other hand, the accumulated evaporation of the Indian Ocean is discharged at once on the coast of Malabar, which is the first land it encounters. Hence the average fall in Western India is from 150 to 200 inches, and at Moulmain, in Pegu, from 200 to 250, while at Madras it is only from 40 to 45.

Notwithstanding this disadvantage, Madras is essentially a rice-producing country, the cultivation of dry grains being much less in proportion throughout the greater part of the southern districts, while they predominate on the table-land above the Ghats. Hence the southern provinces have always been remarkable for the vast amount of hydraulic science employed to secure the means of cultivation. The great dams across the principal rivers, and the enormous embankments raised to intercept the natural drainage of the country, with their subsidiary systems of canals of distribution, are not surpassed either for magnitude* or skill by the public works of any part of the world. These are mostly constructed on the Cáveri, Tungabhadra, Vygey, Támbrapurni, and other southern rivers, and serve as monuments of the wise munificence of early Hindu kings. But of late years they have been emulated by the persevering advocacy and science

* The Chambrambakam Tank, close to Madras, is 15 miles in circumference; the Craveripák Tank, in Arcot, is 30 miles; the dam of the Ponéri Tank, in Tanjore, is 40 miles long, but is now out of repair.

of a modern English engineer; and to Sir Arthur Cotton we owe important accessions to the Cáveri Works, and a magnificent dam across the Godaveri, 4 miles in breadth, with its dependent system of channels and canals, serving both for purposes of cultivation and navigation. A glance at the map of any of the southern districts, as portrayed in Arrowsmith's Great Atlas of India, in which almost every village and tank is noted, will show the immense importance of these reservoirs in which the superfluous water is stored, which would otherwise be absorbed or carried off to the sea; and hence the solicitude with which the progress of the periodical rains is watched by all classes, who feel that plenty or famine depend on the bountiful or scanty supply of the year.

I. Wet Grains.

As soon as the monsoon begins the fields are divided into numerous beds by raised earthen bounds, and are well moistened and converted into liquid mud. Into this the rice-plants, which have been previously sprouted in nurseries similarly prepared, are transplanted, and are then submerged in water, which is added freely to compensate for evaporation, so that the roots of the plants are always kept covered until the grain ripens.

The long period during which rain continues to fall, and the rapidity of vegetation, enable the Indian farmer to raise three crops, not, however, on the same ground, although with fields immediately under tanks a second crop is generally taken off the land that had already yielded a first crop.

These three sowings are called by various names; but in the principal language of the south they are distinguished as the—

Tamil.	*Telugu.*	*Muhammadan.*
Kár.	Punása.	Túsi.
Samba.	Pedda-panta.	Khariff.
Peshánam.		Rabia.

And are sown, the 1st in June; the 2d in July–August; and the 3d in September–October.

This accounts partly for the many varieties of paddy which the ryots recognise by different names. One exhibitor sent one hundred and ninety varieties from Tanjore to the Madras Exhibition of 1857, another sent sixty-five from Travancore, fifty were received from Chingleput, forty-four from Pághat, &c.*

Most of these on the table were selected from the Tanjore collection, and are classed as follows:—

Oryza sativa, Linn.

Dhânyam ; Vríhi (paddy)—*Sanscrit.*
Nívára (wild variety, from *ni*, before, and *vri*, to be)—*Sanscrit*
Tandul† (rice, husked paddy)—*Sanscrit.*
Nel, Nellu (paddy)—*Tamil.*
Arisi (rice, husked paddy, hence the English word)—*Tamil.*
Vari, Vadla (paddy)—*Telugu.*
Nivvari, Nívâramu (wild variety)—*Telugu.*
Biyyam (rice or husked paddy)—*Telugu.*

Kár Series or Early Kinds.

1. Anantádi-kuruvai.
2. 'Arayan.
3. Aruvatan-kodai.
4. Aruvatánál-kuruvai.
5. Anatána-kuruvai.
6. Chitra kár.
7. Chittriyán.
8. Kár.
9. Kalviráyan.
10. Kadapa-kálandai.
11. Kadapa-kár.
12. Káru-vélan.
13. Karun-kuruva.
14. Káruttu-kadapa.
15. Kát-ali . annan.
16. Katalai.
17. Kát-uppu-vannan.
18. Katti-kár.
19. Kombu-kuruvi-kár.
20. Kósu-katalai.
21. Kurun-kár.
22. Kuruvi-kár.
23. Manavari-kár.
24. Muttu-kár.
25. Muttu-kuruvai.
26. Muttu-kuruvai-kár.
27. Perung-kár.
28. Sendi-kár.
29. Sengaláni-kár.
30. Segappu-katalai.
31. Sen-kár.
32. Siluvai-kadapa.
33. Singini.
34. Sura-kuruvi.
35. Vella-kuruvai.
36. Vushi-kutalai.
37. Vella-kadapu.
38. Vella-kutalai.
39. Vella-kár.
40. Vella-sendi-kár.
41. Vella-kuruvi-kár.
42. Yellan-kár.

Samba Peshánam.

43. Atyúr-samba.
44. America (Carolina) samba.
45. Anantán-samba.
46. Alagiyavannan.
47. Bangála-samba.

* Wilson, in the Sanscrit Dictionary voce *vríhi,* says there are eight kinds enumerated by the native authorities, but the varieties are more numerous.

† The terms *tandul* and *arisi* signify properly any grain stripped of its husk, but they are applied, *par excellence,* to rice as the predominating kind.

48. Garudan-samba.
49. Irakku-samba.
50. Irangi-muttán.
51. Jiraga-samba.
52. Kadai-kál-uttán.
53. Kai-vér-samba.
54. Kál-adichán.
55. Kálundai.
56. Kambalai.
57. Kambam-samba.
58. Kártika-samba.
59. Karuppu-peshánam.
60. Karuttu-kalundai.
61. Kási (or Benares) samba.
62. Kattúr-samba.
63. Káttu-kálundai.
64. Kingani-malai.
65. Kodu-válai.
66. Krishna-lilai.
67. Kunkuma-samba.
68. Kuruvai-molagu.
69. Muttu-samba.
70. Molagu-samba.
71. Ottadam.
72. Pan-móharan.
73. Pattu-samba.
74. Patna-samba.
75. Pushpa-samba.
76. Palani-samba.
77. Pumbalai.
78. Péshánam.
79. Parun-jirkini.
80. Perum-molagu.
81. Ponga-samba.
82. Pál-kadukai.
83. Ramnànádan-samba.
84. Sárupáli-samba.
85. Seguppu-sáru-mániyam.
86. Sevan-samba.
87. Sambali-periyan.
88. Seguppu-samba.
89. Sukha-das-samba.
90. Sambálai.
91. Sáda-samba.
92. Seguppu-molagu.
93. Tilla-mayagam.
94. Tovarai-samba.
95. Vella-séru-mányam.
96. Vengu-samba.
97. Vella-molagu.
98. Vella-samba.
99. Ventya-samba.
100. Váda-samba.
101. Vásanai-samba.
102. Vúshi-samba.
103. Yogal.

Several of these exhibit well-marked variations of form, colour, &c.; but doubtless many of them are mere local names, by which the same variety is known at different places.

Besides the cultivated varieties there is a wild kind, which grows spontaneously on the banks of tanks; but whether it is the progenitor of the numerous kinds of rice now in cultivation, or whether it springs from the accidental scattering of the domesticated grain, it is impossible to tell. Certain it is, that it occurs with uniform characters in all parts of the country. Roxburgh apparently entertains no doubt on the subject, and describes the typical *Oryza sativa* from the wild kind, observing in a note that the trivial name is an improper one "for the original wild plant, which is never cultivated; however," he adds, "as custom has established it for the numerous varieties thereof, I cannot well attempt to alter it, in describing what I take for the original wild stock, from whence all the cultivated varieties have sprung." (*Flor. Ind.*, ii. 200.)

The rice obtained from this wild sort is highly esteemed, and is carefully gathered. It is small, very white, and is considered so easy of digestion that it is much recommended for the diet of the sick. In the Azimgurh district of Bengal it is called *tenni*, and there, too, is stated to be much prized.

II. Dry Grains.

Of dry grains there are only forty-five specimens,—a series far too small to afford an adequate conception of the numerous varieties recognised by the Indian farmers. They consist of,—

1. Chólam or Jawári—*Sorghum vulgare*, Pers.
2. Bájra or Kambu—*Penicillaria spicata*, Willd.
3. Rági—*Eleusine Coracana*, Gærtn.
4. Tenai or Kangni—*Setaria italica*, Kth.
5. Sámi, Sávi, or Káda-kanni—*Panicum miliaceum*, L.
6. Varagu—*Paspalum scrobiculatum*, L.
7. Pilarisi—*Cynosurus ægyptius*, L.
8. Pul varagu—*Panicum colonum*, L.

1. *Sorghum vulgare*, Pers.; *Andropogon Sorghum*, Roxb. (Great Millet).

Yavanála, Rakta khurnah } *Sanscrit.*	Jonna, Jonnalu—*Telugu.*
Chólam—*Tamil.*	Jowar, Jowári, Jári—*Hindi.*
	Durra—*Arabic.*

Of Sorghum there are only two specimens, but they represent the two chief varieties, viz., the red and the white Jowári,—the red forming the early, the white the later crop. The varieties exhibited in 1857 were fifty-six.

It is generally known as Great Millet among the English, as *chólam* in the south, and as *jowári* in the north, and is certainly the staple dry grain of India, and, indeed, of all the tropical countries of Asia and Africa. It extends even into the temperate zone, and is largely cultivated in Europe, in the countries bordering the Mediterranean. It is also grown in the United States,—where it has attracted attention from its saccharine properties, and in Peru, and other parts of South America. I have seen it in all parts of India, in Arabia, Abyssinia, Egypt, Asia Minor, Turkey, and Italy; and it probably has a range nearly as extensive as wheat, the most widely diffused of all the cereals. The grain forms the principal article of food among the agricultural classes on the table-lands, as rice does of those below the Ghats; and the straw, under the name of *karbí*, affords an admirable forage for horses and cattle.

Its Sanscrit name indicates a foreign origin, *yavana* being the general term for a Greek, Mohammedan, or other stranger; but the Persians call it *Jowár-i-Hindi*, showing that it came to them from India. The Italian name, *Sorgo*, has been adopted for the genus.

In 1856 considerable attention was given to a variety of Sorghum, introduced into Madras from South Africa under the name of *Imphi*, with supposed saccharine qualities, of sufficient importance to supersede the sugar-cane in the manufacture of sugar.

The subject was carefully investigated by M. Perottet, a well-known botanist of Pondicherry, to whom a series of specimens of the grain obtained from the Cape of Good Hope was sent. He raised plants from all of them, and identified them as the *Andropogon caffrorum* of Kunth (*A. saccharatus*, Roxb.), and, after subjecting the produce to various experiments, he came to the conclusion that they were not suited to the manufacture of sugar. "It must be a matter of surprise," he observes, "that although these plants have been known for upwards of a century, no one has hitherto tried to turn them to account, with reference to their saccharine properties. Is it because this sugar, which is found in the plant in the state of *glycose*, is difficult to extract and difficult to obtain in a state of perfect crystallisation? This is the only conclusion we can come to, and in it we must include the Chinese Sorgho of M. Montigny (*Andropogon niger*) which has been equally well known for a long time." He farther adverted to the difficulty of cultivating it for sugar, on account of its liability to be laid by wind and rain; and the juice itself, when compared with that of *Saccharum officinarum*, he describes as "more insipid, thinner, the impression on the organs of taste evanescent, and more fit for conversion into rum than sugar."

I have always been of opinion that all the different kinds of Sorghum found in cultivation were nothing more than varieties occasioned by domestication of the normal type of *Sorghum vulgare;* and, in a report I was asked to prepare on M. Perottet's paper by the Horticultural Society of Madras, I made the following observations:—

"Seven species of Sorghum are enumerated by Kunth, viz.:—

1. *Andropogon Sorghum*, Brot.
2. *Andropogon niger*, Kunth.
3. *Andropogon cernuus*, Roxb.
4. *Andropogon bicolor*, Roxb.
5. *Andropogon rubens*, Kunth.
6. *Andropogon saccharatus*, Rox.
7. *Andropogon caffrorum*, Kunth.

Of these, Sprengel pronounces No. 2 to be a mere variety of No. 1, and No. 7 a variety of No. 6. We have seen that M. Perottet arrived at a similar conclusion.

Persoon considers Nos. 4 and 5 to be varieties of No. 1; and Willdenow admits the latter, or No. 5, to hold only an intermediate place between Nos. 1 and 6.

Lastly, Roxburgh, in describing No. 3, speaks of it doubtfully as a species, and thinks it may be a variety of No. 1.

Thus, in the opinion of distinguished botanists, the group is reduced to two species:—

1. *Sorghum vulgare*, Pers.—*α. nigrum; β. bicolor; γ. rubens; δ. cernuum.*
2. *Sorghum saccharatum*, Pers.—*α. caffrorum.*

Now, if we contrast the descriptions of these two, we find there is little difference between them save in the denseness or laxity of the head, the glumes being smooth or more or less clothed, and the presence or absence of an awn.

None of these, I apprehend, can be admitted as characterising a specific difference.

With regard to the first point, I can state with confidence, from my own observation, that characters derived from the density or otherwise of the head cannot be relied on.

I had occasion to make a careful examination of the Sorghum crops in the Rajahmundry district in 1853, in the course of which I passed through a succession of fields, from the rich, deep, alluvial *lanka** lands in the islands of the Godaveri, to the shallow, stony soils on the uplands, exhibiting every shade of appearance, from the large, dense, coarctate head to the lax panicle, the branches of which were sometimes upright, sometimes drooping, the colours varying from pure white through every shade of yellow, pink, red, and brown, to black, the height varying from three feet to thirty feet.

A large head, not selected, but taken at random from a *lanka* field, contained 5618 corns, and weighed 10½ oz.

A head from an intermediate field contained 3856 corns and weighed 4 oz.

The average heads of the upland fields were not half the size of the last. Many were even smaller.

Sorghum vulgare is the early *jowári* of India; *S. saccharatum* the late. *S. cernuum* is described from the kind cultivated in the mountain districts of Eastern Bengal. *S. rubens* is sown indifferently with *S. vulgare* as an early crop, and is distinguished from it only by its colour. *S. caffrorum* is an African variety from the Cape of Good Hope, and *S. niger* from China. *S. bicolor* is so called from the black and white coloration of the glumes, but it appears to be merely a variety of *S. vulgare*.

None of these have been seen save in a state of cultivation, and I feel convinced that if many of the other varieties I have seen were laid before a chamber botanist, they might be considered by him entitled to rank as species.

On these grounds I consider that *Sorghum vulgare* should be alone recognised as a good species, and that all the other cultivated kinds should be reduced to varieties of that as the normal type.

The varieties enumerated in the Madras Exhibition of 1857 were the following:—

1. Common red jowári.
2. Common white do.
3. Common yellow do.
4. Alangkáru.—A small milk-white kind from Chingleput and Canara.
5. Shen chólam.—A red variety from Tanjore.

* The Telugu term for alluvial deposits in the beds and on the banks of rivers.

6. Chella chólam.—From Cuddapah.
7. Argudia jowári.—From Hydrabad.
8. Bhendya jowári.—A red variety from the Raichori Do-áb.
9. Lamde jowári.—A red variety from the Raichore Do-áb.
10. Kávali jowári.—A white variety from the Do-áb.
11. Mundara sólam.—From Pondicherry.
12. Muttre sólam.—From do.
13. Dúdh mogra.—White and pink jowári, with flat grains, from Hydrabad.
14. Kăkai chólam (lit. Crow cholam).—A black variety from Pudukotta, in Trichinopoly.

In the Exhibition of 1859 some additional kinds were found, viz.:—

From Cuddapah.

15. Bhat wáni.
16. Gaji wáni.
17. Chandal wáni.
18. Jaipúr.
19. Wunga.

From Mysore.

20. Kolada jola.

From the Raichore Do-áb.

21. Mellaji jola.
22. Bilapla.
23. Ken jola.
24. Niru jola.

From Trichinopoly.

25. Maskata chólam, probably an Arabian variety.

From Tinnevelly.

26. Kuruvi chólam.

From Cuddapah.

27. Kal nakki jowári.
28. Itrinjola.

M. Perottet has observed that the grains or corns of the *Imphi* and Chinese varieties are larger and finer than those of the common *cholam*, and regrets that the ryots do not care to sow them.

This remark suggests the importance of using greater care in the selection of the indigenous seed. From the above remarks on the grain of Rajahmundry, it will be seen how striking are the diversities in the quality of this grain.

There is little doubt that if pains were taken to secure the selection of the best description of seed only, and if such seed was supplied by one province to another, the indigenous grain would become equal in every respect to the African and Chinese varieties. For this purpose, the best and largest corns should be selected, by passing the seed through sieves like those used by the pearl merchants, which retain the larger and permit the smaller grains to pass through. In the experiments made at Rajahmundry, I found that 100 selected corns weighed 52 grains; another set, 53·3; while similar parcels, taken at random, weighed 42·5, 43·2, and 44 grains.

In conclusion, I recommended that the committees of the local exhibitions should be authorised to offer rewards for the best samples of seed-grain."

The attempt to introduce the cultivation of *Imphi* was not confined to Madras. In the last number of the Journal of the Royal Asiatic Society, a short account is given by Mr N. A. Dalzell, Conservator of Forests at Bombay, of the experiments made by officers in charge of districts under that presidency for the same purpose.

From this it would appear that they were attended with success, and that but partially, in three districts only.

In Belgaum the *Imphi* attained a height of 11 feet, with abundance of sweet juice; in Sattara it grew to 8 feet, and forty of the stalks yielded a pound of molasses; while in Kándés they reached a height of 9 feet with a diameter of 3 inches, but were found to contain but little saccharine matter. The *karbi* or straw, however, was found to yield excellent forage for cattle; and in the neighbouring district of Poona, where the trial was even less successful, the collector considered the *karbi* to be worth five times the same quantity of that derived from common *jowári.*

Mr Dalzell recommends that the experiment should be continued, on account of the eminent success it has obtained in Scinde, where it appears to have answered entirely.

2. *Penicillaria spicata*, Willd.; *Holcus spicatus*, L.

Of this grain there appear to be four specimens. It is known under the following vernacular names:—

Spiked Millet.

Kambu—*Tamil.*	Bájra, } *Hindi.*
Gante, gantelu—*Telugu.*	Sazgaran, } *Hindi.*
Sajji, sajjalu—*Telugu.*	

There appear to be fewer varieties of this than of most Indian grains. Roxburgh enumerates four kinds as cultivated by the Telugu ryots:—

1. Pitta ganti.	3. Pulla-boda-ganti.
2. Munda-boda-ganti.	4. Yeora-ganti.

And among those sent to the Madras Exhibition from the south were—

1. Kuruvai-kamba.	3. Perung-kamba.
2. Kátadi-kamba.	4. Puttu-kamba.

Of all of which there are specimens on the table.

3. *Eleusine Coracana*, Gærtn.; *E. stricta*, Roxb.; *Cynosurus Coracana*, L.

Lála, Srinika,	*Sanscrit.*	Tami, Tamidalu, Chollu,	*Telugu.*
Kéviru, Keppai, Kelvaragu,	*Tamil.*	Rági, Náchani,	*Hindi.*

It may fairly be questioned whether Roxburgh was justified in separating his species from the old *Coracana*, from which it differs only in having the spikes straight instead of curved, and being somewhat larger. The natives make no distinction that I am aware of, and they are very ready to see differences.

Rági is perhaps the most productive of all the Indian cereals. Roxburgh mentions the wonderful increase derived from two single seeds which came up accidentally in his garden, and yielded 81,000 seeds or corns.

It is the staple grain of the Mysore country, where it is produced in larger quantity than the demand, and is stored in pits in which it keeps sound for years.

During the great famine of 1813 these stores were opened, and tended greatly to relieve the distress. The Canarese still call this the Rági Bar or Rági Famine, to distinguish it from the great famine of 1802–3, which they call the Dógi Bar or skull famine, from the bones of the victims which lay unburied whitening the roads and fields.

4. *Setaria italica*, Beauv.; *Panicum italicum*, L.

Is represented by six specimens. Its names are:—

Kangu, Kanguni, Priyanguh, } *Sanscrit.*	Korra, Korralu—*Telugu.*
Tenai—*Tamil.*	Kangni, Rála. } *Hindi.*

It is a small, round, shining grain, generally of straw colour, but sometimes passing into black or red. The specimens on the table are :—

1. Aruppu-tenai.	4. Sen-tenai.
2. Seguppu-tenai.	5. Sadai-tenai.
3. Sembu-tenai.	6. Tenai.

5. *Panicum miliaceum*, Linn.

Of this the collection contains seven samples. The ryots distinguish two varieties, the one a small shining seed resembling that of *Setaria italica*, varying in colour from grey to black, and known as *sámai ;* the other of the larger size is called *kádai-kanni*, or quail's eye, and is marked with fine lines. Its names are :—

Varaka—*Sanscrit.*	Boragu, boragalu—*Telugu.*
Sámai, . . } *Tamil.*	Sáwa, sáma, } *Hindi.*
Kadai-kanni, } *Tamil.*	Chéna, chína, } *Hindi.*
Varaga, varagalu—*Telugu.*	

There are no specimens of *Panicum frumentaceum*, Roxb. ; *Oplismenus frumentaceus*, Kth. It greatly resembles the last, and is generally distinguished by the same names :—

Sámai—*Tamil.*	Sáwa—*Hindi.*
Boragu—*Telugu.*	

6. *Paspalum scrobiculatum*, Linn.

Six specimens occur of this grain, which is a small round semi-circular seed, of a brownish or chestnut colour, generally covered with a thin film. Its vernacular names are,—

Kodrava, . } *Sanscrit.*	'Arike, 'Arikalu, } *Telugu.*
Koradúsha, } *Sanscrit.*	'Allu, . . } *Telugu.*
Varagu—*Tamil.*	Kódru, Kóra—*Hindi.*

The florikin, or little Indian bustard, is often found in fields of this grain, and hence is called in Tamil *varagu kóli.* It is an inferior grain, only used by the poorest classes, and not reckoned very wholesome.

7. *Cynosurus ægyptius*, L.; *Dactyloctenium ægyptiacum*, Willd.

Of this two specimens occur. It is a small seed, intermediate in size between that of *Penicillaria* and *Setaria*, covered in part with a bearded husk, through which the shining seed is seen. It derives some of its native names from its resemblance to grass seeds.

Pil-arisi, or grass-rice,	*Tamil.*	Disakalu, . .	*Telugu.*
Kudarai-velai, or horse-tail, . . .	*Tamil.*	Udalu, . . .	*Telugu.*
Erangu, . . .	*Tamil.*	Safayid sáwa, or white millet—	*Hindi.*

The botanical name is given on the authority of Dr Rottler, but the *Dactyloctenium* is not stated to be cultivated by Roxburgh or Voigt. It may therefore be only a variety of *Panicum*, of which several kinds are cultivated by the Hill tribes.

8. The small grain, of which two specimens, one black, the other white, are found under the names of *ray-jira*, *kát-aravi-soppu*, has not been recognised. It was supposed to be a kind of Amaranthus, but is more probably a minute species of *Panicum* or *Eleusine*.

9. *Triticum vulgare*, Vill.

Two specimens of wheat were exhibited, one by General Cullen from seed sown at Ashamber in Travancore, 3000 feet above the level of the sea, where the average fall of rain is 95 inches. The other is from Bengal. It is cultivated, although to no great extent, in the Madras Presidency, on the black cotton soil of the table-land in Mysore and the Ceded districts.

10. *Zea Mays*, Linn.

This grain, though not cultivated as a field crop, is found in almost all native gardens, and in the back yards of the ryots, who toast the heads when nearly ripe, and eat the grain. They also toast the heads of the common Sorghum in the same way just before they become fully ripe. Eaten with butter, pepper, and salt, it makes a very savoury dish. Four specimens occur in the collection. The name is *makka-jonna*, *makka-chólam*, &c.

11. *Bambusa arundinacea*, Willd.

No specimen of the seed of the bamboo occurs in the series on the table, but several specimens were sent to the Madras Exhibition of 1857, among the "articles used for food." Although not generally eaten, it is used by some of the wild tribes inhabiting the forests as an ordinary item of diet; and during seasons of famine, which occur so often in India, numbers of the agricultural classes drive their cattle into the forests which clothe the mountainous tracts, in search of water and herbage, and they themselves subsist on the seed of the bamboo. It is, however, hard and unpalatable.

III. Pulses.

Of the agricultural products employed as food belonging to the *Leguminosæ*, the collection contains twenty-four specimens, viz. :—

Phaseolus vulgaris,	5	specs.	Lablab vulgaris,	3	specs.
Phaseolus Mungo,	2	,,	Canavalia gladiata,	1	,,
Phaseolus radiatus,	2	,,	Pisum sativum,	2	,,
Dolichos biflorus,	1	,,	Kurnool beans,	2	,,
Cajanus indicus,	3	,,	Without labels,	2	,,
Cicer arietinum,	1	,,			

1. *Phaseolus vulgaris*, L. (French bean. Single bean of native gardeners.)

Four specimens were contributed to the Exhibition from Pondicherry, and one from the superintendent of the Botanical Garden at Utakamand. This species is not an article of field produce, nor of general use among the natives of India, its culture being confined to gardens near European settlements. It hardly, therefore, deserves a place in this memorandum, but it is supposed to be indigenous to India, though now spread over the whole world.

2. *Phaseolus Mungo*, L.; var. *α. chlorospermus.* (Green gram.)

Mudga—*Sanscrit.*
Pacha-payar, Siru-payaru, } *Tamil.*
Pacha-pesaru, pacha-pesalu—*Telugu.*
Harya-múng—*Hindi.*

Var. *β. melanospermus; Phaseolus Max*, Roxb. (Black gram.)

Mudga-parni—*Sanscrit.*
Karuppu-payaru—*Tamil.*
Nalla-pesaru, nalla-pesalu—*Telugu.*
Kála múng—*Hindi.*

This is one of the most useful and largely cultivated of the Indian pulses. It is sometimes sown in alternate drills or bands, with the great millet (*Sorghum*), or spiked millet (*Holcus*), and in rice cultivation a crop is very generally taken off the same land when it has become dry. It is sown in the cold weather and is reaped in the hot season, after a period of from seventy-five to ninety days. The grain is largely used by the cultivating classes as an article of diet, mixed with rice, and the straw is left on the ground, which it serves to manure. So large a proportion of the pulse crops does it form, that these are collectively termed *payaru*, hence the word is synonymous with our "pulse." The black variety is less esteemed than the green, and is sown somewhat earlier, being supposed to require more moisture.

The flour of the green variety is an excellent substitute for soap, leaving the skin soft and smooth, and is an invariable concomitant of the Hindu bath.

3. *Phaseolus radiatus*, L. and Roxb.; *Phaseolus Roxburghii*, W. and Arn.

Másha, Vrishya, } *Sanscrit.*
Ulandu—*Tamil.*
Minumu, minumulu—*Telugu.*
Uddalu—*Telugu.*
Másh, Urud,* } *Hindi.*

This is, perhaps, the most esteemed of all the pulses, though not the most extensively grown. It bears a higher price, and is more in request among the better classes, entering largely into many of the more delicate dishes and cakes, such as the

* *Urud* is sometimes applied to the black grain *Phaseolus Max*, but more correctly to this species.

paparam or relish cakes, and those baked for religious ceremonies. Mixed with grain, it is considered to be strengthening for horses. The straw makes good fodder for cattle.

The seeds, as in the last, are both black and green, and hence it has a variety of names, as *máshparnì* in Sanscrit, and *káru-minumu*, in Telugu, for the black kind.

An average seed is the origin of one of the most common weights in use by Hindu goldsmiths. The unit is the *ratti* or seed of *Abrus precatorius*, from five to ten of which make a *másha*, or about seventeen grains troy.

It may be proper here to notice *Phaseolus lunatus*, L., the Lima bean, which is much cultivated in gardens under the names of Duffin bean and double bean. The beans are quite as good as, and supply the place of, those of *Vicia Faba*, the common bean.

4. *Dolichos uniflorus*, Lam.; *D. biflorus*, Roxb. (Horse gram.)

Kulatthá, kulatthiká,	*Sanscrit.*	Ulavu—*Telugu.*
Balukulá,		Kulthi—*Hindi.*
Kollu—*Tamil.*		

This species is much cultivated in South India, and affords the principal food of horses and cattle. For this purpose the seeds are well boiled, and given as soon as cool enough to be eaten. The liquor that remains is used by the lower class of servants in their own food. It occurs of all colours,—white, brown, and black.

Although no specimens are found in the collection, another species of *Dolichos* deserves mention here—

Dolichos sinensis, L.; *D. Catjang*, Roxb.; *D. tranquebaricus*, Jacq.

Rájamásha,	*Sanscrit.*	Alasanda,	*Telugu.*
Sumásha,		Bobbara, bobbaralu,	
Alasandra,		Yenikóte,	
Kárámani,	*Tamil.*	Danta-pesalu,	
Sadai-payaru,		Lobiya—*Hindi* and *Persian.*	

There are several varieties of this pulse,—white, red, dun, green, black, and varying also greatly in size, but distinguished by their form, which differs from all the other kinds in the beans being truncated at either end.

The flour is chiefly used in combination with other grains for making cakes, which are used by all classes.

5. *Cajanus indicus*, Spreng.; *Cytisus Càjan*, L.; *C. bicolor*, DC.
(Pigeon-pea.)

'Adhaki, Varna, varní, } *Sanscrit.*	Dál, the husked pulse or split peas—*Hindi.*
Tuvarai—*Tamil.*	Shákhúl—*Persian.*
Kandu, kandulu—*Telugu.*	In Bengal it is called *arar.*
Túr, the seed—*Hindi.*	

Of this there are several varieties; a small kind, which ripens in half the time of the larger sort, is distinguished as the small *túr*. Two or three varieties are also cultivated in the hills of the North Circars, under the name of *Konda-kandalu, bangara* or golden *kandalu*, remarkable for their beautiful orange and red-spotted flowers.

The pulse, when split, is in great and general esteem, and forms the most generally used article of diet among all classes. It is chiefly eaten mixed with rice, a mess known as *khichrí*—vulgó *kedjari*. Roxburgh assigns to it a comparative value in native estimation, after *Phaseolus radiatus*, to which he gives the first place, and *Cicer arietinum*, or chick-pea, which he reckons the second. But as far as the general and daily use of the several kinds may be taken as an indication of taste, the *Cajanus*, or pigeon-pea, must be considered as number one.

The best *túr* is sown in alternate drills with *Sorghum vulgare*, which ripens first and is cut while the *Cajanus* is quite small. It then remains for two or three months longer, and attains a large size, and is reaped at the very end of the harvest. The stalks are strong and woody, and are used for fuel. They are especially adapted for making the charcoal required in the manufacture of gunpowder.

6. *Cicer arietinum*, L. (Chick-pea. Bengal gram in the South.)

Chanaka, sanakha, Harimanthaka. } *Sanscrit.*	Bút, Harbara, } *Hindi.*
Kadalai—*Tamil.*	Nakhuda—*Persian.*
Senaga, senegalu—*Telugu.*	Hims—*Arabic.*
Chaná, channá—*Hindi.*	

A variety apparently of this pulse was sent from the Hyderabad territory to the Madras Exhibition of 1857, by Captain Taylor, under the name of *lath.*

The chick-pea is extensively cultivated, both as an article of diet among all classes, and as food for horses and cattle, in every part of India, except Madras, where its place is supplied by the *Dolichos uniflorus.* It is a *rabia* or after-crop, and ripens during the cold weather. At this time the dew with which it is covered is very acid, and is collected for vinegar by means of cotton cloths, spread over the field at night, and wrung out in the morning.

7. *Lablab vulgaris*, Savi.; *Dolichos Lablab*, L.; *D. tetraspermus*, Willd.

'Simbi, 'simbini, Nispáva, . .	*Sanscrit.*	Anapa, . . . Anumu, anumulu,	*Telugu.*
Avarai,* . . Mochakottai,	*Tamil.*	Chóta sím, . . Balar, . . .	*Hindi.*

Of this there are numerous varieties, and it is found both wild and cultivated. I am disposed to class the next species, or *L. cultratus*, also as a mere variety of this, the typical form. The difference consists in little more than the degree of curvature of the legume, and of the base of the style forming its point, and in the longitudinal or transverse position of the seeds. Roxburgh has particularised seven varieties of the former and six of the latter, dependent on size, shape, and colour only.

Balar is cultivated to some extent in the fields as a *rabia* or cold weather crop; and it is used as food for cattle, and also enters into the diet of the poorer classes.

Lablab cultratus, DC.

Avarai, . . Válavarai,†	*Tamil.*	Chikkuda—*Telugu.* Chóta sím—*Hindi.*

Several kinds of this variety are cultivated by the natives

* *Avarai* is also a general name of pulse; another generic term is *Tattaipayaru.*

† Literally, Tailed Lablab, from the straight or slightly subulate point of the legume.

in their gardens, and very generally by the poorer classes, climbing over the roofs of their huts, and supported on trellises in front of them. The different sorts are distinguished by the colours of the flowers, which vary from white to red and purple, and by the size and shape of the pods, which exhibit every degree of curvature, from straight to semicircular, one kind being designated *bagh-nak*, or tiger-claw, from its greatly rounded form. The same diversity is observed in the colour of the seeds, which pass from white to yellow, and brown, purple, and black.

Hence the numerous synonyms which it has been found necessary to refer to the normal species, as *leucocarpus, microcarpus, spicatus, albus, purpureus, cuspidatus, cultratus, ensiformis*, all of which have been described by authors as distinct species of *Dolichos*, and all of which may fairly be reduced to *Lablab vulgaris*.

8. *Canavalia gladiata*, DC.

Simbi (common)	—*Sanscrit.*	Tamma-kaya (cult.)	*Telugu.*
Kóli-avarai* (cultivated) . .	*Tamil.*	Adavi shimbi (wild)	*Telugu.*
Tambattanga (wild)	*Tamil.*	Bara sim (common)	*Hindi.*
		Kharsambal, . .	*Hindi.*

Canavalia gladiata, which is only found in a cultivated state, is probably the domesticated form of *C. virosa*. I have therefore included the native names of both kinds in the above list of synonyms. The term *'simbi* or *shimbi* in Sanscrit, like *avarai* in Tamil, and *sém* in Hindi, has a generic signification, and is applied to beans or legumes as a class. *Lablab vulgaris* and *Canavalia virosa* grow wild in almost every hedge, and to a superficial observer have a strong family resemblance, differing only in size. Hence the same native

* *Kole avarai* signifies literally fowl or poultry-bean; *adavi-simbi*, wild bean; *tambattam-kai*, tom-tom or drum-bean; but Rottler has not this application of the word to a vegetable in his Dictionary, although the name is in universal use; *bara sim* is big bean. *Khar-sambal* does not occur in the Hindi Dictionary, but is given in Ainslie's "Materia Medica." The Arabic word *bagla* or *bakila* is also commonly used as a general name for beans; *sadai* or *chadai-payaru* is a Tamil name for large kinds of beans, and is given both to *Canavalia gladiata* and to *Dolichos sinensis*; *payattangai* is another Tamil generic term for pulse, being simply *payaru*-pods.

names are applied indifferently to both, with the qualifying terms, "greater," or "less," or "wild." Another species of Canavalia, *C. obtusifolia*, grows wild on the sands of the sea-shore, and affords excellent pasture for sheep.

9. *Pisum sativum*, L.

Several specimens of the common pea were sent to the Exhibition of 1857, among which were a few prettily mottled with olive-green, which may perhaps have been varieties of Cicer. They were exhibited under the names of—

Pattáni, . . } *Tamil.*	Gundu-sanigalu—*Telugu.*
Vidutti-kottai, }	Batána—*Hindi.*
Bodi-sanegalu—*Telugu.*	

Ainslie states in his Mat. Med., that the pea is indigenous to the Mahratta country, but this appears to be a mistake. Several kinds are cultivated in Bengal under the names of sugar-pea, grey-pea, Patna or field pea, by the natives called *matár*, *dhurwa*, *kiraw*, &c.

The Karnool beans were not identified. They were flat, and prettily striped with white and black.

Besides the above, which refer to the specimens on the table, there are some other descriptions of *Leguminosæ* much cultivated in India, as—

Ervum Lens, L., or *Masúr; Adas*, Arabic.—In Bengal only.

Cyamopsis psoralioides, DC., { Kottavarai, Síni avarai, } *Tamil.* Gúr chikkudu—*Telugu.* Matki—*Hindi.*

Lathyrus sativus, L.—Kasúr, kisári, lang.—Cultivated in Bengal, not in the south.

Vicia sativa, L. (the Tare)—Ankri, *Hindi.*—Cultivated only in Upper India.

Mucuna utilis, Wall.; *M. nivea*, W. and A.; *M. capitata*, Buch., are all cultivated in the gardens of the natives; and I have even met with *M. capitata* among the hill race in the mountains to the west of Vizianagaram. The vernacular names are,—

Púnai-avarai—*Tamil.*	Khamach—*Hindi.*
Surutu, suritkáya—*Telugu.*	

Psophocarpus tetragonolobus, DC., the Goa bean, is cultivated in gardens for the table, but not to any great extent. In Tamil it is called Goa bean; in Hindi, *chandári* and *chár-patti*. *Arachis hypogæa*, L., is grown in the fields for the sake of the oil expressed from its seeds :—

Vér-kadalai, Mannili-kottai, } *Tamil.*	Mung-phali, Bhui-mung, } *Hindi.*
Néla sanagula—*Telugu.*	

and *Trigonella Fœnumgræcum*, L., is grown extensively in gardens for its seeds and leaves, which are in universal use as a tonic and carminative ingredient of curries,—

Mathí—*Sanscrit.*	Methi—*Hindi.*
Vendaiyam—*Tamil.*	Halbah—*Arabic.*
Menti, mentalu—*Telugu.*	Shamlít—*Persian.*

The temperature of the tropics, so unfavourable to the preservation of animal substances, and the habits of the people, derived probably, in the first instance, from this very fact, but now inculcated by their religion, which forbids the use of animal food, explain the importance of the preceding list of cereals and pulses, forming the chief means of subsistence of upwards of 200,000,000 of people. To meet so vast a demand the bounty of Providence has not only bestowed the extensive list of products already enumerated, but has also added a vast supply of gourds, pumpkins, and other cucurbitaceous plants, and of numerous stimulating and carminative spices, for the preparation of condiments, to correct and flavour a diet so extremely vegetable. These, with the coco-nut, plantain (*Musa*), sugar, certain vegetable greens, and the produce of the dairy in the shape of milk, butter, ghee, and cheese, constitute the exclusive aliment of the Brahmins and others of the higher classes, and enter largely into that of the inferior castes, who also indulge in the occasional use of fowls, eggs, mutton, &c.

Of farinaceous vegetables the supply is small. They have nothing to correspond in importance with the potato, on which the poorer classes depend so largely in Europe. Several kinds of yam* (*Dioscorea*), of arum,† and the sweet potato‡ (*Convolvulus Batatas*), come under this head; but they are not consumed to any great extent, and are certainly not in daily general use.

In addition to the tropical cereals, several of the best European grains are also grown in all parts of India, where from greater elevation, or more northern latitude, they can be raised with success. Wheat is grown on the table-lands of the Deccan, and throughout the whole of Northern India, and forms a principal constituent in the diet of the better classes. Barley and oats are also cultivated in the north.

A valuable report on the articles of food exhibited at Madras, in 1857, was drawn up by Dr J. E. Mayer, Professor of Chemistry in the University of that place, and is included in the volume of Jury Reports, published the following year.

Having made a careful analysis of the four principal grains, viz.,

Rági—*Eleusine Coracana;*
Chólam—*Sorghum vulgare;*
Bájra—*Penicillaria spicata;*
Rice—*Oryza sativa,*

he obtained the following results :—

		Nitrogenous Matter.	Non-nitrogenous Matter.	Inorganic Matter.
Rági	contains	18·12	80·25	1·03
Chólam	„	15·53	83·67	1·26
Kamba	„	13·92	83·27	·73
Rice	„	9·08	89·08	·47

Comparing the albuminous or nourishing proportions with those of the European cereals, the following is the result :—

* Kilangu, valli-kulangu, *Tamil;* Pendalam, *Telugu;* Pandálú, *Hindi.*

† *Colocasia, Amorphophallus,* &c.—Sémbu, séppang-kilangu, *Tamil;* Cháma, chára, kandu, *Telugu;* Kanda, kachu, kacham, kachálu, *Hindi.*

‡ Sakara-valle-gaddi, *Tamil;* Chila-gadda, *Telugu;* Genusu-gadda, *Telugu;* Ratnálu, or Shakar álu, *Hindi.*

	Nitrogenous Matter, according to M. Boussingault's Analysis.	According to Mr Horsford's Analysis.
Wheat, . . .	14·45	17·24
Oats, . . .	13·93	15·24
Barley, . . .	,,	14·72
Rye, . . .	10·07	11·92
Phaseolus vulgaris, .	,,	28·64
Pisum sativum, . .	,,	28·02
Ervum lens, . .	,,	30·46

Mr Mayer did not analyse the pulses, but the preceding table shows how large a proportion of nutritive matter they afford in comparison with the cereals. And this affords a remarkable illustration of the coincidence between the results obtained by scientific inquiry and those derived from practical experience. For the native Indian, wholly ignorant of chemistry, has learned to correct the poverty of his rice diet by the addition of pulse, to prepare his favourite mess of *khichrí*, which thus yields an average supply* of nutritive aliment equal to that of the best and most wholesome cereals.

On a Recent Landslip. By Rev. JOHN DUNS, F.R.S.E., Torphichen.†

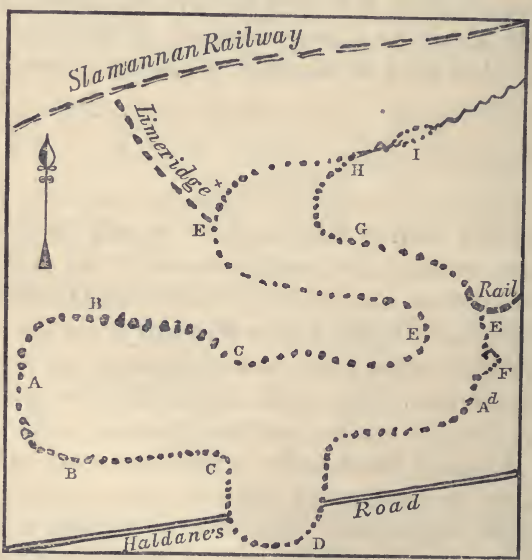
About seven A.M., of Monday, 12th August 1861, when a young man reached the south-east end of the Auchingray Moss, Lanarkshire, with the view of crossing to the other side, he heard, as if all around, a noise like that of the sea. Looking up the moss to the west, he was surprised and alarmed to notice, as he said, "the whole bog sinking and rising in a wavy-way for some minutes, and then breaking up with a loud crash." I visited the locality a few days later, when the moss was still in motion, and made the notes which I now beg to lay before the Society. The observations have some bearing on several not uninteresting phenomena in the formation of modern strata.

In pointing out the site of the landslip, one or two general

* Rice, 9·08 + pulse, 28·02 = 37·10 ÷ 2 = 18·55, the nitrogenous proportion of *khichrí*.

† Read to the Royal Society of Edinburgh, 17th March 1862.

remarks may be made on the prominent physical features of the district. A broad, irregular, and much broken mass of trap stretches in a south-west direction from Linlithgow to Airdrie. The lowest parts of this are generally in the centre. On both edges it shoots abruptly as dykes into the adjacent stratified rocks, and sometimes rises to a considerable height. The central depressions have often no other covering than stiff white or blue clays and peat. The clays, in these hollows, vary in depth from a few inches to nearly 20 feet. The peat ranges from 1 to 16 feet deep. Not far from Airdrie this trap sends one irregular fork to the north-west till it reaches Kilsyth, and another south-west to Glasgow. At the point where the trap ridge divides, and where the parish of New Monkland, Lanarkshire, meets that of Slamannan, Stirlingshire, a broad and deep depression occurs. In this lies the Auchingray Moss, the scene of the landslip.



The accompanying rough plan of the ground lying between the Slamannan Railway on the north, and Haldane's Moss Road on the south, will help to illustrate the following remarks. The area occupied by the landslip is enclosed by dotted lines.

It might be concluded, from the present aspect of the ground, that the slip had been confined, in its whole length, by the heath-clad ridges represented by A and B B, which bound it on three sides. But the space where these elevations now appear was very little, if at all, above the level of the surface set in motion. The great depression now seen is the result of the immense quantity of soil carried away while the force lasted. On sounding some of the water-filled gaps at the centre of the broadest part, B B, I found many of them 6 and 8 feet deep, and one 16 feet deep. This fact explains whence came the vast amount of peat soil, sent not only into the course of the stream below, but even into that of the Avon, to be cast on its banks as far down as Linlithgow Bridge, thirteen miles distant.

The effects of the landslip are first seen at A. Here all the masses have fallen forward to the east. At the widest part B B, the soil on the south side has fallen to the north, and that on the north has given way to the south. The pressure on three sides has thus been to the centre, where the depth is greatest. This seems to indicate that the force had first become active at that point, and also to suggest the explanation of the movement.

About forty years ago the central part was known in the district as the "Blind Loch,"—water, namely, covered with the reeds (*Typhaceæ*), rushes (*Juncaceæ*), horsetails (*Equisetaceæ*), bog-mosses (*Sphagnums*), and the like, which occur in such situations. This has for many years been so far solidified that people could cross it without inconvenience, though, as one remarked to me, "in winter it was always softish."

For some weeks before the occurrence of the landslip continuous rains had fallen. Sabbath, 11th August, was one of the wettest and most boisterous days of the season. The rain fell very heavily, and the wind blew strongly from the west. Great quantities of water appear to have reached the surface of the impervious underlying clay, and to have floated the lightest central part—the area proper of the "Blind Loch." Denser matter would then press in from the sides A and B B, and the slip, having carried away the breast-work on the east, would naturally take the direction of least resistance, namely, the course of the stream which drains the moss.

The area set in motion may be roughly estimated as about 300 feet broad at B B, and 1320 in length from A on the west to A *d* on the east.

In its course it met with elevations at C C. The most formidable of these lies on the north side. This gave the flow a direction to the south, and led to the deposit of the tongue marked D, which is about 160 feet long by 100 feet broad, and is made up of masses of peat from 1 foot to 4 feet thick. Here damage was first done. The material spread over portion of a field on which a crop of oats was beginning to ripen, covered part of a highway formed at the expense of the late Robert Haldane, and known as Haldane's Moss Road, and wasted part of a field of turnips lying on the south of the road. At the point where the flow was forced to turn to the south, some very deep rents were to be seen, and proofs of great disturbance presented themselves everywhere. Irregular masses were lying in all positions. In some cases they have been turned upside down, and lie face to face with the sunken lumps which had previously formed the surface of the bog. Traces of the underlying blue clay, associated with branches and root stems of native birch (*Betula alba*), are to be seen on what is now the surface of the inverted masses. Among these I picked up fragments of land-shells, *Helicidæ*. Two species could be identified, *Zonites cellarius* and *Helix rotundata*,—the former by a fragment showing four whorls of the flattened spire, larger than a piece of any other British form of the genus would have been; the latter by its still distinctly marked radiated striæ. These shells must have been laid down on the clay contemporaneously with the birch branches and roots. No native birches are now to be met with near the moss. A long search for land shells produced only one Helix (*H. rotundata*), a species to be generally met with in the district, but not common on the sides of the Moss Road. The birches, no doubt, bear witness to a former landslip, of which we have now no other record. They must have been buried anterior to 1809, when Auchingray was purchased by the late Robert Haldane. His biographer says, "On the estate, containing 2400 acres, there was but one solitary tree, a weather-battered ash, which stood beside the door in which the Principal of the University of Glasgow, Dr Macfarlan, was born."

A peculiarity of many of the root stems may be pointed out. Instead of being rounded, like the branches, they have a central depression, or *sulcus*, on both sides; they are flat, recurvated, and run quickly to a point. Is this the form they assume when they strike into cracks in clay underlying soil in which they find their chief support? I have often noticed this peculiarity in the roots of one of our firs (*Pinus sylvestris*) in such situations. If this be so, these birches must have stood on a soil much nearer the bottom clay than any tree that might now be planted on the moss would do. In shape the stems curiously bear a strong resemblance to many fragments of *stigmaria*, met with among the debris of the neighbouring coal pits.

When the soil set in motion by the slip reached the extreme south of the tongue marked D, it again turned north, and, bending north by east, it met a plantation of Scotch firs, which stretches from the highway down to the stream which drains the moss. A few of the trees have been carried several yards forward, and now stand in an upright position, as if they had not been moved from their place. Some have been violently thrust top downwards into the underlying clay. Others have been placed horizontally on the edge of arrested lumps of peat. The flow at this point covered part of another cornfield. A little to the north of A *d* it filled a whinstone quarry 15 feet deep, F. At the narrow neck E E, the depth of the flow was more than 12 feet. Turning this neck, it met the Limeridge Railway—a mineral traffic branch of the Slamannan line—swept part of it away, covered a large portion of it, and did much damage to a third corn field lying north-east of the line.

An intelligent lad, who watched the landslip from its commencement, wrote: "*August* 15*th.*—The railway is now covered half-way down to the main line. The company are lifting the rails before it, as they would not get them again, there being such an awful body of it. My father and I came round that way this morning about five o'clock. It was moving at the rate of a yard every two minutes." "*August* 16*th.*—The moss is now coming down Binniehill Burn like tar." "*August* 17*th.*—The moss is now down to Binniehill. The haugh below the office is covered with it as wide as Clyde at the Broomielaw Bridge. It is a black looking country here." The rate of progress was much slower near the centre of the slip. I stood on several of the huge masses as they moved along, but the motion was scarcely perceptible. A peculiar tremulous sensation was communicated by the movement, much like that felt by one standing on a railway platform when a train is slowly passing.

Turning from the Limeridge Railway, the flow filled a small natural basin, marked G G. Many of the lumps left here were of great size. One measured 7 feet by 4 feet, and was nearly 6 feet deep. At H, on the east of this basin, great quantities of flow were carried into Binniehill Burn. As the stream at this point is confined by steep banks, the floated peat must have been 6 feet deep, judging from the traces it left on both sides. At I it entered the haugh described above as being " as wide as Clyde at Broomielaw Bridge." The next place favourable for the flow spreading occurs in the haugh opposite Binniehill House, which stretches down in the direction of the Avon, on the east of Slamannan village. Here it covered the highway at two points, and left in many places about two feet of peat on the top of soil which had been under cultivation.

In preparing this paper several relative topics have been suggested, to which I may be permitted to allude very briefly: —1. The uncertainty associated with fluviatile deposits, both as regards age and manner of deposition. When the material set loose by this landslip reached the Avon, it was drifted at several points into hollows on both sides of the river, in which it left from 1 to 2 feet deep of peat soil. The river suddenly rose higher than usual during the rapid thaw of the snow which fell on Thursday the 6th current (March 1862), and, in some cases, covered the peat with 6 inches of sand and gravel; in others, it swept all traces of the landslip completely away. 2. Though the Auchingray landslip is not to be compared, in its extent and in the injury done, to the great Solway landslip of 1771, yet in many respects they bear a strong resemblance to each other. In the beginning of last autumn Mr James Cunningham and myself visited the scene of the Solway slip, and were able to trace it over the whole area it had influenced, as we afterwards found on consulting the plan given in "Hutchinson's History of Cumberland" (1794). The remains of the flow of the Solway slip is now in many parts covered with nearly a foot of the red soil, formed from the local Permian rocks, which has been pushed in over it from adjacent fields, and deepened by agricultural operations. This was early realised. Hutchinson (as above) writes, "Every inch of the ground, thus almost miraculously destroyed, has been and is totally recovered; and is at this moment waving with richest harvests. All the plain is now in good order and tilth, as if no such astonishing event had happened." The same process is already at work where the Auchingray slip has left its debris. At the centre of influence of the Solway slip deep sections have been made in the peat, and distinctly marked bands of a light colour may here and there be noticed,—traces, no doubt, of inverted masses like those described above. 3. At the place, in the course of the Avon, where the waters were most influenced by the flow, many of the largest trouts perished. Soon after the Solway slip occurred, Gilpin wrote an account of it, in which he says, "The overplus found its way into the Esk, where its quantity was such as to annoy the fish; no salmon during that season ventured into the river." 4. On the day before the Auchingray slip happened, the "Black Loch," which lies in a basin slightly elevated above the moss about a quarter of a mile south by east, was more than usually agitated, and rose higher than it had ever been observed to do. On the day on which the slip occurred, the "Elrigg Loch Moss," nearly three miles distant, moved *en masse* more than 3 feet forward in the direction of the Loch. 5. The county which the flow specially influenced has long been noted for its periodic changes of large areas of surface. Illustrations are given in Nimmo's "History of Stirlingshire" (1777) which deserve to be kept in mind. Many such notes occur in local histories which should not be lost sight of. They not unfrequently correct the conclusions formed from recent surveys, and will always be found useful in the study of the surface geology of particular districts. One quotation may be made from Nimmo. "In the last century," he says, "a phenomenon appeared in this shire, proceeding from the same causes, and similar in many of its circumstances to that which took place a few years ago at Solway Moss. A part of a large moss, called Lethen Moss, lying between the parishes of Larbert and Airth, was suddenly removed out of its place by the water, which had been pent up in its cavities, forcing a passage to itself, and carrying along with it to a considerable distance so large a quantity of the flow as covered near an acre of ground. The scattered fragments that were thus pushed by the flood are still to be seen at the bridge of Pow House, at a great distance from the rest of the moss. The people in the neighbourhood mention the same observations as having been made by their forefathers which were made upon the eruption at Solway, as that the moss at that time sensibly subsided, so that objects before invisible to those that dwelt on opposite sides of it began to appear; particularly that the hill of Airth, which before was totally intercepted by the moss from the sight of those who lived upon the west, became immediately obvious to their view." 6. On visiting the district last month, I noticed that the part marked D on the plan has already begun to lose many of the characteristic marks of disturbance, and is fast assuming all the appearances of a regularly formed gradual deposit. Now, were mining or other operations to lead to the opening up of this sixty or seventy years hence, the surface geologist might find in the section material for generalisations of the most startling kind. A section made to the surface of the trap would reveal the following points,—blue clay, several feet of peat, a grey soil having embedded in it the straw and grains of the common oat, and, on the top of all, peat, say six feet thick. "Peat," the observer might affirm, "is deposited at the rate of one foot in thickness in 300 years. This layer shows all the evidences of gradual deposit through long centuries! Six feet in thickness, it tells the interesting tale of 1800 years. Our Caledonian forefathers must then have been much misrepresented by the Romans. At the period of the Roman invasion the Celts could not have been rude savages. Proofs are before us which should satisfy the most sceptical. They were devoted to agriculture. Here are distinct traces of *Avena sativa!* That iron instrument embedded in the grey soil—a rude form, no doubt, of our highly polished curved harrow-tooth—bears witness to considerable progress in the useful arts!" Such reasoning is not uncommon, based on data *almost* as reliable as those furnished by the Auchingray landslip.

The Geology of Moffat, Dumfriesshire. By William Carruthers, Esq., F.L.S.*

Lithology.

I purpose in this paper describing the geological features of the district around Moffat, taking the village as my centre, and including all that lies within a radius of four or five miles. The district is situated in the centre of the immense Silurian tract of the south of Scotland; its predominant rocks consequently belong to the Silurian period. A red sandstone lying unconformable to them is the only other stratified rock. The superficial deposits are not numerous; they consist of boulder clay, gravel and sand, peat and shingle. A trap-dyke, which runs through the district a mile below Moffat in a south-east direction, is the only igneous rock with which I am acquainted.

Bibliography.

I shall confine this bibliographical notice to works bearing distinctly on the district around Moffat. Hugh Miller has given, in a paper read to this Society in 1852, an admirable history of the Silurian rocks of the south of Scotland.

In the Old Statistical Account of the parish (1792), the Rev. Alexander Brown, the immediate successor of Dr Walker, describes the soils, and alludes to some of the economical products of the parish.

In 1775 Annandale was searched for coal by Mr Burrel,

* Read before the Royal Physical Society, on 26th March 1862.

but the account of his survey remains in the possession of the county unpublished.

In 1800 the county gentlemen were anxious to obtain a geological description to accompany their excellent county map, and for this purpose applied to Robert Jameson, then a favourite student of Dr Walker's, to survey the county. He was on the eve of setting out for Germany, and consequently declined at that time to undertake what he afterwards in 1805, on a renewed application, performed. In the meantime, General Dirom prepared some sections of the county, from published data, which were engraved on the map; and the Messrs Busby, two coal-viewers from Northumberland, were engaged to survey the county. Their journal was published as a supplement to Dr Singer's "Agriculture of Dumfriesshire," 1812. It shows them to have been shrewd men, with quick eyes and sound judgments. They were not led astray by the dark shales to expect coal in the "primitive" rocks; they searched in them for minerals and slate. They found no certain indication of the former, but recommended a locality in the Frenchland Burn as a likely locality for the latter. They bored also for marl, but without success, at Calla Bank and Loch House.

Professor Jameson, in his "Mineralogical Account of Dumfriesshire," 1805, first referred the predominant rocks of the south of Scotland to their true position. Hutton, in his "Theory of the Earth," considered them as *primary* strata, but Jameson showed that they were members of Werner's Transition Series. He gives an accurate account of the mineralogical peculiarities of the rocks, but is entirely ignorant of the contained fossils. He examined the shales at Hartfell Spaw, but noticed only their mineralogical appearance, and failed to observe the graptolites which abound in them. An anonymous critic, evidently acquainted with the rocks of the district, says, in a review of Dr Jameson's work, in the Literary Journal for 1806, "We know that *vegetable petrifactions* are very *common* in the greywacke slates of Dumfriesshire." The graptolites, which this unknown writer had evidently observed, remained unnoticed yet for many years. It seems scarcely possible that the keen eye of Dr Walker could have failed to see them. He says, "During my long residence at Moffat I collected, in a number of short tours, all the remarkable minerals of Dumfriesshire." We cannot now ascertain to what extent the structure and peculiarities of the district had been determined by him, because of the unfortunate loss of all his papers. It was not till the year 1850 that Harkness, Sedgwick, Murchison, and others, again drew attention to the rocks of the district, and re-discovered the forgotten "vegetable petrifactions." In the interval much had been done to determine the structure and position of the rocks of the south of Scotland, by Maclaren, Nicol, and Sedgwick. Professor Harkness, in his valuable and interesting papers published in the "Geological Journal," 1851, refers the rocks of the district to the Caradoc sandstone, from the characters of the graptolites. He describes in detail the anthracitic shales. An examination of their various localities led him to the conclusion that there was an anticlinal axis at Dryfe Water, that the strata north of this dipped northwards, and those south dipped southwards, and that the frequent recurrence of the graptolitic shales was produced by three faults—the various localities grouping themselves, as he supposed, into three series. Sir R. Murchison, while travelling from Dumfries to Moffat in the same year, supposed that the axis existed to the north of the former town, and published this opinion in his "Siluria," 1854, considering it identical with that of Harkness, and using one of that gentleman's diagrams to illustrate his views.

This is the generally received theory of the structure of the districts.

Silurian Rocks.

The Silurian rocks in this district are remarkably similar in their composition and structure. There are no alternations of limestones, sandstones, shales, &c., as in the newer formations, or even in the Silurians of some other districts. The rocks are almost entirely composed of water-worn quartz grains and clay. These materials have been deposited either as mud, or as sand of different degrees of fineness, or of a mixture of both, and have produced shales or sandstones which are extremely indurated, from the long continued metamorphic action to which they have been subjected. The argillaceous sandstone or *greywacke rock* is the predominant rock. It is generally fine grained, and of a uniform greyish colour, breaking with an uneven and somewhat conchoidal fracture. The beds in which it occurs are generally of considerable thickness, though occasionally it is met with in thin layers, as at the Common Craig, where it has for long been quarried as a building stone. It forms a beautiful and very durable building material. A large portion of Moffat is built of it. The *shales* are generally light coloured, but in some places they are more or less blackened by anthracite, derived originally either from the animal bodies whose remains abound in these shales, or more probably from the sea-weeds that were their companions in the Silurian seas, and which, from their soft cellular structure, have left no definite traces behind them on the rocks. Iron pyrites, aggregated in small nodules, or scattered through the substance of the rock, is common in the shales. So also is alum; at Garple the shales are so highly aluminous, that a mineral water is obtained by dashing the water of the burn against the more friable layers. Hand specimens of the shale are frequently broken up in the cabinet by the contained alum forming into masses of beautiful acicular crystals and separating the original layers of the clay. The whole of the strata are singularly free from lime. The only calcareous rock that I am acquainted with is found in Garple Glen, but it contains such a small proportion of lime, joined to a large amount of mud, that it is of no economical value. Small veins of calcareous spar, as well as of quartz, occur frequently in the rocks. The indurated light-greyish or cream-coloured shales have been quarried for roofing slates at the head of Corrieferan Glen. They exfoliate in the planes of stratification, and have no true slaty cleavage. They are thick and heavy; and though very durable, the bad roads, and the working expenses of a quarry in such a locality, have caused them to be neglected.

The general directions of the strike of the Silurian strata is east and west; and the dip, when not vertical, is always at a very high angle—70° or more. Professor Nicol has noticed in Peeblesshire what may be observed in this district also, that the direction of the dip is towards the interior of the mountain chains, being south on the north, and north on the south side. The few scattered records of the strike and dip of the Silurian strata of the south of Scotland seem to be insufficient to establish a satisfactory theory of their structure. This will follow only after the observing and recording on a good map a large series of observations throughout the country from St Abb's Head to Portpatrick, and from the Pentlands to the Solway. The theory of Professor Harkness, adopted by Sir Roderick Murchison, does not seem to meet the facts. Many of the additional localities for graptolitic shales, discovered within the last ten years, do not fit into his three faults. Nor does it seem possible that strata, vertical, or so highly inclined, could repeat themselves in a series of faults. Faults cannot *tell*, except on more or less horizontal strata. It is more in accordance with my own observations and those recorded by others, to believe that the position of the strata is owing to enormous flexures produced in a manner similar, but not so regularly, to what has been observed and ably expounded by the Professors Rogers as occurring in the Appalachian Mountains.

Permian Sandstone.

The red sandstone is a very friable rock, the quartz granules of which are held together by a ferruginous cement. Its structure is frequently very coarse, forming a sandstone conglomerate, containing numerous generally angular fragments of the Silurian rocks. At Newton it has a fine and uniform grain. A few years ago a large quantity was quarried at this place for building, but it was so friable that it could not be used. It occurs in the bottom of the valley of the Annan and some of its tributaries, in strata nearly horizontal, rising slightly towards the surrounding high ground. It may be traced at the base of Hartfell, extending from the Corehead Burn to within about a hundred yards from the Meikleholmside Bridge, where the greywacke rocks come down into the bed of the river, and make an evident break in the sandstone. It appears again further south on the roadside about three-fourths of a mile beyond Moffat. Probably this section and the appearance of the same strata in the bed of the Well Burn, were the foundation for Professor Jameson's statement, that the Gallows Hill (he evidently by mistake writes Chapel Hill) was formed of this sandstone. The same deposit occurs on the west side of the Annan, opposite Moffat, in the Horse Linn, and in Langshaw Plantation. It is found also in the Frenchland Burn, at Beld Craig, Wamphray Water, Raehills Glen, &c.

This sandstone has hitherto yielded no traces of fossils in the district. It is evidently related to the red sandstone of the lower part of the valley, which contains the tracks of reptiles so beautifully figured by Sir William Jardine; and is thus most probably of Permian age. It has been deposited since the valley assumed its present conformation, though some changes have taken place since its deposition, as is evident from the inclined position the beds occupy in the Horse Linn, and in the localities where the junction is seen between them and the Silurian strata. Probably these last changes were contemporaneous with the intrusion of the trap-dyke, which we shall presently notice, and were the result of the causes which produced it.

The Permian sandstone was referred to the Carboniferous series by Professor Jameson, Dr Singer, and others. Hence arose the notion that coal existed in the district. Dr Singer, in his "Agriculture of Dumfriesshire," 1812, at considerable length and with great ability, examines the merits of the case, and concludes that as coal has been found under red sandstone, the Coal-measures may be hid by these strata in this district. He therefore recommended boring, and he regrets that an attempt made near Nethermills was stopped before anything satisfactory could be determined. The examination of the district, however, shows that the conclusion of Dr Singer, though correct theoretically, is really incorrect, for it is evident at the various junctions of the formations, as in the Newton, Hartfell, or Frenchland Burns, that the unconformable sandstone rests immediately on the upturned edges of the Silurian strata.

The occurrence of the black, coal-looking, anthracitic Silurian shales in many localities, has led to the belief that coal existed in their neighbourhood, and has caused several abortive attempts to reach it to be made, in opposition to the published opinions of the Busbys, Jameson, and Singer. It is remarkable that landed proprietors in every Silurian region have been induced to spend their money in vain attempts at searching for coal, where these anthracitic shales occur, on the recommendation of empirics, and generally in opposition to the published or known testimony of scientific men.

The Trap Dyke.

The Trap Dyke has been quarried for some years at a point where it projects on the surface near the summit of the Lochhouse Hill. It supplies the bluish stone which has been extensively used in the recent buildings in Moffat. Its relation to the strata, through which it is intruded, can be best seen in the bed of the Evan, a little above Longbedholm Cottage. Its direction is N.W. by S.E. Beyond the point where it crosses the Evan, it may be traced in a N.W. direction until it crosses the line of the Caledonian Railway. In the opposite direction it has been quarried on Evan road side. It pushes out into considerable prominences in several places on the Coates Hill. It is also quarried, as has been said, on the Lochhouse Hill, and again in a plantation on the farm of Woodhead. Mr David Stewart has observed quarries in it in Dryfesdale and Eskdale. I believe it to be the same dyke that occurs again at Langholm.

It is a compact, fine-grained greenstone, distinctly crystalline in the centre, and becoming compact and amorphous at the edges. It is 32 feet wide at the quarry on the Evan road.

It is difficult to determine positively the age of this dyke from the strata in this district. If the position of the sandstone on the sides of the Coates Hill tells, as it seems to do, that this hill was elevated subsequently to the majority of the hills around, then this trap dyke must be either a contemporaneous or subsequent intrusion.

The Boulder Clay.

The boulder clay is a light-coloured clay, containing small boulders, many of them having the rubbed and polished appearance peculiar to and common in this deposit. It covers the Gallows Hill. The only section of it that I have seen is in a gully in a narrow plantation running down from the Old Well road; but this is of no great depth. It is exposed in the Whins, where it is sometimes dug for use in the village. The shoulder of land between Moffat and Annan Waters, forming Aikrigg farm, seems to consist also of boulder clay. A few of the large boulders here lying on the surface are from the Trap Dyke, which passes through the fields in this locality, although it cannot be detected on the surface.

Gravel, here and there intermingled with sand, occupies the bottom of the valleys. At Granton, on the Dykefarm and in other localities, it exists in considerable masses. It presents no peculiarities requiring particular notice.

The sides of the hills are covered with angular shivers—fragments of the underlying rocks—mixed with soil.

Peat is abundant in the district. The flat summits of the mountains are covered with hill peat formed of, and now forming from, the mosses, lichens, heather, and rushes which cover the hills. It is a friable peat, wanting coherence, and is generally intersected by innumerable gashes (moss-hags), formed by the draining of the rain-water. The peat in the low grounds, as at Lochhouse, contains the trunks of trees of species similar to what still grow in the district,—fir, hazel, and birch.

Epicosmology. By Hugh Doherty, M.D., Dulwich.

In a Philosophical Journal we may deal with the speculative questions of natural science as well as with descriptive outlines; and the increasing difficulties of inductive method show that the time has arrived for dealing with principles as well as facts. We therefore beg leave to ask the following questions, and comment upon them, from a certain point of view.

Is there an Architect of nature, and a plan of order in organic structure and genetic evolution? Does Scripture contain an outline of the plan of natural and spiritual evolution on our globe? Is man himself a microcosmic universe constructed on the same principles of order which reign in the macrocosmic universe?

Can inductive method answer any of these questions, or must we have recourse to a deductive method to put order in the multifarious cumulations of inductive observation and description! We believe there is an Architect; that He has a plan; and that this plan is openly revealed in human nature. From this hypothesis we form a conception of divine order in the realms of nature, and derive from it the principles of a deductive method to complete the labours of inductive science.

Principles of law and order cannot be discovered by induction, which is only capable of descriptive accuracy and congeneric grouping. The conception of a principle or model plan, from which organic method may divine the natural order of arrangement, is necessary to complete the cumulative labours of induction.

Without a teleological conception to give life and purpose to creation, the natural sciences, built up in fragments by inductive method, have no real meaning for the human mind, which looks upon their various results as a child might see a watch, and wonder what it was, or why it was constructed. Without a full and true conception of the principles of order, deductive method may be more delusive than inductive method; and we know that it has led the human mind astray more often in the progress of the ages; but still, the two are necessary to complete each other. One cannot do the work of real discovery without the other. Organic method is, in fact, a compound of the two; and those who think they follow the inductive method only in the natural sciences, delude themselves whenever they attempt to form a natural order of arrangement, and build up a system of classification based upon diversities of the nervous system, or some other portion of the internal structure of animals, or on diversities of the external form alone. Such conceptions, true or false, partial or complete, necessarily give rise to a deductive principle of method and arrangement. And even those who question all such ideas of order, and confine themselves to the study of genetic evolution mainly, conceive a principle of "natural selection" to explain the "origin of species;" while their followers who still indulge the love of order and arrangement, multiply divisions of organic types as they proceed in multiplying observations and descriptions of the unexplored fields of nature. Two distinct "sub-kingdoms" have been lately recognised within the limits of the "zoophytes" of older naturalists,—"Protozoa" and "Cœlenterata;" and this, with all due deference to those who deem it warranted by facts, we venture to think premature, for there has, confessedly, not yet been a sufficient study of the life-history of all the species, and the various modes of genetic evolution in the lower forms of the Invertebrata. The new and conscientious investigations which have led to this arrangement of "sub-kingdoms" cannot be too much lauded, but these distinctions are nevertheless, in our opinion, premature.

The genetic theory of "natural selection," varying with the conditions of external nature and modifying types of structure by gradual changes thus effected, makes no difference to the questions here proposed; for the Architect must have a plan or plans of structure, and a plan or plans of evolution, and the influence of external conditions in modifying structural evolution, as far as true in fact, must form a part of the great plan as a means to an end. The question still remains, What is the plan—what the end in view? To say we cannot know, is merely an evasive answer.

With regard to the distinction of "sub-kingdoms" in organic nature, we may observe that the great naturalists have taken the highest and the lowest degrees of evolution as the limits of distinct types of structure, in forming separate divisions. Cuvier defined four great plans of animal organism in zoology; Linnæus, two main types of vegetable structure in Botany. *Vertebrata*, *Articulata*, *Mollusca*, *Radiata*, *Phanerogamia*, and *Cryptogamia;* these are the most distinct organic forms in epicosmic nature. De Jussieu defined the lowest degrees of distinction in the vegetable world, when he described them as cotyledonous seeds, and acotyledonous. The study of fruits and seeds, and the various degrees of evolution from fruits and seeds to the fullest development of every known species of vegetable, has been well conducted in most departments of botany. The study of ovology and genetic evolution has been more or less pursued in many species of animal organism, but not as yet enough, we think, to warrant us in forming a new "sub-kingdom" for the so-called "Protozoa." It would be just as natural to form a separate "sub-kingdom" for truffles and the lowest forms of cryptogamic vegetation.

All simple germs of organism—ova, spermatozoa, and the earliest stages of evolution in such germs—are more or less albuminous homogeneous bodies in a protozoic state; and when we compare the known varieties of genetic evolution in the lowest types of the Invertebrata with the various modes of propagation in the vegetable forms of structure, and the various stages of arrested development in each division, not to mention teratological deviations, we may hesitate before we form new typical sections such as those implied in the new sub-kingdoms of "Protozoa" and "Cœlenterata."

In this conviction we confine ourselves at present to the old sub-kingdoms in zoology and botany; not that we object to numerous distinctions where they are natural and necessary, for we now propose a list of such divarications in the inorganic realms which may, perhaps, be deemed unnecessary by some competent authorities. The question is, however, one that must be dealt with from the deductive point of view as well as the inductive, before we can hope to arrive at a satisfactory solution. From our point of view, which may be wrong, and is no doubt imperfect, there are but twelve realms in epicosmic nature, half of which are inorganic and the rest organic. The number 12, in human nature, represents fulness and completeness, and not improbably in epicosmic nature also. The conception which postulates this view of things may require alteration, but it will first require proof of being incomplete or otherwise defective. In the epicosmic realms of our globe there are two primary distinctions to be made,—the Inorganic and Organic; and each of these contains several distinct realms of physical type and structure, which require separating from each other in the course of analytical investigation. In the first division there is an *Atmospheric* realm, an *Oceanic* realm, and a *Geo-*

spheric realm, a *Pluvial*, an *Exuvial*, and an *Elemental* realm; in the second division there are six organic realms. A dozen realms in the so-called "animal, vegetable, and mineral kingdoms."

These realms are neither continuous nor dichotomous in their connection; the atmosphere is not a continuation of the sea; the sea is not an "embranchment" of the land. Organic realms are equally distinct and parallel in distributive order. There is no common stem or type in which the different realms or "sub-kingdoms" meet, and therefore the word "embranchment" is inaccurate.

In the human body we have a complex universe of organs, and these are distributed in seven or twelve parallel systems. The teleological parallel between these systems of a complex microcosmic unity and the realms of an epicosmic universe is not, perhaps, self-evident, nor do we mean to dwell upon it here, further than to intimate that such a correlation does exist, as far as parallels of order and degrees are concerned. The skin, the muscles, the bones, and the central nerves, are more or less parallel and concentric in the body. The vascular, digestive, and generative systems are not concentric, but they are parallel in all their sub-divisions; and the same may be said of the five senses co-ordinate with the seven systems. A complete synopsis of the epicosmic realms, then, gives us twelve parallel divisions; thus,—

Inorganic Realms.	*Organic Realms.*
A. Atmospheric Realm.	*ee.* Cryptogamic Realm.
a, b. Pluvial Realm.	E. Phanerogamic Realm.
B. Thalattospheric Realm.	*ff.* Radiata Realm.
b, c. Exuvial Realm.	F. Mollusca Realm.
C. Geospheric Realm.	*gg.* Articulata Realm.
D. Elemental Realm.	G. Vertebrata Realm.

In a complete study of epicosmic unity we should have to consider the dynamic forces of heat, light, magnetism, electricity, cohesion, and gravitation, which affect the whole, but in this outline we need not dwell upon dynamics.

We have now to seek for what is common, as a law of order, in all realms, and also for the primary relations between the inorganic and organic worlds. The former is sustentative to the latter; and organic realms, in their turn, as is manifest in geological formations, serve to modify and improve the structure of the crust of the earth,—many rocks being mainly formed of fossil shells and other remains of animal or vegetable forms.

The sub-divisions of each realm into classes, sub-classes, alliances, and orders, have not hitherto been made on any common principle of method; and probably but few zoologists and naturalists admit that such a principle exists, if we may judge from the diversity of views put forth by men of eminence in each department of the subject. We cannot presume to affirm that such a principle of unitary order does pervade all realms; but we may venture to suggest that it is not improbably the case, and proceed to give an outline of the fact.

In the realm of *Vertebrata*, the most obvious primary distinctions are those of the four classes,—fishes, reptiles, birds, and mammals. And here we remark that three of these classes are *oviparous*, and only one *viviparous*. One main class, then, and three inferior classes, are easily recognised in this realm. Does such a law of sub-division hold in all, or any of the other realms?

But first we may observe that some zoologists have given the name of class to the sub-classes of reptiles and of fishes established by Cuvier, and this we deem a cause of confusion; for it is important not to confound the distinction of classes with that of sub-classes.

In the realm of *Mollusca* numerous classes have been formed by different zoologists, and it may seem presumptuous in us to question the propriety of these distinctions, but we venture to suggest that Cephalic Molluscs form one main class in contrast with three inferior classes of Acephalous or Headless Molluscs. According to this view, Gasteropods, Pteropods, and Cephalopods, form three sub-classes only of the one great class of Cephalic Molluscs.

In the *Articulata* realm, Crustacea and Arachnida form sub-classes only of one main class; and other so-called classes in this realm are only entitled, according to our views of organic method, to the rank of sub-classes. The class of insects alone seems to us quite natural and complete. These views may be deemed erroneous by eminent zoologists, and we merely suggest the idea of a unitary law in all the realms, without pretending to define it accurately in all cases.

In the realm of *Radiata* various divisions into "kingdoms" and "sub-kingdoms," classes and sub-classes, have been recognised by eminent zoologists; and here, again, we venture to suggest that a primary division into one main class of Echinoderms, and three inferior classes of subradiata, would answer all the purposes of primary natural distinction. We leave the question in the hands of those who are most competent.

The *Phanerogamic realm* of vegetable organism contains one main class and three inferior ones,—one dicotyledonous class of "Exogens," and three monocotyledonous classes of "Endogens." All botanists agree in classing Exogens as a superior class; but some difference of opinion exists concerning the distinction of classes in Endogens. The most simple division, from our point of view, is that of A. de Jussieu, who forms three distinct classes, called *Aquatic endogens, Aperianthous endogens*, and *Perianthous endogens.*

The *Cryptogamic realm* has been naturally divided into one superior and three inferior classes. The superior class is that of *Acrogens;* the inferior classes being *Thallogens.* The three classes of the latter type have been well named, *Algales, Fungales*, and *Lichenales.* Hence we see in the organic realms a common principle of distinction between primary and secondary classes; the first stands as *one* to *three* of the latter, just as the main tissues of the human body stand to the inferior connective tissues of the organism.

Let us now examine the Inorganic realms, which are the sustentative and gravitative support of physical life in the organic world, to see if any similar law of order be discernible in these inanimate realms, so intimately blended with superior cosmic nature. Geologists have recognised four distinct classes of rock formation in the *Geospheric realm*,—namely, "the *Aqueous*, the *Metamorphic*, the *Plutonic*, and the *Volcanic*." The first of these is either solely or mainly connected with organic life, while the other three are simply inorganic. We have then, in this realm, one main class distinguished from the other three, as in those just mentioned.

In the *Oceanic realm* there is a certain depth of water which is capable of sustaining organic life, while lower depths are unsuited to the respiration of animals and plants. Are there three distinctions of azoic waters, in any way analogous to the hypogene classes of rock formation? Subterranean waters are certainly connected with volcanic action in hot mineral springs, mud salses, and many other varieties of phenomena connected with geology; but these waters may be mainly derived from pluvial sources. The lowest depths of sea, distinct from all volcanic action, and unfit for animal or vegetable respiration, form a class of oceanic strata which may well be classed apart, as having special uses different from those already mentioned. Is there a third kind of strata, set apart for special uses, which would warrant separation as a class in the economy and constitution of the oceanic realm? What shall we say of the Polar frozen strata of the ocean? Do they not form a special class with definite and distinct functions in the permutations and oscillations of relative density and temperature, and the consequent determination and perpetuation of currents in the sea? We have, then, in this realm, as in the Geospheric, one major class of strata and three minor classes,—the major being *synorganic* and the minor simple *inorganic*, in both realms. The different uses of these strata are as manifest as their respective differences of constituent density. The major class alone is *zoothermal*, while the others are azoic. The frozen constitution and peculiar uses of the Polar ice are sufficiently distinct and manifest; and though the special uses of the coldest and the lowest depths of oceanic strata are not so well understood, the difference of density and temperature which renders them unfit for life at once marks the constitution as distinct from that which is replete with living forms. The subterranean seas have their uses in the oscillations of the solid crust of the earth. The generation of enormous powers of gas and steam from these engulfed waters is supposed to be one of the main uses of this class; the gradual upheaval of extensive tracts of land being the result of terrestrial heat acting upon the land-locked steaming seas. Hence we have four well-defined classes of oceanic strata; and one class is major, while the other three are minor in degrees of rank and uses. Infiltrations of water from pluvial sources have, no doubt, some connection with volcanic phenomena; but it seems not impossible that vast amounts of pent-up steam are the main causes of the gradual upheaval of whole continents.

What of the *Atmospheric realm?* Are there four distinct classes of strata here, as in the Oceanic and the Geospheric realms? There is certainly a primary distinction between the zoic and azoic regions of the air. Organic life is limited to the lowest strata, and this does not extend to more than a third of the entire altitude of the atmospheric ocean. We have, then, a *synorganic* class of strata contrasted with the simply *inorganic* here, as in the other cognate realms. In determining the different strata of the azoic altitudes, we may proceed from the observation of distinct uses to that of constituent form and structure. The Polar regions of the air are subject to the same general conditions of cold as the same regions of the ocean, and for similar purposes of determining and maintaining currents in the atmosphere, as the frozen strata of the ocean serve to perpetuate currents in the sea. Without discussing the question of constituent peculiarities of structure in the air, we may presume, from difference of function, that the Polar regions of the atmosphere differ from the equatorial, as the frozen regions of the ocean differ from the tropical; and that in both cases the Polar strata may be ranked as distinct in character from the other *inorganic* or azoic strata. Whether open seas exist amongst the Polar ice or no, and whether or no such open seas teem with organic life, may be a question for investigation, but the ice itself is certainly azoic. The atmosphere, however, of the Polar regions would not be azoic, if birds and other animals could live and fish in open Polar seas. This class of atmospheric strata is open, then, to doubt, and will require more strict investigation.

From difference of density alone, and the contrast of azoic with organic uses, we find two distinct classes of strata in the ocean; and, from what is known of the increasing density of air from the upper to the lower depths, we may easily conceive a treble series of distinct strata in the atmospheric ocean,—namely, an upper, a middle, and a lower; but this hypothesis of constituent differences of density in structure is barren of result, so long as we have no idea of distinct and definite uses for each. What are the respective uses of the middle and the upper strata? We know the chief uses of the lower and the Polar, but not so well the functions of the other two. These relate most probably to different kinds of action in the relative dynamic powers of heat and light, magnetism and electricity, as manifested in the meteoric phenomena of Polar lights (Aurora Borealis and Australis); but as we know almost nothing of this branch of science, we will leave the question to those who are competent. Meanwhile, it is not unwarrantably presumptuous to suppose that one organic law of order rules in the constituent form and structure, ends and uses, of the strata in this realm, as we have found it more conspicuously manifest in other realms. The height of the Aurora Borealis in (or beyond?) the atmospheric ocean has been estimated variously to be, at times, not more than 50 miles above the earth; at other times, from 80 to 100 miles and more. There is a special use connected with magnetic light, then, in the highest strata of the atmosphere. The highest regions of the clouds do not extend beyond two-thirds of the entire altitude; and in those regions cold is so intense as to act upon the vapours of water in the air, and cause them to condense and fall upon the earth again as rain or hail or snow. By this contrast of temperature and density in the lower and the middle strata of the atmosphere, electrical action is originated for important uses, and therefore we may deem them distinct and separate classes. As in the sea, we have in the air one superior class of zoic, and three inferior classes of azoic strata.

Magnetic luminosity and electric condensation seem to be the most characteristic features of the two upper regions, and these agree in some athermal features with the Polar regions of the atmosphere; whence we designate them as three azoic classes of strata, in contrast with one superior thermal or zoic class.

And now of the subordinate Pluvial and Exuvial realms.

How are they affected by this law of distribution with regard to forms and uses? Is there one main class with three secondary classes here as elsewhere?

In the *Pluvial realm* we easily recognise ascending mists and vapours, floating clouds, descending rains and dews, hail and snow, running streams and stagnant lakes, glaciers, and snow-beds on the mountain tops. These form an *Aquapluvial* class of meteoric phenomena. There is also a *Gaseopluvial* class, a *Pulveropluvial* class, and a *Lithopluvial* class (fall of meteoric stones, &c.) We need not enter into the details of each, as they are quite distinct and manifest. The first of these classes is decidedly distinct from all the others, and superior in relation to the uses of organic life. Ammonia, marsh effluvia, carbonic acid gas, are useful to the life of plants, but other matters are only useful in a physical and simply inorganic sense. The "red snow," and microscopical organic dust carried by strong gusts of wind over immense tracts of sea and showered down upon far distant lands, is a very interesting and little understood class of what may be called pulveropluvial phenomena. The origin and uses of aërolites need not detain us here. The Pluvial realm seems unimportant in comparison with the Atmospheric, as aqueous vapour and carbonic acid gas together form but one two-hundreth part of the whole mass; but structure and uses are what we look for in all natural distinctions. Organic realms are also unimportant in their mass, though not in structure and development.

