THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL

THE EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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Notice of the Species of Meriones and Arvicola found in Nova Scotia. By John William Dawson, F.G.S., Professor of Natural History at Montreal. [Plate I.]*

Having been perplexed by the uncertainties attending the observation of the native Muridæ of America, the writer was induced to attempt forming a collection of all the species found in the province in which he has resided. The following notes exhibit the results at which he has arrived, and may be useful at least as a contribution to local zoology. It is proper to state, that in collecting specimens he has been aided by Mr James M'Kinlay of Pictou, Mr W. G. Winton and Mr A. Downes of Halifax; and that in 1842 he contributed an account of two of the species to the Wernerian Society of Edinburgh.

I. Of the genus *Meriones* (Illiger) there appear to be two species in Nova Scotia. The smaller and more abundant of these was that with which the writer first became acquainted, and he identified it with the *Meriones labradorius* of Sir J. Richardson, and noticed it under that name in the paper above mentioned. He has since, however, obtained specimens of a larger animal, corresponding more closely with Richardson's description, and apparently distinct from the

* Mr Dawson having kindly presented to us the specimens above described, we have thought it right to give a figure of the proposed *Meriones acadi[illegible]s*. The size and proportions have been accurately kept in the drawing.

former. The principal differences between these supposed species are as follow:—

1. *Meriones labradorius* corresponds with the description in the *Fauna Bor. Am.*, except that the tail is five lines longer, and has about an inch of its extremity clothed with short white hairs, which also form a small pencil at the end. There are also slight differences in the colours of the whiskers and ears, a few hairs of the former being white, and the latter a little lighter coloured and more yellow. A young specimen, less than half grown, resembles the adult in form, but has very short hair, and is lighter in colour on the back. This young individual has, like the adult, the extremity of the tail white.

2. *Meriones*, nov. spec.? [Plate I.] The smaller species is similar in general form, but the feet are a little longer in proportion to the size of the animal, and the fur is coarser and not so close. The colour is much darker, there being a greater number of black hairs both on the back and sides, and the yellow band on the side is less deep in colour. The lower parts are yellowish or yellowish-white, shading gradually into the yellow and black of the sides. I regret that, since I became aware of the existence of another species, I have been unable to obtain a recent specimen, for a more full description. The following are the dimensions of three prepared specimens:—

1. Head and body	3 in. 6 lines,	tail 5 in. 0 l.,	hind foot 1 in. 6 l.
2.	3 ,, 9 ,,	... 4 ,, 9 ,,	... 1 ,, 3 ,,
3.	3 ,, 3 ,,	... 4 ,, 4 ,,	... 1 ,, 2½ ,,

These dimensions are sufficient to show the smaller size of the animal, as compared with *M. labradorius;* and a glance at the specimen must render it evident that it is not the young of that creature. It cannot be identical with the *Dipus canadensis* of Davies and Pennant, if that species has ears shorter than the fur; and the *Gerbillus canadensis*, as described by different writers, appears to be a creature as large as *M. labradorius*, if not identical with it. Should this prove to be a new species, I shall claim for it the name of *M. acadicus;* but until I have opportunity for farther comparison and inquiry, I do not insist on its being received as new.

Both species of Meriones inhabit grain fields; but my opportunities of observation have been confined principally to the last or smaller species, which is most easily observed in harvest. At that time the animals are sometimes abundant. They do not burrow, but make little furrows in the shelter of stones, sods, &c., to which they return when driven away; and when pursued, they shelter themselves beneath sheaves of grain, or in the crevices of piles of stones. They lie so close that they can scarcely be observed, and remain motionless till on the point of being seized, when they suddenly escape by a few rapid leaps, each about a yard in length, and then lie motionless as before, or run for shelter to any cover that presents itself. I have not found the nests in which they rear their young or pass the winter, and am not aware that they collect any store of winter provision. They may be seen to feed by day, and in their neatness and agility they resemble the squirrels rather than the other mice.

It is often stated that these leaping mice are specially adapted to open plains. It therefore appears singular that two species should be found in a country originally densely and almost continuously wooded. This may be explained by supposing that the proper habitat of Meriones, in the wild state of the country, was in those tracts desolated by accidental fires, and overrun with herbaceous plants and small shrubs. In the present state of the country, the peculiar powers of both species admirably fit them for finding food and safety in the grain fields.

II. The most common *Arvicola* in Nova Scotia appears to be the *A. pennsylvanica* (Ord). It abounds everywhere, both in the woods and cultivated grounds, and is very destructive. The year 1815 is especially remembered by farmers in the eastern part of Nova Scotia as one in which these animals appeared in incalculable numbers, perhaps in consequence of a failure of their food in the woods.

They excavate burrows under stones and stumps, or in dry ground. These are sometimes a yard in depth, and have two entrances or galleries leading from opposite directions to the neatly-constructed nest of dried grass, which lies in the deepest and most central part of the burrow. In each gallery there is usually a little antechamber, to enable the animal to turn itself without going so far as the nest.

They are active during the greater part of the winter, and form long galleries under the snow, devouring grass, roots, the bark of young trees, and all other edible substances that they meet with in their progress. In spring, when the snow has disappeared, these galleries may be traced by the little ridges of cut grass thrown up along their sides. Even in their journeys at this season they seem to prefer travelling under cover, as I have seen their galleries crossing roads under a very thin coat of recently deposited snow. In winter they also congregate in barns, stacks, and root-houses. In its habits this species closely resembles, and evidently represents in the economy of nature, the European *A. vulgaris*, to which it approaches so closely in appearance.

In the same situations with the *A. pennsylvanica* is found another species or variety, somewhat more clumsy in form, darker in colour, with the eyes set closer together, and a tail twice as long, scaly, and tapering. It approaches more nearly to the descriptions of *A. novoboracensis* than to those of *A. pennsylvanica*, and it may be the species described as *A. hirsutus* in the Report on the Quadrupeds of Massachusetts by Emmons.

III. The white-footed mouse, *Mus leucopus*, is also found in Nova Scotia as a field mouse, and frequents barns and out-houses; but in dwelling-houses it appears to give place to the common domestic mouse. It corresponds with Richardson's description, and must be the animal named *Arvicola Emmonsii* in the Massachusetts' Reports.

IV. Both the brown and black rats of Europe have been introduced. The latter is very rare; I have seen only two specimens, both obtained in the city of Halifax. The brown species is abundant throughout the country, inhabiting houses and sewers, and burrowing in the ground in the vicinity of barns and root-cellars.

Notes on the Natural History of the Province of Canterbury, in the Middle Island of New Zealand. By Sir THOMAS TANCRED, Bart.

Having lived for some months in the Middle Island of the Colony of New Zealand, the few observations which the pressing avocations of a settler with a family enabled the writer to make are confined chiefly to the neighbourhood of Christchurch, in the province of Canterbury, and to the country which would be traversed in a ride of about forty miles to the north-west, and another of about sixty miles to the south-west of that town.

The latitude and longitude of Lyttelton Harbour, in Banks' Peninsula, are 43° 36′ south, and 172° 45′ east. The port town of Lyttelton is situated on an inlet, of a depth of about eleven miles, in the rocky coast of Banks' Peninsula, the whole of which district is composed of steep volcanic hills (from 1500 to 2500 feet in height), the scenery of which in many parts can hardly be surpassed in romantic beauty. The more sheltered parts are clothed with forests of splendid timber, and possess a climate of quite a different character from that of the more exposed plains. At Akeroa, for instance, originally a French settlement on another noble harbour in the peninsula, the grape and peach ripen in the greatest perfection; whilst graceful tree-ferns, spreading their delicate fronds beneath the forests, attest the mildness of the temperature. The more exposed parts of the hills of this peninsula are clothed with the greenest grass when within the influence of the sun, whilst fern covers those parts which are more constantly in the shade.

Altogether, the beauty of this combination of hills, wood and water, under the sparkling sunshine which generally prevails, together with the balsamic odours of the pine woods, and the abundance of fruit, make this district by far the most attractive to the mere tourist; but for more utilitarian purposes, it is fortunate that its character is quite distinct from that of the rest of the settlement.

Leaving, then, the port and harbour, and proceeding to scale the hills to the north, behind the town of Lyttelton, by the steep bridle-path which hitherto has afforded the only means of exit by land, we are struck on reaching the dividing ridge by the majestic chain of alps—

> " There soaring snow-clad through their native sky,
> In the wild pomp of mountain majesty"—

by which the wide-extended plain beneath us is bounded, towards the N. and N.W., at a distance of from fifty to sixty miles. On examining the intervening space more closely, the meanderings of two or three rivers are seen here and there, pursuing a tortuous course towards the low flat coast, against which the ocean surf is beating along a great extent, as it sweeps round in a wide curve to the north-east, where it ends at the Kaikoras.

On descending the northern face of the peninsula hills, and examining the level country more nearly, it will be found to consist, towards the east or seaward, of a range of sandhills of variable width, within which is a tract of rich alluvial soils, interspersed with swamps, where the native flax (*Phormium tenax*), grass, a palm-like shrub, and in the more decided bogs a kind of bulrush (*Typha angustifolia*), called by the natives *raupo*, flourish. A tract of this swampy land also runs along the base of the peninsular hills, and seems to have been, there as elsewhere, caused by a stoppage of the natural outfall of the land waters, either by those hills having risen by volcanic agency, or by the sand banks which in the course of ages have accumulated along the coast of the ocean.

Most or all of these swamps, however, can be easily drained, often by no other operation than the digging of the boundary ditches to fence the land, which then proves of greater fertility than that originally dry. This kind of country—viz., swampy intermixed with drier tracts—extends round at the base of the peninsula hills to the west and south as far as Lake Ellesmere, and also parallel with the coast, for about twenty-five miles northward from the peninsula hills, having a width of from eight to ten miles. The same kind of country prevails to the south of the peninsula, nearly to the boundary of the province. There are also 100,000 acres of rich agricultural land running up to Talbot forest, about eighty miles south of Christchurch, and a fertile belt, of from one to two miles in breadth, at the foot of the mountains. Over these tracts are scattered some small " bushes," or woods, the remnants of much larger tracts of wooded country, but which have been unfortunately destroyed by fires, carelessly kindled by the natives for the purpose of clearing land for their cultivations. The exterior of these woods, therefore, presents a very disappointing sight to one eager to see a primeval forest in a state of nature. You approach them over ground rough with the charred stumps of burnt trees, many of which, dead and scathed with fire, are still standing all round the outskirts of the live trees, giving a desolate and blasted effect to the landscape. These isolated remnants of former forests are generally in the midst of swamps, to which probably they owe their preservation from the devouring fires which have cleared the surrounding country. That these woods were, no great while since, much more extensive than at present, is proved by the stumps and roots of trees still encountered by the plough where nothing of the kind is visible on the surface, and also by the stems of trees found buried in great quantities in old water-courses, which have now become swamps.

It is in these swamps that we have seen bones of the Dinornis disinterred from a trifling depth, and it seems a tradition amongst the natives that the forests were burnt in order to get rid of the Moa. Considering how little is yet known of the interior of the middle island, or even of the large forests of the settled parts, it seems by no means improbable that this gigantic bird may yet be seen alive.

The rich alluvial tracts of country above described consist of most fertile land, easily worked, not a single stone being usually found in the soil, excepting where rivers may have deposited banks of gravel. It varies from a sandy to a clayey consistency, probably with little if any lime in it, the water of the rivers and creeks which traverse it being exceedingly clear and soft. It is capable of producing excellent crops of all the cereals, as well as of potatoes, carrots, and turnips. It is favourable to the growth of English grasses, and of clover which is generally excluded from permanent pastures from its liability to overrun and choke the grasses. It may be observed here, that the potato-apple ripens and becomes a highly-scented and agreeable fruit, like a plum, of which a preserve is made. Potatoes have not been affected with any disease, and are generally of very good quality. In good land, well tilled, the second crop of wheat, by accurate measurement, has been known to amount to seventy-six bushels per acre. Oats are a very heavy crop, but cause great trouble to get them out of the land, as the winter does not kill them, and the old roots throw up fresh shoots in spite of ploughing. The barley is generally a very bright and heavy sample. There seems every probability that ale may very soon be brewed here (the hops being procured from Van Diemen's Land), which will become an article of export to Australia, and even to India.

Carrots and Swedish turnips are calculated to produce from 20 to 25 tons per acre. The plants which succeed the worst in new land are papilionaceous plants, such as pease, beans, lucerne, &c. Onions, also, are apt to fail till the land has been thoroughly cleared of the fern root.

All the common fruit and timber trees and shrubs of England will probably flourish, though there has been a difficulty in raising seedling pines, from their being scorched up by the sun and hot winds ; but this only requires to be guarded against by providing shade and moisture at the proper season, whilst the plants are young. Quickset, gorse or whin, flourish most luxuriantly. Most of our cultivated annuals, when introduced here become weeds, seeding themselves, and coming up next year, in spite of digging the ground.

The rest of the settled parts of the province of Canterbury (lying at a higher elevation than the alluvial tract above described) consists chiefly of widely-extended plains of light dry land, sometimes actually shingle thinly covered with grass, interspersed here and there, near the beds of rivers and creeks, with tracts of the rich land above described. Over this country you may ride or drive a dray, for miles upon miles, steering a course either by marks on the mountains which bound the horizon, or, if the weather is thick, by the compass, till arrested either by swamps or by wide rivers, which have to be forded. The chief exceptions to this character of country are to the north and north-west, where rounded downs, with steep ravines amongst them, are found.*

The plains, as far as we had any opportunity of examining their geological character, are composed of an immense tract of alluvial detritus, the shingle beds, wherever found, appearing to consist of quartzose and micaceous sandstone. Towards the sea, beds of shells are found buried, or even still lying on the surface. The Malvern Hills and the downs, already described, are partly composed of limestone (mountain limestone), and in their vicinity coal appears, as well as ironstone, and it is said copper ore.

These extensive plains are clothed with grass, with ferns in some places, and groups of the Ti-palm, as it is called by the natives (*Cordyline australis*), scattered here and there. In some places a curious thorny plant, by the settlers called Wild Irishman (*Discaria australis*), abounds; whilst in others more moist, the Wild Spaniard (*Aciphylla squarrosa*), a sort of spear-grass, raises its formidable chevaux-de-frise. The root, which tastes strongly of parsnip, is much relished by pigs, and by the native rat, which forms numerous burrows, rendering the soil unsafe for a horse. I have understood that in some parts near the hills, the country is rendered inaccessible by the abundance and formidable size of these plants.

In other parts there are extensive tracts of Manuka scrub, consisting of shrubs, from 6 to 10 feet high of the beautiful plant so called (*Leptospermum scoparium*), which is aromatic like the sweet gale, and bears a flower from the time when it is a foot high resembling that of the hawthorn. It is said to be the same which in more sheltered situations in forests becomes a good-sized tree, and produces an excellent wood.

In other parts the herbage contains a quantity of an aromatic plant like anise (*Anisotome?*), affording a very grateful pasturage to all sorts of stock, and so abundant where it grows, that when crushed by the horses' feet, its scent perfumes the air. In other localities great quantities of sow-thistles make a rich food for cattle.

* The whole extent of the province, from sea to sea, and from north to south, covers about 12,000,000 acres, of which much is occupied by inaccessible mountains.

In some parts of the plains groves of the Ti-palm, as it is called (*Cordyline australis*), occur, whilst in others only single plants appear at intervals. They often assume a grotesque appearance on the solitary plain; some with dead leaves drooping beneath the crown, might be imagined at a distance to be shepherds in loose coats in various attitudes, others like persons with umbrellas behind them, running before the wind. The heart and the pith of the stem are eaten by the natives.

On the extensive range of sand-hills which border the coast, the prevalent vegetation is a sort of stiff bent-grass and the Ti-palm. We found commonly a handsome Senecio, with a large yellow flower, arising from a cluster of roundish-oval leaves of a rich claret colour, and having spines on the upper surface, and downy beneath (*Senecio bellidioides*); together with another yellow composite flower with filiform leaves (*Microseris Forsteri*).

These widely-extended plains, and the downs of a low elevation with which they are connected towards the north and west, as well as the volcanic hills of the peninsula, and much of what will ultimately be agricultural land, are occupied either as sheep or cattle runs, according to the dry or more swampy nature of the soil; on the latter, herds of pigs being also kept. The quantity of wool, as also of dairy produce and pork, is annually doubling itself; and the only material impediment to a very rapid development of pastoral wealth is the scarcity and great dearness of labour. So rapid is the rise of the labouring class to the condition of independent farmers or proprietors, that every member of their families, within a short time after their arrival, is employed in working for themselves at home, instead of for hire. This state of things is being somewhat alleviated by sending out labourers from this country; and if a regular stream of labour can be kept constantly flowing in, as the former arrivals become absorbed into the class of farmers, a very prosperous state of things must be the result. Till this regular and sufficient supply can be safely calculated upon, any undertaking which exceeds the means of the proprietor and his family to conduct themselves, with only occasional recourse to hired labour, must be hazardous, and replete with vexation and disappointment. The supply, too, of domestic servants is so very limited, that persons with young families, unless they are accompanied by unmarried relations, willing and able to undertake all sorts of household work and outdoor labour, will find it almost impossible to remain there.

These, we may hope, are but temporary inconveniences, whilst the permanent character of the country and climate is most favourable to the rapid development both of agricultural and pastoral property. The flocks and herds are here exempt from those severe droughts from which stock-owners suffer so frequently in Australia; and that most destructive pestilence the catarrh is unknown in New Zealand. There is no race of wild animals to molest the stock; though a few dogs which have escaped and become wild are met with in unfrequented parts. The scab is the only disease much to be dreaded, and stringent laws have been passed to prevent the spread of the infection, which, in an open country like these plains, with few natural boundaries, would without constant attention be liable to spread with great rapidity. A good supply of grass all the year round enables a larger amount of stock per acre to be kept here than in most parts of Australia. The climate is also favourable to the breeding of horses, which will doubtless become an important article of export.

Whilst upon the subject of the capabilities of the country, it may be remarked that one of the most serious drawbacks has hitherto been the want of easy access to a port from the productive country which has been described. Some small amount of produce is shipped, and stores received by means of small coasters at one or two points on the coast; but the only harbours where large ships can lie in security are those of Lyttelton and Akerob, in Banks' Peninsula. It is a peculiarity of these, as of most of the harbours in New Zealand, that they are not estuaries formed by rivers, or land-locked bays bounded by low shores, but are mere indentations in the high rocky coast of the peninsula, resembling in character, we should suppose, the Fiords of Norway. The formation of a road by which heavy goods and agricultural produce could be conveyed across such a ridge of hills is of course a serious undertaking for so young a community. It unfortunately happens, also, that two rivers, the Avon and Heathcote, which unite and form a shallow estuary to the north of the peninsula, have a bar at the mouth which frequently stops all ingress or egress for days together. The next river to the north, the Waimakariri, though it also has a bar mouth, is navigable by small coasters for some miles, and on it has lately arisen the town of Kaiapoi. With the exception of the above and the Cust and Halswell, the other rivers of the province, the Ashley, Selwyn, Hurunui, Rakaia, Ashburton, Waitangi, Rangitata, &c., are rapid torrents, forming obstacles, rather than facilities, for transport of goods or communication.

No more desolate scene can be easily witnessed than is presented to the solitary horseman who has to ford one of the wider of these streams, such as the Waimakariri or the Rakaia. After descending from one or two high terraces by very steep slopes, which appear to have been ancient banks to the river, you come to the present bank, from which you behold a wilderness of shingle and sand of perhaps a mile wide, with separate streams meandering through it. It is necessary to be very cautious in determining whether the river is sufficiently low to be crossed, or whether, from the melting of snow in the mountains, it is swollen; for such is the rapidity of the streams, and such their icy coldness, that if of above a certain depth, the horse would be swept off his feet, and the rider probably be benumbed and perish. They thus become impassable, except at a ferry, for weeks together at certain times of the year. On descending into the shingly bed, often composed of stones of the size of a man's head, as the horse plods his way slowly over the boulders, or through sand-drifts, and over banks of shingle, the stranger is struck with the utter desolation of the scene, appearing as if left by an infuriated torrent, which has swept down and half buried the trees, whose bleached and withered arms appear here and there sticking out of the shingle, amidst a mass of reeds or withered grass. The wailing of the sea birds which soar about adds to the impression, as if they were anticipating a feast on the adventurous traveller, and the peculiar cry of the Paradise duck, as he rises from a pool, seems to show how seldom a traveller disturbs the solitude; and sometimes a strong wind rushing down the river bed, carries with it such a constant cloud of sand, that objects are invisible beyond a short distance.

Arriving now at the brink of the first stream, into which the river is divided, the experienced eye will determine by the water being clear or discoloured, whether it is in a state to be crossed, or whether the snow-water makes it white and turbid. In the former case, he proceeds to ride slowly up the stream, avoiding the still current, where it is deep, and selecting a place where the water ripples over a shallow bed. Having entered the stream, the swiftness with which it dashes past, roaring over the stony bottom and splashing against the horse, is apt to make the rider giddy; and, except by keeping the eyes fixed on the opposite bank, it is very difficult at first to know whether the horse is advancing or going backwards, or sideways, so that the sensation is by no means agreeable, and it is a considerable relief to gain the opposite side.

Having crossed one stream in this way, another tract of shingle has to be passed, and another stream to be forded, (avoiding quicksands), and so on, sometimes to the number of eight or nine. It may be conceived how tedious an operation the passage of such a river must be, extending, perhaps, to a mile between the banks, whilst the distance actually traversed is much greater, especially with a dray loaded with bales of wool or other produce. Already, ferries have been established at deeper parts of the rivers where they flow in one channel; but the construction of bridges over streams of such a width and swiftness, and subject to sudden and considerable floods, must be deferred probably for many years.

Having thus given a general idea of the nature of the country, we may proceed to note some of the features of its natural history. The most striking fact seems to be the great paucity of animated beings composing the native fauna. Of terrestrial mammalia, a small rat (or vole) is the sole representative, and this is being exterminated by that formidable invader the Norway rat, which has been imported in ships. The herbage and climate are favourable to the increase of the ruminants, as well as of the horse, the hog, the dog, &c., which have been introduced by Europeans, and would probably prove equally so to deer, hares, and rabbits, and many other quadrupeds. It seems a very singular fact, that it should have remained for ages untenanted, and ready to support at any moment a vast amount of the useful animals which accompany man. The only quadrupeds now wild, which have been introduced, are a few dogs, which have escaped, and in unfrequented arts pare dangerous to the flocks;—and pigs, which have become very numerous in the swamps, and afford a considerable supply of meat to cattle stations, on which they abound. When Captain Cook discovered this island, he found the natives in possession of dogs, and he introduced swine.

Of birds, the supply is more considerable. The water-birds assemble in immense flocks on the lagoons, and particularly on Lake Ellesmere; but as to the number of species, we have no exact information. The ducks are excellent eating; one of them, called the gray duck, is something like our wild duck, another, a shoveller (*Spatula rhynchotis*), one like a teal, and a widgeon. There are also numerous shags, or small cormorants—a black, a bronze green, and a gray species (*G. punctatus*)—and several gulls, terns, and stilts (*Himantopus novæ zelandiæ* and *H. leucocephalus*). The very handsome bird called the Paradise duck (*Casarca variegata*), but which in fact is a small goose, is of a more domesticated nature, frequenting ploughed lands, as does also a ring dottrel, closely resembling the English species (*Charadrius torquatula* or *bicinata*). One of the terns and an oyster catcher, also a large gull, come some distance inland.

It is singular that no species of snipe frequents the numerous swamps, which appear so well adapted to their habits. A very handsome bird, called the water-hen, by the natives pukeko (*Porphyrio melanotus*), is plentiful amongst the bulrush swamps. A beautiful white *crane*, as it is called, native name kotuku (*E. flavirostris*, Wagler), is occasionally seen soaring at a distance, relieved by the purple of the hills behind. It is of the most pure and snowy whiteness. There are also some small birds in the swamps, one of which has a very peculiar note, exactly like the squeaking of the iron wheel of a plough, or of a wheel-barrow which wants grease. Another, frequenting the same locality, has a very distinct, short song, which it constantly reiterates, and seems to stop short in the midst. Some idea may be given of it by saying that it sings the first nine notes of the Agnes Polka; thus,

A bittern, native name, matuku (*Botaurus melanotus*), is occasionally seen in the swamps; also a grebe (*Podiceps rubipectus*).