Aqueous vapour and rain-water may be said to be the same in elemental structure as the water of the sea, and therefore not entitled to distinction as a portion of a separate realm; but this is not a reason for confounding them in physical constitution and organic method. Articulate animals have vascular, nervous, muscular, and other systems in common with Vertebrata, and yet we separate them from each other. The sea is constituted on one general type as a distinct realm, and yet we find four classes of strata, differing from each other in habitual states and uses. The same may be said of the atmosphere and its different altitudes, and also of geological formations.

The Pluvial realm is of a mixed and inferior kind, compared with the seven greater realms; but it is, nevertheless, very important in connection with the sustentation of organic life in animals and plants. It may be inferior in a cosmic view of nature, while it ranks still very high in epicosmic and organic uses. The same may be said of the Exuvial realm, which is not unimportant in a cosmic view, though most important certainly in epicosmic uses.

Evaporation, combustion, and mechanical translation, are the immediate causes of the pluvial phenomena in each class; and these are the effects of heat and light, chemical affinity, and gravitation. Dust-storms and other pulveropluvial phenomena are caused by hurricanes and violent currents of air; and not improbably volcanic eruptions of metallic and non-metallic vapours, carried high up and whirled away to distant parts, may be the origin of many lithopluvial phenomena, or the fall of meteoric stones.

Thus light, heat, electricity, and magnetism, chemical affinity, and gravitation, are the causes of all meteorological phenomena in all the realms of inorganic nature.

The *Exuvial realm* is quite distinct from all the others, as the mere material remains and moulds of living animal and vegetable types of structure. Dead bodies serve as food for living organisms, and as a means of anatomical investigation into the organic forms of nature. They are not living things, but food for living organisms.

The necrological remains of organic bodies form one main class of the Exuvial realm. Secretional exuviæ, such as eggs and milk, fruits, gums, and vegetable juices, form a second class; the moultings of animals and plants, such as the feathers of birds, the wool of sheep, the bark and leaves of trees, and many other kinds of moults, belong also to this class. Honey-combs, birds' nests, the handiworks of man, and such like products, form a third and very natural class of industrial reliquiæ. Fossil remains, petrified or otherwise transmuted in substance, but conserving traces of organic form, constitute a fourth class of Exuvial reliquiæ. One main class, the necrological, and three secondary classes of reliquial forms, may thus be recognised in this subordinate realm.

Anatomy, Palæontology, and Archæology, are mainly interested in the study of this realm, not to mention the cultural arts of industry in producing food for animals and plants.

It is not, however, as dead matter only, but as organic mouldings, that the Exuvial realm is distinguished from the rest; for the study of matter, merely as such, belongs to the Elemental realm.

The *Elemental realm.*—The realm of matter or elemental substance is distinct from form in organic realms, and also from the physical structure and uses of the inorganic realms. Form and structure, use and function, are alone considered in the Vertebrata, Articulata, Mollusca, Radiata, Phanerogamia, and Cryptogamia, irrespective of the elemental substances contained in any special organism; and the same may be said of the physical form and structure of the Atmospheric, Thalattospheric, Geospheric, Pluvial, and Exuvial realms. Biology, anatomy, and physiology, alone are interested in the study of organic realms as such; geology, meteorology, hydrography, physical geography, &c., in the study of the inorganic; with the exception of the Elemental realm, in which chemistry, mineralogy, and physics, are mainly interested. Matter, as matter, then, and almost irrespective of the Inorganic and Organic realms in which it is subservient to peculiar form and structure, is the subject here to be considered. What is matter, and how many kinds of matter are there in the Inorganic and Organic realms of nature? For matter permeates all other realms.

Organic substance differs from inorganic in a marked manner, as far as proximate elements are concerned. We have, then, a primary division in this realm as in the others; and the main difference between the two consists in the extreme mutability and instability of organic matter as compared with inorganic. In the latter, we may easily recognise three secondary classes of substance,—*i.e.*, simple elements, such as gold and silver, oxygen and hydrogen; artificial compound bodies, such as the products of chemistry; natural inorganic compounds, such as minerals and crystals of various kinds. The orderly sub-division of these classes is not, perhaps, an easy matter in the present state of chemistry and mineralogy, but organic compounds have been already more or less distinguished into groups of proximate elements; mineralogists have made various attempts at the systematic arrangements of natural inorganic compounds; and chemists have made certain approximations to what may be deemed a natural arrangement of the simple elements and artificial compounds. Gerhard's unitary system of grouping the elements and chemical combinations seems to be as simple as any; and various systems of crystallography and mineral classification have been suggested by different authors. We need not dwell upon these various methods here, as our present business is merely with the primary divisions of each realm; and in this case, the most natural primary distinction of elemental types seems to be that of one main class of organic, and three secondary classes of inorganic bodies.

The principle of one common law of primary divisions in each realm, as here suggested, may seem arbitrary; and it may, indeed, be really imperfect in more points than one; but is there no necessity for some such method of distinction and classification to complete the numerous shortcomings and perplexing disagreements of inductive method? Is it possible, without a natural standard of perfection as a type of unity, to bring together in one simple whole the endless details of natural science? Experience says it has not yet been possible, for all the leading naturalists of the present age differ from each other and from those of former ages in their methods of arrangement.

We take the human body as a type of organic unity, in which a complex multiplicity of organs is reduced to order in co-operative life and uses, and we *suppose* that one law of order rules in all the complex unities of nature. Is this hypothesis admissible? And can we learn to work it as a method, if it be true in principle? We believe it to be true and not too difficult to analyze, but many failures may occur in application before a perfect method is acquired.

In the present outline the *Elemental realm* may seem to be a superfluous distinction; but it is mainly through this realm that man obtains control over the elements of matter. It would be tedious to argue the question here, and criticism is invited as a means of testing and improving, or supplanting these views of method.

The *divisions* may seem natural in some realms and forced in others. The *classes* may seem natural where they agree with those already recognised, and arbitrary otherwise. The number four, as here applied, does not seem absolutely necessary, as secondary classes may be more or less numerous in different realms. The only point that seems to be certain, is, that there is one main class in the highest division of each realm, and several secondary classes in the minor division. Our arrangement does not agree exactly with others in either the major or the minor divisions, and we may be as far from the truth as they. Critical investigation will decide. Meanwhile, we may observe that Agassiz, who has written a large octavo volume on classification, admits five classes of Vertebrata,—he suggests eight classes, even,—but only three classes of Articulata, three of Mollusca, and three of Radiata; while Milne-Edwards enumerates five classes of Vertebrata, eight classes of Articulata, six classes of Mollusca, and five classes of "Zoophytes" (Radiata). Other eminent zoologists form different arrangements in their leading and secondary divisions, so that unity is nowhere to be found in the inductive systems hitherto proposed. Inductive method is, in fact, only fit for grouping individual varieties and congeneric series; it has no complete ideal, unit, or conception, as a guide to higher combinations and descending analytical progression, and its various attempts to work from an imperfect standard have led to much confusion and diversity of plans.

Some of the classes established by naturalists may be resolved into sub-classes or anomalous orders only, and numerous modifications are required in many of the leading divisions now diversely formed. We need not enter on that question here, as an illustration of the fact is given in our paper which appeared in the number for January 1862. Our present object is to call attention to the want of a deductive principle of method to complete the work of mere inductive cumulation, and to suggest a critical examination of our own hypothesis. The natural distinctions of realms, and primary divisions in each realm, we deem undeniable; those of classes and sub-classes, alliances and sub-alliances, require consideration, and difference of opinion on these points may be expected until science has made further progress.

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*On the Composition of a Pseudo-Steatite.** By MURRAY THOMSON, M.D., F.C.S., Lecturer on Chemistry, Edinburgh, and Mr MORD BINNEY, Student in Dr THOMSON'S Laboratory.

The mineral which is the subject of this short notice I have ventured on denominating a Pseudo-Steatite; it was found by John Gellatly, Esq., late of the Chemical Works at Bathgate, forming a joint between the masses of a kind of serpentine; which latter rock is esteemed of some value for the construction of certain parts of bakers' ovens, and for which purpose it is quarried close to the village of Blackburn, Linlithgowshire.

Mr Gellatly, while making a visit to this quarry, picked up some pieces of the mineral, and sent them to my pupil, Mr Mord Binney, simply with the view of furnishing material to him for analytical practice, and not at first under any impression that the result of analysis would reveal anything unusual. Mr Binney proceeded with the analysis under my direction; and it was only on the completion of it, and inspection of the results, that Mr Gellatly and myself were struck with the disagreement that seemed to exist between the external characters of the mineral and its chemical composition. As it presented the external characters of a steatite, it was regarded by all who examined it to be a variety of that mineral; but the analysis showed it to contain only a comparatively small quantity of magnesia, which is the characteristic base of the steatites, while at the same time, the alumina had a high per-centage; in other minor features, also, the composition did not correspond with any of the published analyses of steatites.

Having arrival at this result, it was needful, to avoid error, to make fresh analyses, which were accordingly made by Mr

* Read before the Royal Physical Society, 7th May 1862.

Binney and myself independently, and the numbers thereby obtained are those which have been put below side by side with each other. The result of these second analyses in a great measure confirmed the first, though they showed a composition widely different from that of steatites generally.

The typical composition of a steatite is, that it consists of silica, magnesia, with more or less water: these are the usual constituents enumerated; but it will be seen that the mineral we have analyzed differs from that type in containing but little magnesia, a good deal of alumina, and protoxide of iron; along with a diminished per-centage of silica. There is, however, one variety of steatite, called by Haüy "saponite,"* which, by both Klaproth's and Swanberg's analyses, contains considerable amounts of alumina as well as magnesia; but even here the quantity of the former base does not exceed 10, and that of the latter is not set down as less than 25 per cent. To neither of those numbers do the per-centages which we obtained approach; so that from the composition of the mineral, coupled with the following physical characters, we are inclined to think there are sufficient grounds for concluding that it is a new species.

The following are the physical characters of the mineral:—It occurs in irregularly striated masses of a dark-green colour, which here and there changes to a brownish tint; it has generally a dull surface, and when exposed to the air effloresces; fracture uneven; it is easily broken and reduced to powder, which has a green colour. Every part of the masses has the genuine soapy feeling of the steatite. Its degree of hardness is 2·2; as it is hardly scratched by gypsum, but is distinctly so by calc spar. Streak dark greenish grey, and sub-lustrous. It does not adhere to the tongue, has no taste, but has a slightly argillaceous odour, especially when a fresh surface is exposed. The specific gravity is 2·469. Before the blowpipe it is infusible, but changes in colour from green to brown; with borax a yellow head changing to green; with carbonate of soda a persistent dull green.

The results of our analyses are now appended.

* Dana, Ed. 1850, p. 253.

	Thomson.		Binney.
Silica, ...	41·89	...	42·78
Protoxide of Iron, . . .	6·62	...	6·31
Alumina, ...	22·05	...	22·53
Manganese, ...	traces	...	traces
Lime, ...	2·42	...	2·54
Magnesia, ...	6·16	...	6·76
Water, ...	20·22	...	18·68
	99·36	...	99·60

	SiO_2	RO	R_2O_3	HO
Oxygen ratio,	4	1	2	3

Recent Observations on the Florida Gulf-stream. By ALEXANDER KEITH JOHNSTON, Esq., F.R.S.E.* (Plate I.)

The Gulf-stream of the Atlantic is the best known, and for its effects on climate and navigation by far the most important, of the vast chain of currents which traverse the expanse of ocean. Flowing through the middle space which at once separates and unites the countries of Europe and North America, it necessarily forced itself on the attention of the early navigators. Columbus was the first to make known the existence of this and other currents, having observed the westerly set of the waters of the Atlantic during his first voyage of discovery in 1492. For thirty years after his time, the route which he discovered and brought into notice was followed by the voyagers of Spain and other countries, till the famous Spanish navigator, Antonio de Alaminos, in 1519, discovered the passages and currents of the Gulfs of Florida and Mexico, and the new ship's course through the "Narrows" of the Gulf-stream and the Bahama Channel. These discoveries changed the entire system of Atlantic navigation, and indicated a route for the homeward voyage from America to Europe which was followed for nearly two hundred years. After Alaminos, many isolated observers recorded their remarks on every part of the Atlantic, but these led to no certain results. The Gulf-stream was still regarded as an

* The substance of this paper was read at the annual general meeting of the Meteorological Society of Scotland in January 1862.

object of interest indeed to the naturalist, but of doubt and dread to the mariner. By degrees, however, new appliances were brought to bear on the question of the direction and the velocity of currents, and the chronometer and the log were being rapidly improved; but it was not till near the end of the eighteenth century when Franklin, in America, and Blagden* in England, ascertained, by means of the thermometer, the true direction of the Gulf-stream, and roughly defined its limits, that endeavours were made to turn its current to the advantage of trade and intercommunication. Benjamin Franklin, thermometer in hand, followed the course of the current from the coasts of America to the Azores and the Bay of Biscay; he gave to the world the first picture or chart of the form and extent of this "river in the middle of the ocean," and by this means reformed again the sea routes of the North Atlantic, especially the voyage from Europe to the United States, which, since his time, has been shortened by nearly one-half.

The immediate result of Franklin's revelation was to direct general attention to the remarkable phenomena of the Gulf-stream; it became the favourite object of observation with voyagers and of study with philosophers, so that the public mind was soon made familiar with its general characteristics; but a special acquaintance with its many peculiarities involved such an amount of research as could not be expected from private and occasional observers. In these circumstances the subject was adopted by the Government of the United States of North America. In 1846 the officers of the "Coast Survey" of that country commenced, and have since carried on, a series of exact and comprehensive observations, more especially on the American or western part of the Atlantic system, which have already conferred great benefits on navigation and explained many obscure appearances in the economy of ocean currents.† Now, the importance of a complete acquaintance with the Gulf-stream in all its phases is so fully recognised, that every

* C. Blagden, M.D., on the heat of the Gulf-stream in Phil. Trans. Lond. 1782.

† For the results of these observations, see Maury's "Sailing Directions," 4to, Washington; various years; and his "Physical Geography of the Sea," 8vo, second edition. 1861.

authentic observation regarding its temperature, its velocity, or its limits, is received as a welcome contribution to our knowledge of marine meteorology and navigation.

Before referring to the observations which are the more immediate object of these notes, it may be well to state, briefly, the extent of our previous information on the subject of the Atlantic currents.

Although it derives its name from the Mexican Gulf, the origin of the Gulf-stream must be looked for in the Equatorial drift current which crosses the Atlantic basin in the region of the equator, and which, on nearing the coast of South America, separates into two branches,—one flowing south to the mouth of the river La Plata, under the name of the "Brazil current," and the other and principal branch passing, in a north-westerly direction, along the coast of Guiana towards the Caribbean Sea, which it enters by many channels. Here it imbibes a portion of the heat which accumulates to its maximum of 88° Fahr. in the Gulf of Mexico. After traversing this crescent-shaped basin, the heated water escapes to the eastward through the Gulf of Florida. This portion, which is called "The Narrows," flows between Cuba, Florida, and the Great Bahama Bank, with a breadth of about thirty-two miles. At the northern extremity of the Bank, between it and Cape Canaveral, the current quits the Narrows, and enters upon the open ocean at the place called "the Outfall" by the old English navigators. When nearly opposite Charleston, its temperature is 84° Fahr. at the surface, and its rate of motion seventy to eighty miles in twenty-four hours. It now begins to expand, till opposite Cape Hatteras its width is about seventy-five miles, and its temperature 83° Fahr. So far the current retains many of its original peculiarities, preserving much of its high temperature, its velocity, its deep indigo-blue colour, and its saltness; its limits are sharply defined and easily distinguished, and its effects on the weather, the trade, and the colonization of the countries on its borders are fully recognised in the history of the North American States. About lat. 37° it forms a great knee or bend, and changes its direction to nearly due east. The Gulf-stream is now fairly launched on a career which ultimately extends over 3000 miles, and during which it keeps in constant motion at least one-fourth of all the waters of the Atlantic. Having now no bounding continent on either side, and no limit but the comparatively cold water of the open sea, it spreads out across the ocean, flowing usually to the south of the great banks of Nova Scotia and Newfoundland; but, since it contracts and expands according to the season of the year, it sometimes overflows these banks. Spreading out in a fan-like form towards the east, the current gradually loses its high temperature, till, in the meridian of 50° west, it has fallen to 77°, and 10° farther east to 73°. (See figures on the chart.) At the same time its rate of motion has diminished to fifty-five miles in the meridian of Nova Scotia, and to thirty-five in that of Cape Farewell.

Arrived now at the middle distance between Newfoundland and the Azores, the Gulf-stream sends off several great branches, which flow towards the east, south-east, and north-east. The eastern branch is not always recognisable, although it was observed by Franklin, and since by Sabine, to extend into the Bay of Biscay. The south-eastern branch is much more permanent; it is first observed at about 10° east of the Newfoundland Banks, where it inclines southward in the direction of the Azores, which lie in its middle course. Having passed these islands, among which it originates many minor currents, it trends still more to the southward, and joins the Guinea current, which flows in the same direction along the west coast of Africa, and with which it runs in contact till it nears the Tropic of Cancer, when it turns towards the west and rejoins the Equatorial Drift, whence it originated. In the middle of this aqueous circulation in the still water formed by the eddy of the current is found the "Sargasso Sea," an ocean covered by an immense deposit of sea-weed, brought by the Gulf-stream from the Gulfs of Florida and Mexico.

The north-east branch of the Gulf-stream, which is of more immediate interest, as the cause of the mild climate of the British isles, and the source of our storms, separates from the main stream at the point before referred to, and stretches across the ocean towards Great Britain, where it impinges on the shores of Ireland, the Hebrides, Shetland, and the

Faroe Isles, on its way to the coasts of Norway, where its influence is still so great, that even up to the North Cape, in lat. 71° 11′, its tepid waters keep the harbours open for shipping all the year round, while those of the Baltic, many degrees farther south, but excluded from its beneficial effects by the intervention of the British isles, are frozen during several months.

The great antagonist of the Gulf-stream is the mighty "Arctic Current" of cold water from the Polar regions, which, sweeping down the eastern shores of Greenland, passes Cape Farewell, and shortly afterwards meets and unites with the "Hudson Bay" or "Labrador Current" from the icy sea. The united stream flowing southward, with its freight of ice-fields and icebergs burdened with the debris of splintered rocks, meets the northward-bound water of the Gulf-stream in the region of Newfoundland, where the result of the conflict that ensues between the cold and heated currents is the melting of the greater portion of the ice, and the deposition of a vast amount of soil, which, in the course of ages, has formed the famous cod-fishing banks of Newfoundland; and where the encounter between the corresponding currents of the atmosphere produces the beautiful but treacherous "silver fogs," so much dreaded by the mariner in winter.

There is every reason to believe that a large portion of this cold water, in pursuing its course towards the Equator, now passes as an under-current beneath the Gulf-stream, to which it acts as a kind of cushion or bed, for the heated water does not in any place reach the bottom of the ocean. Evidences of the presence of this cold under-current have been observed in many parts of the Atlantic, in some of which, while the surface had a temperature of 80°, the thermometer, at a depth of five hundred fathoms marked only 57° Fahr. Far south, in the Caribbean Sea, the surface temperature on one occasion was observed to be 85°, while that at a depth of 240 fathoms was only 48° Fahr. But a considerable part of the Arctic current passes partly through the Strait of Belleisle, and partly round the shores of Newfoundland, towards the eastern coasts of the North American States. Along these shores it flows towards the south, keeping at a distance, greater or less according to the season, the warm waters of the Gulf-stream; and, besides obvious advantages to the climate and navigation of these countries, it secures the presence of the "sheep's head," and many other excellent kinds of edible fish, which could not exist there if the warm water approached the bays and islets in which they congregate.

It will be observed, that in the foregoing sketch no mention is made of the currents in the vicinity of Iceland. Till very recently, indeed, nothing of a precise nature was known regarding the course of the Gulf-stream or the Arctic current in the higher latitudes of the Atlantic; but this desideratum has been ably supplied by an extensive series of observations made under the superintendence of Captain Irminger* of the Danish navy, which satisfactorily explain many of the physical peculiarities of that interesting island. From these observations it appears that in about the parallel of 61° north, and between the meridians of 16° and 18° west, the Gulf-stream divides, sending off one branch, as already noticed, to the north-east,† and another towards the north-west. This latter, the newly observed branch, touches the southern shores of Iceland at Portland, whence it flows west to Reikjanaes, and thence trending again towards the north, it passes outside of Faxe Bugt at the rate of 4·8 nautical miles in twenty-four hours.

Proceeding northwards, its course is arrested, shortly after reaching the parallel of 66°, by the Arctic current of cold water flowing south-west towards Cape Farewell, in Greenland; and here the limits of the two currents are so sharply defined, that within a short distance in longitude the temperature, which in the warm northerly current is 49°, is found in the cold southerly current to be no more than 32°, making a difference of 17° Fahr. To the northward of this, in the meridian of 20° or 22° west, the Arctic current forms a loop

* See "Zeitschrift für allgemeine Erdkunde." Berlin, September 1861.

† An expedition despatched by the Swedish Government in 1861 to investigate the physical geography of Spitzbergen, ascertained that the great Gulf-stream, which sweeps past the Norway coast, reaches as far as the shores of that island. We are thus enabled to trace the Gulf-stream some 8° or 9° further north than we were warranted to do by previous observations; and the details of this expedition will be looked for with much interest.

or bend, and sweeps first in an easterly and then in a southerly direction along the northern and eastern shores of Iceland, till it meets and mingles with the warm current in its north-easterly course.

These observations afford a satisfactory explanation of the origin of the comparatively high temperature of the sea on the west and south-west coasts of Iceland, where the thermometer frequently indicates 50° and 51° Fahr., as contrasted with that of the east coast, where, as shown in the chart, the branch of the Arctic current, before alluded to, flows close in-shore, keeping at a distance the warm north-easterly current, and where, in consequence, on the same parallel of latitude, the temperature sinks to 32° and 33° Fahr., or 18° lower on the east than on the west side of the island. It will be observed from the figures on the chart, that the temperature of the sea on the north of Iceland is much higher near the shore than at thirty or forty miles distance, the difference amounting in some places to 10° or 12°, as in Skagestrands Bugt, where, near the shore, it is 45°, while outside it is 35°, and further east only 33° Fahr.

Captain Irminger endeavours to account for this difference by assuming that, in the months of July and August, when the Arctic ocean is least liable to storms, the warm current, which during the rest of the year is driven by the prevailing south-westerly winds towards the north-east, is then deflected westwards along the northern shores of the island; but this opinion requires confirmation; and it appears more probable that the warm water may reach the bays on the north by the west coast. But since the temperature of the sea has not been ascertained in this quarter beyond the parallel of 66° (where, however, it is as high as 44°·6), the determination of this point must be left to future observers.

Such are the principal results of Captain Irminger's series of observations; and in illustration of the effects produced by this arrangement of the warm and cold currents, he adduces the following facts:—

1. The Greenland ice, which is constantly floating past Iceland, never visits its west and south-western shores, from which it is kept off by the warm water of the Gulf-stream.

2. In Faxe and Brede Bugt the water never freezes, and fishing is carried on all the year round, while the vessel that carries the mail between Havnefiord (near Reikjavik) and England is never hindered, even in mid winter.

3. On the north and east coasts of the island, navigation is often impeded by ice brought down by the Arctic current, the force of which current is so great, that in several instances noted by Dr Scoresby whaling vessels were drifted by it at the rate of thirteen or fourteen miles in twenty-four hours.

4. The usual limit of drift-ice is from forty to sixty miles from the north-west coast of the island, but it occasionally fills the whole space of 160 nautical miles in breadth between the north-west point of Iceland and Greenland.

This drift consists of ice-fields five or six fathoms thick, and icebergs sometimes so large that they have been found grounded in eighty fathoms water. The ice appears first near Cape Nord, and drifts towards the south-west, enclosing the bays between Patriks and Isefiord, rarely passing Fugle Huk (lat. 65° 30′), and bringing with it a degree of cold so intense as to be very injurious to vegetation. The amount of ice-drift, and the consequent degree of cold, vary very much in different years. The years 1384 and 1615 are referred to as seasons of intense cold. In the spring of 1807 the people of the small island of Grimsey, twenty-three miles north of Iceland, travelled over the ice to Ofjord.* In 1826, which is on record as a very cold year, the ice-drift is supposed to have covered an area of 200 square miles. The occurrence of ice on the west coast of Iceland is so very rare, as to lead Captain Irminger to question the statement of Sir John Barrow,† who says, that in 1816, and again in 1817, "ice had broken loose from the opposite coast of Greenland, and floated away to the southward, after surrounding the shores of Iceland, *and filling all the bays and creeks of that island.*" The captain is satisfied that this was not the case, at least in so far as Faxe Bugt and Brede Bugt are concerned.

Between the years 1800 and 1860, the Greenland ice visited

* Ofjord is about thirty miles inland, at the termination of a narrow estuary.

† Voyages of Discovery and Research within the Arctic Regions. London, 1846.

Iceland, for a longer or shorter period, thirty-three times, on each of which occasions the north coast was beset by the drift, especially between Cape Nord and Skagestrand's Bugt; thirteen times it enclosed the entire north coast east to Langenaes; fourteen times it kept outside of the north-west fiords, blocking up some of them; thirteen times the ice made its appearance in various quantities on the east coast, and five times greater or smaller masses of ice have been driven from the east coast by Vester Horn and Portland towards the west.*

Captain Irminger assures us that the thermometers used in making these observations were all verified and delivered by himself; that the results are found registered in the log-books of the different vessels employed, and that the captains who made them were intelligent men, who took an interest in the work, and that therefore there can be no doubt of their accuracy.

It is much to be desired that further observations should be made on the temperature of the sea on the north-west coasts of Iceland, in order to arrive at a satisfactory explanation of the cause of the milder climate near the north shores of the island; but in the meantime this may be accepted as a genuine contribution to the facts of one of the most important departments of marine meteorology.

The following interesting notes and observations, made while crossing the Gulf-stream from Halifax to Bermuda in November 1861, have been kindly furnished by the observer, David Milne-Home, Esq., younger of Milne-Graden. "The weather," he says, "was exceedingly stormy, so that the exact line of demarcation between the tepid waters of the stream and the water of the general ocean through which it flows was

* The mean temperature of the sea and the air at Reikjavik, for the four seasons of the year, is shown in the annexed table, from which it appears that the temperature of the sea is at all seasons, except in summer, higher than that of the air, and that the difference on the mean of the year amounts to 2° Fahr. nearly.

Mean Temperature of the Air at Reikjavik, 64° 9′ N. Lat.

Winter.	Spring.	Summer.	Autumn.	Mean of the Year.
29·1	37·	53·5	37·9	39·4 Fahr.

Mean Temperature of the Surface of the Sea at Reikjavik.

Winter.	Spring.	Summer.	Autumn.	Mean of Year.
35·	39·4	50·5	41·2	41·5 Fahr.

less distinct than usual." Nevertheless, the registry marks plainly enough when the Gulf-stream was entered and when it was crossed.

Observations from the Log-Book of H.M.S. "Nile."

				Difference in Degrees of Fahr.
Tuesday, 19*th Nov.* 1861. Sailed from Halifax at 3 P.M.	10 P.M., temp. of air,	47°	sea, 46°	
	midnight, ...	45	... 47	
Wednesday, 20*th Nov.* Noon, Lat. 41° 12′ N. Long. 63° 41′ W.	2 A.M., ...	47	... 46	
	Noon, ...	52	... 51	
	2 P.M., ...	55	... 54	
	6 P.M., ...	54	... 53	
Enter Gulf-stream, . .	8 P.M., ...	56	... 62	6
	midnight, ...	56	... 64	8
Thursday, 21*st Nov.* Lat. 37° 43′ N. . . . . Long. 64° 23′ W. . . .	4 A.M., ...	57	... 67	10
	6 A.M., ...	57	... 70	13
	9 A.M., ...	59	... 71	12
	10 A.M., ...	57	... 71	14
	Noon, ...	58	.. 70	12
	2 P.M., ...	58	... 70	12
	6 P.M., ...	59	... 68	9
	8 P.M., ...	59	... 70	11
	10 P.M., ...	59	... 70	11
	Midnight, ...	60	... 70	10
Friday, 22*d Nov.* Lat. 34° 1′ N. . . . . . Long. 65° 41′ W. . . . Getting out of Gulf-stream,	2 A.M., ...	59	... 69	10
	4 A.M., ...	59	... 69	10
	6 A.M., ...	60	... 70	10
	8 A.M., ...	61	... 68	7
	10 A.M., ...	62	... 70	8
	Noon, ...	62	... 68	6

It will be noticed that on Wednesday, from 2 A.M. till 6 P.M., while in the open ocean, the difference of temperature between the sea and the air never exceeds 1°; but on entering the Gulf-stream at 8 P.M., the difference at once rises 6° in favour of the water; on Thursday at 10 A.M., the difference increases to 14°, and then it gradually decreases, till, on Friday, getting out of the stream, it falls again to 6°.

The writer says,—" In calm weather, the line of demarcation between the Gulf-stream and the waters which border on it can easily be seen, and was well observed when the 'Nile' (the flag ship) went to Halifax from Bermuda last May. On that occasion the temperature of the water under the *stern* was above 70°, and that of the water under the *bow* at the same moment was under 40° Fahrenheit. This was at the northern edge of the stream; on the Bermuda side, the difference was less."*

* During another voyage in H.M.S. "Medea," from Bermuda to New York and back, Mr Milne-Home says,—" On our return voyage, I find that we took

No circumstance can more clearly demonstrate the definite course which this "river in the ocean" cuts for itself through the surrounding waters than the fact that, within the length of a ship lying across it, the difference in temperature amounted to more than 30° of Fahrenheit, a difference equivalent to that between our mean winter and maximum summer temperature.

The Gulf-stream, as is well known, brings seeds and nuts from the West Indian islands, and deposits them on the coasts of the Hebrides; and it carries drift-wood to the shores of Iceland, affording a much-needed fuel to the inhabitants of that island, where no timber grows. Its effects on climate are strikingly evinced by the looping of the isothermal lines as they cross the North Atlantic; thus, for example, the line of 32° annual mean temperature, which, according to astronomical climate or that due to latitude, would cross from America through the middle of the British isles, is borne up to the northern shores of Iceland and Norway. The occasional excessive mildness of our winter temperature has been, we think correctly, attributed to an abnormal extension of the Gulf-stream to our shores, since the effects produced in heat and moisture are precisely such as might have been predicated from the relative positions of the current, the winds, and the islands.

As an illustration of the effects of the Gulf-stream on the shores of the British Isles, we may refer to a table of the comparative temperatures of the sea and air on the West and East Coasts of Scotland, drawn up by the Secretary from four years' observations, 1858-9, 1860-61, by members of the Meteorological Society of Scotland; the stations being, in the West —Sandwick, Stornoway, Harris, Otter House, Easdale, and Oban. And in the East—Barry, Smeaton (North Berwick), and

four hours, after entering the stream, to reach the warmest portion of it, which was 72° Fahr.; for four hours more the temperature remained at this height, and then it gradually fell until, seventeen hours after, it came down to 60°, and we were getting out of the stream." . . . "The distance we steamed was 110 miles; thus we went forty miles to reach the warmest waters; we remained in them for about thirty miles more, and then went 110 miles before reaching the southern side of the stream. This shows the very sudden *increase* of temperature on the north side, and the more gradual decrease on the south side, owing probably to the proximity of a tropical climate."

East Linton (Dunbar). From these a diagram was constructed, showing the mean sea and air temperatures for each month of the year, and from which the following results are deduced:—

1*st*, That the mean annual temperature of the sea on the West Coast is 1°·1 Fahr. higher than on the East Coast.

2*d*, That the mean temperature of the air is 0°·8 higher on the West than on the East Coast.

3*d*, That the temperature of the sea on the West Coast is at its *minimum* in March, when it amounts to . . . 43·5
and that it attains its *maximum* in July . . . 55·

The difference being . . . . 11·5

On the East Coast the *minimum* occurs in Feb. . . 41·2
and the *maximum* in July . . . . . . 55·8

Difference . . . . 14·6

Hence, that the maximum and minimum occur earlier on the East than on the West Coast, and that the difference between the extreme monthly means is 3° greater on the East than on the West Coast.

4. That the difference between the sea temperature on the east and west is, in winter, greater than the difference of the air temperature; while in summer it is less.

These observations confirm the fact that we are greatly indebted to the Gulf-stream for our mild winter temperature, the difference in favour of the West Coast, on which the tepid current impinges, over the East Coast, being, in Nov., +1·7; Dec., +2·8; Jan., +2·3; Feb., +1·3 *for the air;* and *for the sea*, in the same months—Nov., +3·3; Dec., +3·9; Jan., +3·8; Feb., +2·4 Fahr.

These observations are strengthened and confirmed by the results exhibited in a series of tables prepared by an observer of well-known accuracy, the Rev. Charles Clouston, minister of Sandwick, Orkney.* From these tables, extending over a period of thirty-three years, it appears that "the difference between the mean temperature of February, the coldest month (38° 25′), and that of July, the warmest (55° 14′), is only about 17°; and that during all that period, the mean temperature of

* Communicated to Admiral Fitz-Roy, and inserted in the 5th number of the Meteorological Papers of the Board of Trade.

any month never fell so low as the freezing point, except in February 1838 and February 1855, when it was respectively 31° 31′, and 31° 64′, and that it was never so high as 60° except in July and August 1852, when it was 61° 36′, and 60° 64′. That the Atlantic moderates the extremes, and that it elevates the temperature of winter more than it depresses that of summer, will be evident, when we consider that in 1857 the Atlantic was about 6° warmer than the mean temperature of the air in January and February, and continued warmer for seven months, being nearly equal in April and August, and colder only in May, June, and July, when the difference did not amount to 2° on an average. In 1858 these differences were still more strongly marked, the mean temperature of the Atlantic being 49° 66′, or 3° 46′ above the air, which it exceeded during ten months, and only fell below it during June and August. This explains also, how there is never frost and snow with west wind, and how, if the wind change to the west during frost, the thermometer speedily rises to 40° and upwards, because we have never yet found the Atlantic to be colder than 43°." Again, "The mean temperature of the sea for the year is 49° 6′, or 2° 2′ above that of the air and the soil, and nearly 3° above that of our best springs. It is even above the mean temperature of any year yet recorded, and a little above the mean temperature of the sea around the coast of Scotland. This seems one of the strongest proofs that the Gulf-stream reaches the shores of Orkney, or that some stream from a warmer climate, by whatever name it may be called, raises the temperature of the sea beyond what it could be raised by the power of the sun in Orkney, and higher than it raises that of the air, the soil, or the springs. Without such a stream, we are not aware that the mean temperature of the sea in other places exceeds that of all other things showing the mean temperature of the localities. As this stream carries to Orkney, along with its increased temperature, productions of the West Indies, the Gulf-weed, &c., we think it proved, and know no other satisfactory explanation of all the phenomena."

In a manuscript paper* written since the above was printed,

* Transmitted to the Meteorological Society of Scotland, May 1862.

the observer says: "More extensive data corroborate all the former remarks—the mean temperature of the year over a period of five years being 45° 74′, while that of the sea was 48° 93′, or 3° 19′ higher, being warmer than the air during eight months of the year, even to the extent of 6°, 7°, or 8°, in January, February, October, November, and December, and colder only during four months, viz. May, June, July, and August, and then only 1°·07 at an average;"—"and that even the temperature of the air in the sun is nearly 2° lower than that of the Atlantic."

From the prevalence of south-westerly winds in the North Atlantic, the benefits of the high temperature thus generated are diffused over our islands, otherwise the difference in favour of the West Coast would be greater than it now appears.

The above noted results in reference to Scotland are confirmed by similar observations on the influence of the Gulf-stream on the winters of England and Ireland, collected by Professor Hennessy and Dr Lloyd. (See "Proceedings of the Royal Society of London," 10th June 1858, and the "Atlantis" for July 1858.

Notes on Cuckoo-flowers and the Cuckoo-spit. By JAMES HARDY.*

The Cuckoo's garland consists of several ingredients. They have not been investigated, and what I now present is their first assemblage. The true Cuckoo-flower is *Cardamine pratensis*, the pink or wild rocket of the Borders. "These flower for the most part in April," says Gerard (Herball, p. 261), "when the cuckowe doth begin to sing her pleasant notes without stammering." Stillingfleet says that in 1755 the cuckoo called on the 17th, and the cuckoo-flower was in blow on the 19th of April. The name "Flos-cuculi" is traced to Otto Brunfels, 1536, adapted from the "Gauchblume" and "Kukucks-bluhme" of the Germans. It appears in English, in Lyte's translation of Dodonæus, 1578, as "Coccow flower." The Flemish name is "Cocockbloem," or

* Read to the Botanical Society, May 8, 1862.

"Coeckoecbloem." It is "Göge blomster" in Danish, according to S. Paulli; "Blodeuyn y gôg" in Welsh, but this is modern. "Lychnis Flos-cuculi" is another cuckoo-flower, derived from a German source,—the "Cuculi flos Germanis" of Tragus, 1552. J. Bauhin (Hist. Plant. iii. 348) says the Germans call it "Gauch-blum," "Kuckuck-blumen," and the French, "Fleur du coquu." The Flemish is "Coeckcoeck-bloemkens," and Lyte translates it "Cockow gillofers." In the county of Durham, I found "Gilloflowers" was a common name for *Cardamine pratensis.* In Welsh it is "Blodau 'r gôg." Shakspeare's Cuckoo-flower, in the mock coronet of the mad Lear, must have been a cereal weed.

"Crown'd with rank fumiters and furrow weeds,
With harlocks, hemlock, nettles, cuckoo-flowers,
Darnel, and all the idle weeds that grow in corn."

The "Cuckoo-flower" of Clare, Miss Baker thinks (Northamptonshire Words and Phrases, i. p. 164) is the red-flowered campion, *Lychnis dioica.*

"And oft, while scratching through briary woods,
For tempting cuckoo-flowers and violet buds."

He also names the cuckoo-pint, *Arum maculatum*, the cuckoo-flower :—

"Where peep the gaping speckled cuckoo-flowers,
Prizes to rambling schoolboys' vacant hours."

(*Poems*, p. 8.)

"These harebells all
Seem bowing with the beautiful in song;
And gaping cuckoo-flower with spotted leaves,
Seems blushing of the singing it has heard."

(*Rural Muse*, p. 33.)

In Devonshire, according to Mr Halliwell (Archaic Dictionary), the harebell, *Endymion nutans*, is called "Cuckoo;" in Dumbartonshire, it is "Gowk's hose" (Jamieson). "Cuckoo's stockings," as a provincial name for the harebell, is mentioned in Howitt's "Book of the Seasons," p. 126. The Welsh names are "Esgidiau'r gôg," cuckoo's shoes, and "Hosanau'r gôg," cuckoo's stockings (Thomas Jones); "Bwtias y gôg," cuckoo's boots (Davies' Welsh Botanology). Canterbury bells has the name of "Gowk's hose" in the south of Scotland.

In Lovell's "Herball," Oxford, 1665, p. 72, Canterbury bells is synonymous with "Cuckoo-flowers or Throat-wort;" but unfortunately, at p. 113, it is arranged as a double ladysmock. The common bell-flower, *Campanula rotundifolia*, in the Gaelic list of Lightfoot's "Flora Scotica," is written Curachd-na-cuaig. This seems to be *Curach na-cuaig*, the cuckoo's boat, although an unlettered Skye man, whom I asked, signified that it was the cuckoo's cap, which would be sufficiently expressive if correct. In Gaelic, *Pinguicula vulgaris*, or butter-wort, is "Brogan-na-cuaig," cuckoo's shoes. The *Orchis mascula* is also a cuckoo-flower. Turner's "Herball," 1551, distinguishes it as "Goukis-meat." It is referred to in Lyte's "Dodoens," 1578, p. 226, as "Cuckowes Orchis," and it is so entitled in the index to Gerard's "Herball" by Johnson, 1636. The name in Wales is "Hosanau'r gôg," the cuckoo's stockings or hose (Davies' "Botanology.") In the "Nomenclator Plantarum" of Benedict Berzelius, in the Amœnitates Academicæ, Upsal, 1759, the German "Guckuks-blume" stands opposite to this Orchis. The original Cuckoo's hose may have been the cowslip; but correct application cannot be expected in every instance of popular names. In Lyte's "Dodoens," p. 123, the French names are "Coquu" and "Brayes de coquu," *i.e.*, cuckoo's hose in the modern acceptation. This appears to be from Ruellius, 1537, in whose work the country name is "Cuculi brachula." By others it was written "Bracha cuculi." (J. Bauhin, "Hist. Plant." iii. p. 495; 1651.) In the Flemish Dictionary, "Kilianus Auctus," 1642, both "Brachæ cuculi" and "Braies de cocu" are interpretations for the cowslip. Miege's French Dictionary, 1675, Englishes "Coucou" as primrose. Dr Farmer proposed as the true reading "cowslip-buds" for the "cuckoo-buds" of Shakspeare; but this was unnecessary. Following the old French, it could signify the cowslip, without altering the reading; and there may have been a corresponding name in the common English speech, for we find in the Swedish of the island of Gothland, that the name for the cowslip is "Giök-blomma" (Linn. "Flor. Suecica," first ed., p. 57). Mr Don conjectured ("Hist. of Plants," i. p. 40), that the cuckoo-buds is the *Ranunculus bulbosus*, crowfoot, or buttercup, which blows in May and June; but if it is identical with the "winking Marybuds" "with golden eyes" (which it may not be), it would rather lead us to some flower carrying the name of the Virgin Mary, such as the *Caltha palustris*, the showy marsh-marigold, which, says Linnæus, conforms in time of flowering with the arrival of the cuckoo in Sweden. Stillingfleet found the marsh-marigold to blow April 7th, and the same day the cuckoo sang (" Select Works," ii. p. 373). The Greek word Κοκκυξ signifies cuckoo, and likewise a young fig, and the reason given for it is, that in Greece they appeared together. *Oxalis Acetosella*, the wood-sorrel, bears the vagrant bird's impress in many languages. "It is called of some 'Panis cuculi,' cuckowe-breade, eyther because the cuckowes delight to feede thereon, or that it beginneth to blossome when the cuckow beginneth to utter her voyce." (Parkinson's "Theatrum Botanicum," p. 747.) Ruellius, 1537, gives it that name. In French it is "Pain du cocu," "Pain de coucou;" in Italian, "Pan cuculi;" in old German, "Gouchesampfera;" in modern German, "Kukucksbrot;" other German names are "Gauchklee," "Guckgauchklee," "Kukugsklee" (cuckoo-clover), "Gauchbrot," "Guckgauchbrot," "Guchenlauch," and "Gauchlin;" in Swiss, "Guggersauer;" in Flemish, "Cockoucksbrodt;" in Danish, "Giögebrodt," "Giögemad," "Giögesyre;" in Swedish, "Giökmat," which name in that language, *Vicia Orobus*, shares with it. It is the Anglo-Saxon "Gæces-sure" and the Welsh "Suran-y-gôg;" the "Cuckowe's meat" of Turner's "Names of Herbs," 1548. It is the English Cuckoo-sorrel, Cuckoo-bread, Cuckoo-spice; the Scottish Gowk's-meat; the Border Cuckoo's meat, Cuckoo clover, Cuckoo's sourocks, and the Cuckoo sorrel of the north of Ireland. *Tragopogon pratensis*, goat's beard, has for one of its German names "Gauchsbrot." "Children," says Tragus, "who eat the root while it is yet tender, are wont to call it 'Gauchbrot,' *i.e.*, the bread of the cuckoo, from the sweetness thereof; and if an Apician only knew how good it was, he would never again prefer his acetarian dainties, to all other herbs and roots." (J. Bauhin, Hist., ii. p. 1059.) *Anagallis arvensis*, the scarlet Pimpernel, is in German, Gauchheil, Gochheil, and "Jochheil;" and in Flemish, "Guychelheil," gowk or fool's-heal, from Gauch and Guich, a fool; a secondary derivative. The kind of moss called great Golden Maiden-hair, *Polytrichum commune*, is the "Gowk-bear" of Ayrshire. In Sweden, says the "*Flora Suecica*" of Linnæus, it is known as "Guckulijn and "Giökrag." In the same country the rare and beautiful *Cypripedium Calceolus*, our Lady's Slipper, is "Guckuskor." The sweet-scented violet and the pansy are in Gaelic, "Sail-chuach," the Cuckoo's heel. In Irish, the first is "Sail Covagh," according to Threlkeld. "Geckdox," in Gerard's "Herball," *Galium Aparine*, may rank here. "Cocowort," Halliwell renders the Shepherd's purse; but this may be doubted. We have also Gowk's siller, shillings, or sixpences, *Rhinanthus Crista-galli;* and on the Borders, Cuckoo-grass, *Luzula campestris*, "flowering with the primrose and the dog-violet, and pulled by children to give variety to the spring nosegay."

The Cuckoo-spittle, Gowk's-spittle, Cuckoo's-spittens, Frog-spit, Toad-spit, Snake's-spit, or Wood-sear of England and Scotland; Kukukspeichel and Hexenspeichel (Witch's spit) of the Germans; Guggerspeu of the Swiss; Gred-spott (Frog-spit) of the Swedes; Giögespit of the Danes; Trold-kiaring-spye of the Norwegians; and Crachat de coucou of the French; is a froth discharged by the young frog-hoppers, *Aprophora spumaria*, to defend them from enemies and the overpowering effect of the solar heat. "M. Poupart tells, that as soon as the little creature comes out of its egg, it hastens to some plant, which it touches with the tip of its body, and fastens there a drop of white liquor full of air; it drops a second near the first, then a third, and so on, till it covers itself all over with a scum or froth." These get the name of Gowk-spittles, because they are at the greatest plenty "when the bird gets hoarse, or seems by its voice to have a spittle in its throat." (Mactaggart.) The dates of first appearance are in Berwickshire, May 6, 11, 23, 24; June 8. English dates are June 16, June 2, 21. One writer considers it a kind of hardened dew, another a blight. Sibbald, in his "*Scotia Illustrata*," regards it as an exhalation infecting plants, which speedily corrupts and engenders vermiculi, and unless it is wiped off, it burns up the plants. The enclosed insect lives on the juice of plants, and is often prejudicial to garden blooms. In Sweden it is said to cause madness in cattle that feed where it abounds. The *Cardamine pratensis* and *Lychnis Flos-cuculi* are favourite depositories of its spume, and some conjecture that hence arises the name of Cuckoo-flowers, by which they are distinguished (Dr Johnston's "Flora of the Eastern Borders," p. 33; Miss Baker's "Northamptonshire Words and Phrases," i. p. 165); but it has already been shown that the name does not belong to our language, and has existed for three hundred years at least. And there are plants that it is noticed to affect as much as it does these. "The experience is, that the froth which they call Woodesare (being like a kind of spittle) is found but upon certain herbs, and those hot ones,—as lavender, lavender-cotton, sage, hyssope," &c. (Lord Bacon "Sylva Sylvarum," p. 104; and Sir Thomas Browne's "Vulgar Errors," p. 237.) But there is a plant that has been gifted with a name, "in respect of that kind of frothy spattle or spume, which we call Cuckoo-spittle, that more aboundeth in the bosomes of the leaves than in any other plant that is knowne," viz., *Silene inflata*, Bladder Campion, which Gerard nominated "Spattling Poppy." This is the English of *Papaver spumeum*, which again is translated from the Greek Μηκων ἀφρωδης of Dioscorides, a plant that no one can recognise, but which Gesner thought might be this plant. Gerard's name has not come into common use. Plants besmeared by this insect were formerly considered emblematical of cuckoldom. "There was loyal Lavender," says Green, "but that was full of Cuckow-spittles, to show that women's light thoughts make their husbands heavy heads." The Northumbrian name of the insect is "Brock," and hence, some one told Brockett (Glossary of North-Country Words), the expression, "to sweat like a brock;" but this applies to the badger. Boys take them for the early state of the cuckoo; and Isidore, with all a boy's credulity, tells how at the dog-days they inflict matricidal retribution; for then attaining perfection, they rush upon her in a body, cluster under her wings, and kill her with their bites. (Joh. Johnstoni Thaumatographia, p. 250.) Isidore regarded it as the offspring of the

Musical Cicada of the south of Europe. Our countryman, Muffett, in his "Insectorum Theatrum," 1634, pp. 122, 132, seems to be the first who had a correct conception of the nature of the "young gowk." The passage has been rendered by Sir T. Browne ("Vulg. Err.," p. 237): "Certaine it is, that out of this, some kind of locust doth proceed; for herein may be discovered a little insect of a festucine or pale green, resembling in all parts a Locust, or what we call a Grasshopper." Near Newcastle, the small springing Homoptera, to which class it belongs, are still called Grass Locusts. "Not worth a Gowk-spittle," is a Galloway phrase. (Mactaggart, "Gallovidian Encyclopædia.") "Gesner asketh, how any man dare be so foolish or venturous as to eat of a cuckoe, whose much spitting argueth a corrupt and excremental flesh." (Muffett's "Health's Improvement," p. 99.)

Notice of Flowering Plants and Ferns collected on both sides of Davis Straits and Baffin's Bay. By Mr JAMES TAYLOR, Aberdeen.*

The plants named in the following list were collected by me in the course of five voyages made to Davis Straits, &c., as surgeon on board whaling vessels in the years 1856–61. Some of these years were more favourable for making such collections than others. My time was often very limited, and the ground I could explore much circumscribed by the short stay of the vessels at particular localities. The vessels usually remained longest in Cumberland Gulf, and accordingly the districts round about it have been most completely investigated. But with longer time and more means at my disposal for making protracted excursions into the interior, I have no doubt that the subjoined list could be very greatly increased. I have here given only the flowering plants and ferns. I collected a great many mosses and lichens, but they have not yet been thoroughly examined. On the east side of Davis Straits and Baffin's Bay, I have had opportunity of exploring parts of the country from Disco Island to Wilcox Point; and on the west side my observations have extended,

* Read before the Botanical Society of Edinburgh, 13th March 1862.

with some intervals, from Cumberland Inlet to Cape Adair, a little north of Scott's Bay. It may be explained, that in the list, E. or E. side means Danish Greenland, and W. or W. side, the islands lying to the west of Davis Straits and Baffin's Bay, forming part of the Arctic islands of North America; also, when any particular place is named, it is to be understood as including the district surrounding it. To obviate the necessity of giving latitudes and longitudes in the list, it seems advisable to give here the latitude and longitude of the principal places therein named :—

East side.	N. Lat.		W. Long.
Disco Island, . . .	69° 10′	...	54° 30′
Hassen, or Hare Island, .	70° 30′	...	54° 15′
Dark Head, or Svarthuk, .	71° 40′	...	56° —
Upernavik, . . .	73° 25′	...	57° 26′
Wilcox Point, . . .	74° 18′	...	58° 8′
West side.			
Cape Enderby, . . .	63° 45′	...	64° 30′
Cape Mercy (of Davis), .	65° 10′	...	64° 40′

According to the maps, the latitude and longitude of these two places are—Cape Enderby, lat. 63° 45′, long. 67°; Cape Mercy, lat. 65°, long. 63° 20′.

Niatolik (Nawaktolik), .	65° 50′	...	65° (68°?)
Cape Searle, . . .	67° 20′	...	62° 30′
Scott's Inlet, . . .	71° 10′	...	71° —
Cape Adair, . . .	71° 20′	...	72° —

The Kickertine Islands, and the islands called Midliattwack, are in the middle of Cumberland Gulf. They are composed of metamorphic rocks, which rise in Midliattwack to the height of 557 feet, and in the Kickertines to that of 450 feet. These measurements, as well as those given in the list, were all made by means of the aneroid. To give an idea of the temperature of an ordinary fine day in these latitudes, and show the conditions under which Arctic vegetation makes so rapid a growth, I subjoin the temperature on one of the Kickertine Islands at various altitudes, on the 20th August 1861, when there was a clear sky, a bright sun, and little wind :— At 50 feet, exposed thermometer 69° Fahr.; in shade, 48°·5; sunk 1½ foot in soil, 45°; water of a small lake, 58°. At 100 feet in a valley, exposed thermometer, 70°; in shade (a little more wind), 46°; sunk $1\frac{1}{2}$ foot, in somewhat moist soil, 44°. At 200 feet, exposed thermometer, 58°; in shade, 51°·5; sunk $1\frac{1}{2}$ foot in sandy soil, 45°. At 450 feet, exposed thermometer, 62°; in shade, 41°; sunk 9 inches in sandy soil, 48°. Also, at one of these islands a thermometer was sunk 22 inches in a gravelly soil, and examined every two hours for twenty-four hours. The mean of all the observations was 42°·38.

The following is a list of the flowering plants and ferns collected :—

Ranunculaceæ.

Ranunculus affinis, Br.—Flowers in August. Coast to 500 feet. Soil granitic. W. side, at Kingnite, Cumberland Gulf. Grows to about the height of 18 inches.

R. nivalis, L.—Fl. in June. Sea to snow-line. Perennial; on any soil, but most luxuriant on volcanic. E. and W.

R. hyperboreus. Rottb.—Fl. June and August. Alt. 200 feet. E., Disco, Dark Head, and Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair. Grows in small pools of water, the depth of which modifies its appearance.

R. pygmæus, Wahl.—Fl. June to August. Range same on both sides. Alt., Sea to 1000 feet. Any soil, and grows in small tufts of from 6 to 12 plants. E., Disco and Hassen Islands, Dark Head, Danish Head, and Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

R. sulphureus, DC.—Fl. June to Sept. Range as in last species. Alt., Sea to 200 feet. Any soil. Flower often white, and the whole plant is often under the snow, except the flower stalk; petals very deciduous, and the seeds are often not shed till next spring. E., Dark Head and Danish Head. W., Kingnite, Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

Papaveraceæ.

Papaver nudicaule, L.—Fl. June to Sept. Alt., Sea to 1500 feet. Any soil, but chiefly on glacier drift, of a clayey nature; and amongst animal refuse, where Esquimaux huts have been. Flower sometimes of an inky blue colour, with yellow flowers often on the same plant. The natives appear to make no use of this species Common on both sides.

Cruciferæ.

Arabis alpina, L.—Fl. June to Sept. Alt., Sea to 500 feet. Range limited to the following localities; on trap in loose soil, and associated with few other plants. E., Disco, Dark Head. W., Cape Searle.

Cardamine bellidifolia, L.—Fl. June to Aug. Range 64° to 74°. Alt., Sea to 1500 feet. Mossy soil, amongst *Sphagna*, *Cyperaceæ*, &c. E., Disco and Hassen Islands, Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

C. pratensis, L.—Fl. June and July. Alt., 200 feet. E., Disco.

Draba glacialis, Adams.—Fl. June. Alt., 500 to snow-line. On trap soil, growing singly, with long filiform roots running deep into the soil; appearance much modified by elevation and exposure. E., Dark Head. W., Cape Searle.

D. hirta, L.—Fl. June to Aug. Alt., Sea to 2000 feet. In common with some other Drabas, it sends up two sets of flowering stems, in the earlier and later parts of the season respectively; the siliculæ of the latter generally retaining their seed during the winter. E. Dark Head, Upernavik, Horse Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair.

D. rupestris, Br.—Fl. June to Aug. Alt., Sea to 1000 feet. On any rocky and granitoid soil. E., Dark Head, Danish Head, Wilcox Point. W.. Kingnite, Cumberland Gulf, Capes Searle and Adair.

D. muricella, Wahl.—Fl. June and July. Alt., Sea to 500 feet. Soil granitoid. Perennial. E., Wilcox Point. W., Cape Searle, Scott's Bay.

D. stellata, Jacq.—Fl. June and July. Soil granitic. E., Wilcox Point.

D. lapponica, DC.—Fl. June, July. Alt., 1000 feet. Soil granitoid. Very variable. E., Wilcox Point, Dark Head. W., Cape Searle, Scott's Bay.

Vesicaria arctica, Rich.—June. Alt., 500 feet. Soil granitic. Roots sinking deep. E., Wilcox Point.

Cochlearia officinalis, L.—Fl. June to Aug. Alt., Sea to 200 feet. Grows very profusely. The varieties *fenestrata*, *arctica*, and *anglica* are not so common. E., Hassen Island, Dark Head, Upernavik, Horse Head, Duck Islands, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Caryophyllaceæ.

Silene acaulis, L.—May to July. Alt., Sea to snow-line. Common on both E. and W. sides.

Lychnis apetala, L., and varieties.—Fl. June and July. Alt., Sea to 1000 feet. Any moist soil. Some specimens are but an inch in height, and covered with long hairs; others nine inches, branching freely, and glabrous; flowers pink or white, the former colour most frequent on trap soils, where also the whole plant had a reddish appearance; the latter on granitic soils, the plant being of a dark green. E., Wilcox Point. W., Cape Searle, Midliattwack, and Niatoling.*

L. alpina, L.—June and July. E., Disco.

Honkeneja peploides, Ehr.—July, Aug. Alt., Sea to 50 feet. On the coast, but was also collected about three miles up a river, at the Winter Harbour, Kingnite, on an old sea beach, now raised about twenty feet above spring tides; while it also grew on the present beach, just below, in plenty. W., Kingnite, Cumberland Gulf, Kickertine Island, Cape Searle.

Arenaria verna, L., var. *rubella*, Br.—Fl. June to Aug. Alt., 500 feet (?). Soil granitic. In crevices of rocks. W., Winter Harbour, Kingnite, Cumberland Gulf.

A. Rossii, Br.—July, Aug. Alt., 200 to 1000 feet. Most frequent in trap soil, moistened by melting snow. E., Hassen Island, Dark Head. W., Kickertine Island, Cumberland Gulf, and Cape Searle.

* Niatoling is the name applied to the *district* round the station of Niatolik.

A. arctica, Stev.—July, Aug. Alt., Sea to 1000 feet. On any soil. E., Dark Head, Upernavik, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

Stellaria Edwardsii, Br.—July, Aug. Sea to 500 feet. Soil granitic. W., Winter Harbour, Kingnite, Kickertine Island, Niatolik, Cumberland Gulf.

S. stricta, Br.—June to Aug. Sea to 500 feet. Found in great profusion about the ruins of Esquimaux settlements. E., Women's Island, Duck Island, and Wilcox Point. W., Cape Searle, Scott's Bay, and along the coast.

S. longipes, Goldie.—July, Aug. W., Niatolik, Cumberland Gulf.

S. humifusa, Rottb.—July, Aug. Plentiful in sandy beaches. E., Dark Head, Women's Island. W., Capes Adair, Searle; Kickertine Island, Cumberland Gulf.

S. læta, Rich.—July, Aug. W., Niatolik, Cumberland Gulf, Cape Searle.

Cerastium alpinum, L.—May to Aug. Sea to snow-line. Varieties not unfrequently occur. Very common on both sides.

C. trigynum, Fries.—July. Alt., 1000 feet. E., Disco.

Rosaceæ.

Dryas octopetala, L. (*integrifolia*, Vahl.)—June, July. Alt., 1000 feet. E., Disco, &c. W., Cape Searle, Cumberland Gulf, &c.

Potentilla tridentata, L.—July, Aug. Alt., 300 feet. In crevices of granite rocks. W. Niatolik, Midliattwack Islands, Cumberland Gulf.

P. emarginata, Psh.—July, Aug. Alt., 500 feet. W., Niatolik, Kickertine Island, and Kingnite, Cumberland Gulf.

P. nivea, L.—June to Aug. Sea to snow-line. The specimens sent to Professor Balfour did not appear to him to be the true *nivea*. Are they nearer var. *pulchella* of Br.? E., Dark Head, Women's Island, Horse Head, Wilcox Point. W., Kickertine, Midliattwack, Niatolik Islands, Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

P. Vahliana, L.—July, Aug. Coast to snow-line. A very variable plant, giving rise to many of the varieties of authors. Thus, *P. sericea* seems a two-flowered form, while *P. hirsuta*, Vahl., and *P. Jamesoniana*, Grev., are also varieties of it. E., Hassen Island, Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Onagraceæ.

Epilobium alpinum, L.—July. E., Disco.

E. latifolium, L.—June to Aug. Alt., 1000 feet. Any soil; spreads much, but in some places seldom flowers. In warm valleys, in a southern exposure, it grows luxuriantly; in such places, I have several times found the exposed thermometer to indicate 80° to 90°. The highest temperature I ever observed in these regions was 106° Fahr. E., Hassen Island, Dark Head, Women's Island, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

E. angustifolium, L.—Aug., Sept. Alt., 1000 feet. Only found in the locality indicated, where it occupied a large space of ground amongst *Salix arctica*. W., North side of Winter Harbour, Kingnite, Cumberland Gulf.

Haloragaceæ.

Hippuris vulgaris, L.—Fl. Aug. Range limited. Alt., 100 feet. In small pools, to a temperature of 56° Fahr. W., Kickertine Islands, Cumberland Gulf.

Saxifragaceæ.

Saxifraga oppositifolia, L.—Fl. May to July. Alt., 1500 feet. E., Disco, Hassen Islands, Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

S. tricuspidata, Retz.—Fl. June to Sept. Alt., Snow-line. Any soil, and may reach a foot in height. E., Disco, Hassen Islands, Dark Head, Women's Islands, Horse Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair.

S. Aizoon, Jacq.—Aug., Sept. Alt., 300 feet. In clefts of granitic rocks. W., Kingnite, Midliattwack Islands, and Niatoling in Cumberland Gulf.

S. nivalis, L.—Fl. July, Aug. Alt., Coast to 1000 feet. Best in damp soil, mossy. E., Dark Head and Wilcox Point. W., Cumberland Gulf, Scott's Bay, Cape Searle.

S. cernua, L.—Aug. Coast to 200 feet. By the sides of rivulets, amongst mosses, &c. W., Kickertine Islands, Kingnite, Cumberland Gulf, Scott's Bay.

S. rivularis, L.—July, Sept. Coast to 2000 feet. Any soil, but varies in height from 1 to 6 inches, and often flowers twice a-year. E., Hassen Island, Dark Head, Women's Island, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

S. cæspitosa, L.—June to Aug. Coast to snow-line.

The following varieties occur:—

1. Leaves variable, the cauline ones entire.
2. Leaves tripartite and cuneate.
3. Leaves of both forms, and in 2 or 3 flowers on the same stem.

Common on both sides.

S. Hirculus, L.—Aug. Alt., 100 feet; on clay soil; it grows singly. W., Scott's Bay.

S. stellaris, L.—Aug. Alt., 200 feet. On granite, and often viviparous. W., Kickertine Island, Cumberland Gulf.

S. foliolosa, Br.—July. E., Disco.

S. hieraciifolia, W. & K.—Aug. Alt., 100 feet; on moist granitoid soils. W., Banks of a river south of Scott's Bay.

Chrysosplenium alternifolium, L.—Aug., on the beach amongst mosses. W., Midliattwack Islands, Cumberland Gulf.

Compositæ.

Gnaphalium sylvaticum, L.—June to Aug. Alt., 1000 feet. Any soil; very variable. E., Dark Head, Women's Islands, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

Antennaria alpina, L.—June to Aug. Alt., 1000 feet. Professor Balfour has doubts whether this be *alpina*. W., Kingnite, Kickertine, Midliattwack Islands, Cumberland Gulf.

Arnica montana, L. (*angustifolia*, Vahl).—June to Aug. Alt. 500 feet. Varies much; height, 1 inch to 1½ foot; is smaller in trap than in granitic soils. E., Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle.

Artemisia borealis, Pallas.—June to July. Alt., 500 feet. In crevices of rocks. W., Kingnite, Cumberland Gulf.

Erigeron uniflorus, L.—July to Aug. Alt., 700 feet. Varies much in size. Largest specimens, 18 inches. E., Hassen Island, Dark Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair, Scott's Bay.

Taraxacum pa'ustre, DC.—July, Aug. Sea to 500 feet. E., Disco, Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle.

Campanulaceæ.

Campanula linifolia, Hænk.—Aug., Sept. Alt., 500 feet on granitic soils. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. uniflora, L.—June to Aug. Alt., 500 feet. There seem to be two varieties of the plant. E., Disco, Hassen, Dark Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair.

Vacciniaceæ.

Vaccinium uliginosum, L.—Fl. May, June. Sea to snow-line; often covers large spaces, singly or associated with *Cladonia rangiferina*. The large and juicy fruit was abundant wherever I saw the plant. Common on both sides.

V. Vitis-Idæa, L.—May, June. Alt.. 500 feet. E., Wilcox Point.

Ericaceæ.

Cassiopei tetragona, Don.—July, Aug. Alt., Snow-line. Occurs everywhere, like the *Calluna* of Scotland, and made a fire for us at night when travelling, besides an excellent couch under the shelter of a boulder—no unnecessary luxuries in my longer journeys inland to the West of Cumberland Gulf, &c. Common on both sides.

C. hypnoides, Don.—June, July. Alt., 50 feet. In sandy flats on the coast, in dense masses. W., Kingnite, Kickertine Islands, Niatoling, and Cape Searle, Scott's Bay.

Azalea procumbens, L.—June, July. Alt., 500 feet. E., Wilcox Point.

Ledum palustre, L.—Aug. Mossy soil. Has a powerful odour, and is hence used by the natives in packing and preparing their seal skins; also used as tea. E., Dark Head, Women's Islands, Horse Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair, Scott's Bay.

Andromeda polifolia, L.—July. Mossy soil. E., Disco, Wilcox Point.

Menziesia (*Phyllodoce*) *cærulea*, L.—July, Aug. Alt., 300 feet. In granitic and mossy soils, with *Ledum*. E., Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle.

Rhododendron Lapponicum, L.—June, July. Alt., 1000 feet. Often covers large spaces, flowering in great profusion; more frequent on the E. side. E., Disco, Hassen and Women's Islands, Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Pyrola rotundifolia, L. (*chlorantha*, Sw.).—Aug. Very common on any soil; specimens occur with only one flower. Common on both sides.

Diapensia Lapponica, L.—July, Aug. Sea to 500 feet. The withered leaves of former years remain on the stem, closely packed below the living ones. Often grows on exposed plains, and on dry soil. Common on both sides.

Boraginaceæ.

Mertensia maritima, Don.—July, Aug. Beach, amongst sand. W., Cape Searle.

Scrophulariaceæ.

Pedicularis arctica, Br.—July, Aug. Sea to 500 feet. E., Dark Head, Wilcox Point. W., Cape Searle.

P. Kanei, Durand.—July, Aug. Sea to 1000 feet. Trap soil. E., Hassen Island, Dark Head, Horse Head. W., Cape Searle.

P. hirsuta, L.—June, July. Alt., 800 feet. The most common of the genus. E., Disco and Hassen, Women's Islands, Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

P. Langsdorfii, Fischer.—June, July. Alt., 500 feet. E., Dark Head, Wilcox Point. W., Kingnite, Cape Searle, Scott's Bay.

P. Nelsoni, Br.—June, July. Alt., 300 feet. W., Kickertine Islands, Midliattwack, Cumberland Gulf.

P. Lapponica, L.—June, July. E., Disco.

Euphrasia officinalis, L.—July, Aug. Sea to 50 feet. The plants were very small. W., Kingnite, Cumberland Gulf.

Plumbaginaceæ.

Armeria vulgaris, Willd.—July, Aug. Sea to 500 feet. Only seen at Cape Searle, in trap soil. W., Cape Searle.

Polygonaceæ.

Polygonum viviparum, L.—June to Aug. Coast to 500 feet. Common on both sides.

Oxyria reniformis, Hook.—June to Aug. Sea to snow. Very common, but not used by the natives as a cure for scurvy, for which they use the stomach of a recently killed deer. Common on both sides.

Kœnigia Islandica, L.—July, Aug. 50 to 500 feet. On the ground moistened with water from melted snow, and in moist crevices of rocks. W., Cape Searle, Midliattwack Island, and Kingnite, Cumberland Gulf. Annual.

Empetraceæ.

Empetrum nigrum, L.—May, June. Reaches snow-line. Very common in some places, and with fine fruit, which often survives the winter. In autumn its berries, with those of *Vaccinium uliginosum*, are collected and eaten by the natives. These are also eaten by *Corvus corax*, var. *Americanus*, and *Plectrophanes nivalis* and *P. lapponica;* while the grouse are fond of the young twigs. Common on both sides.

Betulaceæ.

Betula nana, L.—June. Not seen N. of Disco, nor on the west side. E., Disco.

Salicaceæ.

Salix arctica, Br.—May, June. Alt., 1500 feet. The tallest plant seen was 4 feet in height; it often grows to a considerable size, spreading over the southern face of some boulder. Common on both sides.

S reticulata, L.—May, June. Alt., 500 feet. E., Dark Head, Wilcox Point. W., Scott's Bay.

S. herbacea, L.—May, June. Coast to snow-line. Covers extensive tracts, and that too where most other plants cease to appear, except *Junci* and *Luzulæ*. The grouse feed on the leaves in spring. In dry fine weather in September, I have often seen its downy seeds wafted in clouds over land and sea. Common on both sides.

S. vestita, Pursh.—May, June. Alt., 200 feet. W., Niatolik, Cumberland Gulf.

S. desertorum, Rich.—May, June. Alt., 100 feet. W., Kingnite and Scott's Bay.

S. arbutifolia, Sm.—May, June. Alt., 200 feet. Detected by Professor Balfour. W., Kickertine and Midliattwack Islands, Cumberland Gulf. Frequent.

Melanthaceæ.

Tofieldia palustris, L.—June. Alt., 500 feet. Mossy soil. E., Wilcox Point. W., Kingnite, Cumberland Gulf, Cape Searle, Scott's Bay.

Juncaceæ.

Luzula spicata, Desv.—June, July. Alt., 100 feet. W., Niatolik, Kickertine Islands. Kingnite, all in Cumberland Gulf.

L. spadicea, DC.—June, July. Alt., 100 feet. In marshes amongst *Sphagna*. W., Kickertine, Kingnite.

L. arcuata, Hook.—July, Aug. Coast to snow-line. The seeds of this and other *Luzulæ* often survive the winter, being suddenly covered with snow, and thus afford a supply of food in spring to many birds in their northward migration, while they are equally serviceable in autumn on their return. Frequent on both sides.

L. hyperborea, Br.—July, Aug. Reaches snow-line. The leaves and stems of succeeding seasons often remain on the same plant, and from their size, &c. in a measure indicate the character of each season. Common on both sides.

L. campestris, Br., v. *congesta*.—July, Aug. Alt., 200 feet. W., Cumberland Gulf, in various places.

Juncus biglumis, L.—June, July. Coast to snow-line. Common on both sides.

J. castaneus, Sm.—June, July. Alt., 150 feet. Grows where water has stood in the early part of the year. W., Cumberland Gulf, in various places.

J. arcticus, Willd.—Aug. Alt., 100 to 150 feet. Mossy soil. W., Midliattwack Islands, Cumberland Gulf, Scott's Bay.

Cyperaceæ.

Eriophorum capitatum, Host.—June, July. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

E. angustifolium, Roth.—June, July. Coast to 300 feet. Common on both sides.

Carex rigida, Good.—June, July. Coast to snow-line. E., Wilcox Point. W., Cape Searle and Scott's Bay.

C. nardina, Fries.—July, Aug. In dry, stony places, like a dead tuft of grass. W., Cumberland Gulf, var. loc., Cape Searle.

C. misandra, Br.—July, Aug. W., Kingnite, Cumberland Gulf.

C. saxatilis, L.—July, Aug. Alt., 500 feet. Grows in marshes. E., Wilcox Point. W., Scott's Bay.

C. vulgaris, L.—June, July. Coast to 300 feet. W., Cumberland Gulf.

C. glareosa, Wahl.—June, July. At the sea level on the sandy beach, in large circular tufts. W., Cumberland Gulf, var. loc.

C. Stans, Drej.—June, July. Sea, 1500 feet. On the sandy shore this plant is so stunted as to seem very different from specimens at higher elevations and more favourable situations. E., Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. fuliginosa, Hoppe.—July, Aug. Coast to 500 feet. On exposed plains. E., Wilcox Point. W., Cumberland Gulf, Wilcox Point.

C. compacta, Br.—June, July. Coast to 200 feet. Very common, and grows amongst mosses in marshes. Specimens nearly 2 feet high seen. E., Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. aquatilis, Wahl.—July, Aug. In bogs. E., Disco.

C. leporina, L.—June, July. Alt., 200 feet. In marshes amongst mosses. W., Kickertine Islands, Cumberland Gulf.

C. capillaris, L.—July, Aug. Alt., 1000 feet. On granite cliffs. W., Cumberland Gulf, var. loc.

C. serpoides, Mich.—June, July. On granite cliffs. E., Women's Islands, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. Vahlii, Schkh.—June, July. Coast, 500 feet. In mossy soil, and about the edges of bogs. W., Cumberland Gulf, var. locis.

C. rariflora, Smith.—June, July. Coast to 500 feet. In marshes. W., Cumberland Gulf, various localities.

Gramineæ.

Alopecurus alpinus, Sm.—June to Aug. Most plentiful about old Esquimaux settlements; greatest height 2 feet. Common on both sides.

Calamagrostis canadensis, Nutt.—Aug. W., Cape Searle.

Agrostis vulgaris, L.—Aug. Alt., 200 feet. On both dry and moist cliffs. W., Cumberland Gulf.

A. rupestris, Willd.—June, July. Alt., 50 feet. On dry rocky soil. W., Midliattwack Islands, Cumberland Gulf.

Hierochloe alpina, Br.—July, Aug. Reaches the snow-line. A very common Arctic grass; greatest height 2 feet. Common on both sides.

H. pauciflora, Br.—June, July. Sea to 100 feet. On sandy soil by rivers, &c , and on the coast. W., Cumberland Gulf, var. loc.

Poa alpina, L.—Aug. Alt., 1000 feet. W., Cumberland Gulf, var. loc., Cape Searle, Scott's Bay.

P. arctica, L.—July, Aug. Coast to snow-line. Perhaps the commonest Arctic grass, and would often form fine pasture. Common on both sides.

P. cenisia, All.—July. Alt., 500 feet. W., Kickertine and Midliattwack Islands, Cumberland Gulf.

P. Balfourii, Parn.—July. Alt., 500 feet. On cliffs of granite. W., Kingnite, Cumberland Gulf, Cape Searle.

P. angustata, Br.—July. Alt., 50 feet. Confined to the coast, on sandy soil. W., Cumberland Gulf, var. loc.

Festuca ovina —June, July. W., Kingnite, Cumberland Gulf.

F. brevifolia, Br.—July. Coast to 1500 feet. Very common on any soil. Common on both sides.

F. Richardsoni, Huds.—July. Coast to 500 feet. On granitic soils. W., Midliattwack Islands, in Cumberland Gulf.

Elymus arenarius, L.—July, Aug. E., Disco.

E. mollis, Br.—Aug., Sept. Sea level, on sandy soil. W., North side of Winter Harbour, Kingnite.

Colpodium latifolium, Br.—July, Aug. Coast to 500 feet. In marshes and in sandy soil. Common on both sides.

Phippsia algida, Br.—June, July. Coast to 100 feet. In marshes. A very common grass. Common on both sides.

Trisetum subspicatum, Beauv.—July, Aug. Coast to snow-line; very common, growing sometimes $2\frac{1}{2}$ feet high. Common on both sides.

Dupontia Fischeri, Br.—July. Sea to 50 feet—soil sandy. W., Cumberland Gulf, var. loc.

Pleuropogon Sabinei, Br.—July, Aug. Coast to 200 feet. Grows in pools of water, in any kind of soil. It is perhaps the finest of Arctic grasses; its leaves float on the surface, the culm rising from 9 inches to 1 foot above the water, bearing its beautiful purple florets. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

Filices.

Woodsia ilvensis, Br.—July, Aug. Range limited. Alt., 100 to 500 feet, on granitic rocks. I have not found this nor any other of the Ferns descend below 100 feet. W., Niatolik, Kingnite, Cumberland Gulf, Cape Searle.

W. hyperborea, Br.—July, Aug. E., Dark Head, Women's Islands, Wilcox Point. W., Niatolik, Kingnite (very abundant), Cape Searle, Scott's Bay, &c.*

W. glabella, Br.—July, Aug. Range more limited than the last, not abundant in some localities. E., Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Cystopteris fragilis, Bernh.—July, Aug. A fern of great beauty and of rapid growth; ascends 100 feet higher than the other species. The most characteristic specimens of the var. *dentata* were found growing among the dead roots of *Salix arctica*, on the N. side of Winter Harbour, Kingnite, in Cumberland Gulf. E, Disco, Women's Islands, Wilcox Point. W., Kickertine Islands, Kingnite, Cumberland Gulf, Scott's Bay.

C. alpina, Desv. (?)—I have generally brought home with me in a living state the roots of such plants as seemed most eligible for cultivation; and with a little care and experience in packing, this practice affords very satis-

* None of the *roots* brought home have developed into *W. hyperborea*. They have all turned out to be either *W. ilvensis* or *W. glabella*, though the fronds brought home corresponded with *W. hyperborea*.

factory results, as in the hands of Mr John Roy, sen., nurseryman, and the Rev. Mr Beverly.*

Equisetaceæ.

Equisetum arvense, L.—Only seen barren. Alt., Coast to 500 feet. E., Disco, Dark Head, Wilcox Point. W., Cumberland Gulf, Scott's Bay.

E. variegatum, Schleich.—Only seen barren. Alt., 100 feet. Soil granitic. W., Inland from Cape Searle.

Lycopodiaceæ.

Lycopodium annotinum, L.—Aug. Only seen once, and at an elevation of 200 feet. W., North side of Winter Harbour, Kingnite, in Cumberland Gulf.

L. alpinum, L.—Coast to snow-line; seen in all parts of these regions visited by me. Common on both sides.

Rambles of a Naturalist in India, and the Western Himalayan Mountains. By A. Leith Adams, Esq., M.D.

I. *Excursion to the Salt Mountains of the Punjaub.*

During the months of March and April the climate of the Northern Punjaub is delightful. If the heat at mid-day is oppressive, the mornings and evenings are always cool and pleasant.

My old friend and companion Young joined me in this, as in former expeditions, for the purpose of hunting wild sheep, and procuring specimens of game-birds for his collection; accordingly, having despatched our tent and baggage to Ramouthra, a village thirty-two miles south of Rawul Pindee, we started early on the 21st of March, and rode through an almost barren country, intersected by ravines and water-

* Among the Arctic ferns brought home by me, and reared by Mr Beverly, were found last year several plants of one which he, and several others who examined it, suspected to belong to this species. They were led to this suspicion by observing the form and habit of the fronds, and especially the nature of the rhizome, which spreads more widely, and throws up its small tufts of upright fronds at greater intervals than *C. fragilis*. Just now (June 1862) the plants are in good condition, but the fronds seem not quite so like those of *C. alpina* as they were last year. Though this fern is evidently different from the common forms of *C. fragilis*, and in several respects approaches the so-called *C. tenuis*, in others *C. alpina*, it may perhaps prove to be only an extreme form of *C. fragilis*. But it shall be carefully watched as it grows, in order to fix its identity. At all events, in its *present* form, if it is not *C. alpina*, it is intermediate between that species and *C. fragilis*, and as worthy of being raised to the rank of a separate species, as many other varieties that have been so treated.

courses, now floundering through a stagnant pool, now cantering on a level space, covered with pebbles, or rough and hard *Kun-kur.* *

This substance is extensively distributed over the Northern Punjaub, either as a surface deposit of some thickness, or in heaps along the sides of ravines and river beds. It is usually met with in the form of tufaceous nodules, but not unfrequently in larger masses, from which many of the oldest temples in the country are built. When broken up, and mixed with brickdust and lime, it forms a durable cement; it is also used in road-making.

Long before day-dawn the well-known call of the *Spur-winged-lapwing* (*Lobivanellus goensis*) was heard. This unsettled water-sprite often flies about at night, startling the unwary with its cry of "*Did-dee-doo-it?*" "*Did-did-did-dee doo-it?*" Like the crested-lapwing, or pewit, it assails all who intrude on its haunts.

When morning dawned, we found ourselves on the banks of the Swan, one of several streams which rise at the foot of the Himalayas, and coursing westward empty themselves into the Indus. Many of them are completely dried up in summer, or present only a series of pools and stagnant ponds, with broad pebbly beds. They are very different, however, during the rainy season, when, after a storm, the rush of water is often sudden and furious.

During a terrific thunder-storm, which took place near Rawul Pindee, three soldiers were bathing in one of these pools, close to their barracks, when the flood overwhelmed them so suddenly that they were carried away by its violence. One poor fellow was drowned; and on recovering his body some three days afterwards, it was found to be horribly disfigured by a small species of crab which abounds in these parts.

The fish called the *Masseer* is common in these rivers, and often attains a very large size.

* Professor Ansted is disposed to consider this formation referable to the drift period, and gives the following as its composition:—72 per cent. carbonate of lime, 15 per cent. silica, and 18 per cent. alumina. I have, however, observed a similar deposit in course of formation in the Punjaub, chiefly in ravines, and by the sides of streams.

We observed a flock of Cranes (*Ardea grus*, Linn.) in the shallow waters of the Swan. This species migrates to Central Asia in May.

Journeying on we passed little villages surrounded by high walls of mud—clusters of camel-thorn—fields of wheat and barley, with here and there a solitary banyan tree, despoiled by the elephant drivers, who cut down its broad leaves for fodder—now a clump of mulberry or willow trees just budding, —now a ravine or a tract of waste and arid plain,—such are the natural features of this, and great portions of the Northern Punjaub.

Among the low brushwood that covers the sides of ravines and hollows, we frequently noticed the Black Sun-Bird, (*Nectarinia mahrattensis*, Lath.); also the lesser brown-coloured Bush-thrush (*Megalurus isabellinus*, Swain.), chirping and chattering in flocks, in a low note, or fluttering from bush to bush with its characteristic feeble and unsteady flight.

The blue Rock Pigeon (*Columba livia*, Briss.) abounds in ravines, and in the fields and hedgerows. The Senegal Dove (*C. senegalensis*) is generally seen either singly or in pairs.

On the side of a steep ravine I killed a fine specimen of the Spotted Eagle (*Aquila nœvia*, Gmel.), which is by no means rare in the Punjaub. The Black-throated Wheat-ear (*Saxicola atrogularis*, Blyth), is common; its favourite food is a small white worm, which it digs out of the sun-baked soil. Flocks of the Crested Sand-Lark (*Galerida gulgula*, Sykes), were scattered over the desert plains as plentifully as in the southern provinces.

March 22.—It blew strongly during the greater part of the night, and day dawned in the usual Indian style, followed by a brilliant hot day. The first half of our march was very similar to that of the previous day, until we debouched on a vast plain, cultivated here and there. In the distance, running from east to west, the Salt Range was seen, but so far away, that in the hazy atmosphere of mid-day we could do little more than define its outline.

Green Bee-eaters (*Merops viridis*), covered the surrounding country, flitting swallow-like after their winged prey. Numbers of a White-rumped Martin* were often seen,—a species common in the north-west during the cold months. The *Sand-Martin*† is also abundant, and builds in the sides of ravines and in the banks of streams. Around the villages (for what Indian village would be complete without them?) were Govind-Kites, Indian Jackdaws, and Mina-birds.

In the fields and sandy wastes were numbers of a *Sand-Lark*,‡ usually gregarious in the cold months, and often seen asssociating with the crested Sand-Lark first named. This species is larger than the *Anthus agilis* (Sykes), to which it bears a striking resemblance. Its total length is 7½ inches. The markings on the throat and breast are more numerous, with a slight tinge of rufus on the latter; inner surface of the wings dirty white.

March 23.—In order to escape from the heat of mid-day we started very early, and marched the first few miles by moonlight.

The route led by narrow footpaths, through strong ravines and cotton-fields. When day dawned we found ourselves toiling up a rather broad valley, and soon had the mortification of discovering that the guides had lost their way, and our three hours' journey was of no avail; however, we soon got on the right track, and entered on a fine open district, thickly covered with fields of green wheat, and by noon arrived at the town of Chuhkowal, during a Sikh festival, and just as a priest (*Goroo*) was about to address a large assembly in a tent pitched under a noble copse of Peepul, and other trees, where we spent the hottest portion of the day, watching the busy scene.

Pilgrims, fakirs and dirty beggars from all parts of the country were pushing onwards towards the tent, whilst many were bathing in the neighbouring tank. The heat and dust—

* No specimens were procured. I hesitate, therefore, to consider this the *C. urbica,* as Mr Gould found differences in one procured on the Cashmere Mountains sufficient to cause him to name it *C. cashmeriensis.—Proc. Zool. Society*, 1858. [We have *C. urbica* from Himalaya, differing from Scotch specimens only in the steel-blue of the upper parts being not so bright.—W. J.]

† *Cotyle riparia.* Several were procured.

‡ Possibly *Anthus desertorum* (Stanley). My specimen did not altogether agree with those procured in Scinde.

the continual hubbub of human voices—the cawing, chattering and chirping of impertinent Jackdaws (*Corvus splendens*), Bulbuls, and Rose-ringed Parroquets, among the branches overhead—rendered our stay anything but agreeable, and made us only too glad when the afternoon came, and we were able to quit the scene.