In the open plains, the land birds seem to be confined to the quail (*Coturnix novæ zelandiæ*), a buzzard hawk, probably *Circus assimilis* (Jard. and Selb.), and the commonest of all, a sort of ground lark, kotiki (*Anthus australis*). The quails, which a few years since were very numerous, seem to be rapidly diminishing, being destroyed by the wide-spreading fires by which the coarser herbage is burnt off, and also by the shepherds' dogs. Perhaps when corn fields cover large tracts of country, the quails will return. In the meanwhile, a gentleman at Christchurch has, we trust, introduced the partridge, several broods having been reared under hens, and turned out in stubble fields. The pheasant also has been successfully introduced in some of the forests in Banks' Peninsula, where it seems to be naturalized. The hawk or buzzard above mentioned is abundant; it feeds on rats, and on the carcases of sheep and lambs. The ground-lark resembles in its appearance a wagtail. It has a peculiar propensity for running along the ground just in front of a person on horseback or on foot, and will sometimes go on for miles, flying a short distance when nearly overtaken, and again alighting and running, turning its head from side to side to look behind. It is a very familiar bird, and replaces in that respect the sparrow or robin at home. Of the gigantic moa (*Dinornis*), as already observed, numerous bones have been found near the embouchure of the Avon. "Moa-bone Point" is named from them. Besides bones, there are found on parts of the plains little heaps of rounded agates and quartz pebbles (far distant from any rocks of that nature), which are popularly called "Moa stones," and are supposed to be the contents of the gizzards of those birds which have died at the places where these heaps are found.

On entering the bush, or native forest, the ear, so unaccustomed to the "sweet charm of birds," is delighted by the lively and melodious notes of the tui or parson-bird (*Prosthemadera novæ zelandiæ*). The song is not so varied but is more liquid than that of the thrush, which it somewhat resembles. It is very pretty to see these birds, when the yellow Clianthus (*C. puniceus*) is in flower, hanging in graceful attitudes to suck the honey from the blossoms. A beautiful little fan-tailed fly-catcher, which seems to be of the genus *Rhipidura* (Gould), flits like a large butterfly close round your head, and perches on a neighbouring shrub. There is a another beautiful little bird, with black head, yellow breast, and white on the wings and root of tail. The parrot—(of which the native name ka-ka, pronounced *kaw-kaw*, indicates the sound of its note), (*Nestor hypopolius*, Gould)—is seen seated on the topmost branches of some lofty pine. There is also a small parrot (*Platycercus novæ zelandiæ*). Pigeons are plentiful, fat and very good eating (*Carpaphaga novæ zelandiæ*). The New Zealand crow, kokako (*Caleas* or *Glaucopis cinerea*), with red wattles hanging from each side of his neck, we have found so full of a purple-coloured berry, that the whole intestines were stained with the juice, and the whole bird smelt strongly of it. The elegant little cuckoo—pipi-warau-roa (*Chrysococcyx lucidus*) —appears in spring. It is said to have the same intrusive disposition as its larger congener in Europe, and to lay its eggs in the nest of the fan-tailed fly-catcher. There is also a larger cuckoo (*Eudynomys fasciatus*, Forster). A singular bird called the woodhen, by the natives wika (*Ocydromus australis*), is so ill provided with wings that it can only run on the ground. It lays its eggs under a fallen tree or an old stump. Its mode of defence when about to be seized is a most unearthly scream, which, it is said, will terrify the most savage dog when unaccustomed to it, and make him retreat in fear. It has the mischievous disposition of the magpie, entering the tent of a traveller at night, carrying off any small articles, and letting them drop here and there. Two gentlemen were occupying a tent by the side of a bush, and one of them, very early in the morning, heard his companion, in a drowsy voice, saying, "Get away, get away;" and looking out, saw that his friend's slumbers were broken by a *wika* pecking the flies off his head as he lay on the ground. This bird is remarkably fat, its skin, which is very thick, being lined with a solid coating of grease, so that only its legs can be eaten, which are said to be excellent. There is also a hawk, karewarua (*Falco novæ zelandiæ*), and a handsome kingfisher (*Halcyon sanctus*). The bellbird is also found; and doubtless there are a variety of other birds in the forests with which we are still unacquainted.

Reptiles are happily confined to a small harmless lizard. It has often struck us as a matter of congratulation, when trudging through high ferns and shrubs up to the middle, where probably no human foot had trodden before, that one might fearlessly proceed without the risk of dislodging some venomous snake, noxious animal, or even a nest of spiteful insects. The immunity indeed enjoyed in that part of New Zealand from any kind of destructive, and from most kinds of troublesome birds, insects, or animals (the rat being almost the only exception), is very remarkable. Thus neither the farmer nor the gardener see their crops destroyed by plundering birds or eaten off by mice; they are undisturbed by the mole, the rabbit, or the hare; their poultry is safe from the polecat, the weasel, and the fox; their beasts—sheep, horses, &c.—never feel the stings of various flies; their corn fears not the wireworm, nor their turnips the beetle, nor their vegetables and flowers the attacks of slugs and snails; their fruit falls not a prey to wasps. The only exceptions we know to the general absence of these insects, is, that at a certain season a caterpillar is very destructive; but the remedy for this is to have crops either too forward or not sufficiently advanced at that short season of the year when the insects prevail, to be injured by their attacks.

But to return from this digression. The fresh-water fish do not seem very various. It will be perceived, by the description already given of some of the rivers, that neither fish nor the food for them can exist in such furious torrents as the Waimakariri, Raikaia, &c., at least only in the lower part of their course, where they become more tranquil on approaching the sea. In the Avon, Heathcote, Halswell, and in what are called creeks—*i. e.*, deep, narrow streams of clear water, generally flowing out of swamps—there are abundance of eels, some of which attain a great size, up, it is said, to twenty pounds weight. The natives catch great numbers, and dry them for winter provision.

The colonist is generally too much occupied to devote much time to the peaceful pursuits of the angler. We may, therefore, do injustice to the wealth of the rivers and streams in attempting to give a list of the fresh-water fish; but it must be understood that we only mention those which have come under our personal observation in the Avon and Heathcote. These are the white-bait, which is very transparent when alive, but when boiled becomes opaque. There is also a bull-trout, and shoals of smelts, with the peculiar taste of cucumber belonging to that fish. In the Heathcote, and within reach of the tide, are caught flounders and a sort of herring, which are very abundant; and also the smelts. There are also a fresh-water shrimp and large cray-fish. There are abundance of sea-fish of several sorts in the harbour and along the coast, but no one finds it worth their while as yet to make a business of catching or curing them. The sperm whale frequents the coasts, as well as numerous sharks. There are also cuttle-fish; and the natives have a legend, like one of the old Norwegian tales, of a gigantic cuttle-fish twining its arms round a canoe and drawing it under water. Of the sea shells we regret not to be able to give any account. Mussels are very abundant, and some grow to a very large size, and furnish, with the cockles, a great article of food to the natives. Small rock oysters are also abundant, and a large shell, called from its shape the *ear-shell*, containing a purple-black fish, which the natives eat. They are sought for the sake of the mother-of-pearl with which they are lined, under the name of paua-shells, and large quantities are exported. A large periwinkle, with a green, stony operculum, abounds. Shrimps and crabs are abundant. A polype, with a stem like a pentacrinite, abounds. Laver, with several kinds of handsome sea-weeds, grow in Lyttelton harbour.

As, however, we may get out of our depth here, we will return to dry land, and observe the native vegetable productions of the plains. The general aspect of the vegetation strikes a stranger as remarkably English—the fern, interspersed with grass, daisies, buttercups, slender-stalked flowers resembling campanulas, ragweeds, cranes'-bills, &c., have all an English character, though the rustling leaves of the *Phormium tenax* and a species of Dragon-tree (*Cordyline* or *Dracæna australis*), resembling a yucca with a high stem, remind him that he is in a different country. On examining more closely, we find the daisy (*Bellis geifolia*), a very small and delicate representative of its northern congener; also a very small land-cress, growing thick and close to the ground, with other larger kinds. The English water-cress has spread and thriven luxuriantly, and there is also another kind which grows under water, and is very delicate in taste, but, from its having long petioles and small leaves, is less agreeable to eat. Pursuing our walk along the river bank, we admire the dark-green leaves of the native flax (*Phormium tenax*), gracefully nodding over the water, and its spike, of deep maroon-red flowers, rising stiffly in the midst. Fine tufts of the large toi-toi grass (*Cordyline indivisa ?*) wave their heads like ostrich plumes in the breeze, six or seven feet in height, whilst their root-leaves droop in long tresses on all sides, their serrated edges inflicting a deep gash in the hand which should incautiously seize them. In the water, where it is shallow, grows a very curious sort of grass-like plant, from two to four feet high, and as thick as a child's body, with a tuft of grass at the top. The interior of the stem consists of a loosely-compacted bundle of tubular fibres, the outside being black, forming a very singular and grotesque-looking plant, familiarly called negro-heads or maori-heads. Amongst the minor flowers will be observed the pretty white-flowered perennial flax (*Linum monogynum*), like the yellow garden linum, only white and more shrubby; also two or three sorts of ranunculus and cranes'-bill (*Geranium*), as well as a very minute-flowered pelargonium (*P. clandestinum*). Species of willow-herb (*Epilobium*) also are found. A large sort of fern grows in localities by the river sides. A kind of celery also grows in moist places, which Captain Cook used in large quantities. On the hills between Lyttelton and the plains, a very pretty yellow

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oxalis (*O. corniculata*) grows in close tufts on the rocks, and some species of gnaphalium, with woolly glaucous leaves, as well as a minute daisy, before described. Along the cliffs above the port are gay yellow ragworts, with thick succulent leaves, and a pink-flowered mesembryanthemum (*M. australe*). A species of convolvulus, or Ipomœa—the kumerahoa—is cultivated by the natives, who eat the root. Being very tender, it appears to be a plant brought by them from a warmer climate. In some parts, especially about abandoned native pas or villages, great quantities of a sort of brassica grow wild, the young shoots of which make, when dressed, a palatable vegetable, and in some soils the root is somewhat tuberous and edible. It seems probable that it may be the Swedish turnip degenerated by sowing itself without cultivation, as Captain Cook is known to have introduced many vegetables into this island. Amongst plants resembling English ones may be mentioned a dock and a rough-leaved chickweed, and the sow-thistle. Mushrooms also abound, exactly like our own. A white violet (*V. filicaulis*), without scent, is very like the English dog-violet. There are numerous species of chenopodium—one very handsome, with the whole leaf bright red—brighter than that of the prince's feather; another with the upper surface green, and the lower a bright purple, with several smaller ones. A handsome saxifrage (*Donatia ?*), with racemes of white flowers and a green leaf with a reddish-brown edge, grows on the peninsula hills. One white convolvulus, much like our own (*C. Sepium*), and another growing in the bushes, with a small yellow flower, were observed; also one with a beautiful pink flower of a fleshy consistency, and with a leaf like that of the ivy-leavedg eranium (*C. Soldanella*), which creeps on the sand on the sea-shore.

The native grasses are numerous, and, where not too heavily stocked, they will fatten cattle and keep horses in good condition. Not many appear suited to form permanent pastures, as they are for the most part annuals. One of the perennial grasses is very luxuriant, growing to a height of three or four feet, with broad leaves and a succulent stem, which, when crushed in the hand, are very fragrant, like sweet-scented vernal grass or woodruff. From its continuing green through the winter, and flowering very early in the spring, long before any other grass, it might perhaps, if it would stand our climate, be worth introducing. The flower seems to resemble that of *Festuca*, though considerably larger than that of *Festuca pratensis*. Another grass has a flower like that of *Bromus asper*, which breaking off when dry, and adhering to others as it is blown over the plains, forms at last large balls, which bound along before the wind, racing over the wide expanse with headlong speed, like the " Steppe-witch" in Southern Russia.

Leaving the open plains, and entering one of the native bushes or forests, when we have passed the unsightly dead stems which have been killed either by fire or from being barked to thatch the native huts, we find ourselves amidst towering pines, running up with clean stems to a great height, with an under-growth of beautiful evergreens, supple-jacks, &c. The great variety and beauty of the evergreen shrubs and trees is the most striking feature of the vegetation of these parts. The timber trees in the forests near the sea are chiefly the white pine (*Podocarpus dacrydioides*), the black pine (*P. spicata*), and the totara (*P. Totara*). The first is a white, soft wood, like American deal, fit for floor-boards and in-door purposes, the limbs, which are sold as firewood, being exceedingly tough to split or saw, and inferior as fuel. It also shrinks or expands much with dryness or moisture, not only across the grain but longitudinally. The black pine is a heavy wood, stands better as post and railing, and makes handsome furniture; it is also easily split, and throws out a good heat, so as to be worth nearly double the same quantity of white pine as fuel. The totara makes excellent timber for building, paling, shingling roofs, floor-boards, and fuel. All these trees grow to a great size.

In the woods in the peninsula grows the manuka (*Leptospermum scoparium*), the wood of which is valuable from possessing qualities like the ash. It is consequently used for axe and tool handles, spokes of wheels, poles for drays, &c., and is excellent firewood, giving more heat, we believe, than any other. As before mentioned, it is also very pretty as a shrub, flowering and producing perfect seed when not above two feet high. The aromatic leaves are used for tea, as was done by Captain Cook. Another valuable tree is the goi, or yellow clianthus (*C. puniceus*). The wood is hard, and applicable to the same purposes as the last-mentioned, and its graceful pinnate leaves and pretty flowers render it a favourite. A handsome, hard, deep-coloured wood is furnished by the hackiack, as it is called by the natives, of which having no dried specimen we have been unable to obtain the scientific name. It is a tree with thick, dark evergreen foliage, the leaves being stout and crumpled, about the size of those of the sweet bay.

In the forests which clothe the hills, at the base of the high mountains, the sorts of trees differ from those which form the woods near the sea, but we regret never having had the opportunity of examining them except in a cursory manner. Harewood, Alford, and Talbot forests, and others, extending for many miles, as yet almost untouched by the hand of man, would be far more interesting to a lover of nature than the poor remnants of woods which survive in the neighbourhood of the port and capital towns. The natives seem never to have gone far from the coast, so that these magnificent forests have not been exposed to destructive fires, but flourish in all their native luxuriance, not surrounded by the withered skeletons and stems of trees, but overshadowing the grassy plain with their pendant branches to the very outside. Near the hospitable house of a settler on the outskirts of Harewood forest, we enjoyed the pleasure of seeing the rapid channel of the river Eyre emerging from between steep banks, clothed with fine trees and evergreens, which drooped their branches into the stream. This gentleman has had the good taste, in felling timber for building and fuel, not to make a hideous waste of bare stumps, as is too often done, but to leave the beautiful evergreen shrubs, which would be highly prized in any nobleman's grounds, and so to cut the trees as to form walks and roads winding down the bank of the river, on which the ornamental Paradise-duck may be seen floating, whilst parrots, wood-pigeons, and other birds sport amongst the trees, making a scene of which the proprietors of many fine places in England would be justly proud.

The principal timber in this forest, where from its elevation the climate is colder than near Christchurch, seemed to be the black birch (*Fagus Solandri*, Hook. fil.), a useful wood, but not so valuable as some of those above mentioned. There also is found the beautiful pendulous red pine (*Dacrydium cupressinum*), of which there is a good specimen in Kew Gardens, the delicate, drooping spray forming as it were an evergreen fountain. There is also the singular umbrella tree of the colonists (*Aralia crassifolia*), which grows also in the woods near the sea. The native name is *horoeka*. When young it has no branches; but the thick, narrow, strap-shaped leaves (about two feet in length and half an inch wide), with blunt serratures about an inch apart, spring directly from the straight stem, and hang downwards on all sides. When about fifteen or twenty feet high it begins to branch, and the leaves take an upright direction like those of other plants, and gradually become quite of a different shape, shorter and broader. The Fuchsia (*F. excorticata*) forms a tree with a stem three feet in circumference, spirally twisted, exceedingly difficult to split, and useless for firewood. It bears a small green flower with a bluish-red corolla.

The shrubs, as before observed, comprise a great variety of beautiful evergreens, some attaining the size of trees, and of different hues and character of foliage. Near the sea-coast there is a very ornamental sort called the niho, with spotted leaves something like those of the *Aucuba japonica*, but smaller, and when held to the light transparent where the spots are. Here also grows a shrub, called by the natives bulbul (*Solanum aviculare*), with handsome, deeply-cut leaves, and bearing a yellow fruit, which is eaten. Both these last-mentioned shrubs are very tender, and are killed by frost when removed from the sea-side, but there flourish in every garden. Along the river banks are three sorts of very pretty and fragrant shrubby veronicas, called coromico by the natives (*V. salicifolia*, Forst., *V. parviflora*, Vahl., and *V. lævis*, Benth.). The first two are easily transplanted, and soon make the cottage gardens gay and sweet with thick spikes of flower five or six inches in length. One of the handsomest of the larger evergreens has digitate leaves like those of the horse-chestnut, each foot-stalk having seven larger and two smaller leaves, but of which we have not ascertained the name. In moist places grows the *Coprosma robusta* (Raoul), having leaves something like laurustinus in hue and shape, and bearing red berries with two stones in each. Another of the same genus, but very different in the light-yellow-green of its leaves and yellow flowers, is the *Coprosma lucida* (Forst.). A third, very different from either, forms a thick bush in swamps, with minute, thickly-set leaves, bearing a transparent berry like that of the mistletoe, which ripens of a lilac blue (*Coprosma fœtidissima*, Forst.). The *Panax arborea* has umbellate flowers, springing from the axil of a compound leaf of five leaflets, dark, stout, and serrated. It flowers in July,—that is, in mid-winter.

A shrub abounds in some parts of the plains and of the hills of the peninsula having remarkable properties. It is called by the colonists *toot*, from the native name *tu-tu* (*Coriaria ruscifolia*). This has caused the loss of many valuable animals to the colonists. If eaten by sheep and cattle not habituated to it, particularly when fresh-landed from shipboard, or even at any time with an empty stomach, it causes violent vertigo, and they soon fall down and die, the stomach being greatly distended. It is probably by this that the sheep and goats were killed which Captain Cook attempted to introduce, and which he records as having died apparently from poison. The general remedy is to bleed them in the mouth, but belladonna is said to be an antidote administered internally. The shrub is killed to the ground in winter in exposed situations, and when shooting up in spring its young stems resemble asparagus, being at first without leaves. The natives make wine of the berries, which are black, like currants, and full of small seeds, and if eaten in any quantity produce the same effects on human beings as the foliage does on animals. The toot land requires much labour in grubbing up its stout roots, but is of strong quality and very fertile. Another evergreen, with delicate foliage, bearing a bunch of small greenish-white flowers like those of *Olea fragrans*, is supposed to be *Pittosporum eugenioides* (A. Cunn.). Another of the same genus (*P. tenuifolium*) is a handsome, compact shrub, bearing small flowers of a rich claret colour; the fruit something like that of a spindle-tree, splitting open, and the seeds hanging naked as in that tree; the leaves about the size of the birch.

The pepper-tree (*Drimys axillaris*) is so called from its round black seeds being used for pepper; the leaves are of a handsome blue-lilac colour on the under side, and their taste is hot and spicy. The *Corokia Cotoneaster* has bundles of minute leaves, which, with their petioles, are shaped like a battledore, white beneath. On the sandy islands, in river beds, a beautiful shrub, of a stiff, compact character grows, the *Cassinia Vauvilliersii*, crowded with minute yellow-green leaves, the under side orange-coloured, resembling those of a heath.

In spring the whole air of the dry plains is scented with the fragrant flowers of a plant having the appearance of an epacris (*Leucopogon Frazeri*, A. Cunn.); the flowers are white, with pink tips; the leaves terminate in sharp spines. It bears a sweet berry of an apricot colour, much liked by children. Amongst the grass and fern is commonly found a plant having the appearance of a broom, bearing minute pea-shaped lilac flowers, thickly pencilled with a darker shade of the same (*Carmichaelia australis*). It has peculiar flat branches, almost without leaves; and though very tough and woody, horses are so fond of it as to tear off the shoots with their teeth.

Besides many other trees and shrubs in the forest of which we have no specimens—such as *Elæocarpus Hookerianus*, &c. —there are various climbing plants, which pass under the general name of supple-jacks. One of great elegance (*Parsonsia heterophylla*) bears bunches of small opaque white flowers, resembling in shape those of the white Persian lilac, and sweet-scented. The opposite leaves, of a myrtle-green, are some of them long, heart-shaped, and others pointed oval, whence the specific name. The seed-vessel is a long, twisted pod, measuring about seven inches, and full of long-shaped seeds winged with down.

A great ornament to the forest is the *Clematis indivisa*, which climbs up amongst the branches of the tall evergreens, and throws its wreaths of large white flowers over their tops, producing a beautiful effect, as if the flowers belonged to the tree itself. There appears to be another species, with leaves deeply lobed, and very handsome.

The *Rubus australis* with its stems and the long petioles of its leaves furnished with hooked thorns, is a formidable impediment to progress, and from its retentive and entangling properties is commonly known as the "bush-lawyer." Another climber is not above the thickness of stout whipcord, with very narrow leaves, nearly three inches long, waved on each edge. Running over the ground, and climbing up the stems of trees, throwing out rootlets like ivy, is a shrub with small opposite leaves, like those of the small-leaved myrtle (*Metrosideros hypericifolia*, A. Cunn.)

The woods abound with a great variety of pretty ferns besides the tree-fern (*Dicksonia*). One which would hardly be supposed to be a fern, with a fleshy, entire leaf, grows amidst the moss on dead wood. It resembles in character the *Acrostichum simplex* figured in Loddiges' Botanical Cabinet, Vol. viii., No. 709. Another fern, with a large, deeply-lobed, dark green leaf, grows on stems of live trees, climbing up amongst the moss. One, we have already mentioned, grows along river sides. The common fern on the open plains and hills resembles in general character our common bracken (*Pteris aquilina*), but is of a stiffer consistency. A great variety of ferns —many of great beauty and delicacy—flourish under the moist shade of the woods; one is viviparous, having young plants growing on the fronds.

Pools of stagnant water are often covered with a beautiful mantle of the richest crimson and green, like velvet, which, on examination, is found to be composed of a mass of a floating plant, the *Azolla rubra*.

A very singular fungus grows in moist places forming a hollow globe of open meshes, each mesh an inch or more in diameter. It has a very offensive smell like our carrion fungus. The ramifications of the network are pure white, wrinkled and attached to the ground by a very slight connection. It is the *Ileodictyon cibarium*.

Of the climate, it is of course impossible to give accurate details from a residence of only a few months, particularly as the short period during which this country has been colonized has not supplied a sufficiently lengthened course of recorded observations. We heard it once described, pretty correctly, in a general way, by an old resident, as a "convulsive sort of climate," meaning that it was liable to sudden and violent changes. Another described it as "most heavenly when it's fine; but when it's bad weather the most abominable." Nothing in fact can be conceived more delightful than the early summer morning (say from 5 to 9 or 10 o'clock A.M.), when through the transparent atmosphere, and against the clear blue sky, the lofty chain of Alps are seen in all their grandeur, extending for an immense distance from the Kaikoras in the N.E., far away down to the southward, as if carved in marble; on the other side the soft rounded green hills of the peninsula forming an agreeable contrast. The air is then still and deliciously fragrant, whilst the bright gay sunshine is still tempered by the coolness of the night. It is then that the mirage plays most fantastic tricks with the coast line and the swamps and sandhills, presenting tempting pictures of fine forests, which, had they any existence, would be worth L.100 an acre, and often making visible others, with rivers, &c., which in truth are below the horizon. Usually between 10 and 11 A.M., this stillness is interrupted by a lively breeze, which, if it proceed from the N.W., is of a hot parching character, injurious to vegetation, and accompanied by stifling clouds of dust from every road or bare piece of ground, along the river beds, &c. At other times it is a sea-breeze from the N.N.E. and not disagreeable.

The phenomenon of this hot wind, blowing as it does directly from a mass of snowy mountains, at no great distance, appears paradoxical. An explanation of it has been given by a colonist of scientific acquirements, which seems a just one. It is pretty evident that this hot dry wind cannot come from the continent of Australia across fifteen hundred miles of ocean. On the contrary, it arrives on the coast of New Zealand charged with moisture from the sea, and suddenly coming in contact with the snowy peaks which rise very near the west coast, an immediate and copious deposition of moisture by condensation there takes place, by which much latent heat is evolved, and thus the wind becomes hot and dry, and rushes over the intervening plain to seaward on the east coast. It is a fact corroborative of this suggestion that the hot north-west wind is always accompanied by a hazy atmosphere over the mountains, as if rain were falling there, and that the rivers which issue from them become, under its influence, swollen by the melting of the snow, &c.

For several weeks together in summer there are periods of very fine settled weather, only subject to occasional hot winds. The bad weather comes from the south-west, especially in winter. These storms come on very suddenly and with great violence. We have been riding in a westerly direction with the wind towards the north and a clear sky, when a small collection of cumuli was observed in the south-west, which has rapidly extended and advanced towards us. If, at the same time, the point of the peninsula hills towards the sea is obscured by mist, it is pretty certain that a storm is at hand. The sky may still continue clear overhead and towards the north and east, from which quarter the lower current of wind blows steadily, feeling dry and warm, when suddenly it chops round to a contrary direction, and sweeps the cold rain in torrents directly in our faces, so that the horses almost refuse to meet it. So bitterly cold is the rain from the south-west that men have perished when unexpectedly caught in it, as happened in the first storm of the winter of 1854, on the 15th of May, which came on about four in the afternoon, in which three people were lost, and others had narrow escapes. The suddenness of these storms is expressed by the colonial name of "Southerly Bursters." They generally last about three days, clearing up in the course of the third; but if they continue beyond this period, they often last the greater part of six days. From the south-east there is occasionally thick drizzling rain for some days at a time, and there seems no particular period during which rain from that quarter is observed to continue. Notwithstanding the large quantity of rain which falls at these times, the yearly average does not exceed 25 inches, which is about the same as in Middlesex.