The Red-vented Bulbul (*Pycnonotus bengalensis*) is generally distributed over the Punjaub. The lesser Yellow species (*P. leucotis*), although not so plentiful, is by no means rare. They are often seen together.

The inhabitants of this part of the Punjaub, known as the *Scind Sagour Doab*, are chiefly Mussulmans. They are a fine, manly-looking race, with long flowing beards and large turbans. The women (such as we were permitted to see) wear capacious peg-tops (!!)—their hair knotted behind; while a loose jacket and a piece of red cloth over the head complete their eccentric costume.

The Pale-chested Harrier (*Circus pallidus*) and Turtle-Dove (*Turtur humilis*) were occasionally seen. The gay Indian Roller (*Coracias indica*) was constantly observed perched on the stump of a decayed tree, or pursuing its cork-screw-like flight through the hazy atmosphere.

The Palm-Squirrel (*Sciurus palmarum*) is common in every grove.

A Fox*, differing, in some respects, from the Bengal Fox (inasmuch as the lower parts, which are white in the latter, are in this species black), was not uncommon in the ravines and around the villages.

The Pied Wagtail (*Motacilla luzoniensis*) is plentiful at this season.

March 24.—We started early, and performed the greater part of the march by moonlight. At daybreak we reached the side of a steep ravine overlooking a most beautiful valley, composed chiefly of reddish marl and grey sandstone, cultivated in several places, and with a large lake of several miles in circumference occupying its centre, on whose placid waters the smoke from the neighbouring villages lay still and defined, as the morning sun shone with brilliancy on the scene.

* To all appearances the *V. pusilus* of Blyth, Jour. As. Soc., 1854, 730.

Flocks of wild fowl covered the surface of the lake, and the pink and white plumage of the Flamingo added much to the beauty of the landscape.

The Wandering Pie (*Pica vagabunda*) was observed. I do not think I have ever seen more than two of these birds together; in habits, it resembles the British Magpie.

The Pied Stonechat (*Saxicola picata*, Blyth) is common.

The Indian Robin (*Thamnobia fulicata*), so general in most parts of Hindustan, is seen here in almost every village and field. Although differing in plumage from its European congener, there is much similarity in their habits; it frisks before the door, and picks up the crumbs, jerking its tail as it hops along! How often have associations of home been brought to mind by seeing this pretty little warbler pursuing its gambols before the door of our Eastern bungálow. Although the song of this species is far from unmusical, it wants the melody of the other.

The Indian Porcupine (*Histrix leucurus*) is found among the low scrub and bush; as an article of food its flesh is much sought after, by Europeans as well as natives.

The Salt Range extends from the Western Himalayas in the east in nearly a straight line to the Suliman Mountains in the west, and is composed of low hills intersected by narrow ravines, or prominent ridges, for the most part devoid of vegetation.

Saliferous sandstone, marl, limestone, red and grey sandstone, would appear to form the chief geological features of the portion of the range visited by us.

The surface, except where extensive denudation had taken place, was covered with scanty soil and rounded pebbles, mostly formed from the breaking up of the limestone strata. Salt is found in various situations, more especially in the neighbouring district, where there are several extensive salt-mines.

The barren and sun-burnt appearance of these mountains strikes the traveller; indeed, it is chiefly that which renders them a safe retreat for the wild sheep, for except in the more fertile situations, these dreary and desolate wastes are seldom disturbed by man.

The *Houriar*,* or wild sheep, extends along the eastern portion of the Salt Mountains, but to the best of my knowledge has not been found to the east or south of the Beas River.

As regards British India, it is confined to the north and western portions of the Punjaub, including the Suliman chain, where it is known by the name of *Kuch*. It is also a denizen of the mountains around Peshawar, including the Khyber Pass, Hindoo Coosh, and Kafiristan.

The *Shapoo* of Ladakh, if not identical, is certainly very closely allied; its differences, I opine, are slight, and such as might result from the great diversity of climate and vegetation of the two regions. The "Sha" of Tibet, described by Vigne, has also a close affinity; and possibly the *wild sheep* of Western Affghanistan, Persia, the Caucasus and Armenian Mountains, are likewise of the same species. There is considerable diversity with regard to form and size of horns, in specimens I have examined from the Salt Range and Ladakh, as well as in the build of the animal; for example, the Ladakh sheep were larger, and had the upper surface of the horns rounded, and the tips turned more inwards, whilst the other had the upper surface of the horn flat. However, with reference to other peculiarities, they did not seem to differ in the slightest degree.† The peculiarity in the shape of the horn is certainly striking, and affected all the rams' horns I examined from Ladakh; but too much value must not be put on these distinctions, as every one familiar with horned ruminants in a wild state knows that these appendages are subject to much diversity in individuals of the same species.

The upper parts of the Houriar of the Salt Range are fawn colour; the belly and inner sides of the thighs pure white. The male has a black line of rather long hair extending down the dewlap and breast; the horns resemble certain varieties of the domestic animal, but perhaps rise higher and curve more backwards; the horn often measures from 25 to 30

* *Ovis vignei*, Blyth, Proc. Zool. Soc., 1840, 70.

† My collection of skins and horns is preserved in a little museum in my native village, Banchory-Ternan, Aberdeenshire.

inches over the curvature, and from 8 to 12 inches around its base; that of the female is small, and seldom exceeds 6 inches in length.

On the 25th of March we ascended the side of a steep ravine covered with brushwood, and gained a broad plateau, partly cultivated; there we flushed several covies of Chuckore (*Caccabis chukar*) and Sisi (*Ammoperdix bonhami*, Gray). The former is by no means common on these ranges, or indeed in any part of the Punjaub, although occasionally met with around Attock and Rawul Pindee; its favourite haunts are on the Himalayas, where it extends northwards even to the Altai Mountains. The average weight of an adult male is about 1½ lb. It is found likewise in Persia and Affghanistan. I have seen and examined specimens from all these countries. Mr Vigne in his Travels mentions red-legged partridges in Kurdistan, but does not identify the species with the above.

The *Greek Partridge*, found in south-eastern Europe, specimens of which I obtained in the markets of Constantinople, appears to me identical with *P. chukar* from the Western Himalayas, with which I have compared it. The white throat and fainter rufous colour of the ear-coverts are not invariable distinctions by which the Greek can be distinguished from the other, inasmuch as many Chukore I examined had similar characters.

The Sisi is known to Europeans as the "Bastard chuckore;" it is much smaller than the last. The male measures in the flesh about 10 inches, the female about 9½ inches; the iris is hazel; bill, brownish-yellow, lighter on the legs. Its existence has been known to naturalists for several years, but all the specimens were brought from Affghanistan, where it abounds on sandy wastes and barren mountains. The Sisi is not found in Ladakh or on the ranges to the south and east; and, I think, with the Salt and Suliman Ranges, and probably with the mountains around the Khyber Pass, we define its limits in British India. It is often seen associated with the Chuckore, to which, in habits, it has a close resemblance; the call-note, however, is very different.

The pretty little Red-fronted Fly-catcher (*Muscicapa* *parva*, Meyer), is much like the Robin in appearance, and, although less familiar, has many points in common; it affects hedges and dense jungle, and is usually seen solitary. This little creature has a wide Asiatic distribution, and extends westward to southern Europe, even to the south of France.

March 27th.—We pitched our tent close to the little village of Norpoor, and were not settled before its *kotwal* or governor arrived to offer his services in procuring supplies, bringing with him a rupee, which, according to the usual Indian custom, he held out for our acceptance. He appeared, however, somewhat dubious as to our social position, especially our acquaintance with the etiquette which requires that gentlefolks should, on such occasions, merely touch the offered gift, and then make a salaam of satisfaction to the host. As each of us laid our hand on the coin, our Sikh friend squeezed it the firmer, and even closed his fingers over it, then grinned a smile of perfect contentment when he found out that we were persons of consequence—a discovery our shady jungle costume was not calculated to impress. I spent the day among hot marl and sandstone ravines, searching after wild sheep. The reflection was excessive, and we suffered much from want of water, which was only procurable in the shape of red muddy pools in the worn-out basins of water-courses. After much fagging, and several snap shots at wild sheep and ravine deer which we started in the narrow fissures between the marl beds, I espied two of the former lying under the shade of an acacia, and, by dint of much trouble, managed to crawl unobserved within twenty yards, when, forgetful of the old adage, "A bird in the hand is worth two in the bush," I sought a nearer approach, in order to gain a chance of killing *both*, and, by so doing, had the mortification to lose them, for the ram, catching a glimpse of me, sprang to his feet, and, sending forth his loud whistle, disappeared at once among the tortuous lanes. This mishap was one of many, which eventually taught me never to lose a good opportunity in hopes of obtaining a better, and this advice I can confidently give to all young hunters.

The *Emberiza caniceps* (Gould), Lammergeyer (*Gypætus barbatus*), which doubtless feeds sumptuously at this season on the young Houriar, and the "Blue Water Thrush" (*Myiophonus Temminckii*, Vig.), hitherto observed only on the Himalayas, were now occasionally seen. The Raven is common. The Crow (*Corvus culminatus*, Sykes) was not seen on the Salt Range or about Rawul Pindee, where, however, the Rook is plentiful during the cold months. Now and then the Pied Woodpecker (*P. himalayanus*, Jard.) was observed on the acacia and other trees.

Hares (*Lepus nigricollis*) were killed occasionally. I obtained a specimen of a short-tailed field mouse. Wild pigs are very plentiful and exceedingly destructive, but seldom seen, as their depredations are made at night, and they secrete themselves in the most secluded and impervious jungle during the day.

We pitched our tent in the most retired spot we could discover, distant from the habitations of man, and in the centre of the Salt district, where the Houriar repair at dusk to lick the salt-encrusted rocks. The streams and wells of the neighbourhood were all more or less tainted with that substance; fresh water was therefore very scarce.

During our day's ramble, and when clambering across a rough mountain ridge, I suddenly encountered a brawny Sikh; he was minus his nose and right hand, which he said were cut off by order of Runjit Sing as a punishment for murder, he having at the age of eighteen killed his brother. When told that now-a-days his life would be forfeited by such a crime, he replied, "Yes, sir," most unconcernedly; and, with a sly shrug of his shoulders, my friend turned and moved down the ravine (I fancy to pursue his habit of salt stealing), whilst I pushed upwards, and gaining the summit of the mountain, had a magnificent view of the Indus, tracing its winding course for upwards of thirty miles through the hazy atmosphere of the plains. The heat of the sun and the reflection from the sides of the red ravines were very powerful.

Of wild sheep we saw many, but the cover was scanty, and they were always on the alert. If a herd was feeding in a ravine, an old ram was seen to be on the outlook on some near eminence, and as soon as he apprehended danger, he sent forth a loud whistle, and the whole herd took to flight. There are few ruminants in which the senses of sight and smell are more highly developed than in the Houriar, although natives allege that the latter sense is either very feeble or wanting altogether.

By European sportsmen this animal is frequently called the "deer-sheep," and viewed abstractly, it is certainly a strange-looking admixture of the two—the horns, gait and bleat, are decidedly ovine; it has the infra-orbital apertures of the deer, together with the gracefully formed limbs and fleetness of that animal. The hair is thick, and though not long or curling, is in texture quite different from that of the deer.

In barren stony places, among the ravines, we often saw a Redstart,*—the Bay-backed Shrike (*Lanius hardwickii*, Vigors) was plentiful in bushy places, and on the acacias.

The Black Sun-Bird was beginning to pair, and the soft note of the male sounded sweetly from the surrounding bushes. Its song resembles that of the chaffinch, but is more melodious.

All over this country, in secluded valleys, on hill-sides, and out of the way places, graves were of frequent occurrence; some had an erect pillar at either end, marking the head and feet, while many have an intermediate one. I was told the latter distinction denoted the grave of a female.

We noticed more of the ancient buildings before named—they are chiefly in ruins. One quadrangular-shaped building, composed of large blocks of limestone, was observed near the village of Jubba; narrow archways, opening into separate compartments, were on each side of the square. The generality of these buildings are flat-roofed, and seldom more than from four to five feet in height, surrounded by trees and accumulations of rubbish.

A native sportsman assured us that tigers, leopards, hyenas, wolves and antelopes,† besides an occasional black bear‡ from

* No specimens were procured; but I believe the species to have been *Ruticilla phœnicura* from the white on the forehead. *R. indica* I have not recorded in my notes of the Punjaub, and am inclined to think I have overlooked that species, which is said to be common in North-Western India.

† *Cervicapra bennoarctica*—the Black Buck of Indian huntsmen.

‡ *Helarctos tibetanus*, Cuv. *H. malayanus* is not found in the Punjaub.

the Himalayas, jackals, foxes, &c., are met with on the Salt Range.

March 30th.—Although the scenery of these mountains is generally devoid of beauty, one comes occasionally on little spots by no means wanting in natural attractions.

This morning we rose at daybreak, and after an hour's toil across a very stony plain, covered with briars and thorns, we arrived at the brink of a broad ravine, the sides of which were covered with dense and luxuriant vegetation.

The peepul, camel-thorn, mulberry, and wild fig, formed small shady groves in which the Fakirs had built beautiful little temples, surrounded by gardens in flats, like steps. Patches of wheat, tobacco, and the red and white opium-poppy, grew in these.

On a prominence jutting into the ravine, stood a shrine, which at a distance looked like a miniature castle; and far down, among tangled briars and bushes, rolled a clear stream.

Flocks of pea-fowl, preserved by the religious devotees, were seen in all their native elegance and beauty, their wild cries resounded through the glen, as now and then one darted past us, his gorgeous shades of plumage refulgent in the morning sun. It was an enchanting scene, but as the heat was increasing every moment we hurried onwards, and soon gained the opposite plain, where we discovered a herd of Houriar, headed by two great rams; the nature of the ground, however, prevented a nearer approach than 300 yards, from which distance I fired on the largest male and broke his hind leg, but unfortunately the poor animal escaped after I had followed his bloody trail for several hours under a burning sun. When once scared, it is seldom the Houriar rests for the remainder of that day, but, keeping on the alert, moves along the most commanding ridges. If caught young, the animal is easily domesticated. I have seen an adult female become so tame as to feed with a herd of goats, and regularly attend at the kitchen for food. I believe, hovever, the rams are very unmanageable and pugnacious; they fight in the same way as the tame species, and their *bleat* is similar.

When driving a jungle in search of wild pigs, I observed a specimen of the Great Wild Cat or Chaus (*Felis* (*lynx*) *chaus*, Guldenst.). It is pretty common in the Punjaub, and hunts among the ravines and broken-up country. In a hollow, more or less covered with scrubby jungle, we were suddenly startled by observing large blood-stains, and in one spot decided traces of a struggle with the foot-prints of what must have been either a leopard or a tiger, more likely the latter, as the villagers informed us that their cattle, sheep, and goats were often carried away by tigers—and on the present occasion a young bullock was missing. It is difficult, however, to be certain as to the depredations of one or the other, as they are chiefly committed at night. The Leopard (*Leopardus varius*, Gray; *F. pardus*, Linn.), seldom attacks cattle, and chiefly confines itself itself to the smaller deer, tame sheep, goats, or dogs—the latter it has been known to carry away at night from the centre of a village.

The Black Partridge (*Francolinus vulgaris*, Steph.), is not generally distributed in these parts, the country not being sufficiently cultivated and inviting; moreover, I do not think the Chuckore and this species ever frequent the same cover, although the former and the gray partridge are often found together.

Flocks of the Wood Pigeon (*Columba palumbus*) were common in the fields. All the Indian specimens I have examined had the neck patch clay coloured; but in other respects there does not appear any difference between the European and Eastern bird.

April 2.—A hail storm took place during the day, and lasted for upwards of twenty minutes; many of the hailstones were as big as sparrows' eggs. The palæontology of these ranges must be very interesting, but my time was too much occupied with the object of our excursion to allow me leisure to examine the geological formations with care. I wandered over a rugged hill-side above this village, picking up fossils at almost every step, chiefly bivalve and large spiral univalve shells and species of galerites, and other echinoderms, until attracted by a large lake which was covered with flocks of flamingoes—their tall, gaunt forms looking like balls of pink and white suspended in the shallow waters. As usual, with this species when roosting, each bird had its head under its wing, and was supported on one leg, with the other drawn up. I am afraid I rudely disturbed their slumbers, for, resting my rifle on the wall of a house overlooking the lake, I sent a leaden messenger into the densest part of the flock, and when the frightened host had fled, one was seen to drop and float into the deep water. The average length of the flamingo (*Phœnicopterus roseus*, Pallas) from the bill to the extremity of the middle toe, is 5 feet 7½ inches, and between the tips of the wings 5 feet 10 inches; weight 5 lbs. These measurements are the result of many trials. The genital organs of two shot at the latter end of March were very small. I have found this the case with several migratory species, especially those which breed on the lakes of Tartary, such as the White-fronted Goose, Ruddy Sheldrake, &c. The flamingo is certainly migratory in Northern India, and most probably breeds on the lakes of Central Asia, where I have gathered the eggs of ducks and geese as late as the end of July. There is considerable variety both as to size and the colour of plumage, irrespective of age and sex. Mr Jerdan mentions a small race appearing in separate flocks.* All I have seen on the rivers of Northern India were of the larger variety, with long legs. In a flock many may be seen with dark-coloured backs and pink under the wings, with the rest of the plumage pure white—these may possibly be young or immature birds; others with a delicate pink all over, the intensity keeping pace with age. Coots (*Fulica atra*) were common on this swamp. Behind the village of Kotila arises a steep mountain, probably the highest on the range; its top only is covered with long grass and a few fir trees (*Pinus longifolia*). I looked in vain on the highest hill tops in the neighbourhood for any botanical productions similar to this little isolated patch, which was clearly owing to the greater altitude of the Kotila mountain top; these few plants and a tree only to be seen at certain elevations on the Himalayas, were detached like an oasis on the top of this barren mountain.

In many situations whole fields of grain are laid waste by wild pigs; we observed their depredations in the wheat fields, and the ground covered with their masticated pellets, com-

* Madras Journal, vol. xii. p. 217.

posed entirely of the tops of grain. The hills around Kotila and Sookeysir are too much frequented by tame goats and sheep to afford day retreats for the Houriar, which is seldom found in the open country except at night or in the early morning; their favourite resting-places during the day are among the wild, dreary, and desolate ravines, where "huntsman's horn was never heard, or hum of forest bee." Wild pigs secrete themselves in the dense jungles during the day, and repair to the cultivated tracts at dusk, returning again at break of day, in spite of the exertions of the farmers to frighten them away by loud noises. Perhaps like the black bear of the Himalayas, they soon get accustomed to sounds, and care little for anything of the sort unless in their immediate vicinity.

The Ravine or Bennett's Deer (*Gazella Bennetti*, Sykes), better known to English sportsmen as the "Chinkara," is pretty plentiful among the low hills of the Northern Punjaub, especially on the Salt Mountains; it does not, however, affect any portion of the Western Himalayan range. The horns of the male seldom exceed 18 inches; those of the female are smooth, and usually 4 inches in length. The ravine deer is usually seen solitary, but occasionally small herds may be observed. The cerumen or wax from the infra-orbital sinuses of a male killed by me on this occasion was rubbed on the horns, and produced a polished appearance, which, even in the dead animal, lasted for several weeks. As I have often seen this species, the Cashmere stag, and other animals, with the above mentioned appendages, rubbing their foreheads and horns on trees, I have supposed they might be pressing out the wax, the use of which may be to prevent the horn decaying. When we consider the apparent smallness of the little bag on the rump of an eagle, and the number of feathers which its contents are supposed to lubricate, we need not be surprised at this disproportion between the contents of the sinuses of the moose or red deer with the great surface of horn they may be imagined to preserve from decay.

April 6.—The ravines around Jubba have a peculiar appearance; viewed from a height, they present a series of worn and denuded angular hillocks, intersected by narrow defiles, by no means inviting to the traveller. Not a blade of grass is visible, and the red marl suggests the idea of sleeping volcanic embers, more especially during the heat of mid-day. I have scarcely ever witnessed a scene so perfect in its desolation; however, we determined to descend, in spite of the excessive heat, and reflection from the marl and sandstone. While threading our way among these hillocks, we came on a young Houriar just born, and evidently abandoned by its mother. On seeing us approach, several herds of rams were observed dashing across the ravines, and I had a snap shot occasionally. By noon, as we had anticipated, the heat became excessive, and thirst intolerable; no water could be procured save what was strongly impregnated with salt. At last, exhausted, I gave in, and must have been verging on a *coup de soleil*, as my senses began to leave me, and I felt my eyesight and hearing rapidly failing, accompanied by loud sounds in the ears. In this condition I lay stretched on the shelf of a rock, whilst the Shickaree* set off in search of a spring of fresh water. Soon afterwards the voice of a native roused me from my helpless stupor, and I gazed on a half-naked man carrying a basin of milk and platter of cakes, which he begged I would accept. "The good Samaritan," a Mussulman, had seen my distress from his dreary watch tower on the top of a neighbouring hill, where he resided for the purpose of guarding a vein of salt. Never shall I forget the kindness of the poor fellow, who, unsolicited, came to my aid at a time his services were so sorely needed. Whilst in the neighbourhood of Jubba, we were visited by a young Englishman, employed in the Salt Revenue Department. He appeared a regular Robinson Crusoe, having spent many years among those horrid hot ravines, without any companions save his native followers. He said that during the hot months he was obliged to turn day into night, in consequence of the heat, as it was certain death to visit his various posts in the day time. He was an example of (what may be often seen in India), an Englishman born and brought up in that country without the shadow of an idea of anything beyond Hindustan and its European society, and

* Native sportsman.

even the smallest portion of thought on the latter; for his manners were more in common with the natives, whose language he spoke more fluently than his own. The poor fellow was somewhat concerned about his health, in consequence of a fever which had twice nearly finished him, and looked forward with dread to the approaching summer, indulging, however, in a hope that he might get another district where he would as least have the advantage of a better house to cover him. And judging from his wan and pale face, there seemed just cause for his anxiety.

My friend, during a hunting ramble, found three young Houriars, and had the good fortune to kill two old ones. Our little herd—now increased to two males and two females—took kindly to the tame goats, and became as much attached to their foster-mothers as they would have been to their parents. The goats also got reconciled to them, except one old dame, that positively refused to suckle her foundling, and required to be held during the process. It was pleasing to see the lambkins frisking about the goats, and rushing towards them for protection, bleating whenever they got separated. For several days all seemed to thrive, when they began to pine and die, one after another, with a discharge from their noses, and a cough, which I discovered afterwards arose from inflammation of the lungs, portions of which were very much congested, and here and there consolidated (to use a medical expression, hepatized).

The Blue Rock Thrush (*Petrocincla cyanea*) is not a rare tenant of rocky situations and bleak hillsides. All I have examined in the Punjaub and lower ranges of the Western Himalayas were of the short-billed variety; the other (*P. longirostris**), I obtained only in Ladakh and Tibet. This thrush is a wild and wary bird. The Black-breasted Sand Grouse (*Pterocles arenarius*), or Rock Partridge, as it is better known to sportsmen, repairs in flocks at daybreak and dusk to drink at tanks and ponds.

Both the Moor Buzzard (*Circus æruginosus*) and Pale-chested Harrier were common, and usually seen hovering over the wheat-fields for mice, lizards, or quails. I have

* Blyth. See Jour. As. Soc. vol. xvi. p. 150.

seen them pick up and carry off quails immediately after being shot.

The Daurian Swallow (*Hirundo daurica*) was plentiful in and about the ravines. I procured a specimen of the Roseate Finch (*Carpodacus erythrinus*, Pallas) from a flock which was feeding on the blossoms of a mulberry tree. Numbers of the Malabar Grosbeak (*Munia malabarica*) frequented the hedges. Its sweet plaintive twitter is very pleasing. This little creature is so tame that you may approach it within a few yards. They are easily caught with nets, and in much request as cage-birds.

April 12.—Arrived at the Kuller Kahar Lake, although many of the avi-fauna of this lake had taken their departure for the cooler regions of Tartary to breed, still many interesting species remained, and afforded us ample occupation in shooting and preparing specimens. It would appear that in many migratory birds the aphrodisiacal tendency is not always incited by spring. For instance, the genital organs of two males of *Casarca rutila*, and several Flamingoes, examined on this occasion, showed no symptoms of enlarging, whilst in the Shoveller Duck and several of the other migratory species these organs were observed to be rapidly increasing in size. This agreed with my previous experience on the Ladakh lakes, where I found the first with eggs and young just hatched as late as the end of July, whilst shovellers, teal, mallard, &c., had long since left the marshes, and were assembled on the lakes with their broods fully fledged. It is probable, therefore, that as long as the sexual organs remain small the longer will the birds remain in their winter quarters, for it is evident that the development of these organs takes place before the bird commences its migration; as, on the other hand, want of food and climate send it back again in autumn. It is apparent, however, that birds often over-reckon distance, and exceed the bounds of their usual sojournings, as numerous examples in the avi-fauna of Europe show. Many are driven from their haunts by stress of weather. Thus, although birds are wonderfully unerring in their judgment of distances, they are not always exact. How often have carrier-pigeons been lost?

For several days previous to our arrival at Kuller Kahar Lake the weather had been unusually hot, and the day haze denser than I had ever seen it. There is no difficulty in accounting for this phenomenon in many localities where exhalations from the soil are present; but when observed, as it often is, in the desert, and in dry parched places, we cannot so easily attribute its presence to the same causes. Possibly some unexplained electric or other condition of the atmosphere also enters into its composition. I have seen it up to 6000 or 7000 feet on the Himalaya, but not in the rainless region of Ladakh or Tibet. A thunderstorm seems to disperse the fog, and renders the atmosphere particularly clear for days afterwards, even during a fierce sun. On the night of our arrival at Kuller Kahar we were awoke by a furious storm which nearly blew our little tent down; the roar of the thunder and the brilliancy of the lightning were perfectly appalling, whilst the rain fell in torrents; the whole did not last above an hour, and left behind the usual delightful and exhilarating weather which comes so grateful to man and beast after days or weeks of feverish heat. I will never forget the enchanting little scene and bright sunny morning following, as groups of red and white flamingoes in long lines stretched along the shallows of the lake, and ducks and other aquatic birds lined the margins, or crowded in dense flocks in the deeper parts, whilst from the jungle-clad hill on the right loud wailings of peafowl kept by the fakirs of the temple on its summit resounded across the valley, and the green bee eaters, black Drongo shrikes (*Dicrurus longicaudatus*) and others hunted around the copse in which we were encamped, pursuing the countless myriads of insects that appear on these occasions, especially the white ant, which affords great diversion to these birds. We found flocks of long-legged Plovers (*Himantopus candidus*) on the lake. This species is common in the pools of the Northern Punjaub during the winter months; specimens are often met with having their legs bent and deformed.

The Cinereous Godwit (*Limosa œgocephala*), Green Sandpiper (*Totanus ochropus*), and Water Rail,* are generally distributed over the lakes and fens. The Lark Toed and Pied

* *Rallus aquaticus* of Indian authors. *R. indicus* (Blyth), Jour. As. Soc. xviii.

Wagtails are plentiful. The Ruddy Goose (*A. rutila*) was often observed. The Castaneous Duck (*A. nyroca*) was seen in flocks. We bagged also a few jack and common snipe.

The *Vanellus leucurus* I did not observe elsewhere; it is certainly rare in most parts of India. The bill is black, irides hazel, margins of eyelids red, legs yellow. This Lapwing is probably migratory in the Punjaub. I was told that it is common in Affghanistan, where it is known by the name of "Chiric." In habits it closely resembles sandpipers, frequenting margins of lakes and wet situations; it runs at great speed.

Besides the Long-tailed Swallow (*Hirundo filifera*), I procured a small Sand Martin, which I mistook at first for the common Bank Swallow (*C. riparia*). It is different, likewise from the *C. brevicaudata*,* with which it was compared by Sir William Jardine, who informs me that if not a small or local variety of one or other of the above, or *C. subsoccata*† of Mr Hodgson, it is a new species. The total length in the flesh four inches. Upper parts greyish umber. Wings darker; length $3\frac{2}{10}$ inches, as long as the tail. Tail moderate and nearly even. Throat dirty white. An irregular band of greyish umber across the breast. Belly, vent, and under tail-coverts, white. Tarsus almost naked, except the minute tuft above the insertion of the hind toe. To the above we added the Shoveler (*A. clypeata*), Red-crested Pochard (*A. rufina*), Garganey Teal (*A. querquedula*), Red, and Green-shanks (*Totanus calidris* and *glottis*), Little Grebe (*Podiceps minor*), and Temmincks Sandpiper (*Tringa Temminckii*).

We returned to Rawul Pindee by a somewhat different route, more to the north and east of that by which we came. Thunderstorms were of daily occurrence for upwards of a week, and always followed by fine cool and brilliant weather, when we enjoyed magnificent views of the great Himalayan chain from the Benibur Pass to Attock on the Indus. The last ten days of our journey, however, were very hot, the thermometer standing as high as 92° in our tent, and 115° a foot from the ground outside the tent. Near the village of Bone, on the northern skirts of the Salt Range, we came on a party em-

* Proc. Zool. Society, 1839. 156.

† Cat. Brit. Mus., No. 332.

ployed sifting the soil for gold, which is found in minute particles among the dark-coloured earth on the sides of hillocks and in dried up water-courses. Native boys were employed pouring water on the earth, which after percolating through a perforated box, was removed and carefully examined. They assured us what of the precious metal they found was scarcely enough to repay the labour.

On the rugged footpaths among the ravines were round cairns of stones similar to the "*chaits*" seen in Ladakh; and solitary graves of travellers, murdered during the Sikh dynasty, were often observed on the road sides, and surrounded by heaps of stones, rags of various colours, pieces of wood, cotton, &c., the donations of passers by, who invariably leave some token of respect, and more from that than anything else, we got into the habit of doing the same. Moreover, it reminded my companion and myself of the ancient habit of "adding a stone to the cairn once so prevalent on the bleak hill sides of old Scotland." What Scotsmen are not tenacious of their ancient customs?

April 18.—The mulberry was ripe, and the trees laden with this delicious fruit, which in flavour equals that of Cashmere.

Our route for some days led through fields of grain then fast ripening, or across ravines, and streams swollen by the late rains, which had furrowed the country with deep chasms, and borne vast quantities of alluvium to the greater rivers, to be in turn conveyed to the mighty Indus.

The Persian lilac (*Falso sicomoro)* was in full bloom, and an abundant spring harvest approaching. Everything promised well for the industrious people who had settled down to our rule; and, if they would only confess, are far more comfortable and safe than when under the oppressive sovereignty of the native rulers. The village boys were employed in the wheat fields frightening away thousands of Brown-headed Buntings (*Euspiza icterica*) and Rose-coloured Pastors (*Pastor roseus*), flocks of which were seen scouring across the country, and weighing down the ears of the grain as if it had been laid by the wind. The former is only seen in the Northern Punjaub during the harvest months, and may possibly come from the west; it is said to be common about Candahar,* from April to the autumn months. The other species is generally distributed and indigenous in the Punjaub. There is a lizard about a foot in length—blunt-nosed, tail obtuse, body covered with large and broad scales—plentifully distributed over the wastes, where it forms burrows, and may be seen basking in the sun at their entrances.

The Blue-throated Warbler (*Cyanecula suecica*) was occasionally observed, and as usual, with the spot on the breast rufous.

The Black-bellied Larkfinch (*Pyrrhylauda grisea*) is a common denizen of arid and barren plains, and squats close on the ground. Herons (*Ardea cinerea*) were hunting in the shallow pools, and the Gull-billed Tern (*Sterna anglica*) was observed flying wildly northwards in scattered flocks, and not settling anywhere, evidently on their way to the cooler regions of Central Asia. We also hurried on towards our homes, for the hot blasts from the west told of the approaching summer, and showed we could not much longer roam over these plains at mid-day. Within ten miles of Rawul Pindee, we found our horses waiting us, and mounting, scampered across the country, sorry indeed to return to the dismal monotony of a small cantonment life. My companion, "a huntsman keen," grumbled at his indifferent luck in not having procured more game; for my own part I had no cause to be dissatisfied, having combined much healthy recreation with intellectual improvement.

Notice of a Mass of Meteoric Iron, found in the Village of Newstead, Roxburghshire; with some General Remarks on Meteorites. By JOHN ALEXANDER SMITH, M.D.† (Plate II.)

Description of Mass of Iron.—The external surface of this mass of iron (exhibited to the meeting) is rough and irregular; and it affects the magnetic needle very strongly.

* See Catalogue of Birds in the East India Company's Museum, vol. xi. p. 487.

† Read before the Royal Physical Society of Edinburgh, April 23, 1862.

Its shape and general appearance is rather elegant, consisting principally of a large rounded and lobulated mass, irregular in outline, which tapers rapidly at one end to a four-sided pyramidal extremity, and terminates in an obliquely truncated point. (See Plate.)

For the purpose of a detailed description of its form, it may be divided into two portions: the larger extremity, which is rounded in its character; and the smaller, flattened, and smoother on its surface, which tapers to a blunt point. The first, or larger portion, is formed of a clustering mass of rounded lobes irregularly grouped together, and terminates behind in a broad blunt edge. The lobes vary in size, and in their greater or less projection from its surface. A deep furrow runs obliquely round the whole mass, and in front of it (towards the pointed extremity) there rises a large, round, and prominent lobe, with a smaller lobe on one side, and two, more irregularly shaped, projecting masses on the other; by measuring round these masses you get its greatest circumference. The second, or smaller portion of the meteorite, lies immediately in front of the prominent lobes just described, its rounded outlines rapidly changing into four irregular smoother surfaces or planes, which, meeting one another with two acute and two obtuse angles, together form a somewhat pyramidal four-sided figure, which tapers rapidly towards this end of the mass, and terminates in an irregular quadrilateral or lozenge-shaped extremity. The sides of this lozenge measure each about $2\frac{1}{2}$ inches in length; and one of these sides (showing a dimpled outline), from the oblique position of this lozenge-shaped extremity to the general mass of the meteorite, forms its small terminal edge, or pointed extremity.

The whole shape of this piece of meteoric iron suggests the idea, that when its fall took place, the extremity, now the smaller and more pointed, first reached the earth, which, from its resistance, crushed the glowing and softened mass into these peculiarly flattened surfaces of its pyramidal extremity, bending even the oblique point itself, a little upwards and backwards; while the larger extremity, though slightly flattened below, where it struck the ground, still shows in the projecting masses of its upper surface, the part least affected by the shock of its terrible descent through our atmosphere, to bury itself in *terra firma*.

Size.—The mass of iron measures 11½ inches in its greatest length, and 7 inches across the widest part, about the middle of its length; the larger blunt-edged extremity measuring 5¾ inches across. Its circumference round the larger extremity is 1 foot 7 inches; round the large lobular projection (about the middle of the mass) its widest part, 1 foot 9½ inches; while within 1½ inch of the point, it measures only 9½ inches in circumference.

Weight.—It weighed 32 lbs. 11 ounces 1½ drachms, avoirdupois, equal to 39·60 lbs. troy.

Specific Gravity.—The specific gravity of the entire mass, Dr Murray Thomson informs me, is 6·517.

Colour.—The external surface of this meteoric iron is of a dark reddish brown, approaching in some parts to black; and the lobulated parts show here and there, especially in the furrows which divide them, spots of a brighter red colour, due apparently to the partial oxidation of its surface.

Photographs.—The general appearance of the meteorite is well shown in the photographs exhibited. These have been beautifully taken by Mr Alexander M'Coll. The mass of metal was laid on the 8vo vol. of the Royal Physical Society's Proceedings, which thus gives a correct idea of its relative size and proportions; and, when the second picture was taken, the volume was turned quite round, without touching the iron; and in this way an exact representation of both its sides was obtained. From one of these photographs the accompanying Plate of the meteorite is taken.

Plaster Casts.—For the purpose of preserving completely the original appearance of the meteorite, a mould was carefully taken before it was sent to the lapidary to be cut. This has been very successfully done, as shown by the casts* exhibited, coloured after the original.

Rarity.—This mass of meteoric iron is the largest that has yet been discovered in Great Britain; only *one* other

* Mr Alexander Stewart, 1 Surgeon Square, will be glad to supply casts, at a very moderate price, to any one who may wish to possess an exact *fac simile* of this rare specimen of a Scottish meteoric iron.

indeed, is known, a very small one—about the size of a hazel-nut. Robert Philips Greg, Esq., of Manchester, in his recently published valuable work,* and in letters with which he has favoured me, states that this small mass of meteoric iron "was found a good many years back by Da Costa, at Leadhills, and is now in Mr Greg's collection." It has since been secured for the national collection, the British Museum. Mr Greg tells us the proportion of meteoric stone to iron-falls may be taken at 25 to 1,—*i. e.*, 96 per cent. of all that fall consist of stony matter; and in his Mineralogy he gives a list of nineteen or twenty meteoric *stones*, the fall of which has been recorded, as occurring in Great Britain and Ireland. The instance above referred to is, however, the only one of meteoric *iron* previously known and recorded. In the neighbouring country of France one specimen has been observed; and Mr Greg gives twenty-seven instances of meteoric irons found in the old world.

History of the Discovery of the Meteoric Iron.—The ancient village of Newstead, where this mass of iron was found many years ago, lies at the eastern extremity of the valley of Melrose, its cottages rising gradually up the bank, towards the higher ground beyond, which was probably the site, as I have formerly pointed out, of the Roman town of Trimontium.† Having already referred to this neighbourhood when various relics of the Roman occupation, discovered here, were presented to the Museum of the Society of Antiquaries of Scotland, I shall now simply point out the exact locality where this mass of meteoric iron was discovered. Like other Scottish villages which have not been interfered with in their formation by the over-ruling taste of some adjoining great landowner, the dwellings of the little proprietors or feuars have been scattered over the ground as their own fancy or convenience dictated,—keeping, however, in a general way by the lines of the roads which intersect the village, and clustering especially along the principal highway which passes through, running east and west, from Drygrange Bridge

* A Manual of the Mineralogy of Great Britain and Ireland. By R. P. Greg and W. G. Letsom. London: 1858.

† See Trans., vol. iv., and Proc. Soc. Ant. Scot., vol. i. &c.

towards Melrose. On the south side of this last mentioned road, and near the eastern termination of the village, there is a group of three cottages, beyond which a narrow cross road turns southwards into the valley behind, past one of the village wells, and crosses the little streamlet which runs at the bottom of the cottage gardens.

In the year 1827, Mrs Kate Williamson or Davidson, the proprietor of the third cottage from the cross road just referred to, commenced to build another small cottage along the western border of her garden, to which there was access past the open end of her house, forming as it did the farthest west of the little group of cottages. The house was to be erected behind the other cottages and at right angles to them, and, to save the garden ground as much as possible, it was to be placed along its boundary. The garden was enclosed by a broad mound of earth or old turf wall with some stones intermixed; this, of course, had to be removed, and the ground brought somewhat to a level surface before the foundations of the house could be dug; these were then cut out of the firm undisturbed clay below, and the building operations commenced. Mrs Davidson had her own peculiar ideas of what were to be the special conveniences of her new cottage, and, accordingly, she caused two small pits or cellars to be dug in the floor of the kitchen, at no great distance from the back wall and fireplace, which were to be covered over with wooden lids or doors, and in them coals or other necessary articles were intended to be kept. Curious enough, it was in the process of digging out one of these sunken cellars that the black extremity of this piece of meteoric iron was noticed sticking in the clay, at a depth of some three or four feet from the floor of the house. These pits were dug out of the ground, close by the boundary of the garden, on that part of it formerly covered by the broad mound of earth, or old turf wall, which formed the original fence. (The site of this house is well seen in the Ordnance Survey Map of the village, in the small division No. 2211.)

The unusual appearance and great weight of the black-looking stone attracted the attention of Mr George Burnet, one of the masons employed at the work; and as he had a taste for collecting anything peculiar, he carried it to his own cottage, which was only a few doors farther down the village. Mr George Burnet died in 1842, and Francis his brother succeeded to the cottage and garden, which he still occupies. Some time after a stone wall was built round this cottage garden, and as specimens of different kinds had been collected, an old stone trough, which happened to be in the way, was laid on its side and built into the wall, forming thus a sunk recess, where those various specimens which were considered scarcely ornamental enough to be kept in the dwelling house, could be placed in safety ; and here this mass of meteoric iron has lain, for five-and-thirty years ; exhibited from time to time, with the other curiosities, to any chance visitor whose fancy might lead him to examine them.

Francis Burnet is an intelligent, observing man, and to him I was formerly indebted for collecting some of the Roman relics which were found in the neighbouring fields. When residing in the district last summer, I visited the village, to learn if anything new, or rather old, had been observed in the course of the agricultural operations of the last few years ; and my attention was soon attracted to the small collection of specimens in Mr Burnet's garden. I was at once struck with the very peculiar appearance of this mass of metal, which we removed to the burn side at the foot of the garden, to get washed and inspected more carefully. I then learned the history of its discovery, already so minutely detailed, and afterwards inspected the locality itself, being anxious to collect and put on record all the incidents relating to this specimen, which I was inclined to think might turn out to be a mass of Meteoric Iron. A hammer was got, and one of its corners was slightly abraded ; this showed the pure metal of which it seemed to be composed ; and its great weight, as compared with its size, proved that it must consist almost entirely of metal, it was therefore no ore of iron. While its peculiar shape was totally unlike that of any kind of manufactured metal—for its hardness, and closeness of grain, suggested that it resembled hammered iron, or steel ; the district however, was no iron-producing one, and forges of greater size than that of the village blacksmith were quite unknown, and its history pointed to a period probably long before historic times. I was therefore convinced the specimen was native iron; and from the very great rarity of this metal in any quantity, and the fact of its being found buried in the clay bank, there appeared to be little doubt it was of meteoric origin. Stating my conclusions to Mr Burnet, and my anxiety to get possession of the iron for a more careful and decisive examination, he kindly agreed to let me have it for this purpose. Accordingly, it was arranged it should be immediately forwarded to my residence, that I might take it with me on my return to Edinburgh, for a complete determination of its true character and peculiarities. On mentioning to Mr Burnet my astonishment that no person had ever called attention to this very singular-looking piece of metal, the true character of which had been so long overlooked, I was informed that, some three or four years before, the Rev. Dr Rogers of Stirling, when on a visit to Newstead in search of Roman remains, among other things had examined it, and seemed to take a somewhat similar view to mine of its origin; but nothing having been said or done to settle the apparently very doubtful question, Mr Burnet had thought no more about the matter

On bringing the mass to Edinburgh, it was shown to various friends, who at once agreed with me there was little doubt of its meteoric character. With Mr Alexander Bryson and Dr M'Bain's kind assistance, an abrasion was made on its surface, and the nitric acid test applied, when a slight appearance of the peculiar and characteristic etching became manifest; a little of the metal was then filed off, and put into the hands of Dr Murray Thomson, lecturer on Chemistry, without letting him know its history, and he informed me the filings consisted of iron, with a proportion of nickel. Native iron of terrestrial origin being almost chemically pure, and never containing any proportion of nickel, the mass of iron was therefore of meteoric origin, being an alloy of iron and nickel; the latter generally existing in very small proportion to the former.

The peculiar shape and appearance of this mass of metal itself, so entirely unlike any handiwork of man, was indeed almost proof enough to many of its meteoric character, of which, however, there was now no room for doubt.

The subsequent steps taken to learn the special peculiarities of its structure and chemical analysis have now to be detailed.

Section of Meteoric Iron.—The iron was cut longitudinally into two portions, by Mr Young, lapidary, as I was anxious to see whether any difference of structure existed in any part of the mass, or whether cavities containing olivine could be detected. Nothing of this kind, however, was disclosed, the mass being equally solid, dense, and steel-like in its appearance throughout, and the colour beautifully bright and white, like steel. With a new steel file, and Mr Alexander Bryson's assistance, I next proceeded to rub down as much of the surface of one of the pieces, as would suffice for a minutely detailed chemical analysis being made; and in assisting to do so, soon made a practical discovery of the extreme hardness or toughness of the metal, which in a comparatively short time turned the sharp points on the file itself. The hands soon became much blackened by the operation, as if plumbago was mixed with the iron. There seemed no doubt the metal was steel, from the carbon which was so manifestly present. The surface of the mass varied somewhat in its resistance to the file; its prism-like point was very close and hard externally, and contained apparently more of the blackening part of the iron; the upper and rounded portions were also harder and denser, at least externally, offering more resistance to the file. The tool seemed also to have less effect upon the iron when it was used across the mass, than in its longest diameter. Its hardness, as shown by a graving tool, was greatest next its outer surface—the inner portions being apparently softer, and more open in texture, while the prism-like point was tougher before the tool, and more like hammered iron; the explanation probably being—that this peculiarity was due to the shock of its fall being given principally to this part of the mass; and also, from its being suddenly cooled by the contact of its surface with the earth in which it was found buried.

The filings, of which about a troy ounce were procured, were black, and showed little of the shining metallic appearance of pure iron.

Chemical Analysis.—The filings were sent for examination to Dr Murray Thomson, who gives details of their composition in his subsequent communication. (See Analysis of Meteorolite, by Dr Murray Thomson.)

Test of Etching by Acid.—Each portion of the iron has been partially etched with the acid used by engravers on steel, which consists of equal parts of nitric and acetic acids; and the etched surfaces show the rough, irregular, projecting lines of the crystalline structure of the mass; which have been apparently but slightly acted on by the acid, from the presence of nickel; the dark lines and spaces showing where the acid has acted with greater effect. The acid was applied in the usual way for etching, and appeared to bite all at once, and that pretty deeply; it was then removed, the surface of the metal washed, and the acid reapplied, when it acted very slightly, and soon ceased to act altogether, not biting any deeper into the surface of the metal. The rough etched surface is characteristic of meteoric iron, various bright lines or points being observed in the fine frosted like appearance of the crystalline or fibrous surface of the metal. This etched surface is finer and more minute in its texture than that of any meteoric irons, the etchings of which I have been able to examine, suggesting a more minute subdivision of the particles of the iron and nickel, and a more general mixture of the nickel through the mass.*

A steel-plate, treated in exactly a similar manner as this meteoric iron, was exhibited, and showed simply a regularly smooth depressed portion where the acid had been applied.

These etched patches, having been placed near the middle of each surface of the two portions of the meteorite, perhaps rather unfortunately, give to a careless observer the idea of the mass having a core or central part of a different structure; this appearance is of course due entirely to the action of the acid.

Printed Impression from Etched Surface.—I was anxious

* Mr R. P. Greg of Manchester informs me this minute texture resembles the structure of the iron also found in Britain, and described by him, more than any other meteoric iron known; only the minute markings of his specimen appeared to be more angular and sharp in character.

to learn if it would be possible to get a cast or squeeze in wax, taken from the etched surface, on each of the two portions into which the mass was cut, that it might be electrotyped, and the electrotype cast (which thus exactly corresponds to the original surface of the iron) backed up with metal in the usual way, so that impressions might be printed from it. The cast taken from the larger patch of etching was so large, and the raised markings so slightly defined in their character, that, when it was used as a woodcut, the printer could not prevent it getting blotted all over, when attempting to take an impression from its surface. The smaller etched patch, from its less size, and possibly slightly more defined markings, was found to answer better, and an impression of it is accordingly exhibited, which gives a *fac simile* of the etched surface and structure of the metal.

Impression of Etched Surface of the Meteoric Iron.

The cast has been printed from, in the same manner as a woodcut, and shows the projecting parts black, the light spaces between being the more deeply etched parts of the surface, and the smooth polished metal surrounding the whole, appearing like a black border. The white spots which cross the picture show traces of the decay and line of the fracture, by which the mass became separated into two portions; for I was rather startled to learn that the process of taking the wax squeeze from the surface of the smaller half of the meteorite with the ordinary printer's press, had broken it in two. It was evident, however, from the fractured surface, which was simply a weathered looking or oxidised continuation of the deep furrow which partially surrounded the mass, that this furrow had penetrated much deeper than was suspected, and that the few scattered dark spots, like corrosions on the polished surface of the sections, were the termination of the inner portions of this very furrow, part of the decay of which might be caused by the exposure and weathering the mass had undergone, in the five-and-thirty years of its existence on the surface of the earth; the origin of the furrow being due to the lobulated arrangement of the mass.

Weight of each of the Sections of the Meteorite.—Dr Murray Thomson has furnished me with the following notes of the weight and specific gravity of the two portions of the meteorite:—

"Of the two pieces, one was lighter than the other and weighs:—

In air,	13 lbs.	4 oz.	10 drs.	(Avoir.)
In water,	11 ,,	3 ,,	13½ ,,	,,

The larger and heavier mass weighs:—

In air,	18 lbs.	3 oz.	12 drs.	(Avoir.)
In water,	15 ,,	6 ,,	1 ,,	,,

The specific gravity of the first is therefore . 6·364
and of the second, . . . 6·385

"It is strange that neither of them should quite come up to the specific gravity of the mass when it was whole, which was, as formerly stated, . . . 6·517"

The difference in the specific gravity of these two portions may be explained, it seems to me, by the presence, in the smaller portion of the mass, of this large furrow, filled up with earthy-looking matter* of lighter specific gravity.

In conclusion, I may add a few notes on the general subject of aërolites.

Theories of the Source or Origin of Aërolites.—Various theories have been at different times brought forward to account for the presence of aërolites, these strange and apparently accidental visitors.

* Dr Thomson afterwards examined some of this earthy-looking matter, and found it to consist of the same chemical components as the rest of the mass, the iron, however, being in the state of an oxide.

These theories may be arranged in two great divisions :—

First, The terrestrial sources—the source or origin of these bodies being supposed to belong to our earth ; and, *secondly*, The cosmical sources, which derive their origin from beyond our earth. These again may be each subdivided into two sections, or classes :—

I. Terrestrial Sources.

1. *Volcanic*—from the volcanoes of the earth.
2. *Atmospheric*—from their supposed formation in the atmosphere of our earth.

II. Cosmical Sources.

1. *Lunar Volcanic*—from the volcanoes of the moon.
2. *Interplanetary Space*—the planetary or asteroidal theory.

I shall not enter here into the arguments that have been brought forward both for and against these various theories, merely remarking that the old idea of their terrestrial origin is now almost entirely given up. The second of these divisions, and in particular that which derives their origin from a supposed belt of planetoids or asteroids revolving in space on the borders, or just beyond the most distant part (from the sun) of the earth's orbit, being now generally considered as the view which meets and explains most easily the peculiarities of their structure and appearance ; I need only refer to the well-known memoirs on these subjects of Professors C. U. Shepard and J. L. Smith, M.D., of America,* and especially of Mr Robert Philip Greg of Manchester. M. Haidinger, director-general of the Geological Survey of Austria, has also published his views on the origin of aërolites, in a recent communication to the French Academy of Science.

Catalogues of Meteors and Meteorolites.—Catalogues detailing the particulars of all known meteors, aërolites, &c., have been from time to time published. I may refer to those given in the Reports of the British Association, and to the very complete list by Mr R. P. Greg in the Report of the year 1860.

Aërolites may be supposed to have fallen on our earth from

* American Journal of Science.

the earliest periods of its history. I am not aware, however, of any instances that have been noticed connecting their existence with the earlier or geologic history of our globe. In the sacred Scriptures, such expressions as the *great stones*, and the hailstones, that were cast down from heaven, on the enemies of Israel, on the memorable occasion when an apparent interruption of the earth's motion took place (Joshua x. 11); and, again, the use of such terms, as *coals of fire*, in addition to the lightning, by the Psalmist, when speaking of the wonders of the Almighty (Ps. xviii. 12, 13), suggest, at least, the possibility of an allusion to these mysterious bodies at that early period.

Meteoric Stones worshipped.—In the book of Acts (xix. 35) we have reference made to the image of the Diana of Ephesus, which fell down from Jupiter, undoubtedly an aërolite. The fall of one of these bodies among an ignorant and superstitious people, with its attendant phenomena of fire and explosion, would naturally be considered as a message from the gods, and especially from the presiding deity of the district. Various instances of falls of this kind are noticed by ancient authors, whose statements we have no reason altogether to disbelieve. We have also instances of the fall of aërolites recorded in our own day being followed by similar results, as in a case noticed by the Rev. Baden Powell, M.A., &c., in his Report on Meteors to the British Association in 1859; of a stone-fall at Dooralla, near Loodianah, in 1815, when the natives worshipped it, and commenced subscriptions for erecting a temple over it. Two stones fell at Parnallee, near Madras, in 1857; and their fall was followed by exactly the same results—crowds of natives worshipping the larger stone, "as the image of their deity, which had fallen from heaven" (see Silliman's American Journal of Science, No. 32, Nov. 1861). One of these stones weighs 130 lbs., and is the largest meteoric stone known; it is now, I am glad to say, deposited in the British Museum.

There seems little doubt that meteoric falls were one, at least, of the causes of the stone-worship of the ancients, instances of which are represented on their coins, under canopies or shrines. The Diana of Ephesus is not represented in this way, although on an ancient medallion given as an illustration to a learned paper on the Coins of Ephesus, by Mr A. G. Akerman, and struck, he supposes, for those who came to wonder and to worship at her shrine, there is a rude mummy-like figure of the goddess, and on its head, if not simply an imperfect *modius*, with which she is often represented, something which reminds one of the very distinctive shape of a meteoric stone or aërolite (Numismatic Chronicle, vol. iii. 1841, p. 118).

Mr Akerman, in a paper on the Stone-Worship of the Ancients, illustrated by their Coins (Numismatic Journal, 1838), since pointed out to me by Mr G. Sim, also refers to the probability of aërolites being objects of worship.

Map of Meteoric Stone and Iron Falls.—The illustration of the subject of aërolites would be increased if, in addition to these published catalogues, we had also a map showing their fall over all the world. I would be especially anxious, in a map of this kind, that a careful distinction be made (by colour or otherwise) between metallic, and earthy or stone falls; a distinction which, it appears to me, has scarcely been kept sufficiently in view by some writers, when considering the question of the distribution of aërolites. Had we such a map, we could judge at a glance whether meteoric falls were generally pretty uniform in their distribution over the earth, according to Mr Greg; or whether there are any signs of the local aggregation of these bodies in particular districts, as in the two so-called meteoric zones of Professor Shepard.

Have Meteoric Falls any relation to Terrestrial Magnetism?—We already possess maps, giving us the rain-fall over the world; and what a pleasure it is, when studying them, to be able to turn to other maps of allied phenomena, as, for example, the map of the winds, and to see at once how these different agencies act and react upon each other, and how the one map helps to explain to us the other. If we had our map of the aërolite falls, could we turn to any other map in our physical atlas that would help us to understand them any better? I cannot tell—but would be greatly interested in examining and comparing with it the maps illustrating the difficult subject of our terrestrial magnetism, and would be anxious to see whether the one threw any light, or appearance of light, at all on the other. To enable me the better to judge of this, I would carefully distinguish all *metallic* from *earthy* meteoric falls, and would be curious to observe whether the apparently irregular scattering of the former over the world could be seen to bear any particular relation to the various centres of greater magnetic force.

There are four poles or maxima of magnetic attraction known to exist in our earth, a stronger and a weaker, in the northern hemisphere; and also a stronger and a weaker pole in the southern hemisphere. Supposing I have correctly stated these views of our terrestrial magnetism, it does seem interesting to find an observer like Professor Shepard coming to the conclusion, from entirely different data, of the existence of the two meteoric zones, which at once attract me by their position, appearing to bear some relation to these northern poles of magnetic force. He tells us, he finds the meteoric zone of the old continent rather strangely translated farther to the north than that of the American continent; this seems also to show a relation between terrestrial magnetism and these meteoric falls, as it is stated that the northern pole of magnetic force of the Old World (the weaker of the two), lies a good many degrees farther north than that of the New World.

Another fact, which is rather a puzzling one, is the very great relative proportion of *metallic* falls which have been discovered in America, as compared with any other part of the known world—thirty-two meteoric irons having been found in the United States, according to Professor Shepard, twenty-three of which are included in his meteoric zone. While only fourteen meteoric irons (whose time of fall is unknown) have been recorded as found in the Old World, and eleven of these falls are included in its so-called meteoric zone.* Mr Greg gives the number of localities of meteoric irons in the Western Hemisphere as fifty-seven; those of the Eastern Hemisphere being twenty-seven.† Various explanations have been given of these facts; it is rather curious, however, to observe, that in the New World we have the greatest

* American Journal of Science, 1850. † Essay on Meteors, 1855.

number of metallic falls apparently in the neighbourhood of the very locality where the magnetic force is described as being in a maximum in the northern hemisphere. The metallic falls of the Old World seem also to bear a relation to the other northern magnetic pole; though, from its force of attraction being relatively weaker, it may be, the number of these metallic aërolites here is less, and the concentration of them together would also appear to be less; the meteorites straggling, in their deposition, to greater distances from its centre, and so adding to the apparent length of this so-called meteoric zone. Can these various circumstances be dependent simply on an accidental coincidence? or do they not, at least at first sight, suggest the idea that this strange agent of magnetism has really something to do with these peculiar arrangements?

Writers on terrestrial magnetism tell us, as one of the ascertained results of their labours, that the agents of the greater part of the magnetic force of the earth are situated exclusively in the interior of the earth, although minor magnetic oscillations and influences on its surface are due, without doubt, to the direct magnetic influence of the sun and moon; still these are only minor influences, the great magnetic force of the earth being situated exclusively in itself. Now, in my ignorance mayhap of the question, it does not seem to me to be a thing past belief, that when the earth in its orbit comes into the neighbourhood of the region in which these aërolites are now believed to exist; and, when their occasional proximity is close enough to bring the attractive powers of the earth—the greater mass, to overbear that of the smaller—the aërolite; besides, the mere attractive force of gravity dragging it down to the earth, that mysterious agency, the earth's magnetic attraction, should also come into operation; and, that a greater influence should of course be exerted over those bodies which are purely metallic, the component parts of which being also magnetic, are all strongly acted on by this magnetic influence; so that, as the daily revolution of our world takes place, the metallic meteoric falls would especially occur, as near as possible, to the poles of the greatest magnetic force; or at least as near as would be compatible with the power of the other forces which might assist in attracting them to the surface of the earth. The possible, shall I say probable, result being, that *metallic* meteorites, other things being equal, would be found clustering in greatest numbers near the points of the earth's greatest magnetic force, at the time of their fall ; and, the stony meteorites, attracted magnetically in a less degree, would, from the more general causes of their attraction, be spread more abroad over the general surface of the globe.

Of course the poles or points where the magnetic force is in a maximum state, in the southern hemisphere, would also have their share of these metallic masses ; but with these regions we are comparatively unacquainted, and must not forget the greater presence of water—the sea—in this part of the world, which hides at once any meteoric fall that might take place on its surface. Metallic meteorites, however, are not altogether unknown in Australia, two very large masses having recently been discovered within some twenty miles of Melbourne. A friend of mine, just returned from Melbourne, tells me he has seen portions of them, and they somewhat resemble the piece of iron I have exhibited.*

Whether there may be any truth in these theories or not, I cannot determine, only they make me the more anxious that we should be possessed of a map of reference of these strange phenomena ; and I hope our townsman, Mr Alexander Keith Johnston, will be good enough to give my hint of a map of the "Distribution of Aërolites over the Surface of the Earth"† his favourable consideration, when preparing for publication a new edition of his valuable national work, the "Atlas of Physical Phenomena."

* One at least of these masses has been lately secured for the British Museum.

† Mr Greg of Manchester has since informed me that a map of meteoric falls has been published in Germany ; he does not, however, state whether the author has made a point of distinguishing the *metallic* from the other meteoric falls.

Analysis of the Meteorolite described in the foregoing paper by Dr J. A. Smith. By MURRAY THOMSON, M.D., F.C.S., Lecturer on Chemistry.*

In giving a chemical description of this remarkable mass of meteoric iron, I have to call attention, in the first place, to its specific gravity. The process of doing this was first performed on the undivided meteorite, and afterwards on each of its halves. Of course, with such a weighty mass this process could not be done by means of the ordinary delicate balance. I had therefore recourse to the standard beams and weights contained in the office of the Inspector of Weights and Measures at the County Hall, Edinburgh. The weight in air of the whole mass was 32 lbs., 11 oz., 1½ drs., avoirdupois, equal to 39·60 lbs. Troy weight. The weight in water was 27 lbs., 10 oz., 13½ drs. This gives a specific gravity, it will be seen, of 6·517, which is very low for meteoric iron. It stands at the lowest limit of recorded specific gravities of other meteoric irons. Shepard (Silliman's American Journal of Science, vol. ii. New Series, p. 377) gives the specific gravities of iron and nickel meteorolites as ranging from 6·5 to 8·00. After the mass had been divided, the specific gravity was taken in a similar manner to the above, and the heaviest and most solid half gave a specific gravity of 6·385. The analysis was made on some filings of the mass obtained after polishing the surfaces of the halves. I should have preferred for this purpose a sample derived from various parts of the mass, but this, it would appear, was not easy to obtain without endangering the good appearance of the meteorolite.

There is no point in the analysis calling for special description, except, perhaps, the determination of the nickel. This metal was estimated by dissolving a known weight of the meteorolite in hydrochloric acid, and after separation of the gangue of carbon and silica, the iron was peroxodized by heating with nitric acid, and then the iron oxide was precipitated

* Read before the Royal Physical Society, April 23, 1862.

by carbonate of baryta, and the excess of baryta afterwards removed by sulphuric acid. The precipitate of sulphate of baryta was removed by filtration, and the filtrate presented a decided green colour, which on concentration was deepened, showing the amount of nickel it contained to be considerable. The nickel in this solution was then precipitated and weighed as oxide. To arrive at a good result, it was necessary to operate on as much as 60 or 70 grains of the meteorolite. In the course of this process other metals, such as manganese, chromium, cobalt, &c., were carefully sought for, but no trace of them could be discovered. The qualitative analysis, therefore, showed the presence of iron, nickel, carbon, and silica; and these are present in the following proportions per cent.:—

Iron, ...	93.51.
Nickel, ...	4·86.
Silica, ...	0·91.
Carbon, ...	0·59.
	99·87.

It will be seen, therefore, that its composition is very simple, and not unlike that recorded in the analyses of other observers.

It may be remarked, in conclusion, that the occurrence of nickel in it, in such marked quantity, sets at rest any question that might be raised as to its meteoric origin. Though one or two pieces of undoubted meteoric iron exist without any nickel in their composition, yet that metal is held by Shepard (*vide* Silliman's Journal, *ut sup.*) to be the second most frequently occurring constituent.

[*Several Reviews and Notices of Books have been postponed till October for want of space.*—Ed. N. Phil. Jour.]

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 17*th February* 1862.—Professor KELLAND, V.P., in the Chair.

The following Communications were read :—

1. On the Condition of the Salmon Fisheries of England and Wales in 1861 ; with a Notice of some of the Modes of Fishing, especially those practised in the Severn and Wye. By Sir William Jardine, Bart., F.R S., &c.

(This paper is given in the April number of this Journal)

2. Cases of Poisoning by Goat's Milk. By Alexander E. Mackay, M.D., Surgeon H.M.S. " Marlborough."

3. Note on the Electricity developed during Evaporation and during Effervescence from Chemical Action. By Professor Tait and J. A. Wanklyn, Esq.

One of Professor W. Thomson's Divided-Ring Electrometers having been recently procured for the Natural Philosophy collection in the University, we have made use of it in repeating and extending the experiments of Volta, Pouillet, and others, on the electricity produced during the evaporation of various bodies. In some cases our results agree with those already known, but in others we find effects differing totally in kind or degree from the accepted ones; and with some substances we find occasionally contradictory indications among our own results.

The Electrometer is in every respect a far superior instrument to the gold-leaf electroscope, which (sometimes with the addition of a condenser) was used by former experimenters, and enables us to give our results in a form easily reducible to absolute measure. The charge of the instrument was such that, when the half rings were respectively connected with the zinc and platinum of a single Grove's cell, the deflection observed amounted to about 5·8 scale divisions. This was found to be the most useful charge for the bulk of our experiments, but it was easily increased twenty or thirty fold when we sought to verify any very delicate indications.

Our apparatus consisted of a platinum dish, placed on an insulating stand, and connected with the insulated half ring. A lamp could be placed on the stand so as to heat the dish; and while this was going on the indications of the electrometer gave us the atmospheric charge. The experiments were all conducted when the latter was very small, so that although the sputtering of the fluids dropped on the hot plate may have prevented us from observing some slight effects, the large deflections we observed in many instances can have nothing to do with the electric state of the air of the room. With a different disposition, which enabled us to use a Bunsen lamp to heat the dish, we obtained the atmospheric potential by burning a little ether or alcohol on the dish itself, when the lamp was removed.

We agree generally with previous experimenters, that during the continuance of the spheroidal state, there is little, if any, perceptible disengagement of electricity. We also agree with the statement that the main effect is produced while the fizzing sound that accompanies the loss of the spheroidal state is heard, and that during the continuance of the mechanical action to which that sound is due, the indications of the electrometer in general steadily increase. That the greater part of the electricity produced is due to friction is proved by the fact that, when fluids are forcibly squirted upon the hot dish, the electrical indications are very much increased, and that a concave surface gives far more powerful deflections than a convex one at the same temperature. The sputtering or violent boiling which succeeds the fizzing state, shows little, if any, disengagement of electricity. The principal interest of the results which we have obtained is in the cases of iodine, bromine, and various other bodies which do not seem to have been before examined. We have as yet met with no discordance in our own results as far as *simple* bodies are concerned.

In giving the following numbers, we have not attempted any correction for the loss of electricity which is caused by the high temperature of the platinum dish.

Mean Electric Effects given by a few substances during the continuance of the fizzing sound which immediately follows the disappearance of the Spheroidal State, 5·8 representing the Electromotive Force of a Single Grove's Element.

Bromine, . . .	+ 400
Iodine, ...	+ 90*
Bromide of Ethyl, . .	+ but very small indeed, if any
Iodide of Methyl, . .	In many experiments strong +, but in three cases pretty strong −
Benzole, . . .	No effect
Valerianic Ether, . .	No effect
Common Ether, . .	Very slight and dubious effects
Chloroform, . . .	− if plate very hot, + if colder
Ammonia, . . .	− 200

* This sample was in fine crystals. Far higher effects (also positive) were obtained from it in powder.

Alcohol, . . .	− 10
Mercury, . . .	− 75
Chloride of Sulphur, .	− 100
Water (distilled), containing only a trace of carbonic acid, which was too small to be detected by lime-water, . . .	− 80
Solutions in Water of—	
Carbonate of Potash (strong),	− 310
Caustic Soda (strong), .	− 40 *
Do. (dilute), .	− 25 *
Caustic Potash (combustion strength), . .	+ 150
Nitric Acid (strong), .	+ 7·5
Do. (1 in 4 of water),	− 35
Hydrochloric Acid (strong),	− 160
Do. (weak),	− 50
Sulphuric Acid (strong),	+ 15
Strong solution of Na Cl .	− 400
Do. KI .	− 80
Do. CuO,SO_3	− 1000 ?
Solution of double Oxalate of Chromium and Potash,	Very trifling effect
$Fe_2 Cl_3$, solution moderate,	Negative effect
Acetic Acid (Monohydrate),	+ 3
Acetic Anhydride, .	− 9

The sulphate of copper solution is by far the most remarkable that we have tried. The smallest globule, on leaving the spheroidal state, gave intense effects, sending the lamp image entirely off the scale.

We have also commenced a set of experiments with a view to test the electricity developed during the brisk disengagement of a gas by chemical action, which was discovered eighty years ago by Volta. In some of these experiments it was observed that when the gases were disengaged with considerable effervescence, and in a mass of large bubbles foaming over the platinum crucible in which the experiment was conducted, the bursting of each bubble was attended by a simultaneous increase of deflection in the electrometer. These experiments are, as yet, exceedingly imperfect, but they seem, like the preceding, to indicate friction as a main cause of the observed results. The effects on the electrometer are by no means so uniform, either as to kind or quantity of electricity, as those given by evaporation.

Electricity developed during Effervescence.

$Zn + HCl$ . .	− 750	
$Zn + NO_5HO$.	+ 175.	In another trial − 120

* This is a very difficult substance to experiment upon.

$MnO_2 + HCl$	. .	− 150
$CaO,CO_2 + HCl$	. .	Trifling effects
$NaO,SO_2 + HCl$	. .	At first a small negative deflection, finally + 50
$NaCl + SO_3HO$	.	+ 10

Monday, 3d March 1862.—Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Pressure Cavities in Topaz, Beryl, and Diamond, and their bearing on Geological Theories. By Sir David Brewster, K.H.

In this paper the author gave a brief account of the various phenomena of fluid and gaseous cavities which he had discovered in diamond, topaz, beryl, and other minerals. He described—

1. Cavities with two immiscible fluids, the most expansible of which has received the name of *Brewstolyne*, and the most dense that of *Cryptolyne*, from the American and French mineralogists.

2. Cavities containing only one of these fluids.

3. Cavities containing the two fluids, and also crystals of various primitive forms, some of which melt by heat and recrystallise in cooling.

4. Cavities containing gas and vapour.

The author stated that the first class of cavities existed in thousands, forming strata plane and curved, and intersecting one another at various angles, but having no relation to the primitive and secondary planes of the crystal. From these facts he drew the conclusion that the minerals which contained them were of igneous origin; and he considered this conclusion as demonstrated by the existence of what he calls *pressure cavities*, which are never found in crystals of aqueous origin. These microscopic cavities, which are numerous in diamond, exist also in topaz and beryl. The gas which filled them had compressed by its elastic force the substance of the mineral around the cavities, as shown by four sectors or quadrants of light which it polarises; and consequently the mineral must have been in a soft or plastic state by fusion when it thus yielded to the pressure of the included gas.

2. On the Anatomical Relations of the Surfaces of the Tentorium to the Cerebrum and Cerebellum in Man and the lower Mammals. By William Turner, M.B. (Lond.), Senior Demonstrator of Anatomy in the University of Edinburgh.

Comparative anatomists have of late directed considerable attention to the determination of the relations of the cerebrum and cerebellum. This has been in great measure due to the publication by

Professor Owen of a system of classification of the Mammalia founded on their cerebral characters. The statement made by that eminent anatomist, that the posterior, or third, lobe of the cerebrum is peculiar and common to the genus Homo, and that equally peculiar are the "posterior horn of the lateral ventricle" and the "hippo-campus minor," which characterise the hind lobe, has led to much discussion. Various anatomists have published descriptions and drawings of dissections of the brains of many of the Quadrumana, especially of several of the higher apes. From these dissections, as well as from the older observations of Tiedemann and Cuvier, it may now be considered as fully proven, that in the Quadrumana the surface of the cerebellum corresponding to the superior surface of the human cerebellum is covered by the cerebrum; that posterior lobes, posterior cornua and hippocampi minores, are possessed by these animals.

In the mammalia lower in the scale than the Quadrumana, it appears to be the general opinion of anatomists that the posterior cerebral lobes do not exist, and that, from this circumstance, there is always a greater or less amount of cerebellum projecting behind the cerebrum, and uncovered by it. Tiedemann has, however, made an exception in favour of the seal, in which animal he says posterior lobes occur, although shorter than in the Simiæ. Cuvier also recognises the exceptional arrangement in the seal, and places along with it the otter and the dolphins. Retzius states, that in the mammalia lower than man, posterior lobes are found only in the apes, and that rudiments only are met with in the Cetacea and seals.

In the course of a series of observations which I have been making for some time back, on the crania of different mammals, my attention has been especially directed to the relative positions of the cerebrum and cerebellum. These observations have led me to come to the conclusion, that considerable misconception exists as to the relations of the two chief divisions of the encephalon.

If we turn to the descriptions of the cerebellum of man, given in our standard text-books of human descriptive anatomy, we shall find it stated that the cerebellum consists of a central median part—the vermiform process, or worm; and of two lateral lobes—the hemispheres. Of these, the hemispheres preponderate greatly in size The cerebellum presents an upper and lower surface, and a circumference. The upper surface corresponds to the tentorium cerebelli; the lower is lodged in the concavity of the inferior occipital fossæ, to which it is accurately adapted. The circumference of the cerebellum corresponds to the line of junction of the upper and lower surfaces with each other, and along it a deep fissure, the great horizontal fissure, extends. The circumference—called also the posterior margin—corresponds, therefore, to the line of attachment of the tentorium to the transverse line of the occipital bone, and marks with great precision the divergence of the two surfaces of the cerebellum from each other. Of these surfaces, that which is superior, and in contact with the tentorium, which we may therefore appropriately term tentorial, is the only one related to the cerebrum, the posterior lobes of which not only cover, but even project beyond it. The inferior surface, in contact with the occipital bone, which may therefore be termed occipital, never possesses any relation whatsoever to the cerebrum.

An examination of several members of most of the great orders of the class Mammalia has satisfied me, that it is quite possible to arrive in them at as correct a conception of the relations of the cerebrum to the cerebellum as in man. In every animal which I have examined, I have found the cerebellum to possess two surfaces. One of these is in contact with the tentorium, and, through the intervention of that membrane, is in relation to the cerebrum. The other is in contact with the wall of the occipital fossa. The surfaces are distinguished from each other by looking in different directions. The tentorial, corresponding to the superior in man, looks, as a rule, more or less forwards. The occipital, corresponding to the inferior in man, looks, as a rule, more or less backwards. These surfaces along their line of junction form an angle, more or less marked in different animals. This angle corresponds to the circumference, or posterior margin, of the human cerebellum, and is in contact with the line of attachment of the tentorium to the occipital bone. The tentorial aspect of the cerebellum, therefore, is that which is in constant relation to the cerebrum, and, not only in man, but in all the mammalia, is covered by it.

In a Chimpanzee, the tentorial surface of the cerebellum was directed upwards, and was evidently flatter than the corresponding surface in man. The occipital surface was directed downwards. The posterior margin was clearly marked. The posterior lobes of the cerebrum corresponded to the whole of the tentorial surface, and extended as far as the posterior margin of the cerebellum, beyond which they might even be stated slightly to project. The inferior vermiform process was lodged in a slight furrow between the two cerebellar hemispheres.

In the brains of several specimens of Cercopitheci, the tentorial and occipital surfaces, with the posterior margin of the cerebellum, were distinctly marked. In all, the posterior cerebral lobes extended over the tentorial surface as far as the posterior margin. In two of the brains, it might be stated that the cerebral lobes projected backwards beyond that margin. The comparatively greater development of the inferior vermiform process, over the lateral hemispheres of the cerebellum, was indicated by the absence of that fossa between the hemispheres in which it lies in the more highly developed human cerebellum.

In a Macacus, a vertical section through the skull and brain of which animal I examined, the cerebrum corresponded to the tentorial aspect of the cerebellum; the posterior lobes of the one and the superior surface of the other extended as far as the margin of attachment of the tentorium to the transverse line of the occiput.

In two specimens of Cynocephali, the same relation of the posterior lobes of the cerebrum to the tentorial aspect of the cerebellum was observed. In neither of these brains was the inferior vermiform process lodged in a depression between the hemispheres, but formed an almost continuous surface with them.

In three brains, from animals of the genus Ateles, the posterior cerebral lobes extended quite up to the posterior margin, separating the tentorial from the occipital surface of the cerebellum. In all the lateral hemispheres projected slightly beyond the inferior vermiform process, which was lodged in a shallow depression between them.

In a lion monkey (*Midas leoninus*) the occipital surface of the cerebellum was separated from the tentorial by a very clearly defined posterior margin, as far as which the posterior cerebral lobes extended. The inferior vermiform process projected beyond the cerebellar hemispheres, which were comparatively feebly developed.

The Cetacea possess, not only in their great mass of brain, but in the number and complexity of the convolutions of their hemispheres, very decided evidences of a high degree of cerebral organisation. Professor Goodsir has allowed me to examine the brains of a porpoise, a bottle-nosed dolphin (*D. Tursio*), and a rorqual (*Balænoptera*), either in his possession, or in the Anatomical Museum. In all, in accordance with the peculiar antero-posterior compression of the cranial cavity, the corresponding diameter of the cerebral hemispheres was very much shortened, so that the brain was widened out, and heightened greatly in its vertical diameter. In all, the distinction between the tentorial and occipital surfaces of the cerebellum was very clearly marked. The cerebrum passed backwards as far as the posterior margin of the cerebellum. The cerebellum in them was a cerebellum inferius; for, as far as could be judged from an inspection of the brains, as they lay out of their cavities, the cerebellum was not exposed when looked at from above. The cerebrum possessed very decided posterior lobes; for, on account of the great extent of the tentorial surface of the cerebellum, and the heaping up of the cerebral convolutions in the vertical diameter, a large proportion of the cerebral hemispheres was placed above the cerebellum. The brain of the bottle-nosed dolphin had been lying for many years in spirit in the Anatomical Museum. A section had been made into the lateral ventricle on the right side, from which it appeared as if there were indications of a prolongation of the ventricle in the direction of the posterior lobe. When the dissection was extended, so as to obtain a more complete view of the arrangement, it was seen that the lateral ventricle was continued backwards and outwards, sweeping along the posterior part of the optic thalamus. It then changed its direction, and passed downwards and forwards, so as to form the inferior horn At, or about, the spot where this change took place, a recess, extending backwards in the substance of the cerebral mass was met with. This recess, from its position and curvature, must, I think, be regarded as a rudimentary posterior cornu. As the soaking of a brain in spirit, for a series of years, has a tendency to render the examination of the ventricular arrangements more difficult, than would be the case in a recent brain, I hope, in the course of the summer, to supplement this observation, by an examination of the brain of the common porpoise.

In the brains of those Carnivora which I have been able to examine, the cerebellum has been seen to possess tentorial and occipital surfaces, separated by a slight, yet definite, ridge, which corresponded to the line of attachment of the tentorium to the occipital bone. The cerebellum is not, however, so decidedly a "cerebellum inferius" as in the examples already described. The surfaces of the cerebellum consequently look more or less forwards and backwards.

In the otter, the cerebrum not merely covered the tentorial aspect of the cerebellum, but even projected beyond it in a very striking manner. Thus, when the brain was looked at from above, no part of the cerebellum was exposed. From the cast, it would appear as if the occipital surface of the cerebellum looked almost directly backwards. The cerebral hemispheres possessed considerable width posteriorly. In the seal, nearly the same relations prevailed as in the otter; the posterior projection of the cerebral hemispheres was more strongly marked laterally than in the middle line. This was due partly to the ossification of the tentorium and falx cerebri, and partly to the posterior cerebral fossæ not passing quite so far back in the middle line as they did somewhat further outwards.

Of the Pachydermata and Ruminantia, I have examined *in situ* the brains of the pig and sheep. In both these animals the tentorial and occipital surfaces of the cerebellum were clearly indicated by the line of attachment of the tentorium to the occipital bone. In both, the cerebral hemispheres extended backwards as far as that line, so that the tentorial surface of the cerebellar hemispheres was completely covered by it. In the pig, the tentorial surface of the cerebellum was larger proportionally than in the sheep, so that the extent of cerebrum in relation to the cerebellum was greater. When the brain of either animal was examined from above, a partial projection of the cerebellum behind the cerebrum might be seen; but the exposed surface was the occipital, and not the tentorial. From an examination of the brains, preserved in spirit, of the Warthog (*Phasco-chæres*) and Peccari (*Dycoteles*) in the possession of Professor Goodsir, it would appear, that in them, as in the common pig, the tentorial surface is covered by the cerebrum.

In the Rodentia, Insectivora, Cheiroptera, and Marsupialia, the cerebellum is no longer placed below the cerebrum, but behind it, so that it becomes really a cerebellum posterius. From the statements which have been made in the works of several anatomists of great distinction, it would appear to be their opinion that the cerebrum has, in these orders, so slight a relation to the cerebellum, that the *corpora quadrigemina* are more or less exposed between the two. From an examination which I have conducted *in situ*, of the brains of several members of these important groups, I think it very doubtful whether such a general statement is correct. Of the Rodentia, I have examined the rabbit, guinea-pig (*Cavia cobaia*), and rat. In all these animals it was quite possible to distinguish a tentorial and occipital surface in the cerebellum. The area of the former was small, and possessed a forward direction. The latter was much larger, and at first sight appeared to be the only surface which the cerebellum possessed. It was directed more or less upwards and backwards. The separation between the two surfaces was indicated by a slight ridge which corresponded to the line of attachment of the tentorium to the occipital bone. As far as this line the cerebrum extended posteriorly. The anterior surface of the cerebellum was thus in relation, through the tentorium, with the cerebrum. Owing to the limited area of this surface, the amount of cerebrum in relation to it was necessarily extremely small, and might be considered as little more than the posterior edge of the cerebral hemispheres. Neither in the rabbit nor guinea-pig could the *corpora quadrigemina* be seen, until the cerebral hemispheres were drawn on one side, or the cerebellum pushed back. In the rat, the hemispheres of the cerebrum were in relation to those of the cerebellum; but, in the middle line, owing to their divergence from each other at the posterior end of the great longitudinal fissure, the upper aspect of the *corpora quadrigemina* could be seen. When a bird's-eye view of the brain was made, a large proportion of cerebellum was exposed lying behind the cerebrum, but this exposed surface was the occipital.

Of the Insectivora, I have dissected *in situ* the brains of the mole and hedgehog. Of the Cheiroptera, I have dissected but one species. In these animals the surfaces of the cerebellum had about the same relation, as regards direction and size, as in the Rodentia. In all, the small tentorial surface was in apposition with little more than the posterior edge of the cerebrum. In none of the animals examined could the *corpora quadrigemina* be seen until the cerebral hemispheres were turned on one side.

Of the Marsupialia, through Professor Goodsir's kindness, I have been enabled to examine two brains of the kangaroo (*Macropus*). Although these brains had been for some time in spirit, and had evidently to some extent lost their original form, yet it was possible to distinguish in them the tentorial and occipital surfaces of the cerebellum, and to note that the cerebrum had to the former a relation corresponding to that which had been noted in the mammals already described. In the kangaroo, therefore, the exposed surface of the cerebellum is the occipital. The *corpora quadrigemina* could not be seen until the cerebral hemispheres were drawn to one side.

3. On the Connection between Organic Force and Crystalline Force. By H. F. Baxter, Esq.

(This paper appeared in the April number of this Journal.)

Monday, 17th March 1862.—Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On a recent Landslip. By the Rev. John Duns, Torphichen.

(This paper appears in the present number of this Journal.)

2. On the Rainfall in the Lake District in 1861. With some Observations on the Composition of Rain-Water. By John Davy, M.D., F.R.SS., Lond. and Edin.

3. Observations on the Absorbing Power of the Human Skin. By Murray Thomson, M.D., F.C.S., Lecturer on Chemistry, Edinburgh. Communicated by Dr Douglas Maclagan.

For the last sixty years physiological and other authors have been maintaining two very opposite views in regard to the absorption by the skin of substances dissolved in the water of baths. Some authors holding that such salts as iodide of potassium readily reach the blood through the skin, when applied in the form of a bath containing that salt; while others hold that absorption, under such circumstances, never takes place.

My experiments were all made on my own person at various intervals during the last two years. Six of them were made on as many successive nights, so as to try if frequency of bathing rendered the skin more permeable. The general method of making the trials was this:—Into an ordinary bath, a measured quantity of warm water was let, the temperature of which was recorded. Means were taken to keep the heat constant during the experiment. The temperatures ranged usually from 90° to 98°. The salt to be tried was then dissolved, and mixed with the water. The time in the bath was noted; it varied from half an hour to one hour and a quarter. The whole body was immersed, excepting the head and neck. All the urine voided in twenty-four hours after each bath was collected and concentrated, then tested for the substances experimented on.

Six baths were taken, in which iodide of potassium was dissolved. The quantity of the salt varied from 200 to 1300 grains.

Five baths, in which quantities of ferrocyanide of potassium, varying from 1400 to 5000 grains, were dissolved. Four baths were taken, the water of which was rendered strongly alkaline by soda. The result of these fifteen experiments was, that I could not find that any of the substances in the baths passed through the skin into the blood, so as to be found in the urine; the soda baths did not render it alkaline, nor could I detect the other salts in it; and it is to be noted that the tests for them are extremely delicate.

The general conclusion which my experiments lead me to are, (1.) That though not denying that absorption by the skin of aqueous solution does take place, yet it seems to be the exception and not the rule. (2.) That medicated warm baths, whether natural or artificial, do not appear to owe any virtue they may have to the substances dissolved in them reaching the blood through the skin. At the same time, as there are other ways by which one can conceive such baths to operate on the system, it is not to be concluded that, because absorption may not take place, such baths are useless as therapeutic agents.

4. On the Constitution of Mannite. By J. A. Wanklyn, Esq., and Dr Erlenmeyer.

Chemists are in the habit of assigning to mannite the formula,

$$C_6H_{14}O_6;$$

but the reasons which have hitherto been given for that formula seem not very conclusive. By a process of fermentation, alcohol and a number of other compounds of well established composition may be obtained from mannite; but inasmuch as disintegration takes place in this process, the formulæ of the products afford no guide to the constitution of the original body.