In December 1853 we find five days recorded in our journal on which some rain fell during the course of the twenty-four hours, and in January 1854 only one day; on April 20 we have an entry "first rain for an immense time." During fine weather the clearness of the atmosphere is very remarkable, none of that soft mist which constantly veils the distance in England being present, everything within the range of vision appearing sharply and distinctly defined. From the same cause the moonlight is most brilliant, and the rainbows appearing to rest on the peninsula hills display the brightest hues which we have ever witnessed. Probably also from this cause there is seldom any closeness, or even balmy softness in the night air, for even in the height of summer, immediately after sundown, a sharpness is perceived much greater than after a hot day in England.

Partly from this cause, and partly probably from the proximity of snowy mountains, spring and autumn frosts at night disappoint the expectations of the gardener in rearing tender crops at those seasons. In winter also the frost is often of considerable intensity at night. In 1854 we find it recorded that the first frost occurred on the night of April 17, when the minimum thermometer, under shelter, marked 30°, and potatoes, tomatoes, &c., were affected, It was not lower than that till May 9th, when it marked 27°, and the high mountains were covered with snow. On the 14th of May it is registered at 26°. After that till the middle of June it does not seem to have reached the freezing point. Towards the end of July and beginning of August was the coldest weather, when on one or two occasions the thermometer fell to its minimum for the year, which was 22°. As it is only in very clear weather that it freezes at night, the sun during the day has such power that the ground becomes quite soft by about ten o'clock A.M., and even in the shade very seldom remains frozen for a whole day. There was one fall of snow about Christchurch during the coldest weather last year, which all melted in the course of the day. Higher up the country, near the hills, the cold is much greater. There the snow remained on the ground for about a fortnight, but we have no precise observations relating to parts at a distance from the sea. The winter lambing of ewes, however, where, from want of proper arrangements, this took place, was very precarious, and without great attention in sheltering them, and housing the young lambs, serious losses from cold occurred. In reference to the staple production of the country, the circumstances of its climate indicate that before the settler encumbers himself either with stock or agricultural produce, he should take the precaution of securing himself from loss by providing proper protection against the weather, from the neglect of which disappointment often ensues. For instance, if there are not proper paddocks for rams, &c., fenced in, the consequence is lambing twice a year in an irregular manner, and with great loss from storms, &c. So also if crops are grown without proper provision for threshing, storing the grain, &c., much loss from weather and vermin will ensue. In a new colony, labour, when most wanted, cannot perhaps be procured, and things cannot be done on the spur of the moment as in an old country. A person having a threshing machine might intend to thresh his corn in the field without even stacking it, which might have been done (if hands to work it could have been hired) at the harvest of 1854 ; but on inquiring for sacks he would at that time have found that there were none at all to be got in the settlement, and perhaps he would have provided no granary or other secure place to store his grain.

To conclude these remarks on the temperature of the settlement I append the result of observations recorded for six months, with considerable regularity by means of a self-registering thermometer, suspended under a verandah in the shade, and also the mean of observations at half-past eight in the morning, for the sake of comparison, as it was found by hourly observations taken at the Bay of Islands, that the mean of those taken at that hour represented accurately the mean temperature of the whole twenty-four hours. It will be seen, however, that, as might be expected, the same does not hold good in a latitude so far south of that position as Canterbury.

1853.		Mean of Maximum.	Mean of Minimum.	Mean of Max. & Min.	Mean at 8½ A.M.
Spring Months.	August, 18 last days,	53°·25	36°·58	44°·91	42°·0
	September, . . .	56°·0	39°·60	46°·30	45°·32
	October, ...	61°·0	41°·0	51°·0	51°·0
Summer Months.	November, . . .	65°·3	42°·5	53°·9	56°·6
	December, . . .	67°·5	47°·5	57°·5	58°·76
	1854.				
	January, . . .	75°·3	52°·8	64°·5	63°·9
Mean of summer temperature		69°·36	47°·60	58°·63	59°·75
February, first 10 days,		81°·6	51°·1	66°·3	61°·4
		The other days of February would of course have considerably diminished these means.			

The highest summer temperature in 1854 was marked on 12th January, when the maximum thermometer registered 92°. The next highest was during a hot wind on 7th February, when it reached 90°, and the next 16th Jan., 87°; during the rest of the summer it seldom reached 80°. The greatest cold in July, as before observed, was 22°.

Notwithstanding the quantity of land which in its state of nature is during more than half the year flooded to a slight depth, constituting what is called by the colonists *swamps*, it does not there produce any unhealthy miasma. No agues or intermittent fevers prevail, and the country is esteemed very healthy for young and old, though land similarly situated in Italy would be uninhabitable from malaria during the greater part of the year. The raupo swamps, in which the bulrush grows, are totally impassable except by particular tracks; but the flax swamps are generally sound at bottom, though laborious for a horse to traverse, and generally admit of easy drainage.

Storms of thunder and lightning seem never to pass over the plains, whence they may be seen at a distance discharging their fury amongst the mountains or the hills of the peninsula. The fearful earthquakes which have visited the province of Wellington in the Northern Island, near which is the great volcano of Tongariro, are very slightly felt at Canterbury, and have never done any damage there.

It may be expected that some mention should be made of the native race of men which is found sparsely scattered along the east and north coasts of this island. The whole native population of the province of Canterbury does not exceed a few hundreds, and they seem never to have occupied any part of the country at a distance from the coast, where alone they could supply themselves with the simple articles of food on which they formerly depended. These scattered communities seem to have degenerated since their separation from the main body of their tribes in the northern island, by whose hostile attacks they were exposed to great suffering. In short, it appears wonderful how a few helpless men, women, and children, thrown upon this coast, where the land naturally produced no animals useful for food, and very few edible vegetables, without iron tools, could have existed. They seem to have had recourse chiefly to the fish which they managed to catch in estuaries by means of stake-nets woven from the *Phormium tenax*,—the invaluable plant from which their dresses were made, as well as mats, sails, &c. They could also secure, by spearing them or catching them in springes, wood-pigeons, parrots, the woodhen, the apteryx, and other birds. When Captain Cook visited them they kept a few dogs, which were an article of food, and which probably supported themselves by catching birds. That great navigator introduced pigs and fowls amongst them, and attempted to stock the island with sheep and goats, but they were found poisoned, probably by eating the shrub called *toot*, formerly described.

For vegetables, they eat the fern root peeled and beaten, also the pith from the heart of the Ti-palm ; and Captain Cook mentions his men having eaten celery and cress, which still grow wild. The only plant they seem to have cultivated is a sort of convolvulus, the *kumerahoa*. A chief article of food seems to have been the mussels and cockles, which are very fine, of the shells of which great heaps are found, as well as holes in which they baked birds by means of hot stones, which they potted in their fat and preserved for winter. Eels are also caught in great numbers by means of eel-pots formed of the native flax, and by lines. These are a fine species of silver eel, which sometimes exceeds twenty pounds in weight.

They are dried and preserved for winter stock. Large maggots found in trees are considered a delicacy by the natives. The only tools by which trees could be felled and cut up for building, or hollowed out into canoes, or elaborately ornamented with carving, were made of stone ground to an edge, or sharks' teeth.

From the above sketch of their primitive condition, it may be imagined what vast improvement in their physical circumstances (independently of their moral improvement, of which it is not our present purpose to speak) must have resulted from the colonization of the country by a European population, provided with all the appliances and comforts of civilization. Ample reserves have been allotted to them on the banks of rivers or on the shores of bays, comprising abundance of valuable timber and fertile land. Most of them are now dressed in European clothing, the men often as well as superior mechanics or gamekeepers in England; some few with gold chains, frock coats, &c., equal to those worn by the best-dressed Europeans. The women seem more negligent in their apparel, generally paying attention to their sleek black hair, but wearing often an incongruous mixture of clothing, and frequently barefooted. The great object of ambition seems to be to possess a fine horse, for which they frequently give from fifty to sixty guineas, and equip with well-appointed bridle and saddle. At the races at Christchurch in 1854, one was won by a horse owned by a Maori, but ridden by an English groom, and another by a native in shoes and trousers riding his own horse against several English riders. They easily obtain the means of indulging in the luxuries of good clothes and horses—beyond which their ambition does not seem to extend—by raising wheat, potatoes, Indian corn, pigs, and poultry, for which they find a ready sale at high prices, as well as for their firewood, which they convey in canoes or whale-boats. They do not as yet value cows or sheep, nor do they employ carts or animals of draught. The cost of living is very moderate, as one room suffices for living and sleeping, their few implements, clothes, &c., being kept above the joists overhead. Their stores are secured on platforms raised on tall poles, each having a wide notch all round near the top to prevent the ascent of rats, and thatched over. They purchase no tea, little sugar, some tobacco, no bread or meat, or candles. Many of the older people are tattooed, but the custom is not adopted with children born of late years. It is a curious sight to see a troop of them riding into Christchurch, men and women alike astride, and the mares followed by their foals. A woman seen on horseback from behind, with a wide-awake hat, and veil hanging over her shoulders, would not perhaps look strikingly different from a European, till on overtaking her you would perhaps find she was smoking a short cutty-pipe, to which both sexes are much addicted.

They seem a light-hearted, good-humoured race, as they usually meet you with a broad grin, and with the salutation "Tina-koe," which being pronounced rapidly has the sound of a single word, *tinaque*. It is very much to their credit, considering their recent state, that they hardly ever appear before the magistrates for any offence against the law. On such rare occasions the magistrate is assisted by a native assessor. In their dealings they consider it right to get as much for their produce or labour as they can, having no idea of a regular market price; but when once a bargain is struck they are religiously faithful in the fulfilment of it; so much so, that I have heard a gentleman accustomed to deal with them say that it was safe to pay them the price of an article at once, though not ready for delivery, as they would be sure to complete the transaction though some time might elapse, and that thus a favourable purchase might often be secured.

Being able easily to obtain what to them are the luxuries of life by working for themselves, they have not as yet been of much assistance to the settlers as hired labourers, for which, though complained of by the settlers, we cannot think them much to blame. Some will undertake a job with a grubbing hoe, with which they work much better than with a spade; some of the women can wash; and one man who was my bullock-driver gave much less trouble, and was steadier and more trustworthy, than many of the English. They are also good sailors, some small coasting schooners being owned and manned entirely by Maoris.

As to their religious condition, we regret that we had not better means of becoming acquainted with it. It is well known how readily they received instruction in Christianity. The first missionaries in the extreme north, about the Bay of Islands, complained heavily of being deserted by their most promising disciples as soon as they had acquired some knowledge of the new doctrines. It was afterwards found, however, that these men had carried the glorious tidings of the gospel far and wide where no European had ever set foot. Thus, having no priesthood or idols, or system of caste, to offer a resistance to the true faith, the leading doctrines of religion were received with wonderful celerity and ease. As the main part of their religion consisted of a belief in Atoas or spirits, it was no way repugnant to their habits of thought to conceive that the white man's Atoa (our blessed Saviour) might be superior in power and goodness to all of whom they had formerly known. They are regularly married, and bring their children to be christened by our clergy, and are, we have understood, very regular in having prayers read in their villages by some of the older men, who are appointed to officiate where there is no English catechist or clergyman. They seem most of them to be able to write their own language in the English character, according to the orthography which has been adopted in translating the Scriptures and other books into Maori, in which the vowels have the same sounds as in Italian. Many sounds in our rough, hissing language, are wholly strange to them—such as *th*, *ch*, and all words ending in a consonant—so that they give up all attempt to pronounce them, and adapt them by more or less change to the softer and simpler sounds to which alone their organs have been trained. Thus we have a letter addressed to the worthy master of the grammar school at Christchurch, who by his knowledge of the language has gained their confidence and esteem, as follows:—"Kia Henare Hakopa, Karaitihati;" which means, "To [the Rev.] Henry Jacobs, Christchurch." The language appears by its grammar to exhibit considerable refinements in some particulars, such as in having a dual number, and also in the significance given by the use of numerous personal pronouns, according to the relations in which the persons spoken of stand to the subject of the discourse.

The subject of language naturally suggests the inquiry, Whence the New Zealanders came, and how long they have been located in these islands, and in the Chatham Islands, which are inhabited by the same race? From the traditions which have been collected by the late governor, Sir George Grey, and also by Mr Shortland, protector of aborigines, it clearly appears that they arrived in several canoes, to which they give the names of the Arawa, Tainui, &c., from some country to the north-east. From Captain Cook's account of Tahiti, and the vocabulary of that language which is given in Cook's Voyages, any one at all acquainted with New Zealand would immediately recognise many striking similarities, in the names of the numerals and other words. Two adjectives which he has not given in his list, are found on his map of Otaheite, of which one part is called *Otaheite Nui*, and the other smaller part, *Otaheite Ite;* these being New Zealand words for great and little. So the common salutation which we have above given is written in the Otaheite language by Cook, *Tinahooe*, being in New Zealand, *Tinakoe*. Also, *ehoa*, "friend," is the same in both. *Moa* also is the name of a fowl in Otaheite, and was given, *par excellence*, to the gigantic dinornis by the New Zealanders. So "cold" is in Otaheite *marreede;* in New Zealand, adopting Captain Cook's orthography, it is *maccarreede*, though written now, giving the Italian sound to the i, *maccaridi*.

The custom of tattooing, the tangi, baking meat in ovens with hot stones, &c., are further points of resemblance between the inhabitants of these two groups of islands. In spite, however, of all this, it seems conclusively established, by the traditions collected by Mr Shortland, that the New Zealanders came from a far more distant group,—the Sandwich Islands; which, from the size of their canoes, and the time of year when tradition represents them to have arrived, he shows is not impossible, being in the calm autumn weather, when the berries of the karaka (*Corynocarpus lævigata*) are ripe. Their traditions agree in calling the country whence they came Hawaiki, which Mr Shortland identifies with Hawaii, one of the Sandwich Islands, written by Cook, Owaihee. By tracing up several genealogies of the chiefs, which he was obliged to investigate officially in order to determine claims to land, Mr Shortland found that they all concurred in pointing to a period of eighteen generations, or about 500 years, since the canoes containing their ancestors reached New Zealand. To account for the undoubted resemblance of the languages and customs of Tahiti and New Zealand, he states that there is reason to suppose that the Sandwich Islands were peopled from Tahiti.

It cannot be doubted that the natives of New Zealand generally possess considerable intelligence. This is exhibited by their readily distinguishing, by well-recognized names, a great variety of trees, shrubs, plants, birds, &c. With the geography of their own islands they are pretty well acquainted, having given names to the several islands, and to the chief headlands, bays, rivers, mountains, and lakes, along a coast line of some fifteen hundred miles, as well as to particular forests and districts of country. A European will often be surprised at being recognized by natives with whom he has met but once perhaps several months before, and whom he may be unable to distinguish from other natives till they recall the place and circumstances to his recollection. In the science of defending positions by strong stockades, and in many warlike enterprises, they proved themselves a match for English officers and troops. Oratory and poetry are highly esteemed, and deemed essential requisites in a chief. Sir George Grey has shown, in a very learned essay, that in music their ear is trained to recognise much smaller intervals than is employed in our music, such as are described in the ancient Greek music, and are still practised by the Chinese and Arabs, "amounting to little more than an imperfect elevation or depression of the voice within the limits of what we call a sound or harmonious note." In navigating small coasters, they are safe and expert pilots. In short, in appreciating the advantages of European settlement amongst them, and in adopting the religious belief and many of the appliances of civilization, they have shown themselves capable of advancement and adaptation to a higher scale of existence in a far greater degree than many other races; yet we fear, in spite of their improved condition, that the native race is not destined to maintain itself, in the Middle Island at least.

Whether the climate is too rigorous for their constitutions, or from other causes, they are very apt to die of consumption, and rheumatic affections are very common. It is said also, that the former custom of killing female children, in order not to be encumbered in war, has caused a large excess of males. Few children seem to be born. This decrease of population cannot be laid to the charge of spirituous liquors, as they seem very distasteful in general to the natives, and it is a punishable offence to sell any to a native. Until last year the measles had been unknown in Canterbury, as are also small-pox and scarlet fever; but during the spring of 1854 measles were prevalent, and spread rapidly amongst the natives, but no fatal cases we believe occurred. Now that they have lost faith in the spells and incantations by which illness was formerly encountered, they come readily into the quiet, clean hospital at Lyttelton, where they are well cared for by a medical gentleman, who unites to skill in his profession the knowledge of their language, which is doubly grateful to those oppressed with sickness.

In concluding the above notes on a country in which the writer must ever feel the liveliest interest, he is grateful for the opportunity of bearing his testimony to the great amount of sterling worth comprised in the community which has made this fine country its home. Though in the execution of such an enterprise as the planting of a well-ordered English community at such a distance from their native land, some mistakes have occurred to mar the completeness of the great scheme announced by the originators of the settlement, it is certain that a most excellent body of colonists are thus founding a community at the antipodes, in which Britain may behold her moral and social virtues clearly reflected, unclouded by much of the evil which obscures their brightness in an older and more artificial society.

Astronomical Contradictions and Geological Inferences respecting a Plurality of Worlds.

II. *Geological Inferences.*

Those ignorant of geology have no right to question her facts!

Geologists have been frequently condemned for what have been termed rash speculations upon the creation of the planet and the beginning of life. These accusations are generally made by those who, excessively fearful lest the geologist should pry too closely into the Creator's works, or endeavour to examine too minutely into the evidence of creative intelligence, power, wisdom, and foresight, are themselves the most bold concerning the mysteries of Holy Writ. Startled by researches which stamp conviction on those minds that have studied them, of the infinite attributes of the Eternal—awed at the grandeur of bygone creations, and doubting, through ignorance, these gentlemen frequently do not hesitate for one moment to give us a lucid and learned disquisition upon things which we are told, "angels desire to look into." Nothing comes amiss—mystery is no mystery to them. And they explain the hidden doctrines of Holy Writ, or pen a religious novel with the same self-gratulation and cool confidence, as they talk of geology being "fit only for the burlesque or the libel of human understanding." "Against the language of the Almighty there can be no evidence," says Dr Croly on the Plurality of Worlds (*Morning Herald*, January 5, 1855). "All demonstration must be fallacies—all discoveries must be delusions—all theories must be presumption. In Scripture, the Eternal stands before us uttering His truths; and are the feeble and limited faculties of man to meet him, with their fragments of rocks and fossils, and the little apparatus of their shallow science, and tell the Creator, that He is ignorant of the time and manner of His own creation? Can we wonder, with this recklessness for its guide, that wisdom should turn into folly, science should be infatuation, and practised understandings should make themselves notorious only for dreams." We do not agree with the Rev. Doctor; and a certain quotation from Hugh Miller (*Footprints of a Creator*) forces itself upon our memory—"The clergy, as a class, suffer themselves to linger far in the rear of an intelligent and accomplished laity, a full age behind the requirements of the time." Such is our respect for the personal character of Dr Croly, that we most heartily wish he had never penned that letter to the *Herald*. In his fanatic abuse of the geologist, he seems to have forgotten that thousands of men, many of them wiser, more learned, and as religious as himself, believe firmly in the teaching of geology, and would tell Dr Croly that it is not the Scriptures they doubt, but *his* interpretation of them. We recommend, above all things, practical field investigation, and the works of Professors Sedgwick, Hitchcock, and the Rev. James Gray, to the perusal of the Rev. Doctor, assured that when he has made himself ACQUAINTED WITH THE SUBJECT, he will write no more geological strictures in the public newspapers, or speak of God's creations in former days, as "fragments of rocks and fossils, and the little apparatus of a shallow science." Such language sounds to the ear of those naturalists who read their history, and bow to the truths they teach, as something very like an insult to their Maker. The student of nature's page possesses quite as jealous a feeling respecting the Most High as Dr Croly, and can allow no derogation of HIS WORKS, "fragments" and "little apparatus" though they seem to the Doctor; for he knows that philosophical inquiry and even legitimate speculation can never be displeasing in the eyes of HIM, concerning those researches into His creative wonders, which He never would have revealed, if He had never intended them to be studied.

No important contradictions among Geologists.

Among the thousands of intelligent and practical geologists now at work in the New World as well as the Old, and who hammer and theorise and collect evidence from the North Pole nearly to the Antarctic, and who send their sections of rocks and collections of fossils from the Frigid and the Torrid Zones, from Siberia and from Africa; it would be difficult to find ONE who disputed the geologic truths long since established, viz., that this planet has existed for myriads of past ages, and that there has been a series of creations or of "successive periods of life."

The evidence afforded by the buried ruins of former worlds leads to such conclusions, and each investigation seems to fix them upon a firmer basis. The practical geologist would as soon think of disputing the discoveries of Copernicus, as of teaching or believing that the series of formations which compose a portion of this earth's solid crust did not require an indefinite period of past time for their elaboration.

So impossible is it to contradict geologic evidence upon this vast antiquity of the planet which is now the habitation of man, that we find the astronomer and mathematician endeavouring to give a definition of geologic notions of past time, by comparing magnitudes and distances in space with cycles of ages. He assumes that four periods of the earth's existence,—"the present organic condition of the earth; the tertiary period of geologists which preceded that; the secondary period which was anterior to that; and the primary period which preceded the secondary,—may compare, on the same scale as the numbers which express these four magnitudes:—the magnitude of the earth; that of the solar system compared with the earth; the distance of the nearest fixed stars compared with the solar system; and the distance of the most remote nebulæ compared with the nearest fixed stars."—(*The Plurality of Worlds*, ch. 5, p. 166, 3d edit.)

The astronomer thus affords us a fair, tangible comparison which we are not likely to contradict. The geologist knows well that the earth on which he lives HAS revolved through space for countless ages, and that the formation even of those strata nearest the surface must have occupied vast periods, utterly beyond all human powers of calculation. He therefore thanks the astronomer for a tangible analogy with "infinite expansion."

Opinions of Geologists and Astronomers respecting a Beginning.

We are told that the most subtle and profound investigations of astronomers have led them to the conviction, that the motions of the earth may have gone on as they now go on for an indefinite period of past time. "There is no tendency to derangement in the mechanism of the solar system, so far as science has explored it." The solar system, and the earth as part of it, constitute, so far as we can discover, a perpetual motion. Geologists believe that they CAN trace certain indications of a beginning in the history of our planet, and a commencement to animal and vegetable life, and their belief is supported by the very high recommendation of the evidence of the senses.

The author of the Essay on the Plurality of Worlds expresses his opinion, "that the solid materials of our globe were formerly fluid, possibly that they were once gaseous and nebular." The first page of "Siluria" informs us, "that, looking to the structure of those rocks which lie at great depths, or have been extruded from beneath, the geologist has inferred that the crystalline masses which issued out from below all other rocks, and constitute possibly their existing substratum, were at one time in a molten state." Again, speaking of the lowest sedimentary or bottom rocks, which rest upon the solidified and Plutonic masses, Sir R. Murchison declares them to be almost entirely azoic,"—"the heat of the surface during those earlier periods having been, it is supposed, adverse to life."

The opinions of Sir C. Lyell upon this subject are too well known to need comment; and although he expresses his doubts as to whether man has or ever will find any "decided evidence of a commencement," no one who ever read his glorious "Principles" can doubt that he believes in a BEGINNING, though millions upon millions of ages must have elapsed since the period when our planet was uninhabited, and its surface in a chaotic condition.

In the first number of this paper,* we remarked, that "the geologist learns, above all things, from the records of his science, never to base positive conclusions on merely negative grounds, for if he does, the chances are that he lives to find himself mistaken!" Since those lines were penned, the discovery by Mr Salter of trilobites and fucoids in the Cambrian rocks of Wales, and by M. Barrande in Bohemia, teach us

* Edin. New Phil. Journ., Oct. 1855.

the truth of those words of Sir C. Lyell,* that as regards "TIME," "the confines of the universe lie beyond the reach of mortal ken." At all events, it is now impossible to affirm that any stratified deposit is AZOIC; on the contrary, it is probable that with the earliest condition for life—life was created.

No *practical* geologist doubts that the Plutonic rocks were once molten, though it is still a question whether those Plutonic masses may not themselves once have been stratified. We have as yet no means of accurately estimating their thickness.