Up to the present time no compound of known formula has been got from mannite by other than disintegrating processes.

The uncertainty about the real composition of mannite has finally been illustrated by Berthelot, who in his "Chimie organique fondée sur la Synthèse," has proposed the formula,

$$C_3H_7O_3.$$

Berthelot has supported his view by bringing forward a number of salts of mannite, and has hinted at the possibility of preparing the substance from allyl compounds.

The reaction we have to bring forward in this paper is in contradiction to Berthelot. By distilling mannite with a great excess of strong hydriodic acid, in a stream of carbonic acid gas, it is almost completely resolved into Iodide of Hexyl. The change may be thus represented :—

Mannite.

$$C_6H_8(HO)_6 + 11HI.$$

Iodide of Hexyl.

$$= \overbrace{C_6H_{13}I} + 6H_2O + I_{10}.$$

This reaction is conclusive against Berthelot's formula, for it cannot be maintained that an easy reduction with hydriodic acid would increase the complexity of the carbon molecule. A parallel reaction between glycerine and hydriodic acid was observed by one of us some time ago.*

Glycerine.

$$C_3H_5(HO)_3 + 5HI =$$

Iodide of Propyl.

$$\overbrace{C_3H_7I} + 3H_2O + I_4.$$

We are thus conducted to the result: mannite is the hexatomic alcohol of the C_6 series, or, as we prefer to write, Mannite is Hexyl-hydride, wherein six atoms of hydrogen have been replaced by six atoms of peroxide of hydrogen.

From the recognised connection subsisting between mannite and the sugars, we may expect that the sugars also belong to the Hexyl-hydride series.

Furthermore, just as glycerine has been got from the Propyl series, so may we hope to get mannite from the Hexyl series. It is our intention to attack this problem. We propose to make $C_6H_8Br_6$, and to endeavour by some means to effect a replacement of the Bromine by peroxide of hydrogen.

We subjoin a slight sketch of a few hexylic compounds. Iodide of hexyl $C_6H_{13}I$. (obtained from mannite), is a colourless liquid, having a smell very like that of iodide of amyl. It is very slowly acted upon by light; sp. gr. = 1·439 at 0° C. Boiling-point about 165° C. It can be distilled without suffering decomposition.

Hexyl-alcohol $C_6H_{13}HO$ may be obtained by decomposing the iodide of hexyl by means of oxide of silver and water. Its smell does not bear the slightest resemblance to that of amyl-alcohol

Hexylene C_6H_{12} is obtained by digesting iodide of hexyl with alcoholic solution of caustic potash. It is a light oil, smelling like amylene; boiling-point about 69° C. Its vapour-density has been found to be 2·88 and 2·97. The formula C_6H_{12} requires 2·9022. It combines with great violence with bromine, yielding

$$C_6H_{12}Br._2.$$

Hexyl-hydride, C_6H_{14}, may be obtained by decomposing the iodide with zinc in presence of alcohol. It is a light oil, having a very fragrant smell, and not attacked by Bromine at any rate in diffused daylight. In these two particulars it differs widely from

* Erlenmeyer. Zeitschrift für Chemie ū. Pharmacie.

hexylene, which has an abominable smell, and which hisses when Bromine is dropped into it. In boiling point there is very little difference between hexylene and hexyl-hydride.

All of these compounds have given satisfactory analyses.

Monday, 7th April 1862.—The Very Rev. Dean RAMSAY, V.P., in the Chair.

The following Communications were read :—

1. On the Structure of *Lerneopoda Dalmanni*, with Observations on its Larval Form. By Wm. Turner, M.B. (Lond.), and H. S. Wilson, M.D., Demonstrators of Anatomy.

This apparently little known form of parasitic crustacean has been as yet described only by Retzius and Kröyer. It does not appear, up to this time, to have been recognised as a British species. During the present year, many specimens obtained from the nasal cavity of more than one *Rasa batis*, caught by the Newhaven fishermen, have been examined by the authors.

Female.—One of the largest of the Lerneadæ, divided into cephalo-thorax and abdomen by a constricted neck. Cephalo-thorax $\frac{4}{10}$ths of an inch long; it projected almost at a right angle from the anterior end of the abdomen. On its dorsal surface were a pair of 3-jointed hooked antennæ. In front of the antennæ, and close to the anterior end of the head, was the buccal apparatus. Situated in the middle line was a short, conical, retractile snout, which possessed an oral aperture bounded by two fringed lips at its extremity. The structure of these lips, with that of the jaws and palpæ connected to them, was then fully described. On each side of the snout is a short stump-like process—a modified foot. It was segmented, and possessed a bifid, free extremity, the posterior division of which was armed with a terminal hook; the anterior division, much larger than the posterior, was studded with short bristles. Connected to the base of each stump-like process was a segmented palp-like structure, set with three or four conical papillæ at its free end.

Springing from the sides of the cephalo-thorax, immediately in front of the neck, was a pair of elongated cylindrical arms. Each arm ended superiorly in an expanded clasper. The two claspers were in close contact by flattened, opposed surfaces, but not united together. In the concave upper surface of the opposed claspers a cartilaginous-like bar was placed. The authors then described the structure of the arms and the bar, and the mode of connection of the parasite through these arrangements to the wall of the nasal chamber of the skate. The structure of two bulb-like protuberances from the sides of the cephalo-thorax, immediately in front of the roots of the arms, was then described. These were the eye-like spots of Retzius and Kröyer.

Abdomen $\frac{7}{10}$ths of an inch long, $\frac{4}{10}$ths broad; had an inverted heart-shaped form; imperfectly defined segmented appearance. The fourth segment, the largest, possessed a median slit-like anal aperture, two elongated ova strings, and two posterior abdominal appendages. The arrangement of the intestinal canal, ovaries, and cement organ was then described. The authors then pointed out certain appearances which they considered indicative of the existence of a nervous system.

The authors agreed with Milne-Edwards in thinking that the elongated cephalo-thorax and the posterior abdominal appendages point decidedly to the advisability of separating this animal from the genus lerneopoda. None of the specimens they examined had the male attached, so that they have not examined it. They have seen the larvæ in various stages of development. When free, the larva was $\frac{1}{37}$th of an inch long and $\frac{1}{60}$th of an inch broad; oval when viewed from dorsal surface; profile view showed a convex dorsal and almost flat ventral surface. It possessed a pair of antennæ and two pairs of limbs. Each of the first pair of limbs was bifid, the two branches bearing long hairs at their extremity. Each of the second pair was bifid, the two branches bearing each a spinous hook at its extremity. A remarkable tail-like prolongation, fringed with pinnate hairs, was then described. The curved intestinal canal, the eye spots, and the pigment masses within the visceral chamber, were then adverted to.

2. Memoir of the Life and Writings of Robert Whytt, M.D., Professor of Medicine in the University of Edinburgh, from 1747 to 1766. By William Seller, M.D., F.R.S.E., F.R.C.P.E.

3. On a difficulty in the Theory of Rain. By James Dalmahoy, Esq.

The difficulty which the paper discusses is the paradoxical fact discovered by Dr Heberden,—namely, that if there be three exactly similar rain-gauges, and one of them be placed on the ground, the second on the roof of a neighbouring house, and the third on a still higher edifice, then, notwithstanding every variety in the positions of these gauges as respects surrounding objects, and notwithstanding the prevalence of the opposite conditions of high wind and of absolute calm, it is observed that the lowest gauge receives more rain than the middle one, and the middle gauge more rain than the upper one.

The paper endeavours to show the inadequacy of the explanations which have hitherto been given of this difficulty, and quotes, on this point, the authority of Sir John Herschel. It then proceeds to prove, both theoretically and by observation, the existence of a slow downward current of air mingled with minute globules of water, the current itself being the effect of the rain, and originating in the cloud from which the rain proceeds. The twofold agency of this downward current in producing the paradoxical results is then explained; and the paper concludes with a numerical estimate, the object of which is to prove that the quantity of water which it is necessary to assume as being contained in a given volume of the atmosphere, *at a given time*, in order to account for even the more remarkable results on record, is too small to give rise to the appearance of cloud; and so, by proving this, to obviate what would otherwise have been a formidable objection to the proposed explanation of the phenomenon.

4. On the Structure of the Bark of *Araucaria imbricata*, with special reference to Palæontology. By John Hutton Balfour, A.M., M.D., F.R.S., Sec. R.S.E., Professor of Medicine and Botany.

The frost of December 1860 caused serious damage to trees and shrubs in the Botanic Garden of Edinburgh. On the morning of 24th December, Fahrenheit's thermometer stood at 6° below zero, according to the Kew standard. An account of the injury inflicted has been already published in the Transactions of the Botanical Society of Edinburgh. It has been stated that the great cold in the garden, as compared with other places near Edinburgh, may be accounted for by its low sheltered situation, and the descent of the heavy cold atmosphere from the more elevated localities around.

Among the plants which suffered were two very fine specimens of *Araucaria imbricata*, which had stood for upwards of thirty years, and one of which had attained the height of 24½ feet, with a circumference of 4 feet at the base of the stem, and with twenty whorls of branches. These trees, which were great ornaments of the lawn in front of the range of hothouses, have been cut down. An opportunity was thus afforded of examining the structure of their wood and bark. The former is very hard and heavy, and promises to be valuable timber. In regard to the latter, the scars and markings, and their relation to the leaves, seem to deserve special notice. The sharp-pointed triangular hard and spirally arranged leaves are remarkably persistent. None of the plants in the garden have ever shed their leaves. They become sometimes of a brown colour; but even then they continue to adhere to the stem, and appear as unsightly appendages. In one of the plants cut down the leaves show a splitting at the base, apparently from distension in the parts underneath, similar to what takes place in the petioles of many palms before they are detached. It is possible that, in the Araucaria, the splitting of the basis of the leaves may sometimes be the precursor of their fall. From the lower part of the leaves prolongations extend along the surface of the bark, and give rise to peculiar markings, which are well seen when the leaves are cut off close to their union with the stem (fig. 1). The base of the

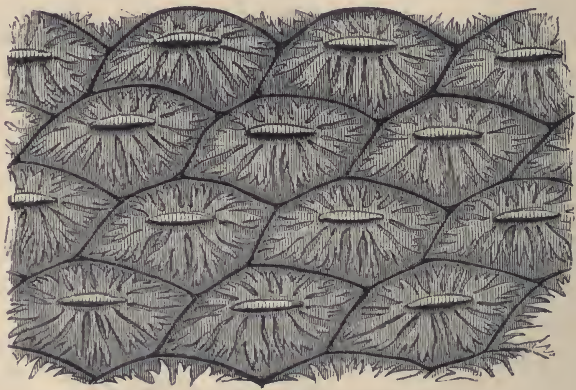


Fig. 1.

leaf remaining in the bark has the form of a narrow elongated ellipse, surrounded by cortical foliar prolongations. The markings on the bark, viewed externally, have a somewhat oblique quadri-

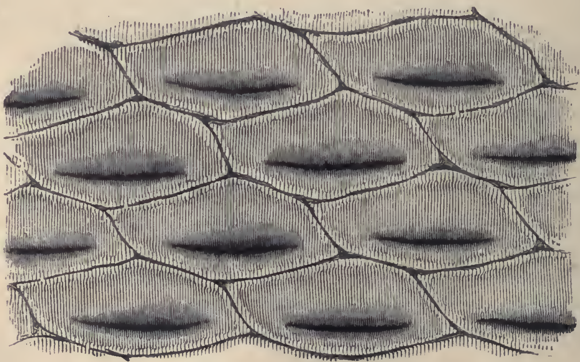


Fig. 2.

lateral form. The leaves, when examined by the microscope, show stomata on both surfaces, running in lines, not unlike the appearance presented by stomata in Equiseta.

On removing the epiphlœum or outer bark, and examining its inner surface, we remark a difference in the appearance presented at the lower and upper part of the stem. In the lower portions the markings have an irregular elliptical form, with a deep depression, and fissures where the leaves are attached (fig. 2). Higher up the epiphlœal markings assume rather more of a quadrilateral form, with the depressions less deep, and the fissures for the leaves giving off prolongations on either side. Farther up the markings are smaller in size, obliquely-quadrilateral, and present circular dots along the boundary lines chiefly (fig. 3). Higher still the

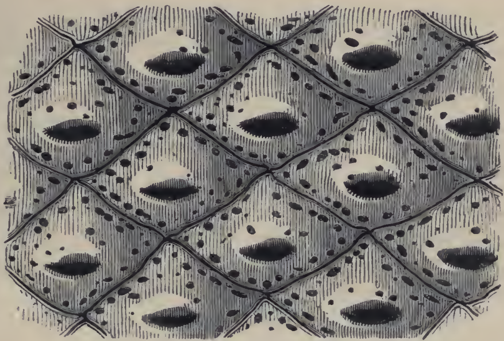


Fig. 3.

quadrilateral form becomes more apparent, and the dots disappear (fig. 4). The epiphlœum thus presents differences in its markings at different heights on the stem.

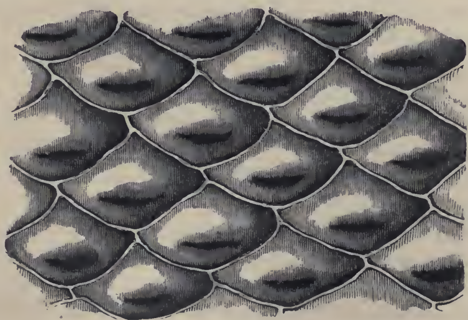


Fig. 4.

The middle part of the bark, or mesophlœum, is well developed, and is of a spongy consistence. When examined microscopically it is seen to be composed of cells of various shapes—some elongated fusiform, others rhomboidal, others with pointed appendages. The variety of forms is very great, and it is possible that this may be partly owing to the effects of frost on the cells. On the spontaneous separation of the bark, the mesophlœum was seen to consist of distinct plates of a more or less quadrilateral form, with some of the edges concave and others convex, a part in the centre indicating the connection with the leaf, along with which it is detached. In fig. 5 a leaf is shown with a mesophlœal plate attached.

Fig. 5.

The endophlœum, liber or inner bark, is of a fibrous nature, and consists of elongated woody tubes.

The appearances presented by the outer and middle bark of *Araucaria imbricata* bear a marked resemblance to those exhibited by certain fossils included in the genera Sigillaria and Lepidodendron. The sculpturesque markings on the stems of these fossil plants have induced geologists to look upon them as allied to the ferns and lycopods of the present epoch. But it is evident, from the specimens of Araucaria now laid before the Society, that much caution is required in making this determination. Other points of structure must be examined before a proper decision can be formed; when, for instance, the presence of scalariform tissue, or of punctated woody tissue has been satisfactorily shown under the microscope, we are entitled to hazard an opinion as to the affinities of the fossils. In many instances, however, external appearances are the only data on which to rely for the determination of fossil genera and species; and rash conclusions have often been drawn by geologists who have not been conversant with the structure of plants.

The Araucaria markings point out the need of care in drawing conclusions, and their variation at different parts of the bark indicate the danger of a rash decision as to species. There can be no doubt that in vegetable palæontology the number of species has been needlessly multiplied—any slight variation in form having been reckoned sufficient for specific distinction. We can conceive that the Araucaria bark markings in a fossil state might easily supply several species of Sigillaria, or of Lepidodendron. The geologist, with little knowledge of the present flora of the globe, ventures often to decide on an isolated fragment, which a well-informed botanist would hesitate to characterise. Hence the crude descriptions of fossil vegetable forms, and the confusion in which Palæophytology is involved. Every geologist who examines fossil plants ought to be well acquainted with the minute structure of living plants, the forms of their roots, stems, leaves, fronds, and fructifications; the markings on the outer and inner surfaces of their barks, on their stems, and on their rhizomes; the localities in which they grow, and the climates which genera and species affect in various parts of the world.

Monday, 21*st April* 1862.—PROFESSOR CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Theory of Numbers. By H. Fox Talbot, Esq.

2. On the Carboniferous Volcanic Rocks of the Basin of the Forth. By Archibald Geikie, Esq., F.R.S.

After referring to a previous communication to the Society, in which the author had given an outline of the chronology of the igneous rocks of Scotland, he proceeded in the present paper to describe in detail the character of the volcanic phenomena in one district—that of the carboniferous system of the Forth basin. The igneous rocks of this district consist partly of doleritic and felspathic lava-form masses, and partly of various kinds of ash or trap-tuff. These materials present a considerable diversity in their modes of arrangement. But the author had found that all the volcanic hills of the district might be reduced to three types of structure:—1. A simple cone of ash, round and over which the ordinary sedimentary accumulation of the carboniferous period had been deposited. 2. A cone of ash with the crater filled up by a neck or plug of basalt. 3. Sheets of different lavas with intercalated ash or sedimentary matter.

He described in detail the succession of volcanic phenomena in the Lothians and in Fife, pointing out how local and limited the eruptions had been as a whole. They were confined to the earlier half of the carboniferous period, no interbedded igneous rock having yet been found in the formations that overlie the carboniferous limestone. The whole of this district appears to have been dotted over with volcanic cones, from each of which independent eruptions took place. To such a kind of scenery the nearest parallel in Europe is probably the region of Auvergne and the Haute Loire, which the author had recently visited for the purpose of comparison. The concluding part of the paper was devoted to a sketch of the subterranean movements of upheaval and depression which can be shown to have taken place during the volcanic period in the basin of the Forth, and to some remarks on the abundance of life in the immediate vicinity of the volcanic orifices.

3. On the Constitution of Society in this Country, with reference to the Proportion which Male Life bears relatively to Female Life, and the Effects of an Excess of Female Life. By W. T. Thomson, Esq.

(This paper has been published as a pamphlet.)

4. On the Danger of Hasty Generalisation in Geology. By Alexander Bryson, Esq.

5. On the Deflection of the Plummet caused by the Sun's and Moon's Attraction. By Edward Sang.

In this paper it was shown that the attraction of the sun causes a deflection of the plummet, having its maximum about the 240th part of a second, and proportional to the size of twice the sun's zenith distance; the deflection is at its maximum when the sun is 45° above or below the horizon, and occurs in the vertical plane passing through the attracting body.

The deflection due to the moon has its maximum about the 60th part of a second, and follows the same law; it is toward or from the attracting body according as the zenith distance is less or more than 90°.

Upon the cross-level of a transit instrument, the joint effect is to cause a semi-diurnal oscillation small at the quarters and rising to the 24th part of a second at new and full moon; while the influence upon meridian observations is sufficient to cause a disagreement between the greatest inclination of the moon's orbit, as observed at St Petersburg and Madras, amounting to the 50th of a second.

The general conclusion drawn was, that we cannot determine the positions of the heavenly bodies true to the 100th part of a second without having made allowance for this source of disturbance.

6. Note on Gravity and Cohesion. By Professor William Thomson.

The view, founded on Boscovich's theory, commonly taken of cohesion, whether of solids or of liquids, is, that it results from a force of attraction between the particles of matter, which increases much more rapidly than according to the inverse square of the distance, when the distance is diminished below some very small limit. This view might, indeed, seem inevitable, unless the idea of "attraction" is to be discarded altogether; because the law of attraction at sensible distances—the Newtonian law—demonstrated by its discoverer for distances not incomparably smaller than the earth's dimensions, and verified by Maskelyne and Cavendish in a manner rendering it impossible for any naturalist to reasonably doubt its applicability to the mutual action between particles a few hundred yards or a few inches asunder, seems to give only very small, scarcely appreciable, forces between bodies of such masses as those we experiment on in our laboratories, everywhere placed as close as possible to one another,—that is to say, in contact, and does not seem to provide for any considerable increase of attraction when the area of contact is increased, whether by pressing the bodies together, or by shaping them to fit over a large area.

But if we take into account the heterogeneous distribution of density essential to any molecular theory of matter, we readily see that it alone is sufficient to intensify the force of gravitation between two bodies placed extremely close to one another, or between two parts of one body, and therefore that cohesion may be accounted for without assuming any other force than that of gravitation, or any other law than the Newtonian. To prove this, let two homogeneous cubes be placed with one side of each in perfect contact with one side of the other; and let one-third of the matter of each cube be condensed into a very great number, i, of square bars perpendicular to the common face of the two; and let the other two-thirds of the matter be removed for the present. The mass of each bar will be $\frac{1}{3i}$ of the whole mass originally given in each cube.

Let us farther suppose that the two groups of bars are placed so that each bar of one group has an end in complete contact with an end of a bar of the other. The attraction between each two such conterminous bars, however small their masses are, may be increased without limit, by diminishing the area of its section, and keeping its mass constant. But the whole mutual attraction between the two groups exceeds i times the attraction between each of the conterminous pairs, and may therefore be made to have any value, however great, merely by condensing each bar in its transverse section, and keeping their number and the mass of each constant.

We may now suppose another third of the whole mass to be condensed into bars parallel to another side of the cube, and the remaining third into bars parallel to the remaining side. If, then, either of these cubes be placed with any side in contact with any side of the other, and allowed to take the relative position to which it will obviously tend—that in which the bars perpendicular to the common side of the two cubes come together end to end, there will be produced, by pure gravitation, a force of attraction between them which may be of any amount, however great, and which will be greater, the greater the ratio of the whole space unoccupied within the boundary of either cube, to the space occupied by the matter of the bars.

This illustration has been chosen merely for the sake of definiteness and simplicity; but it is clear that any arrangement, however complex, of woven fibrous structure, provided only the ratio of the unoccupied to the occupied space is sufficiently great, will lead to the same general conclusion. Farther, it is clear that the same result would be produced by any sufficiently intense heterogeneousness of structure whatever, provided only some appreciable proportion of the whole mass is so condensed in a continuous space in the interior that it is possible, from any point of this space as centre, to describe a spherical surface which shall contain a very much greater amount of matter than the proportion of the whole matter of the body which would correspond to its volume. Except in imposing this condition, the theory now suggested interferes with no molecular hypothesis hitherto propounded, continuous or atomic, finite atoms, or centres of force, static or kinetic.

Physical science abounds with evidence that there is an ultimate very intense heterogeneousness in the constitution of matter. All that is valid of the unfortunately so-called "atomic" theory of chemistry seems to be an assumption of such heterogeneousness in explaining the combination of substances. This alone, it is true, does not explain the law of definite combining proportions; but neither does the hypothesis of infinitely strong finite pieces of matter; and whatever is assumed to be the structural character of a chemical compound, a dynamical law of affinity between the two substances, according to the proportions of them lying or moving beside one another, must be added to do what some writers seem to suppose done by their "atomic theory."

It is satisfactory to find that, so far as cohesion is concerned, no other force than that of gravitation need be assumed.

Monday, 28*th April* 1862.—PROFESSOR CHRISTISON, V.P., in the Chair.

The following Communications were read :—

1. Experimental Inquiry into the Laws of the Conduction of Heat in Bars, and into the Conducting Power of Wrought Iron. By Principal Forbes.

The experiments described in this paper were all made in 1850 and 1851, upon a plan which was fully explained by the author in letters to Mr Airy and Professor Kelland in the former year. Some notice of them appeared in the British Association Reports for 1851 and 1852, and the apparatus was supplied by a grant from the Association.

In previous inquiries into the thermal condition of a long conducting bar heated at one end, two assumptions have always been made: *First*, that the flux of heat across any transverse section of the bar is proportional throughout to the rapidity of the decrement of temperature reckoned along the axis of the bar (or to $\frac{dv}{dx}$, where v represents the temperature, above that of surrounding space, of any point of the axis of the bar at a distance x from the origin). *Secondly*, That the loss of heat by radiation and convection from the surface of the bar is at every point proportional to the same temperature v. By assuming these principles (the last of which is certainly more or less inexact), the well-known solution of the problem of the heated bar is, that the temperatures (or excesses of temperature) diminish in a geometrical progression from the origin, and finally, of course, become insensible. Previous experimenters have confined themselves to finding the constants of the logarithmic curve for different substances, and thence their *relative* (not absolute) conducting powers.

In the experiments now described, neither of the above-mentioned principles is assumed. The external loss of heat is *directly* ascertained by experiment, and the admissibility or otherwise of the former principle is also *directly* tested. That principle may be thus symbolised: $F = -k\frac{dv}{dx}$, where F is the flux of heat across unit of section, k the conducting power for the substance employed, and v and x have the same signification as before.

I. In the first instance, a bar of iron 8 feet long and $1\frac{1}{4}$ inch in diameter, was heated by means of a crucible at one end, containing melted solder. Thermometers were inserted at various points of its length. The results, v in terms of x, were projected in a curve (approximately a logarithmic), and the values of $\frac{dv}{dx}$ were found by projection or calculation, or both.

II. Next a short bar (20 inches long), perfectly similar in section and condition of surface to the long bar, is heated to above 200° Cent. in a bath of fusible metal, and allowed to cool in free space, a thermometer being inserted at the centre of its length. This gives us the *rate at which such a bar is parting with its heat from all causes whatever*, in terms of the temperature shown by a thermometer in its axis.

III. The losses of heat in unit of time (one minute) last found may be taken as representing the amount of heat dissipated from each point of the long bar in the statical experiment (I.), being given in terms of the temperature proper to each point of such a bar. A curve may thus be constructed, having for its line of abscissæ the axis of the long bar, and for ordinates, the rate of dissipation of heat from each portion of its surface due to both radiation and convection.

IV. If we can by mechanical quadrature, or otherwise, find the whole amount of heat dissipated between any point of the long bar and its coolest extremity, we have, in truth, the flux of heat passing from the hotter extremity of the body across the particular section in question; for the condition of permanence of the temperature of the bar arises from the equality of the heat supplied and dissipated. But the whole heat dissipated in unit of time is the integral of the partial dissipations represented by vertical ordinates of the last-named curve, taken between any assumed point x and the farthest or cool end of the bar. This quantity, then, is F or the flux across unit of section at the point x.

V. We are now able to resolve the question whether or not the flux of heat is in the given bar everywhere proportional to the rapidity with which the temperature decreases as x increases, or whether the equation holds, $F = -k\frac{dv}{dx}$, the conducting power k being supposed to be constant.

The following table (the result of an *approximate* reduction made in 1852) shows that the constancy of k in the case of iron cannot be assumed; on the contrary, that the conductivity diminishes as the temperature increases. The first column is the observed temperature of given points of the bars; the second and third columns give the values of k from the preceding equation—(1.) as deduced from experiments on the iron bar with a polished surface; (2.) when the surface was covered with thin paper. The general coincidence of the two is satisfactory, since the external cooling was considerably different in the two cases.

Actual Temperature, Centigrade.	$\frac{F}{-\frac{dv}{dx}}$; polished bar.	$\frac{F}{-\frac{dv}{dx}}$; covered bar.
25°	·0136	·0147
50	·0130	·0138
75	·0131	·0123
100	·0126	·0113
125	·0122	·0107
150	·0112	·0107
175	·0100	·0102
200	·0087	...

The mean of both series may be tolerably represented by a uniformly diminishing conductivity as the temperature increases. When reduced* to the usual units of conducting power expressed in terms of the amount of heat necessary to raise by 1° Centigrade a cubic foot or a cubic centimètre (one gramme) of water respectively, we have the following absolute measures:—

* The numbers in the preceding table refer to the thermal capacity of iron instead of water.

Temperature, Centigrade.	Conducting Power of Wrought Iron. Units, the Foot, Minute, and Cent. Degree.	Conducting Power of Wrought Iron. Units, the Centimètre, Minute and Cent. Degree.
0°	·0133	12·36
50	·0120	11·15
100	·0107	9·94
150	·0094	8·73
200	·0082	7·62

It is to be observed that thermometric readings have not yet been finally corrected, so that these numbers may receive some slight modification. The author hopes to complete the verification of the calculations, so far as wrought iron is concerned, in the course of the present summer. The state of his health has been the cause, not only of the suspension of the experiments, but of the long delay which has taken place in publishing the results so far as obtained.

2. On Certain Vegetable Formations in Calcareous Spar. By Principal Sir David Brewster.

3. On the Existence of *Acari* between the Laminæ of Mica in Optical Contact. By Principal Sir David Brewster.

4. On the Secular Cooling of the Earth. By Professor William Thomson.

The fact that the temperature of the earth increases with the depth below the surface, implies a continual loss of heat from the interior by conduction outwards, through or into the upper crust. Since the upper crust does not become hotter from year to year, there must therefore be a secular loss of heat from the whole earth. It is possible that no cooling may result from this loss of heat, but only exhaustion of potential energy, which in this case could scarcely be other than chemical affinity between substances forming part of the earth's mass. But it is certain that either the earth is becoming, on the whole, cooler from age to age, or that the heat conducted out is generated in the interior by temporary dynamical action (such as chemical combination). To suppose, as Lyell has done,* that the substances combining together, according to the chemical hypothesis of terrestrial heat, may be again separated electrolytically by thermo-electric currents due to the heat generated by their combination, and thus the chemical action and its heat continued in an endless cycle, violates the first principles of natural philosophy in exactly the same manner and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going for ever.

Adopting as the more probable, the simpler hypothesis that the

* Principles of Geology.

earth is merely a heated body cooling, and not, on the whole, influenced to any sensible degree by interior chemical action, the author applies Fourier's theory of the conduction of heat to trace the earth's thermal history backwards. From data regarding the specific heat and thermal conductivity of the earth's substance, he investigates the time that must elapse from an epoch of any given uniform high temperature throughout the interior, until the present condition of underground temperature could be reached. Taking into account the very uncertain character of the data when high temperatures are concerned, he infers that most probably either the whole earth must have been incandescent at some time from 50,000,000 to 500,000,000 years ago, or that at some less ancient date, but still anterior to the earliest human history, there must have been up to the surface a temperature above the boiling-point of water. Either alternative—or indeed any theory whatever consistent with the principles of natural philosophy regarding previous conditions of the earth—is as decisive against the views of those naturalists who acknowledge no creation of life on the earth within fathomable periods of time, as the plainest elements of dynamics are against those who maintain that we have no evidence in nature of an end.

5. Notice of the Ravages of the *Limnoria terebrans* on Creosoted Timber. By David Stevenson, Esq., F.R.S.E., M.I.C.E., &c.

The author stated that it would be difficult to estimate the value of any chemical or mechanical process whereby timber might be rendered permanently impervious to the ravages of the *Limnoria terebrans*, that small but sure destroyer of timber structures exposed to the action of the sea.

The justly approved creosote process, patented by Mr Bethell, had been largely employed in railway works, with universally admitted success, and, in common with many of his professional brethren, the author adopted it in several marine works, in the expectation that it would prove an antidote to the Limnoria; but he had now ascertained beyond all doubt that creosote was not a universal or permanent preservative of timber used in such works.

6. On some Thermic Properties of Water and Steam. By Professor W. J. Macquorn Rankine.

The author refers to the general equation of the mechanical action of heat which Professor Clausius and he arrived at independently by different methods in 1849, and points out that the form of that equation, which was laid before the Society by him in a paper read on the 4th of February 1850, comprehends, as a particular case, the law which connects the volume of a given weight of steam with its temperature, pressure, and latent heat. He describes the use of that law, with proper numerical data, to compute, in the absence of direct experiment, tables of the density and volume of saturated steam, more accurate than those founded on the assumption of the perfectly gaseous condition, as exemplified in tables which he published in 1855 and subsequently. Referring next to the direct experiments of Messrs Fairbairn and Tate on the density of steam, published in the Philosophical Transactions for 1860, he gives a tabular comparison of the volumes of one pound of steam as determined by these experiments, and as computed theoretically from M. Regnault's experiments on the latent heat of steam, with the aid of Joule's mechanical equivalent of heat; and from that comparison he draws conclusions which may be summed up as follows:—

1. At temperatures below 212°, the differences between the results of theory and experiment are inappreciable.

2. At temperatures above 212°, the differences, although too small to be of any consequence in practical calculations connected with steam-engines, are appreciable, the volume of a pound of steam by theory being slightly greater than by experiment.

3. Small as those differences are, there exist no known sources of error either in the data of the theoretical calculation or in the method of experimenting sufficient to account for them.

4. They are therefore most probably caused by some unknown difference in the molecular condition of the steam in M. Regnault's experiments on latent heat, and in Messrs Fairbairn and Tate's experiments on density.

5. That difference of condition is probably connected with the fact, that in M. Regnault's experiments the steam was in rapid motion from a boiler towards a condenser; whereas in the experiments of Messrs Fairbairn and Tate the steam was at rest.

6. Further experimental researches are desirable.

7. Formulæ connected with small continuous Displacements of the Particles of a Medium. By Professor Tait.

Royal Physical Society.

Wednesday, 26th March 1862.—ALEXANDER BRYSON, Esq., President, in the chair.

The following communications were read:—

1. *Notice of Indian Insects exhibited at last meeting by Mr Elliot of Wolflee.* By R. F. LOGAN, Esq.

2. Dr James M'Bain exhibited what were believed by the fishermen to be the ova of the herring. He described the development in the

ovum, and also exhibited the small fry, which eight days ago had proceeded from these ova.

3. *On the Differences between the Young Herring*, Clupea harengus, *and the Spratt*, Clupea sprattus. By J. M. Mitchell, Esq.

4. *On* Phryxus paguri. By John Anderson, M.D.

5. *Observations on British Zoophytes and Protozoa.* By T. Strethill Wright, M.D.

1. *Clava nodosa* (new species, T. S. W.) Polypary Creeping. Scleroderm membranous, "Polyps single, small, aurora coloured, each springing from a small knot of convuluted tubes." This zoophyte was found on the fronds of Delesseria sanguinea at Queensferry and Largo. The very delicate threads of the polypary creep over the fronds of the seaweed, and at intervals twine themselves into a convoluted knot of membranous tubes, from which a single polyp arises. The species occurs only at low tide mark; while C. repens, for which it may be mistaken, is found in shallow rock pools.

2. "Polypary branched, spirally twisted. Polyps pale orange, with two rows of tentacles. The lower row from 4 to 12, the upper row from 2 to 8 capitate."

On stones carrying Caryophyllia Smithii, received from Ilfracomb. This little tubularian was about a quarter of an inch high, with three polyps, and resembled in habit Tubularia larynx. It bears the same relation to Vorticlava that Corymorpha does to Tubularia larynx.

3. *Zooteirea religata.*—I described this animal to the Society about three years ago. It is a stalked actinophrys. The body, as in other animals of this class, consists of two elemental tissues, to which I have given the terms ectosarc and endosarc,—terms which have been adopted by Dr Carpenter. The ectosarc or external tissue is prolonged into a thick brush of the most delicate contractile palpocils or tentacles, like threads of spun glass, by which the animal is constantly seizing small organic particles, and conveying them to the endosarc or inner tissue, which is the nutritive element. I stated that the stalk was formed of a prolongation of the ectoderm, similar to the tentacles; but, having again discovered large colonies of these animals last summer, and again this winter, I have been enabled to study the structure of the stalk more closely, and find that it is an elastic tube, which appears to consist of denser tissue than either of the elements of the body. The axis of the tube is occupied along its whole length by a powerful muscular band, which is well seen in the figure in which the tube is distended with water, as sometimes occurs. The animals are very sluggish, remaining for days motionless, with all their rays extended; but the moment they are touched they vanish, drawn close down by their powerful muscular apparatus into the interstices of the shells in which they are generally found. Zooteirea multiplies by gemmation, the buds being given off close to the stalk, and separate as a minute actinophrys, which instantly fixes itself and develops its stalk.

4. *Freya* (*Lagotia*) *obstetrica et Freya stylifer*, (new species, T. S. W.)—It is now some years since I described several species of the new genus Lagotia to the Society. It appears, however, that Claparede and Lachmann had already constituted the genus Freya for animals evidently belonging to my genus Lagotia, in a memoir which they communicated to the French Academy, which memoir was printed after my communication to this Society. The species of Freya discovered by them differed from any of my species, and I have now to describe two other

species of this very remarkable genus. *Freya obstetrica.*—"Lobes of rotatory organ very broad, not folded; the tips bluntly rounded and incurved, so as to resemble very closely the blades of the obstetric forceps. Body fusiform, scarcely longer than the rotatory lobes. Nucleus large, colourless, surrounded by dense green pigment. Body and rotatory lobes covered with striæ, bearing fringes of cilia. Cell flask-shaped, without a trumpet-shaped mouth. Colour of animal and cell pale bluish green." *Freya stylifer.*—"Rotatory lobes short, narrow, and widely expanded, one of the lobes bearing at its tip a fleshy prolongation or style as long as the lobe; cell tubular, without trumpet-shaped mouth; cell and animal colourless." Freya stylifer is the smallest species I have yet seen of the genus to which it belongs; when contracted within its tube, it projects the curious style, which is doubtless a sense organ, beyond the opening, only entirely retracting it when rudely disturbed.

During the last summer I had an opportunity of watching another species of Freya (*F. producta*) building up its remarkably constructed cell. The cell of this species, which is often immensely prolonged, is formed of a spiral ribbon of chitine, cemented by a thick internal layer of soft green sarcode, secreted by the body of the animal, so that the whole forms a hollow tubular spring, like the spiral wire tubes formerly employed for conveying gas to moveable burners. These tubes will therefore bend aside like a willow twig on any rude contact from the animals which are constantly coming dashing about, and will instantly regain their proper position. The young *Freya producta*, which is a free swimming larva, fixes itself, and secretes the lower part or body of the cell from the outer surface of its body; it then begins to form the elongated neck by depositing the chitine and sarcode on the upper edge of the constantly lengthening ribbon, carefully moulding the plastic materials with its two short rotatory lobes, which it uses like a pair of hands, just as Sabella and Serpula mould their tubes with their hand-like secreting leaflets. Having built its tube to the requisite length, it finishes it off with a handsome trumpet-shaped mouth, and then retires to develop its long rotatory lobes. Occasionally the animal outgrows its dwelling-place, and finds it necessary to lengthen its tube. For this purpose a large quantity of dark green matter is collected in the body of the animal, a little below the rotatory organ, and from this part chitine and sarcode are secreted, which are instantly moulded into shape by the rotatory lobes, and a new spiral tube rises up from within the trumpet-shaped mouth of the old one.

Chatospira maritima (new species, T. S. W.)—Two species of this remarkable animal have been noted by Lachmann—C. Mulleri and C. mucicola. Chatospira is defined as a Stentor, in which the ciliary spiral and the parenchyma of the body supporting it are drawn out into a long thin process. When the animal issues from its tube, it protrudes its ciliary organ as a fleshy column, fringed on one side by a row of very long motionless cilia, but in an instant the column is twisted into a spiral, and the cilia are set in violent motion, urging currents of water towards the mouth. The marine species approaches in character as to its rotatory organ, to C. Mulleri, while it inhabits a mucous tube like that of C. mucicola.

Oxytricha longicaudata.—This remarkable animal, resembling very much Oxytricha retractylis, described by Claparede and Lachmann, was found in great numbers with Chatospira maritima. The tail in this species is fully twice as long as that of Oxytricha retractylis, and is dragged after the swimming animal like a trailing rope, when suddenly the extremity of the tail is fixed by the long cilia at its extremity, and the Oxytricha, by violent contractions of its tail, jerks itself backwards and forwards in the most violent manner. The structure of tail, under an excellent power of eighty diameters, presents a peculiar striated and plaited appearance, like that of voluntary muscular fibre, but I could not make anything of it under higher powers.

6. *On peculiar hooked Spines on* Ophiocoma bellis, *with Observations on the Spines of other* Ophiocomæ. By Charles William Peach, Esq., Wick.

7. *Geology of Moffat, Dumfriesshire.* 1. Lithology. By William Carruthers, Esq., F.L.S.

(This paper appears in the present number of this Journal.)

Wednesday, 23d April 1862.—John Coldstream, M.D., President, in the chair.

The following communications were then read :—

1. *Observations on the* Phocidæ *of the Greenland Seas.* By John Wallace, M.D.

2. (1.) *Notice of a Mass of Meteoric Iron found at the Village of Newstead, Roxburghshire, with some general remarks on Meteorites.* By John Alex. Smith, M.D.

(This paper appears in the present number of the Journal.)

(2.) *Chemieal Analysis of the Meteoric Iron found at Newstead, Roxburghshire.* By Murray Thomson, M.D.

(This paper appears in the present number of the Journal.)

3. *On Professor M'Coy's Ray without a name, taken in the Firth of Forth, May* 1861. By William S. Young, Esq.

(Specimen exhibited.)

Wednesday, 7th May 1862.—John Coldstream, M.D., President, in the chair.

The following communications were then read :—

1. *Note of the Capture of the Red-Crested Whistling Duck* (Fuligula rufina, *Selby*) *in Argyleshire.* By John Alexander Smith, M.D.

Dr Smith read a communication he had received from J. W. P. Orde of Kilmory, Esq., of the capture of a male of the *Fuligula rufina*, the red crested whistling duck, which was shot in company with some golden eyes on a fresh water loch near Craignish, Argyleshire, in the month of January. This bird is a rare occasional visitor to England, and was first noticed by Yarrell in 1826. Several specimens have been since observed, but none before this in Scotland. It is a bird of eastern Europe, emigrating southwards in winter.

Dr Smith also read a note from Richard Bell, Esq., of a wild duck's nest, with eggs, noticed amongst the small branches of a thorn tree on the farm of Billholm, Dumfriesshire, in May 1861. It was eleven feet from the ground, and about forty yards from the river Esk. The nest was not the old one of any other bird, as crows, &c., which has sometimes been observed, but was the work of the bird herself. It was compactly built of birch twigs, and was lined with down. Instances of wild ducks occasionally using the nests of other birds, and at as great a height as thirty feet from the ground, have been observed. In these instances, it is believed, the young birds are brought down to the ground by the bill of the mother.

2. *On a Case of Abnormality in the Ossification of the Parietal Bones in the Human Fœtus.* By Ramsay H. Traquair, Esq.

In this communication Mr Traquair carefully described the parietal bones of a fœtus, one of which was composed of two portions, the smaller one nearly the third of the size of the bone; it was therefore formed from two distinct osseous centres,—a very unusual variety, of which no exactly corresponding case was known, the bone being generally formed of one piece and from one osseus centre.

3. (1.) *Remarks on the so-called raised Sea Beach Bed, and its Relations to other Deposits in the neighbourhood of Leith.* By James M'Bain, M.D., R.N.

(2.) *Supplementary Communication on the so-called Raised Sea Beach Bed at Leith.* By Alex. Bryson, Esq.

4. *On the Equoreal Pipe Fish.* By T. Strethill Wright, M.D.

5. *Observations on British Zoophytes and Protozoa.* By T. Strethill Wright, M.D.

6. *Report of the Committee on Marine Zoology.* By George Logan, Esq., Convener.

The Committee in their report noticed the discovery of a fish, new to the Firth of Forth,—viz., the poor or power cod, *Gadus minutus* of Linnæus,—*Morrhua minuta* of Fleming, and described by Yarrell, vol. ii. p. 241, of his "British Fishes," in a very interesting manner. This little fish was first detected during the spring among a number of the common codlings, by Mr R. F. Logan,—the fishermen always confounding it with the whiting pout or brassey, the *Gadus luscus* of Linnæus, which it much resembles. Some of the specimens were found to be full of mature spawn. A fine specimen of the Greenland shark,—*Scymnus borealis*,—caught on the Dogger Bank 30th April 1862, was secured for the examination of the committee; and Mr Young has favoured them with a detailed description. Mr Young states,—"This specimen was presented to me by Mr Finlay, fishmonger, Leith, and this is only the sixth instance, so far as known, that the Greenland shark has been observed in our seas. Length, 8 feet 6 inches; greatest circumference, 3 feet 7 inches at posterior angle of pectoral fins. The colour was a uniform light-bluish grey, skin covered with minute hooked spines—hooks pointing backwards. A row of mucous ducts extended from the tail to the head, their apertures, four-tenths of an inch apart, forming the lateral line, which branches off at the head into symmetrical curves. These ducts are about half an inch in length, and communicate obliquely with a longitudinal canal just under the skin, lined with a dark pigment membrane. On dissecting the fish, the liver, consisting of two lobes, each 5 feet in length, weighed 35 pounds. In the stomach was found a large pultacious mass, along with portions of the cat-fish, cod, and haddock, and a large cod-hook, with a part of snood attached. The claspers at the base of the ventral fin showed this to be a male fish; and an elongated testis, covered by a delicate membrane, extended on each side of the spinal column the whole length of the abdominal cavity. Three years since, in the month of May, a somewhat larger specimen than this was caught near Inchkeith, and is now preserved in the Natural History Museum here."

7. *On the Composition of a Pseudo-Steatite found near Bathgate.* By Murray Thomson, M.D., and Mord Binney, Esq.

(This paper appears in this number of the Journal.)

8. Mr Robert Brown exhibited a small fœtal specimen of a Narwhal; another and larger fœtus was also found in the uterus of the same fish, which was captured in Davis' Straits.

Botanical Society of Edinburgh.

Thursday, 13*th March* 1862.—Professor Balfour, V.P., in the chair.

Professor Balfour made a few remarks on the death of James Townsend Mackay, LL.D., M.R.I.A., Curator of the Botanic Garden, Trinity College, Dublin. Dr Mackay was a Nestor in botany, and was well known as the author of "Flora Hibernica." He died, 25th February last, of bronchitis, at Dawson Grove, near Dublin, at the age of 87. For many years he had been affected with paralysis. He was attended assiduously by his friend, Dr Croker. His remains were interred in the Jerome Cemetery. He was elected a member of the Society in December 1836.

The following communications were read:—

1. *Does Magnetism possess any Influence over Organic Forces?* By H. F. Baxter, Esq. Communicated by Professor Balfour.

(This paper appeared in the number for April.)

2. *Notes on* Cyperaceæ, *No.* 2. *On* Scirpus Holoschœnus *and* var. β (S. romanus). By Benjamin Carrington, M.D., F.L.S.

The author stated that in 1849 he received from the Edinburgh Botanical Society a variety of *Holoschœnus* (*Link*), having a more graceful habit and differing from the Braunton Burrows plant, which is the typical form. The specimen was from Watchet. He described the plant under the Linnean name of *Scripus australis*, and communicated the opinion of the late Mr Borrer on the subject.

3. *Notice of flowering Plants and Ferns, collected on both sides of Davis Straits and Baffin's Bay.* By Mr James Taylor, Aberdeen. Communicated by Professor Balfour.

(This paper is in the present number of the Journal.)

4. *Remarks on Disease of the Beech.* By Mr R. G. Foggo.

The author remarked—For two or three years preceding 1858, my attention was directed to a disease which had proved fatal to some very fine specimens of beech in a gentleman's park in the county of Suffolk. The trees in question were greatly valued by the proprietor as objects of ornament, and various means were tried to effect a cure, and, if possible, to arrest the further progress of the disease, but without any beneficial result. The beech is one of the most accommodating trees as regards soil and situation, and it was evident that the disease did not arise from any peculiarity in the soil, which consisted of the sandy loam, with subsoil of chalk and gravel. In hot dry seasons the trees suffered much from drought. I mention this fact beeause I have seen the same form of disease among trees growing in wet, low-lying districts; and when seeking information from foresters and others interested in such matters, they have invariably attributed it to dampness of situation. The disease is caused by minute insects, and not as some have thought, by a species of fungus. The trunk of the tree is first attacked, and while some portions of it to all appearance remain in a healthy state, those which the insects infest gradually assume a dry appearance, and when closely examined, the bark will be found to separate from the wood, and become dry and lifeless. Other unfavourable influences may, of course, favour the speedy decay of the trees, but it soon becomes evident that future healthy development is arrested, and when the trees are cut down the ravages of the insects cease with the life of the bark. This is, I think, the most curious circumstance connected with the disease, and may under careful investigation go some length to make us acquainted with means to effect its destruction. Whiie the ravages of the insects seem to be confined to patches and districts of plantations, their existence is pretty widely spread throughout the country, and on trees growing under all circumstances. Attempts to effect a cure or to prevent the occurrence of the disease have, as far as I can ascertain, proved a failure. Other trees more valuable that the beech are in some places affected with a disease to all appearance similar: as, for example, the silver firs on the estate of Dunmore, near Stirling. Amongst the many plans adopted there, the only one which has succeeded to any degree is that of brushing with a *hard* brush the parts infected, when the bark was dry.

Specimens of the Nardoo plant of Australia were shown in a germinating state. The sporocarps had been sent to the Botanic Garden by Mr James Sceales, 1 Cassels' Place, Leith, and they had sprouted in a moist situation in the hothouse. Mr John Scott, one of the gardeners, took notes of the germination, and submitted the following statement:—The spore-fruits of the Marsilea consist of short legume-like capsules, containing sporanges of two kinds—antheridial and ovulary—on short receptacles arranged in a biserial manner on a mucilaginous cord. The antheridial spores consist of single cells, containing a great number of small granules, the functionary import and developmental history of which is differently explained by authors. Thus Lindley and Valentine regard them as abortive ovulary spores; while Hofmeister believes them to be the male organs of the plant, stating that each of the granules produces a number of spermatozoa. Schleiden, on the other hand, while agreeing with Hofmeister in regard to the functions they perform, maintains that they develop tubes somewhat similar to those produced, as he formerly supposed, by the pollen-grains of Phanerogams, one of which penetrates the ovulary spore, and is developed into the young plant. The ovulary spore, according to Schleiden, presents the following structure:—" A very large cell with firm walls, containing large grains of starch, mucilage, and oil. The embryo-sac is surrounded by a white coriaceous membrane, which is formed of very minute scarcely distinguishable cells. This membrane forms at one extremity a papilla, which is covered by a membrane open at the point, and called the simple coat of the bud." The spore-fruits immersed in water at a mean temperature of 65° Fahr. burst in two days, and emitted a gelatinous cord, one extremity of which was free, the other attached to the base of the fruit. This cord, through the absorption of moisture, expanded rapidly in various degrees—in one instance, under our own observation, it formed a filament two inches long by two-eighths of an inch in diameter; this, however, according to Schleiden, must be a minimum of the size it usually attains, as he states that it forms a round filament from one or two lines thick, and four to five inches long, exceeding in volume twenty or thirty times the whole fruit. It is on this cord, as formerly stated, that the receptacles bearing the antheridial and ovulary spores are arranged, the latter being confined entirely to their interior sides, the former covering the others; nevertheless, though a peculiar, they are not an exclusive, product of this part, as receptacles frequently occur void of ovulary spores, their places being then occupied by antheridial cells, and in general they are irregularly intermixed on this part with the latter—a fact which favours the conjecture of Lindley, that they are simply abortive ovulary spores. On detaching an ovulary spore from a receptacle, a small opaque papilla is observed protruding, which is the point from which germination invariably takes place. If we place a few of these receptacles on moist soil, in a mean temperature of 65°, the papillæ are developed in a few hours into truncated conical tumours of green cellular tissue, usually a line long, covered with a delicate transparent membrane. This is called the prothallus, which is here, as in the *Lycopodiaceæ*, confluent with the spore. The development of the prothallus now ceases, and it gives off at a right angle to the axis of the spore the primordial leaf, which is straight and subulate, usually attaining half an inch in length, and partially sheathed by the membrane covering the prothallus. Before this leaf is fully developed the root has made its appearance in a line directly opposite to it, as a delicate fibre, destitute of the green granules which are found in the leaf. Shortly after the root has made its appearance a second leaf grows from the prothallus close to the first. This leaf at once bursts the sheath which had partially enveloped the latter. The vernation of this second leaf is similar to the first; it differs from it, however, in form, as the petiole in this case bears an entire obovate lamina.

Professor Balfour read a letter from Dr Dubuc, of H.M.S. Cossack, written from Auckland, New Zealand. Dr Dubuc writes—"The Cossack arrived here with the Governor, Sir George Grey and suite, after a quick but stormy passage from the Cape. The Governor, who takes great interest in natural history, brought with him a Wardian case containing *Quercus virens*, a cactus with cochineal insects, a willow, and other plants likely to be useful in the colony. I have examined some of the plants of this neighbourhood. By the border of a rivulet I gathered many ferns, amongst them *Cyathea dealbata*, which is an elegant tree fern. I also observed *Phormium tenax*, New Zealand flax, in fruit, one of the useful economical plants. *Corypha australis*, which imparts a somewhat tropical feature to the scenery, *Altingia excelsa*, the Norfolk Island pine, and some Cape species may also be seen. Many of our common English weeds are abundant, such as *Ulex Europæus*, *Plantago lanceolata*, *Verbascum Thapsus*, *Geranium molle*, *Nasturtium officinale*, a common species of *Rumex*, and others. Through the kindness of the secretary, Mr Layard, I have been enabled to procure the desiccated body of a caterpillar with a peculiar fungus (*Sphæria Robertsi?*) projecting from it. The spores of the fungus attack the body of the animal, and ultimately destroy it by their growth." A drawing of the caterpillar was sent.

Professor Balfour read the following extract from a letter of Dr Giraud, Professor of Chemistry in the Medical College of Bombay:—"I have travelled over nearly the whole of the Bombay Presidency, and have explored much interesting botany and geology. The last place we were at a few days ago was one of the most beautiful hills of the western Ghats called Mathoran, 2500 feet above the sea, and thirty miles from the coast, prettily wooded with *Sizygium*, *Sterculias*. *Erythrinas*, *Memecylon*, *Osiris*, *Sapota*, *Glycosmis*, *Actinodaphne*. &c., &c., with under shrubs of *Canthium* and lovely *Strobilanthi*, *Barlerias*, and *Ruellias*."

James G. Wilson, Esq., of Batavia, Craigneuk Villa, Lauder Road, exhibited specimens of twin coco nuts; each stalk producing two fruits, one of them fully developed, the other abortive and appearing in the form of a curved appendage. Mr Wilson stated that out of many thousand trees growing on the Coco Islands only one tree produced fruits like those exhibited, every fruit having the same appearance. Occasionally three fruits have been produced from the same peduncle, one being perfect, the other two abortive, having the same horn-like aspect. The tree was blown down about six years ago. Nuts have been sown by Mr Ross, the Governor of the island, and it will be interesting to learn if the progeny produce similar nuts. Mr Wilson presented one of the specimens to the Museum of the Botanic Garden.

Mr M'Nab gave the following report on the flowering of plants in the open air in the Botanic Gardens:—*Sisyrinchium grandiflorum*, February 14; *Nordmannia cordifolia*, February 15; *Scilla bifolia* (blue) February 20; *Symplocarpus fœtidus*, February 26; *Narcissus pumilus*, February 27; *Dondia Epipactis*, February 28; *Erica herbacea*, February 28; *Aubretia grandiflora*, March 8; *Arabis albida*, March 8; *Scilla bifolia* (white), March 10; *Scilla præcox*, March 10; *Primula denticulata*, March 12; *Scilla bifolia* (pink), March 12.

Wm. Tod, Esq., St Leonard's, Lasswade, sent specimens of peculiar lacerated varieties of *Lastrea dilatata*, and *L. spinulosa*, from Dumcrieff, near Moffat.

Thursday 10*th April* 1862.—T. C. Archer, Esq., President, in the chair.

Professor Balfour intimated the death of Dr Emilius Dubuc, of H.M.S· Cossack, who had been an active member of the Society, and had contributed to its Herbarium and Museum.

The following communications were read:—

1. *The Ahtoor Ghaut and the Ascent to the Shevaroy Hills from Madras* By Dr Alex. Hunter, Madras.

On Friday, the 27th December 1861, I left Madras by the early six o'clock train, bent on enjoying a week's relaxation, and trying the bracing effects of the cool climate of the Shevaroys. For the first twenty or thirty miles the country seemed to be a good deal under water, and the tanks and ditches were fuller than I had expected, considering the light monsoon. Some of the paddy crops were fair and promising, and the cool breeze blowing over the wet fields felt very refreshing. There is little to attract the eye beyond a long flat expanse of low level country, densely wooded in the vicinity of Madras, but becoming bare and uninteresting for nearly twenty miles. The Naggery range of hills, with the bolder Nullamullys to the north, stretching up along the Pulicat lake, are the first objects of interest. These hills were resorted to some years ago as a sanitarium, and were inspected and reported upon, but their height is not sufficient to command a cool bracing climate, and being only from 800 to 1200 feet above the level of the sea, the temperature is not much below that of the plains. On approaching Arcot and Vellore the hills become more rugged, bold, and picturesque. In parts of this range some hills have hardly a trace of vegetation from the base to the summit, while others are covered to the very top with brushwood. This difference seems to depend on the character of the decaying rocks of the hill,—the white pegmatites and pale gneiss rocks yielding a poor sterile soil, while the decomposing green-stone, dark granites, and trap rocks, yield more productive soils. This fact can be easily verified on several parts of the line—as, first, on the bold bare slopes of the Amoor Hill, where the stratified appearance of the pale grey gneiss can be well seen at a great distance. It may also be observed on several of the hills between the Arcot and Vellore stations, where the white pegmatites or binary granites are in all stages of decay; but their slopes are nearly all equally sterile. At 4.20 the train reached Ahtoor; and after a ride of nearly two miles through nearly level country, very richly covered with tall brushwood, thickly studded with a great variety of trees, all of a few years' growth, the village of Ahtoor was reached. In the vicinity of the village large patches of the jungle had been cleared for the cultivation of castor oil, horse gram, sesamum, and earth or ground nut (*Arachis hypogæa*), from which a fine white oil is made. The castor-oil plant seemed very luxuriant, attaining a height of ten or twelve feet in some fields, while much that had been seen in the plains near Vellore was only three or four feet in height. In one field, a little beyond the village, along with the castor oil, there was cultivated a great deal of the cockscomb, or love-lies-bleeding, and of a begonia, used by the natives as a vegetable like rhubarb, and attaining a height of four to six feet. At five o'clock the foot of the ghaut was reached, and for about a mile the ascent was very easy, being through bamboo jungle, interspersed here and there with very fine straight tall trees, chiefly of the bombax or silk cotton, and *Eugenia jambolana,* with here and there a young promising teak (*Tectona grandis*), Pterocarpus, Cassia, or Euphorbia, the letter growing to the dimensions of a good large tree. Many of the trees were overhung with very picturesque creepers in great luxuriance, but most of them had passed into seed; amongst these were the Cryptostegia, which yields one of the finest India-rubbers, a very strong fibre from the bark, equal to that of the Yercum or to English flax, and a strong and feathery silk cotton around the seed. Among the other creepers were varieties of Convolvulus and Ipomœa, some, like the moon-creeper, attaining a gigantic size, and towering up to great heights, and dangling gracefully in festoons or wavy lines nearly vertically for twenty or thirty feet overhead. For about half a mile the bamboo jungle becomes very dense, and the stems attain a thickness of five or six inches. The trees diminish in number, as well as change in their character, being apparently harder, with their wood more knotted and gnarled. *Dalbergia latifolia* and *D. sissoides*, and a tree very like the true mahogany or Swietenia, were seen; this we believe to be a Cedrela, like the Toon-wood of Bengal. The *Pterocarpus santalinus,* a good red wood, here attains a considerable size. The road now became more steep, tortuous, and difficult. I stopped to admire the scenery and the gorgeous sunset. Below was the level, long expanse of country terminating in the Mysore ranges of hills, with here and there a little streak of water; and, as I afterwards learned, the river Cauvery can be seen in the distance. As the ascent for the last half mile had been rather steep, I dismounted and walked up to ease the pony; but I was soon warned by the attendants that it was only half way, and that we must push on as quickly as possible. For the next half mile the scenery became very varied and bold, from the winding nature of the road, and the large bare rocks piled one above another in the bed of the stream below. About eight o'clock I reached the welcome bungalow, and highest house on the Green Hills.

2. *On the Institution of Government Gardens at Travancore, Southern India.* By J. B. Maltby, Esq., President, Travancore.

His Highness, the Rajah of Travancore, having liberally sanctioned the application of large sums towards the establishment of a public garden or gardens for the introduction into his kingdom of useful and ornamental plants, I proceed to state the manner in which I think that the object sought may be best advanced. The site selected for the principal garden is at Peermade, or rather at a new station named Maryville, a place which appears to be admirably suited for the purpose. It is at an elevation of about 3300 feet above the sea, and enjoys a temperate climate. It is on the line of the high road about to be constructed between Alleppy and Madura. There is every reason to hope that it is free from malaria, being exposed to the influence of the sea-breeze, and experience up to the present time bears out this expectation. The ground is undulating and the soil varied; forests and grass plains alternate with one another.

The thermometer (December) falls to 58 in the morning and rises to 73 under shelter at 2 P.M. The rainfall is not accurately known, but is probably about 100 to 125 inches. But the advantage of the site will be more apparent if the objects which chiefly call for attention at the present time are considered. These are, 1. Cinchona; 2. Tea; 3. Coffee; 4. Cotton; 5. Vanilla. The cinchona is of so much importance, that the garden may be viewed as formed to aid in the introduction into the mountainous country of Travancore of this invaluable tree, and the other objects may be considered as subordinate to this.

3. *On the Cultivation of Cotton in Mysore.* By C. B. SAUNDERS, Esq., Officiating Commissioner for the government of the territories of his Highness the Maharajah of Mysore to the Secretary to the Government of India, Foreign Department, Fort-William.

When the subject of an increased supply of cotton became one of more than usual importance, I made many inquiries regarding the cultivation of cotton in Mysore, and learned not only that several of the talooks in the northern parts of Mysore still continue to produce considerable quantities of indigenous cotton, but that the New Orleans plant, when tried on a former occasion, by order of the late commissioner, had produced a very superior staple, specially commended by the jury of the Great Exhibition of 1851. I also ascertained that the experiment of cultivating it had been abandoned solely because, when the native gin was ascertained to be unequal to the task of cleaning New Orleans cotton, Sir M. Cubbon found that it would not pay Government to maintain an establishment for purchasing and cleaning the quantity then produced. The Mysore government, on the occasion referred to, monopolised the crop obtained from the New Orleans seed at a fixed rate, and itself became the exporter or sole agent. Bearing in mind the necessity for holding out every fair inducement to the ryots to cultivate more extensively the superior plant, without deviating from the instructions of government, which prohibit all direct interference with the cultivation or sale of cotton, I felt that the practice formerly pursued was inadmissible. But having ascertained, beyond a doubt, that certain large belts of land in the northern and central talooks were highly favourable to the cotton plant, I decided upon at once initiating indirect means of assistance, which I have every hope will encourage the cultivators of Mysore, and will, by stimulating them to increased exertions, lead to the production, in 1862–63, of a cotton crop of superior quality in many parts of the province. I have, in the first place, made arrangements for obtaining from Dharwar a large supply of the best seed of the New Orleans plant, which will be sold to the ryots at cost price. *Secondly*, I have, through the superintendents of districts, notified to the ryots of cotton-growing talooks, that any waste land taken up for the cultivation of New Orleans or Egyptian plants will be given on half assessment for five years, and that gins will be provided for cleaning the same, at a fixed rate per candy, in one or more of the principal places in each talook. *Thirdly*, As it has been found that the great drawback to the cultivation in Mysore of the New Orleans or other foreign plant is the difficulty of cleaning it with the rough native machinery of this country, I have secured, as a temporary measure for the construction of saw gins, the services of a Mr W. Davis, who was for many years employed by a Bombay house as an agent for purchasing cotton, &c. in the Dharwar country.

4. *On some of the Fibrous Plants of Madras.* By Dr ALEX. HUNTER.

At a meeting of the Agri-Horticultural Society of Madras, on 15th January 1862, Dr Hunter laid on the table samples of the cleaned fibres of the *Sanseviera cylindrica* introduced into the Society's garden by Sir Charles Trevelyan, from cuttings furnished by Sir William Hooker, which are thriving well in Madras, also fibres of the *Sanseviera zeytanica*, brought down last year by Mr Brown from the Naggery Hills, and cultivated in the garden; also cleaned fibres of the Manilla Plantain, *Musa textilis*, introduced by Lord Harris and Colonel Balfour. These all come under the class of Nars or coarse fibres for cordage and carpet-making. They are all very clean and fit for taking dyes, and possess considerable strength and gloss; but the Manilla Plantain does not yield the silky-looking fibre that is produced by the garden Plantain, *Musa paradisaica* of India. This fibre is now coming into use for making carriage braid, and hearth-rugs, and is nearly as glossy as silk when it is properly cleaned. Mr Whytock of Edinburgh imports it largely for these manufactures from Bengal. Samples of the Madras Plantain fibre are being carefully prepared for the London Exhibition. Dr Hunter also laid on the table the cleaned fibres of the Yercum bark, *Calatropis gigantea*, or Bowstring hemp of India—one of the strongest fibres known. It possesses most of the qualities of flax, and can be worked with the same machinery, as the fibre splits to almost any degree of fineness with the hackle, and bears dressing and beating well. For many years this fibre was employed by the wealthy natives for making strong cloths, cambrics, and lawns worn by the Rajahs, and it is still employed for making fishing-lines, nets, gins, bow strings, and tiger-traps, on account of its strength. It does not rot readily in water, as the resinous milky-juice of the plant seems to preserve it. The silk cotton from the pod of the same plant was also exhibited. This is also becoming an article of export from India, for the manufacture of a light substitute for flannel; it has been employed by Messrs Thresher and Glenine, of London, for this and other manufactures. It works well with either silk or cotton, and is known now in commerce as Mudar silk cotton.

5. *On the Cultivation of Cinchona in Java.* By ALEXANDER FRASER, Esq., Consul at Batavia. Communicated by ALEXANDER THOMSON, Esq. of Banchory.

The cultivation of the Cinchona plant in Java is still in a state of experiment, and requires scientific management. The conduct of the experiment has been entrusted to the care of Dr D. F. Junghun, a scientific gentleman of considerable eminence; and it is the intention of the Government to leave it under his superintendence until the cultivation shall be considered as quite successful—*i.e.*, when the present trees are large and old enough to be barked, and the propagation no longer requires scientific supervision. Dr Junghun is assisted in the management by Dr J. E. de Vry, a chemist of some eminence, whose special duty it is to apply chemical tests from time to time to the barks of the Cinchona to ascertain their intrinsic value. To these officials is attached the following staff of overseers and labourers, whose duties, as well as those of Dr Junghun, the superintendent, are laid down in a printed memorandum of instructions. The whole present permanent annual outlay may be stated as follows:—Salary of superintendent, L.1250; salary of chemical assistant, L.1000; allowances for house rent, L.200; European overseers, L.725; native overseers and labourers, L.81. Total, L.3256.

On the 31st December 1860, the state of the Cinchona plantations in Java was as follows:—*Cinchona Calysaya*—seeds in germination, 264; young plants in the beddings and germinating sheds, 5510; plants and trees planted out, 1806. *C. lucumæfolia*—Seeds in stock, 700,000; do. in germination, 533,396; young plants in the beddings, 349,700; plants and trees planted out, 56,686; *C. succirubra* (red Cinchona)—Young plants in the nursery shed, 13, planted out 14. *C. lancifolia* (yellow Cinchona)—Young plants in the nursery shed, 38; do. planted out, 42. Besides the above, there was then a supply in the nurseries of 1030 live cuttings of Calisaya, 8 do. of succirubra, 28 do lancifolia, 10 lanceolata. The extreme height attained by the trees at the same period (31st Dec. 1860) was *C. Calisaya*, 15 feet 8 inches English measurement; *C. lucumæfolia*, 25 feet 8 inches; *C. succirubra*, 8 feet 8 inches; *C. lancifolia*, 15 feet 2 inches; *C. lanceolata*, 13 feet. The ultimate success of the Cinchona experiment in Java would seem mainly to depend upon the question (which time only will solve), whether a supply of seed shall continue to be obtained from the *Calisaya* and *succirubra*? The *other* sorts contain less *quinine*, and it is specially maintained that the *lucumæfolia* is a species producing very little quinine.

Mr John Dawson, Alloa, sent specimens of a beetle (*Rhagium bifasciatum*), the larvæ of which are destroying the Scottish fir trees in various parts of the country. Mr Dawson also sent a specimen of a diseased state of silver fir, accompanied by the following note:—" A piece of bark of silver fir, infested by some sort of insect or fungus. The disease may be common enough, but is new here, and has made a good deal of noise in the quarter. A great many trees (silver firs alone) are affected by it, and their growth injured or destroyed. Cutting down and burning the trees are the remedial means employed" Mr W. R. M'Nab, who had examined the specimen, reported it to be a species of Coccus, and allied to *Coccus fagi*. The insect is of a dark red colour, oval in shape, and very small. When the contents of its body are squeezed out, a red molecular fluid appears to fill up the cavity, which in a few minutes assumes a green colour when exposed to the air.

Mr William Gorrie exhibited a flower and foliage of *Rhododendron Nuttalli*, from the greenhouse of Messrs P. Lawson & Sons, Golden Acre. The plant, which is at present in full flower, is about 8 feet high, and bears three umbellate heads, each composed of eight flowers, which measure 5 inches in width by about 5 in depth.

Dr Macgowan exhibited and presented to the Museum a Japanese broom made of bamboo and the fibres of *Chamærops Fortuni*.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

The Economic Animals of Australia.—On the 28th of October last, Dr George Bennet delivered in Sydney a lecture on Acclimatisation, in which he gave a full account of what has been done in Europe in this department, and suggested what ought to be immediately attempted in Australia. As part of a general survey of the entire subject, he gave the following account of the native quadrupeds and birds of that country, as deserving the attention of the Acclimatisation Society which is now being formed there:—

" The attention of this Society will also be directed to the rearing and domesticating the animals of this country, and to preserve them from destruction. Among the mammals we have the kangaroo of different genera, some of enormous size, and others very diminutive, displaying a variety of colours—blue, red, grey, black, tawny, brown, mottled, &c.

The native sloth, or koala, often called by the colonists native bear (*Phascolarctus cinereus*), the wombat (*Phascolomys wombat*), the opossum (*Phalangista vulpina*), the bandicoot (*Perameles nasuta*), and others, all forming good food; and although the flesh of the kangaroo is said to be dry, I have no doubt it could be improved by being fed on succulent grasses and other suitable food; but it must be acknowledged that kangaroo-tail soup is not to be surpassed. Wombat is rarely to be met with, but when procured, its flesh is always regarded as a great treat. The lively night animal, the bandicoot, is, when cooked, only to be compared to sucking-pig in flavour. The opossum is good also, especially when curried or stewed; but the monitor lizard, or guana, if one could overcome the repugnance of its appearance, is delicate and excellent food. Among the birds we have numbers available for the table. The talegalla, or brush-turkey, is excellent, the legs being regarded as the epicure's portion, and the eggs are delicious. The large bustard, the wonga wonga, and bronze-wing pigeons, variety of ducks, curlew, teal, redbills, the megapodius, and a number of others, form excellent articles of food for the table.

"Owen says, when comparing the Australian animals with those in other parts of the world, that the Dasyuri, or native cats, play the part of the foxes and martens; the Perameles, or bandicoots, of the hedgehogs and shrews; the Phalangers, or flying squirrels, and the Koalas, or native bears, of the squirrels and monkeys; the wombats of the beavers, and the kangaroos of the deer tribe.

"When acclimatising animals foreign to the soil, I have before mentioned that endeavours should, by domestication, be made to preserve the mammals and birds indigenous to Australia from extermination, as they will prove valuable to us not only for food and ornament, but also as a medium of exchange with other countries; for Australia is rich in zoology. In the intertropical regions, we find, besides the Eucalypti or gum-trees, Banksias, and other trees of the southern coast, dense forests of canes, mangroves, &c. Each of these districts has a zoology peculiarly its own. For instance, the Banksias are everywhere tenanted by true honey-eating birds: the Eucalypti, or gum-trees, by the Tricholossi, or honey-eating parrots, and Ptiloti, another group of the honey-eaters; the towering fig-trees by the regent and satin-birds; the palms by the Carpophagæ, or fruit-eating pigeons; and the grassy plains by the ground pigeons and grass parrokeets. The circumstance of the boles of the trees in this country being destitute of a thick corrugated rind or bark will doubtless account for the total absence of any member of the genus Picus, or woodpecker, a group of birds found in all parts of the world, with the exception of Australia and Polynesia.

"The birds represent many of the types found in Europe; yet the Australian continent possesses genera exclusively its own, many of which are nocturnal—probably more in proportion than are to be found in any other country; and a remarkable feature connected with Australian ornithology, is that of its comprising several forms endowed with the power of sustaining and enjoying life without a supply of water, that element without which most creatures languish and die. Many of the Australian birds also display an extraordinary fecundity, breeding three or four times in a season, but laying fewer eggs in the early spring, when insect life is less developed, and a greater number later in the season, when the supply of insect food has become more abundant. One bird, the black swan, is as prolific in England as in its native country, producing four broods in one year, and proves a very profitable bird to the owner. So well has this Australian bird been acclimatised in England, that during my recent visit to that country, Mr Wolf, the celebrated animal artist, had visited Mr Gurney's residence in the country, at that gentleman's request, to make a drawing of one rearing its brood in the winter, in the midst of the snow—which drawing I had an opportunity of seeing—and it displayed the old bird, with its sooty plumaged young, nestled near the banks of an icy river, their dark plumage contrasting with the whiteness of the snow around them.

"In Australia the parrots are a numerous family, forming four large groups. The large cockatoos, such as the black cockatoos, who procure their food of grubs, &c., from the Banksias, Casuarinas, or Eucalyptuses; the Cacatuæ, such as the rose and crimson-crested cockatoos, &c., feeding upon the bulbs of plants, more particularly the orchids; the honey-eating parrots (Trichoglossi), with their feathered tongue and no gizzard, such as the blue mountain and other parrots, subsisting only upon the nectar extracted from the blossoms of the gum-trees and other flowering trees yielding honey; and the ground and grass parrokeets, as the lovely king rosehill, Adelaide parrots, lory, and others, living upon the seeds of various grasses which abound on the plains.

"In commencing the domestication of our indigenous birds, both useful and ornamental, we cannot select one more interesting than the satin bower-birds (*Ptilonorhynchus holosericeus*). They have succeeded, both in England and in this city, in being kept in a state of captivity, but have not yet built a nest, laid eggs, or reared their young; indeed, the nest and eggs of this bird is at present unknown. They are amusing, playful, and delightful mocking birds, imitating the notes of the various birds within hearing. The adult male satin bird has a glossy blue-black plumage, of satiny texture. The young males and females are of a dull green colour, which in the males becomes spotted with black, and they do not attain their full plumage for three and four, or even five years. The satin-bower birds are found in New South Wales, but the pink-necked or spotted bower-birds (*Chlamydera maculata*), whose habits are precisely similar, are found in Central, North-West, and Northern Australia. The bower constructed by these remarkable birds is perhaps the most extraordinary event in bird architecture, more especially as not being a nest for the young, but a playing place—a decorated ball-room, as it has been called—wherein the young couple flirt, and make love previous to entering upon connubial life. It is constructed with a consummate skill amusing to witness. They may be observed constructing their runs at all seasons of the year, and imitating, when at work, the notes of the various birds around. The bird is seen—from the remains of an old broom, or any twigs thrown into the aviary—to take a twig, place it firmly in the ground, slightly bent inward, the bower being left open at the top, and forming a run of an uncertain length. The ornamentation of this run is a source of constant solicitude to the birds; almost daily they make a fresh arrangement of bright-coloured feathers, shells, bleached bones, bits of coloured rags and other decorative materials, which they bring from long distances when in a wild state,—appropriating every ornament placed within their reach when in captivity.

" The various pigeons indigenous to the colony, such as the wonga wonga, harlequin, and other bronze-wings, are all delicious for eating; the first named has the flesh white, delicate, and of surpassing flavour. The large fruit-eating pigeons of the northern districts would also form a great acquisition. They are strictly arboreal in their habits, frequenting the lofty fig-trees and feeding upon the fruit, and their flesh is excellent eating. The beauty of their plumage would also render them an acquisition to the aviary. The brilliant rifle birds (allied to the creepers), of which there are three known species, two of large size, and the no less elegant regent birds, would be a great acquisition as ornamental birds.

" It would be well to impress upon the public in this colony the necessity of preserving birds to a certain extent, so as to fulfil what nature has ordained with infinite wisdom and care—the equalisation of the races, and of obtaining a knowledge of their habits and economy, which will be found valuable to man as regards his comfort, as well as affording him security against important depredations. Many, regardless of this, are continually destroying useful animals, and thereby permit those of a noxious kind to increase. In October 1856, the territory of New South Wales suffered severely from the devastation occasioned by aphides, and all the cruciferous vegetables, as cabbages, &c., were almost entirely destroyed by them throughout the colony, when many of the soft billed birds, ruthlessly killed or driven away, might have prevented the evil. Every endeavour should therefore be made to preserve our useful and ornamental indigenous birds and animals; for if the wholesale destruction of birds and their eggs proceed in the same ratio as at present—and the Acclimatisation Societies in Europe rear and preserve them—there is no doubt we shall have to import many of our valuable birds from Europe, for among many others the emu is becoming scarce in this country. In Tasmania it is extinct in a wild state. Birds have been found of such importance in Europe to the gardener and the agriculturist, that in the French Senate in June last, M. Bonjean read a report on four petitions praying that measures might be taken to preserve birds which destroy insects hurtful to agriculture. The report is an amusing essay upon insect-eating birds, their habits, anatomy, and species of food. It treats at length of the ravages of insects, and the importance to man of the objects they destroy. France, as well as other countries, is infested with thousands of species of insects, nearly all of which prey on what should serve the purposes of man. The first section of the report is headed, ' Importance of Birds to Agriculture.' It states that the wire-worm consumed L.160,000 worth of corn in one department alone, and was the cause of the three deficient harvests which preceded 1856. Out of 504 grains of colza gathered at hazard at Versailles, all but 296 had been rendered worthless by insects. The reduction of yield in oil was 32·8 per cent. In Germany, according to Latreille, the larva of a species of moth (*Phalæna-monacha*) consumed whole forests. In Eastern Prussia, three years ago, more than 24,000,000 cubic metres of fir had to be cut down because the trees were attacked by insects. Man is unable to cope with these destroyers of the produce of his labour. His eye is too dull to perceive, and his hand too slow to catch them.

Without the aid of birds he would be vanquished in the struggle. The commission excludes birds of prey, such as magpies, ravens, &c., with the exception of buzzards and rooks, from the benefit of its protection, because the buzzard consumes about 6000 mice yearly, and the rook an incalculable amount of white worms. Sparrows are restored, and their usefulness shown by reference to the fact, that when their destruction was attempted in Hungary winged insects increased so rapidly that rewards for the destruction of sparrows were suppressed, and given for bringing them back. Frederick the Great ordered the destruction of sparrows because they ate his cherries; but in two years' time he found his cherries and all other fruits consumed by caterpillars. In a sparrow's nest on a terrace in the Rue Vivienne were found the remains of 700 cockchafers. Owls and birds of that class, which agricultural ignorance pursues as birds of evil omen, ought to be welcomed. They are ten times more useful than the best cats, and not dangerous to the larder. The martens that were killed were found to have in their stomachs the remains of 543 insects. It recommended a prohibition of bird-nesting and destruction of eggs or young birds.

"The larger and typical gallinaceous birds are entirely wanting in Australia, being represented by birds whose mode of incubation indicates an inferiority of type, as the Megapodius (*Megapodius tumulus*), Leipoa or mallee bird of the Murray (*Leipoa occellata*), and the Talegalla or Brush turkey (*Talegalla Lathami*), all considered good eating, and by many considered, when young, and in the perfection of season, preferable to our European game. It is to the last bird, the brush-turkey, I shall now direct attention; it forms part of a great family of birds inhabiting Australia, New Guinea, the Celebes, and the Philippine Islands, and whose habits and economy differ from every other group of birds which now exist in the world. In their structure they are nearly allied to the gallinaceous birds. They do not incubate their eggs, and are consequently regarded by ornithologists as the lowest representatives of their class. The brush-turkey is now becoming acclimatised in England; the young are reared in the Zoological Gardens of London, and I hope that we shall soon see it forming its mound, and the young birds emerging from it, in or near Sydney; for, as I have before remarked, they are an excellent article of food, and are well worth rearing for the table. A very interesting account is given in the proceedings of the Zoological Society of London of the incubation of these interesting birds, and the production of the young; it also proves how easily they can be domesticated, and from their tameness, and the interest attached to them from their peculiar habits, may induce us to lose no time in making an early trial of them here. The pair of talegallas during the spring and summer of 1860 formed a large hatching mound, composed of leaves, grass, earth, and other material. Within this heap of warm fermenting gatherings the female deposited twenty eggs, with the small end downwards. The *time of laying*, the *interval of time between each egg*, and the period of *incubation*, are at present unknown.

"In the talegalla we seem to approach the reptilian character, not only in the form and general appearance of the eggs, but in the manner in which they are deposited, and the absence of care bestowed upon the young. I believe, with this exception, all birds feed or provide for their young, while, on the other hand, I am not aware any reptile is known to do so, and that all the reptiles that lay eggs leave them to hatch, and the young to provide for themselves,—their young, as in the talegalla, coming forth in a very perfect and well-developed condition, and being enabled to seek and obtain their food without the aid of the parents. It is for this reason, as I have before remarked, the family Megapodidæ are placed in the lowest form of birds.

"Another remarkable bird, native of New South Wales, is the *Menura superba*, 'lyre bird, or pheasant of the colonists.' For a long time this bird divided ornithologists as to the situation it should occupy in the natural system, and for upwards of fifty years from its discovery but little was known respecting its habits and economy. Having only external structure to guide them, it was placed amongst the gallinaceous birds. Notwithstanding its great size and extraordinary form of tail, in every other point it differs from the Gallinaceæ. It forms one of the Insessores or perching birds, and by one ornithologist, from its covered nest, it was placed among the wrens, but it is more correctly classed among the thrushes. The young are helpless and blind when hatched. It will be necessary to preserve these birds from extermination, especially the talegalla and that family; for they are now becoming scarce, and from the present wholesale destruction of the eggs and birds, they will soon be numbered with the extinct birds, as the Philip Island parrot, the gigantic New Zealand rail (*Notornis Mantellii*), and many others.

As fish is so necessary an article of food for all classes, being digestible and nourishing, an Acclimatisation Society should direct their attention to the introduction of new and valuable kinds, as well as preserving and increasing those already existing in our rivers, bays, and salt-water creeks—for fish fall an easier prey to man than the beasts and birds.

Artificial ponds, for the maintenance of fish, is a very early invention, and was even known among the ancient Egyptians. Vivaria among the ancients are mentioned by Columella, Varro, and Pliny, and fish were brought from a great distance; and an extraordinary fact is mentioned by Columella, that rivers and lakes were turned into natural vivaria, by carrying to, and depositing therein, not fish only, but the spawn of all such species as, though born at sea, are in the habit of penetrating some way up estuaries or streams. He speaks of the perfect success of the experiment in several rivers. Various kinds of fish have been and are still being introduced, by preserving the ova, into different waters of England and on the Continent, in localities where previously they had no existence; they have succeeded well, and where congenial food is plentiful, the result is perfectly satisfactory.

The Australian blacks on the coast are expert fishermen; and Mr Edward Mill, who possesses much information on the subject, informs me that when the beautiful waratah or native tulip blooms, it is a well-known sign to these children of nature that the sole (a rare fish to be seen in the Sydney market, but of excellent flavour) is very abundant on the sand banks about Botany Bay and in the vicinity of Cook's River, where they may be captured at early dawn, before the ripple comes upon the water. According also to the flowering season of other trees and shrubs, the blacks know the season when the mullet, schnapper, Port Jackson shark (Cestracion), or other fish, are plentiful in the bays or harbours of the coast.

One of the first acts of the Acclimatisation Society, when established, would be to introduce that fine and delicious fish of the perch tribe, called the Murray River Cod, and which has been introduced with perfect success in the Yarra, and lately in Lake George, by the honourable the Speaker, Mr Murray, in 1848. Suitable localities could also be found in the Nepean, Hawkesbury, and such rivers and lakes in the colony where it does not at present exist.