Of the strata that rest upon them, the Bottom or Cambrian stratified deposits, we have better means of judging. In Shropshire they are estimated at a thickness of 26,000 feet.† In America they are believed to be thicker still. For years these basement beds had been searched and examined, before they afforded a trace of animal existences. Now, the *Oldhamia antiqua* of the Cambrian rocks of Ireland, the Trilobites, &c., of the Longmynd range, and no less than eleven species of these crustaceans in the "primordial zone" of M. Barrande, are significant and suggestive witnesses against the author of the Essay's doctrine of "*waste!*"

No truth is better established by geologic evidence, than that the myriads of bygone existences now fossil had all a *beginning*, and that in the order of Providence the higher animals succeeded the lower. Another light seems now breaking upon us, viz., that there were no lifeless seas, no lifeless shores, but that this planet was inhabited by certain groups at its earliest periods. It is, however, altogether against experience, and in downright opposition to proof, to suppose that we *may* yet find FOSSIL ANGELS in the Lingula flags. Fishes and reptiles are not found for thousands of feet above those rocks which first afford us the *Oldhamia*, *Oleni*, and *Lingula Davisii;* and with all our respect for Sir David Brewster, and our appreciation of his great worth as a philosopher and a man, we repeat that it is directly contrary to geologic evidence to expect that "Another creation may lie beneath the Earth's granite pavement, more glorious creatures may be entombed

* Principles, 9th edit., p. 799. † Siluria, p. 174.

there;" or that "the mortal coils of beings more lovely, more pure, more divine than man, may yet read to us the humbling lesson that we have not been the first, and may not be the last of the intellectual race."

The language of Sir David Brewster in his chapter on the "Geological condition of the Earth," is very eloquent, but unfortunately extremely opposite to geologic evidence; "the startling revelations"—"from the deep vaults to which primeval life has been consigned," as far as 26,000 feet of Cambrian strata register—amount only to a polype, trilobites, and fucoids. And it is contrary to the geologic records to believe, with Sir David, that the stratified rocks were deposited at the bottom of the sea in a shorter space of time than is required by sedimentary deposits now in formation. This supposition is entirely groundless, as any geologist who has studied the evidence of gradual convulsions, depositions, and after denudation, will tell him at once. Sir David's idea that "plants and animals which in our day require a century for their development, may, in primitive times, have shot up in rank luxuriance, and been ready in a few days, or months, or years, for the great purpose of exhibiting, by their geological distribution, the progressive formation of the earth," is ideal indeed, and ideal only. Evidence worked out by thousands of active eyes and active brains, tells another tale. Ascending in the history of the planet's surface, and leaving the 26,000 feet of Cambrian rocks, we enter upon the Lower Silurians of Sir R. Murchison, where we meet with that early shell (*Lingula Davisii*), accompanied by Trilobites and Phyllopod crustaceans. The contemporary beds in Bohemia afford vast numbers of fossils allied to our English species; and before we leave the Lower Silurian rocks, upwards of 1000 species of animals are known to the geologist. Mollusca of many genera, with highly organized Crustacea and Zoophyta, swarm in the seas of that ancient period, but we have no shadow of the Vertebrata; and yet the Lower Silurians and the Cambrian rocks average "50,000 feet of sedimentary strata."

Throughout the periods indicated by this enormous measurement, tribes of living beings lived their time on earth, died, and left their fossil relics for future man to study. The humblest fossil amongst them still bears upon its stony frame the marks of wise contrivance, and of adaptation to the period and the circumstances in which it lived.

It is not for the geologist, with the knowledge he possesses, and the evidence of purpose and design which everywhere surround him, to question HIS indescribable power of foreseeing future good through endless ages. But we believe that the creation of an animal, at any period of the planet, is a fact which should be allowed to rest *per se*, or we may be involved in the development hypothesis and its consequences. The Lower Silurian fauna had its purpose and adaptation, *pro tempore ipso*, and entirely independent of the future man, although as fossils they fulfil another end, in exercising our reasoning powers, and adding to our knowledge of the Creator's works.

Persons who can argue that the planet Saturn with his ring was created principally for the edification of astronomers, and "therefore, not altogether without its use," may also believe that the Lower Silurian animals were created solely for the contemplation and study of future geologists, a conclusion which we believe to be a misreading of the geologic record.

The testimony of geology on the question of creation, agrees with the statement of Professor Owen, that "the recognition of an ideal examplar for the vertebrated animals, proves that the knowledge of such a being as man existed before man appeared; for the Divine Mind which planned the archetype also foreknew all its modifications;" and our evidence certainly goes to prove the general progress in creation, that mollusks, crustaceans and zoophytes preceded the vertebrata, and the lower division of the vertebrata preceded the higher; that fish were created before reptiles, reptiles before birds, birds before mammals, and mammals before men. Is it on this evidence that the author of the Essay in his argument from geology believes, that all the earth's previous ages, "its seas and its continents, have been *wasted* upon mere brute life; often, so far as we can see, for myriads of years, upon the lowest, the least conscious forms of life, upon shell-fish, corals, sponges"? This word WASTE rings unpleasantly in our ears, and however devout "the spirit of reverence" which prompted the sentiment, it certainly has a contrary effect upon ourselves. Geologists do not believe that life was struck by electricity out of albumen, or in the "generatio originaria et secundaria" of Professor Lorenz Oken: they presume not to question the how or the wherefore of Creation, or to call that "waste" which of its kind was very good; but they do believe that they possess a certain amount of evidence on the order and progress of creation, while they must decidedly reject the language used by the author of the Essay as applicable either to their science or their creed. For our own part, we believe that creative acts rest as it were upon parallel lines, which have been lengthened and have progressed throughout endless ages, but they are not lines of "convergence;" and the Cambrian and Lower Silurian fauna had a part to fulfil entirely independent of the amusement and speculation of man! Geologists do not believe that all the previous ages of earth "have been *wasted* upon merely brute life," and strongly object to speaking of acts of creation as "germs of life" "inserted in the terrestrial slime."

These are lines of "convergence" with a vengeance! They converge into that soaring fancy which winds up the planets neatly into balls, and Jupiter and Neptune into watery worlds with a nucleus of slag!

In his essay on the Plurality of Worlds, the author repudiates the nebular theory of the universe, and constitutes a watery theory for the solar system, of his own conception. "The planets exterior to Mars, Jupiter, and Saturn, especially as the best known of them appear, by the best judgment we can form, to be spheres of water." "Mars seems to have some portion at least of aqueous atmosphere." "The Earth we know has a considerable atmosphere." "The moon has none." "On Venus and Mercury, we see nothing of a gaseous atmosphere; and they and Mars do not differ much in their density from the earth." Now does not this look as if the water and the vapour, which belong to the solar system, were driven off into the outer regions of its vast circuit; while the solid masses which are nearest to the focus of heat are all approximately of the same nature. "Instead therefore of Jupiter, Saturn, &c., contracting by cooling, after the hypothesis of the nebular theory, they are like water and vapour driven from wet objects placed near the kitchen fire," *i.e.*, wet blankets and kitchen fires *versus* zones of nebulosity and central attractions!

In conversing with those persons who uphold the opinions of the author of the Essay, we have been much struck with the general disposition to *take for granted* the truth of that author's speculations. People rush eagerly at any new idea; hence the sudden acceptation of the development hypothesis, the creation of animalcules by electricity, and the non-plurality of worlds; we must therefore remind our readers who may be thus predisposed, that after all it is quite unnecessary to give more latitude or consequence to the astronomical opinions of the author of the Essay than they are worth. His speculations are many of them necessarily based merely upon conjecture, and his statements have no claim to be considered more true or less rash than those of Sir David Brewster, De la Place, the Herschels, and Arago. These great astronomers have adopted in their teaching and works the belief that there ARE more worlds than one. The author of the Essay and "a Mr Alexander Maxwell" hold just the reverse. We stated at some length, in the first part of this paper, the contradictions of the astronomers on some most important points, and we really do not see why we are to assume infallibility for the author of the Essay, or any reason why the geologist, in considering the subject, and the arguments to be derived from his own science, should take for granted that the author of the Essay and Mr Alexander Maxwell are right, and every other distinguished astronomer is wrong!

The belief of Sir D. Brewster and Dr Lardner that there IS a very strong analogy between our Earth, Mars, Jupiter, &c., and that they must be the "dwellings of tribes of organized creatures, having a corresponding analogy to those which inhabit the earth," is quite as likely to be true as the "slag" and water theory of the author. With this consideration in our minds, and premising that these planets are as OLD or OLDER than our own planet, we will endeavour to discover some geological analogies.

Suppose an intelligent Being allowed to visit this planet at the close of the Lower Silurian epoch, and that his knowledge extended to our present geological evidence upon the subject;

such a Being might be able to trace the changes this planet had undergone from the period of its first creation up to the time of the Bala and Caradoc limestones, where the countless skeletons of extinct races of highly organized animals of the molluscous, articulated, and radiated orders reveal the fact of the Creator's workmanship.

That Being, if possessed of the telescopes of our astronomers, would, we apprehend, have also observed much the same *celestial phenomena*, at least as regards our solar system, as we do at present; that is to say, he would have seen Mars, Jupiter, Saturn, Uranus, and Neptune revolving about the sun in nearly circular orbits, revolving also, like the earth, about their own axes, and some of them, as this planet, accompanied by their moons.

It has been argued that analogy is not identity, and that we have no right to suppose that ANY ANALOGY holds between our earth and other planets. We reply that even the author of the Essay does establish a certain identity, and we can therefore hardly avoid drawing conclusions from analogy. Although he only grants to Jupiter, with his four satellites, the possibility of "boneless, watery, pulpy creatures" as the *summum bonum* of organization, he does allow "a few cinders at the centre," and "an envelope of clouds around it," though all the rest be a mere "mass of water." We have, then, the "slag" or "cinders," water, and clouds. Now "slag," water, and clouds, must have a very considerable analogy on whatever globe of the solar system they exist.

We reserve awhile the considerations to be derived from the water and clouds, and merely request our readers to allow an analogy between the "barren masses of stone and metal, slag and scoriæ, dust and cinders," which our author allows to the condition of all the planets, and the "slag" or Plutonic rocks of our earth.

Inferences derived from a consideration of Plutonic Rocks and their probable Analogies.

We are informed at the commencement of the chapter on the argument from design, that "there is no more worthy or suitable employment of the human mind than to trace the evidences of design and purpose in the Creator!"

From the remotest epoch in this planet's history to the present hour, the laws which govern inorganic matter appear to have continued unchanged, and mineralogical, chemical, and mechanical laws have acted the same part as regards animal and vegetable substances. We believe, therefore, that the chemical composition of Plutonic minerals and masses, and the variety of Plutonic ingredients necessary to the existence of plants and animals, should be recognised at the very outset by those who would read in Nature's first pages the first manifestations of DESIGN. The evident and beautiful adaptation of the Plutonic rocks of our own planet to the organization of numberless forms that for myriads of ages have ceased to exist, and that adaptation still continued to living animals without number, should be especially remembered, as it is possible that the first step in geologic history may afford a clue and analogy respecting our sister planets, and certain satisfactory data against the arguments of the Essay.

All the stratified deposits of our earth rest upon a mass or nucleus of Plutonic rock, the author's "slag," &c., contemporary, we may be allowed to assume, with the "slag" of Mars, Venus, and Jupiter. From the very beginning the Plutonic minerals of this earth appear to have occupied an important part in the general scheme of creation. We cannot in a disquisition of this kind attempt to offer explanation of a tithe of the important part they have occupied and still occupy in terrestrial operations. Suffice it to state that the COMMONEST Plutonic minerals, the components of rocks coeval probably with the solar creation itself, are absolutely necessary to the support of life.

The quartz pebble of our ancient Plutonic rocks enters largely into the food of vegetables, and the silica of other days is necessary for the straw of our crops. The decay of the mineral felspar reduces the potash it contains into a soluble condition, and it is absorbed by the roots of the plants that furnish our cattle with nourishment. It was necessary to the vegetation that sustained the Mastodon and Dinothere, the plants of the Old Red sandstone, and probably the Lycopodiums of the Upper Silurians.

Hornblende, so abundant in old Plutonic rocks, unknown in new, contains a large portion of magnesia, the presence of which is requisite to constitute a fertile soil. Without these and other Plutonic minerals and elements in nature, the vegetable, and therefore the animal world, must cease to exist. Take away all silica, potash, alumina, and magnesia, from the soil, and the earth would become a desert.

Thus, as we look upon those simple minerals we may learn something of the far-seeing power of Him who fashioned both them and us. They are the earliest pages, as it were, of the earth's history, inscribed with records penned, it may be, " before life was breathed upon the waters."

These minerals are the compounds of the ancient igneous rocks, the equivalent in time with the Plutonic rocks of other planets, and they were consolidated probably before the earliest waves that washed the earliest shores. Thus they surely reveal that *nothing* was created without its future purpose, to be developed for after good when myriads of years had passed away! We bear about with us, in our bodies and our blood, elements which once, it may be at creation's dawn, existed in another form. The geologist, therefore, may well pause ere he allows the author of the Essay to persuade him that all the amount of " slag," which he himself admits to exist in the universe, should have been created for myriads of ages pro nil!