Sharks and other fish might be procured for their oils, both for economical and medicinal purposes,—and for the latter, might equal the cod liver oil, now imported in such large quantities. At present the Dugong oil is used as a substitute, an animal belonging to the mammalia, and is said to be beneficial to invalids afflicted with strumous disease ; but its virtue, except as a nutritious diet, is very questionable. It is a curious fact, that while we regard this and cod liver oil as new remedies in pulmonary diseases, that in 1790, Valliant, in his travels in Africa says :—" At the Cape the fat of the hippopotamus is thought so wholesome, that they affirm if it is taken in regular portions, *it will radically cure all disorders of the breast.*"

Sir Emerson Tennent, in his interesting volume on Ceylon, made mention of musical sounds said to arise from some of the lakes in the island. In his later published work, " Sketches of the Natural History of Ceylon," &c., where he has brought together his zoological and botanical observations, he again refers to the very curious subject of sounds given out by the mollusca, stating that the Indians believed the sounds alluded to were produced by the animal of a shell and not by any fish, and that those sent to search for the shells brought him specimens of a *Littorina* and *Cerithium*, the latter being *C. palustre*. Sir Emerson Tennent states also that similar sounds are heard at some places on the western coast of India, especially in the harbour of Bombay. At Caldera, in Chili, musical cadences are stated to issue from the sea near the landing place, and the same have been observed at Pascagonda, in the state of Mississippi, and in another river on the northern shore of the Gulf of Mexico. In a letter received lately from J. Hepburn, Esq., San Francisco, who has been travelling in Columbia and Vancouver's Island, the following observation occurs :—" A fact that I discovered, which greatly interested me, is the existence in Vancouver's Island of a singing fish (at least shell-fish), such as Sir E. Tennent met with in Ceylon. Some of my fishing friends, who had never heard of Sir E. Tennent's book, told me that at a certain arm of the sea running out of Victoria Harbour, they always heard a noise which they compared to the sound of a Chinese kite when flying, a sound well known to all inhabitants of San Francisco, and which is produced by fixing pieces of metal to the kite's tail. I went there and heard it several times, clearly proceeding from the water. The Indians are well acquainted with the noise, and say it proceeds from a stone-fish (shell-fish), and promised to get me some, which, however, they had not done up to the time of my leaving. When I return I will inquire further into it, though I do not know that I can establish anything further than that such an animal exists at the place where the sound is always heard. It is not likely that the Indians and the Cingalese should both attribute the sound to a similar cause, unless there is some foundation for it."

There is no doubt whatever that sounds are produced; and we trust that by calling attention to the facts as stated by Sir E. Tennent and Mr Hepburn, attention will be directed to the elucidation of the cause.

MISCELLANEOUS.

River Niger.—The Niger receives in its course numerous tributaries, flowing through regions abounding in interesting and valuable productions. It is affirmed that the tributaries, entering it within a distance of two leagues from where the river on which Timbuctoo is placed makes its junction, amount to thirty. For two hundred miles above this point, and below it to the neighbourhood of Rabba, the river is navigable for the largest canoes. Rabba, which is about 280 miles from our new possession, Lagos, across the Yoruba country, is also only eleven days' journey from Kano. Kano is the most southern and western large emporium for the European goods brought overland on camels above 2000 miles from Morocco and Tripoli. That part of the interior of Africa has still a large population, although much wasted by slave-trade wars; as not only have the Morocco and Tripoli caravans to be supplied with slaves for much of the value of the goods they have brought, but thousands are also sent through Rabba, for the foreign slave-trade of Dahomey, and for the supply of the native markets on the coast. The African-Aid Society has represented to the Government the necessity of stopping that horrible trade, and stimulating the industrial development of these rich districts, by establishing a consul at Rabba, with a gunboat at his command there, to give him additional weight and influence in arranging all disputes amongst the natives, and to enable him effectually to prohibit the slave-trade of Dahomey. From Egga, below Rabba, along the whole coast of the Niger upward, and even to Dahomey, that valuable shrub or tree, which produces the Shea butter, abounds. There can be no doubt that, if a proper stimulus be given, and if the natives felt that the establishments formed among them by Europeans at Egga and Rabba were permanent ones, the entire of that rich caravan trade, from Morocco and Tripoli to Kooka and Kano (and those caravans are often of from 2000 to 3000 camels each), would be diverted to the Niger route, by which goods from Europe may be conveyed at one-tenth of the cost by caravans from Tripoli. And it is almost equally certain, that, within a few years, Shea butter alone (which now costs about L.6 to L 8 a ton near Egga, and would fetch—for any quantity—in England L.40 a ton) would pay, every year, for hundreds of thousands of pounds' worth of Birmingham and Manchester goods. And when to Shea butter we add palm-oil, ground-nuts for oil, copal and other gums, ivory, ebony, indigo, other dyes, and dye-woods, cotton, coffee, chili pepper, ginger, arrowroot, wax, honey, India-rubber, saltpetre, antimony, gold, silver, copper, and other valuable commodities, it must be granted that there is a real Hesperides in the fields of the great Mississippi of Western Africa—the River Niger.—*Church Mis. Gleaner*, February 1862.

PUBLICATIONS RECEIVED.

1. Proceedings of the Literary and Philosophical Society of Manchester for February, March, and April 1862.—*From the Society.*

2. Journal of the Chemical Society for February, March, April, May, and June 1862.—*From the Society.*

3. The Canadian Naturalist and Geologist for February 1862.—*From the Editors.*

4. Proceedings of the Academy of Natural Sciences of Philadelphia. Pp. 145–556.—*From the Academy.*

5. Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. V. Part I.—*From the Academy.*

6. Bulletin de l'Academie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Nos. 1–4. Bruxelles, 1862.—*From the Academy.*

7. Volcanoes—the Character of their Phenomena, their Share in the Structure and Composition of the Surface of the Globe, and their Relation to its Internal Forces. By G. Poulett Scrope, M.P., F.R.S. 1862.—*From the Publishers.*

8. Project of a New System of Arithmetic, Weight, Measure, and Coins, proposed to be called the Zonal System. By John W. Mystrom, C.E. Philadelphia, 1862.—*From the Author.*

9. Annual Report of the Geological Survey of India. 1860–61.—*From Professor Oldham.*

10. Memoirs of the Geological Society of India. Vol. III.—*From Professor Oldham.*

11. Journal of the Asiatic Society of Bengal. No. 4. for 1861.—*From the Secretaries.*

12. Remarks on the Grounds of Faith, suggested by Mr Pattison's Essay on the Tendencies of Religious Thought. By C. Gooch, M.A., Fellow of St Mary Magdalen College.—*From the Author.*

13. The Colony of New South Wales; its Agricultural, Pastoral, and Mining Capabilities. Compiled by the Commissioners of the Colonial Government. With a Map of the Colony.—*From the Commissioners.*

14. On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the Good Effects of Intercrossing. By Charles Darwin, M.A., F.R.S.—*From the Publisher.*

15. The Student's Manual of Geology. By J. Beete Jukes, M.A., F.R.S. New Edition. 1862.—*From the Publishers.*

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On the Excess of Water in the Region of the Earth about New Zealand; its Causes and its Effects. By JAMES YATES, M.A., Fellow of the Royal, Linnean, and Geological Societies, Member of the Manchester Geological Society.

§ 1. *Question stated.*

In the earlier part of the last century, an idea prevailed that there must be a great continent about the South Pole, capable of balancing the large tract of dry land which surrounds the North Pole. James Cook and other navigators were sent on voyages of discovery to ascertain this fact; but nothing of the kind was brought to light, and no land has ever been discovered in sufficient mass to correspond with the great extent of land in the northern hemisphere. I propose to inquire whether the equipoise may not be found in another way, namely, under the surface of the earth. There is reason to believe that one half of the moon is heavier than the other half. In like manner, I think it probable that the half of the solid earth to which New Zealand belongs is heavier than the opposite hemisphere; and it will be my endeavour to explain the grounds of this supposition, and to follow it into its consequences.

§ 2. *Distinction between Land and Water Hemispheres.*

Geographers were formerly satisfied with the observation, that the ocean is vastly more extensive about the South than about the North Pole. Recently they have stated the fact with much greater accuracy. Berghaus, in his Physical Atlas,* exhibits the earth divided into two hemispheres on this principle. One, called the Land Hemisphere, contains nearly all the dry land, whilst the other, called the Water Hemisphere, consists almost entirely of water. The centre of the aqueous portion is marked by the meridian of 170° west longitude from Paris, where it intersects the parallel of 40° south latitude.

§ 3. *Shown on a Terrestrial Globe.*

The same fact may be easily rendered manifest by taking a terrestrial globe, and turning it so that the point just described may be in its zenith. It will then be seen that the hemisphere placed above the wooden horizon is almost entirely water. It will contain no portion of "the four quarters of the globe," except the extremities of South America, and of the Malay Peninsula. New Holland occupies a large space, and the ocean is studded with innumerable islands, the largest of which are, Japan, New Guinea, Sumatra, Java, Borneo, Celebes, and New Zealand. We also observe the borders of land of unknown extent in the direction of the South Pole, called South Victoria, Enderby's Land, and by other names.

§ 4. *Height of Mountains in Land and Water Hemispheres.*

The mountains rise to a far greater elevation above the surrounding seas in the Land or European, than in the Water or New Zealand hemisphere. This will appear from the subjoined tables. The first contains the heights of ten conspicuous mountains in the land hemisphere, chosen as much as possible from remote parts of that hemisphere; the second includes ten mountains, chosen in like manner from remote parts of the water hemisphere, and equally remarkable for their superior elevation. The two columns being added up, the amounts show at a glance the comparative average eleva-

* Physikalischer Atlas, Gotha, 1ter Band, 3te Abtheilung, "Erdkarte zur Übersicht der Vertheilung des starren und flussigen." A similar map on a much smaller scale may be seen in Petermann's Atlas, Nos. 1 and 2; Stieler's Hand-Atlas, No. 8; Keith Johnston's School Physical Atlas, No. 2; The Earth and Man, by Guyot, London (Parker), 1857, p. 14; Lyell's "Principles of Geology," 1853, p. 110.

tion of the two sets of mountains—viz., 5524 metres for the one, and 3604 for the other.

I. *Mountains in the Land Hemisphere.*

	Metres.	
Deodunga, Himalaya, . . .	8748	
Acancagua, Chili, . . .	7314	
Kilimanjaro, Equatorial Africa, . .	6095	
Elbrouz, Caucasus, . . .	5646	
Popocatepetl, Mexico, . . .	5400	
Mount St Elias, Rocky Mountains, .	5113	
Mont Blanc, Europe, . . .	4810	
Klieutschewsk, Kamtschatka, . .	4804	
Teneriffe, Atlantic Ocean, . .	3710	
Wrangell's Volcano, Coppermine River, .	3600	
		55,240

II. *Mountains in the Water Hemisphere.*

	Metres.	
Singalang, Sumatra, . . .	4570	
Mowna Kia, Sandwich Islands, . .	4252	
Mount Terror, South Victoria, . .	4232	
Tobreonow, Otaheite, . . .	3725	
Semeru Gunong, Java, . . .	3720	
Fusi-no-yama, Japan, . . .	3710	
Alaid, Kurile Islands, . . .	3648	
Mount Ambotismene, Madagascar, .	3507	
Mount Egmont, New Zealand, . .	2700	
Mount Kosciusko, Australia, . .	1976	
		36,040
Difference in average height .		19200

§ 5. *Comparative Areas of Land and Water.*

In addition to the two principal facts which I have now stated, viz., the great excess of water in the region around New Zealand, and the greater elevation of the mountains in the opposite hemisphere, geographers have also endeavoured to make an accurate comparison between the extent of the earth's surface covered with water, and the surface which is left dry.

Professor Rigaud of Oxford made the computation in the following manner:—He obtained from a map and globe-maker in London a set of the gores which are used to make a terrestrial globe. He cut out all the continents and islands, and weighed them. He then weighed in like manner all the waters, having taken care that the two sets of papers were equally free from moisture.* The weights of the two parcels gave the relative quantities of land and water, which appeared to be in the proportion of 100 to 270. Professor Link of Berlin, on the other hand, estimates the whole surface of the earth at 9,282,060 square German miles, and the dry land at 2,380,000.† According to this statement, the dry land is to the water as 100 to 289. Humboldt makes the proportion as 100 to 280.‡

Soon after the appearance of Rigaud's memoir, Mr William Hughes, an eminent Professor of Geography in London, pursued the investigation in a totally independent manner. He divided the surface of the terraqueous globe into 180 zones, each covering one degree of latitude, and he constructed a table, which showed the area of each zone in succession from the equator to the poles. He then obtained copies of the largest and best maps, and, taking each zone separately, he measured with extreme care the land and water. The result in English square miles was as follows:—

Land, 51,448,594·743; Water, 145,413,160·256.

"The close agreement of these calculations," says Mr Hughes, "with the results arrived at by Professor Rigaud, through an entirely different mode of investigation, affords a strong confirmation of their general correctness." §

The last published computation is 51 to 146, equivalent to 100 to 286, in which the author, Sir John Herschel, has provided for "the recently discovered tracts of land in the vicinity of the poles."‖ In 1838, Berghaus gave the entire surface of the ocean = 6,636,800 square German miles, and the land = 2,423,700. This would be in the proportion of 100 to 273.¶

* Transactions of Cambridge Philosophical Society, vol. vi. part 2, A.D. 1837, p. 297.

† Physikalische Erdebeschreibung, I. (Berlin, 1826), p. 116.

‡ Cosmos, Mrs Sabine's Translation, I. (London, 1846), p. 279.

§ Hughes's Principles of Mathematical Geography (London, 1843), pp. 125–128.

‖ Physical Geography (London, 1861), p. 19.

¶ Physikalischer Atlas, *l.c.*

But in his *Grundriss der Geographie*, Breslau, 1843 (p. 119), he assigns 261 : 739 = 100 : 283, as the result of the most careful inquiries; and in a still more recent work, *Was man von der Erde weiss* (Berlin, 1856), he informs us, that at the suggestion of Humboldt he had examined the subject again, and in consequence of Sir James Ross's discoveries within the Antarctic Circle, and of the discovery of islands to the north of America, he had fixed the proportion at 281 : 719, taking 20 from the sea to give it to the land. The result of this is land 100, water 256. Thus, if the land be estimated at 100, the water will certainly be somewhere between 256, the lowest estimate, and 289, the highest; and it will be of use to observe, that these numbers are respectively the squares of 16 and 17, 100 being the square of 10.

§ 6. *Answers to the question by Forster, Peterman, Herschel.*

As the determination of the proportion of land to water was the chief object of Cook's second voyage, it necessarily engaged the attention of his companions, and especially of the celebrated John Reinhold Forster, who was appointed to the office of Naturalist to the expedition. Accordingly, in his volume of "Observations made during a Voyage round the World" (London, 1778), chap. ii. sec. iii. p. 68, he states that they had not been able to discover land "sufficient to counterpoise the lands of the Northern Hemisphere;" and adds, "I am therefore apt to suspect that nature has provided against this defect by placing, perhaps at the bottom of the Southern Ocean, such bodies as, by their specific weight, will compensate the deficiency of lands; if this system of the wanted counterpoise be at all necessary. But there may, perhaps, be other methods to obviate this defect, of which our narrow knowledge and experience have not yet informed us."

Forster's idea of a counterpoise at the bottom of the Southern Ocean does not appear to have attracted the least notice. On the contrary, those who have attempted a solution of the problem seem to have directed their attention entirely to the opposite hemisphere, and have had recourse to the action of internal forces, which are supposed to have raised the continents above the sea-level in the Land Hemisphere. Mr

Peterman says, in his "Atlas of Physical Geography" (Orr and Co., Amen Corner, 1850), "The preponderance of land in the northern hemisphere indicates the superior intensity of the causes of elevation in northern latitudes at a remote geological epoch."

Sir John Herschel gives the following solution, which appears to be not essentially different from Peterman's, except that "tumefaction" may denote geological energy in action at the present time. "The fact of the existence of two hemispheres," the one chiefly land, the other almost entirely water, in the words of this author, "proves the force by which the continents are sustained to be one of *tumefaction*, inasmuch as it indicates a situation of the centre of gravity of the total mass of the earth somewhat eccentric relatively to that of the general figure of the external surface, the eccentricity lying in the direction of our antipodes, and is therefore a proof of the comparative lightness of the materials of the terrestrial hemisphere."*

§ 7. "*Tumefaction*" *Theory insufficient.*

It appears to me that this theory, though partly true, is not entirely supported by facts, and does not reach the requirements of the case. Confining ourselves to Europe, we know that, if the coast of Sweden has been gradually rising by the swelling of substances beneath it, the coasts of Holland, Belgium, the north of France, and the opposite coasts of England, have been sinking. The Temple of Serapis at Puzzuoli is a well-known instance of the land rising and falling within a brief space of time. Thus the intumescence of some regions is balanced by the subsidence of others. But another mass of facts is furnished by Herschel himself in answer to his own theory. The passage which I have quoted is near the beginning of his highly valuable and interesting work, and at the end of the same volume he gives a "Table of the Heights of Mountains," classing them according to the usual great divisions of the earth, and distinguishing those which are now

* Physical Geography (Edinburgh, 1861), § 13. See also § 132, where this author supposes a "general substratum of liquified matter" to support the solid crust of the earth.

active volcanoes. From this list we learn that out of 465 mountains in the Land Hemisphere, 62 are volcanic, being rather more than one-seventh; whereas, in the Water Hemisphere, 66 in 109, or more than one-half, are active volcanoes. It is also important to observe, and Sir John Herschel bears witness to the fact (p. 254), that earthquakes are no less frequent and violent in the Water than in the Land Hemisphere. If, then, earthquakes and volcanoes are evidences of the "superior intensity of the causes of elevation," this cannot be the true explanation, for they abound in the one hemisphere, at least, as much as in the other. The only visible difference between the two hemispheres is, that the mountains are much higher, and the tracts of dry ground much more extended in the Land than in the Water Hemisphere. I must not be supposed to deny the existence of "tumefaction," or its great importance in explaining the present configuration of the earth. I shall hereafter (§ 20) have occasion to show when and how it plays its part. But at present I wish rather to take the existing facts, so far as they are known to us, and to use them as the basis of our reasoning. Not only are the ocean and the atmosphere subject to continual fluctuation, but the external covering of the earth is, to a certain extent, pliant and flexible. Mr Babbage has shown that its expansion by heat may sensibly change its elevation.* Also the portions now submerged cannot but have been dry ground in former geological epochs; otherwise it is impossible to account for the phenomena of the sedimentary rocks. Elevations and depressions have always been going on, and must be attributed to the agency of expansive forces, which act from below upwards, expel great quantities of vapour, and leave behind hollows and cavities filled with water.

§ 8. *Solution attempted by Aid of a Diagram.*

To assist in arriving at a true solution of the problem before us, I shall now refer to a diagram constructed, as all diagrams are, to aid our conceptions and reasonings.

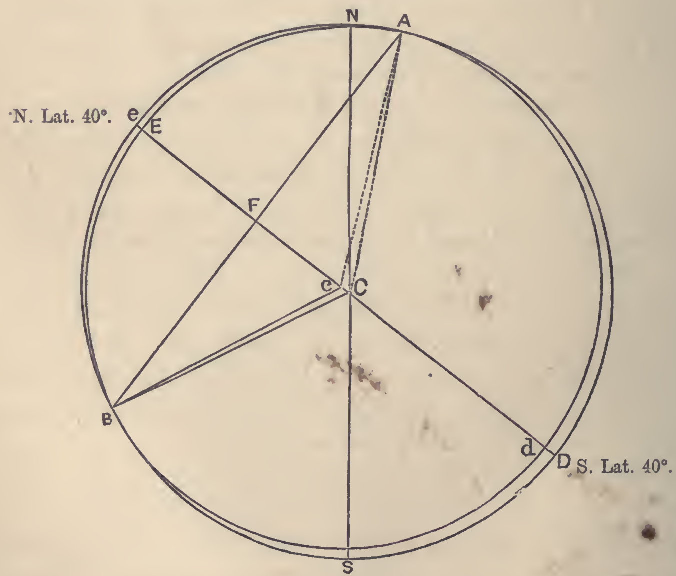
This diagram must be supposed to represent a section of the

* Proceedings of the Geological Society, vol. ii., March 1834, pp. 74–76, and Ninth Bridgewater Treatise, pp. 209–216; Lyell, p. 562.

earth through the meridian of New Zealand, and to show the ocean partly encompassing the earth, the atmosphere surrounding the whole, but not represented. The letters N and S denote the North and South Poles at the extremities of the axis of the earth. The point C, which bisects the axis, is assumed to be the geometrical centre of the surrounding atmosphere, it being pre-supposed that both the atmosphere and the earth are spherical. It is not attempted to represent the earth's ellipticity, because, in the first place, its amount is not known; secondly, if it were known, it is too small to be represented on a diagram; and, thirdly, no regard need be paid to it with a view to the correctness of the conclusions at which I aim in the following memoir.

Ideal Section of the Earth in the Meridian of New Zealand.

The space ADB, is the ocean; the space on the other side of the chord AB, is the dry land, drawn from c as a centre, with radius cB.



NCS = Axis of rotation.

C = Mathematical centre of the atmosphere and of the ocean, and centre of gravity of the atmosphere and terraqueous globe.

c = Mathematical centre of the solid earth.

Table of Dimensions, with reference to the Ideal Section of the Terraqueous Globe.

1 English foot = ·30479449 metre.

AEBD, circumference of the terraqueous globe, 360°, 4000 myriametres, or 40,000 kilometres, or 40,000,000 metres = 21,600 geographical miles of 60 to a degree = 21,600 minutes of a degree ∴ 1 geographical mile, or minute of a degree = 1852 metres nearly.

DE, diameter of the same, $\frac{40{,}000{,}000}{3{\cdot}14159265}$, = 12,732,396 metres.

DC, AC, EC, semi-diameter or radius of the same, = 6,366,198 metres.

Dd, greatest general depth of the ocean, being about 1920 metres, or $\frac{1}{6631}$ of DE, the earth's diameter (see below, § 13).

Ee, greatest general elevation of continents above the sea-level, being about 600 metres, or $\frac{1}{21{,}220}$ of DE, the earth's diameter (see below, §§ 14–17).

Arc AEB, being 125° nearly, = 7500 geographical miles, or about 1380 myriametres (§§ 9–14).

Arc AE, being 62°30′ nearly, = 3750 geographical miles, or about 6900 kilometres.

Cc, eccentricity of the earth's centre of gravity, 1260 metres (§ 16).

Diameter DE, divided at the point F in the proportion of 109 to 40, or of 9,314,303 metres to 3,418,093 metres (§ 15).

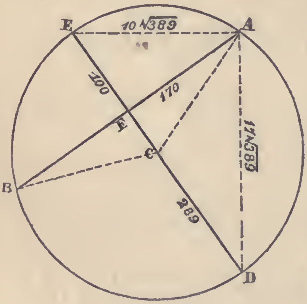
Besides the axis another diameter bisects the circle, being drawn from the point D, which is 40° from the equator; in other words, it is drawn from the point where the meridian of New Zealand intersects the parallel of 40° south latitude. I believe that, in fixing this point, Berghaus had the advice and co-operation of two of his fellow-citizens who were indisputably pre-eminent as physical geographers, Alexander von Humboldt and Karl Ritter.

Having chosen this diameter, DE, in conformity with Berghaus's computation, I suppose the ocean to extend to an equal distance on every side of it, and to thin off towards the chord AB, corresponding to the circle on the earth's surface, which would be the boundary of the ocean, if it were all collected into one uniform mass of water, instead of being ramified and distributed into oceans, seas, bays, and straits.*

§. 9. *Determination of the points* A, B, *in the Diagram.*

The determination of this chord AB is important, and may be made with sufficient accuracy for the purpose of the present inquiry, on the grounds that I have already assumed in treating of the relative quantities of dry land and water.

Reasoning from the facts, that the surface of a sphere is equal to the surface of a hollow cylinder whose height and diameter are equal to the diameter of the sphere, and that the surface of any segment or zone of the sphere, intercepted between parallels perpendicular to the axis, is equal to the surface of the cylinder intercepted between the same parallels,† we may divide the diameter DE into two parts in the proportion of 100 to 289,256, or any intermediate number, and through the point of division F draw a perpendicular cutting the circle in the points A, B. The segment of the terraqueous globe, corresponding to AEB, will then be to the other segment in the proportion of EF to FD.



Or we may compute as follows :—

* According to some writers on physical geography, the centres of the land and water hemispheres are much nearer to the poles than 40°. Professor Ansted (Manual of Geographical Science, London, 1852, p. 216) says, "If an observer were stationed vertically above a point in England not far from the Land's End in Cornwall, and could thence see one-half of the globe, he would have before him almost all the land, while, on the other side, would be scarcely anything but a few islands and a portion of Australia and Patagonia visible above the water." This opinion is supported by Sir John Herschel, "Phys. Geography," p. 14. Hence I am inclined to think that the points D, E, may be placed nearer the poles than I have supposed. If, instead of 40°, we place them at 45°, we may be as near the truth, and we may possibly obtain some facilities for our reasonings and computations. The general results cannot be affected by so small a difference.

† Hutton's Mensuration (Newcastle-on-Tyne, 1770), p. 193.

First, taking the proportion of 100 to 289.

To find chord AE.

$$AE^2 = EF^2 + FA^2. \quad \text{Euclid, B. I., 47.}$$
$$= EF^2 + EF \times FD. \quad \text{Euclid, B. III., 35.}$$
$$= (100)^2 + 100 \times 289.$$
$$= 100 \times 389$$
$$\therefore AE = 10\sqrt{389}.$$

In same way, $AD = 17\sqrt{389} \therefore AE : AD = 10 : 17.$

Again, arc AE : arc AD $= \angle \cdot ACE : \angle \cdot ACD.$ Euc. VI. 33.

$= \angle \cdot ADE : \angle \cdot AED.$ Euc. III. 20.

To find $\angle \cdot AED$.

$$\text{Tan.} \angle AED = \frac{170}{100} = 1{\cdot}7$$
$$\therefore \angle AED = 59^\circ\, 32' \text{ nearly.}$$
$$= 59\frac{8}{15}$$
$$\therefore \angle ADE = 90^\circ - AED = 30\frac{7^\circ}{15}$$
$$\therefore \angle ADE : \angle \cdot AED = 30\frac{7}{15} : 59\frac{8}{15}$$
$$= 457 : 893$$
$$\therefore \text{Arc AE} : \text{arc AD} = 457 : 893$$
$$= 10 \quad \frac{8930}{457}$$
$$= 10 : 19\frac{247}{457}$$
$$= 19\frac{1}{2} \text{ nearly.}$$
$$\angle ACE = 2 \cdot \angle ADE$$
$$\ldots \quad = 60\frac{14^\circ}{15} = 60^\circ\, 56' \text{ nearly.}$$

$\therefore$ Arc AEB subtends an angle $= 121^\circ\, 52'$ nearly,

and arc ADB ... $= 360^\circ - (121^\circ\, 52')$

... ... $= 238^\circ\, 8'$.

Secondly, taking the proportion of 100 to 256.

Let EF = 100, and FD = 256,

Then AF = 160,

$$\text{And tan.} \angle AEF = \frac{160}{100}$$
$$\ldots \quad \ldots \quad = 1{\cdot}6$$
$$\therefore \angle AED = 58^\circ \text{ nearly.}$$

(58° is a little in excess).

$$\therefore \angle \text{ADE} : \text{AED} = 32 : 58$$
$$\ldots \quad \ldots \quad = 16 : 29$$
$$\therefore \text{Arc AE} : \text{arc AD} = 16 : 29$$
$$\ldots \quad \ldots \quad = 10 : \frac{290}{16}$$
$$\ldots \quad \ldots \quad = 10 : 18\frac{1}{8}$$
$$\text{Hence } \angle \text{ACE} = 2 \angle \text{ADE}$$
$$\ldots \quad \ldots \quad = 64^\circ \text{ nearly.}$$
$$\therefore \text{Arc AEB subtends an angle} = 128^\circ \text{ nearly,}$$
$$\text{and arc ADB} \quad \ldots \quad = 360^\circ - 128^\circ$$
$$\ldots \quad \ldots \quad \ldots \quad = 232^\circ.$$

Having taken the two extreme cases of the greatest excess of water and the least, so far as they have been proved by observation, we may safely assume as the amount of our arc 125°, since this is as nearly as possible the middle between the two extremes. If we regard this as the diameter of the land hemisphere at the level of the sea, we cannot be far wrong, and we shall then be able to find the corresponding curve of the earth's surface in geographical miles and myriametres by the following proportions :—

Geographical miles.

360° : 125° :: 21,600 : 7500 geographical miles.

Myriametres.

360° : 125° :: 4,000 : $1388\frac{8}{9}$ myriametres.

§ 10. *Question may be solved in two ways.*

If we endeavour to show why there is so great an excess of water in the south-eastern hemisphere, we may account for the fact in two ways. Either we may suppose that the solid earth is lower in all that portion ; in other words, that a large mass is wanting to complete its sphericity, and that the space is occupied by water instead of earth ; or, *secondly*, we may suppose that the submerged hemisphere is heavier than the other, and attracts the water by its greater density and specific gravity. The first supposition is at variance with all the ideas hitherto received, and does not harmonise with what we know of the form of the other planets. I therefore think it unnecessary to dwell upon this hypothesis, and shall confine myself to the other.

§ 11. *Supposed greater Weight of the Land Hemisphere.*

The greater weight of the New Zealand hemisphere may arise from two causes; it may contain a greater proportion of igneous rocks and mineral veins, and the opposite hemisphere may contain a greater proportion of cavities filled with water.

From all we know of the crust of the earth, it is certain that its constituent parts are mingled together, and interposed without any constant rule or law as to their specific gravities. We may therefore regard it as indisputable, that the two hemispheres are of unequal weight. The only question is, which preponderates over the other, where the limits of the heavier portions are to be found, and what effects may be ascribed to them. It appears to me, therefore, that there cannot be the slightest objection to the assumption, that there is a greater abundance of mineral veins in that part of the earth which lies beneath New Zealand and the islands and seas surrounding it. Also beds of ironstone may be supposed to exist in superabundance throughout the same region, together with basaltic rocks and others of high specific gravity.*

On the other hand, the Land, or European hemisphere, besides the inferior specific gravity of its mineral constituents, including more especially beds of coal, may abound in depressions, or in cavities filled with water. It is generally supposed that the waters of the Atlantic occupy a great valley, which divides the Old from the New World, and extends from pole to pole. Its lowest depths have never been reached by soundings. According to Captain Maury,† "the greatest depths at which the bottom of the sea has been reached with the plummet are in the North Atlantic Ocean." But besides valleys, or hollows on the surface, we have reason to believe that this hemisphere contains numerous and extensive cavities beneath the surface. On the shore of one of the Ionian Isles, Cephalonia, is a considerable cascade of sea-water,

* See list of "Specific Gravities of Rocks," and deductions therefrom, in De la Beche's Geological Researches, pp. 74–78.

† Physical Geography of the Sea, § 701.

which, after turning a mill, pours itself in a constant stream into the bowels of the earth.* Springs of fresh water, on the other hand, rise from the bottom of the Mediterranean Sea in many places. The whole coast, from Cette in Languedoc to Ruad in Syria, may be said to be studded with these so-called "occhi."† In the Caribbean Sea, so great a volume of fresh water rises to the surface, that ships go there for a supply, and the manati (*Trichecus manatus*), an amphibious fresh-water mammal, frequents the same spot. By land, we have the mud-volcanoes of South America, the geysers of Iceland, with innumerable hot springs at Bath and other places, and the clouds of steam issuing from Etna, Vesuvius, and other vents. All these facts prove that whatever uncertainty there may be about the superabundance of heavy mineral masses on one side of the globe, there can be no denial of the existence of large and extensive cavities filled with water on the other. Hence, I assume as a fact, which, though not absolutely certain, is extremely probable, that the New Zealand half of the earth is heavier than the other half.

§ 12. *Centre of Gravity and Centre of Magnitude.*

This assumption makes it farther necessary to assume that the earth's centre of gravity differs from its centre of magnitude, and is situated in the diameter DE on the side of the centre of magnitude towards the part where the waters of the ocean are accumulated. It will be convenient to call the centre of magnitude c. Then let c be taken as the centre of a circle, which may represent the surface of the solid earth. It is evident that this will be a smaller circle than AEBD, the circle corresponding with the surface of the ocean; because, if the earth were perfectly spherical, as we suppose for our present purpose, and if the ocean were equally attracted on every side, it would form a sphere of water surrounding the earth,

* Proceedings of the Geological Society, vol. ii, pp. 220, 221, 393, 394.

† For particulars I refer to Fellows's "Lycia" (London, 1839), p. 184, and to my note on the passage, p. 336; also to Admiral Smyth's "Sicily," p. 171, and to his "Mediterranean" (London, 1854), pp. 140, 141. Leake, "Travels in the Morea," ii. p. 480.

and everywhere of equal depth. If therefore we take the supposed point c as a centre, and cA=cB as radius, we shall describe a circle falling within the surface of the ocean ADB, and extending beyond the greater circle at E to a distance a little less than Cc, which is the eccentricity of the earth's centre of gravity.* We shall call the extremity of the radius where it meets the surface of the solid earth e.

We have thus obtained the arc of a second smaller circle, which is constructed upon the same chord, AB, with the greater circle, but which has c, the centre of magnitude of the earth, as its mathematical centre. This arc coincides with the surface of the earth where it rises above the ocean.

§ 13. *Computation of the Depth of the Ocean at* D.

It will now be our object to compute the greatest distance between these two circles at the opposite extremities of their common diameter, because the distance Dd, at the one extremity, will probably agree pretty accurately with the greatest general depth of the ocean, and the distance Ee will, in like manner, represent the greatest general elevation of the dry land above the sea-level. Of the former, *i.e.*, the distance represented by Dd, we may, I think, form a judgment from the elevation of the mountains above the ocean in the two hemispheres. We may use them as gauges, and, supposing the heights of mountains to have some approach to equality in both hemispheres, we may reason as follows. In the Land Hemisphere, the average elevation of the highest mountain masses is about 5524 metres; in the Water Hemisphere, 3604.† The difference between these two quantities is 1920 metres, which we may suppose to represent the general depth of the ocean. An ocean of this depth would be sufficient to submerge three-fourths of the solid earth, so as to leave the con-

* The distance between D and d will be equal to the eccentricity together with the difference between the two radii cA and CA.

On the other hand, the distance between E and e will be equal to the eccentricity, minus the difference between the two radii.

$$\text{Or, } Dd = Cc + \overline{CA - cA} = 1920 \text{ metres.}$$

$$Ee = Cc - \overline{CA - cA}.$$

† See above, § 4.

tinents and islands rising above it as they actually do. Moreover, it will be found by computation that the supposed depth would be about $\frac{1}{6631}$ part of the earth's diameter. If some such quantity as this be taken as the ordinary depth of the ocean, it will follow that where much greater depths are ascertained by soundings, these must be attributed to dislocations which have taken place at the bottom; they must be regarded as submarine seas, valleys, and lakes, analogous in their mode of formation to those which are found at the general level of the dry ground.*

§ 14. *Computation of the Height of the Land.*

Reverting to our section of the earth, we may now observe that, on the assumption of all the imagined circumstances on which the diagram is constructed, the points A, B, and the small circle of the sphere bisected by them, will be on the shores of the ocean, and will represent the water-level, which will coincide with the whole surface of the ocean, provided that it is not subject to any local and disturbing attractions. Hence the smaller arc AeB, encompassing the dry ground, will be an excrescence or protuberance rising above the water-level. Its greatest elevation will be represented by the distance between the two circles at the points E, e, which will be equal to Cc, the eccentricity before mentioned, minus the difference between the radii of the greater and smaller circles. It may be expected that this elevation should in general correspond with the elevation of the great areas of the continents, the separate mountains and ridges being regarded as the effects of local upheavals. If all the continents and islands of our earth were contracted into the form of a meniscus, that is, something like a watch-glass, or the shield of a Highland warrior, the length of any arc passing through its centre, such as AEB, being, on the supposition above assumed, an arc of 125°, would be equal to 7500 geographical miles, or about

* It has been generally assumed by geologists, and, as it seems to me, with sufficient reason, that in receding from the shores of continents and islands, the sea deepens in proportion as the land rises. According to this supposition, the deepest parts of the sea may be expected to be not much less than 1920 × 3 metres, which agrees sufficiently with the computations by soundings and other methods.

1380 myriametres, measured at the level of the sea. It may be observed that the solid here spoken of would be formed by the revolution upon Ee of the plane, which is bounded by the two arcs AEB and AeB.

We may now endeavour to explore the dimensions of this land meniscus, representing the continents and islands accumulated into one mass, by a method something similar to that which we have employed in regard to the supposed collection of waters.

The arc AE, being half the diameter of the meniscus, is an arc of 62° 30′, and is consequently equal to 3750 geographical miles, or 6945 kilometres.

What must be the thickness of this meniscus in its centre, or, in other words, its greatest elevation above the level of the sea, in order that rivers may flow from its centre to the ocean?

In reply to this question, we may compare three of the greatest rivers in Europe, Asia, and America, which flow over tracks of alluvial and sedimentary deposits, so as to have a remarkably even and gradual slope.

I. The Danube, the water of which, having been first discharged into the Euxine, forms part of the stream flowing through the Straits of Dardanelles into the Mediterranean Sea. It is navigated all the way to Ulm in Bavaria, with only a partial obstruction by rapids at the Iron Gate, where it intersects the Balkan Mountains. Its total course is reckoned at 1494 geographical miles* = 2767 kilometres. The elevation of Ulm above the sea is 369 metres.†

II. The Yenesei flows into the Arctic Ocean through a course of 4666 kilometres. The elevation of Irkutsh near its source is 378 metres.‡

III. The Missouri, joining the Mississippi, is navigable from the Great Falls in the Rocky Mountains to the sea, through a distance of 6436 kilometres.§ Below the Great Fall it is 460 metres above the sea.

The Volga rises at an elevation of only 633 English feet

* Herschel, Physical Geography, § 217.

† Annuaire du Bureau des Longitudes, p. 251.

‡ William Hughes' Training-School Atlas, 1861; Physical Map of Asia.

§ Herschel and Hughes, "4000 miles."

above the Caspian Sea. Its length is 2200 English miles. Hence its fall is only 1 in 18,350. Though perhaps an extreme instance, it suffices to show how small a declivity is sufficient to determine the flow of rivers.

These statements, compared together, give an average fall of 1 in 11332. If we apply this fact, by means of a simple proportion, to the solution of the preceding question, we shall find that the meniscus may be supposed to be 605 metres thick in its centre. At least it appears certain that this elevation would be sufficient to discharge from its surface every shower falling from the atmosphere, and to convey its water to the ocean.*

§ 15. *Another Computation by Geometry.*

I have noticed the importance of the points A, B, which are ascertained by observation. These points are at the apex of two equal and similar triangles, AcC and BcC, and it is also of great importance to Physical Geography to ascertain the elements of these triangles, since with them is connected our knowledge of the eccentricity of the earth's centre of gravity, of the general depth of the ocean, and of the general elevation of the continents above the water level. Only one of the elements in each triangle is exactly known, viz., the side CA or CB. This is the semi-diameter of the terraqueous globe, and is consequently found with the greatest ease by taking the usual divisor 3·1415926, dividing by this number 4000 myriametres, which is the circumference of the globe, and, after having thus obtained the diameter, taking the half of this as the radius. The two other sides of each triangle, cA=cB, being the semi-diameter of the solid earth, and Cc, the amount of the eccentricity, may probably be ascertained with equal exactness. At present, we shall try what can be done by the application of geometry. We may bring into comparison our two circles by means of the chord AB, which is common to both. The square of half this chord, AF, is equal

* It is gratifying to find that Professor Phillips, who has kindly perused this essay in manuscript, reasoning by a different process, makes the mean altitude of land, in round numbers, 2000 feet, which is substantially the same with my own conclusion. (*Manual of Geology*, London, 1855, p. 583.)

to DF × FE (Euclid III. 35), and it is also equal to dF × Fe. Therefore, DF × FE = dF × Fe. Hence

$$dF : FE : : DF : Fe.$$

First, to find DF and FE, it will be most convenient, and probably nearest the truth, to fix the point F, as in the preceding instance, by taking a proportion half-way between 100 : 289 and 100 : 256, thus :—

$$\begin{array}{l} 100:289 \\ 100:256 \\ \hline 200:545,\ i.e.,\ 40:109. \end{array}$$

We shall then obtain the two following proportions :—

$$\left.\begin{array}{l} 149 : 109 : : \overset{\text{Metres.}}{12{,}732{,}396} : \overset{\text{Metres.}}{9{,}314{,}303} = DF \\ 149 : \ \ 40 : : 12{,}732{,}396 : 3{,}418{,}093 = FE \end{array}\right\} DE$$

Also $\qquad dF = \overset{\text{Metres.}}{9{,}314{,}303} - \overset{\text{Metres.}}{1920} = \overset{\text{Metres.}}{9{,}312{,}383}$

And the above proportion will be expressed in figures thus :—

$$\overset{\text{Metres.}}{9{,}312{,}383} : \overset{\text{Metres.}}{3{,}418{,}093} : : \overset{\text{Metres.}}{9{,}314{,}303} : \overset{\text{Metres.}}{3{,}418{,}798} = Fe,$$

Then 3,418,798 − 3,418,093 = 705 metres, being the measure of Ee, the thickness of the land meniscus.

Thus geometry makes the general elevation of the continents above the sea considerably more than our calculation derived from the flow of rivers, being one-seventh in excess. But it is to be observed, that the three rivers which have been selected, and which make the general elevation of the dry land above the sea only 605 metres instead of 705, flow through vast territories of remarkably even slope. It seems probable that the general elevation of the continents is greater than this even in those districts which are neither mountainous, nor characterised by any traces of subterranean action, but which consist of alluvial and sedimentary strata, and are drained throughout by navigable rivers. Hence I should be inclined to prefer 700 as the true measure of the height of the dry land above the water. This would make the height of the dry land rather more than a third part of the depth of the ocean ; and it seems a remarkable coincidence that the weight of the one meniscus would then pretty nearly counterbalance that of the other, since the specific gravity of sea-water may be considered as bearing to that of the minerals composing the crust of the earth, the inverse ratio of 19 to 7.

§ 16. *Computation of the Eccentricity.*

We now proceed to calculate the eccentricity. This is Cc in the diagram, the space through which the earth's centre of gravity is removed south-eastward from its centre of magnitude. We have already found the following equations (p. 189):—

$$Cc + \overline{CA - cA} = Dd$$
$$Cc - \overline{CA - cA} = Ee \qquad \text{Add together,}$$
$$2\ Cc = Dd + Ee$$
$$= 1920 + 600$$
$$= 2520$$

Therefore $Cc = 1260$ metres.

This amount of eccentricity is found to be adequate to the production of every existing appearance, and, being much less than the length of Oxford Street in London, cannot be said to exhibit any violent or extravagant assumption.

§ 17. *Comparison with the Statements of Herschel.*

Before leaving this part of the subject, I wish to compare the preceding inferences with the statements of Sir John Herschel, not only on account of his great eminence as a philosopher, but because his "Physical Geography" is the latest publication on the science, and is replete with facts as well as theories, which are of the greatest moment in the inquiry.

Sir John Herschel estimates (p. 119, § 135) the mean elevation of the continents at 1800 feet. This is less than the calculation just made in these pages; but, if it be considered that Sir John Herschel also supposes a higher proportion of the water to the land, viz. 146 : 51, or 286 : 100, instead of the medium of 272·5 : 100 (see above, p. 178), and that as the water rises in our scheme the land will fall, it will appear that his inference rather justifies than infringes the methods of computation here pursued. Assuming his data, let us now try them by both methods.

First, by the flow of rivers.

Referring to the diagram we shall have

DF = 146 and FE = 51, or DF = 286 and FE = 100.

The arc AEB will thus be reduced to about 122°, instead of 125°. The half of it will be 61° = 3660 geographical miles, or 6778320 metres. This divided by 11332, will give 598 metres, instead of 605, for the elevation of the land, as above computed from the flow of rivers.

Next, let us try the investigation by geometry.

$$DE = 51 + 146 = 197 = 12{,}732{,}396 \text{ metres.}$$

$$\left.\begin{array}{l} 197 : 146 :: 12{,}732{,}396 : 9{,}436{,}192 \text{ metres} = DF \\ 197 : \ 51 \ :: 12{,}732{,}396 : 3{,}296{,}204 \text{ metres} = FE \end{array}\right\} DE$$

Also $$dF = 9{,}436{,}192 - 1920 = 9{,}434{,}272.$$

The proportion in figures will be

$$9{,}434{,}272 : 3{,}296{,}204 :: 9{,}436{,}192 : 3{,}296{,}874 = Fe.$$

Then $3{,}296{,}874 - 3{,}296{,}204 = 670$ metres, thickness of the land meniscus, Ee.

Thus, as in the former case, the computation by geometry gives more to the height of the land than the computation from the flow of rivers. It is also remarkable that Herschel's statement of 1800 feet for the elevation of the continents agrees sufficiently with the deduction from his reckoning of the proportion of water to land. On the whole, therefore, I think it safe to adopt in substance his opinion, by taking 600 metres, a convenient number, as the elevation of the land, or the measure of Ee in the diagram.

§ 18. *Mass of the Sea.*

Sir John Herschel (p. 20) further estimates "the mass or weight of the sea (taking the specific gravity of sea-water under a pressure of two miles 1·0151) 3,270,600 billions of tons." He does not explain his method; but I shall endeavour to weigh the sea upon my own assumptions, and to compare the results, as one way of testing my own theory. In doing this, and more especially in guarding against mistakes in long sums of arithmetic, I have had the kind assistance of Mr Samuel Lobb, M.A. of Cambridge, late Mathematical master in the Grammar School at Highgate. Great facilities have been afforded to us by the adoption of the metric instead of the English weights and measures.

On referring to the diagram, it will be evident that the quantity sought is the difference between the two circular segments ADB and AdB. To find it Mr Lobb has given me the following formula:—

$$\text{Water-meniscus} = \pi.\ \text{FD}^2 \left(\text{R}w - \frac{\text{FD}}{3}\right) - \pi.\ \text{F}d^2 \left(\text{R}l - \frac{\text{F}d}{3}\right).$$

On working it out he makes the cubic contents of the water-meniscus to be rather more than 3,157,302 billions of cubic metres. Consequently the ocean contains, on the preceding assumptions, an amount equal in weight to so many billion tons of pure water, because the weight of a cubic metre of water is a metric ton. But it is necessary to add ·0151 per cent., as Herschel has done, for the greater weight of sea-water, and ·0156 per cent. on account of the quantity by which the English ton exceeds the metric ton. These percentages added together make about 3 per cent., and will bring our computation within a very little up to Sir John Herschel's.*

§. 19 *Symmetry of the Terraqueous Globe.*

In discoursing upon such a subject as the present, it becomes one, who does not profess any familiar acquaintance with the mathematical and physical sciences, to express himself with caution, modesty, and reverence. In conclusion, therefore, and in this spirit, I wish to reply to the objection which will be raised against my theory, as contrary to our notions of the symmetry and beauty of the material universe.

I might reply, that plain matters of fact must be admitted, however contrary to our private wishes and feelings. We must not refuse to look at a Begonia on account of the inequality in the form of the leaves, which strikingly pervades

* Having proceeded thus far, we are enabled, by the further application of the Metric System, almost at a glance to estimate the mass of salt in the sea, that is, of the solid contents which would be left behind if all the water were evaporated. It appears that it would be something more than 400 cubic myriametres. I would observe that Forchhammer estimates the solid matter in the ocean much higher; viz., 34·304 per 1000. (*Proc. of R. S*, May 1862, p. 131.)

the whole genus. But I think that a careful examination of the present question will show that there is not the slightest ground for the objection.

According to the view which I have endeavoured to explain, the eccentricity of the earth's centre of gravity is balanced by the attraction of the ocean to the south-east, by which the centre of gravity of the solid earth becomes also the centre of gravity of the terraqueous globe. The protuberance of the water on one side will make the centre of gravity of the terraqueous globe coincide with its geometrical centre, which will be in the same diameter with the previously assumed centre. Again, when the atmosphere comes into action, its centre of gravity will coincide with the centre of gravity which has already been assumed, first, for the earth, and, secondly, for the terraqueous globe. The original extra weight of the earth on one side will thus be balanced by the greater lightness of the water on the same side. The result will be, that the centre of gravity of the whole system will coincide with its geometrical centre and determine its axis of rotation.

§ 20. *Important Consequences of the Eccentricity.*

It might be presumptuous in beings so ignorant as we are to say that the eccentricity here spoken of is intentional; but it is certain that it produces the most useful and admirable results. This appears more especially in considering the land hemisphere. Were not the force of gravity such as it is, the whole surface of the meniscus AEB would become a swamp. The waters falling from the sky would necessarily remain where they fell. But the force of attraction draws them down declivities on every side of this meniscus; it unites them into streamlets, brooks, and rivers, and at length they reach the level of the line AB, and mingle with the ocean. In going down the declivities they dig channels in the surface of the meniscus, which become larger and larger by their union. The surface is thus eroded and carried off in the state of sand, mud, and pebbles, and these solid materials, as soon as they have reached the ocean, are deposited beneath the water at its edge. If this process were to go on interminably, the whole meniscus would be worn down and brought to a level with the ocean; but here another agent begins its work. The internal heat disturbs the primæval repose, raises, and often breaks, the ribs of rock, and either elevates the surface of the earth by a gradual and general intumescence, or, in a more sudden paroxysm, exhibits the upheaval of a lofty range of mountains. By processes of this kind, the land hemisphere assumes the useful qualities and the beautiful and varied aspects which we now behold. Mountains in lengthened ridges, which have in most cases turned on an axis as the lid of a box turns on its hinges, present gradual slopes on one side and bold precipices and escarpments on the other, and thus penetrate the regions of eternal ice. These mountains are the chief condensers of the atmospherical waters, which flow down the plains and steppes as already described, until they discharge themselves into the ocean, every great stream being divided into its torrential portion, passing through the elevation and its navigable part, which marks and measures the general surface of the Land Hemisphere. Such are the wonderful and beneficent consequences, distinctly traceable to the eccentricity of the earth's centre of gravity.*

§ 21. *Solidity of the Earth's Centre.*

An obvious consequence of the theory here propounded is the general solidity of the earth's interior. To say nothing of the "great abyss of waters," held by Burnet, Woodward, and others, all the recent theories of a liquified or incandescent state of the interior of our planet must be rejected on this hypothesis; for in such circumstances the force of gravity would so act upon the moveable fluids as to make the two centres of magnitude and gravity coalesce. In short, the eccentricity, which is an essential part of this theory of the earth, would be obliterated. It is, indeed, possible, perhaps even probable, that there may be in the innermost parts of the earth cavities filled with mercury or other heavy fluids, and so far answering to the cavities filled with water in its exterior;

* Respecting the precise mode of action of the atmospherical agencies in disintegrating, eroding, distributing, and rearranging the solid materials of the earth's surface, I beg to refer the reader to my Memoir communicated to the Geological Society of London in November 1830, and published in the "Edinburgh New Philosophical Journal" for July 1831.

but I conceive that a solid framework of rock must nevertheless extend from every part of the earth's surface to its centre. At the same time it is clear that the two centres of magnitude and gravity, being mathematical points (C, c, in the diagram), are far from being immovable; on the contrary, they must move so as to correspond with the changes of position of all substances on the earth's surface. Every day they must approach or recede to the extent of at least some millimetres, in obedience to the flight of clouds and other atmospheric agencies, and still more in consequence of the removal of detrital matter, and of the subterranean forces of upheaval.

§ 22. *Permanency of the Earth's Surface.*

The doctrine of two centres, thus intimately connected with the distribution of water over the earth's surface, further presents an important view of the general permanency of that surface. If the centres were to coalesce, or if they were either to approach or recede to any considerable extent, not only the relative proportions of sea and dry land would be changed, but the forms and boundaries of all continents and islands without exception would be completely altered. Now we know that this has not been the case for an indefinite length of time. We have historical proofs that the great landmarks of the old world, the main boundaries of Europe, Asia, and Africa, are the same now as in all former periods of which we have any record, and we may probably extend this inference even to vast geological epochs, inasmuch as the fossil remains of quadrupeds are sometimes found to belong to certain orders in their appropriate regions, of which we have a striking instance in the discovery of an abundance of marsupials in Australia throughout all periods, both ancient and modern. So far as we can judge, Australia always was Australia, and, notwithstanding the immense superficial changes continually in progress, the larger elevations and depressions of our globe remain from age to age in much the same relative position, a result which could not be expected unless the innermost parts of the earth were so precluded from motion as to confine the two above-defined centres within very narrow limits, and with extremely little variation in their distance. Here a very important observation of Professor Phillips appears apposite, as a confirmation of my reasoning: "By no stretch of conjecture, that is not absolutely monstrous, can we torture the known laws of terrestrial arrangements into agreement with the hypothesis of any but small changes of the level of the ocean; a conclusion of the highest value, since it enables us to argue upon that level as a general standard, to which we may refer all the effects of internal movements, in whatever period, and by whatever forces produced." *

§ 23. *Constitution of the Earth's Interior.*

Having ventured to dispute the commonly received doctrine of the fluid or liquified state of the central parts of the earth, I may be required to suggest some better hypothesis. Let us then suppose, in conformity with the example of most of our predecessors, that the earth originated in a mass of vapour. It has been commonly assumed, that this would condense into a fluid. I think that for the most part it would become solid without passing through the fluid state, because this appears to be the case with most substances, whether simple or compound, of which we have any knowledge, *e.g.*, iodine, camphor, sulphur, carbonic acid (as shown by Thilorier), metals and their oxides, with innumerable other bodies. These matters, even in their extreme state of comminution or vaporisation, show a disposition rather to crystallise at once than to become fluid. The most common earths, such as clay, silex, and felspar, in the finest dust become gritty, when immersed in water, agitated, and allowed to subside. But the most familiar example occurs in the formation of snow and hail; and more especially, we may appeal to those hailstones, of rare occurrence, which become very destructive in consequence of their great size, which are rough and irregular in form, and are produced by the aggregation of a multitude of smaller crystals. In like manner, the pre-existent vapour, whirling round a centre, and composed as the earth now is of more than sixty elements, would crystallise, first, into an endless variety of simple and compound bodies of small dimensions,

* Manual of Geology (1854), p. 584. Compare Humboldt's "Cosmos," Sabine's Trans. vol. i. p. 278.

and gradually into larger and larger masses, until some of them might even approach our conception of planetoids or asteroids. The tendency of all these heterogeneous bodies, though long kept separate by the centrifugal force, would be to fall together by degrees, always whirling round their centre of gravity, and assuming the form of a spheroid of rotation. Fluids might originate in the process, and mingle with the general system; but the formation of an entirely fluid spheroid would, as it appears to me, require such peculiar conditions of temperature and pressure as would be very improbable at any time.

§ 24. *Chemical Agency.*

The theory which I have endeavoured to trace presents an unbounded field for chemical contemplation. The able arguments of Mr Sterry Hunt* and others, in regard to the formation of metamorphic rocks, might be applied to all combinations of matter, down to the very centre of the earth. The doctrine of chemical affinities seems to combine with numerous geological phenomena in proving that metallic alloys, and all solids of heterogeneous composition, are subject to slow internal changes, the atoms of matter being destined gradually to overcome the contiguous mechanical impediments, so as to arrange themselves ultimately according to their greatest affinities; and, if this be so, another important consequence seems to follow, namely, that chemical action will evolve heat, which will be continually propagated upwards and outwards. Thus the most striking events and appearances on the surface of our planet, such as thermal springs, earthquakes, and volcanoes, may stand in direct though distant relation to the excess of water in the region round New Zealand.

§ 25. *Magnetic Storms.*

The evolution of heat, combined with chemical action, can scarcely fail to have an influence on the magnetism of the earth, and, notwithstanding the obscurity of the subject, the question suggests itself, whether the so-called "magnetic storms" may not be explained on this theory. We seem to

* In Quart. Jour. of Geol. Soc. 1859, p. 489.

have arrived at something like evidence of the existence of cavities in the interior of the solid earth, irregular in their form, communicating occasionally with one another, and containing various substances in a fluid or aeriform condition. These may from time to time burst though their barriers, and either fall downwards or rise to some receptacle nearer the surface. Such sudden and varied motions within the earth appear to exhibit some relation to the action of the needle, when, instead of trembling "to the pole," it suffers a mysterious and violent agitation.

This view of the origin of magnetic storms appears to be supported by the fact, that the needle exhibits the same kind of agitation in the vicinity of volcanic eruptions. Also, it is important to observe that the cause of earthquakes has been shown to be very deep-seated. The seat of the great earthquake at Lisbon was investigated by Professor John Playfair, by a reference to its diffusion over the earth's surface, and was calculated by him to be at an immense depth beneath the surface.* If this remark be taken in connection with the fact that magnetic storms are in like manner "simultaneous, in the strictest sense of the word, over land and sea, over hundreds and thousands of miles,"† all seems to tend to the inference, that the central parts of the globe are subject to the same kind of convulsions, which we call earthquakes and volcanoes, when they occur immediately beneath our feet.

§ 26. *Proposed Theory agreeable to Ancient and Established Doctrines.*

According to Diogenes Laertius (ii. 1.) the doctrine of the sphericity of the earth was taught by Anaximander, so that it appears to have belonged to the earliest period of the Greek philosophy. From the Greeks it passed to the Romans. Ovid clearly states it in the well-known lines, which are now found to be exactly and literally true :—

Circumfuso pendebat in aëre tellus,
Ponderibus librata suis.

Met. I. 12, 13.

* Trans. of Royal Society, Edinburgh, 4to, about A.D. 1812.

† Humboldt's "Cosmos," Sabine's Trans. i. pp. 24, 167, and Note 143.

Plato briefly expresses the opinion, that the frame of the universe was constructed with the nicest adjustment of parts, when he says, "Ο Θεὸς ἀιεὶ γεωμετρει.—" The Divinity always acts geometrically," that is, by just and adequate "numbers, weights, and measures."* In the Sacred Scriptures the same idea is beautifully expressed in various passages. Wisdom was present when God "set a compass on the face of the deep" (Prov., viii. 27). Here is a reference to the use of the compasses in geometry, the word in the Hebrew being *og*, the origin of our word ocean.† Every one will call to mind the verse of Isaiah (xl. 12), "Who hath measured the waters in the hollow of his hand, and meted out heaven with the span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance?" According to the conception of the writer, not only was the earth spherical, but the atmosphere, the ocean, and the crust of the globe, were all adjusted by weight and measure. Thus it appears to me, that the theory which I have advanced respecting the equipoise of our planet is conformable to the most ancient and venerable principles of oriental wisdom, whilst it explains the actual course of nature, when, in the language of our own learned, philosophical, and sublime poet,

"Earth, self-balanced, on her centre hung."

On the Arrangement of the Muscular Fibres of the Valve in the right Ventricle of the Heart in the Bird.‡ By W. Carmichael M'Intosh, M.D., Perth. (Plate III.)

Everywhere throughout the mammalian series is found at the right auriculo-ventricular orifice an arrangement of fibrous valves connected with *cordæ tendineæ, columnæ carneæ*, and

* Bentley, Sermon at Boyle's Lecture, No. viii., 5th edit., p. 304.

† Compare Milton, Paradise Lost, vii. 1. 224–242.

‡ The most of this paper formed a fragment of an essay "On the Arrangement of the Muscular Fibres of the Ventricular Portion of the Heart in Vertebrata," given in during the Winter Session 1858–9, for competition in the Senior Anatomy Class of Professor Goodsir.

musculi papillares, whereby regurgitation is prevented, and other important steps in the economy of the cavity furthered. In some, too, we have muscular fibres developed in these valves, as in the horse and dog, while in the *Ornithorhynchus paradoxus* a large amount of this tissue is stated to be found; thus, as it were, forming the connecting link by which we arrive at that curious structure in the right heart of birds. The left ventricle in the latter contrasts strongly with the single muscular valve of the right, since it has fibrous valves similar to those in the mammal.

Without referring at present to all the peculiarities of the bird's heart as distinguished from that of the mammal, it may be mentioned that, after boiling, the bases of the two differ especially in the comparative shapes of the auriculo-ventricular openings. In the bird, the left is circular and surrounded by a solid ring of the thick muscular wall; the other presents an elongated slit-like curve with its convexity to the right. There being no annulus venosus, the auricle is continuous with the thick layer of endocardium which covers the auricular or septal side of the valve, except at the ends, where there are firmer fibrous connections. There is only a very slight fibrous margin to the free edge of the valve.

In examining into the special arrangement of the muscular fibres necessitated by the valve, which is seen entire in fig. 1., *v*, I shall in the first instance pursue those from the right or proper wall of the ventricle, according to their depth and direction, and thereafter any additional bands which this method leaves undetermined.

In most birds' hearts the superficial fibres which assist in the formation of the valve have a pretty uniform course, as coiling out at the apex, they proceed upwards, and bending to the right, many sweep over the brim of the right ventricle, and form part of the septal surface of the valve. Without dissection it may be seen, that, when turning the margin of the brim, some diverge to the anterior fillet obliquely downwards and forwards, meeting fibres which come from the free ventricular wall; others spread over the septal surface of the valve; while a third set plunge backwards into the left ventricular wall; and we shall meet them again when describing the great band of fibres at this part. On raising these superficial fibres, as seen in fig. 2 (where *aab* are portions of the superficial fibres reflected), it is found that most take a direction obliquely forwards over the brim and septal surface of the valve, some joining the general mass of fibres at the anterior angle, others merging into the accessory slip from the free wall of the ventricle. Many of the superficial fibres likewise sink into the fillet which often so conspicuously guards the anterior part of the valve and ventricle. See *np*, fig. 3.

The subjacent fibres course at an acute angle to those we have just described, and proceed exactly in an opposite direction, the superficial mounting upwards and forwards, the deeper sloping upwards and backwards. The great mass of fibres forming this layer of the right ventricle are seen coursing from the anterior surface of the left ventricle upwards and backwards. Some make a twist, and join that fillet which plunges into the septum past the root of the aorta, and form part of the highly important arch of muscle at *n* and *p*, fig. 3, previously mentioned, which covers in the anterior and upper part of the ventricle, and completes the smooth pouch terminating in the aperture of the pulmonary artery. Other fibres of this layer (seen at *d*, fig. 2), slanting upwards, come to the brim of the ventricle and also of the valve; and here they fold over and proceed downwards and backwards, forming the greater part of the substance of the valve, to the posterior border of the ventricle, and crossing the septum enter the left ventricular wall, where they will be pursued by and by. A third set, to the left of *d*, fig. 2, curve inwards and upwards to be attached to the cartilaginous setting at the posterior part of the aortic base at the septum,* and assist in the completion of the margin of the ventricle. The brim of the ventricle is of a different construction here from what it is at the anterior angle; for there the mass of the valve has merged into the proper wall, leaving the brim unprotected as regards any fibres essentially connected

* By prolonged boiling, it is probable that the muscular fibres may be conveniently separated from the tendinous rings, since many dissections of the heart of the mammal, as well as of the bird, have convinced me that numerous fibres are inserted into these structures.

with it, while at the posterior part the brim of the ventricle is continuous with the margin of the valve, new fibres, even to the last, folding over to join the general body of this structure.

When this layer is raised, the great bulk of the fibres is seen to enter into the formation of the oblique band after doubling the ventricular brim; the rest continue in succession to the posterior border, some forming part of the posterior portions of the valve, others being inserted into the cartilaginous setting at the aortic base, or plunging, are lost in the septum. The fibres that course over the upper part of the ventricle take most part in the formation of the oblique band, the others assist in the construction of the posterior arch of the valve.

The deeper portion of these fibres, from their forming a smaller angle with the brim, make another layer of ventricular fibres, but their relations to the valve are somewhat similar. They are seen at *cc*, fig. 4. The fibres at the root of the pulmonary artery—belonging to this and the previous layer—take great part in the formation of the origin of the valve; that is, its prominence anteriorly from the rest of the cavity is caused by the bulging of fibres from that region.

There is no difficulty experienced in raising the foregoing from the innermost or fourth layer, most of whose fibres slant in an opposite direction. That portion of the internal layer, seen at *aa*, fig. 5, chiefly coming from the pulmonary region, takes little part in the formation of the valve, except in joining that structure with itself, and in giving *musculi pectinati* to its outer surface to strengthen the connection. Posteriorly it wends up to the brim in a similar manner, some of its fibres entering the left wall, others becoming attached to the cartilaginous setting mentioned previously. The most important connection of the internal layer with the valve is its relation to the accessory slip. A strong band of fibres is seen coursing down from the right half of the pulmonary artery over the upper part of the right ventricle, which, arriving at the point of attachment of the slip, gives many of its fibres to assist in its formation by means of a well-marked twist. Out of the slip itself a band emerges, which sweeps over the upper part of the ventricle in the course of the other fibres of the internal layer, and, like them, being attached to the fibro-cartilaginous setting posteriorly, and also taking part in the posterior arch of the valve. At this point of ingress and egress an evident dimple is produced; see *b*, fig. 5. It is very distinct in many hearts, and the arrangement forms, as it were, a sling by which the accessory slip is hung.

The valve has thus connections with all the layers of the ventricle, its most powerful bundles coming from the second layer, and from the pulmonary band of the fourth layer in connection with the accessory slip.

The *accessory slip* of the valve (fig. 1, *c*), as has been seen, comes chiefly from the inner layer of the free wall of the ventricle, and has the aspect of a large and powerful muscular column, which, tacked to the yielding anterior edge of the valve, has an important influence in its action. Springing in the fan-shaped manner already described, the fibres, converging, pass along its pillar, again to diverge when they meet those of the valve. In some hearts the fibres pass a little way up beyond the lower margin of the valve. On either side, then, it has pretty extensive connections, which must be correspondingly affected by the movements of its column. There is a thin muscular band attached to the upper margin of this structure, which connects it with the fillet crossing to pass into the septum at the base of the aorta.

The *Great or Oblique Band* of the valve (fig. 6, *h*) is that mass of fibres which takes a slanting and well-defined course from the brim of the ventricle to the septum, from right to left. On the inner or septal surface it is less distinct, but, externally, it forms a prominent column of muscle, constituting, in fact, the whole external aspect of the valve, with the exception of the accessory slip. In most hearts, the direction of the fibres is uniformly oblique; but in the heart of the Emeu, and probably in others, a fillet of nearly horizontal fibres at the upper part breaks the usual obliquity. Following the fibres of this great band into the left ventricular wall, it is seen that, on passing the septum (*s*, fig. 6), their course is somewhat altered; for many gently curving over the posterior part of the left wall spread and intermingle with other fibres taking a similar direction; as seen in the figure. Many of the superior fibres slant upwards to be attached with accompanying fibres to the cartilaginous setting near the root of the aorta, anteriorly, and to the left (*i'*, fig. 7). The rest, forming a portion of the third layer of the left ventricular wall, coil with it through the septum, and are no longer distinguishable.

It will thus be seen that the single valve in the right ventricle of the bird's heart is no simple structure, but that, from the direction of its fibres and its connections, its action must be somewhat complicated. In the relaxed state, the rounded margin of the right ventricle presents a concave surface to the septum; and the latter being continuous with the valve, it is clear that any movement in either must correspondingly affect the other. When contraction of the valve occurs, its actions, judging from the anatomical structure, would seem to be the following:—The right or proper wall will be forcibly approximated to the septum, the concavity of the border or brim becoming lessened; the falciform edge will also be tilted upwards by the obliquity of the fibres which slant over the brim, thus closing the auriculo-ventricular opening, and preventing regurgitation. The fibres of the oblique band would seem to depress the brim of the ventricle, and, the cavity being filled with blood, would present in its connection with the free wall an irresistible propulsive or compressing force to the fluid. But it may be thought that, since the valve does not extend entirely across the cavity, the blood will escape through the opening where the valve is small and imperfect, as at its origin, anteriorly; this is provided against by the cavity being arched over at this portion by the fillets near the aortic base, previously described, so that the pulmonary channel alone being patent, no obstacle is afforded to the speedy passage of the blood. If the pouch of the valve is examined when the ventricle is filled with coagulated blood, the wise provision of the oblique arrangement of the fibres is readily observed; for they permit of extreme dilatation in all directions. This is very well seen in cases where the heart is boiled with its right ventricle filled with blood; the fibres of the valve and the upper part of the ventricle are stretched and attenuated to the utmost, yet in no case did I ever observe rupture.

EXPLANATION OF FIGURES.

Fig. 1. Heart of Capercailzie. The right ventricle is opened by the usual incisions for exposing the valve; *av*, the septal surface of the valve, with the varying direction of its fibres; *bb*, the cut surfaces of the muscular arch, which closes in the pulmonary region; *c*, the accessory slip; *d*, the pulmonary artery disappearing behind the aorta.

Fig. 2. Heart of the Heron, showing the superficial fibres reflected at *aab*, and likewise those fibres *cd*, of the second layer, which are connected with the formation of the valve.

Fig. 3. Superficial fibres of the heart of the Swan, from the posterior aspect; *m* and *o* are the superficial fibres passing over into the valve; *n* and *p*, the fillet and the arch of muscle, which complete the anterior and upper portion of the right cavity.

Fig. 4. Heart of the Swan, exhibiting the third layer of fibres *cc*; *b*, the second layer reflected; *aa*, portions of the same which could not be raised entire on account of their peculiar bending over the valve.

Fig. 5. Internal fibres *aa* of the heart of the Swan, as they slant from the pulmonary region; *b*, the twist caused by the entrance and exit of fibres connected with the accessory slip.

Fig. 6. Heart of the Capercailzie; *h*, the great or oblique band; *ij*, diverging fibres, connected with the same; *k*, the prominent brim of the ventricle; *m*, the cartilaginous setting at the posterior coronary track into which many fibres are inserted; *n*, the smooth or septal surface of the ventricle; *o*, the mass of muscle wending round the apex; *p*, the aperture of the pulmonary artery; *s*, point of junction of the right or free ventricular wall with the septum.

Fig. 7. The same heart turned round to exhibit the course of the upper diverging fibres, *ii′*, of the oblique band, as they sweep to the region of the aorta, anteriorly, and to the left.

Remarks on the Nature and Peculiarities of the Fern-spore.

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The second volume of the Linnean Transactions contains a paper on the development of fern-spores, by Mr Lindsay. This was read before the Linnean Society in January 1792, and appears to be the earliest record of the production of these plants from spores. Since that period, the spore, its nature and peculiarities, have been the subject of frequent discussions, without eliciting, however, any perfectly satisfactory conclusions. This can scarcely be attributed to any inherent anomalies, but rather to an unfortunate desire, in many instances, to

* Read before the Botanical Society of Edinburgh, 12th June 1862.

homologate essentially distinct organs, *i.e.*, buds and spores. The fallacy of this view has been so repeatedly exposed, that a re-statement may appear quite superfluous, were we not confronted with the fact, that authors still persist in ignoring the distinction, so lucidly drawn by Carpenter, Berkeley, and others, between the terms Homology and Analogy. This tendency of studying from preconceived hypothetical standpoints, is, we think, the chief source of the intricacy pertaining to the subject we are about to consider.

The following remarks lay small claim to originality, being in most instances re-statements of those peculiarities and anomalous properties of the fern-spore which are said to render all explanations of its nature hitherto offered unsatisfactory. In one or two instances, however, there will be found notices of certain peculiar properties, which, so far as we are aware, have not been recorded before, and likewise a few remarks explanatory of those peculiarities, the correctness of which, however, we leave to the judication of others. On these considerations, then, and as a record of conclusions based on a series of careful observations of the fern-spore in its various stages of development, the following remarks may not, perhaps, be deemed superfluous.

The sporanges of ferns are generally attached to the lower surface of the frond, though in the *Polypodium anomalum* they are confined entirely to the upper. The spores are productions of cell-division within these, and, accordingly, unattached. They consist of simple cells, having two coats like pollen grains, the outer of which is variously marked with warts, spines, or reticulations. The history of their development is similar in every essential respect to that of pollen grains, being, like them, products of a free cell-formation. This, however, is a point entirely ignored by those who regard the spore as the homologue of the flower or leaf-bud, and hence, we are inclined to think, arise the difficulties in giving an explanation of its apparently anomalous properties. For it can scarcely be denied that all proposed explanations, at least of that peculiar facility afforded by spores for the reproduction and perpetuation of any accidental variation of the parts upon which they originate, are, upon the whole, insufficient. The most satisfactory, as we are inclined to think, is contained in a paper "On the Production of Ferns from Spores," by Professor Balfour, in the Trans. Bot. Soc., vol. vi. It is there remarked, "that the spores which are not the direct products of reproduction, may be regarded as analogous to parthenogenetic seeds." . . . "These may have a tendency to propagate particular forms of plants, just as is the case in Cœlebogyne, where female plants have always been produced by seeds said not to be acted on by pollen. In this way, then, we may account for the spores of those fully developed anomalous forms always reproducing varieties like their parents." This view, so far as regards the nature of the spore, appears to be perfectly satisfactory; it seems, however, scarcely to meet the exigencies of the case, when we consider the spore in connection with its peculiar properties. In the offspring of parthenogenetic seeds, we have no positive evidence of their propagating other characters differing from the normal specific type except as regards the sexual organs, which, in fact, are specifically normal; whereas in ferns other abnormal characters are regularly reproduced.

Another explanation has been proposed by Dr Lowe in his paper "On the Homologies of the Floral Organs of Phanerogamia and the Higher Cryptogams," of a very different nature from the preceding. In it the author believes that this peculiarity, *i.e.*, of reproducing anomalous forms, "can be explained only on the supposition that the spores are nothing more than buds, and that the real act of reproduction comes after their separation from the parent plant." But, aside from the difference of origin of the *bud* and *spore* before alluded to, we cannot but regard this explanation as entirely opposed to the laws governing the reproduction of variations in Phænogams. It appears to be generally admitted that the longer the incipient plant is developed under the direct formative tendency of the parent, the more will it partake of its individual peculiarities; that this is, in short, the cause of buds reproducing the peculiarities of their parents. In reproduction by seed, on the other hand, an embryo is separated from the individuality of the parent, "and develops itself out of itself, so that the influence which the parent plant exerts, even though it be definite and assimilative, is yet always an external one, and is modified by the peculiar vital power of the reproductive cell;" hence, in reproduction by seeds, the specific characters alone are in general reproduced. Now, in the fern spore, we have an organ still less developed, under the direct formative tendency of the parent, than even the seed; as, according to the theory we are examining, the embryo is not alone separated from the individuality of the parent, but all the floral organs are developed in perfect independence of it, so that the definite and assimilative influence exercised by the parent over the embryo of the seed, small though its individualising influence may be, is not even called into action in the case of the embryo developed from the spore. Hence we are certainly justified in asserting that were these organs the homologues of buds, floral or foliar, the reproduction of the morphological variations of the individual must be rare in the extreme—the exception not the rule—so purely dependent is the incipient plant on the specific morphological tendency.

Again, in a paper by Mr W. K. Bridgeman, entitled "The Influence of the Venation in the Reproduction of Monstrosities among Ferns,"* the author supposes that this peculiar property of spores is dependent on an abnormal distribution of the veins. This opinion is formed on a few experiments made upon certain abnormal forms of *Scolopendrium vulgare*, in which the venation was abnormal in one part of a frond and normal in the other. Selecting a frond of the variety *laceratum*, and taking spores from a reticulated and abnormal veined portion of the frond, the author found that the offspring from these spores exhibited the same characteristic forms as the parent frond. Those, on the other hand, taken from the normally veined portion of the frond, exhibited few of the characteristics of their parent, a large proportion of them being perfectly normal. On these, then, and one or two more experiments, the author believes, as before stated, that the reproduction of varieties is dependent upon an abnormal venation. This, however, is little more than a new mode of expressing the fact, that the spore reproduces the part upon which it originates. The statements differ from

* Mag. of Nat. Hist., December 1861.

each other, however, in this respect, that the view under examination appears to regard the form of the pinnæ as dependent on the venation, while the other avoids particularising, and makes no attempt to solve the question, whether the distribution of the veins influences the form assumed by the parenchymatous tissue, or *vice versa*. The latter view is held by Dr Dickie, who remarks that the quantity of cellular tissue in a leaf determines the development and position of the veins. Not pretending, however, to decide such a question, we may simply remark, that in the majority of ferns there is little or no departure from the normal venation of their respective species. Few will be found to exhibit so striking a departure as some of the crested forms of *Scolopendrium vulgare.* Nevertheless, it is an acknowledged fact, that the spores from normal-veined, though abnormal-formed, fronds, do reproduce with great regularity the latter peculiarity. The numerous varieties of the British ferns now annually raised from spores, in which there is no departure from the normal venation further than a greater or less development of them reciprocally with the tissue, affords sufficient evidence on this head. We should like to know in what manner the variegated ferns are dependent upon an abnormal distribution of the veins for the perpetuation of their peculiarities. In fine, we are induced to regard the produce of the spores from the differently-veined portions of the Scolopendrium as merely a casual concurrence, from the superabundance of evidence demonstrating the reproduction of variations with a perfectly normal venation. And there is not, so far as we are aware, a single instance on record, of the reproduction of an abnormally-veined frond or pinna, in which the form of the parenchymatous tissue was normal. An example of this kind is required to demonstrate the possibility of the reproduction of an abnormality in the venation alone. Instances of this kind would certainly appear to be very rare. Berkeley, alluding to a paper by Dr Hooker on the "Vegetation of the Carboniferous Period," as compared with that of the present day, observes that two pinnules are there figured of the *Callipteris malabarica*, in one of which the veinlets anastomose, in the other they are perfectly free. As we have not had an opportunity of seeing these figures, we cannot say whether they differ in form or not; but we have observed pinnules upon this fern with free venules, differing in no respect from that characterising a normally-veined pinnule. This, then, is an instance in point, and would serve to illustrate in a certain degree the power of the venation in the reproduction of its own abnormalities. As yet we have never had an opportunity of trying the experiment, as we have not succeeded in finding spores upon one of those abnormally-veined pinnules. Although Mr Bridgeman has, in our opinion, failed in showing conclusively the influence of the venation in the reproduction of variations, he has nevertheless furnished us with interesting illustrations of that peculiar individualising power possessed by the fern-spore, even in a continuous tissue, as occurs in Scolopendrium, by which it reproduces the form of the part upon which it originates.

It now behoves us to enter into a more particular examination of the spore in its different stages of development, to exhibit those physiological peculiarities which render it so distinct from the organs of phænogams having a similar functional import. And we trust that by thus exhibiting the very distinct conditions of the reproductive organs in ferns and the higher plants, we shall be enabled to understand the nature of that peculiar power of spores which affords such great facilities for the reproduction and perpetuation of individual variations.

The reproductive organs of phænogams, as is well known, are always products of two morphologically distinct organs, the stamens producing the pollen, the carpels producing the ovules; if they be not, as some authors are inclined to think, physiologically distinct, *i.e.* the *anther* a modified leaf, and the *ovule* a modified extremity of the stem. This separation of the reproductive structures, and their necessary union for the development of the embryo, must tend to impress more fully upon *it* the essential characters of the species. The embryo being in this case the *modified resultant* of two originally distinct organs, there will necessarily be a greater tendency to efface any individual peculiarities of these than would have been the case, had the embryo been the product of a single organ. And this is simply an application of the laws of hybridisation for the reproduction and continuation of the normal specific form. As it is well known that a hybrid may in a few generations, by repeatedly crossing the successive offspring with one of the original parents, be brought back, or nearly so, to the normal form of that parent, so in the case of the specific individual, the reciprocal action of distinct morphological organs—stamens and pistils—for the production of the embryo, will have a tendency to modify the occasional variations these organs may individually be liable to in the *resultant* of their combined action, and thus be a comparative safeguard against any sudden divergence from the characteristics of their parent.

The relations of the reproductive organs of thallogams to the morphologically perfect plant, are, on the other hand, very different from what obtains amongst phanerogamous plants, as the following summary will show. The fern-spore, as before stated, originates free in the sporangial sac, the latter being an immediate product of the foliaceous structure. After its discharge from the sporangial-sac, it produces, in favourable conditions, the prothallus, upon which the true organs of reproduction are ultimately produced. The formation of the latter organs in general closes the developmental history of the spore and its prothallus; an archegonial cell, or, as instanced by a prothallus of the *Adiantum pubescens* in the Edinburgh Botanic Garden, two of these cells have been impregnated, each of which has produced a perfect morphological representative of the parent. It occasionally happens, however, that none of these cells are impregnated, and in this case the prothallus frequently exhibits an interesting analogy in its gemmative powers to those lower order of plants which it morphologically resembles—each cell seeming to possess an independent formative power, and generating secondary prothalli, morphologically similar to the primary one. As this formative power seems not to have been observed, or at least recorded before, we shall take the opportunity of illustrating it in a subsequent part of this paper.

The phenomena indicated in the preceding brief detail of the origin and development of the spore, justify the following deductions explanatory of its peculiar individualising powers.

The spore has been defined, "the ultimate germinating cell of the plant"—*objectively*, an independent organ of generation, *subjectively*, however, and truly, part of the individual cycle of the plant upon which it originates. This latter relation is, we are aware, denied by Hofmeister and others, who, in accordance with Steenstrup's theory of alternation of generations, regard the spore and its immediate products as a distinct and perfect generation. This, however, as has been observed, confounds the true generative process with a mode of mere gemmative development; hence, we prefer to apply Huxley's definition of the zoological individual to the merely objective definition which Steenstrup's views afford, and, accordingly, regard the *phytological individual* as being equal to the total result of the development of a single fertilised ovule, the cycle of individuality being only completed with the generative act. The spore, then, being an independent self-developing organism, produced by a lateral organ, the frond, and undergoing no modification by the *immediate* action of any others, *similar to what obtains in the production of the Phanerogamic embryo*, is, consequently, less influenced by the *specific morphological tendency;* and this, we believe, affords a full explanation of the phenomena in question. The spore, being a product of a single lateral organ, and thus uninfluenced by the restrictive modifications of any other, inherits and reproduces the peculiarities of this organ, or rather that part of it upon which it originates, with *greater facility* than those characteristic of the species. This view is furthermore supported by the fact, that abnormalities of the pinnæ are inherited with much greater facility than a rachidal deviation, thus demonstrating, that even in those parts of the frond less directly connected with the spore, the *specific morphological tendency* becomes equally as energetic as the *individualising.* In illustration of this, we may refer to *Lastrea dilatata*, plants of which occasionally produce from a single stipe two normal fronds. Taking spores from such a specimen, as has been done in the Botanic Garden here, and sowing them, the offspring does not, in the early state, exhibit the bifurcated rachis of the parent frond; although, as the plants increase in age, a few of them produce these abnormal fronds pretty regularly; the majority of them, however, like their parent, produce them very irregularly. Spores having been taken again from the most regularly abnormal of these, we find that all the offspring exhibit the bifurcate fronds, the abnormal and normal being nearly equal. The plants are as yet, however, in a young condition, and will no doubt, as they advance in age, like their progenitors, produce with still greater regularity the abnormalities in question.

Before passing from this part of our subject, we would briefly direct attention to the agreement exhibited between the laws governing the inheritance of peculiarities in the Animal Kingdom, and those of the Vegetable. This law has been expressed in the following manner by an eminent naturalist, as obtaining amongst animals: "That at whatever period a peculiarity first appears, it tends to appear in the offspring at a corresponding age, *though sometimes earlier*."* To clearly exhibit the concurrence of the law of inheritance in plants with that admitted to obtain amongst animals, we must necessarily know at what period in the life of the individual the peculiarity first made its appearance. Another point must also be taken into account in considering the doctrine of inheritance at different periods—viz., that in each successive generation the peculiarity appears to be exhibited at a slightly earlier period. Hence an apparent objection might be raised against the doctrine, by taking the third or fourth generation reproducing an abnormality, which had originally appeared on a frond from an old plant. As in either of these generations, the peculiarity, as has been already shown in the case of the *Lastrea dilatata*, may have begun to make its appearance in the earliest stages of the plant's life. In those ferns, however, which have dissimilar barren and fertile fronds, should the variation not appear in the early stage of the plant's life, we are inclined to suppose that the variation in the offspring will be confined to the fertile fronds, the barren retaining their normal form. In illustration of this, we may mention the *Doodia media*, var. *corymbifera*, which produces with the greatest regularity, in the mature state, the characteristic, erect, densely-tufted fronds. In raising this

* Darwin's "Origin of Species."

fern from spores, however, we find that the young plants, which produce only barren fronds, differ little, if at all, from the normal specific form, having the same spreading habit. As they advance, the cresting begins to exhibit itself on the lateral pinnæ, with a larger crest on the terminal; and they are usually two or three years old before the rachis begins to exhibit any ramifications. Occasionally, however, even in the mature state, as instanced by a plant in the Botanic Garden here, the normal barren frond is produced,—thus favouring the supposition that the variation has originated from a monstrous frond, produced by an otherwise normal representative of the species. Again, the *Blechnum Spicant*, vars. *crassicaule* and *cristatum*, on the other hand, reproduce with the greatest constancy, and, from the earliest stages, their characteristic, abnormal, sterile and fertile fronds. And the plants cultivated in the garden were perfectly abnormal when found, so that the early appearance of the abnormality in the young plants is readily explained, by supposing that the causes of variability have been called into action at an early period of the development of their original progenitors. These, then, are a few illustrations of the laws governing the inheritance of peculiarities in plants, as taken from our own observations, and we hope that others will be forthcoming, as we fully admit that there is an extreme paucity of evidence in support of these views; nevertheless, so far as we are aware, there is no evidence of a negative nature that has been brought to bear against them.

Having now briefly considered the relations of the fern-spore and plant, and indicated the probable cause of that peculiar power which the spore possesses for the reproduction of accidental variations, we will next proceed to consider the spore as a product of parthenogenesis. To substantiate our claim, however, for regarding it as such, it is necessary to show what grounds there are for the belief in parthenogenesis in plants, as of late the doctrine has been doubted, and even denied, by many botanists. It therefore becomes necessary, in hypothetically regarding the fern-spore as such, to furnish some positive evidence of parthenogenesis amongst plants. In using the expression "positive evidence of parthenogenesis," it is of course only in the sense that a plant may be developed from a germ without any direct action of the male element. Professor Owen's theory of parthenogenesis may, or it may not, be true; it is sufficient for our purpose to give examples of the phenomena. And, indeed, by so doing, we substantiate a claim for the acceptance of the theory, as it can scarcely be denied that the inherited portion of the generative force—at least in the lower forms of vegetative life—is of too subjective a nature to exhibit any objective existence.

Accepting, then, the supposition alluded to in a preceding part of the paper, we regard the *spore* and its *immediate products* as parthenogenetic, satisfied that in so doing we shall have the most philosophically accordant explanation of the phenomena under consideration. And, by thus limiting the influence of the preceding generative act to the spore and its immediate products, *i.e.* the prothallus, antheridial, and archegonial cells, we invalidate an objection to the theory in its present application which has been thus expressed: "If the impregnation of the spore influences the whole future individual and its produce, would it be reasonable to expect the spores from an abnormal frond to reproduce in their offspring that abnormality?" The tenability, however, of this objection to the doctrine, even as originally applied, is very questionable, on a fair consideration of the results of parthenogenesis. It is well known that the offspring of parthenogenesis do not represent all the characteristics of the species, the male individual being always, so far as known, absent. Hence, the fact that female individuals alone are produced, demonstrates a modification in the inherited portion of the generative force, otherwise both would have been reproduced. And why, it may well be asked, may not the inherited portion of the generative elements in ferns also undergo a modification similar to the organs through which they have been transmitted, and thus admit of the reproduction of a similarly modified individual? In fine, we consider the latter view as much less gratuitous, though, as we before showed, insufficient for all the requirements of the case, than that which, regarding the *spore* as a *flower-bud*, must necessarily assume that the reproductive elements generated upon the prothallus, and which consequently have had no objective existence in the parent, will nevertheless faithfully reproduce the characters of that organ of the parent they never had any immediate connection with.

The opinion, then, that the spore and its immediate products are the resultants of that portion of the generative force inherited from the preceding generative act, seems to be more fully accordant with observed phenomena than any other yet proposed. This hypothetical accordance will, however, be of small avail, if, as has been averred, parthenogenesis has no existence amongst plants. Such is the position assumed by Dr H. Karsten in his paper "On the Sexual Life of Plants and Parthenogenesis," in the Ann. and Mag. of Nat. Hist. vol. viii., from which we extract the following, being the conclusions which Karsten considers his investigations justify: "That all known species of plants possess, besides an asexual multiplication of individuals by cell-division or gemmation, a means of preserving the species by sexually developed germs, and that in these special reproductive organs a normal germ is never formed without the operation of a fertilising material; that, consequently, parthenogenesis never occurs in plants." Generally sweeping, however, as this conclusion is, it is far from being based on a general examination of all the known instances of parthenogenesis in plants. Dr Karsten undoubtedly proves that certain supposed cases of parthenogenesis were in fact true products of sexual generation, as instanced by Cœlebogyne, which produces at times hermaphrodite flowers; but there are other cases in which no such error of observation has yet been detected. Braun, in treating this subject, gives, besides the Cœlebogyne, a Chara in illustration of the doctrine. Karsten, however, in examining this paper, satisfies himself by exposing the errors of Braun's observations in the former instance, the latter being entirely ignored, which certainly is not a fair procedure in one who avers an anxiety for the discovery of the truth, and eschews the fallacious evidence of a preconceived interpretation. The example alluded to is, nevertheless, perfectly satisfactory, as may be seen by the following extract from the notice of Braun's paper in the Trans. Ed. Bot. Soc. vol. vi.:—"The *Chara crinita* is said to be diœcious, yet we seldom can detect antheridia. Braun has in vain attempted to find these organs; he therefore considers it as usually represented by female individuals, and that, nevertheless, it produces in abundance sporangia and fertile spores. M. Requiem has recently found male plants at Courtheson, near Orange, bearing antheridia. . . . . Braun considers himself justified in attributing to *Chara crinita* the power of producing, at least in certain localities, without the action of male organs, perfectly formed spores fit for germination, and that, consequently, it is a true case of parthenogenesis." Another example has come under our own observation in the Botanic Garden here, where we have been successful in raising the Nardoo, *Marsilea quadrifolia*, var. *macropus*, from archegonial spores separated carefully from the antheridial, after the bursting of the primary receptacle, and before they had been acted upon by the spermatozoa of the latter, as the antheridial cells do not burst for several hours after the dehiscence of the primary receptacle. It is worthy of remark, however, that the germination of the archegonial spores, so far as our observations go, is much retarded by their separation from the other organs of the receptacle. This may partly be attributed, perhaps, to the mere chemical action, arising from the decomposition of the contents of the receptacle, which will no doubt have a tendency to accelerate the development of the unseparated spores, independently of the fertilising influence of the antheridial. Again, it has been shown by Duverney, that the archegonial spores of Salvinia are also capable of development, when separated from the antheridial. And this affords even a more conclusive instance of parthenogenesis than Marsilea, as the antheridial and archegonial spores of the former are contained in distinct receptacles, while in the latter they are contained in one.

These few examples, then, will, we trust, be sufficient for our present purpose, *i.e.*, to substantiate a claim for the existence of parthenogenesis in plants. And, at a subsequent period, we hope to lay before you the results of a series of experiments instituted for the purpose of testing more satisfactorily the validity of this doctrine, which, according to Karsten, has lost its last insecure prop; and who states "that the doctrine of parthenogenesis in plants is thrust aside, and it is established beyond doubt, that the production of a normal germ in the female organs is dependent upon the co-operation of the male organs of plants."

We will now proceed to examine the phenomena presented by the prothallus after the abortion of the archegonial cells. In a normal condition, the prothallus, after attaining a certain size, ceases to develop cells externally, and shortly after, from a point on its under surface, near the sinus, the primary frond is in general produced. At times, however, the prothallus, instead of producing the young plant, recommences a merely vegetative development, in a variety of ways. Thus, it at times increases by the development of cells at its circumference, attaining a large size, or it may produce a number of upright lobes, while in another these lobes are recumbent, the one overlapping the other. These, then, are the more common modes in which prothalli develop, the lobes in all these cases being very irregular, and indefinite in form. Instead of producing these indefinite forms, however, the prothalli at times exhibit a tendency to a "vegetative repetition of similar parts;" an example of which occurred under our own observation in the Botanic Garden here, where the whole surface of a prothallus became covered with minute granulations of green cellular tissue. These, on examination, were found to originate from the individual cells of the prothallus; each, however, retains its individuality, and now present miniature fac-similes of *normal prothalli.* In this instance we found no less than *forty* of these *secondary prothalli* developed from the surface of the single primary prothallus. In another example of this kind, which occurred on a prothallus of the *Asplenium obtusatum*, these secondary prothalli were confined to the circumference, forming a fringe around its margin. Another very anomalous appearance presented itself in the *Gymnogramma leptophylla*, of which we raised a fine healthy pot of prothalli in March 1861. These, however, having been inadvertently exposed to the direct action of the sun, were nearly shrivelled up before they were observed. Indulging a hope that they might possibly recover, we did not turn them out, but placed them in a moist, shady situation, and found that, to a certain degree, this had the desired effect of restoring them. They, however, never regained their former appearance, and in a short time a gradual decay commenced from the circumference inwards, till at last we thought they had entirely died off. On examining a few of the dried-up and apparently lifeless remains of these prothalli, we were surprised to find that they had each produced a small, somewhat ovoid, cellular nodule. These nodules, or gemmoid bodies, appear to perform the functions of hybernacula, as, after a short period of rest, they each produced, in varying numbers, small tufts of narrow, erect, forked, marchantia-like processes. Whether these will ultimately produce young plants, or continue for a time a merely vegetative development, and ultimately decay, it is impossible, in their present condition, to say; and so far as our examination goes, there are as yet neither antheridial nor archegonial cells developed upon them. The late Professor Henfrey, in treating upon these points, remarks, " that after the abortion of the archegonial cells, the prothallus may again commence a vegetative development, but *will never produce young plants.* The latter opinion, however, does not agree with observed facts, as we have at present prothalli which recommenced this vegetative development some time ago, and from which young plants are now produced; and, we may also remark, that these are produced upon newly developed portions of the prothalli—thus demonstrating that the power of reproducing the plant *is* retained after the abortion of the primary archegonial cells. It must be borne in mind, however, that this has reference to those kinds of development alone where the original prothallus is increased by the development of cells around its circumference. As to the results of the other modes of development we are as yet ignorant, though it does not appear at all improbable that even these more anomalous prothalloid developments may likewise produce young plants.

Before concluding our remarks, we may briefly examine two other points connected with the subject we have been considering. First, the supposed incapability of the early spores of tree-ferns to germinate; and, second, the power which the fern-spore possesses of retaining for lengthened periods its vitality. In regard to the first of these opinions, then, it has been observed by Dr Lowe, " that the early spores of tree-ferns are asexual, and incapable of germination." Following out this somewhat gratuitous opinion, Dr Lowe completes the fanciful analogy he has drawn between the organogenetic powers of the higher plants and ferns, by regarding these so-called non-fertile spores as similar to the *leaf-buds* of the higher plants. Thus, he remarks, " it is well known that young trees have a greater tendency to produce leaf-buds than flowers, and this may serve to explain why the earlier spores of tree-ferns are asexual, if we regard them as *leaf-buds*." " In later life," he continues, " the plant would naturally produce floral-buds, and these, of course, would be provided with sexual organs." This opinion, however, of the infertility of the early spores of tree-ferns, though thus given as an acknowledged fact, we cannot but regard as very doubtful, inasmuch as we have found no difficulty in raising various species of tree-ferns from the first spores produced by young plants. We may state, that we have succeeded in raising the following tree-ferns from these early spores, viz., the *Alsophila excelsa*, *A. Miquelii*, and *Hemitelia grandifolia*, all of which germinated freely. Again, the existence of those so-called " asexual spores" is disproved by the fact, that the first spores of the dwarfer kinds of ferns exhibit no such phenomenon, which they certainly ought to do were the view under consideration correct. And we have experimented on spores from very young plants. Amongst others which we have tried, we may mention *Asplenium Shepherdi*, *Athyrium Filix-fœmina*, and *Lastrea dilatata*, all of which, as is well known to the fern-cultivator, exhibit a tendency, even in the youngest fronds, to produce spores. These, then, like those produced on the early fronds of the more noble representatives of the order, are theoretically asexual, as they must be regarded by the supporters of the preceding analogy as occupying the same position amongst ferns that the perennial shrubby plant does amongst phænogams.

These experiments, however, have been considered as inconclusive, on the ground, that as restriction of the roots has a tendency to produce the more early production of floral-buds, so in the case of ferns grown and restricted in pots, they, as a natural consequence, will produce the homologue of the floral-bud—the perfect spore. This, so far as regards the mere production of spores—in tree-ferns at least—is quite correct, as we observe Professor Balfour, in his "Class-Book of Botany," in remarking on the rare occurrence of fructification in fossil-ferns, directs attention to the tree-ferns of the present era, whose fronds rarely exhibit fructification, as affording, in all probability, an explanation for the rare occurrence of fructification in fossil ferns. In admitting this, however, we do not at all invalidate our experiments, seeing they were made upon the *earliest spores* produced by the young plants, consequently they ought to have been the "asexual" productions, if such are ever produced, and of which we have already expressed our doubts. In fine, the non-germination of the spores in the experiments—which we suppose have been made—may be due to unsuitable physical conditions, as has been well shown by an experiment in point made in the Botanic Garden here. Mr M'Nab had been repeatedly unsuccessful in his attempts to raise the *Cyathea arborea* from spores taken from a fine old plant in the stoves. These experiments were tried in a mean temperature of 60° Fahr. From the success attending other experiments which Mr M'Nab had been repeating in higher temperatures, he was induced to try the spores of the *Cyathea arborea* with an increase of temperature likewise. They were accordingly placed in a moist, shady situation, in a mean temperature of 75° Fahr. The experiment proved perfectly successful, as in fourteen days, by the aid of the lens, the spores were all seen to be in a germinative state, and at present there are plants in the stoves raised from them. Thus we have an instance which might have induced the less demonstrative theorist to conclude at once that these spores were imperfect "asexual" productions, without for a moment considering that their so-called asexuality might be a consequence of uncongenial physical conditions. And therefore we consider ourselves justified in regarding the non-germination of the early spores of tree-ferns, in the experiments we presume to have been made, as due to accidental causes, such as unsuitable physical conditions, immaturity of the spores; or, perhaps, the bursting of the spore-cases, and escape of the spores before the former were committed to the soil. These, then, are a few of the probable causes that may afford an explanation of the opinions we have been considering. But whether they do so or not, our experiments nevertheless demonstrate that there is no generally recognised law in the economy of the tree-ferns warranting the acceptance of the view, that *asexual spores* precede the *sexual* in the life of the individual.

2. In regard to the capabilities of spores retaining for lengthened periods their germinative powers, little information is at present to be found. Indeed, so far as we are aware, the only instance on record is that mentioned by Professor Balfour, in his "Class-Book," p. 628, where it is stated, that "two plants of *Gymnogramme calomelanos* were obtained from spores which were taken from the Herbarium of Forster, and were about fifty years old." We, however, have been less fortunate in our attempts to raise ferns from spores taken from Herbaria, though we have experimented on a large scale. Having taken spores from upwards of two hundred species, from the University Herbarium here, the dates of which varied from 1827 to 1859. Amongst these we observe the *Gymnogramme calomelanos* occurs twice, bearing respectively the dates 1827 and 1844. From neither of these spores, however, did we succeed in raising a single plant of the *G. calomelanos*, though a few other ferns came up in the pots. This was, indeed, the case in the majority of our experiments; but not a single instance occurred of plants of the species labelled being produced in their respective places. The growth of other species of ferns in the pots took place, though the greatest care was taken to exclude all other spores, each pot being covered immediately after the spores had been sprinkled on the surface of the soil. May this not have been the case in the example of the *G. calomelanos* raised from old spores? We are much inclined to suspect that the *Gymnogramme* may have been produced from the accidental introduction of recent spores amongst the old ones; more especially because *it*, and other species, are perfect weeds in

the stoves where they are grown, springing up wherever a suitable *nidus* presents itself. Indeed, it is difficult otherwise to understand the complete failure in the numerous experiments we have made for the purpose of determining the vitality of fern spores, as these were taken from fronds in an excellent state of preservation, and the conditions they were placed in were fully sufficient to have called into action their dormant vitality, had they possessed the power of retaining it. In fine, the numerous unsuccessful experiments we have made on this point certainly justify us in concluding, that the spores of ferns do not retain their germinative power for any length of time in the ordinary conditions of Herbaria. What their capabilities may be for retaining *it* when buried in the soil, we cannot at present positively say, though it would appear, from experiments now pending, that they, like certain phanerogamic seeds, may retain this power for long periods.

On the Origin of Aerolites. By Mrs G. S. Silliman. Communicated by the Authoress.

Fragments of stone of a peculiar character, not identical with any telluric masses, are known to have fallen from the atmosphere upon the earth for more than two thousand years. They have come from fire-balls careering in the clear sky both in the day and by night, and also from small, very dark clouds, which suddenly threw down showers of stones like hail. These were dissimilar in size, appearing to have been shattered and crushed in the fall, but possessing a thorough identity of constituents with those which fell from the meteor or fire-ball. In their original condition they are invested or coated by a crust or rind peculiarly characteristic of these bodies, being only a few lines in thickness, often glossy and pitch-like, and sometimes veined. This black crust, though adhering closely, is divided from the inner light-grey mass by a sharply defined line of separation.*

Biot states that we are indebted to the all-registering

* Humboldt, Kos. i. p. 118. The peculiar colour of the crust was observed as early as the time of Pliny.

Chinese for the record of the most ancient aerolites, and he enumerates sixteen falls between years 644 B. C. and 333 A.D. They have fallen in India, in Siberia, in Greenland, and in many parts of Europe and America. The most remarkable one of antiquity fell at Ægos Potamos, in Thrace, 400 years B.C. It is stated in the *Parian Chronicle* that it was the size of two millstones, equal in weight to a full waggon load.*

The largest masses have been seen to fall from fire-balls, or single meteors, moving swiftly in the clear sky, accompanied by flashing light and a report like prolonged peals of thunder. The aerolite which fell in Weston, in Connecticut, in 1807, excited no common attention. A reliable witness† of it told the writer that a flashing light and the noise of a crashing fall a few feet from the place where he stood, drew him to the spot, where he found broken pieces of stone quite hot, and instantly the report followed like thunder. Two or three miles beyond this first fall, several more fragments were deposited within the area of a mile. The largest piece fell in a ploughed field, and was nearly buried. It weighed 36 lbs. Other pieces descending on pasture ground, and two, in particular, on a grassy door-yard, did not penetrate below the surface.‡

When aerolites have fallen from small, very black clouds, like showers of hail in variously shaped, often angular, fragments of all sizes, they have been accompanied with flashing light and rattling reports like artillery. Such were those seen in the Department of Ardeche, in France, also in the Llandes, and at Alençon and Aisne.§

The ancients were not indifferent observers of these surprising phenomena. They proposed a great variety of theories and hypotheses accounting for them. Among many others, Anaxagoras of Clazomena, and Diogenes of Appolonia, thought they were projected from dark invisible bodies or stars moving in space. According to Diogenes "invisible masses of stone move with the visible stars, and the former sometimes fall

* *Par. Chron.*, 113 of the Attic era.

† Merwin Burr, Esq,

‡ The pieces discovered were estimated at three hundredweight.

§ In this instance there fell upon an elliptical surface, whose major axis had a length of six miles, a great number of meteoric stones, the largest of which weighed seventeen and a-half pounds.

upon the earth."* The Greeks, more distinguished for fertility of imagination than for patient and thorough inquiry, after the fall of the great Thracian aerolite adopted the views of Anaxagoras and Diogenes, as did the Ionian school before the close of the Peloponesian war. This opinion prevails to some extent at the present day; while some imagine that the stones fall from terrestrial satellites, some that they come from the moon, some that they are projected from volcanoes, and others that they proceed from invisible comets revolving in very elliptical orbits; that when approaching the earth they fall within its atmosphere, and by the friction of the air become heated and electrified; that then the electricity is discharged and sends off a portion of the mass, and the comet pursues its way into the regions of space. By many it is believed that they are foreign to the earth, and fall upon it from some other sphere. Humboldt suspects that "they may come from some crumbling asteroid, because the solid mass could not instantly run together from any known state of gas or vapour, and because their motions have been observed to be opposite to the rotatory movement of the earth.† Kepler is one of the few who dissent from these and similar hypotheses. With such an example, and a few of modern date, I may without temerity entertain different views from those generally received.

It seems not in accordance with ascertained science to ascribe mysterious appearances on the earth, or in its atmosphere, to causes proceeding from planets, or spheres moving in space, *independent* of the earth and its system. Looking into unknown regions for subtle and complicated causes will not be likely to unveil mysteries; for, "when revealed, those mysteries are always found to be the result of a few simple, invariable laws."‡ It has been said truly, that "the only media by which we are brought in connection with any portions of the universe beyond our atmosphere are light and heat."§ The question then arises, whether the elementary materials and chemical processes which originate meteorites

* Humboldt, Kos. i. p. 569. Stobeus Ency. Phys. p. 503.

† Kos. i. p. 237. ‡ Sir John Herschel, System of Astronomy.

§ Kos. i. p. 125.

do not all exist and act in our atmosphere. If masses of solid matter descend upon the earth from other planets, satellites, or asteroids, would not the *position* of the earth, after receiving such additions, be altered in space? Would not its course deviate from its primary orbit in the progress of ages? Would it not interfere with, and ultimately come in collision with, some of the heavenly bodies, destroying the harmony and stability of the system? It has been replied, that the quantities are so inconsiderable that the added weight would be inappreciable. If not at once appreciable by our senses, would there not be in process of time a failure in the astonishing accuracy with which the planetary motions are fulfilled in space, even to the fraction of a moment? Would not the added weight from other spheres be sufficient to sway a globe poised with *infinite* exactness? The accumulated weight in long periods of time must be much greater than appears on a slight or hasty view of the subject.

Meteors cannot be, as some imagine, astronomical phenomena. Their *erratic character* is a conclusive test that they are not. The movements of the heavenly bodies are certain, regular, and strictly periodical, while the movements of atmospherical bodies are uncertain, irregular, and only occasional. In striking contrast with the solemn certainty and grandeur of the heavenly bodies are the fleeting fugitive motions of the dark meteoric stone. The sun, moon, planets, constellations, comets, are all obedient to *periodical law.* Their times, and circuits, and motions, are defined by the most rigorous mathematical computations; and they fulfil their rounds with hair-breadth precision, far above and beyond the fickle currents, the forces, attractions, and affinities, wavering in the atmosphere.

"The fall of meteorites is much more frequent than is generally believed. Great numbers must fall in the ocean, and on uninhabited parts of the land unknown by man."* Doubtless as many have fallen through all past ages upon this continent as upon the old world, where over our past wildernesses, and lakes, and rivers, and oceans, there was no eye to see them. If a trapper or an Indian had been awe-struck by the pheno-

* Connection of the Phys. Sci. p. 312.

menon, he had no way to communicate his astonishment; there was no auditor to comprehend or remember them, nor hand to record them. Pliny describes the fall of meteoric stones as being "*frequent;*" and, in more modern times, Olbers states, "that it appears probable, from the researches of Schreibers, that there are about 700 falls annually." In the great Italian shower at Crema, in 1663, Cardenas affirms that "1200 fell; that one fragment weighed 120 lbs., and was of an iron-grey colour." The stones were of all sizes, and the cloud from which they fell of uncommon blackness and thickness.* Many more cases might be cited of their existence in the Arctic and Tropical regions, and in every part of the world, but always known, wherever they are found, by the presence of nickel and iron, which combination does not exist in telluric rocks. Would not the aggregate of all these masses, known and unknown, displace the almost invisible fibre by which the exactness of planetary motions is computed?

As the constituents of aerolites are identical with minerals and metals found on the earth, *though the combinations are different from any terrestrial masses, it is rational to search for their formation among the agents and forces known to exist within the earth's system.*† Is not magnetism, with other known agents, and the power of chemical action, sufficient to attract and consolidate meteorites with their accompaniments, as fireballs, fiery meteors, or very black clouds, from which they are precipitated upon the earth? It is a fact to be remembered, and one of great importance, that meteorite stones in all zones, and wherever found, have the same phy-

* Kos., iv. pp. 588, 589.

† The recent study of those wide-spread atmospheric accumulations of meteoric dust—a single case being recorded where the area must have been thousands of square miles in extent, and where the quantity of earthy matter must have been from 50 to 100,000 tons in weight—makes known to us the vast scale on which terrestrial matter often pervades the regions of the upper atmosphere."—*Shephard's Report on Meteorites.*

"According to Biot, clouds of metallic dust are retained in those remote distances."—*Idem.*

"Showers of dust sometimes accompany and follow the fall of aerolites, which are a fine impalpable powder, whose chemical composition corresponds with that of meteoric stones."—*Idem.*

siognomic resemblance. Perhaps it is not second to that other fact, that the presence of iron and nickel combined in them is an unfailing criterion of their meteoric character.

Professor Faraday (on Atmospheric Magnetism) states, that "magnetic power emanates in lines of force from the earth, rising into the atmosphere, which is in reality a magnetic medium, where it is ever present in greater or less degrees of intensity, completing in the air its circuit of power." Iron and nickel are peculiarly susceptible of magnetic attraction. They are invariably associated in meteorites; they are "always *present* in them, if amounting only to an alloy, and are an especial criterion of the meteoric nature of the mass." According to Berzelius, "many specimens of meteoric stones contain other metals and earths; in all one-third of the simple substances known, and the same which are met with through the crust of the earth;" and it is a striking fact, that no strange or anomalous substance has ever been found among their constituents—nothing but specimens known to be of terrestrial origin. Magnesia constitutes commonly one-half of the earthy constituents of the meteoric stone. Water is ever present in the atmosphere; also magnesia, carbon, sulphur, iron, nickel, and other metals and earths in a state of vapour, or gas, or dust.*

In the various analyses of aerolites, *silica* is a prominent constituent. Whether it is raised mechanically in dust, or in its soluble state, and how it performs its part in the mysterious compound, is a problem for further inquiry.†

Silicic acid united with oxide of iron and magnesia, or other earths, forms rocks differing in character, according to their quantitative proportions.‡ Sulphur and sulphurous acid must

* Ehrenberg says, that the dust region in the atmosphere is of vast extent.

† In April 1719, there fell into the Atlantic Ocean, in N. L. 45°, a shower of sand, preceded by a luminous meteor. No volcanoes on those coasts."—*Certified by the Captain and Crew of a vessel to Father Feuillee,* Ed. Encyc.

A shower of sand accompanied a fall of small stones at Cazone.

Certain it is, that sand was mingled in the Sienna meteorites, thus pointing to an intimate connection between silex in the loose and in the consolidated state.

‡ "When water is cold it contains carbonic acid in solution, and then decomposes many minerals—even those which appear unalterable, such as hornblende, feldspar, &c. Combined with heat and pressure, it will dissolve sand,

be among the active agents in the meteoric aggregation, as the odour of sulphur is always present when the meteor falls, and sulphur is generally found to be one of its constituents. The masses vary in solidity and compactness; some being weakly coherent and porous, others sprinkled with metallic specks and rounded oval grains; and while some resemble grey porphyry, others again are very hard and refractory, such as the meteoric iron masses.

When it is considered that there are ponderable substances in the atmosphere—that it is laden with thousands of bodies foreign to its component parts—it may be inferred that nickel, iron, and other metals, with the various earths, are magnetically and chemically attracted and consolidated in the air The atmosphere itself, though always the same in its composition, is not always in the same state; not always equally attenuated at corresponding elevations; not always calm nor always disturbed at the same altitudes; it varies with the effects upon it of many agents that are not understood, and is subject to many phases that have not been accounted for. But it is known to sustain heavy bodies. These fall to the earth when, by their inherent properties, or the sudden action of heat, or some explosive or other force, the power which had upheld them is overcome. Humboldt remarks: "There is something strange about them (meteorites). The combination of the elements is unlike all that our terrestrial mountain and rocky masses exhibit." Hence it is obvious that they are formed in a different medium, and not on the earth or under the sea. Although the constituent parts are often identical with many mountain and rocky masses, yet they bear the impress of atmospheric laws, and show that they have not been elaborated by heat under pressure, nor by sedimentary deposits from floods, *but by the action of chemical affinities, magnetic attractions, and other invisible forces in the* FREE AIR.

one of the most insoluble of substances. The chemical reactions occurring in waters holding different compounds in solution would account for many changes, and the action of exhaling gases from the earth must exert a decided influence."—*Silliman's First Principles.*

"Phosphoric and titanic acids have been detected in aerolites by *Rammelsberg.*"—*Ann.* 83, p. 337.

If the elements are attracted and combined by magnetism and chemical affinities, elevated and moved by elastic vapours and aerial electricity, the mass may be suspended in part by its form and by the upward pressure of the atmosphere; if it is an inflated, hollow sphere, then in part by its contents, and possibly in part by the occult forces which take up and convey heavy bodies in the black cloud of a tornado. The suspension of a meteor in the air can cause no surprise when the ascent of a balloon with men and horses and other ponderous substances is not found impracticable.* The meteor has this great advantage: it depends on no *artificial adjustment*, but all the materials, affinities and forces requisite for its aggregation, suspension, and ultimate explosion and descent, are present in the free air, with an energy not attainable by man. The irregular convexity of surface which marks many meteoric stones indicates that the masses were globular when entire, and if globular, it is further evidence of atmospheric combination; because all fluid and plastic substances assume spherical forms if suspended in the air; and these masses were doubtless plastic, though not probably fluid, in the incipient stage.† Their internal constituents appear to have been primarily aggregated without the influence of heat. Even the rounded globules found in many of them bear no mark of fusion, but "are evidently dependent on a cause analogous to that which determines the configuration of hailstones."‡ Some are soft when they fall,§ impressible like putty, and harden by exposure to the air; but almost all the specimens, when found, seem to have been rent by explosions, which suggest that there was a cavity or cavities in the mass, containing water, perhaps hydrogen or other expansive vapours.

Chemical action evolves electricity. Electricity is a source of heat. It appears as though a sudden electro-magnetic action,

* "Bodies in air lose a part of their weight."—*Silliman's First Principles*, p. 214.

† "They have in general a *spherical figure*, in which we often observe indentations."—*Ency. Amer.*, vol. viii. p. 439.

‡ Professor Shephard's Report on Meteorites.

§ As at Barbotan—*Ency. Ed.*, p. 138; and at Scriba, N. Y.—*Shephard's Report*, p. 20.

or perhaps it were better to say a meteorological process evolving heat, spontaneously igniting and fusing the gaseous materials and vapours which were collected and slumbering around the exterior of the mass, by its flashing fires, produces the thin, dark coating which invests them all. "The dark crust must be the effect of a powerful, though momentary heat; for the sulphurous and metallic particles immediately beneath it do not change colour or lose their lustre." By the same process, and at the same time, it is most probable that the mass is suddenly heated enough to expand any explosive contents enclosed in it, kindling the vapours and gases, swelling and rending the bubbling meteor, and with tornado energy hurrying its swift descent to the earth.* Who has analysed the fierce cloud of the hurricane, or the sullen simoom, or the resistless power which lifts and conveys heavy bodies on the dark wing of the tornado? These phenomena are seen in these lower regions of the air; yet the tremendous chemical action, the attractions and affinities making up the meteorological processes in them and in the upper air, are unexplained. The gain of knowledge, however, thus far obtained, almost gives assurance of further revelations.

Much has been done and is doing to measure and ascertain the deposits, deep-sea currents, and drifts of the ocean, and their influence on the earth and air. The great atmospheric ocean, with its mysterious phenomena of intense interest, this age of inquiry cannot fail to explore.

It is maintained by some that the meteor is a large body traversing the heavens, and that after disengaging fragments of itself, and shooting them off to the earth, it moves on, revolving around the planet, or pursuing its way into the regions of space. But has the main body of the meteor ever been seen after the explosion? In all the descriptions given by eye-witnesses of the many falls contained in the accompanying catalogue, not one has ever seen the meteor "*travel on.*"

* "Chemical rays of light may have some part in this matter; for, by their action on chlorine and hydrogen gases, they are made to combine with explosive energy."—*Sillimann's Chem.*, p. 50.

It has been long known that the direct rays of the sun would cause the explosive union of these gases.

The general remark of those who saw the fall, or who were near at the time, has been, "*it fell and went out*," or, "*it vanished.*" Must it not be believed that the whole body, be it more or less, fell to the ground when it exploded?

Among many very striking incidents which might be cited favouring this inference, is a letter from Maurice Crosby Moore, Esq., of Moore's Fort, near Limerick, county Tipperary, giving conclusive evidence of the descent of the entire mass to the earth.

"In May 1810, some workmen laying leads on the roof of my house, between 11 and 12 o'clock A.M., heard a strange noise, and thought the chimney was on fire. On looking up, they saw a small black cloud, very low, carried by a current contrary to the mass of the clouds. It flew with great velocity over their heads, and fell in a field three hundred yards from the house. *They saw it fall.* The stone was immediately dug up, carried to the steward's house, and remained two hours cooling before it could be handled. I saw the hole it made in the ground, not more than a foot in depth. It weighed 7½ lbs., and the entire surface was covered with a thin, brownish-black crust, evidently the effect of a rapid heat."* The other particulars of this account, even the rounded globules contained in the stone, and the analysis showing it to be a genuine aerolite, are here omitted for the sake of brevity. The incident is quoted for the evidence it gives in the full light of day, that the *whole mass fell*, and no remainder "travelled on."

The projectile force of the explosion must direct the course of the meteor, which may or may not conform to the earth's rotation. Its course being opposite to the earth's rotation, is therefore no token that it came, as Humboldt imagines, from a "crumbling asteroid."

Many of the computations regarding the immense height from which meteorites are supposed to fall may be erroneous; but if not, and the formation of the meteor takes place in the upper air, where it is supposed that the great accumulations of meteoric dust are, it still more favours the theory of their

* Edin. Encyclopædia, xiii. p. 149.

atmospheric origin. Their altitude may be far beyond reach of our vision before the descent commences.

It seems to be no valid objection to the atmospherical combination of aerolites that " they cannot instantly run together from any known state of gas or vapour."* It does not follow that the time required to form the aggregation must be instantaneous because its appearance is sudden. The meteor may be long in forming, though the flashing light and the thunder of the explosion give the first notice of its existence to the inhabitants of the earth. The fall of showers of stones from pitchy clouds, in thousands of irregular, often angular-shaped fragments, indicates that they are broken by explosion ; and their constituent parts being the same as those from fire balls, or single meteors, identify them as meteoric stones. The lightning flashes and reports, sometimes like musketry and artillery, at others like long-continued thunder, add presumptive evidence that they are combined in the air.

In reviewing this subject, it is seen that this phenomenon awakened the attention of the ancients more than two thousand years ago. It has caused every eye-witness to wonder and pause, from Greenland and Siberia to sunny Italy, Greece, and Spain. In the middle ages it excited religious terror and superstition, as being portentous of dark vicissitudes and public calamities. In these later times men discard the gloomy imaginings of the past, and are diligent in divining and investigating its origin and cause,—seeking its advent here from distant planets or the regions of space,—from " crumbling asteroids" and invisible satellites. Science has removed the dim but fearful shadows that hung over the student of nature, obscuring his way. By the clear revelations and facts now before him, he ventures upon hypotheses which, if only probable, may open the way for brighter light to beam upon the future inquirer.

In view of the attracting and forming powers and forces known to exist in the atmosphere,—the gases, the acids, the dust, the chemical affinities, the great solvent *water*, electricity, and magnetism, all present in the free air, and all acting conformably to the laws and properties made inherent in

* Humboldt, *ut sup.*

them by the Creator,—is it not more in harmony with the integrity and perfection of His works that this phenomenon should originate in a meteorological process, than that the symmetry of the creation and the order of the planets should be violated by a visit to the earth of a lone, foreign intruder from the depths of space, or from some other sphere, without analogies or any apparent purpose?

The following catalogue is compiled principally from the "New Edinburgh Encyclopedia," vol. xiii., and the Chronological List in the first volume of the "Edinburgh Philosophical Journal," consisting of Cladnis' printed catalogue and a MS. list by Thomas Allan. The remainder has been derived from sources equally reliable, and every instance named is believed to have been that of a true and unmistakable Aerolite.

Chronological Table of Aerolites.

B.C.

1478. A stone fell in Crete. Regarded as the Symbol of Cybele.—*L.* 18, 19, *Chronicle of Paros.*

1200. Also one in Orchomenos.—*Pausanias.*

1168. A stone fell on Mount Ida.—*Chron. Paros.*

750. The deity which fell down from heaven, worshipped by the Phœnicians, was a large black stone, not polished by hands, circular below, and terminating in a cone.—*Herodian.*

705. The Ancyle, or sacred buckler, fell from heaven in the time of Numa.—*Plutarch.*

670. A shower of stones fell in the days of Tullus Hostilius. "Was solemnly celebrated as a supernatural occurrence."—*Livy.*

654. "The earliest historians of China make mention of stones falling from heaven."—*De Guignes.*

491. A stone fell in Crete.—*Calmet.*

466. The famous aerolite of Aegos Potamos was the wonder of all the countries of Greece, and was exhibited by the people of the Chersonesus, who held it in the greatest veneration, and deemed its fall an omen of victory.—*Plut. Life of Lysan.* vol. iii. p. 100.

463. A stone fell in Ancona; also one near Thebes.—*Val. Max. Schol. Pind.*

461. A shower of stones in the marsh of Ancona.—*Liv.* lib. 7, c. 28.

B.C.

343. A shower of stones fell near Rome.—*Jul. Osequi.*
211. A stone from a meteor in China.—*De Guignes.*
205. Fiery stones.—*Plut. Fab. Max.*
205. A fall of stones in Ancona.—*Livy.*
204. A stone of a dark hue and metallic aspect fell in Pergamos. Was worshipped as a sacred idol in Rome.—*Plut. Fab. Max.*
206. A shower of stones; and
196. Several large stones in China at nineteen different falls. } *De Guignes.*
176. A fall of stones in the Lake Mars.—*Livy*, xii. 3.
56. Spongy iron in Lucania, and a shower of stones at Acilla in Africa.—*Cæsar.*

38. Six stones,		
29. Four ,,		
22. Eight ,,	}	Fell in different provinces in China.—*De Guignes.*
12. One ,,		
9. Two ,,		
6. Sixteen ,,		

A.D.

452. Three large stones fell in Thrace.—*Chromion.*
501. A shower of stones at Bender, in Arabia.—*Procopius.*
501. Two stones from a globe of fire on Mount Lebanon.—*Proust.*
823. A shower of pebbles in Saxony.—*Mezeray Bonaventura.*
852. Stones fell in Tabristan and Chenan in Japan.—*De Sacy.*
855. Five stones fell in Egypt.—*De Sacy.*
905. Stones fell in Japan, also in Ahmedadab, and at Hoang Lee, in Corsa.—*Quatremere.*
998. A very large stone fell near Augsburg.—*Albertus Stabius.*
1009. A fall of stones near Magdeburg, and one near the Elbe; also one in Cordova.—*Avicenna.*
1021. A number of stones fell in Africa.—*De Sacy.*
1135. Large stones were precipitated from the air in Thuringia.—*Spangenburg.*
1198. Stones fell near Paris.—*Henry Panvel.*
1249. The descent of stones from the sky was remarkable in various parts of Saxony.—*Spangenburg and others.*
1263. Stones fell at Wieloxoi, Russia.—*Gilbert, Annalen.*
1280. A large stone in Alexandria, Egypt.—*De Sacy.*
1304. Oct. Many stones fell in the fields in Saxony, doing much damage near Friedland.—*Krantz.*
1305. Burning stones fell in the country of the Vandals.—*Bonaventura St. Amable.*
1328. In Mortchia and Hoang Lee.—*Quartremere.*
1368. Stones fell from the clouds in Yorkshire.—*Phil. Mag.*

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1379. Stones fell at Minden in Hanover.—*Lerbecius.*

1438. Stones fell near Burgos, Spain.—*Proust.*

1480. Stones fell in Bohemia and Saxony.—*Phil. Mag.*

1480. The fields were strewed with stones.—*Proust.*

1491. A fall of stones near Crema.—*Simmut.*

1492. On Martinmas eve fell the remarkable stone of Ensishieme, near Torgau, weighing 260 lbs. It was placed in a church as a miracle. Now in the library at Colmar.—*Trithremius.*

1496. Three stones fell between Cesona and Bertonari, also a shower of stones.—*Sabellicus*, p. 341.

1510. A Carthusian monk saw the fall of about 1200 stones in a field not far from the river Adda, in Milan. One of them weighed 120 lbs., one 60 lbs. &c. &c.—*Gardenas.*

1511. Stones weighing 8, 11, and 9 lbs. each fell at Crema.—*Giovanni.*

1516. Sixteen globular stones fell in the province of Yoi tchouan, weighing 16 lbs., 27 lbs., &c. &c., to 1 lb. each ; and in

1520. In May, stones fell in Arragon.—*Diego de Sayas.*

1540. A large stone fell in the Limousin.—*Bonaventura St. Amable.*

1548 to 1552. Stones fell in different parts of Thuringia, making much havoc near Schliessingen.—*Spangenburg.*

1559. At Miscoltz in Transylvania " five stones, large as a man's head, fell from the heavens."—16th vol. *Breslau Collection.*

1560. Stones fell in the Torgau.—*Gesner and de Boot.*

1580. Stones fell in Gottingen.—*Bange.*

1581. " A stone weighing 39 lbs. and very hot, fell in Thuringia, from a serene bright sky, with an explosion, from a globe of fire."—*Birchard's Chron.*

1583. March. A stone of the size of a hand grenade fell in Piedmont. In June one of 30 lbs. weight, resembling iron, fell at Rosa in Livadia.—*Casto Mercati.*

1596. A stone fell in Valencia in Spain full of metallic veins.—*Cesias, the Jesuit of Coimbra.*

Large stones fell at Kunnendorf.—*Annales Marchi.*

1596. Stones fell at Crevaloore.—*Mettarelli.*

1618. A great fall of stones in Styria.—*De Hammer.*

1618. A metallic mass fell in Bohemia.—*Kronland.*

1620. A large body of iron fell in the Punjaub in India. The Emperor Jehangire had made of it two swords and a dagger.—*Jehangire's Memoirs.*

1622. A stone fell from the sky in Devonshire.—*Rumph.*

1628. A stone, 24 lbs. weight, fell in Berkshire, England.—*Gent. Mag.*, *Dec.*

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1634. Stones fell in the Charollois.—*Marinus.*

1636. A burnt stone fell in Silesia.—*Lucas.*

1637. Stones fell in Vago, at Calce, and at Saga, in Silesia; also one in Provence, which was *spherical*, and fell from a fire-ball; its weight was 54 lbs.—*Gassendi.*

1637. Near this date fell on the ground of the Benedictines, near Verona, a very large stone, broken into many pieces, some 3 feet long.—*Gassendi.*

1642. A stone weighing 14 lbs. fell near Woodbridge in Suffolk. —*Gent. Mag.*

1643. Stones fell in the sea.—*Wurfhain.*

1647. A stone fell near Twickgau.—*Schmid.*

1647. Stones fell in Westphalia.—*Gilbert, Annalen.*

1650. A large stone fell at Dordrecht.—*Singuised.*

1653. A stone fell into the sea.—*Malte Brun.*

1654. A shower of stones in the Island of Funen.—*Bartholinus.*

1654. A large stone fell from the atmosphere at Warsaw, Poland. —*Pet. Borellus.*

1654–5. A stone fell at Milan, killing a Franciscan monk.—*Musi. Sept.*

1668. A great fall of stones near Verona, weighing 800 lbs. and 200 lbs., &c.—*Vallinieri.*

1671. Stones fell in Swabia.—*Gilbert, Annalen.*

1673. Two large stones fell in the canton of Glarus.—*Scheuzer.*

1674. Stones fell in a field at Dietling.—*Leonardus.*

1675. A stone fell on a boat in the Orkneys.—*Gent. Mag.*

1676. March 26, O. S. A fire-ball came as if over Dalmatia, obliquely to Leghorn, where it exploded, and the fragments fell into the sea with a hissing noise. The meteor appeared as large as the full moon at Bologna.—*Montenari's Report*, No. 312, *Gent. Mag.*

1677. Stony masses fell in Calabria and in Saxony.—*Misi.*

1680. Stones fell in London.—*King.*

1697. Stones fell from the sky in Sienna.—*Transactions Acad. Sc., Sienna.*

1698. Black stones fell with many explosions in the canton of Berne.—*Scheuzer.*

1706. June. A stone weighing 76 lbs. fell from a small dark cloud at Larissa, Macedonia.—*Lucas.*

1719. A shower of sand fell in the Atlantic, N. L. 45°, preceded by a luminous meteor. The captain and crew of a vessel certified the fact to *Feuillee.*

1722. June. Stones fell near Scheftlas, in Friesingen—*Mirchelbirk.*

1723. Thirty-three stones fell from a small black cloud in Bohemia.—*Breslau Collection.*

1727. Stones fell at Lilaschiltz, Bohemia.—*Stepling.*

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1738. Stones fell at Carpentras.—*Castillon.*

1740. Stones fell at Rasgrad.—*Gilbert, Annalen.*

1741. A large stone fell in Greenland.—*Egede.*

1743. Stones fell at Liboschitz, Bohemia.—*Stepling.*

1750. A large stone fell at Niort, near Coutance.—*Lalande.*

1751. May 26, at 6 o'clock in the evening, a remarkable fire-ball exploded in Upper Sclavonia. A stone fell from it and broke in two pieces; one part weighed 71 lbs., the other 16 lbs.—*Klaproth.*

1753. A stone fell in Eichstadt.—*Cavallo.*

1753. Four large stones fell in Strokow, when the air was perfectly tranquil and the sky a little shaded with fleecy clouds. Their fall was preceded by three long, loud peals of thunder, or more like the rattle of artillery. A specimen remains in the Cabinet of Vienna, and one in the Bosnian Collection.—*Analysed by Howard. Reported the year after it fell by Stepling.*

1753. In September. Two spherical stones, one of 20 lbs., the other 11½ lbs., fell near the village of Liponas, preserved in the Cabinet at Dijon. They fell from a clear sky, with loud explosions like the successive discharge of cannon.—*Lalande.*

1755. A stone fell in Terra Nuova, Calabria, weight 7 lbs. 7 oz. —*Domin. Tata.*

1766. In July, from a clear sky, at Albareto, near Milan, a large, dark, burnished stone fell with a whizzing noise and the sound of artillery.—*Troili and Vassali in Physico-Meteorological Letters.*

In August a stone fell at Novellara.—*Beccaria.*

1768. November. Stones fell near the Castle of Luce in Maine. —*Memoir Acad. Paris.*

1768. A stone fell near the Inne in Bavaria with a hissing noise; weight 38 lbs.—*Imhof, in Gilbert, Annalen.*

1768. A stone fell at Lena, in Arragon, of an irregular spherical shape, and covered with a dark vitreous crust common to aerolites. It was extremely porous, and was composed of rounded oval grains, scarcely larger than hemp-seed, among which were sprinkled metallic particles and sulphur. The stone is preserved in the Royal Collection at Madrid.—*Proust.*

1775. Stones fell in Rodach near Cobourg.—*Gilbert, Annalen.*

1776. Stones fell in Volhynia.—*Gilbert, Annalen.*

1776. A great shower of stones fell in the ancient Duchy of Camarino.—*Soldani.*

1777. Two stones fell in a meadow in Westmeath, Ireland.—*Gent. Mag.*

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1780. Stones fell in Beeston, England.—*Lloyd's Ev. Post.*

1782. A large stone fell near Turin.—*Tata.*

1785. September. In Eichstadt a brickmaker saw several stones fall, accompanied by a loud peal of thunder. He ran to take hold of one, but it was so hot he was obliged to let it cool in the snow before he could handle it. They abounded in iron and nickel, and were analysed by *Vauquelin.*

1790. July 24. Fell the remarkable shower of stones at Barbotan, in the Llandes of Bordeaux. A large meteor was visible for 50 seconds, when it exploded with great noise and scintillations. The weather was very fine. When the stones fell, they had not their present hardness; some falling on bits of straw, the straw became incorporated with them. The fire-ball was of a pale but bright light, sufficient to dull the moon. The diameter of the meteor was larger than the moon. It proceeded from south to north with great velocity, and broke into portions of considerable size, flying in different directions like a bomb that bursts in the air. The light of these fragments went out as they fell on the ground, and they soon became hard. The explosion was like firing many pieces of ordnance, jarring the windows and throwing down utensils from their shelves. The fallen stones were found in a circular space two miles in diameter. The stones were much broken, and were of all sizes, 25 or 30 lbs. being the largest.

Specimens of the Barbotan stone are not uncommon in the cabinets of the curious.—*Certified by the Mayor and Procurator of the Commune of Lagrange Juillac, in the Llandes of Bordeaux.*

1791. Stones fell in Tuscany.—*Soldani.*

1795. June. Twenty or more stones of a black, glossy surface, apparently recently vitrified, fell from a cloud in Sienna with an explosion resembling the discharge of cannon and musketry. Their fall was accompanied by a shower of sand, and the analysis showed that the sand and stones were identical in their composition, and were true meteorites.—*Phil. Trans.*, vol. 92.

1795. Stones fell in Ceylon.—*Beck.*

1795. A very remarkable fall of stones in the Wolds of Yorkshire. The largest weighed 56 lbs.—*Certified by Mayor Topham.*

1796. January. Stones fell in Beloga, Russia.—*Gilbert, Ann.*

1796. "Stones fell in the Meer of the Herdado, Portugal, with reports like the explosion of mines."—*Southey's Letters.*

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1798. Twelve stones fell at Sales, "one of which was the size of a calf's head."—*Marquis de Dree.*

1798. Stones fell in Bengal.—*Howard.*

1798. In the evening of March 12th a round or oval body, diffusing the most vivid light, moved westward over Ville Franche with a hissing, whizzing noise, like a bomb traversing the air. It exploded at a low elevation with a loud report. A large mass, irregularly oval, fell in a vineyard. Its weight was about 20 lbs. It was invested with a black varnished coating, and gave fire with steel.—*Jour. Phys. Sci. M. Dree.*

1798. A great fall from a luminous meteor or globe of fire took place at Benares, India. The natives gathered many fragments from the fields of various sizes, externally covered with a glossy black crust, and much broken by the explosion and fall. Internally they consisted of a great many spherical bodies imbedded in a light greyish, gritty, pliable substance, interspersed with metallic spicula. The spherical bodies were much harder than the surrounding stone. The outside attracted the magnet.—*Lord Valencia Howard.*

1799. April. Stones fell at Baton Rouge, Mississippi.—*Belfast Chronicle.*

1800. A vast luminous body passed over and was lost in the unknown wilds of America. "Perhaps," says Mr Howard, "its magnitude and solitary situation may become the astonishment of future philosophers."—*Phil. Mag.*

1801. In Isle au Tonnelliers, stones fell from a globe of fire.—*Bory de St Vincent.*

1802. September. Stones fell from the sky in Scotland; and

1803. April 25th. A great fall of stones occurred at L'Aigle in Normandy. They were about 3000 in number. Fourcroy, Vauquelin, Biot, and others made the most thorough examination of them, and Vauquelin's analysis establishes their character as aerolites by the unfailing criterion of iron combined with nickel among their constituent parts. The sky was very clear when a globe of fire, of uncommon splendour, was seen moving toward the North, accompanied by reports resembling thunder, and double reports of cannon, with strange hissing and rattling like musketry; vapours were projected momentarily with the explosions, and innumerable stones were seen to fall. The largest weighed 17 lbs. and gradually hardened by exposure to the air Fourcroy says, "They were exceedingly various in size and weight, covered

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with a black crust, and filled with small agglutinated grains of iron." When immersed in water they gave a sound "like the humming of a fly held by one wing." As they dry after being withdrawn from the water, they appear marked with curvilinear parallel layers.—*Biot's Letter in Journal des Debats.*

1803. Fragments of stones containing iron and nickel fell from a ball of fire, which struck the White Ball Inn at East Norton, England.—*Lit. Journal.*

1803. Stones fell in Avignon.—*Bibl. Britannica.*

1802. December. A stone fell near Eginfield in Bavaria—*Imhof.*

1804. April. Three large stones fell near Glasgow.—*Van Beek.*

1804. An aerolite fell in October near Vaucluse.—*Analysed by Zagguire and Vauquelin.*

1805. March 25. Stones fell near the river Indoga in Siberia.—*Gilbert, Annalen.*

June 6. Stones covered with a black crust fell in a public square in Constantinople.—*Jour. of Mines.*

1806. Two aerolites fell at Alais.—*Analysed by Thenard and Vauquelin.*

1806. March. Two stones fell at St Etienne and Valance.—*Pierre Robout.*

1806. May. A stone fell near Basingstoke, Hampshire, England. —*Monthly Mag.*

1807. Stones fell at Smolensko 168 lbs. weight.—*Gilb. Annalen.*

1807. Dec. 14. A shower of stones fell from a brilliant meteor in Weston, Connecticut. The largest fragments found weighed 20, 25, and 35 lbs. Many fragments were much broken, but the estimated weight of the whole was 200 lbs.—*See Silliman's and Kingley's Memoir in Med. Rep.*

1808. Stones fell at Borgo, San Diolto.—*Guidottie.*

1808. Aerolites fell near Parma.—*Analysed by Guidottie.*

1808. Aerolites fell at Iglave, Moravia.—*Analysed by Vauquillier.*

1808. Aerolites fell at Lissa, Bohemia, with detonations like heavy ordnance. The sky was clear.—*Analysed by Klaproth.*

1809. In July a stone fell on an American vessel, N. L. 30° 58′, 70° 25′ W. Long.—*Bibl. Brit.*

1810. January. A stone fell near Hillsborough, N.C.—*Phil. Mag.*

1810. A great fall of stones at Shahadabad, India.—Vol. 37, p. 236, *Phil. Mag.*

1810. A stone fell from a small black cloud, with a whizzing noise, near Limerick.—*Analysed by Higgins.*

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1810. Nov. 23. Stones fell near Orleans, France, accompanied by reports like blowing up a powder magazine. One stone weighed 40 lbs., another 20 lbs., and one was lost. The day was very clear and bright.—*Analysed by Vauquelin.*

1811. A meteorite of 15 lbs. weight fell at Tcheringoff, Russia, with loud whizzing sounds and reports like thunder.—*Gilbert, Annalen.*

1811. July 8. Stones fell from the sky at Ballanquillas, Spain.—Tome 48, *Bib. Britain.*

1812. April. A shower of stones at Toulouse.—*De Auboison.*

1812. Stones fell at Chantony, La Vendee, resembling the Barbotan stone, but containing more iron.—*Brocharest.*

1813. Large masses fell with a hissing noise and peals of thunder in Limerick. They broke in many pieces, the largest weighing 64 lbs.—*Attested by Samuel Maxwell, Esq*

1814. Stones fell in Calabria, and also in Bucharest, Russia.—*Gilbert, Annalen.*

1814. September. Large stones fell at Agen.—Vol. 14, *Phil. Mag.*

1814. November. In the Doab, East Indies, nineteen stones were found, weighing 30 and 40 lbs.—*Phil. Mag.*

1814. Sept. 5. A few moments before mid-day, and the sky serene, violent detonations were heard in the Department of Lot and Garonne; at first a rolling noise and sound of musketry, then the rumbling of carriages, and last of a falling house. There were a great number of stones found of all sizes, some weighing 20 and 30 lbs. Many were picked up by the peasants and worn as reliques.—*Annales de Chem.*

1815. Oct. 3. A large stone fell at Langres.—*Pistollet.*

1816. A stone fell in Glastonbury, Somersetshire.—*Phil. Mag.*

1817. Stones fell in the Baltic after the great meteor at Gottenburg.—*Chladni.*

A few instances of Malleable Meteoric Iron will close this Catalogue.

The mass of malleable iron found by Pallas in Siberia was traditionally ascribed by the Tartars to a fall from the heavens. Its descent is lost in the remoteness of antiquity, but its appearance and its texture, little contaminated by impurities, lead to a belief in its meteoric origin. Its weight was somewhat more than 1658 lbs. and it was coated with the black varnished crust common to aerolites. The cavities in the mass were filled with a transparent amber-coloured substance in roundish drops. It was found lying on the top of a ridge, covered with fir trees, without adhering to the ground, or to any rock. No iron was near it; no volcano within a thousand miles. It was first known to the learned of Europe in 1750.—*Voyages de Pallas*, tom. iv., p. 545; Paris, 1793.

A large mass of native iron was found in Bahia, Brazil. Its solid contents were estimated at 14,000 lbs. Its colour of a dark chestnut, and its surfaces coated with a glossy crust, indented, like the Sienna stone, and many other aerolites, as if struck with a hammer in its plastic, forming state, before it hardened. It was magnetic, and manifested well-defined polarity. Mr Mornay writes to Dr Wollaston—"From the presence of nickel in this mass, we cannot but regard it as of meteoric origin."—*Mornay to Dr Wollaston in Phil. Trans.* 1816.

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1818. A large mass, weighing 1635 lbs., discovered in Texas—now in the Cabinet of Yale College.—*Silliman's Chem.*

1792. Iron combined with nickel was found near Magdeburg; and an enormous mass, weighing 1900 myriogrammes, of iron and nickel fell near Agram in Hungary.—*Humboldt.*

1798. In Zacateccas in Mexico, a body of malleable iron and nickel was found analogous in its entire interior and exterior character to that Siberian mass described by Pallas.—*Humboldt.*

Meteoric iron fell at Elbogen, Bohemia. Also a large mass of iron at Lenarto, Hungary.—*Gilbert, Annalen*, vols. 42 *and* 44.

Native iron was seen by Captain Ross within the Arctic Circle at 76° N. L. Knives were made of it by the Esquimaux.

At the Smithsonian Institute in Washington is a fine specimen of meteoric iron from Mexico, weighing 252 lbs.

Since arranging the foregoing Catalogue I have been so fortunate as to see Shephard's interesting report to the "American Association for the Promotion of Science," which gives some additional accounts of meteoric iron, with a list of American Aerolites.

Meteoric Iron from Xiquipilco Toluca, Mexico, discovered in 1784.

Zacatecas,	discovered in	1792.
Cape of Good Hope,	,,	1793.
Bitburg in the Eissel,	,,	1805.
Resgalta, Columbia,	,,	1810.
Elbogen, Bohemia,	,,	1811.
Lenarto, Hungary,	,,	1814.
Texas, Red River,	,,	1814.
Lockport, New York,	,,	1818.
Burlington,	,,	1819.
Guilford, N.C.,	,,	1820.
Randolph Co., N.C.,	,,	1822.
Atacama, Bolivia,	,,	1827.

Meteoric Iron from	Bedford Co., Penn.,	discovered in	1828.
	Bohumilitz, Bohemia,	,,	1829.
	Scriba, N.Y.,	,,	1830.
	Claiborne, Alabama,	,,	1838.
	Cocke Co. & Sevier Co., Tenn.	,,	1839.
	Walker Co., Alabama,	,,	1839.
	Ashville, N.C.,	,,	1839.
	Green Co., Tenn.,	,,	1842.
	St Augustine Bay, Madagascar,	,,	1843.
	Arva, Hungary,	,,	1843.
	De Kalb Co., Tenn.,	,,	1845
	Otsego Co., N.Y.,	,,	1845.
	Hotmoney Creek, Buncombe Co., N.C.,	,,	1845.
	Black Mountain, N.C.,	,,	1845.
	Tennessee (locality not ascertained).		
	Scelasgen, Brandenburg,	,,	1847.

List of American Aerolites from Shephard's Report on Meteorites to the American Association for the Promotion of Science.

From	Weston, Conn.,	Fell in	Dec. 14,	1807.
	Nobleboro, Maine,	,,	Aug.	1823.
	Nanjemoy, Md.,	,,	Feb.	1825.
	Sumner Co., Tennessee,	,,	May	1827.
	Richmond Va.,	,,	June	1828.
	Forsythe Ga.,	,,	May	1829.
	Little Piney, Pulaski Co., Mo.,	,,	Feb.	1839.
	Bishopsville, S. Carolina,	,,	March	1843.
	Linn Co., Iowa,	,,	Feb.	1847.
	Castine, Maine,	,,	May	1848.

On the Effect produced on Trees and Shrubs by the Severe Frost experienced in December 1860 *and January* 1861. By Duncan Forbes, Esq., Culloden.

The intense frost of Christmas 1860 proved, as is well known, very destructive to vegetation; many trees and shrubs were killed, and a still larger number were so severely injured that several years must elapse before the loss sustained can be repaired. The great majority of those which have been killed or much injured, will in general be found to be such as are indigenous to countries where the temperature does not fall so low as it occasionally does in Britain. Many plants which were destroyed down to the ground, commenced on the return of spring to show signs of life, and as the season advanced put forth fresh and growing wood, which, in many cases, will result in their restoration to full health and vigour. To some extent, therefore, the loss will be only temporary, and not of so severe a nature as it was at first supposed to be.

The mean temperature of the summer and autumn of 1860 was, as ascertained by the Culloden Meteorological Register, more than 3°·0 below the average, which, combined with the extreme wetness, had a most injurious effect on the growth of trees and shrubs,—the young wood having, in consequence, never ripened or hardened properly. Plants were thus less able to withstand the severe cold to which they were exposed, and to this cause must be ascribed, in part, the fact that many trees and shrubs which were considered hardy, from having withstood the severe winters of 1838, 1841 and 1855, perished under the severe frost of December 1860.

The districts embraced in this notice comprehend that portion of the Highlands which is included in the counties of Sutherland, Ross, Cromarty, Inverness, Nairn, Elgin, and part of Banffshire, and covering an area of nearly 300 square miles in extent.

A few facts we have gleaned relating to the effects of the severe frosts of 1838 and 1855 may not be out of place here. In February 1838, at Beaufort Castle, near Beauly, *Aucuba japonica*, Laurustinus, and Sweet Bays were killed. At Messrs Morrison and Son's nursery at Elgin, many plants till then thought hardy were killed. At Lossiemouth, the thermometer fell to 4°·0, as shown from Dr Geddes's Register. At Belladrum, a low-lying situation, it is reported to have fallen to $-12°·2$.

At Culloden, during the frost of 1855, the thermometer at 4 feet from the ground fell to 11°·0, whilst on the ground it indicated 1°·0. The snow became so crisp and hard, that heavy objects in passing over it made no impression. On the

Nairn, the ice was so thick and firm, that horses and carts passed freely over it; and along the shores of the Moray Firth, there was an immense accumulation of ice, extending far out to seaward, and consisting of blocks of great size and thickness. Hares, rabbits, birds, and even some wild fowl, died from the intensity of the cold. The effect on vegetation, as might have been expected, was very destructive. In gardens, many kinds of shrubs, Laurustinus, Portugal and Bay Laurels of 20 feet in height, and Roses of various varieties, including China, Ayrshire, and other hardy sorts, were either killed or greatly injured. Forest trees also suffered,—the bark and stems of some kinds, such as the elm and the ash, being in many cases rent and split. In the grounds at Culloden, Laurustinus, Sweet Bays, Arbutus, *Rhododendron Russellianum*, several varieties of Roses, &c., suffered much. Some of the underwood of two promising Araucarias (the Chilian pine) were considerably injured, but all the specimens of the genus Pinus—*Cedrus Deodara*, *Picea nobilis*, *Abies cephalonica*—escaped untouched. At Dalvey, Morayshire, the temperature was repeatedly below zero; and hardy Laurels were very much injured, and Bays killed down to the snow-mark. At the Elgin Nurseries of Messrs Morrison and Son, a considerable number of shrubs were killed, viz., Arbutus, Sweet Bay, Cistus of sorts, various varieties of Cupressus, *Buddlea globosa*, and many others, much injured. At Gordon Castle, Banffshire, on the 22d February, there were instances of the stems of standard Portugal Laurels split to a considerable extent.

Frost of December 1860.—Previous to the 18th of the month the weather continued open and mild for the season; but on the forenoon of that day snow came on in thick showers from the north, so that by 10 o'clock at night the ground was covered to the depth of 4 inches. With this fall of snow, there was a great and sudden fall of temperature, the thermometer sinking to 18°·8 on the morning of the 19th, and never again rising (except once) to the freezing point, till the 29th. On the 24th the thermometer fell to 11°·2, and the mean temperature for the day was only 16°·7. So intense and continued was the frost after the 18th, that ice from 8 to 12 inches in thickness, formed along the shores of the Moray Firth, and extended several hundred yards out to seaward.

I shall now add the several Reports I have received on the actions and effects of the frost, from the various districts embraced in this Report:—

Sutherlandshire.

1. Mr Mitchell, gardener, Dunrobin, writes,—" The effects of last winter's frost here were not more injurious to vegetation than in any ordinary season. The lowest our thermometer registered being 15·5, the only things injured more than usual were Laurustinus, *Aucuba japonica*, and *Cryptomeria japonica*, the two former being killed in the ground, and the latter, a good plant, about 10 feet high, losing all its last year's growth. No doubt, our proximity to the sea had much to do with the milder temperature, our grounds not extending more than half a mile from the shore. I append a list of the injured and uninjured trees and shrubs:—

" *Injured.*—Laurustinus, Aucuba japonica, Cryptomeria japonica.

" *Uninjured.*—Araucarias (from 4 to 20 feet high), Cedrus Deodara, Wellingtonia gigantea, Cupressus Lawsoniana (and varieties), Buddlea globosa, Escallonia rubra, Escallonia macrantha, Gynerium argenteum, Sweet Bay, Common Laurel, Portugal Laurel, Roses, Apricots, Peaches, and other fruit trees."

Ross-shire.

2. Mr Hannay, gardener at Invergordon Castle, writes: " We have lost very few plants from the effects of the frost of last winter,—the *Wellingtonia gigantea*, of which we have two, the one the finest in the north, 7 feet high, and five years planted, stood out well; they appear quite hardy. The Deodaras had the points of the previous year's shoots killed. Aucubas and Larustinus killed to the ground. The thermometer was never below zero."

3. Mr Andrew Smith, of Dingwall, reports generally on the effects of the frosts in various parts of Ross and Cromarty,

including the well-known gardens of Conon, Castleleod, Tulloch, and Ardross.

"*Killed.*—Cupressus torulosa.

"*Injured.*—Cryptomeria japonica, Araucaria imbricata, Abies Kæmpferi, Pinus Sabiniana, P. Craigana, Thuja aurea, T. Lobbiana, Berberis Darwinii, Cupressus Macnabiana, Cedrus Deodara.

"*Uninjured.*—Wellingtonia gigantea, Cupressus Lawsoniana, C. Lambertiana, Abies Douglasii, Berberis japonica, Pinus Jeffreyi, P. Monticola, Cephalotaxus Fortuni.

"I have observed some instances of perpendicular rents, from 3 to 8 feet in length, in Turkey oaks. I have heard of a good many deaths among grown-up trees, but cannot specify as to numbers or species killed. I may mention that I have observed that Araucarias and Deodars have suffered less in high and exposed situations than when growing in low over-sheltered places."

4. Mr Christie, gardener, Conon, reports the loss of a few plants of interest:—

"*Killed.*—Cupressus Macnabiana, C. torulosa, Cedrus Deodara (two years seedlings killed, older plants suffered in foliage only), Picea nobilis (seedlings), Araucarias (seedlings), Arbutus, Chinese Privets.

"*Injured.*—Common Laurels lost their branches in a few instances; and all fruit trees suffered more or less—neither Apple nor Pear trees bearing any fruit on them.

"*Uninjured.*—Cupressus Lawsoniana, Thuja borealis, T. gigantea, Wellingtonia gigantea, Portugal Laurel, Abies Douglasii (a bed of 100 seedlings all untouched), an older Araucaria, the finest in the north, if not the largest specimen in Scotland, quite safe."

5. Mr Stewart, gardener, at Brahan Castle, supplies the following information as to the action of the frost:—

"*Killed.*—Cephalotaxus Fortuni (male killed, female much injured), Cupressus torulosa (out of twenty-four plants, 18 inches high, only six remain alive), Pinus excelsa (some killed and the others very much injured), Biota orientalis aurea (one plant killed, the others very much injured), Arbutus Unedo.

"*Injured.*—Picea Webbiana (severely), Cedrus Deodara (slightly), Cryptomeria japonica, Sequoia sempervirens (young wood of previous year killed), Taxus adpressa, and Cupressus Goveniana (severely).

"The only kind of timber I see injured in this quarter is the Turkey Oak. I see rents on this kind of Oak from 2 to 8 feet long, in nearly all trees which have attained to the age of thirty or forty years. No other kinds of growing timber show any appearance of injury. The Whin has been killed in several places in the neighbourhood. The Rhododendrons and Azaleas grow in millions in the shrubberies from self-sown seed. The seedling Azaleas have been partially destroyed by the frost; but the Rhododendrons do not appear to have sustained any injury. Out of 120 varieties of Rhododendron, *Falconeri* and *Victoria Regina* have suffered more than any others."

6. Mr Fraser, gardener at Redcastle, reports—"That the severest frost experienced at Redcastle last winter was on the night of the 24th December, when the thermometer fell to $-3^{\circ}\cdot 0$. The injury, however, to tender plants was not very great.

"Some fine specimens of *Picea Webbiana*, from 8 to 10 feet high, had the previous year's wood killed, and to all appearance will never recover. *Cedrus Deodara*, young plants much injured; *Pinus Sabiniana*, killed; *Araucaria imbricata*, untouched. This is a particularly fine specimen, height 21 feet, branches cover 14 feet; girth, at one foot from the ground, 2 feet 3 inches; and at 6 feet high, 1 foot 9 inches; was planted as a seedling in 1843, and has made rapid growth each year; *Cupressus torulosa*, a strong plant, killed."

Inverness-shire.

7. Mr Muir, gardener at Beaufort, informs me that the injury done there has not been very great. "*Abies Douglasii*, except on low, damp, exposed grounds, where the young unripened wood has been killed. *Araucaria imbricata*, where exposed in the parks, slight injury done to the points; but the principal specimens in the shrubbery untouched. *Taxodium sempervirens*, young wood killed; Common Laurel slightly injured; Rhododendron safe, except in one part of the shrubbery, low and damp, where they are slightly injured. A few Hybrid Perpetual Roses, on 4 feet stocks, killed; a few

root grafted also killed; Bourbon and China Roses likewise killed. The Whin in exposed situations has been killed."

8. Mr Findlay, gardener at Relig, writes, "That the frost of December and January did little or no injury. One large Apricot tree and a few Hybrid Bourbon Roses only killed. None of our coniferous trees have suffered in the slightest degree. The grounds at Relig contain particularly fine specimens of *Abies Douglasii*, *Cedrus Deodara*, and *Pinus Cembra*. In 1858, the sizes of each of these were taken. The height of *A. Douglasii* was then 31 feet 8 inches, girth near the ground 2 feet 3 inches. *Cedrus Deodara*, height 25 feet 8 inches, girth of trunk 4 feet. *Pinus Cembra* was 30 feet 8 inches in height, girth at the ground 6 feet. There are likewise here several Cedars of Lebanon in great beauty. A severe frost in the spring of 1846 slightly injured the foliage and tender wood, but since then they have continued healthy, and during the past winter have, in common with the Pines, remained uninjured."

9. Messrs Howden, Brothers, of the Muirtown Nurseries at Inverness, report, "That the frost has done very little damage here, as compared with the nurseries further south. Near Edinburgh, the hardiest shrubs, such as Common and Irish Yews, Common and Variegated Hollies, and *Rhododendron ponticum* have suffered, while here the same shrubs escaped injury. As regards Forest Trees, they have sustained no injury; and the same remark applies to Ornamental and Fruit Trees, except Peaches upon walls, which have had the points of the shoots destroyed, and some trained on boards are more seriously injured—a few even killed. The state of the Shrubs and Conifers affords the best criterion of the last winter; but, as we had a heavy covering of snow sheltering the main part of our stock, we will only report on such plants as, being above the snow, were exposed to the severity of the frost:—

"*Killed.*—Arbutus Unedo and Aucuba japonica (killed above snow), Cryptomeria japonica (young plants killed, older plants injured), Cupressus sempervirens, C. torulosa, C. Lambertiana, C. funebris, Eleagnus reflexa, Euonymus japonicus, German cistus, Jasminum revolutum and Common White, Jasmine, Juniperus

Bedfordiana, J. recurva, J. lycia, Laurus nobilis, Lavender, Laurustinus, Rosemary, Taxodium sempervirens, Irish Whin.

"*Injured.*—Araucaria imbricata (much), Cedrus Deodara (young shoots), Portugal Laurel (slightly), Phillyreas (much), Irish Whin, double flowering (much)."

The plants above stated to be killed are alive where covered with snow; and it is hoped that those may recover which are only injured. Roses—Climbing Evergreen, Bourbon, Noisette, hybrid and tender varieties, killed to snow covering.

"*Uninjured.*—The following plants among others have escaped injury, though exposed to the full effects of the frost:—Cupressus Lawsoniana, Wellingtonia gigantea, Garrya elliptica, Thujopsis borealis, T. aurea, Juniperus excelsa, Pinus Douglasii."

10. Mr Findlay, gardener, Aldourie, says, "That having only a small collection of tender shrubs at Aldourie, the memorable frost of last winter did not do so much damage. Besides, the fact of being situated on the banks of Loch Ness, the water of which has never been known to freeze, may have had the effect of lessening the severity of the frost.

"*Escallonia rubra* killed to the surface of the snow.

"The following have been injured—Common Laurel, Portugal Laurel, Sweet Bay, Laurustinus, many Standard Roses, *Cedrus Deodara, C. Libani, C. atlantica.* The injury is in general slight, but in some instances last year's shoots have been destroyed."

11. Mr Barnet, gardener at Culloden, has furnished me with the following note for December 1860 and January 1861:—

"The frost, though very severe during the period over which it extended, has not injured, to any great extent, any of the Pines or tender shrubs.

"*Killed.*—Laurustinus, Laurus nobilis, Escallonia, Phillyrea, Aucuba japonica.

"*Injured.*—Irish Whin (yellow), and Portugal Laurel (slightly), Roses, many varieties, and Myrtles in exposed situations (more or less).

"*Uninjured.*—Araucaria imbricata, Pinus nobilis, P. cephalonica, Cedrus Deodara, Irish Yew, Common Yew, Common

Laurel, Common and Variegated Hollies, Rhododendrons, Evergreen Oaks."

Moray or Elginshire.

12. Mr Mair, gardener, Darnaway Castle, considers the damage done by last winter's frost to have been greater among Fruit Trees and Roses generally than was the case in 1855; that the various kinds of shrubs suffered to a greater extent during the frost of that period, when all the common varieties were cut down to the ground.

" *Wellingtonia gigantea*, *Abies Douglasii*, and *Pinus Jeffreyi*, were all uninjured. I have not heard of any trees being damaged by the action of the frost in any part of the Darnaway forests during the past winter."

13. Mr Berry, gardener at Dalvey, writes, " That the collection of Pines and other half-hardy plants is not a very extensive one; consequently we have not had many losses arising from the severity of the winter.

" The thermometer fell no lower last winter than 3°·0, whereas in 1855, for four nights in succession, it fell to −5°·0. But, owing to the unripened state of the wood, Roses suffered more severely last winter than during the previous fourteen winters.

" *Killed.*—Cupressus funebris, C. torulosa, Pinus longifolia, Abies Brunoniana.

" *Injured.*—Taxodium sempervirens, Berberis Darwinii.

" *Uninjured.*—Cedrus Deodara, Cryptomeria japonica, Thuja Craigana, Araucaria imbricata, Wellingtonia gigantea, Laurels, Hollies, Yews, and hardy Evergreens.

" The thermometer fell to 22°·0 on the 18th of December, and ranged during the four following nights between 8°·0 and 14°·0, and on the night of the 23d it fell to 3°·0."

14. In the nurseries of Messrs Morrison and Son, at Elgin, the loss among pines, shrubs, &c., has been considerable, though not to so great an extent as, judging from other causes, might have been expected. Mr Harrison says—" From whatever cause, our loss was less severe than what was generally experienced farther south. Our common Laurels are but little

injured; last year (1859) we had great numbers of them cut down to the ground. Many other shrubs have also escaped this year. Amongst our Pines, *Wellingtonia gigantea* appears quite hardy, as well as all the species from Upper California, and from our new colony on the Fraser River. Those introduced, however, from Lower California, are more or less injured, such as *Pinus insignis, P. radiata*, and the allied class of Pines. They appear to have much sap in them in summer and autumn, and I believe it never ripens; and when severe frost sets in, the tissue is destroyed. When covered with snow, they remain uninjured ; and I consider it not unlikely, that if grown in poor light soil along the sea-coast, they would stand. Most of the newly-introduced shrubs are turning out hardy. I am, however, sorry to see *Escallonia macrantha* a good deal injured when not covered with snow. The covering of snow furnished a valuable protection, the greatest damage sustained having taken place after the slight thaw that occurred in the early part of January. The lowest temperatures which were observed here were 7°·0 and 9°·0 at two different stations. On the 24th December, at Altyre, near Forres, the thermometer was observed so low as −4°·0, and there, in two cases, trees were split by the frost. This has been confined to hard wood, ash being apparently more liable to splitting than elm or oak. Since it occurred in old trees, it was supposed at first that there had been some internal decay, into which water had found its way, and thus caused the splitting; but nothing was found on examination leading to such a conclusion. Hence the splitting was probably due to the freezing of the sap. *Araucaria imbricata* has been very much browned, but one plant growing in a very exposed situation has stood quite uninjured. It has been killed to a great extent in the Aberdeen nurseries. In most gardens in this district, Peaches have been injured, especially young trees, but I have not heard of any of the older ones being actually killed. No seedling forest trees have been injured here, except one plot of one-year seedling Thorns, which were very strongly grown, and the tops of which had not been well ripened. The same thing occurred in regard to some Planes or Sycamores, and a few seedling Oaks, which had made a second growth. The only transplanted trees I observe injured are some Spanish Chestnuts. All our Roses have been considerably injured.

List of Plants which have been either killed or injured.

" *Seedling Forest Trees.*—Common Thorn, Plane or Sycamore, and English Oak—slightly injured.

" *Transplanted Forest Trees.*—Spanish Chestnut—slightly injured.

" *Plants suitable for Underwood.*—Bignonia radicans—killed. Vinca major elegantissima and Wistaria sinensis—slightly injured.

" *Standard Ornamental Trees.*—Quercus Cerris, Q. Lucombeana, and Q. Cerris Exoniensis—slightly injured.

" *Hardy Deciduous Flowering Shrubs.*—Amygdalus persica alba, rubra, and incana—killed. Azalea japonica, Cotoneaster acuminata, and Hydrangea arborescens—slightly injured.

" *American Plants and Evergreen Shrubs.*—Abelia uniflora, Laurus regalis, and Mitraria coccinea—killed. Arbutus Unedo, Aucuba japonica, Escallonia macrantha, E. organensis, E. Pterocladon, Garrya elliptica, and Common Holly—slightly injured. Ceanothus azureus, C. dentatus, Cistus formosus, C. lusitanicus, Eugenia, Laurus nobilis, Ligustrum lucidum, L. japonicum, Phillyrea angustifolia, P. ilicifolia, Rhamnus alaternus, Veronica Andersoni, Viburnum Tinus—much injured.

" *Hardy Coniferous Plants.*—Araucaria imbricata, Cedrus atlantica, C. Deodara, Cupressus funebris, Pinus maritima, Taxodium sempervirens—slightly injured. Abies Brunoniana, Cryptomeria japonica, Cupressus Lambertiana, C. torulosa, Pinus insignis, P. muricata, P. radiata, P. tuberculata—much injured.

" Young Nectarines and Peaches in some instances were killed."

Banffshire.

15. Mr Webster, gardener at Gordon Castle, supplies the following information:—" The injury done here by the frost in December and January has been comparatively little. Roses, which have suffered generally throughout the country, have sustained considerable injury. Ayrshire Climbing, with a few exceptions, have been killed. Hybrids, Perpetuals, and Bourbons have also suffered. I find it difficult to say which are really hardy, as I find them dead in one situation, and alive in another. Of shrubs, the following have been injured:

—Laurustinus, Evergreen oak (young only), Phillyreas, Arbutus (young).

" A plant of *Magnolia grandiflora*, covering a wall 12 feet high by 15 wide, lost nearly all its leaves, and some of its young wood; another of Magnolia, larger in size, uninjured, except in its flower buds.

" *Clematis azurea grandiflora*, killed to the ground.

" We are not in possession of extensive collections of Pines, but those we have have proved hardy, and are uninjured—Cedrus Deodara, Wellingtonia gigantea, Araucaria imbricata, Cryptomerias, Cupressus, Common Laurel, and Portugal Laurel.

" I have not observed any of the largest forest trees injured in any way. Whins in the surrounding districts have suffered, particularly those in exposed situations and in hedgerows.

" The lowest temperature, 10°·0, was observed on the morning of the 26th December. The lowest within the last ten years was on the 22d February 1855; the thermometer then indicated 4°·0; the injury to roses and other plants, however, at that time, was comparatively little."

Observations on Atmospherical Temperature, by Dr WILLIAM BALFOUR BAIKIE; *made on the West Side of Tropical Africa.* Communicated by Sir JOHN RICHARDSON.

According to observations which I have made pretty regularly since 1857 in Mipe, and at the confluence of the Kwora and Binuwè, the coldest period during the twenty-four hours is from fifteen minutes to an hour after sunrise.

With a very few exceptions, the thermometer always falls just after sunrise, from 0°·2 to 2°. If the thermometer be read about fifteen or twenty minutes before sunrise, and then at sunrise, it will be found to have risen from 0°·5 to 1°, but fifteen or twenty minutes later it will be found to have fallen again. For example, this morning at 5^h 45^m A.M. the thermometer was 75°; at sunrise it was 76°, and at 6^h 30^m it was again 75°.

Another constant rule is, that the lower the thermometer the more certain is this fall after sunrise, and the greater its extent. In December and January the mornings are very cold, the thermometer sometimes showing 60°, and even 58°, and it is then that the fall after sunrise is most marked. During the rain-season the temperature is more equable, less in extremes, and then this fall is much less, sometimes scarcely perceptible. As far as I have observed, the fall is greater after sunrise the farther north we go, and is more marked on high than on low lands. In December and January I have seen the thermometer range more than 40° daily. From June to October the range seldom exceeds 15° or 16° daily.

During 1860 and 1861, the temperature of Tornado rain, whether by night or by day, was rarely below 70° or above 72°. Tornadoes are from N.E. to S.E. Rain coming from the S.W. is generally rather warmer.

On the Danger of Hasty Generalization in Geology. By ALEXANDER BRYSON, Esq., F.R.S.E., President of the Royal Physical Society of Edinburgh.*

It is proper, before alluding to the failings of our friends in making hasty generalizations, to confess our own failures, so that by plucking out the beams from our own we more readily detect the motes in our neighbours' eyes. The first instance which I shall notice of erroneous conclusions, drawn from scanty data, occurred to myself in 1856. Our late lamented fellow, Dr Fleming, brought me one day a very beautiful specimen of Carrara marble, on which was exhibited the most decided marks of a fossil plant, and, being much engaged at that time in the microscopic study of the Carboniferous flora, I felt no hesitation in pronouncing it to be a true Stigmaria. This being a new fact in geology, of course the specimen was often exhibited to demonstrate the existence of carboniferous fossils in the primitive limestone. Fortunately for truth, a friend obtained many similar specimens in the establishment of a marble-cutter in Leith Walk, where I

* Read before the Royal Society of Edinburgh, April 21, 1862.

soon found the true explanation of the structure which had led me to maintain its organic origin.

It is usual for the marble-cutters at Carrara, before sending out the blocks from the quarry, to reduce them into as small dimensions as possible. This operation is performed by what is called a matting-hammer, consisting of many separate and blunt teeth placed alternate to each other, and is used by bringing the hammer down, in a perpendicular direction, to the flat face of the marble block. By this method a series of quinquncial indentations are produced precisely similar to those found in Stigmaria, and, to render the illusion more perfect, where the percussion of the teeth of the hammer is greatest (which is at the point), the limestone at the bottom of each depression is more crushed, and being deprived of its air by the greater force, exhibits a different structure from the surrounding walls, and thus presents the regularity, both in shape and direction, of the protruding petioles of Stigmaria.

Unfortunately, before this discovery was made, my dear friend Professor Fleming died, and I have no doubt that this specimen is now lying in his cabinet, labelled on my authority as a Stigmaria,—no stigma on his naming, but on mine.

In the summer of 1856 a few friends joined me in a yachting expedition to examine geologically the islands of the Firth of Forth. Among other islands we visited Inch Mickery, and spent some hours examining its structure. On the southern summit of the rock we found a quantity of lead filling up many of the interstices of the trap, which besides had a very scorched appearance. This circumstance naturally excited our curiosity, and many theories were formed to unriddle the enigma, but in vain. We carefully examined the island, but could not find a trace of fire by which the lead could have been melted, except at such a distance from the spot as to render the idea of lead being carried so far without cooling inadmissible. Then the lead had run into the crevices of the rock, showing that it must have been very fluid when it fell.

The absence of every trace of carbon around the lead, or at all near the rock itself, was very puzzling. About this time Dr Heddle had announced the occurrence of native lead embedded in meteoric iron, and I at once held my Inch Mickery lead as truly meteoric in its origin. This idea was rendered the more probable, as the late Dr George Wilson, who kindly analysed it for me, failed to detect in it any trace of silver. Professor Fleming, although he scouted the idea of its meteoric origin, was induced to accompany us on a second visit to the island. After a personal examination, he was unable to throw any light on the subject, but advised us to wait patiently, and time might clear up the mystery. We would have rejoiced had he lived to learn the simple explanation, only obtained a few months after his lamented death.

The Board of Fisheries, some years since, perhaps believing that garvies were young herrings, passed a law forbidding nets to be used the meshes of which were smaller than those employed in taking full-grown herrings. The officers of the Board happened to detect a boat using the illicit nets just off Inch Mickery; they, acting according to orders, took the offending nets to this rocky knoll and burned them. The leaden sinkers attached to the nets supplied my meteoric lead, and the cordage of the net yielded sufficient fuel to fuse it. The winds and rain soon took away all traces of the cause by which the lead was fused, and thus led to our confusion,—and so our hypothesis went to the winds.

I have now to deal with another instance in which a hasty generalization has met with more attention in the geological world than any of those I have mentioned, but not less than it deserved. Mr Geikie, in a paper published in the "Edinburgh Philosophical Journal," vol. xvi. p. 102, has stated his belief that the ground on which Leith is situated has risen to the extent of 25 feet since the Roman period. The section from which he has come to this conclusion is in a sand-pit at the Junction Road, Leith, and is represented in the diagram, which is the same as Mr Geikie used to illustrate his paper. He thus describes the succession of the strata as seen in the sand-pit:—

"The lowest bed (1) visible is one of coarse gravel or shingle, the pebbles being all well rounded, and loosely cemented in a sandy and somewhat ferruginous matrix. (2) Is a bed of fine white sand, about six feet thick. It is full of false bedding, the diagonal stratification being beautifully exhibited by the alternations of darker and lighter coloured layers. Its upper surface is irregular, and is overlaid by a well-marked seam (3) of sand and gravel, which averages about sixteen inches in thickness. Its lower part is gravelly and ferruginous. This stratum is covered by three or four inches of a stiff greenish clay (4), which contains numerous perpendicular (sometimes dichotomous) ferruginous pipes, probably marking the remains of the stems of plants. This stratum passes up into a bed (5), about six feet thick, of dark silt or sandy clay well stratified, having thin lenticular inter-

Section of Sand-pit, Junction Road, Leith.

laminations of sand, with occasional oyster-valves, a few stones, and fragments of bones and pottery. The upper part of this bed becomes more sandy, and graduates into the superincumbent stratum of brown sand (6). The highest bed of the section (7) consists of stratified sand and shingle full of littoral shells, and some of the stones having *balani* still attached. The irregular deposit (marked *h* in the diagram), which rests unconformably upon the edges of the strata just described, is a mass of loose humus, which has been thrown down here at no distant date, perhaps to fill up an irregularity of the surface. It is full of stones, bricks, bones, pieces of earthenware, tobacco-pipes, &c., and its origin is sufficiently explained by a large board a few yards distant—' Rubbish may be laid down here free.'"

" It is with the stratum marked 5, that we have chiefly to deal. But before entering into its details, I would dwell pointedly on the fact, that it is a regularly stratified deposit, with thin parallel interlaminations of sand and clay; its oyster-valves and stones lie horizontally, and it passes upward by gradations into brown sand, which is covered by well stratified shell-sand and gravel. It cannot for a moment be confounded with the dark earth *h*, in which no trace of stratification can be detected, and which, moreover, rests on the edges of the other deposits. Whatever may be the contents of this bed of silt, they are undoubtedly of contemporaneous deposition; in other words, all the materials imbedded in the stratum were laid down at the same time with the stratum itself. And that this deposition and arrangement were effected tranquilly by the tides, is abundantly manifest from the stratified aspect of the bed, as well as from that of the sand which covers it." In this bed (5) Mr Geikie found pieces of pottery and bones, to which he thus alludes:—" The pieces of pottery found by Dr Young and myself were of two kinds; the first and most abundant were of a pale yellowish-grey colour, from two to nearly six lines in thickness, and of a firm compact, but somewhat granular clay. They showed no glaze, but had a rough exterior and a rounded form like fragments of a flagon or urn. All the pieces we obtained occurred in the space of two or three yards, and might have belonged to one vessel. We also found, however, one or two fragments of a thinner and finer kind of pottery of a red colour, and coated with a pellicle of greenish glaze. Having obtained as many fragments as could be gathered, after a careful search during two visits to the sand-pit, we submitted them to Mr M'Culloch, the curator of the Scottish Antiquarian Museum, requesting his opinion before informing him where they had been found. He at once pointed out, that they strongly resembled fragments of Roman pottery; and he stated, that if found near a Roman station, he would have no hesitation in pronouncing them to be Roman." " We have no doubt, therefore, that the pieces of pottery embedded in the elevated littoral silt of Leith are of Roman origin."

" Along with these remains occurred numerous fragments of the bones of some ruminant, apparently a deer. With the exception of a broken tibia, all the pieces were of small size, like little chips and splinters. There occurred also a number of ferruginous pipes of irregular size and form, occasionally branching. They arose probably from the decomposition of ferruginous soil round the decaying stems of plants, though they sometimes resemble annelide burrows.

"I have just shown that the bed of silt in which these remains occur, is a truly stratified deposit formed by water, exactly as a similar silt is being laid down on the shores of the Frith at the present day. The occurrence of stratified shell-sand and shingle above this silt proves that it was a littoral deposit; and the inference is irresistible, that the land here has risen about 25 feet since the deposition of these littoral strata. Further, the existence of fragments of Roman pottery in the silt shows us, that the deposition of these upraised strata was going on during the Roman occupation of Britain, and therefore that this rise of the land has taken place since the time of the Romans. This may seem, indeed, a startling deduction, when we consider the comparatively large increase of land which it demands, the short interval it allows for the process of elevation, and the silence of historians as to any change of level. But these objections are only negative, and cannot be entertained in the face of the clear, positive evidence of the raised sea-beach itself."

When this communication of Mr Geikie's appeared, Dr M'Bain (who had previously studied the relation of the beds) and I determined to make a careful investigation of the sand-pit, more particularly bed No. 5 of Mr Geikie's section. We were aided in our researches by the kindness of Mr Field, the proprietor of the sand-pit, who placed his men at our service for the purpose of excavating the stratum. The result of many visits confirmed our belief, that there was no proof of any rise of the shore at Leith within the human period, for the following reasons, which I shall briefly state.

First, as to bed No. 5, in which the so-called Roman pottery was found, on which Mr Geikie lays so much stress, and is indeed the *point d'appui* of his whole argument. Instead of finding this bed to be of marine origin and distinctly stratified, as Mr Geikie has described it, we found it (as any one can determine the fact for themselves) to consist of two distinct beds, the lower one, which rests on gravel, is evidently a marsh silt due to the overflowing of the Water of Leith, the remains of which may still be seen about 100 yards to the west. That this marsh existed not in the Roman age, but within the memory of the oldest inhabitant, is rendered highly probable, by the situation bearing the name of Puddock Hall, evidently from its proximity to the abode of frogs. That this marsh silt was deposited long posterior to the Roman occupation, we shall endeavour in the sequel to prove. The silt stratum or lower portion of bed (5) contains no remains of animals nor pieces of pottery; when dessicated by exposure to the air, it separates into prisms perpendicular to the clay-bed below, and is thus easily differentiated from the upper stratum in which Mr Geikie found the so-called Roman pottery.

The upper portion of No. 5 is distinguished from its lower congener by numerous vesicular coal cinders, evidently acted on by heat, and as the matrix shows no symptoms of fusion from internal heat or otherwise, I take leave to denominate as simply coal ashes. Side by side with the incinerated coals we found oyster shells, not *all* lying flat, as deposited in a bed, but at *all* angles to the horizon, precisely as any one may find them in a humus bed, where a farmer, knowing their worth for manure, had shut them in at random. Nor were the stones, as Mr Geikie has said, lying on their sides (as would have been the case if this bed had been a lacustrine or marine deposit) but were arranged in as higgledly-piggledly a manner as the oyster shells. We, with the assistance of Mr Field's men, had no difficulty in supplying ourselves with from thirty to forty specimens of pottery, also bones of sheep, the common ox (*Bos taurus*), teeth of the same, and also of the horse. Only one evidence of the deer was found, and that was a tooth. Before entering into the further proof of this bed being of *very* modern origin, let us consider first the occurrence of the burned coal so largely sprinkled through its mass, and ask ourselves or Mr Geikie the question, was coal so commonly consumed at the period of the Roman invasion, so as to yield so large a percentage of the bed? For myself I answer in the negative. With regard to the horizontality of the oysters and stones, I leave those who feel interested in the controversy to convince themselves; but I cannot help expressing my own opinion that the number of oyster shells in the upper part of bed (5) are not greater than can be found in any humus bed supplied by the manure of the city of Edinburgh ; nor are they evidence of marine deposition more than can be afforded by any well-cultivated field of Mid-Lothian. I shall now advert to the character of the pottery found in bed (5), where Mr Geikie found his Roman pottery. Above I have stated that we found upwards of thirty specimens of the fictile art; these were submitted to the inspection of Mr Birch of the British Museum, the first authority we have in the kingdom as regards pottery. His answer was, "not one piece is of Roman origin."

Another gentleman, second only to Mr Birch in his knowledge of pottery, pronounced them to be of local and modern origin; in this opinion he was both right and wrong. In regard to the pottery being of local origin, I found that the red pottery owed its formation to a manufactory at Portobello, where elegant jugs after the Etruscan mould were made to hold butter-milk, and the others were remains of neat glazed flower-pots from Holland, which forty years ago the skippers brought over to adorn the parlours of their wives.

During our diggings in this bed No. 5, we frequently met with the stems of tobacco pipes, which, of course, did not by any means prove its Roman deposition; pursuing our researches further, we found five heads or bowls of pipes bearing the initials T. W. Knowing only one tobacco-pipe manufacturer in Edinburgh, we submitted them to him, and asked when they were manufactured. His reply was, "these are the initials of my father-in-law, to whose business I succeeded, and could not have been made before the year 1814, when he founded our establishment."

But another proof of this bed No. 5 being a humus bed, exists in the testimony of an old man, Thomas Anderson, who forty years ago cultivated this identical bed before beds Nos. 6 and 7 were laid down.

The question now arises, how were the beds 6 and 7 laid down? Bed (6) was the "tail end" of Mount Falcon, raised by Oliver Cromwell, and levelled over bed 5, when the road was made for the proposed advent of George IV. into Edinburgh in 1822. Bed No. 7, Mr Geikie describes as consisting of a true beach bed with all its shells and balani, and he is led to believe that the deposit was truly laid down by the sea. There are, however, two facts which at once set this aside; 1. The balani are often found on the stones with their valves *downwards*, instead of exposed to their native element; and, 2, bed No. 7 was taken out within eight years from the foundation of a house, and entirely consists of the same shells, &c., which form bed No. 1 of Mr Geikie's section, to which I shall now devote a few words, showing that it was formed within the historic epoch, and long after the advent of the Romans. From the Ordnance Survey map I have taken various contour levels of the streets and quays of Leith to the number of seventy-two. These give an average height above mean high water of 28·7 feet. Now, as the tides vary from neaps to springs about 16 feet, we must deduct from this half the amount, equal to 8 feet; this leaves for average tides a height of 20·7. Now, as the oyster bed of Mr Geikie, or rather his No. 1 (which I call a storm-raised bed) is 15 feet below the average of the streets of Leith, we have only to account for a storm-wave five feet in height, to throw up their so-called raised sea-beach bed so much insisted on by Maclaren and Chambers.

Such condition of the tides have often been observed by the elder inhabitants of Leith, the effects of which could not of course affect land lying below the houses. But let us suppose the condition of Leith before or immediately after the Romans laid the "Fishwife's Causey," and man had not placed barriers against the sea, but that the piers, harbours, and houses of Leith, with all their defences, were removed, old Ocean would soon re-assert his former sway, and claim as his domain the links of Leith, and leave at all high tides, and during N.E. storms, effects equivalent to those which make this storm-raised bed the stumbling-block of all geologists who attempt to prove that we have any very *modern* evidence of a subsidence of the sea or a raising of the land.*

* Since the above was written, the bed No. 7 of Mr Geikie's section has been nearly all removed, the only portion remaining may be carried away in six or eight cart loads. The section exhibits now, what it did before, that humus and sand were alternate, as the carts which carried the stuff of the foundation were loaded anon with earth and then with sand.

Remarks on the so-called Raised Sea-Beach Bed in the Neighbourhood of Leith, and its Relations to other Deposits. By JAMES M'BAIN, M.D., R.N.*

The superficial deposits which repose upon the grooved and dressed surface of the solid rocks have been classified under various appellations, according to the opinions entertained from time to time as to their mode of origin. In the "Reliquiæ Diluvianæ," published in 1823, the superficial strata are ascribed to a recent and transient inundation, considered to be identical with the Noachian Deluge; hence the terms diluvial, ante-diluvial, and post-diluvial, adopted in that celebrated work. These names ceased to be employed in this sense by geologists after the well-known reply of Dr Fleming, entitled "The Geological Deluge, as interpreted by Baron Cuvier and Professor Buckland, inconsistent with the Testimony of Moses and the Phenomena of Nature." A general description of the superficial accumulations has been given by Mr Milne-Home in a valuable memoir "On the Lothian Coal-Fields." This author states, that it is possible to identify and individualise at least seven formations, each having separate characters, and probably belonging to different epochs. Under the existing soil supporting vegetation, there is, 1*st*, An upper covering of gravel and boulders; 2*d*, A deposit of sand and shells; 3*d*, Beds of fine sand; 4*th*, Beds of fine clay; 5*th*, Coarse gravel or stony clay; 6*th*, Lowest boulder-clay; 7*th*, Beds of sand and gravel. In the "Lithology of Edinburgh," Dr Fleming divides the strata belonging to the modern epoch into three groups,—1*st*, The Taragmite series, formed subsequently to the dressings and groovings of the solid rocks, and, where present, reposing on them. They seem to have been formed when violent aqueous movements were taking place, and probably at a period when the state of our island was widely different from the present. The second, or Akumite series, is chiefly characterised by its laminated clays and sands, and indicates the assorting power of water under circumstances of comparative tranquillity. The Phanerite group consists

* Read to the Royal Physical Society, May 7, 1862.

of deposits produced by causes in ordinary operation, and respecting the circumstances under which they have been formed little obscurity prevails. I had repeated opportunities of visiting the critical sections in this neighbourhood with the late Professor Fleming, and of verifying the accuracy of his observations. I shall therefore make use of these generalised expressions in the remarks which follow.

The lowest bed of the Taragmite group which has been observed in this neighbourhood consists of loose angular fragments of rock, 2 to 3 feet thick, which rest on the edges of strata composed apparently of the same materials, and in other places of sand and gravel. The extent of this basement deposit is at present but little known. The result of three borings, shown in a diagram which is copied from one in possession of Mr George Robertson, civil engineer, proves that the basement bed of the Taragmite series is of considerable extent in the neighbourhood of Leith. Two of the borings were made for the purpose of Artesian wells, and one for the foundation of a splendid work of art, the new Graving Dock. At a flour-mill situated near the west end of Leith Docks, the section passes through 80 feet of boulder-clay, then through a bed of sand 22 feet thick, resting on the solid rocks. The excavation made for the Graving Dock passed through 24 feet of marine sand; and the boring shows that the boulder-clay is here 35 feet thick, when a bed of sand is again reached 18 feet in thickness, or 4 feet less than at the flour-mill section. At the rope-walk on the north side of Leith Links, the boring passes through a bed of marine sand 30 feet thick, then through 70 feet of boulder-clay, which at this place is found to rest on the mineralised strata, without any intervening bed of sand. Mr Milne-Home, in his "Memoir on the Lothian Coal-Fields," says, "that at Leith, and in the manufactory lately occupied by a Mr Burstall, a well was sunk through the boulder-clay 45 feet. A bed of sand and fine gravel was then reached, from which water immediately gushed up, showing that the bed was probably of considerable extent." I am informed that the boring referred to by Mr Milne-Home was made in King Street, a little to the eastward of South Leith Poorhouse; and the borings since then instituted confirm his remark, and prove that this deposit underlying the boulder-clay is of considerable extent in the neighbourhood of Leith. This lower stratum of sand and shivers possesses a peculiar interest, inasmuch as it seems to imply that a period of time elapsed between the dressings of the rocks and their covering by boulder clay, sufficient to admit of disintegration and the formation of extensive sedimentary deposition. Additional observations on this basement bed of the Taragmite series, and its existence in other localities, are still wanted, and may assist in throwing some light on certain obscure phenomena connected with the formation of the boulder-clay—a deposit which, Dr Fleming remarks, "has been to many *pons asinorum.*" There are numerous examples where the boulder-clay is observed passing upwards into stratified beds of sand and gravel. In the foundation for the new Post-Office of Edinburgh, Mr A. Bryson and myself noticed the upper portion of the boulder-clay becoming of a light-brown colour, with an increased proportion of sand, and several horizontal layers of sand and gravel distinctly stratified, one of which, at 6 feet below the surface of the clay, was 16 inches thick, and could be traced for 20 feet.

The Akumite group in the ascending order of the superficial strata consists of three distinct kinds of deposits—silt, sand, and gravel. Sections occur in this neighbourhood to prove that, subsequent to the deposition of the Taragmite series, and previous to the commencement of the Akumite group, extensive denudation had taken place, by which the newer or upper portion of the Taragmite beds had been removed. In all the sections examined in this neighbourhood, the silt appears as the basement bed of the Akumite series, and, where present, is seen to rest immediately on the boulder-clay. There is evidence to show that in all probability the Akumite group may be regarded as a lacustrine formation, into which marine remains have occasionally been thrown by irruptions of the sea. Like the Taragmite formation, in passing upwards it graduates into sand and gravel; and where sand occurs without the boulder-clay or silt being exposed, its true relation cannot be satisfactorily determined. There are grounds for supposing that deposits of sand belonging to the boulder-clay and silt periods have been frequently confounded with a bed of marine sand of a different origin, to which the name of raised sea-beach bed has been given. This bed belongs to the third group in the ascending scale, or Phanerite series, of the superficial accumulations; and although, as its name implies, it presents characters very distinct and easily observed, it has nevertheless formed the subject of much geological controversy.

At the concluding meeting of the Royal Physical Society for 1859, I gave a brief description of that portion of the so-called raised sea-beach bed which extends between the old sandstone quarry at Granton and the Magdalen Burn, near Fisherrow. I then stated that the lateral extent of this so-called raised sea-beach bed, and its relation to other accumulations of a similar lithological structure, but destitute of any trace of marine remains, had not yet been satisfactorily determined. The importance of this investigation will be readily admitted when it is considered that it forms, as it were, the starting point whence the great generalisations of geology begin. The raised sea-beach bed is described by Hutton, and is alluded to by his eloquent disciple Playfair, in his "Illustrations of the Huttonian Theory," p. 441. "The marks of an ancient sea-beach," he says, "are to be seen beyond the present limits of the tide, and beds of sea shells, not mineralised, are found in the loose earth or soil, sometimes as high as 30 feet above the present level of the sea. The ground on which the Botanic Garden of Edinburgh is situated (the Old Botanic Garden in Leith Walk), after a thin covering of soil is removed, consists entirely of sea sand, very regularly stratified with layers of a black carbonaceous matter, in thin lamellæ, interposed between them. Shells, I believe, are but rarely found in it, but it has every other appearance of a sea beach." In the "Lithology of Edinburgh," Dr Fleming, in reference to the remarks of Playfair, says,—"The assumption here of 'sea sand' and 'sea beach' seem alike unwarrantable from the description given of the sand; and I may add," he says, "that the occurrence of sea shells in the sand has not been since authenticated." On the high ground that extends between Granton and North Leith, thence inland towards Edinburgh, I have had opportunities of examining numerous excavations and sections where deposits of sand and gravel are frequently exposed, without finding a trace of marine remains. These deposits constitute the upper portion of the Taragmite and Akumite series, and are extensively distributed over the surface in the vicinity of Leith and Edinburgh. The ground chosen for the various cemeteries, and for the Experimental and Botanical Gardens, is a portion of the same deposit; and the general inequality of the surface seems to indicate that the materials were assorted under the action of strong currents and eddies, in comparatively shallow water. A little to the westward of Leith Fort, there is an interesting section of the boulder-clay, known as the Man-trap, where a bed of ferruginous sand is seen resting on the clay, 15 feet above the high-water line. A short time since a cutting was made for a drain in the sloping bank, which extended from the margin of the cliff up to Anchorfield buildings. The cutting passed through 2 feet of soil, and from 2 to 4 feet of ferruginous sand, in which no marine remains could be detected. The extent of the drain, from the margin of the cliff (which is here vertical) up to Anchorfield Buildings, was 90 feet, with a rise of 5 feet. For several years past the sea has been making rapid encroachments upon this part of the coast; and there is evidence to show that, during the last forty years, 90 feet of cliff with a similar gradient has crumbled down and been removed. The bed of sand, which rests on the boulder-clay at a height of 12 to 15 feet above high-water mark, has been considered a portion of the so-called raised sea-beach bed. It would then have been 5 feet lower than at present, and, if the slope continued at the same gradient seaward, would come in contact with the ripple-zone, composed of materials similar to what is now observed at the base of the cliff. This zone extends between the limits of the high-water marks of spring and neap tides, where sands and gravel are thrown up in ridges of ever-varying elevation, and amongst which marine rejectamenta of the most varied character are to be found. The nature and contents of the present ripple-zone deposits are similar to those composing the so-called raised sea-beach bed;

and it is difficult to conceive they could have had a different origin. An attentive examination of the heterogeneous contents included in the older deposits, as exposed, for example, at the Foul Burn between Leith and Portobello, will not fail to satisfy the zoologist that the remains of molluscan life, huddled together in a bed several feet thick, could never have been associated during life. The bed is seen resting on the boulder-clay at the level of ordinary spring-tides; and at one spot is even interrupted by a slight rise in the clay of only 3 or 4 feet above the level of the tide. At this place the sea is observed to be again encroaching on the older deposits; and from observations made by my friend Mr William Young of Fillyside, it appears that 10 or 12 feet of the low cliff has fallen down during the last twelve months. Three years ago, a great abundance of living oysters were cast ashore from the oyster-bed that lies off at a short distance in one or two fathoms water. Several of our geological writers have appealed to the marine shells contained in the so-called raised sea-beach bed, to prove that a rise in the bed of the Forth has taken place within a comparatively recent geological period. In "The Lithology of Edinburgh," the instances adduced are proved to be unsatisfactory, and neither in accordance with the habits of the animals nor with the mode of distribution of the materials of a sea beach.

An attempt has lately been made to prove a rise of the coast of the Firth of Forth within the historical period, by an appeal to the so-called raised sea-beach bed deposits. It is contained in a communication by Mr Archibald Geikie, of the Geological Survey, and published in the "New Philosophical Journal" for July 1861. Mr Geikie states that he found "fragments of Roman pottery in a stratified deposit of marine silt, the deposition of which was going on during the Roman occupation of Britain." He says that "the strata with which this bed of silt is connected lie 25 feet above high-water mark, and are unequivocally those of the raised beach;" and therefore he infers that a rise in the land to this extent has taken place here since the time of the Romans.

In a communication to the Royal Society of Edinburgh by Mr A. Bryson, "On Hasty Generalisation in Geology," it was shown that this so-called marine silt-bed* (No. 5 of Mr Geikie's diagram), supposed to be of the Roman age, contained also abundance of broken pieces of recent pottery, fragments of bone belonging to the sheep and ox, and bits of burnt coal with vesicular cavities irregularly disseminated throughout the mass. This sand-pit is situated on the south side of the Junction Road at Leith, and at the foot of Bowling Green House garden. The section in this sand-pit furnishes a remarkable instance of old artificial deposits, bearing so close a resemblance to natural beds, that experienced observers, not geologically familiar with the locality, have entirely mistaken their nature and character. I examined this sand-pit upwards of two years ago, with the view of tracing the lateral extent inland of the marine deposits. The uppermost natural deposit in the section consists of a bed of sandy clay, three or four feet thick, superimposed upon stratified beds of sand and gravel, and can be traced by its small columnar structure, due to shrinkage in drying and exposure, so characteristic of clays, as also by its light brown colour, onwards to the northern extremity of the section. This bed gradually blends with a dark unstratified mass of old humus, which, at the north end of the pit, is overlaid by a tongue of shot sand, with patches of humus intermixed, presenting an appearance of two beds that are represented in Mr Geikie's diagram as beds 5 and 6. Bed No. 7, which Mr Geikie says "is the highest in the section, and consists of stratified sand and shingle, full of littoral shells, and some balani still attached," is not seen in the sand-pit section; and the only representative that has been observed is a narrow strip of marine shingle and sand, mixed with humus, laid down at the bottom of the garden. The whole of this locality is overspread with artificial deposits. A diagram, prepared by Mr Sharbau, assistant marine surveyor, gives a correct representation of the phenomena observed in this sand-pit section. The lowest bed consists of sand and coarse shingle, and contains abundance of worn marine shells, the balani adhering to the interior of the oyster valves. This bed is four or five feet above the sea level, and its character

* This bed is not distinctly stratified. There is no trace of lamination, and there are bits of burnt coal scattered throughout the mass.

and contents are identical with a ripple-zone deposit. The overlying stratum is composed of marine sand, and varies in thickness. In this sand-pit it is five or six feet, whilst in an adjoining one, a few yards to the eastward, and now filled up, it was eleven feet thick, and contained abundance of worn marine shells and comminuted fragments. It is continuous with the bed of marine sand, in great part blown, on which the town of Leith is built, and is connected to the shore sand. This bed is frequently exposed in foundations for buildings and cuttings for drainage, and when passed through is found to rest on the boulder clay. The deposit of sand and gravel which overlies this bed in the sand-pit section is destitute of marine remains, and appears to be of fluviatile origin. It is remarkably irregular, and rises at the south end of the sand-pit into a protuberance six feet thick. The bed of marine sand disappears in the direction of the river, and the gravel is cut off to the eastward, where the overlying bed of sandy clay, and the lower bed of marine sand are observed to come in contact. This protuberance of sand and gravel extends towards the centre of the sand-pit, where a depression occurs which has been filled up with humus. This short lateral ridge of sand and gravel presents an appearance similar to what is formed by the bifurcation of rivers, or by currents heaping up deposits along their margins. The uppermost bed of sandy clay, which forms part of the so-called stratified marine silt, has all the characters of a marsh silt or lacustrine deposit; and the neighbouring hollow indicates the existence of a former lake. This is still a marsh, over which the Water of Leith occasionally flows as far as the Bonnington road; although the river is now confined within narrower limits, and guided by piers across the extensive foreshore of flat sand to its junction with the sea.

REVIEWS AND NOTICES OF BOOKS.

On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the good Effects of Intercrossing. By CHARLES DARWIN, M.A., F.R.S., &c. John Murray, London, 1862. 8vo, pp. 366.

The object of this work is to point out that the contrivances by which Orchids are fertilized are as varied, and almost as perfect, as any of the most beautiful adaptations in the animal kingdom; and, *secondly*, to show that these contrivances have for their main object the fertilization of each flower by the pollen of another flower. This latter statement bears on the author's views, as given in his work "On the Origin of Species," that it is a universal law of nature that organic beings require an occasional cross with another individual, or, which is about the same thing, that no hermaphrodite fertilizes itself for a perpetuity of generations. In treating of the subject, the author enters into interesting details in regard to the structure of Orchids, the arrangement of the parts of their flowers, their homologies, and the varied adaptations which have been observed in their organs. He has produced a most fascinating volume, which ought to be perused by every one who wishes to understand the nature of Orchids. This extensive family embraces at least 433 genera and about 1000 species. "These wonderful, and often beautiful productions, are unlike common flowers in their many adaptations, in having parts capable of movement, and others endowed with something like, though no doubt really different from, sensibility. The flowers of Orchids, in their strange and endless diversity of shape, may be compared with the great Vertebrate class of Fish, or, still more appropriately, with tropical Homopterous insects, which seem to us, in our ignorance, as if modelled by the wildest caprice."

The author states, that his "treatise affords an opportunity of attempting to show that the study of organised beings may be as interesting to an observer who is fully convinced that the structure of such is due to secondary laws, as to one who views every trifling detail of structure as the result of a direct interposition of the Creator." In this passage he seems to us to mistake the views of those who believe that everything, however minute, must be under the direction of the Creator; that not a sparrow, nor a hair of the head, falls to the ground without God. No one doubts the existence of what are called secondary laws, or, in other words, that the Creator chooses to work by certain great laws which He has made and upholds every moment. These laws are but the expression of the way in which the Creator works; but it is clear that they have no independent existence; they are not self-acting, and they cannot operate except by the continued superintendence of the Lawgiver. We think that no one who reads God's Word aright can look upon the world as a mechanism set a-going by the Creator in the first instance, and then left to work out its wonders without Him; or can believe that the Creator, like a human engineer, retires from the scene, and leaves the machine to go on of itself. This is the view apparently maintained by some, and it is one which we consider irreconcilable with the statements of Holy Writ.

The parts of the flower of an Orchid are arranged in five rows, each of which consists of three parts. There are, normally, three stigmas, two of which are usually confluent, and one is modified into the rostellum; six stamens in two rows, the inner row of these (two of which are fertile in Cypripedium) usually abortive, and modified to form the clinandrium; the outer row of three, one being fertile and two abortive, combined with the lower petal, forming the labellum; the fourth row consists of three petals, and the fifth or outermost of three sepals. Darwin finds that there are fifteen groups of spiral vessels corresponding to these fifteen parts. An Orchid flower, according to him, "consists of five simple parts—three sepals and two petals; and of two compound parts, namely, the column and labellum. The column is formed of three pistils, and generally of four stamens, all completely confluent. The labellum is formed of one petal and two petaloid stamens of the outer whorl, likewise completely confluent. This view of the labellum explains its large size, its frequently tripartite form, and especially its manner of cohesion to the column." Such are the homologies of Orchids, and in this manner the arrangement and forms of their curiously moulded organs are explained.

The subject of Orchid fertilization has engaged the attention of many eminent botanists, such as Sprengel and Robert Brown. The nature of the pollen-masses and of their appendages, as well as the formation of pollen-tubes, and the general agency of insects, are facts which have been already recorded in various works; but it remained for Darwin to ascertain fully the mode in which insects act in the process of fertilization, as well as to show the true structure of the pollinia, and the way in which they are applied to the stigma. He has done this in a most masterly and convincing manner. His experiments are reported with great clearness and candour, and the reader is made acquainted with the difficulties which he encountered and the mode in which they were overcome. The whole is the work of a philosophic naturalist, having powers of observation of no ordinary kind, and a wonderful facility of communicating scientific facts in an attractive and popular manner.

The phenomena of fertilization have been examined in fourteen genera of British Orchids—viz., *Orchis*, *Aceras*, *Ophrys*, *Herminium*, *Peristylus*, *Gymnadenia*, *Habenaria*, *Epipactis*, *Cephalanthera*, *Goodyera*, *Spiranthes*, *Malaxis*, *Listera*, and *Neottia;* and in forty-three exotic genera, including, among others, *Cattleya*, *Epidendrum*, *Masdevallia*, *Bolbophyllum*, *Dendrobium*, *Oncidium*, *Stanhopea*, *Calanthe*, *Angræcum*, *Acropera*, *Catasetum*. The chief facts recorded are illustrated by characteristic woodcuts.

According to the author, all the British species of Orchis require absolutely the aid of insects for their fertilization. This is obvious from the fact that the pollinia are so closely embedded in the anther-cells, and the disc with its ball of viscid matter in the pouch-formed rostellum, that they cannot be shaken out by violence. A list is given of twenty-three Lepidoptera which were found with the pollinia of an Orchis attached to their probosces. The viscid matter secreted in the disc at the foot of the pollinia adheres easily to any body with which it comes into contact, and it has the power of becoming hard during drying, so as to be firmly fixed in its position. Various means are adopted for securing the withdrawal of the pollen-masses. In some Orchids, nectar secreted in the spur of the corolla is easily obtained by moths; in such cases the pollinia are at the same time withdrawn, and their viscid disc adheres at once to the probosces. In other instances nectar is secreted between the two membranes of the spur, and in order to reach it the moth must rupture the delicate inner membrane. These phenomena seem to be connected with a difference in the viscidity and setting of the discs. In those cases where the viscid matter requires time to set and grow hard, the moths are delayed in getting nectar, so as to allow the discs to adhere to their probosces. This is a singular case of adaptation. Remarkable movements are manifested by Orchids in various parts of their flowers. The labellum of *Bolbophyllum barbigerum* is furnished with a beard of fine hairs, which causes the labellum to be in constant motion from any breath of air. In Acropera the labellum is articulated to the base of the column by a thin strap, so elastic and flexible that a breath of wind sets it vibrating. The Australian genus Calæna has a remarkably irritable labellum. When an insect lights on this labellum, it suddenly shuts up against the column, and encloses its prey as it were in a box. In *Stelis racemiflora* the little flowers are widely expanded; but after a time the three sepals close with perfect exactness, and shut up the flower, so as to appear like a bud. It is thus difficult to distinguish an old flower from a bud. The closed flower opens under water. Numerous are the movements shown by the pollinia. In *Dendrobium chrysanthum* the anther has a peculiar springing action, by which it scoops the pollen-mass out of the concave clinandrium, and pushes it up in the air with exactly the right force, so as to fall in the middle of the viscid stigma, where it sticks. In many Vandeæ the pedicel of the rostellum has a strong natural elastic tendency to spring up at right angles to the disc; in other cases, hygrometric movements are seen. As regard the movements of the pollinia in British Ophreæ, these are "due to the nicely regulated combination of that small portion of membrane (together with the pedicel in the case of Habenaria) lying between the layer or ball of adhesive matter and the extremity of the caudicle. In most of the species of Orchis the stigma lies directly beneath the anther-cells, and the pollinia simply move vertically downwards. In *Orchis pyramidalis* and in Gymnadenia there are two lateral and inferior stigmas, and the pollinia move downwards and outwards, diverging at the proper angle (by a different mechanism in the two cases), so as to strike the two lateral stigmas. In Habenaria the stigmatic surface lies beneath and between the two widely-separated anther-cells, and the pollinia here again move downwards, but at the same time converge."

The mode in which insects act in the case of *Orchis pyramidalis*, is thus described :—" Let a moth insert its proboscis between the guiding ridges of the labellum, or insert a fine bristle, and it is surely conducted to the minute orifice of the nectary, and can hardly fail to depress the tip of the rostellum; this being effected, the bristle comes into contact with the now naked and sticky under-surface of the suspended saddle-formed disc. When the bristle is removed, the saddle with the attached pollinia is removed. Almost instantly, as soon as the saddle is exposed to the air, a rapid movement takes place, and the two flaps curl inwards and embrace the bristle. When the pollinia are pulled out by their caudicles, by a pair of pincers, so that the saddle has nothing to clasp, I observed that the tips curled inwards, so as to touch each other in nine seconds; and in nine more seconds, the saddle was converted, by curling still more inwards, into an apparently solid ball. The probosces of the many moths which I have examined, with the pollinia of the Orchis attached to them, were so thin, that the tips of the saddle just met on the other side. This rapid clasping movement helps to fix the saddle with its pollinia upright on the proboscis; but the viscid matter rapidly setting hard would probably suffice for this end, and the real object gained is the divergence of the pollinia. The pollinia being attached to the flat tip or seat of the saddle, project at first straight up, and are nearly parallel to each other; but as the flat top curls round the cylindrical and thin proboscis, or round a bristle, the pollinia necessarily diverge. As soon as the saddle has clasped the bristle, and the pollinia have diverged, a second movement commences; which action, like the last, is exclusively due to the contraction of the saddle-shaped disc of membrane. The second movement causes the divergent pollinia, which at first projected at right angles, to the needle or bristle, to sweep through nearly 90 degrees towards the tip of the needle, so as to seem depressed and finally to lie in the same plane with the needle. This second movement was often effected in thirty or thirty-four seconds after the removal of the pollinia from the anther-cells. The object of this double movement seems to be, to allow the ends of the pollinia to touch the double stigmatic surface, when the proboscis of the insect is pushed between the guiding ridges of the labellum into the nectary of the same or another flower. These stigmas are so viscid, that they rupture the elastic threads by which the packets of pollen are bound together; and some dark-green grains will be seen, even by the naked eye, remaining on the two white stigmatic surfaces."

The phenomena connected with the fertilization of *Listera ovata* may be given as another illustration. They are thus summed up:—" The anther-cells open early, leaving the pollen-masses quite loose, with their tips resting on the concave crest of the rostellum. The rostellum then slowly curves over the stigmatic surface, so that its explosive crest stands at a little distance from the anther; and this is very necessary, otherwise the anther would be caught by the viscid matter, and the pollen for ever locked up. This curvature of the rostellum over the stigma or base of the labellum is excellently well adapted to favour an insect striking the crest when it raises its head, after having crawled up the labellum, and licked up the last drop of nectar at its base. The labellum becomes narrower where it joins the rostellum, so that there is no risk of the insect going too much to either side. The crest of the rostellum is so exquisitely sensitive, that a touch from a most minute insect causes it to rupture at two points, and instantaneously two drops of viscid fluid are expelled, which coalesce. This viscid fluid sets hard in so wonderfully rapid a manner, that it rarely fails to cement the tips of the pollinia, nicely laid on the crest of the rostellum, to the insect's forehead. As soon as the rostellum has exploded, it suddenly curves downwards till it projects at right angles over the stigma, protecting it in its early state from impregnation, in the same manner as the stigma of Spiranthes is protected by the labellum clasping the column. But as in Spiranthes the labellum after a time moves from the column, leaving a free passage for the introduction of the pollinia, so here the rostellum moves back, and not only recovers its former arched position, but stands upright, leaving the stigmatic surface, now become more viscid, perfectly free for pollen to be left on it. The pollen-masses, when once cemented to an insect's forehead, will generally remain firmly attached to it, until the viscid stigma of a mature flower removes these encumbrances from the insect, by rupturing the weak elastic threads by which the grains are tied together, receiving at the same time the benefit of fertilization."

In the case of another genus, Catasetum, the author points out a series of remarkable phenomena. In these plants, some mechanical aid is required to remove the pollen-masses from the receptacle, and to carry them to the stigmatic surface. Some of the species, such as *Catasetum tridentatum*, *C. saccatum*, and *C. callosum*, are unisexual, and require that the pollen-masses should be transported to the female plant, in order that seed may be produced. *Catasetum tridentatum* presents three forms—1. The ordinary male form; 2. The female form, which has been named *Monacanthus viridis;* 3. The hermaphrodite form, called *Myanthus barbatus.* These three sexual forms are borne on separate plants, but sometimes they are mingled together, so that the plant becomes Polygamous. The three forms are wonderfully different from each other. In the male and hermaphrodite flowers, irritable antennæ (tubular horn-like processes, formed by prolongations of the anterior face of the rostellum) are present, which are specially adapted to receive and convey the effects of a touch to the disc of the pollinium; causing the membrane to rupture, and the whole pollinium to be ejected by its elasticity. If we required further proof, nature has afforded it in the case of the so-called genus Monacanthus, which is the female plant of *Catasetum tridentatum*, and has no pollinia to eject—and here the antennæ are entirely absent.

"When the left-hand antenna of *Catasetum saccatum* (or either antenna of *C. tridentatum* and *C. callosum*) is touched, the edges of the upper membrane of the disc, which are continuously united to the surrounding surface, instantaneously rupture, and the disc is set free. The highly elastic pedicel then instantly flirts the heavy disc out of the stigmatic chamber with such force that the whole pollinium is ejected, bringing away with it the two balls of pollen, and tearing the loosely attached spike-like anther from the top of the column. The pollinium is always ejected with the viscid disc foremost." The pollen-mass is sent out with considerable force, sometimes even to the distance of two or three feet. The viscid matter sets hard, and firmly fixes the winged pedicel to the insect's body. The insect then flies from flower to flower till at last it visits a female or hermaphrodite plant; it then inserts one of the masses of pollen into the stigmatic cavity. When the insect flies away, the elastic caudicle, made weak enough to yield to the viscidity of the stigmatic surface, breaks, and leaves behind the pollen-mass; then the pollen-tubes slowly protrude, penetrate the stigmatic canal, and the act of fertilization is completed. How interesting and surprising are these complex and admirable arrangements.

Self-fertilization is a rare event with Orchids. In *Cephalanthera grandiflora* it occurs, but in a very imperfect degree, and the early penetration of the stigma by the flower's own pollen-tubes seems to be fully as much determined by the support thus given to the pillars of pollen, as by the production of a small proportion of seed; certainly the fertilization of this orchid is favoured by insects. In some species of Dendrobium self-fertilization apparently occurs; but only if insects accidentally fail to remove the flower's own single pollen-mass. In Cypripedium, the Frog Orchis, and perhaps in a few other cases, it will depend on the manner (at present unknown) in which insects first insert their probosces by the one or the other entrance, whether the flower's own pollen, or that of another flower, is habitually placed on the stigma; but in these cases there will assuredly always be a good chance of the stigma being fertilized by pollen brought from another flower. In the *Ophrys apifera* alone there are special and perfectly efficient contrivances for self-fertilization. "In this Orchid the caudicles are very slender; the mother-cells naturally open, and the masses of pollen, from their weight, slowly fall down to the exact level of the stigmatic surface, and are thus made to vibrate to and fro by the slightest breath of wind, till the stigma is struck. This phenomenon seems to be plainly adapted in this instance for self-fertilization. Hence, in this species, all the capsules are frequently perfected. At the same time there are manifest adaptations in this Orchid for the occasional transport by insects of the pollinia from one flower to another, as in the other species of the same genus." Darwin thinks that Nature tells us in the most emphatic manner that she opposes perpetual self-fertilization. He has endeavoured to prove this in the case of many other plants besides Orchids, and even in plants which are hermaphrodite, such as species of Primula. The conclusion at which he thus arrives is considered by him of vast importance, and as justifying the ample details given in this volume. "For may we not infer as probable," he says, "in accordance with the belief of the vast majority of the breeders of our domestic productions, that marriage between near relations is likewise in some way injurious; that some unknown great good is derived from the union of individuals which have been kept distinct for many generations?"

In reviewing all the variations which occur in the flowers of Orchids, the author thinks that "the simple and intelligible view is, that all Orchids owe what they have in common to descent from some monocotyledonous plant, which, like so many other plants of the same division, possessed 15 organs, arranged alternately 3 within 3, in five whorls; and that the now wonderfully changed structure of the flower is due to a long course of slow modification,—each modification having been preserved which was useful to each plant during the incessant changes to which the organic and the inorganic world have been exposed." If we had every Orchid which has ever existed throughout the world, he supposes that "every gap in the existing chain, and every gap in many lost chains, would be amply filled up by a series of easy transitions." The more he studies nature, the more he is convinced of the correctness of his conclusion, "that the contrivances and beautiful adaptations are slowly acquired through each part occasionally varying in a slight degree, but in many ways, with the preservation or natural selection of those varieties which are beneficial to the organism under the complex and ever-varying conditions of life."

The connection between certain tribes of insects and orchids is well shown in the case of the beautiful Madagascar plant called *Angræcum sesquipedale.* This plant has a whip-like green nectary, 11 or 12 inches long, with the lower part only filled with nectar, and requiring visits from insects with very long probosces. In collecting the nectar, the insect requires to insert its proboscis up to the very base through the cleft of the rostellum, and by this means provision is made for the attachment of the pollinia to the proboscis during its withdrawal. The author remarks that, if the Angræcum in its native forests has its nectary filled more than in the specimens he examined, then small moths might obtain their share of the nectar, but the pollinia would not be moved, and thus fertilization would not be effected. The pollen-masses can only be withdrawn by means of an insect with a wonderfully long proboscis, trying to drain the last drop of nectar. "If such great moths were to become extinct in Madagascar, assuredly the Angræcum would become extinct. On the other hand, as the nectar, at least in the lower part of the nectary, is stored safe from depredation by other insects, the extinction of the Angræcum would probably be a serious loss to these moths. We can thus partially understand how the astonishing length of the nectary may have been acquired by successive modifications. As certain moths of Madagascar became larger through natural selection in relation to their general conditions of life, either in the larval or mature state, or as the proboscis alone was lengthened to obtain honey from the Angræcum, and other deep tubular flowers, those individual plants of the Angræcum which had the longest nectaries, and which consequently compelled the moths to insert their probosces up to the very base, would be best fertilized. These plants would yield much seed, and the seedlings would generally inherit longer nectaries; and so it would be in successive generations of the plant and moth. Thus it would appear that there has been a race in gaining strength between the nectary of the Angræcum and the proboscis of certain moths; but the Angræcum has triumphed, for it flourishes and abounds in the forests of Madagascar, and still troubles each moth to insert its proboscis as far as possible, in order to drain the last drop of nectar."

In these passages we see the bearing of the facts of Orchid fertilization on the production of new forms, as propounded by the author in his work on the "Origin of Species." He traces all modifications through successive generation, and thinks that this is a better view of the case than to suppose that the Creator at once called into existence the varied forms of the present flora. He thinks that if we could trace back floral forms from generation to generation for long epochs, extending it may be over millions of years, we would be able to account for all variations in a more philosophic manner than by referring them to one creative fiat of the Almighty. He deprecates the idea of M'Cosh and others, that in these modified forms of great types the Creator displayed the plan and order of His work, and that in the abnormalities in the forms of organs and their gradation God has shown the principles of His arrangement, and has developed the workings of His all-creative mind. For our own part, we do not see the great superiority of the Darwin view over this latter hypothesis. Both are no doubt theoretical. The obstacles to the reception of Darwin's hypothesis in its full extent are great. To believe that all the forms of animals and vegetables spring from a cell, which through countless millions of ages has undergone an infinite series of transformations by natural selection, correlation of growth, struggle for life, &c., is certainly not an easy thing for the mind, more especially when *man* is included in the category. Here it is that the difficulty occurs; and it is precisely at this latter stage that the opponents of Darwin's views have a sure foundation to rest upon. For here Revelation steps in, to tell us of man's creation, of his relation to the Deity, of his present fallen condition, and of his future prospects, and speaks in such terms as to preclude the possibility of our adopting the Huxleyan view that, as the lowest ape, in the conformation of its skeleton, differs as much from the highest ape as the latter does from man, therefore we are merely transformed apes.

In his work on Orchids, however, Darwin does not stretch his view to this limit. He details facts with the utmost candour, and then very plausibly shows how they might be accounted for on his view of transmission by generation. Setting aside all theory, and looking at the work in itself, we have no hesitation in saying, that it is one of the deepest interest, well worthy of being studied; that it presents forms and functions to us under new aspects; illustrates in no ordinary degree the beautiful adaptations which are seen in plants, and is calculated to exalt our ideas of the wonder-working Jehovah.

Volcanos: the Character of their Phenomena, their Share in the Structure and Composition of the Surface of the Globe, and their Relation to its Internal Forces; with a Descriptive Catalogue of all known Volcanos and Volcanic Formations. By G. POULETT SCROPE, M.P., F.R.S., F.G.S., &c. 2d Edition, revised and enlarged, with a Map of the Volcanic Areas of the Globe, &c. London: Longman & Co., 1862. 8vo. pp. 490.

The study of the subterranean forces which have everywhere broken up the rocks of the globe and altered their composition, is one of great interest and importance. The manifestations of these forces are distinguished in the phenomena of earthquakes and volcanoes. "The first are, to outward apprehension, purely dynamical, consisting in sudden and transient *shocks* and wave-like vibrations of extensive superficial areas, attended by fracture, disturbance, and often permanent change of level in their component rocks. The latter are characterised by *eruptions*,—that is, the forcible expulsion of heated matters, gaseous, fluid, or solid—(usually all these together)—from the interior of the earth upon its surface, these phenomena being very generally accompanied or preceded by earthquakes of a minor and local character." These two kinds of subterranean action are probably modifications of the same force, acting from different depths and under different circumstances. The author distinguishes between plutonic and volcanic action, and differs from Humboldt in his view of the latter. He gives a general view of volcanic action, and points out the connection between earthquakes and volcanic eruptions. He gives the localities of volcanos, their number and geographical position, and illustrates the latter by a map. The phenomena of ordinary subaërial eruptions are considered under three phases:—1. That in which the volcano exists incessantly in outward eruption,—phase of permanent eruption. 2. That in which eruptions, rarely of any excessive violence, continue in a comparatively tranquil manner for a considerable time, and alternate with brief intervals of repose,—phase of moderate activity. 3. That in which eruptive paroxysms of intense energy alternate with lengthened periods of complete external inertness,—phase of prolonged intermittences. "The main agent in all these stupendous phenomena—the power that breaks up the solid strata of the earth's surface, raises, through one of the fissures thus occasioned, a ponderous column of liquid mineral matter to the summit of a lofty mountain, and launches thence into the air, some thousand feet higher, with repeated explosions, jets of this matter, and fragments of the rocks that obstruct its efforts—consists unquestionably in the expansive force of some elastic aëriform fluid struggling to escape from the interior of a subterranean body of *lava,*—that is, of mineral matter in a state either of fusion, or at least of liquefaction, at an intense temperature. This body of lava is evidently, at such times, in *igneous ebullition.* That it conducts itself, on obtaining access to the outer air through some crevice sufficiently widened for this purpose, precisely after the manner of a boiling liquid or paste, has been ascertained by repeated observations." By the rapid, continuous, and explosive discharge of steam-bubbles ascending from some depth within lava which has forced its way up some fissure to the outer surface, this orifice is gradually enlarged, the intercepting matter blown into the air, and a crater formed of varying magnitude. At first, pieces of broken rocks are ejected; these are followed by jets of liquid and incandescent matter, accompanied with ragged fragments torn off from the solid crust. The force is so great that a rock weighing 200 tons has been sent up to a height of several hundred feet into the air. The author gives the following account of the phenomena connected with eruption:—" Some of the more liquid portions of the lava shot up assume, by rotation through the air, a globular or pear-shaped figure. These are the volcanic *bombs* often found in the vicinity of an eruptive vent; and, as they can only be produced in the manner here indicated, their occurrence on any spot affords a useful indication of the site of an eruption at some former period, when other signs are perhaps wanting—as in Monts Dore and Cantal. Their nucleus is usually compact, and sometimes consists of a solid fragment of some earlier rock caught up and enveloped in the liquid lava; but towards the surface they have a vesicular envelope beneath an outer shell of compact texture. In size they vary from that of the largest block in a man-of-war's rigging to that of a nut or almond. The great bulk of the ejected fragments of lava, cooling rapidly in their passage through the air, possess ragged, tattered shapes, and when examined are found to be full of vesicles. Those of the heavier ferruginous lavas are called *scoriæ,* from their resemblance to the cinders, or slags of iron-furnaces. The scoriæ of the felspathic lavas, which have an inferior specific gravity, are usually still more vesicular or filamentous, and have a vitreous fracture. They are called *pumice.* In some cases, where the lava is peculiarly tenacious and tough, it is drawn out into filaments, having a silky lustre almost equal to that of asbestos. As the eruption progresses, the surface of the lava sinks within the vent more or less rapidly, owing either to its outflow from some orifice at a low level in the flank of the volcano, or to the exhaustion of the subterranean eruptive energy by loss of heat through the amount of vapour discharged from it . . . . Of the smaller fragments ejected vertically from an eruptive vent, those which, by their mutual friction in the air, have been reduced to a sort of gravel of rounded scoriæ, are called *lapillo* by the Italian geologists,—a word sometimes corrupted into *rapilli;* when, by still further attrition, they are comminuted into sand, *puzzolana;* and when brought to the condition of fine dust, *cineri* or *ashes.* The lapillo is generally of a deep black colour; the puzzolana is red, like burnt brick-dust; the fine ashes are of a whitish grey."

The phenomena connected with lava are considered by the author in reference to its emission, its outflow, its progression and coagulation, the forms it assumes, the rents and caverns which are seen in it, the dykes and columns which it forms, and the metamorphic action which it exerts. The mineral characters and constitution of lava-rock, of trachyte, basalt, and traps, in all their varieties, and the mode in which volcanic mountains are formed, are fully considered. A chapter is devoted to craters on volcanic mountains, cones of different kinds, volcanic islands, crater lakes, solfataras, craters of the moon, and lunar volcanos. The lunar craters, compared with those of the earth, are more generally distributed, deeper, and of greater diameter. They appear to have been formed by the explosions of vapour breaking through a surface of soft and semifluid matter in successive bubbles, and throwing off all round a concentric ridge formed of repeated layers of the substance.

Besides subaërial volcanos there are others formed under water, and termed *subaqueous.* Instances of submarine eruption have been observed off St Michael one of the Azores, in the Grecian Archipelago, off the coast of Iceland, among the Aleutian group of islands, off the south-west coast of Sicily, on the coast of New Grenada near Carthagena, as well as on the west coast of Africa, and the east coast of South America. "In all these submarine eruptions, volumes of smoke (steam mixed with ash) by day, and flames (jets of red hot scoriæ) by night, were seen to rise from the sea, which was considerably agitated, discoloured, and heated to such a degree as to kill a number of fish." The dark island rocks afterwards showed themselves above the sea level, and either remained as permanent volcanic islands or disappeared. Coral islands are in many instances raised on lava rocks.

The consideration of the relation between plutonic and volcanic action, and the subject of metamorphic rocks, leads the author to the following general conclusions in regard to telluric phenomena: —1. The earliest condition of the lowest known matter of the globe is that of a granitoidal triple mineral compound, consisting generally of felspar, quartz, and mica; the mica being at an intense temperature, and in a state of violent elastic tension, and thus pressing forcibly on the overlying substance. 2. The highest layers of this matter, acted upon by upward pressure, have acquired a more or less laminar arrangement of their component crystals, and have been split and penetrated by the intrusion of more liquid matter beneath, and have often been forced up the axial fissure in a folded and crumpled manner. 3. Fissures formed by these disturbances, opening downwards into the heated lava or granitic matter, have been filled with matter which, on consolidation, produced a plate or dyke of crystalline igneous rock. 4. The jar accompanying the rending of such fissures, and the injection of heated matter into it, occasion an undulatory vibration in the adjoining masses of solid rock, producing the effect of an earthquake shock. 5. When the crevice penetrates to a focus of liquefied igneous matter, it occasions the formation of a dyke; and when the matter is sent up into the atmosphere or shallow water, it enters into violent ebullition, causing a volcanic eruption. 6. The lava so erupted is sometimes in a complete state of glassy fusion, but more usually in one of more or less imperfect crystallisation, mixed with interstitial heated water or steam, the escape of which hastens the consolidation of the matter and the formation of lava rock. 7. The erupted matters consolidate in the form of a conical mound over the vent—the orifice whence the eruptive explosions proceeded being marked by a saucer or cup-shaped crater; and by the accumulation of repeated ejecta, a volcanic mountain is formed. 8. These outward eruptions are accompanied or followed by subsidence or upheaval of the surrounding area. 9. The cause of these changes in the earth's crust appear to be the unequal transmission through it of heat from beneath upwards; and this heat, varying in different parts, gives rise to the phenomena of elevation and subsidence. 10. The cause of the internal heat of the globe is still undetermined; the author does not consider it to be due to oxidation of any metallic nucleus, nor to the generation of electric currents within the globe; but he inclines to the supposition of a gradually cooling nucleus, still retaining much of the intense temperature possessed by it at the time of its original formation.

"The theory suggested above as to the emanation of the central heat, not only provides a reasonable origin for plutonic upheavals and the formation of fissures and faults, but also for the occasional extravasation and ebullition of some portion of the subterranean mineral matters (known, as far as we are acquainted with them, to contain water), which increased temperature or diminished pressure has liquefied and caused to effervesce. It moreover accounts for the relative geographical position of the elevated ranges and the eruptive ones. One hypothesis alone suffices to explain the whole series of terrestrial phenomena—elevations and subsidences in mass, earthquake shocks, and volcanic eruptions, as well as their mutual relations,—that hypothesis being the shifting of the flow of heat (which we know to be continually rising out of the interior of the earth) from one subterranean mass of mineral matter to another.

"It has been shown that such a shifting is not only probable but inevitable, through the ever-varying capacities for the conduction of heat of those areas of the globe which are respectively subaërial and subaqueous—variations that must necessarily arise from the varying influences of the oceanic, meteoric, and organic forces.

"This theory seems to me to explain both the plutonic and the volcanic phenomena better than any other, and the harmony and general accordance of all its parts is the best test of its truth."

In an Appendix, the author gives a catalogue and description of volcanos now or recently in activity, with some account of earlier volcanic formations. In this last he includes the volcanos of Europe, those of the Levant, Asia, the Eastern and Western Atlantic, the Southern Ocean, South America and Eastern Pacific, Central America, North America, Western, Southern, and Central Pacific.

We have thus endeavoured to give a brief abstract of the valuable facts in regard to volcanos, as given in Mr Scrope's book. The work is most ably written, and it is one of great interest alike to the general reader and to the geologist. The details are given in a clear manner, and the more important are illustrated by an excellent series of woodcuts. The subject of volcanos must necessarily command the attention of all who study the history of our globe. The awe which they inspire, the overwhelming convulsions which they cause, the awful destruction which they occasion, and the terrific phenomena which accompany their eruptions, cannot fail to make them objects of deep interest. They proclaim the existence of igneous matter in the interior of the solid earth, and they seem to point to the period when the earth and all things therein shall be dissolved, and when the elements shall melt with fervent heat.

The Student's Manual of Geology. By J. BEETE JUKES, M.A., F.R.S., Local Director of the Geological Survey of Ireland. A new Edition; partially recast, and supplied with Lists and Figures of Characteristic Fossils. Edinburgh: A. & C. Black. 1862. 8vo. Pp. 764.

This appears to us to be the best Manual of Geology in the English language; and we are glad to see that a second edition has been called for, and that the author has made important additions and improvements. In these days, when geology occupies an important place in education, it is necessary that the student should be supplied with a condensed view of the great facts of the science, and that he should be properly directed in his researches. These objects are fully attained by the present compact volume, which can be put into the hands of students with the utmost confidence, as being the work of an eminent geologist, who has been long engaged in the practical details of the science, and who possesses the power of communicating information in a clear and interesting manner.

The work is divided into three parts :—

I. *Geognosy*, or the study of the structure of rocks, independently of their arrangement into a chronological series. This is subdivided into—1. *Lithology*, or the study of the internal structure, the mineralogical composition, the texture, and other characters of rocks, such as could be determined in the closet by the aid of hand-specimens ; 2. *Petrology*, or the study of rock-masses, their planes of division, their forms, their positions and mutual relations, and other characters, that can only be studied in the field, but without entering on the question of the geological time of their production.

II. *Palæontology*—The study of the laws which have governed the distribution of life, both in space and in time, and the consideration of the chief points in the structure of the more important extinct races, and their relations to those now living.

III. *History of the Formation of the Crust of the Globe*, including chronological classification, the history of the principal and typical groups of rocks known to have been produced, and an account of some of the more common and best-marked fossils which lived at different parts of the earth during each of the known great periods of its existence.

Under the head of Lithology are considered the subjects of chemistry and mineralogy, rock-forming minerals, origin, classification, and determination of rocks, igneous, aqueous, aërial, and metamorphic. Under the head of Petrology are included, the formation of rock-beds and rock-blocks, disturbance in the earth's crust, inclination of beds, faults, dislocation, cleavage and foliation, denudation, unconformability, granitic, trappean, volcanic rocks, Orography, or the structure and origin of mountains, mineral veins, and the art of mining. Under Palæontology, the author considers Zoology and Botany, and the laws and generalisations of Palæontology. The third part contains accounts of the formation of the Palæozoic, Mezozoic, and Cainozoic epochs. An Appendix contains remarks on geological surveying. The Index contains an explanation of words derived from the Latin and Greek, and the pronunciation of the words is indicated.

In speaking of the practical importance of fossils, Mr Jukes makes the following observations :—

" The importance of the study of fossils to all those who wish not only to learn the past history of life upon the globe, but to understand the problems involved in its present multiplicity of form and variety of diffusion, will be obvious even from the slight and hasty observations that precede. Their importance, however, is not limited to the theoretical speculations, or the philosophical conclusions that may be derived from them, for those, like many other scientific conclusions, may be coined into actual money, or money's worth, by their practical application.

"If in any particular part of the earth beds of any substance of economic value to man were formed during a particular geological period only, it is obvious that those beds, and the others in which they lie, will contain the remains of the animals and plants that lived during that period, and no others. If, therefore, the valuable beds be but a few thin seams occurring here and there in a great series, and our object be to discover where any part of that series reaches the surface, in order that we may search for the valuable beds, it is clear that the fossils will be of the greatest assistance to us.

"The mere lithological character of the other beds of the series may be of little or no use to us as a guide, and may even mislead us, since there may be other series having beds of precisely similar character, but not containing the valuable beds.

"The most striking instance of what is here stated generally, is the occurrence of beds of coal in the part of the series which is hence called the Carboniferous formation. Coal is not confined to that formation, since in different parts of the world good workable coal occurs in other formations; but, in Britain and Western Europe, although thin beds of coal occur in other formations, extensive beds of workable coal have only been found in the Carboniferous formation. Coal is usually associated with black and grey shales in that formation, and the same association occurs in other formations, where the coal is too impure or in too small quantity to be valuable. Black and grey shales also occur in parts of the Carboniferous series, where there is no coal, and in other formations entirely devoid of coal. The coal miner being always accustomed to see coal associated with black and grey shale, and not having had occasion, like the geologist, to see black and grey shales in other formations, naturally looks upon the occurrence of the black and grey shale as indicative of the presence of coal. The geologist, on the other hand, having a wider experience, knows, that not only do black and grey shales occur where there is no chance of coal being found, but that even thin seams of coal occur in formations where no coal worth working has ever been found in the British area or in Western Europe.

"He therefore knows, that all 'indications' are worthless as evidence of the presence of the 'Carboniferous formation,' except the occurrence of the 'Carboniferous fossils.'

"Even where the fossils occur there may be no coal, but all sinking for coal in beds containing any other than the Carboniferous fossils is pure waste of labour and money.

"Within my own experience large sums of money have been absolutely thrown away, which the slightest acquaintance with palæontology would have saved. I have known, even in the rich coal district of South Staffordshire, shafts continued down below the Coal-measures deep into the Silurian shales, with crowds of fossils brought up in every bucket, and the sinker still expecting to find coal in beds below those Silurian fossils. I have known deep and expensive shafts sunk in beds too far above the Coal-measures for their ever being reached, and similar expensive shafts sunk in black shales and slates in the lower rocks far below the Coal-measures, where a pit might be sunk to the centre of the earth without ever meeting with coal. Nor are these fruitless enterprises a thing of the past. They are still going on in spite of the silent warnings of the fossils in the rocks around, and in spite of the loudly-expressed warnings of the geologists, who understand them, but who are supposed still to be vain theorists, and not to know so much as 'the practical man.'

"I have elsewhere stated my belief that the amount of money fruitlessly expended in a ridiculous search after coal, even within my own experience, would have paid the entire cost of the Government Geological Survey of the United Kingdom. It is a curious perversity of the human mind, that men prefer to take the advice of those whose interest it is to get them to spend money, rather than the warnings of those who can have no interest in inducing them not to spend it."

Genera Plantarum, ad Exemplaria imprimis in Herbariis Kewensibus servata, definita. Auctoribus G. BENTHAM et J. D. HOOKER. Voluminis Primi, Pars I., sistens Dicotyledonum Polypetalorum Ordines LVI. (Ranunculaceas—Connaraceas). Londini, 1862. Royal 8vo, pp. 454.

The work of Endlicher, having a similar title, was long the chief authority in regard to the genera of all known plants. During the life-time of the author, it was kept up to the state of science by the publication of supplements; but after his death, it was allowed to fall behind the demands of the botanical world. The work was also deficient in many points, both as regards arrangement and definitions. There was a want of a complete work on genera—one drawn up by a botanist of decided eminence and authority, in which the characters would be given in a terse and clear manner, and in which the definitions would be founded on the examination of a large collection of specimens from all quarters of the globe. The present publication most effectually supplies this desideratum. It is the result of the united labours of two of the most distinguished botanists of the age, who have travelled much and seen the Floras of various parts of the world, and who have had the advantage of the admirable collections of Kew, which are probably the largest in the world. They have brought to bear on the subject extensive practical knowledge and philosophical acumen of no ordinary kind; and they have produced a standard work, which, while it will add to their renown, will at the same time be hailed by every botanist as one of the greatest boons which the science has received.

The authors tell us that Linnæus was the inventor of genera, and that they have therefore neglected all the so-called generic names before the time of Linnæus, and which have not been adopted either by him or by subsequent authors. They have attributed the generic name either to Linnæus or to the author by whom it was first used according to the Linnean rule. They mention the work in which the genus was first named, either by Linnæus or by those after him. They also quote the volume of Decandolle's Prodromus or of Walper's Supplements, in which there is the most recent enumeration of the species; and they indicate also other works, in which new and remarkable species are described, as well as some of the best drawings to be consulted. Synonymes are carefully given, and the generic characters have been verified in general by the examination of several species. Doubtful genera are enumerated, but those which have been rashly adopted, and which have not been properly described, are omitted. The first part of the work embraces the Polypetalous Dicotyledons, from Ranunculaceæ to Connaraceæ inclusive. A conspectus is given of Polypetalous Dicotyledons. These are divided into three series: 1. *Thalamifloræ*—Calyx very generally free from the ovary, petals in one, two, or numerous rows; stamens indefinite or definite, inserted often on a small or elevated or stalk-like torus; ovary very frequently superior. 2. *Discifloræ*—Calyx often free from the ovary; petals in one row; stamens more commonly definite, inserted within or above or round a torus, which is commonly expanded into a disc; ovary usually superior or immersed in a disc. 3. *Calycifloræ*—Tube of calyx often embracing the ovary or adnate to it; petals in one row, inserted into the calycine tube; stamens indefinite or definite, very often inserted into the calyx tube, or into the disc lining the calycine tube; ovary often included in the tube of the calyx, or inferior.

Under the Thalamifloral series there are six cohorts: Ranales, Parietales, Polygalineæ, Caryophyllineæ, Guttiferales, Malvales. Under the Discifloral series there are four cohorts: Geraniales, Olacales, Celastrales, Sapindales. As anomalous orders, or rather genera, are given, Coriarieæ and Moringeæ. The order Connaraceæ belongs to the Calycifloral series, a conspectus of which will be given in the next part. Under each order there is a valuable conspectus of the genera, with an indication after each genus of the country or countries in which the species chiefly occur. At the head of each page the order and the tribe are printed, so as to allow of easy reference. Among the changes which have been made as to the usually recognised orders, the following may be mentioned :—Calycanthaceæ are placed as Order III., between Dilleniaceæ and Magnoliaceæ; Schizandræ are put as a tribe of Magnoliaceæ; Lardizabaleæ as a tribe of Berberideæ; Cabombaceæ and Nelumbiaceæ as tribes of Nymphæaceæ. Under Papaveraceæ we have Fumarieæ as a sub-order; Pangieæ are a tribe of Bixineæ; Reaumurieæ and Fouquiereæ are tribes of Tamariscineæ; Rhizoboleæ, Marcgravieæ, Saurajeæ, and Bonnetieæ, are considered as tribes of Ternströemiaceæ; Buettnerieæ are put as a tribe of Sterculiaceæ; Prockieæ and Elæocarpeæ are tribes of Tiliaceæ; Hugonieæ, Erythroxyleæ, and Ixonantheæ, are tribes of Lineæ; Limnantheæ, Vivianieæ, Wendtieæ, Oxalideæ, Balsamineæ, along with Tropæolum, are included under Geraniaceæ; Rubiaceæ include Cusparieæ and Zanthoxyleæ, Toddalieæ and Aurantieæ; Meliaceæ include Cedreleæ; Hippocratieæ are a tribe of Celastrineæ; while Elæodendreæ are a sub-tribe of the same order; Acerineæ, Dodonææ, Meliantheæ, and Staphyleæ, are tribes of Sapindaceæ; an order Sabiaceæ is defined, including the genera Sabia, Theleosma, Phoxanthus, and Ophiocaryon.

It is impossible to enter upon detailed notices of the genera. The definitions of them are given with great skill and discrimination. There is no tendency to split up and multiply genera. Much judgment, on the contrary, is displayed in uniting, in place of separating, species, genera, and orders. The book will be invaluable to practical botanists, and it will form an indispensable companion of those who are engaged in botanical explorations in every quarter of the globe. We shall look anxiously for its completion, and in the meantime we must congratulate the authors on the successful issue of the First Part of this *Opus Magnum.*

PROCEEDINGS OF SOCIETIES.

Botanical Society of Edinburgh.

Thursday, 8th May, 1862.—Professor Balfour, V.P., in the chair.

The following communications were read :—

1. *On the plentiful occurrence of* Buxbaumia aphylla (*Haller*) *in Aberdeenshire.* By William Sutherland, M.A.

The suspicion entertained by many muscologists that this interesting moss is of far more general occurrence, in favourable situations, than the paucity of stations hitherto given for it would indicate, has lately received ample confirmation in this district. Mr Wilson in his "Bryologia" gives twelve localities, two of which are in England. Since the species was many years ago recorded by Mr Jackson as found "near Aberdeen," two additional localities have been discovered in our country; first, some years ago, but very sparingly, near Ballater, by Mr Cruickshank, and last year in great abundance by Mr Coutts in various places on the hills in the parishes of Towie and Cushnie. These hills lie about thirty miles west of Ava, and about ten miles north of Ballater, the river Don flowing immediately to the north of them. In August last I had the pleasure of visiting the principal of these stations, which is situated in a slight depression near the northern summit of the range, and found that here, over a considerable space of ground, the heather had been recently burned, and had but very sparingly regained its footing. In the bare places, and little ledges of peat, all over this tract, the Buxbaumia occurred in more or less abundance, either singly or in groups of from two to six, while, besides the fully-formed capsules, I noticed many little green ones just appearing above ground, cylindrical in form, and with somewhat of the general appearance of a *Splachnum.* On the 12th November last I had occasion to examine two pieces of turf, each 1½ by 1 foot in surface area, which had been sent to Professor Dickie, and on one of these were no less than 49 specimens *in situ*, while the immature capsules seen in August had all attained the normal shape and size, but still remained green in colour. From this circumstance I am inclined to think that this species begins to fruit in the summer or early autumn months, and is not fully ripe until the next spring, having spent the intervening winter under a mantle of snow.

2. *On the Occurrence of* Isoetes echinospora (*Durieu*), *in Scotland.* By William Sutherland, M.A.

One of the most interesting botanical localities near Aberdeen has always been the Loch of Drum (or Park), and now it has the additional attraction of being at present the only station known in Scotland for the new species of *Isoetes*, recently established or proposed by M. Durieu. Although Professor Babington has had under examination specimens of this genus from most of the Scotch localities, all these were found to belong to *I. lacustris*, with the exception of the few specimens sent by me, and which had been collected in the Loch of Drum. The commoner species also grows there, and that, too, probably in greater abundance. It appears that the intended monograph on *Isoetes* by M. Durieu has not yet been published, and therefore no detailed description can be referred to at present,* though no doubt can be entertained of the fact of its occurrence here, as judging from a specimen sent him by Professor Babington, he has given the Loch of Park as a new station for it, in a recent number of the *Bulletin de la Soc. Botanique de France.* Professor Babington has found the species in Wales. It differs from *I. lacustris* in its generally smaller size, more spreading and robust habit, and yellowish green colour. I take the liberty of giving Professor Babington's general description of the spores, as kindly communicated to me:—"If you look at the larger spores in a dry state, and before they have been removed from the cases in which they lie, you will see that they are covered with very fine spines; in *I. lacustris* they bear blunt but rather high tubercles. The spines, and indeed the tubercles also, are so easily broken that they seldom remain perfect upon spores removed from their case."

* The plant is now described in Professor Babington's Manual. Fifth edition, just published.

3. *Notes on Cuckoo-flowers and the Cuckoo-spit.* By James Hardy, Esq., Penmanshiel.

(This paper appeared in the July number of the Journal.)

4. *Notice of* Adelges piceæ *of Ratzeburg.* By James Hardy, Esq.

In a letter to Professor Balfour, Mr Hardy says—"I see by the report of last meeting of the Botanical Society that a supposed *Coccus* is infesting the silver firs about Alloa. This, I apprehend, will be the *Adelges picea* of Ratzeburg, specimens of which I enclose, rather more advanced than those seem to have been which were sent by Mr Dawson, and examined by Mr W. R. M'Nab. It is closely allied to the species found on the twigs of the larch, *Adelges laricis.* It is most hurtful to young trees, by destroying the leading shoots; on the trunks of old trees it will remain for years without visibly impairing their vitality, and one tree will continue infested while a long avenue will remain clean. It probably occurs more or less in every collection of silver firs. Mr Andrew Murray sent me specimens from Kinross-shire several years since, and I had others from Roxburghshire from the late Rev. James Duncan. There is another so like this, on the bark of the Scotch pine, that I cannot observe any difference in wingless specimens. It is the *Adelges corticalis* of Kaltenbach. It has come from the nurseries on young trees; I have not seen it prove fatal in this vicinity. The larch Adelges began to excite notice in the country about 1814, as appears from the thirteenth vol. of the 'Bath Society's Papers.' It is now found on almost every tree, and yet the larch continues to flourish."

5. *Notice of an Ash Tree struck by Lightning near Edinburgh.* By Mr M'Nab. (Plate IV.)

On Thursday the 1st of May at 10 p.m., a severe thunderstorm passed over the south side of Edinburgh, damaging a large ash tree standing on the grass lawn half way between the porter's lodge and the dwelling-house at Moredun, three miles from Edinburgh, the seat of David Anderson, Esq. The tree seems to have been struck by the electric fluid about 40 feet above the ground, at the point where the stem divided into branches. A portion of the west side of the tree is entirely torn away to the depth of 6 inches and 2 feet broad, proceeding from the top to within 3 feet of the ground, at which point the stem is 10 feet 4 inches in circumference. The portions torn from the tree were thrown to various distances, some as far as 212 feet. One piece, 6 feet long and about 6 inches in diameter, was thrown 180 feet distant. The fragments averaged 120 in number, varying from 6 inches to 8 feet in length, and were scattered more or less all round the tree, the heaviest portions being towards the north; several had their ends stuck deep into the ground. The pieces as they now lie scattered about, all denuded of their bark, have more the appearance of being blown into their present grotesque positions with gunpowder than by a stroke of electricity. (See Plate.)

Dr A. Christison sent from India a specimen of *Allosorus nitidulus*, Presl., a rare fern, which he had collected in Kooloo in a solitary spot.

Thursday, 12th June 1862.—Professor Balfour, V.P., in the Chair.

The following communications were read:—

1. *Remarks on the Nature and Peculiarities of the Fern-spore.* By John Scott, Royal Botanic Garden.

(This paper appears in the present number of the Journal.)

2. *Gleanings among the Irish Cryptogams.* No. I. By Benjamin Carrington, M.D., F.L.S., &c.

Introductory Remarks.—Killarney is professedly a place of autumnal resort. There are few visitors before the beginning of July. Why this should be is hard to say, for nothing can be more varied and lovely than the early summer tints; nothing sweeter than the songs of summer birds; and the only period almost uniformly free from rain is that from April to June. I was unable to obtain accurate statistics of the rain-fall, but in Galway, in 1861, it was upwards of 57 inches—24 inches falling between July, and September. The proportion is still greater in the mountain regions of Kerry, and many a visitor has found the meaning of the lines:—

"Thy suns with doubtful gleam
Weep while they rise."

If the botanist desires to pursue his calling unmolested by crowds of visitors, and picturesque but pestiferous beggars, he should reach Muckross in May. Most of the distinctive plants of the district are then in perfection; he will find the hotels empty, and landlords and guides ready enough to oblige him.

It would be vain to attempt a description of these famous lakes. I have visited most of the English lakes, and the more beautiful scenery of Loch Lomond and the Trossachs; but there is a fulness of beauty, and enchantment about Killarney, which surely exists nowhere else. Like the author of the "Irish Sketch Book," we felt inclined to pronounce "each of the lakes in turn the most beautiful, and so at every point we stopped at, we determined that that particular spot was the prettiest in the whole lakes." It is only gradually, as day by day the mind drinks in the varied loveliness of colour and outline, that we are able to form a critical judgment of the whole. The mountains which enclose the lakes on either hand, are less remarkable for height than for gracefulness of form. The culminating peaks of Mangerton, and Carron Tual, measure respectively 2756 feet, and 3414 feet. The geological features of the district are worthy of study. On the eastern shores we find scars of carboniferous limestone, strangely honeycombed, and worn into most fantastic shapes by the action of the waves. Underlying these are dark slaty strata, like the Silurian rocks beneath the limestones of Craven. Further west the mountains divide, forming bold headlands between the indented bays of Dingle and Bantry, and are for the most part composed of shales, and conglomerates of the Old Red system. But the rugged skeleton of the rocks only peeps out here and there; the general surface is clothed with a "pomp of groves," and an exuberance of vegetation only equalled in the isles of the Southern Ocean. Many hills, such as Torc, Cromaglan, and Glena, are covered from the water's edge to the very summit, with a continuous forest. Near the summit, the heather, 6 or 8 feet in height, mingling with trees and shrubs, forms an almost impenetrable barrier. The trees are of various kinds—oak, beech, and ash predominating. There are some lofty pines on the Torc mountain, and the yew, and holly are not uncommon. Solitary trees of the former occur of great age. The ivy luxuriates everywhere, hanging pendant from the trees, or covering rocks and walls with its dark lustrous foliage. But the plant which will possess most novelty to the botanist is the *Arbutus Unedo.* It is found both on the islands and shores of the lakes, but nowhere in great abundance. In size and form it is not unlike an apple tree, with a smooth cinnamon-coloured stringy bark, and shining rhododendron-like leaves.

It is interesting to note how the introduction of one species like the arbutus, and the prevalence of other evergreens, alter the tone of the woods, giving them a sub-tropical aspect. Even in winter they must be very beautiful. There is some danger that this interesting species, like the Trichomanes, may become exterminated before very long by the rapacity of the guides. Young plants are now extremely rare, and when found are invariably taken and sold to visitors. As it is a tender plant, most of these perish in English gardens. The young arbutus resembles the rhododendron, and I was informed that some of the guides keep a supply of slips of the latter, and pass them off for the true plant. While upon this subject, I may state, with a regret which all true botanists will share, that the *Trichomanes brevisetum*, not many years ago the gem of the Torc and other ravines, is now nearly extinct in the Killarney woods. I searched for it many a day in places where it once abounded, but without success. It has been in such request with the fern collectors, that the guides are constantly on the look-out, and when a tuft is found, they exterminate it root and frond. Patches are still brought from the distant ravines above Glencoe.

Although vegetation is so profuse, the number of flowering plants about Killarney is probably smaller than in any area of like extent in England. We miss the various introduced species, colonists, escapes from gardens, from corn-fields, and viatical plants.

Still more remarkable, considering the elevation of the land, is the entire absence of the Highland type of flora. On much lower hills in England and Wales, many subalpine species are met with. This fact would seem to militate against the theory of Forbes, and to indicate some ancient communication with the Spanish coast, rather than with those of Britain. Nor do we find the absence of accustomed forms compensated by many indigenous species. The greatest novelties are the saxifrages, represented by *Saxifraga Geum*, and *S. umbrosa*, their starry blossoms forming a conspicuous object by the wayside. Tufts of *Euphorbia hibernica* were often met with, as was also that floral gem of Killarney, *Pinguicula grandiflora*, in fine blossom early in June. Few plants excel it in delicacy of form, and intensity of colour. The waters abound with lacustrine species. Among them I observed a peculiar variety of *Nymphæa alba* with crisped leaves, and a form of *Nitella flexilis* with dense, distant whorls of capsules, looking to the naked eye like balls of gooseberry pulp, an exquisite object under the microscope. But the real attraction of the south-west of Ireland consists in the variety of its cryptogamic flora. Those accustomed to observe mosses and lichens in England can form no idea of their luxuriance and beauty there. They form so considerable a proportion of the entire vegetation, as to give a peculiar type to the scenery, obvious even to the uneducated eye. Many rare species will be met with on banks and walls. The trunks of trees are often hidden beneath an eruption of strange forms—crustaceous and frondose lichens—great purple patches of *Frullania*, and other *Hepaticæ*, and a variety of mosses.

On young oaks, growing with *Orthotrichum Drummondi*, *O. crispum*, *O. phyllanthum*, &c., I was fortunate enough to secure a supply of a new species, *Ulota calvescens*, with the calyptra almost smooth. It was first collected by my friend Mr D. Moore, but the specimens were immature, and both Mr Wilson and M. Schimper passed it over as a form of *O. crispum*.

On leaving the roadside we are at once shut out by the foliage from the external world, and only catch an occasional glimpse of the lakes from some ledge of rock. Ascending over rocks literally paved with cryptogams, new and unaccustomed forms continually meet the eye of the botanist—*Hypnum micans*, *H. demissum*, and *H. eugyrium*, and a crowd of hepaticæ, and lichens. Thus he passes on in a whirl of wonder and excitement, until the shades of evening warn him to return. The only drawbacks are the heat of these close coverts, and the swarms of gnats which assault all who invade their humid domains. This plenitude of cryptogamia seems due, less to the equability of the climate, than its extreme humidity. The warm air, laden with the vapours of the Gulf-stream, meets its first barrier in the mountains of Kerry. On looking at a physical atlas, it will be seen that the zone of greatest moisture passes through the south-west of Ireland, then crossing the Channel, intersects a portion of Devon and Cornwall. In connection with this fact, we may state that many of the rarer Irish cryptogams reappear again in Cornwall—viz., *Dumortiera* (*Marchantia*) *irrigua*, *Blyttia hibernica*, *Phragmicoma Mackaii*, *Lejeunia minutissima*, *L. calyptrifolia*, *Frullania fragilifolia*, and such mosses as *Hookeria læte-virens*, *Campylopus polytrichoides*, and *Bartramia rigida*.

Although I devoted six weeks to Killarney, so thoroughly has the district been examined, that I met with few novelties. My investigations will rather tend to reduce the number of species adopted by Dr Taylor, and others. The finding new species in our day must be a rare circumstance; but every botanist may add something to the common stock of knowledge, by finding new stations, and by testing the permanency of specific forms, and the limits of variation.

Dr Douglas Maclagan stated to the meeting that, in examining the ovaries of *Richardia æthiopica*, he found them to contain abundance of acicular crystals or raphides, and starch granules,—the former being 1-1000th of an inch in length, and the latter 1-6000th of an inch in breadth. By chemical analysis he ascertained the crystals to be composed of oxalate of lime and not phosphate of lime.

Professor Balfour announced that General Grey had transmitted to the Museum at the Botanic Garden, by command of the Queen, a collection of Scotch Alpine flowers, modelled in wax. The flowers are some of those found in the neighbourhood of Balmoral, and they have been modelled by Miss Matheson of Aberdeen. Their names are as follow:—*Calluna vulgaris*, common heather or ling; *Erica cinerea*, fine-leaved bell heath; *Erica Tetralix*, cross-leaved bell heath; *Vaccinium Myrtillus*, bilberry or blaeberry; *Vaccinium Vitis-Idæa*, red whortleberry, flower and fruit, the fruit of this plant is usually called cranberry in the Highlands; *Arctostaphylos Uva-ursi*, red bearberry; *Empetrum nigrum*, black crowberry; *Rosa canina*, dog rose; *Rubus cæsius*, dewberry; *Potentilla reptans*, creeping cinquefoil; *Campanula rotundifolia*, round-leaved harebell; *Bellis perennis*, common daisy. The flowers are neatly arranged on a small rockwork of granite, which is raised on an oval pedestal of imitation granite. The whole is covered by a bell-jar, and the date is marked "June 1862."

Dr Greville exhibited roots of New Holland acacias which emitted a strong garlic odour. He stated that while repotting a number of these plants he found the same strong garlic smell to be given off by twenty different species.

William A. Stables, Esq., sent specimens of *Pinguicula alpina*, from the Black Isle, Ross-shire, accompanied by the following note:—"I was lately in the vicinity of the habitat of *Pinguicula alpina*, and send you herewith a few dried specimens. I have sent a few roots at the same time to the Botanic Garden. The station is wofully encroached upon by the plough, a very small corner of it indeed being left. One outlying portion of the habitat, and the first I came to, afforded no specimens at all—the marsh being converted into square fields, on which large bullocks were grazing. The progress of improvement along the 'Millbuy' is very great, and will, I fear, soon remove *P. alpina* from the list of British plants."

A letter was read from Mr John Sim, in which he mentioned that he had found *Claytonia alsinoides* in great abundance, along with *Asperula taurina*, *Symphytum officinale*, *Valeriana pyrenaica*, *Doronicum plantagineum*, &c., by the side of a small stream in the woods of Murrayshall, about three miles east of Perth. On Moncrieffe Hill, near Bridge of Earn, he had also met with the following plants:—*Asperula taurina*, *Doronicum pardalianches*, *D. plantaginea*, *Anchusa sempervirens*, *Allium scorodoprasum*, and *Scrophularia vernalis*.

The following note from John Anderson, Esq., Perth, was read:—"I enclose a very singular shoot from the plant known as *Taxus japonica* or *Cephalotaxus Koriana*, which proves it not to be a distinct species as described, but a sub-variety of *Cephalotaxus drupacea*, or Fortune's female variety."

Lieutenant William Jardine, of H.M.S. Nile, sent specimens of foliage, fruit, and wood of the Bermuda cedar (*Juniperus bermudiana*), from Bermuda.

Thursday, 10th July, 1862.—Professor BALFOUR, V.P., in the Chair.

The following communications were read:—

1. *List of Arctic Cryptogamic Plants, &c., collected by* ROBERT BROWN, *Esq., during the Summer of* 1861, *on the Islands of Greenland, in Baffin's Bay and Davis Straits, and presented to the Herbarium of the Botanical Society.*

(The Plants were determined by Mr JOHN SADLER.)

In this paper the author gave an account of a scientific voyage, during the year 1861, to the seas round Spitzbergen, Jan Mayen, and Greenland, describing the structure of the various islands of Davis' Straits and Baffin's Sea (Bay), as illustrating the nature of their flora. In addition to several mosses and lichens rare to the Arctic Flora, he had discovered *Laminaria longicruris* of De la Pylaie's Flora of Newfoundland, for the first time, as occurring plentifully within the Arctic circle; and *Melobesia calcarea*, hitherto only recorded from Spitzbergen, for the first time, in Davis' Straits (Haven Island, four fathoms.)

No. 1. Collected on the Big Duck Island and Duck Islands Baffin's Bay, June 8–11, 1861.

Stereocaulon paschale.
Cladonia uncialis.
papillaria.
Cetraria islandica.
nivalis.
Parmelia parietina, var.
saxatilis.
omphalodes.
conspersa.
Lecanora tartarea.
ventosa.
Gyrophora hirsuta.
Cornicularia ochroleuca.
bicolor.
Pogonatum alpinum.
Bryum cæspiticium.
Hypnum aduncum.

No. 2. Collected on one of the Browne Islands, Women's Islands, Baffin's Bay, off North Greenland, lat. 74° 7′, long. —— ; primary rocks and boggy wet soil almost wholly composing the islands. June 5, 1861.

Several species of Stereocaulon and Cladonia.
Dicranum Richardsoni ?
Aulacomnion turgidum.
Pogonatum alpinum.
Hypnum uncinatum, var.
Hypnum, sp.
Urceolaria scruposa.

No. 3. From Hare Island, west coast of Greenland; lat. 70° 43 N.; long. 55° 42′ W.; greenstone, gneiss, and other rocks, jutting out above the snow. 27th May 1861.

Bryum nutans.
Cornicularia bicolor.
    pubescens.
Lecidea rupestris.
    petræa.
Gyrophora arctica.
    hyperborea.
Gyrophora proboscidea.
    proboscidea, var.
Cetraria nivalis.
Lecidea geographica.
    var. apicula.
Parmelia caperata.
    olivacea.

No. 4. The following were the only flowering plants seen, and brought home intermixed with the mosses.

Salix lapponum. In all the islands.
Stellaria humifusa. Duck Island.
Saxifraga rivularis. Duck Islands.
Papaver nudicaule. In all the Islands.
Silene acaulis. Duck Islands.
Empetrum nigrum. Duck Islands.
Poa alpina. Browne Island.
    danica. Browne Island.

2. *Remarks on some Fibrous Plants of Canada.* By George Lawson, Ph. D., Professor of Chemistry and Natural History in the University of Queen's College, Kingston, Canada.

All the excitement of late years, in regard to Fibre Plants, has had but little practical effect in Canada. It is certainly remarkable that a country whose soil and climate are so suitable for the growth of Fibre Plants should be still so little known in European commerce as an exporter of fibres. However, we are not entirely without progress in this department. Within the last year or two the exertions of our agricultural societies have resulted in the somewhat general cultivation of flax, although still in restricted quantities, throughout various parts of Upper Canada. The flax produced is of very good quality, and has met with approval in England and Scotland, especially in the Dundee market, where flax is the staple manufacture. It appears to me that the chief obstacle to the universal cultivation of flax, and the introduction of some other improvements in this country, is to be found not so much in the high rate of wages as in the collateral expenses of hired field-labour; for unfortunately our farmers have none of the advantages of the bothy system, but have to make provision in their own houses for the farm-labourers of so extravagant a kind as virtually to throw the majority of farmers back upon the labour of their own families.

Under such circumstances, it is not to be wondered if our progress in the cultivation of a crop like flax, requiring so much field-labour, should be slow. On the other hand, Fibre Plants of easy cultivation, with little labour, would hold out a strong inducement. I suspect that the key to our successful production of fibre in large quantities is to be found in the culture of perennial plants, which require less labour and care. We have many such among our indigenous plants capable of producing fibres,— Urticaceæ, Apocynaceæ, and Asclepiadaceæ, all easy of cultivation in our soil and climate, and capable of holding their own against the inroad of weeds.

In the Botanic Garden, now in course of formation here, we are collecting the various fibre plants suited to the climate, with a view to experiment, and hope ere long to publish the results. In the meantime I enclose a few samples of Canadian fibres, and copy of correspondence on Asclepias cotton and Asclepias flax, in which some members of the Botanical Society of Edinburgh may possibly feel an interest, after the suggestive papers of Dr Alexander Hunter and Dr Cleghorn on the Fibre Plants of India. I ought to mention farther, that common hemp is obviously suited for successful cultivation in this country.

COMMUNICATION FROM HIS EXCELLENCY LORD MONCK, ON A FIBRE PLANT SUITED TO THE CLIMATE OF CANADA.

(1.) *Letter from* Denis Godley, Esq., *His Excellency's Secretary*, to Professor Lawson, *Secretary of the Botanical Society of Canada.*

Quebec, *May* 16, 1862.

Sir,—I am directed by the Governor-General to transmit to you herewith a copy of a letter which was addressed to Lord Lyons by Doctor Hart, and which Lord Lyons forwarded to His Excellency.

Some of the seeds of the plant to which Doctor Hart alludes are also enclosed.

His Excellency thinks it likely that the Botanical Society of Canada, of which you are Secretary, may be interested in this matter, and will cause the seeds to be sown with a view to testing the value of the plant bearing them.—I have the honour to be, &c.

Denis Godley, *Governor's Secy.*

George Lawson, Esq., &c. &c. &c.

(2.) *Letter from* Frederic W. Hart, M.D., *St Louis, to the* Lord Lyons.

St Louis, *May* 1, 1862.

My Lord,—Feeling that Her Majesty's Government is deeply interested in the cultivation of cotton in the British Provinces, and having, during a sojourn in the Rocky Mountains these last three years, discovered a plant that excels cotton in length of fibre or staple, firmer in texture, and fine as silk, I determined to plant a few seeds taken from the wild plant, and last year found, to my satisfaction, that the seed-vessels, which in the wild plant are about the size of hen eggs, under culture grew to the size of a turkey or goose egg, and bore twice the quantity of silk that the Mississippi plant bears of cotton.

I gathered four pounds of the silk from the plant, and saved a quantity of the seed, some of which I herewith forward you.

On my return in January last to the United States, I was robbed by the Indian Kiowas on the plains. They stole my silk but left my seed.

The silk weed of the Rocky Mountains grows on the creek bottoms, pushes out in June, and ripens in September, October, and November.

It is about five feet high. It does not branch in the wild state, but it branches under cultivation, and bears full of large bolls or pods.

The seed is all on the *outside* of the silk, and slips off at a touch, leaving the most beautiful silk I ever saw.

It can be cultivated on the St Lawrence bottoms, Canada; and in Upper Canada the whole country is suitable for its cultivation, the climate being similar and even warmer than that of the localities where I discovered the plant.

As an old cotton planter of Mississippi, having raised ten crops in Yazoo, my brands invariably commanding the highest market price, I feel the fullest confidence in recommending this seed to the attention of Her Majesty's Government for cultivation in the Canadas.

Should your Lordship require further information on this subject, I shall be happy to continue this correspondence.—I remain, &c.

(Signed) Frederic W. Hart, M.D.

The Lord Lyons, &c. &c.

(3.) *Letter from* Professor Lawson, *Secretary of the Botanical Society of Canada*, to Denis Godley, Esq., *Secretary to His Excellency* Lord Monck, *Governor-General of Canada*, &c. &c.

Kingston, *May* 22, 1862.

Sir,—I had the honour to receive your letter of 16th May, with accompanying copy of letter addressed to Lord Lyons by Dr Hart, of St Louis. And I have to request that you will convey to His Excellency Lord Monck, the best thanks of the Members of the Botanical Society for the information which he has done them the honour to communicate, and for the accompanying seeds.

I have also to state that, in accordance with His Excellency's wishes, the seeds have been sown in the Botanic Garden here, with a view to testing the value of the plant as a source of fibre. The crop will be watched with care, and duly reported upon to His Excellency, so soon as the results can be obtained.

In the meantime, it may be desirable to indicate briefly the probable character of the plant, and what likelihood there is of its becoming useful.

An examination of the seeds shows Dr Hart's Fibre Plant to be an Asclepias, of which genus there are many species, inhabiting different parts of the American continent, all producing a greater or less amount of fibrous material, usually of great beauty and lustre; and fibre-yielding plants of allied genera occur in India and elsewhere.

The beautiful silky material contained in the seed-pods of Asclepias has necessarily attracted attention in this as in other countries, but, as attempts to spin it failed, its use in the arts has hitherto been confined to the stuffing of pillows and beds, and such like purposes, among the settlers. There is every reason to believe, however, that the silk-cotton of our Asclepias may now be economised for spinning purposes, and therefore a greater interest is to be attached to Dr Hart's plant at the present time than would have been necessary a few years ago.

The results of experiments that have been made in India, and by manufacturers in England, with the silk-cotton obtained from an allied plant, the *Calotropis gigantea*, or Mudar Plant of Bengal (which is essentially an Asclepias), offer inducements to attempt the raising of Asclepias fibres in Canada. The silk-cotton of the Mudar Plant is now becoming an article of export from India for the manufacture of a light substitute for flannel, and has been employed by Messrs Thresher & Glennie, of London, for this and other manufactures, as appears from the remarks of Dr Alexander Hunter, made at a meeting of the Madras Agri-Horticultural Society on 15th January last. The Mudar material works well with either silk or cotton, and is now known in commerce as Mudar Silk-Cotton. There is no reason whatever why the silk-cotton of Dr Hart's plant, and the silk-cotton of our indigenous Canadian Asclepiads, should not prove as applicable to the purposes of the manufacturer as the silk-cotton of India.

It is desirable to observe that the silk-cotton found in the pod of Asclepias represents only half its riches as a fibre plant. A beautiful and apparently very valuable fibre is also obtained from the stem, which I am inclined to regard as of even greater importance than the silk-cotton itself. It is of quite a different character from that found in the pods, being not cottony, nor so glossy, but of much greater strength, resembling, in fact, not cotton, but flax. One of our Canadian species, *Asclepias incarnata*, has been experimentally cultivated with a view to the production of fibre, and the results of the experiments have been given by Judge Logie in the second part of the Botanical Society's Annals, page 87. Specimens of the fibre were exhibited by Mr Freed to the Hamilton Association in 1860, and the Report of Mr M'Miking, a paper manufacturer, is given in Judge Logie's paper, showing the fibre to be strong, flexible, silky, of a beautiful high colour, brilliant lustre, and easily bleached—in fact, too good for paper-making, but of undoubted utility and value as a fibre. This species is still under experiment in the Botanic Garden here.

The success that has attended the use of the Mudar flax in India (as well as the Mudar cotton) seems also to hold out a strong inducement to the use of Asclepias flax in this country. The Mudar flax, from its tenacity, is called "Bowstring Hemp" in India, and is one of the strongest fibres known. Dr Hunter, who has carefully studied the vegetable fibres of India for many years, states that it possesses most of the qualities of flax, and can be worked with the same machinery, as the fibre splits to almost any degree of fineness with the hackle, and bears dressing and beating well. For many years it was employed by the wealthy natives in India for making strong cloths, cambrics and lawns, worn by the rajahs; and it is still employed for making fishing lines, nets, gins, bowstrings, and tiger-traps, on account of its strength. It does not rot readily in water, as the resinous milky juice of the plant seems to preserve it.

Other Indian Asclepiads likewise yield fibre of great strength, which seems to be partly due to the presence in the plant's juice of an organic product similar in physical properties to caoutchouc or gutta percha.

Judging from the observations and experiments of Dr Hart on the silk-cotton plant found by him on the Rocky Mountains, and from the results of experiments that have been made by others on allied species—on Asclepias flax in Canada, and on Asclepias cotton and flax in India,—it is not unlikely that both Asclepias flax and Asclepias cotton may ultimately become important materials of export from Canada. The Asclepiads grow luxuriantly in a wild state throughout Canada, especially in the western parts; and, being strong-growing perennial plants, they are capable of easy cultivation, and would require not a tithe of the field labour necessary for the growth of common flax.

Permit me farther to mention that, in addition to the seeds sown in the Botanic Garden, some have also been sent to members of the Botanical Society, in other parts of Canada, for trial, and copies of your communication, with Dr Hart's letter, have been furnished to the members, with a view to inquiry, and to observation and experiment on Dr Hart's Asclepias, as well as on the indigenous species of our country.—I have the honour to be, Sir, your most obedient humble servant,

George Lawson, Ph.D., LL.D.,
Secretary to the Botanical Society of Canada.

Denis Godley, Esq., Secretary to
His Excellency Lord Monck,
Governor-General of Canada.

3. *Gleanings among the Irish Cryptogams.* No. II. By BENJAMIN CARRINGTON, M.D., F.L.S., &c.

I have already noted the abundance of cellular plants in the south-west of Ireland, tracing it to the prevailing humidity of the climate.

These plants, which occur everywhere, from the sea-level to the mountain top, impart a surprising freshness and greenness to many districts, and justify the name of the *Emerald Isle.* But as it is natural to associate the ideas of verdure and plenty, strangers are apt to form an erroneous estimate of the richness of the soil. The cryptogams are mostly epiphytic in habit; they ask little more than a surface to grow upon, and abundant moisture. However interesting to the botanist, it must be confessed they represent a low type of development, and form an unprofitable, if not unwholesome, kind of vegetation. Meantime, in these days of drainage, the student will appreciate as it deserves such a field of research as Killarney. We cannot always trace the true relations and uses of objects, and are too ready to consider everything worthless, and unworthy attention, that does not administer directly to our wellbeing. That the Creator has bestowed such care upon the structure and preservation of these plants, should teach us they were not made in vain. How many secrets of life and development their translucent tissues have revealed! And what a multitudinous series of forms they assume; what adaptability to extremes of climate, and wonderful powers of reproduction! Even in an æsthetic point of view they claim no mean place. The ferns are universal favourites; but few reflect how much of the beauty of rock or ruin,—of gnarled trunk or wave-worn cliff,—is due to cryptogamic plants. Artists have not studied as they might have done, those touches of colour, white and red—golden and purple—the wrinkles, and "time stains" of the ages gone by. Strip the ruin of these, and you efface all that told of the past and made it venerable.

Of modern writers, Wordsworth, and Ruskin alone seem alive to these influences.

> "The gentler work begun
> By nature, softening and concealing,
> And busy with a hand of healing,—
> The altar, whence the cross was rent,
> Now rich with mossy ornament."

The Cryptogamia attain their culmination in Ireland for the Northern, as they seem to do in New Zealand, for the Southern hemisphere, where, from the insular character of the land, and the moist atmosphere of the southern ocean, similar conditions prevail. A comparison between the two floras presents us with one of those examples of representative distribution so interesting to the naturalist.

	Ireland.	New Zealand.
Lichens, . . .	295	150
Mosses, . . .	230	250
Hepaticæ, . .	88	190
	613	590

This table is not very recent, but will be found relatively correct. It will be observed how closely the numbers correspond. Many are common to both countries, and the majority belong to the same genera. The abundance of Hepaticæ in New Zealand is compensated by the number and beauty of Irish lichens.

Of the eleven weeks of my stay in Ireland, nearly six (May 11th to June 18th), were spent at Killarney. The four succeeding weeks were devoted to sea-bathing at Ross Bay; and the last week we visited Glassnevin, and Dublin.

Ross Bay is a primitive bathing hamlet at the head of Dingle Bay. I was induced to prefer it rather than Bantry, because the district was unexplored. But upon examination I found there was little to discover. The hills are composed of a loose Old Red conglomerate, with uniform rounded contours, and destitute of trees, which add so much to the charm of Killarney. Still, the bay was very fine, and a narrow isthmus of sand dunes, which extends nearly to the northern shore, formed a capital strand, and perpetual barrier to the Atlantic swell.

Algæ were very abundant, many of great rarity; and such gigantic Laminariæ, and great tufts of Rhodosperms, I never saw before. After a storm the beach was literally piled with them, and scores of people were employed carting them away. They form the only manure used in this district, and, indeed, the only riches the natives derive from this rich bay. The staple, of course, is the potato, which flourishes wonderfully under this treatment. There are no kitchen or flower gardens about Irish cottages. If we wanted a salad, fruit of any kind, or the commonest pot herb, we had to send to Killarney, more than twenty miles; and even there, they could only be obtained from the gardens of the gentry. How the people exist without these, to us, indispensable necessaries, I cannot tell. But they seem too apathetic and indolent to cultivate anything but what will barely keep body and soul together. Who can wonder there should be chronic famine in the west of Ireland? Until they learn to develop the resources of sea and land, and are taught the benefits of horticulture and husbandry, no legislation can aid them. Once create the desire for other diet than potatoes, and one of the greatest difficulties would be overcome.

In lieu of better employment, we spent much time in boating, and shooting inoffensive penguins and gulls. The white breast of the gull was in great request for ladies' plumes, and it was my task to preserve them. I met here again that curious amphibian the natter-jack, (*Bufo calamita*); it is a pretty harmless creature, and its bell-like chorus at eventide could be heard at a great distance. I had previously observed it among the sand-flats of Southport, a very similar habitat.

By far the larger portion of my collections were made at Killarney. Two or three times a week I made excursions, seldom beyond six miles from Mucross, into the woods. The best spots were the Torc Mountain, Cromaglan, and the Eagle's Nest; and weeks might be devoted to any one of these without exhausting it.

The stillness of these woods is almost oppressive, only broken by the alarm note of some startled bird, or the continuous hum of clouds of gnats, which I found almost as tormenting as the mosquitoes of South America. On one occasion, near the summit of Torc, I met with a rather unpleasant adventure. Depending from twigs of broom, I saw what appeared a tissue-paper balloon, and wondering how it reached such a place, I unthinkingly tore it open, but in a moment an angry buzz warned me that I had invaded a wasp's nest. Fortunately the density of the shrubs which made the ascent so laborious, now proved my salvation; for leaping and rolling down the steep sides of the mountain, I soon outstripped pursuit.

There is one spot I think of with peculiar pleasure—the Torc or Turk Cascade, made classical by the researches of Mackay, Taylor, Wilson, and many others. It was only about half a mile from the hotel, and almost every evening we strolled there. Ascending a short ravine covered by trees, we reach a sunken amphitheatre of rocks, down which the tumultuous water flows. Here, on spray-moistened boulders, and the steep sides of dripping rocks, we behold the perfection of cryptogamic life.

Noble ferns droop from the fissures, mosses of many kinds fringe the rocks, or cover them with a glossy, many-coloured pile. The colours of some species are very rich and characteristic; thus, *Hypnum eugyrium*, (which here replaces *H. palustre*), occurs in wide patches with a coppery lustre. The fronds of *Hypnum demissum*, and *H. flagellare* are golden, and those of *Hookeria lucens*, pale and silvery. But the Hepaticæ claim precedence for the number and beauty of their species. Depending from the dripping ledges are large tufts of *Frullania Hutchinsiæ*, and *Anema pinnatifida*. *Plagiochila punctata*, *P. tridenticulata*, and *Lepidozia tumidula*, grow on trees and rocks. Parasitic on other species, we find *Lejeunia ovata*, *L. hamatifolia*, and *L. microscopica*; whilst *Radula voluta*, *Phragmicoma Mackaii*, *Frullania fragilifolia*, and a host of others, will repay careful research. But the pride of Torc Cascade, and perhaps one of the finest species in the world, is *Dumortiera irrigua*, (*Marchantia*, Tayl.) It grows on the steep faces of rocks, in patches of several yards in diameter, and nothing can surpass the gracefully scalloped outlines, and dark velvety greenness of the fronds. The effect is heightened by the beads of spray which cover the surface with a translucent film, like so many pearls. Unfortunately it shrinks in drying, and the expressive form and colour are lost.

It will be observed that the list of Hepaticæ is relatively more perfect than the other orders. The fact is, my chief object in visiting Ireland, after the renovation of health, was the collection and study of that group. The eye sees what it is trained to see, and this will account for my overlooking some rare lichens, and mosses; whereas, with the exception of *Gymnanthe Wilsoni*, *Syn. Hep.*, I got all the rarer Hepaticæ. Descriptions of several species will be found in the following catalogue, not hitherto recorded as British.*

List of Lichens collected at Killarney, from May 11*th to June* 18*th*, 1861.

This collection represents very inadequately the Lichenological riches of Killarney. It comprises only the more conspicuous species; those growing on rocks were purposely omitted, from their bulk and weight. I am indebted to Mr W. Mudd for the determination of these plants, and the nomenclature is that of his work on British Lichens (1861). Whatever may be the difference of opinion as to the value of the genera adopted, there can be none as to the great labour and research, and practical acquaintance with species, exhibited in this work. The genera are founded on the form of the spores, a system advocated by Köerber, Nylander, Hepp, and others. I do not feel myself competent to decide how far it is likely to stand the test of experience.

The following remarks of the Rev. C. Babington seem to me very judicious:—" It is perhaps presumptuous to offer an opinion on a subject with which I am not so familiar as the above mentioned authors are; but it appears clear that the employment of microscopic characters must be very cautiously introduced. It is certain that the forms of these organs (the spores) vary considerably in the same species, even in the same specimen, as any one may convince himself by a little experience."—*Fl. New Zealand*. Part II. p. 268.

COLLEMACEÆ, *Nyl.*

Ephebe pubescens, *Fries*.
On damp rocks, Loch Leane, and below Cromaglan; fruit rare.

Ephebe byssoides, *nov. sp.*

Collema furvum, *Ach.*

* Some of the rarer species are published in Rabenhorst's Hepaticæ Europ. Excis. Decas. xxi.–xxii.; and Bryotheca Europæa, fasc. xi. Dresden, 1862.

Collema pulposum, *Bernh.*
Synechoblastus flaccidus, *Kbr.*
(*Collema flaccidum, Ach.*)
S. aggregatus, (*Ach.*) *Mudd.*
(*Col. fasciculare var. aggregatum, Ach.*)
Leptogium lacerum, *Kbr.*
L. Schraderi, *Nyl.*

LICHENACEÆ, *Nyl.*

I. *Gymnocarpi.*

Cladonia alcicornis, *Fries.*
C. gracilis α. cervicornis, *Mudd.*
(*C. cervicornis, Schær.*)
C. squamosa, *Hoff.*, et
ε. cæspititia, *Mudd.* (*Lichen cæspititius, Eng. Bot.* t. 1796.)
C. furcata, *Huds.*
β. racemosa, α. erecta, *Mudd.*
C. rangiferina, β. sylvatica, *L.*
C. coccifera.
γ. Flöerkeana, *Fries.*
Beamyces roseus, *Pers.*
Stereocaulon paschale, *L.*
β. corallinum, *Laur.*
Ramalina pollinaria, *Ach.*
Nephroma lævigatum, *Ach.*
(*N. resupinata, Hook.*)
Sticta pulmonacea, *Ach.*
scrobiculata, *Scop.*
fuliginosa, *Dicks.*
limbata, *Sm.*
elegans, *Deak.*
herbacea, *Huds.*
Parmelia perlata, *L.*
saxatilis, β. leucochroa, *Wallr.*
sinuosa, *Sm.*
encausta, *Sm. ?*
caperata, *Dil.*
Borrera cæsia, *Hoff.*
aquila, (*Ach.*) *Mudd.*
Physcia candelaria, *Nyl.*
Pannaria plumbea (*Lightf.*), *Massol.*
(Parmelia plumbea, *Fries.*)
This fine species, and the following, are very abundant on trees about Mucross.
Pannaria rubiginosa, *Thunb.*
brunnea, *Sw.*
(*Lecanora pezizoides, Bor.*). Found on Cromaglan and the loftier mountains.

Lecanora atra, *Huds.*
pallescens, β. tumidula *Pers.*
Gyalecta cupularis, *Ehrh.*
Lecidea scapanaria, *nov. sp.*
Biatorina grossa, *Pers.*
(*Lecidea leucoplaca, Leight. Ex.* 125).
Bacidea luteola, *Ach.*
muscorum (*Sw.*), *Mudd.*
Sandhills, Malahide. The only species not collected about Killarney.
Bacidea atro-grisea, *Delise.*
Opegrapha rupestris, *Pers.*
varia ε. tigrina, *Ach.*
atra, *Pers.*
α. denigrata, *Ach.*, et
c. nigrita, *Light.*
vulgata, *Ach.*
Stenographa anguina α divaricata, *Mudd.*
(*Graphis scripta Leight. Ex.* 19.)
Graphis serpentina *var.* flexuosa, *Leight.*
Aulacographa elegans (*Sm.*), *Leight.*
Stigmatidium crassum, *Dub.*
(*Sagedia aggregata, Fries.*)
Arthonia ilicina, *Tayl.*

II. *Angiocarpi.*

Sphærophoron coralloides, *Pers.*
Endocarpon miniatum, *L.*
β. complicatum, *Sw.*
Normandina jungermanniæ, *Del.*
This species is very common on patches of *Frullania tamarisci*, &c., about Killarney, but only few apothecia were found.
Pertusaria communis, *DC.*
fallax, *Pers.*
Verrucaria chlorotica, *Ach.*
rupestris, *Schrad.*
calciseda, *DC.*
Thelidium immersum, *Mudd.*
gemmatum, *Mudd.*
Pyrenula nitida, *Ach.*
Arthopyrenia nitescens (*Salw.*), *Mudd.*
epidermidis, *Ach.*,
β. analepta.
ε. punctiformis, *Mudd.*

4. *Letter from Dr John Kirk (of the Livingstone Expedition), dated H.M. Ship Pioneer, River Shire, East Africa,* 14*th December* 1861. Communicated by Professor Balfour.

My dear Dr Balfour,—During the last two years we have been moving over a considerable geographical area, and getting news of all your doings at home only very seldom. Our mails are most uncertain, and some get lost in crossing the bar. Unluckily there have been lives lost there also, so that we think little of letters. Africa will soon be opened up. Vast things have been done by Burton and Speke; the West, too, has been entered at one point by De Chaillu. I hoped to have heard long ago of my plants having reached England, but I fear most of them have been lost. What portion has reached I am not yet certain, but from the absence of many genera in the catalogue of what reached, I see that those collected in Zomba at high elevations have not been among the fortunate ones.

You have heard, I dare say, long ago of our journey to the Makololo country. By the time we reached it, the small remnant of the mission had gone off south; they had lost more than half their number through fever. At home they are laughing at the mixture we make of quinine and calomel; but yet we have spent four years out here and never lost a case, and during the past year we have had a large body of Europeans exposed to the fever, and frequently attacked by it, but as yet the treatment has proved successful. The *preventative* action of quinine is *bosh* in our experience, and we have tried it fairly. We are to make the attempt again. In the vessel we have always had several sick at one time; so, if the quinine changes this state of matters we shall believe in it. We did try it about seven months ago, with no perceptible result one way or another.*

In the interior we found the Makololo tribes fast on the decline. The chief Sekeletu had been seized with leprosy, and, believing himself bewitched, had killed some of the old men, his father's best soldiers. Now he is dependent on the young, and they—educated among the subject tribes, and feeling their weakness, being few, among so many—have degenerated into a very different race from their fathers who took the country. Now, the subject tribes are better than Makololo; but, with the Makololo, the subject tribes about them have gone down in the scale of honour too. The contrast was marked on leaving the free people of the Batoka lands, and entering that of the Makololo. In the former we had to purchase nothing; they gave the best willingly. The Batoka lands are the only ones suited for Europeans between the coast and the interior along the Zambezi. There are many places where people eager to make money might risk themselves, but this is the only European climate, and here the thermometer sometimes falls to 32°. Sheep would succeed admirably, but for the interior there will be some time needed. The Zambezi is not navigable much above Tette, and even to that place ships only of the most limited size could ply throughout the year. Above the Kebrabasca rapids the Zambezi is again navigable, but there are rapids, and a small trade would never pay. When trade, however, does get into this region, there are immense fields of coal ready to be taken from the mountain side, and to be tumbled on board the vessels.

* [Dr Livingstone gives the following prescription:—Six or eight grains of resin of jalap, and the same amount of rhubarb, with four grains of calomel, and four of quinine, made into pills with spirit of cardamoms. The whole is a full dose for a man. On taking effect, quinine (not the unbleached kind), in four-grain or larger doses, is given every two hours or so till the ears ring or deafness ensues. This last is an essential part of the cure.]

Our return was in canoes, and by them we got over a vast extent in a short time. We had Bashubea canoe-men, and they managed these logs of wood most admirably. We came down many rapids such as I had no idea could be passed at all. The skill displayed by these men was surprising. My crew were the best, and delighted in going first. We, however, got upset in Kebrabasca, while trying to be ready to help Dr Livingstone. It was quite astonishing how we got out of this fierce rapid with perpendicular rocks all about. The canoe-men behaved well; but all my gear was lost, notes, &c., including a Government box chronometer worth L.60. In all, upwards of L.100 worth went down, and we were lucky in saving ourselves. We have been since then round to the Roruma, but this ship requiring between five and six feet when full of cargo, prevented us from getting up beyond thirty miles.

The Roruma Bay is magnificent, and the river has no bar, and has great advantage over the Zambezi, where there is a bad anchorage, and a nasty surf. But whether the Roruma comes from the lake we have not found out, although we have been at the trouble of going to see, and carrying a boat over the forty miles of the Shire which is obstructed by rapids. We spent upwards of a month on Lake Nyassa, and sailed 200 miles north on this huge inland sea; then we heard of its north end, but hunger (for the country there had been desolated) forced us to return; and, indeed, we were quite done up, for we had been robbed twice, and lost our clothing. Don't suppose they did this by force—they came at night. If they had come by day we could have settled them. The exposure on the lake in an open boat to the full effect of the sun at the hottest season was most trying, while the daily storms rendered our progress slow. On Lake Nyassa severe storms come on suddenly, and lash the shore with a surf through which no boat can pass. Indeed, a vessel to sail at all times must be one fit for the ocean. The width of the lake varies from fifteen to fifty miles, but we could not cross it on account of the storms. The waters are deep enough for all practical purposes. We got 100 fathoms at the mouth of a bay, and at one mile off shore no bottom with 690 feet of line; so, where the bottom is to be found in the centre, I cannot tell—perhaps it is below the sea level. The botany of the lake has nothing of interest until you get beyond Lat. 12°; then the trees change considerably, and the hills come down near the lake. From the rich green on these hillsides the country must be better watered than that to the south, for we were there during the dryest time of the year. The people are Marimba on the west side, but the north-west is occupied by a tribe of Zulus, who had migrated from the country south of the Zambezi, and fought their way north, having established themselves with their cattle on fine table lands, described as healthy, and seemingly quite like those of the Batoka up the Zambezi. The borders of this land are deserts, all the people having been killed; and it has been a dreadful slaughter, for the shores are covered with skulls, and where a foraging party has passed, fresh bodies beginning to decompose lie scattered on the sand. Marimba are a treacherous, cowardly race, and cannot face the fierce charge of the Kaffir, who comes to close quarters at once, and defends his body with the ample shield, while he uses the club or spear with his right hand. The language of these Zulus is that of their native country, but they mix with it some words of the Lake tribes. They kill all they find except young children, and these they carry off to educate them as their own. They do not engage in the slave trade. Their only thought is the cattle; they live for them entirely, and remove from place to place according to the pasture. The slave trade is at present very active; it has received a great impulse through the so-called free colonisation of the French. The Portuguese and Arabs are the people who take them to the coast. To the Portuguese is due the whole of that vast slave trade carried on from Ibo to Sofala. They hold that coast only to enable them to do this, while it was guaranteed them that they might put the slave trade down. Government have full knowledge of what goes on ; indeed, so must the home Government of Portugal, for they give as court favours the several governorships, which are much sought after, knowing that the salaries are perfectly inadequate. How can these men make the fortunes they do, but by countenancing the slave trade? Already the slave agents of the Portuguese merchants of Tette have filled the Manganja hills discovered by us. They have come on our track; and now, after being absent a year, we discovered that we had been the means of opening a slave-hunting country. The hunting was done by a coast tribe—the Ajawa. The Portuguese sent their slaves to purchase the captives. On their way, the fine rich populous valley from the south end of Lake Nyassa to the rapids of the Shire had been laid waste, and now not a village stands where, when we first passed, all sorts of food could be obtained for a few beads. We drove back the first white Portuguese who ever entered the Manganja hills. He came at the head of a large body of armed slaves, intending to save the price paid to the Ajawa, and do the hunting himself. On hearing that we were destroying all Portuguese slave bands, he turned and fled. We have made a number of captures of Portuguese agents with slaves. Those they have are chiefly children. We settle all the prizes with the Bishop; in fact, we have made him chief of a large village, and given him such a start as no mission ever had before. Not only has he got all the slaves we took from the Portuguese, but also natives come and settle near him, for the security they feel. The Manganja country is at present in a strange state. There is no great chief, but each village is ruled by an independent man, and these seem to have sold the people for a long time back; now they are being carried off wholesale by the Ajawa. To the latter there cannot be much blame attached. The Manganja would do the same if they were not such cowards. They cannot face the Ajawa, but they do quite as bad by assisting the Portuguese to carry off the slaves bought from Ajawa, who are many of them their countrymen, and taken from some neighbouring village. One village seems to hate another, so that they quietly allow them to be carried off. They are quite incapable of a united attack to drive the intruders out. If the Ajawa could be reclaimed they possibly might prove the better people. Dr Livingstone thought to go and speak to them, but the intentions of his party were mistaken, and they found themselves surrounded and attacked. Our party, including some of the Bishop's, had to fight in earnest, and the Ajawa did not retreat until several had been killed. We had left the vessel without any intention of fighting, and this small affair used up all the cartridges. It would be gross folly to go unarmed here—that is, without arms in the party. On Lake Nyassa, our party (over twenty men), well armed with the best of rifles and revolvers, was not numerous enough to prevent the natives robbing us twice by night, and once attempting a night attack; and it was on the other side they killed Roscher, a Hamburg gentleman, who had reached the Lake about two months later than we did when we first discovered it in 1859. In order that the mission here (under Bishop Mackenzie) may be of use, the country must be opened up, and commerce begun; for until the natives can sell their produce, they cannot be expected to give up the slave trade. They grow cotton, and could grow any quantity. If merchants could get in to purchase it and other things, then the natives would be able to rise in civilization; but I don't believe in missions which are not accompanied by other means besides teaching. A mission, to be successful, must aim at raising the natives; and the missionary's work is vastly diminished if the civilizing is in a great measure done for him by merchants and traders, and his hands thus left free for teaching. The Portuguese claim the coast, and, I daresay, the interior too; but the rivers ought to be open to all nations. At present it would be in vain to send out to purchase anything here. Being Government officers, we may do as we please; but a trader would be turned who came without a passport, and no foreign vessel would be allowed to pass.

Now, I have completely tired you out, and not said a single word about botany; and the fact is, I have done very little to it of late. We have had a great deal of work in the steam-vessel, which is two feet too deep for the river. I have had no opportunity of getting up among the hills again. My collections and notes from the Makololo country were lost when my canoe upset. On the lake we met with an oil palm with small fruit. I see it mentioned by Captain Burton on Lake Tanganyika.

I enclose some of the cotton growing uncultivated on the hills at the north end of Nyassa. It will show you the fine quality of stuff which might be obtained even now.—Yours ever, very affectionately,

(Signed) JOHN KIRK.

5. *Letter from* DR A. LEITH ADAMS *to* SIR WILLIAM JARDINE, Bart., *relative to Poisoning with Euphorbia in Malta.*

"MALTA, *25th May* 1862.

"I send you a few seeds of the sea-spurge; there are upwards of twenty species of Euphorbia in Malta, and during the summer months, when the intense heat has withered the plants, and pasturage becomes scanty, goats often nibble the decayed stalks of one or other species, chiefly the *E. pinea*, which is the most common. The Tenhuta is a name generally applied to all the species. The goats do not eat Euphorbia eagerly, and when there is plenty of green pasture not at all. The milk impregnated with this poison has, I am creditably informed, proved fatal to children under three years. Nausea, vomiting, and diarrhœa are the chief symptoms induced. The dangerous effects of milk so poisoned have been known to the natives from time immemorial; and in the country districts, when wishing to take a brisk purgative, the natives are in the habit of drinking milk to which a few drops of the white juice of the plant have been added. I am told diarrhœa is a certain result. I have been particular in attempting to find out if the goats themselves are affected, but all the herdsmen say, not apparently in the slightest degree. With reference to Dr Mackay's suggestion in explanation of the more violent symptoms in some of his patients compared with others, that the same was owing to yellow streaks in the milk and their unequal distribution, I cannot discover any proof. All the goat-herds I have caused to be questioned on the subject state that the poisoned milk does not differ in appearance from other milk, and that they have no means of knowing when milk is poisoned by Euphorbia until it is used. This is also the experience of Dr Gulia and other Maltese doctors. The Maltese consider the berries of the Persian lilac (*Melia Azedarach*) a deadly poison, and are careful not to let the goats eat them. Dr Gulia thinks it is a vulgar error; but many Maltese have assured me to the contrary, and that they have known persons to have been poisoned by milk of goats fed on these berries."

6. *An Account of Professor Balfour's Botanical Trip to Moffat, Dumfriesshire, on 5th July* 1862. By MR JOHN SADLER.

7. *On the Addition of* Cystopteris alpina (*Desv.*) *to the Arctic Flora.* By WILLIAM SUTHERLAND, M.A., Aberdeen.

In my frequent examinations of the Arctic plants brought home by Mr

J. Taylor, I have always had doubts as to the propriety of consigning all his specimens of *Cystopteris* to that much-embracing species, *fragilis*. And now, after a careful examination and comparison of all the descriptions and figures, besides a few (cultivated) fronds of *C. alpina* (Desv.) within my reach, with the Arctic specimens, both dried and at present growing, I have no hesitation in stating that many of the dried, and perhaps all the living specimens, must be referred to the species indicated. Both the growing plants, and the fronds dried when gathered, were found by Mr Taylor, in Cumberland Straits, British North America.

As to the propriety, indeed necessity, of awarding *specific* honours to this *Cystopteris*, we believe there can be now no doubt. Mr Bentham, in his " Handbook of the British Flora," is the only authority we have found who has suspicions on the subject. He, however (probably from the alien character the species enjoys as British), but cursorily refers to it, and gives no characters to distinguish it from *fragilis;* while entertaining the very highest admiration and respect for the profoundly philosophic and logical character of Mr Bentham's mind, I cannot but think that had the plant been such as to call for more minute examination by him, he would have felt constrained to dismiss all doubts as to its specific claims. The case, I believe, to be *far* stronger than that of *Lychnis diurna*, and *L. vespertina*, where, with great judiciousness, he has recognised the probable existence of two distinct species. Sir William Hooker, in his " British Ferns," just published, considers this species as undoubtedly nearly allied to *fragilis ;* but I think, truly distinct, in the more deeply pinnatifid, and more finely cut pinnules, the segments being oblong-linear, or cuniate entire, obtusely toothed. Mr Francis, an excellent authority, and the pioneer of the vast array of pteridologists who have recently, to a degree unprecedented in any other department of science, inundated the British market with their wares, speaks in equally strong terms :—" These marks clearly indicate this to be a distinct species, far removed from both the others, and in cultivation, instead of approaching the *fragilis* or *dentata*, it becomes yet more different, as the pinnules increase in length, but scarcely in width, as in the former cases."

Cystopteris alpina (Desv.), then, is a very elegant little fern, with *fronds* seldom exceeding six inches in height, herbaceous, and of a bright green colour, oblong-lanceolate, tripinnate, but often only subtripinnate, and erect in growth (*fragilis* not unfrequently reaches a foot in height, and then especially has a drooping, not an erect habit). The *rhizome* branches dichotomously, the one branch growing to the side and then throwing up a tuft of stipites, the other pushing onwards to continue this process ; a much greater interval also exists between the points of divarication than in *fragilis*, which, as seen in pot cultivation, sends up its fronds more in a mass than *alpina*, where they run in more scattered groups ; it is black, fibrous, and scaly towards the apex. *Stipes* slender, scaly towards the base, one-third the length of the frond, often less, and altogether shorter, less brittle and juicy than in *fragilis ; rachis* compresso-alate. While the majority of fronds are quite smooth, I have noticed one or two having a few very small scattered scales along with stipes and rachis, an observation which does not seem to clash with one of Sprengel's characters, *fronde tenerâ, glabriusculâ. Pinnæ*, about ten pairs, with a tendency to alternation rather than otherwise, except the first pair, which is opposite, not so markedly ovate as the pinnules, *i.e.*, slightly acute (though not always so), their midrib winged, so much so in some forms as to produce complete coalescence of all the pinnules but the first pair. *Pinnules* " ovate, obtuse, deeply pinnatifid, oblong or linear-cuneate, very obtusely bi-trifid, rarely entire" (*Hooker*). *Venation* straight, and corresponding to the divisions and toothing of the pinnules (not more or less tortuous as in *fragilis* and its forms). *Sori* small, circular, mesial, scattered, pale, not crowded, and perhaps never confluent as in other species. I have not as yet satisfied myself that there is really any constant character whereby its *indusium* may be distinguished from that of *fragilis*, while authorities seem to differ on the point.*

While the plant is of easy cultivation, it is said to suffer more from the accumulation of moisture about its roots than does *fragilis*, a circumstance quite credible, from its favourite stations on the Continent being high alpine rocks, where, indeed, it would seem to be by no means very rare. Mr Foster was the first to notice the plant as British in Symon's "Synopsis," 1793. No doubt can be entertained as to the genuineness of the Low Leyton (Essex) plants, where it was said to grow *apparently* wild, and that, too, in a part of Britain very little above the sea-level. The reconcilement of this fact, with its occurring nowhere on the Continent but at elevations of from 6000 to 8000 feet (the equivalent of the new arctic station), must, we fear, always remain a botanical enigma. Mr Moore, excluding cases where *fragilis* has been mistaken for it, considers that he has received fronds of the true plant from Derbyshire and Yorkshire, as also from the Lake District. It is somewhat curious to note that Sprengel in 1827 gives "Anglia" alone as the geographical range of this plant, not apparently having recognised it on the Continent. The otherwise recorded stations are, the Alps, the Pyrenees; in Greece, Mount Taygetes (Bory, Heldreich), and Taurus (Kotschy); to which list we have now to add Cumberland Straits, British North America, in Dr J. Hooker's "Province of Arctic E. America" (excluding Greenland). *C. fragilis* is found in all his five arctic provinces except the Asiatic. I have but one specimen from Greenland, collected at Disco by the late Dr Mellis of Alexandria, and it I must certainly refer to this species. It does not, of course, follow from this, or its not having been hitherto recorded, that *alpina* does not occur in Greenland; on the contrary, it is quite possible that it may do so, as also in Scandinavia, &c. But it must be confessed, that so scanty is the information (from its being easily overlooked), that it would be rather premature to discuss the history of its distribution, which may be as wide as that of *fragilis*, which in his laborious and most able essay "On the Distribution of Arctic Plants," Dr J. Hooker has shown to be very extended. In the meantime, therefore, it must be placed in the somewhat small list of plants common to Arctic America and the Alps of Europe, but not occurring in Arctic Europe, thus extending from Arctic America through Central Asia and Northern India to Central Europe, a supposition to which the Grecian stations lend some support.

A letter was read from Mr J. Chalmers Morton, editor of the "Agricultural Gazette," in which he expressed a wish to know the predominating plants growing on the irrigated meadows at Craigentinny. Professor Balfour had sent Mr John Scott, one of the gardeners in the Botanic Garden, to make a collection of the plants, of which the following is a list:—*Stellaria media, Poa trivialis, Ranunculus repens, Rumex obtusifolius, Senecio vulgaris, Polygonum amphibium, Cardamine pratensis, Atriplex patula, Ranunculus sceleratus, Alopecurus geniculatus, Glyceria fluitans*, all of which were growing very rank and luxuriant, forming almost the entire pasturage. On the sides of the ditches occurred *Ranunculus acris*, sparingly, *Anthriscus sylvestris, Holcus lanatus, Galium aparine, Triticum repens, Leontodon Taraxacum*; and in drier

* I may here mention that Mr Sim gives a form called *intermedia* (of which a frond is before me). It really seems judiciously named, for it certainly combines both the characters of *fragilis* and *alpina*.

spots *Potentilla anserina*, *Trifolium repens*, *Plantago lanceolata*, *Alopecurus pratensis*, *Lolium perenne*, *Phleum pratense*, *Dactylis glomerata*, *Hordeum murinum*, *Arrhenatherum avenaceum*, *Geranium dissectum*, *Cerastium triviale*, and *Bellis perennis*.

SCIENTIFIC INTELLIGENCE.

BOTANY.

Number of Seeds Produced by Orchids.—Darwin estimated the seeds contained in four capsules of *Cephalanthera grandiflora* at 24,000, and in thirty capsules on a plant of *Orchis maculata* at 186,300. An acre of land would hold 174,240 plants of *Orchis maculata*, each having a space of six inches square, which is rather closer than they would flourish together; so that allowing 12,000 bad seeds, an acre would be thickly clothed by the progeny of a single plant. At the same rate of increase, the grandchildren would cover a space slightly exceeding the Island of Anglesea; and the great-grandchildren of a single plant would nearly (in the proportion of 47 to 50) clothe with one uniform green carpet the entire surface of the land throughout the globe.—*Darwin on Orchids.*

Hybrid Plants Returning to their Original Species.—In 1854, M. Naudin fertilised *Datura Tatula* and *Datura Stramonium* with each other, and obtained hybrids (*Comptes Rendus*, 1856, 1st semestre, p. 1007). In 1861, he repeated the experiments, with the view of carrying out the results more fully. Seeds preserved from the first crossing in 1854 were sown in the month of April 1861. He thus obtained the hybrid *Datura Stramonio-Tatula* of the first generation, which reproduced all the characters which had been observed by him six years previously, namely, the size double that of the parents, the flower of the first seven or eight dichotomous divisions falling so that the flowering was retarded, and a colouring of all the parts of the plant perfectly intermediate between that of the two parents, which are in that respect very marked,—the one, *D. Stramonium*, having the stem and branches of a bright green, and the flowers all white,—the other, *D. Tatula*, having the stem and branches purplish-black, and the flowers violet. In consequence of the flowering being late (towards the end of September), when the plants belonging to the pure races of *D. Stramonium* and *D. Tatula* had long finished flowering, and had even ripened their seeds, the hybrids were placed in an isolated condition, so that they could only be fertilised by themselves. In consequence of the advanced state of the season, a few of the capsules in the hybrids only arrived at a semi-maturity; but these contained seeds in a condition to germinate. These seeds, sown in April 1862, produced twenty-two plants of the second generation, the greater part very different from those of the first. They divided themselves in the following manner: 1. Five individuals reproduced *Datura Stramonium* in all its purity, with the stems and branches of a clear-green, and the flowers all white. They also regained the size and the precocious fecundity of the species, flowering and fruiting at the first dichotomous division. The fruits ripened, and the seeds came to maturity. 2. Nine individuals, with purplish-black stems and branches and violet flowers, reproduced perfectly the typical *Datura Tatula*. They also flowered and fruited at their first dichotomous division. The seeds were being ripened. The plants did not in any respect resemble *D. Stramonium* (their grandfather). 3. Two other individuals flowered and fruited in the same way, and exhibited the normal size of *D. Tatula ;* but the stems and branches in them were of a less deep purple, and the flowers of a paler violet colour than in the typical species. These two specimens were different from the hybrids of the first generation, but they did not return completely to the type. They still showed marks of hybridity. 4. Finally, six individuals approached decidedly nearer to *D. Tatula* than did the hybrid of the first generation, but they still showed a relation to that hybrid in their size being larger than that of the parents, and by the fall of the flowers on the first dichotomous branchings. It is clear, however, that the flowering is not far distant, and that it will be more abundant than that of the hybrid which produced them. It is probable that the posterity of the third generation will return completely to *D. Tatula.*

Many other examples of a similar kind might be given. All, without exception, demonstrate the fact of the spontaneous disappearance of fertile hybrids, without the intervention of a crossing with one or other of the parent species. This return of hybrids to their productive types appears to Naudin inexplicable at present, but he means to take up the subject at a future time.—*Comptes Rendus, Août* 18, 1862, p. 321.

Marine Algæ found on the Buoys in the Firth of Clyde, from Port-Glasgow to the Cumbraes and Garrochhead.

Upon eight buoys.
Laminaria saccharina.
Chordaria flagelliformis.

Upon seven buoys.
Ceramium rubrum.
Enteromorpha compressa.

Upon six buoys.
Chorda lomentaria.
Ectocarpus tessellatus.
Polysiphonia urceolata.

Upon five buoys.
Desmarestia viridis.
Punctaria plantaginea.
Ulva latissima.
 Linza.

Upon four buoys.
Desmarestia aculeata.
Polysiphonia elongata.
 atro-rubescens.
Porphyra laciniata.

Upon three buoys.
Ectocarpus siliculosus.
Polysiphonia Brodiæi.
Rhodymenia palmata.
Conferva Youngana.

Upon two buoys.
Chorda filum.
Ectocarpus littoralis.
Chrysymenia clavellosa.
Delesseria sanguinea.
 sinuosa.
Callithamnion Daviesii.
 virgatulum.
Enteromorpha erecta.

Upon one buoy.
Laminaria digitata.
 bulbosa.
Cutleria multifida.
Punctaria tenuissima.
Ectocarpus fasciculatus.
 Hincksiæ.
 pusillus.
Rhodomela subfusca.
Polysiphonia violacea.
 nigrescens.
Cladophora lanosa.
Enteromorpha ramulosa.

Dr Grieve and Mr Robertson in Proc. of Glasg. Phil. Soc.

GEOLOGY.

Geological Survey of India.—This survey is going on with vigour, under the able superintendence of Dr Oldham. By the last Annual Report, it appears that the following districts have been surveyed more or less completely :—In Bengal, the country adjoining the Kurruckpore Hills in Monghyr, and extending across the district of Behar, so far on the parallel of Gya ; also the coal-fields in the south, from the limits of the Burdwan district to the Ghats at Dhurwa, and southward to Hazaribagh; in Central India, the Rewah district, in the southern part of which coal exists; in the north-western provinces, the Sewalek and sub-Himalayan rocks of and near Kangra; in Madras, the districts of Cuddapah and Kurnool; in Pegu and Tenasserim, the district of Henzada, which contains some petroleum wells. The publication of the Memoirs of the Geological Survey, with excellent palæontological plates, is an important step in geology. This valuable work reflects the highest credit on Dr Oldham and the officers of the Survey, and bids fair to develop the mineral treasures of our Indian possessions. The formation of a geological museum and library is also a subject of congratulation.

Summary Statement of the Amount of Coal Raised throughout India for the years 1858–59–60. By T. Oldham, LL.D.—In publishing the following summary of the amount of coal raised throughout India during the above-mentioned years, it must be premised that the term *year*, here used, does not exactly coincide with the ordinary year, but refers to the season or time from the commencement of the working season, in November or December, to the close of the same season, in May or June following, for all open works or quarries, and from the same time to the following November for all pit-work. In the Ranigunj field, the only mode of transport originally was by the river Damuda, a stream only navigable during the freshes of the rainy season; and hence arose the custom of closing the year's account in that district, when, after the passing away of the rains, the river became so dry that no more could be sent to market. The end of September or of October thus became the acknowledged end of the year for accounts. The statements here given are therefore up to the 30th of October in each year:—

Name of Field.	Coal Raised.					
	1858.		1859.		1860.	
	Maunds.	Tons.	Maunds.	Tons.	Maunds.	Tons.
Ranigunj............	5,917,000	217,136	8,949,600	324,754	8,559,097	304,094
Kurhurbari.........	4,000	147	108,182	...	275,256	...
Palamow.............	...	...	28,648	...	30,900	...
Rajmahal Hills Brahmini Nuddi and neighbourhood	92,000	...	90,000	...	101,860	...
Bansloi Nuddi......	27,000	...	97,000	...	81,000	...
Goomani.............	100,000	...	150,000	...	340,000	...
North-west of Hills Borah, Hurra, &c.......	...	...	506,000	...	700,000	...
Silhet Hills.........	22,319	...	32,498	...	...	...
	6,162,319	226,140	9,461,928	347,227	10,088,113	370,206

For the Singrowli field, in the south of Rewah, I have not been able to procure any return; but the amount raised has not been large. In the Nerbudda district no coal has, I believe, been yet brought to market;

but the Nerbudda Coal and Iron Company have this year commenced their operations. In the Punjab no coal is raised, the small and irregular patches of lignite which occur in the Salt Range and elsewhere yielding only a few maunds of fuel in the year. In Oude—none; in Madras—none; in Bombay—none. In Sindh, in the Lynah Valley, a quantity amounting to 45,300 maunds was raised in 1858–59; but this could scarcely be called a colliery, and the works were soon abandoned.

The total amount of coal raised in India generally (indeed it may be said in Bengal), has increased from 226,140 tons in 1858, to 347,227 in 1859, and to 370,206 in 1860.

ZOOLOGY.

Bombyx Cynthia or *Ailanthus Silkworm.*—This silkworm was first introduced from China in 1856 by Fantoni, a Piedmontese, who sent a few living cocoons to some friends in Turin. The moths emerged from their cocoons in June 1857, and laid eggs which were hatched in a few days. The worms were fed on the leaves of *Ailanthus glandulosa*, a plant belonging to the natural order *Simarubaceæ.* In 1858, the silkworm was established in Europe, and it has since been reared extensively in France, and partially in Britain. It is said that in France more than 2000 amateurs are now engaged in rearing this worm. Mr Howgate, in the "Social Science Review," makes the following remarks on this subject: "The eggs of the Ailanthus Silkworm are not preserved through the winter like those of the Mulberry Silkworm, but are hatched a few days after being laid, and the worms attain to maturity so rapidly that in China and Algeria three generations are produced in the course of one summer; even in our colder latitudes two crops of cocoons can be gathered each year, the moths of all the second and part of the first gathering remaining inside the cocoons until the following spring. After emerging from the egg, which is twice as large as that of the Mulberry Silkworm, the caterpillar of the *Bombyx cynthia* passes through five stages of existence before forming its cocoon, at which time it is about two and a-half to three inches long. In the first stage it is yellow with black spots down the belly. After this it passes from yellow to white, and from white to green. The cocoons, as we have said before, differ from those of the ordinary silkworm in having an elastic opening at one end. This opening is not made by the thread being cut, as some have supposed, but by its being turned back at a very acute angle. The colour of the cocoons is a pale grey, and they are from one and a-half to one and three-quarter inches long, and about three-quarters of an inch broad. The butterfly of the Ailanthus Silkworm is much larger and more beautiful than that of the ordinary silkworm; the head is of a greyish brown, the wings of a light brown colour strongly tinted with grey, with a bar rising near the middle of the anterior edges of the superior wings, and continued along the inferior wings, forming an equilateral triangle, the outer part of which is ash-coloured, and the inner part light brown. At the top of each of the superior wings is a small eye, the lower part of which is black and the upper part white, whence a faint white line runs to the extremity of the wing. A small narrow black line runs along the external edge of all the wings. There is also another ash-coloured bar on the superior wings, and an ash-coloured crescent verged with black on the middle of the inferior wings; another crescent, larger and much fainter, appears a little higher up. The extreme facility with which the *Ailanthus glandulosa,* the tree which furnishes food to this new species of silkworm, can be cultivated, seems to render the introduction of this new branch of industry into England a matter of very little difficulty." Another kind of silkworm in China feeds on the *Ricinus communis* or castor-oil plant, but it does not suit the climate of France. The culture of this insect has been successful in the Canaries.

As great disease has recently occurred among the silkworms in France, it became important to introduce a new species. The silk culture in France alone yields 300,000,000 francs per annum. The silkworm ordinarily produces about 150,000,000 francs of raw silk, besides which about 60,000,000 francs value have been imported. The silk, after being manufactured at Lyons, Nismes, St Etienne, &c., acquires a value of more than 310,000,000 of francs. The disease of the silkworm becomes, therefore, to these manufacturing centres, a perfect scourge. The Society of Acclimation in France endeavoured to examine into the cause of the disease among the silkworms. It appears that the disease is caused principally by a diseased state of the mulberry trees, on the leaves of which the silkworms are fed. The insect disease was cured by placing the infected eggs for some time in a box containing a little spirits of turpentine. This treatment, however, does not prevent the reappearance of the disease in the worms when they are fed upon the leaves of the diseased mulberry trees.

MISCELLANEOUS.

Observations upon Photographic Pictures. By J. Alexander Davies. —I would observe that in photographic pictures we may at once perceive the comparative luminosity of any colour, the several colours of any object or objects being represented by shades of black, which are lighter in proportion to their *luminosity*, or, which is the same thing, their resemblance to *white*, and *not* according to their *intensity*, or, in other words, degree of shade. This distinction is one of great importance, and has not, as far as I am aware, before been noticed.

Many, undoubtedly, have observed that all single and stereoscopic photographic landscapes, involving great distances, are in one way unnatural—which is, that the distant parts appear too near, and that this imperfection is actually greater in proportion to the perfection of the work; but the cause of this has not, I think, been pointed out, neither, in my knowledge, has the fact been recorded. I say, therefore, that it arises from the circumstance that we judge of the distance of any object by the *intensity*, and not the *luminosity* of its colour, on which account it is in every case possible to estimate distances in good paintings, where, the colours being given, their intensities may, of course, at once comparatively be seen; and would also mention that the magnificent photographs of Alpine landscapes are illustrations of the imperfection in question—an imperfection which it is not possible to deny, unless the spectator endeavours to imagine the *proper* distances between him and the several distant objects when they are imagined *properly* to represent these distances. I doubt not that the necessary imagination is generally put forward, and hence, that by the majority of individuals the imperfection is not perceived; and would further remark, that this faculty is of great importance in every phenomenon of vision, the mind being the ultimate instrument of all our visual knowledge, and should therefore very carefully be watched Thus, the act of endeavouring to imagine that any painting is a model, certainly *somewhat* impresses us with the idea of the solidity of the various objects represented; we then have them appear more or less protuberant. And inasmuch as the stereoscope only effects solidity, that is, by throwing the pictures into the same space, by which effect this idea is produced, the idea of distance, even in this case, being a *mental* result, it may be affirmed that the above reasoning can be applied to its use. The distant parts of well-executed photographs appear nearer than do those of inferior ones, and this because the minuter delineation of every object makes us the more reject the idea of the distance intended.

Aluminium.—M. Garapon, an artisan of Paris, has solved the problem of drawing aluminium into wires. He furnishes the wire from 60 to 100 per cent. cheaper than silver wire of the same length. The price of aluminium is about 200 francs per kilogramme. For the purpose of drawing into wire they commence with rods of one metre in length and 12 millimetres diameter; this the inventor easily reduces to wires of the size of a hair, and many hundred kilometres in length.

Table of Heights of some of the Principal Peaks in the World.

A. IN INDIA.

1. Nílgiris.				2. Ceylon.	
Name.	Feet.	Name.	Feet.	Name.	Feet.
Doddabétta	8,640	Kundamóya	7,816	Péduru tálla gálle	8,305
Bevoibétta	8,488	Tamberbétta	7,292	Kirigalpótta	7,810
Makúrti	8,402	Kokalbétta	7,267	Totapé la	7,720
Daversolabètta	8,380	Urbétta	6,915	Samanála, or Adam's Peak	7,385
Kúnda	8,353	Daverbétta	6,571	Namúna Kuli	6,760

3. Central India.		4. Dékhan.			
Parisnáth	4,469	Kalsubái	5,410	Pútta	4,569
Abu	3,850	Dhórup	4,745	Ikhára	4,482
Rajmirgárh	3,753	Varáda	4,655	Aunda	4,339
Búlbul	3,354	Tórna	4,619	Mándvi	4,123

B. IN THE HIMALAYA.

Gaurisánkar	29,002	Yássa	26,680	Nánda Dévi	25,749
Kanchinjínga	28,156	Jibjíbia	26,306	Ibi Gamin	25,550
Síhshur	27,799	Barathór	26,069	Naráyani	25,456
Dhavalagíri	26,826	Yángma	26,000	Jánnu	25,304

C. IN THE KARAKORUM.

Dápsang	28,278	Díamer	26,629	Masheribrúm	25,626

D. IN THE KUENLUEN.

The peaks seem not to exceed 22,000 feet.

E. IN THE ANDES.

Authorities: *H* = Humboldt; *K* = Kellet and Wood; *P* = Pentland.

Aconcagua	23,004 *K*	Gualateiri	21,960 *P*	Sorata or Ancohuma	21,286 *P*
Sahama	22,350 *P*	Pomarape	21,700 *P*	Illimani	21,145 *P*
Parinacota	22,030 *P*	Chimborazo	21,422 *H*		

F. IN THE ALPS.

Mont Blanc	15,784	Weisshorn	14,813	Grand Combin*	14,134
Monte Rosa	15,223	Mont Cervin*	14,787	Strahlhorn	14,100?
Täschhorn, or Lagerhorn	14,954	Dent Blanche*	14,305	Finsteraarhorn	14,039

American Journal of Science and Arts, July 1862.

* The heights are taken from p. 511 of "Peaks, Passes, and Glaciers," edited by J. Ball; London, 1859. The others, for which no modification is known since 1854, are from Schlagintweit's "Phys. Geographie der Alpen."

Table of the Principal Mountain Passes.

A. IN INDIA.

1. Dékhan.

Name.	Feet.	Name.	Feet.
Bapdéo	3,499	Pocháma	2,446
Katrúj	3,019	Nána	2,429
Par	2,698	Jām	2,328
Nagchérri	2,645	Málsej	2,062
Návi	2,617	Tal	1,912
Sápi	2,478	Bhōr	1,798

2. Málva.

Name.	Feet.
Péndera	3,498
Silva	1,928
Mándla	1,626
Póppera	1,560
Gúmba	1,553
Singrámpur	1,437

3. Karnátik, Nílgiris, and Ceylon.

Sigur	7,204	Rangbódde	6,589	Gantvarpílli	2,373
Sispára	6,742	Kodúr	2,401	Kistnaghérri	2,150

B. IN THE CREST OF THE HIMALAYA.

From Sikkim to Kíshtvaár.

Ibi Gamin	20,459	Umási	18,123	Kiungar	17,331
Dónkia	18,488	Lángpia	17,750	Níti	16,814
Jánti	18,529	Máyang	17,700	Vallanchún	16,756
Párang	18,506	Lípu	17,670	Púling	16,726
Mána	18,400	Uta Dhúra	17,627	Shínku La	16,684
Nélong	18,312	Birmkánta	17,615	Bára Lácha	16,186
Kióbrañg	18,313				

C. IN THE CREST OF THE KARAKORUM.

From long. E. Gr. 76° to 79° 30′.

Mustágh	19,019	Changchénmo	18,800	Karakorúm	18,345

D. IN THE CREST OF THE KUENLUEN.

From long. E. Gr. 78° to 80°.

Elchi	17,379	Yurungkásh	16,620

E. IN THE ANDES.

Alto de Toledo	15,590	Langunillas	15,590	Assuay	15,526

F. IN THE ALPS.

St Théodule	11,001	New Weissthor	12,136	Old Weissthor	11,871

American Journal of Science and Arts, July 1862.

Heights of Lakes of Western Tibet, Turkistan.

	Feet.		Feet.
Aksáe Chin	16,620	Nima Kar	15,100
Tso Gyagár	15,693	Hánle	14,600
Tso Kar, or Kháuri Taluá	15,684	Tso Gam	14,580
Múre Tso	15,517	Tso Rul	14,400
Kiúk Kiol	15,460	Tso Mitbál	14,167
Mansaráur, or Tso Mápan	15,250	Upper Tsomognalarí	14,050
Ràkus Tal, or Tso Lánag	15,250	Lower Tsomognalarí	14,010
Tsomoriri	15,130		

American Journal of Science and Arts, July 1862.

On Norfolk Island, its Character and Productions. By Charles Toogood Downing, Esq., M.D.—Norfolk Island, discovered by Captain

Cook in 1774, is a small spot of land in the Pacific Ocean, south latitude 29° 2′, east longitude 168° 1′. From the capital of Tasmania, of which it is a dependency, it is 1200 miles distant, and about 900 from the port of Sydney. With it are associated Phillip and Nepean Islands on the southern side, and the Bird Islands, or Rocks, seven or eight in number, on the northern shore. The variation of the needle is 11°·00 E.

The group is isolated, not only from its distant position, but its inaccessibility. There is no secure harbour, and the surf beats so heavily on the coral reefs and igneous rocks with which the coast is guarded, that often for weeks together no landing can be effected. A moderate depth of water extends some miles from the shore, the bottom consisting of banks of coral sand mixed with shell, and affording, although exposed, anchorage; but nearer in, and especially between the islands, the ground is hard and rocky, rendering the holding insecure, and fouling frequent. The insecurity from this source is much increased by the force of the current, which often runs at the rate of 2½ or 3 knots an hour between the islands.

The general tides are regular and usually equal, flowing by the shore six hours each way. They make, however, two hours sooner on the Norfolk Island coast than in the stream, or over towards Phillip Island. The flood runs to the S.W. by S., the ebb to the N.E. by N. The rise is from 5 to 7 feet, and the flow, at full and change, 7¾ hours. Commonly speaking, the tides on this coast will carry a ship clear of danger, not into it. The only exceptions are with respect to the Bambora Rocks at the S.W. extremity of Norfolk Island, and a low point almost corresponding to them, projecting from the S.W. point of Nepean Island. On both these the tides set almost directly, and as they are respectively at the east and west extremities of the bay in which the settlement is placed, and not more than three miles and a half apart, they add much to the danger. On these Bambora Rocks the *Sirius* was wrecked from this cause in 1791.

Norfolk Island, of an irregular quadrangular form, is about seven miles in length from east to west, by four in breadth from north to south. From the survey taken by Major Burney, the commanding Royal Engineer of New South Wales, in 1840, we learn that the superficial extent of the island is 8960 acres; of this, 1080 acres were then cleared for agriculture, and about 1000 were pasturage. The relative proportions of these have since varied, and rather more land has been brought into cultivation.

The average height of the island is from 300 to 400 feet above the level of the surrounding ocean, although the land is generally higher on the northern side. In this direction lofty perpendicular cliffs bound the shore, and Mount Pitt, with its double summit, rises to an elevation of 1050 feet above the level of the sea. From hence the surface has a gradual declension towards the south, and terminates in a level flat, but little above high watermark, on which the settlement is placed. The surface is so irregular that, in the language of a sailor, if correctly laid down in a plan, with all the hills and valleys accurately represented, Norfolk Island would very much resemble the waves of the sea in a gale of wind; for it is composed wholly of long, narrow, and very steep ridges of hills with deep gullies, which are as narrow at the bottom as the hills are at the top.

The soil of the island is very uniform, consisting of a red, porous, ferruginous earth, originating in the decomposition of volcanic rocks (Wacke) of ancient date, which occur in seams of various shades of colour like true strata, and pass insensibly into basalt; of which, sometimes columnar, the cliffs on the northern shore are formed. This friable earth alternates with white concretionary marl, both studded with boulders of porphyritic rock, gradually disintegrating. This is evident by their outer layers crumbling into dust under the finger, but gradually becoming denser towards the centre, where their texture is as hard and crystalline as granite. Pumice is found abundantly on the coast. In fact, the whole geological character of the island is indicative of volcanic agency. The low flat on the southern shore, previously alluded to, about a mile in extent from east to west, and a quarter broad, is alone of aqueous origin. It consists of coarse marine limestone, or calcareous grit of recent deposit, and is usually employed for building purposes, but yields, on burning, lime of great purity. Near this is also obtained sandstone, or calcareous grit of fine quality, from which dripstones and other porous vessels are manufactured.

The only metal found on the island is iron, in the mineral forms of red and yellow ochre. A chalybeate spring has been noticed at Orange Vale.

Phillip Island is about five miles distant from the settlement. It is 1¼ mile long, ¾ths of a mile broad, the general elevation being greater than that of Norfolk Island, and averaging 800 or 900 feet above the level of the sea. In physical structure the two islands are identical, Phillip Island consisting of porphyritic rocks more or less disintegrated, and a small quantity of calcareous grit, known as the Sloop Rock, on the shore.

Nepean, situated within the former, is about 400 yards from the beach of Norfolk Island. It is a rugged, rocky islet, a quarter of a mile long, and of a horse-shoe form, open to the east. Formed entirely of marine limestone, it rises about 50 feet above the level of the sea, and serves as a habitation to birds, and to them alone.

Rocks, chiefly basaltic, which are separated from the northern coast of Norfolk Island by rapid currents, and worn into caverns by their waves, constitute the Bird Islands.

Norfolk Island is abundantly supplied with water of excellent quality. The streams are small and insignificant, but fountains rise from the rock in every direction, and collecting, run as brooklets down the valleys. The rain which falls during the year is moderate in quantity. Sometimes, as might be expected in a country so near the tropics, it falls abundantly. Yet, however heavy or long-continued the shower, no water accumulates, as the drainage is thoroughly accomplished by means of the deep gullies which radiate in all directions from the high land towards the sea. Vegetation is hence most luxuriant. Rain falls at all periods of the year, but chiefly during the winter. Fogs and mists are unknown. But few days occur in the course of the year in which the sky is not more or less clouded, and the horizon rarely presents that clear defined outline so common in the Australian Colonies. In the summer seasons the prevailing winds are generally dry and from the eastward. In the winter months they come chiefly from the opposite quarter, accompanied by clouds and showers. The few heavy gales are from the south. But the wind most dreaded is that from the north, which comes loaded with heat and moisture, and exercises a relaxing and baneful influence upon the human frame. The average duration of these winds is two or three days, and they usually occur three or four times in the month.

The temperature of the island may be considered both moderate and equable. The highest reading of the thermometer during the year 1847 was 87° Fahrenheit, the lowest 49°; the mean annual temperature, deduced from four daily observations, including the lowest at night and the highest by day, was 68½°; the mean difference between the extremes of day and night 17°. In the year 1850, the highest reading of the thermometer in the shade out of doors was 85°, the lowest 51°, showing an annual range of 34°. The mean monthly temperatures during the same year were as follow :—

January	74°	July	62½°
February	74½		
March	73	September	64½
April	70	October	65
May	65½	November	70½
June	63	December	72½

These figures indicate an extreme of mean monthly range for the year of 12½; less by 1½ than that of 1849; with an annual mean of 68°,—exactly the same as that of the previous twelve months.

The *climate* of Norfolk Island, although somewhat relaxing, is considered salubrious. The chief diseases to which residents are subject, as gathered from the medical reports of many years, result from the prevailing heat and moisture, often producing debility and relaxation of the mucous membranes. Few escape without some symptoms of this on their first arrival. Dysentery, of a type intermediate between tropical and European, is rather common, and may be attributed, in addition to the causes previously mentioned, to the inordinate use of lemons, guavas, and other wild fruit. It is in a measure endemic in the island. Ophthalmia, chiefly conjunctival, prevails almost epidemically during the months of August, September, and October, the exciting cause being atmospheric. Bronchitis again prevails during the winter months. The same may be said of the many rheumatic cases that occur, and which are almost all muscular, such as pleurodynia, lumbago, &c.; the articular form being of very rare occurrence. Such are the ordinary ailments of the place; but it is by no means free from other occasional visitations. Scarlet fever, for instance, made its appearance on the island, without apparent propagation, at the time it prevailed as an awful scourge in Tasmania.

The soil of Norfolk Island is of exuberant fertility, so that the rewards of industry may be obtained without its exertion. Forest trees grow in great abundance, and beneath them a rich growth of underwood. This appears to have been the case at the time of its discovery, for Captain Cook remarked that the ground was so thick with shrubs and plants for about two hundred yards from the shore, that there was great difficulty in penetrating further inland. This great navigator noticed the striking similarity in natural productions between this group and New Zealand. This was doubtless the case at the time he paid his visit; but since then, so many things have been introduced, so many plants have been cultivated, abandoned, or suffered to grow wild, that it is no easy matter to determine at the present day which are and which are not indigenous. It will be well perhaps to describe the nature and economical uses of the more remarkable of these productions.

The most striking objects that meet the eye on nearing the land are the lofty tops of the Norfolk Island Pine, the *Araucaria excelsa* of botanists. This, one of the most elegant of the Conifers, towers high above the surrounding forest, or takes its position singly or in clumps on the very verge of the ocean. It thus forms a characteristic feature in the landscape. In height, it may formerly have ranged from 150 to 200 feet, but of late years few trees of this latter elevation have escaped the axe. This pine, compared by some to those of Caledonia and New Zealand, resembles the Norway spruce, although the tiers of its branches are more distant and regular. The timber is not of good quality, as it soon rots when exposed to the weather, and fearful ravages are made in it by the teredo or auger-worm, when exposed to its action. The bullock-fences of the island require renewal every two or three years. When employed for building purposes, such as flooring in the interior of houses, it is more durable. The knot of this pine is compact, hard, and fine in grain, and, from its translucency and rich dark tint, is admirably adapted to hollow turnery. Beautiful specimens of this work, executed in this wood, were sent from Tasmania to the Paris Exhibition. These pine-knots, when defective, serve another very useful purpose. They make excellent fuel, and, on account of the rich hydro-carbons with which they are charged, burn with the brightness and persistence of the best English coal.

For economical purposes, the iron-wood, *Notelæa longifolia*, or *Olea apetala*, is the most important and valuable of the indigenous timber-trees of Norfolk Island. It yields a fine, close-grained wood, very hard and durable. This is chiefly employed in wheelwright's work, but may be used with advantage by the cabinetmaker, as some specimens are remarkably well veined.

Among the many ornamental woods obtained from this ocean isle should be enumerated the rosewood, believed to be a species of acacia, the beech (so called), the maple, *Acer Dobinea* (?), the hopwood, obtained from the *Dordonia orientalis*, the hard yellow-wood, from the *Blackburnia pinnata*, the white-wood, and the cherry-tree,—a species of *Exocarpus;* the bark of this latter, rich in tannin, has been used in making leather.

Pursuing our investigation of the vegetable kingdom, we come to what is locally called the White Oak, the *Hibiscus*, or *Lagunea Patersonii.* It is perhaps the largest plant known to exist belonging to the *Malvaceæ*, or Mallow Tribe. Attaining sometimes an elevation of sixty or eighty feet, and displaying a profusion of large pink flowers with leaves of whitish green, it would form an elegant addition to the shrubbery. In an economic point of view it is valueless, except for firewood.

The Cabbage-tree, *Areca*, or *Seaforthia sapida*, was noticed by Cook, and has been since well described by one who visited the island. It is a handsome palm, with a trunk about twenty feet in height and from one and a half to two feet in circumference, with annular scars, left by the fallen leaves.

The *Freycinetia Baueriana*, or Norfolk Island Grass-tree, belongs to the tribe of *Pandaneæ*, or Screw Pines. Its stem, an inch and a half in diameter, and marked by rings as the former, lies on the ground, or, winding round the trunks of trees, climbs like ivy to their summit. The branches are crowned with crests of broad, sedge-like leaves. From the centre of these arise masses of red, pulpy fruit, four inches in length and as much in circumference. While in flower the centre leaves are scarlet, which adds to the splendid appearance of the plant.

In the open, grassy valleys, two or three species of tree-fern, the *Alsophila excelsa* and *Cyathea medullaris* exhibit, with *Marattia elegans*, their rich crests among the surrounding verdure. They often measure forty or fifty feet in height, and have fronds of great length and magnificence. From the centre of the trunk a black wood is extracted, and used by cabinetmakers for stringing.

The Norfolk Island Bread-fruit differs much from that grown at Tahiti or the West Indies. It is the *Charlwoodia australis.* Attaining twenty feet in height, it branches from within a few feet from the ground, and forms several heads with flag-like leaves, and long branched spikes of greenish star-flowers. These are succeeded by small purple berries, the food of parrots.

The native Spice-plant, by many thought to be the pimento, is the *Piper Psittacorum*, or *Ava* of the South Sea Islands. It yields fruit of a yellow colour and long cylindrical form, which has an aromatic taste, and may be employed as a pickle or preserve.

The Blood-tree yields on tapping a fluid of a bright red colour. This has been used as medicine as an astringent, but is more generally employed as a marking ink, as the stain on linen is indelible.

The Cotton-plant was once cultivated by Captain Maconochie with advantage. It is now wild, and overruns every part of the island to such an extent as to render the Bush almost impracticable.

The *Phormium tenax*, or New Zealand flax, has always grown abundantly on the cliffs of the northern coast, and on the steep declivities of the hills inland. It is a large, handsome plant, with sedge-like leaves. It has not lately been cultivated for economical purposes. We are assured, however, that two New Zealanders were once introduced to teach the people how to prepare it, but their process was so tedious that the scheme was abandoned.

The chief medicinal plants growing wild are the *Datura Stramonium*, *Ricinus communis*, and the *Solanum nigrum*. This latter is a fine, ornamental shrub, the berries of which, reported poisonous in England, have been cooked and eaten here with impunity.

Many climbers of great luxuriance and beauty are seen winding round the trunks of fern and forest trees, or hanging in graceful festoons from stem to stem. The slender Jasmine, *Jasminum gracilis*, at home a delicate hot-house plant, is one of the most distinguished of this group. Its twisted stems, of considerable thickness, may often be seen hanging like ropes from the lower branches of the pine, or white-oak, while its flowers cluster in the top. The rosy-pink petals of the *Ipomœa pendula*, greatly resembling those of the *Convolvulus major*, and the purple and green pea-flowers of the Wistaria, deserve especial notice. Two species of passion-flower also grow in the Bush, and attract much attention.

Whilst a convict station, upwards of 1200 acres have been brought under cultivation for agricultural purposes. The chief produce has been rye, oats, and Indian corn. The soil and climate are not adapted to the growth of wheat; several times it has been tried unsuccessfully. The crops were most uncertain, chiefly owing to rust and smut. The fungi of these diseases were speedily developed, and proved destructive by their rapid dissemination. The farm operations have always been effected by manual labour; yet that it has not been unproductive is shown by the returns for three consecutive years, obtained from the Commissariat Office. There were harvested in

1845.........425,365 lbs.	of maize,	or about	8,507 bushels.
1846.........421,790 lbs.	ditto		8,435 bushels.
1847.........711,296 lbs.	ditto		14,225 bushels.

There were two large gardens belonging to the Government: one at the Cascades, the other at a lovely spot called Orange Vale. In these, as well as in the private grounds of the civil and military officers, the variety and luxuriance of produce were extreme, the chief labour arising from the necessity of constant weeding. At the dinner table of some of the residents I have observed seven or eight different kinds of vegetable, obtained the same day from their gardens. It may be well to enumerate some of the things cultivated, in order to show the capabilities of the island in this respect.

The Coffee-plant thrives well, and yields berries of small size and good flavour.

The common or round potato is cultivated, but not with success, although four crops are produced yearly from the same soil. There is a great tendency to run to stalk, from rapidity of growth, and the tubers are generally small and watery.

The Sweet Potato, or *Buck*, as it is called, the large tuberous root of the *Batatas edulis*, a plant of the Convolvulus tribe, is the chief garden esculent. It yields good crops twice a year, and may be eaten roasted, boiled, or fried in slices.

The Arrow-root is very extensively and successfully cultivated in Norfolk Island. The starch is separated in the usual manner, in the months of September and October, and is found to be of superior quality.

Cayenne pepper, manufactured from pods of the Capsicum grown in these gardens, has a quality and flavour equal to any that can be obtained. It is much in demand.

The Sugar-cane is seen in many places growing luxuriantly, but quite neglected. The first settlers introduced the plant, and made rum of its juice. Under the subsequent regime this distillation was forbidden, and hence the cane became valueless.

Garden fruits, though varied and abundant, are not always of good quality. The banana, strawberry, and grape grow freely, and may be cultivated to advantage. Raspberries grow vigorously, but do not fruit. The apple also fails, chiefly through blight. There are inferior qualities of pineapple, fig, olive, pomegranate, almond, quince, melon, and peach. The loquat, originally derived from Japan by the way of Batavia, is rather plentiful during the season; as well as the passion-fruit. Orange and citron plants, introduced from Sydney, are now just beginning to bear; but it is considered doubtful whether the walnut and mulberry trees, brought by Mrs Maconochie, will ever yield fruit.

Wild fruits are abundant in the Bush; limes and lemons may be gathered all the year round. The apple-fruited guava is everywhere plentiful, as well as the *Physalis edulis*, or Cape gooseberry. A few orange trees may also be met with. There is a tradition that the fruit of this tree was once so abundant, and offered so much sustenance to absconders, that the then commandant (Major Morrisett) ordered them to be extirpated. Upon careful inquiry I find this statement incorrect. Oranges never were abundant. An attempt was once made to destroy the wild guava and lemon trees; but their abundance at the present day proves that the effort was abortive.

It may be concluded from the preceding observations, that Norfolk Island offers every facility to the settlement and welfare of a limited community. The chief want is that of a harbour. But this might be supplied readily at a place called Ball's Bay, a mile or two eastward of the settlement. A profitable fishery might there be established. Many more tropical or semi-tropical plants, such as the real bread-fruit, coco-nut, yam, and mango, might be introduced; while the proper cultivation of those already there would yield surplus supplies for exportation. Coffee, maize, sugar, cotton, arrow-root, castor-oil, and cayenne have hitherto yielded well, even with forced unwilling labour and manual industry. Much more may therefore reasonably be expected from steady perseverance, aided by all the appliances of modern husbandry. It must not be forgotten, however, that the very prolificness of the soil offers great temptations to indolence; and that, unless this vice be steadily resisted, the most virtuous people will rapidly, both socially and morally, degenerate.—*Transactions of the Royal Society of Tasmania.*

PUBLICATIONS RECEIVED.

1. Journal of the Asiatic Society of Bengal. No. 1 for 1862.—*From the Society.*

2. Journal of the Chemical Society, for July, August, and September 1862.—*From the Society.*

3. Transactions of Tyneside Naturalists' Field Club. Vol. V. Part III.—*From the Club.*

4. Bulletin de l'Academie Royale des Sciences, &c., de Belgique. Parts 5, 6, and 7, for 1862.—*From the Academy.*

5. American Journal of Science and Arts, for March and July 1862. —*From the Editors.*

6. Compte-Rendu Annuel. Par A. T. Kupffer, St Petersburg, for 1859 and 1860.—*From the Directors of the Observatory.*

7. Canadian Naturalist and Geologist, for February and June 1862. —*From the Editors.*

8. Schriften der Königlichen Physikelisch—Oekonomischen Gesellschaft zu Konigsberg. Parts 1 and 2 for 1861.

9. Memoirs of the Geological Survey of India. Palæontographia Indica. By Thomas Oldham, LL.D.—*From Dr Oldham.*

10. The True Figure and Dimensions of the Earth. By Johannes Von Gumpach.—*From the Author.*

11. The Eccentric and Centric Force; a New Theory of Projection. By Henry F. A. Pratt, M.D.—*From the Author.*

12. Our Moral Relation to the Animal Kingdom. By the Right Hon. the Earl of Harrowby.—*From the Publishers.*

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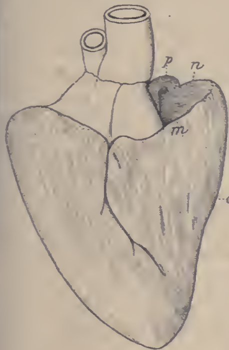
Fig. 3.



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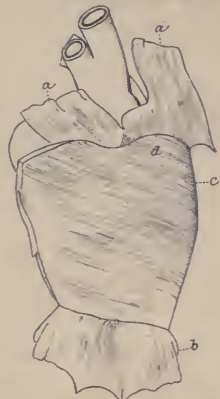

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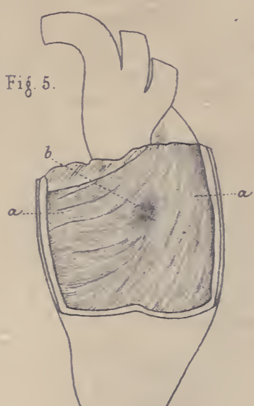

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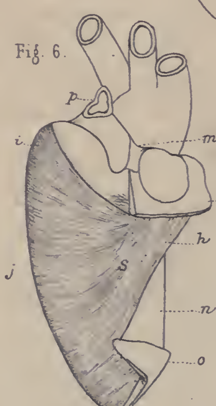

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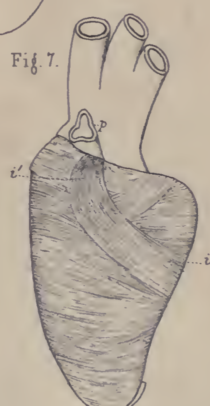

W. C. Mc Intosh, delt. W. H. Mc Farlane, Lithr. Edinr.

Ash-tree at Moredun,
struck by lightning.