But it may be said, that these evidences of design in the elaboration of the earliest materials of the earth's crust only prove the hypothesis of the author of the Essay, that the Earth is " the oasis in the desert of our system," and " the only world in the universe,"—that the Plutonic rocks of this planet had from the first a nobler destiny than the "slag" of any other planet,—that our ancient minerals had *vital tendencies*, which no minerals of any other planet could possibly possess,—that the material mass of our embryo world was destined to sustain the plant, that feeds the animal, that is devoured by heads of colleges, astronomers, and geologists. " All its previous ages, its seas and its continents, have been wasted upon mere brute life;" *ergo*, the benefits resulting from our Plutonic rocks and minerals have been "wasted upon mere brute life" until the time when, in the shape of silicates, phosphates, and sulphates, they enter into the bodies of philosophers! As geologists, we believe the records of the earlier animals have other tales to tell.

We remarked in the first part of this paper, when treating on the astronomical arguments of our author, that if his Essay be true, "systems disappear, suns are extinguished, the varied scenes of life and population, believed to be implanted by the Almighty's hand on other planets, are blotted out from the face of the whole broad universe, save on our own planet. The creation is a void; solitude reigns everywhere but here on earth; all that Chalmers, Newton, Brewster, have written upon this subject are wasted words; Earth, and Earth only, is the object worth caring for in the sight of the Almighty, and the rest of the universe all 'slag.'"

The same kind of reasoning is also applied in his geological considerations. Clever as his argument from geology undoubtedly is, and indisputable as are many adduced facts, still the hypothesis has the same tendency. As the other planets of the solar system are gigantic shams, so are all animals previous to man "brute and imperfect races;" the depreciation of every other creative act, and the glorification of the human race, is the burden of the song. There may be any amount of "wastes of space," any "multitudes of material bodies" surrounding our planet, while this earth may have been occupied by any number of "brutes that perish, and that, compared with man, can hardly be said to have lived;" but without man, all the past has been a *waste!*

That this is the tendency of the argument from geology, there can be no doubt. That there is one educated PRACTICAL geologist who believes in one word of this hypothesis, we doubt extremely.

Geological inferences from the consideration of the First Animals.

An intelligent Being who had studied the evidence furnished by the Cambrian rocks, and considered that NO SEDIMENTARY DEPOSIT is probably void of the relics of ancient life, might be inclined to extend a like analogy to other spheres, and believe that contemporary seas of the other globes of the solar system were tenanted also. If the earth was "brute and inert" during the Plutonic period, it is possible that Mars and Saturn were so also. But "when the germs of life were gradually and at long intervals inserted in the terrestrial slime," it would have probably occurred to our intelligent observer, that they might also have been inserted in Jupiter.

Respecting the physical condition of Mars, the author himself says, "Astronomers discern in his face the outlines of continents and seas." That there is also "an atmosphere on which clouds may float, appears to be further proved by brilliant white spots at the poles of the planet, which are conjectured to be snow."

Thus in Mars we have, in addition to "slag," continents, seas, and an atmosphere.

Again, we are told that "we may easily imagine that the seas of Mars are tenanted, like these, by huge aquatic animals, of the nature of seals and whales."

Surely it is probable that life may have been introduced upon Mars and Jupiter at least as soon as upon our Earth, and that their seas are as ancient as those of our own planet! Why, in the name of common sense, are we to suppose that the seas of those planets should be left void throughout unnumbered ages, when, with the first evidences of WATER upon this planet's surface, the Cambrian sedimentary strata, we have proofs of the introduction of life. Geologists have no doubt of the antiquity of the seas of this planet, or the antiquity of marine life. Astronomers have no doubt of the antiquity of the seas of Jupiter and Mars. Are we, then, without a vestige of testimony, and contrary to all analogy, to suppose that these seas were uninhabited throughout ages which the author of the Essay himself compares to "the distance of the most remote nebulæ compared with the nearest fixed stars?"

At any rate, a person who has extracted so "many pleasant imaginations out of the doctrine of the fluidity of Jupiter," can have no disposition to be hard upon us if we suppose it just possible that the same Creator who thought fit to introduce certain forms of life during the Lower Cambrian epoch, might have thought proper also to have adapted other forms to the exigencies of other planets of the solar system.

As regards the first appearance of life, we have before said, "Creation always will, we apprehend, be to mortal man a mystery of mysteries," whether the thing treated be the Plutonic rock, the first coral, the first mammal, or the first man.

The author of the Essay is sarcastic on the "enjoyment which the mere life of the lower tribes of animals implies, the enjoyment of madrepores and oysters, cuttle-fish and sharks, tortoises and serpents;" he might be still more sarcastic at the enjoyment of Oldhamias, Cruzianas, and Trilobites, the organizations of the Lower Cambrians, the "germs of life" "inserted in the terrestrial slime!"

Nevertheless, the evidences of former life ARE THERE, and the basement sedimentary rocks prove the existence of animals which assimilated the first elements!

We learn from our author, that "wherever pure intellect is, we are compelled to conceive that, when employed upon the same objects, its results and conclusions are the same." The intelligent inhabitants of the Moon, if there be any, may, like us, have "employed their intelligence in reasoning upon the properties of lines, and angles, and triangles," and, no doubt, have meditated upon the intricacies of the Pons Asinorum!

We beg to assure our readers that we do not extend the slightest degree of identity or sameness in our endeavour to prove a probable analogy of life in other planets besides our own. We do not conceive that the pure intellect of the Creator has been employed according to our author's ideas, or that "its results and conclusions have been always the same." We believe those ways to be past finding out, and as infinite in variety as design. We can easily imagine that the design evidenced by our own Plutonic rocks was extended to the Plutonic rocks of Jupiter, Mars, and the other planets, but we do not imagine that they were necessarily to furnish nourishment to IDENTICAL animals.

Our earliest seas possessed their zoophytes, crustacea, &c., but we do not suppose that the first seas of Mars were necessarily inhabited by the Oldhamia and Trilobite. The geologist knows that the modifications of animal and vegetable life prevailing at different epochs of the earth's history are too varied, to allow for one moment the supposition, that the forms of earth would be implanted on other spheres, or the moulds of inhabitants of other planets, identical with those created for our own.

The evidence furnished by geology, which God has been pleased to vouchsafe on the early history of life on this planet, all goes to prove that creation followed creation. Now creation is the act of bringing out of NOTHING the matter of which all things are constructed, and giving life to matter; the absolute creation or origination of a Trilobite or Coral must be as absolute and independent as the creation of a man or an angel. God may have willed the creation of a man or an angel at the earliest period of our own planet, but we have not a shadow of evidence that he did; on the contrary, all evidence proves exactly the reverse, and that he willed the lower animals should appear first.

That there is geologic evidence that the higher orders of creation succeeded the lower, it seems to us impossible to deny, "for the most sedulous research in many parts of the world has failed to discover the trace of any vertebrated animal in the lower division of the Silurian system." (*Siluria*, p. 205). Yet, with the exception of fishes, we find every other representative of marine life. Arguments have been founded on the Lower Silurian deposits having been deep-sea deposits, and that hitherto we have discovered no coast-lines to search. The Bala sea-beaches surrounding the Longmynd and adjacent Lower Silurian rocks, are a strong argument against this supposition, and it is difficult to say why, amongst those myriads of extinct forms, some relic or traces of fishes should not have been present, if they had been *there!* As, however, we said before, it is wiser never to base positive conclusions upon merely negative grounds, and the discovery of fish in the Bala limestone would not astonish us, nor would this invalidate the great fact of PROGRESS in creation, of which at present there appears to be such indubitable evidence!

The first fish and the first land plant made their appearance, *according to our evidence,* at the close of the Upper Silurian epoch; and the reptile, as at present known, does not appear upon the scene until the epoch of the Old Red sandstone. We object to draw conclusions where evidence is wanting, as it is possible evidence of older vertebrated forms may never be forthcoming.

The author of the Essay insists particularly on the "existence of the human species upon the earth being a progressive existence. We have not yet arrived at the human species, but as geologists we discern indications of progress from the BEGINNING, "a gradual improvement in our common mansion-house the earth, in its bearings on the conditions of existence," from the earliest Plutonic mineral and first Cambrian zoophyte, until "man's house was fully prepared for him," and "the reasoning, calculating brain, was moulded by the creative finger, and man became a living soul."*

Leaving the first steps of our upward course, and ascending the scale of deposits, the Lower and Upper Silurians, with their many subdivisions, furnish proofs of progress and design, also of the dateless antiquity of the earth. Added to the Cambrians they possess a thickness of upwards of ten miles.

The epoch of the Old Red sandstone which succeeds is also represented by a mass of rocks in some localities not less than 10,000 feet in thickness.

So far as geologic evidence extends, its air-breathing reptile and ganoid fishes, its tree ferns, marine and fresh-water shells and highly-developed crustacea, reveal no PROGRESSIVE development as regards ANIMAL LIFE,—for the Silurian placoid was as highly organized as the Old Red ganoid,—but progression in the HISTORY OF THE DEVELOPMENT OF THE PLANET!

The Carboniferous epoch which succeeds the Devonian groups of strata is equally remarkable, for its masses of marine limestones are derived altogether from animal exuviæ; probably there is not an atom of these limestones that has not been "once alive." Corals, shells, crustaceans, and fish, contribute their skeletons to swell the amount of these catacombs of the past. As regards the terrestial conditions of this great period, the coal-measures of South Wales are estimated to attain the

* Footprints of a Creator, p. 289.

thickness of 12,000 feet. The coal strata consist of the spoils of successive ancient forests, and we have evidence of the temperature of the climate, of heat and cold, drought and moisture, and other atmospheric influences. Reptiles inhabited its shores, sauroid fishes the waters, insects were wafted through the air,—" brute forms," but eloquent witnesses against the doctrine of " Waste."

The Permian epoch probably represents the passage or transition from the palæozoic to the neozoic zones of life, for palæozoic forms of life are unknown in the triassic or mesozoic strata that succeed.

" The two greatest revolutions in the extinct organic world," says Sir R. Murchison, " are those which separated the primeval or palæozoic rocks from mediæval or secondary strata, and the latter from the tertiary and modern deposits. The mass of the organic remains of the permian system constitute a mere remnant of the earlier creations of animals. The dwindling away and extinction of many of the types which were produced and multiplied during the anterior epochs, already announce the end of the long palæozoic period."*

No one possessed greater perception and discrimination, or had a more thorough knowledge of palæontology, and indeed all branches of natural history, than the late lamented Professor Edward Forbes. This great naturalist and geologist believed the permian and triassic formations to be the POINT OF JUNCTION of the spheres of palæozoic and neozoic life. He tells us, " that during the Palæozoic period the sum of generic types and concentration of characteristic forms is to be observed in Silurian and Devonian formations. During the Neozoic period it is, during the cretaceous, tertiary, and present epochs, that we find the maximum development of peculiar generic types." " The creation of the fauna and flora of the oldest palæozoic epoch would seem to be the primordial, and the appearance of man the closing biological event."† " Regarding all the epochs after the trias to be combinedly equivalent to those preceding (or the palæozoic), he maintains that the development of types of life, as manifested by generic combinations during the long secondary and tertiary epochs, is in opposition to, or

* Siluria, pp. 314, 315. † Edin. Phil. Jour., Oct. 1854.

in a relation of polarity with, the comparable phenomenon during the palæozoic period."*

Professor E. Forbes thus points out the relation of "polarity" in particular groups, or the manifestation of a relation among organic beings in geological time:—

Palæozoic.	*Neozoic.*
Ganoid and Placoid Fish.	Cycloid and Ctenoid Fish.
Entomostracous Crustacea.	Malacostracous Crustacea.
Tetrabranchiate Cephalopods.	Dibranchiate Cephalopods.
Palliobranchiate Acephala.	Lamellibranchiate Acephala.
Crinoidea.	Echinoidea.
Four-starred corals.	Six-starred corals.

As far, therefore, as our evidence on the scheme of creation goes, it is the opinion of two of the greatest authorities on the subject, that palæozoic creation was as UNIQUE, as much PER SE, and as distinct and special, as the neozoic or later system of organization.

It is important to remember this, as the author of the Essay insists particularly on the unity of the world, and that man "is a creature unique in the creation." We do not say that man is not a unique creation, but we say that there were a great many other unique creations in palæozoic ages. Where are now the ganoids of the Old Red sandstone, or the sauroid fishes of the Coal? Where the graptolite, orthoceratite an trilobite of earlier seas? Was not the earth occupied for myriads of ages by these extinct forms, and do one of them ascend into the neozoic zone? The palæozoic creation MUST have been a special creation and received a special care, though the earth, as then constituted, did not support human life. It may here also be necessary to observe that the Oldhamias, Lingulas, and Cruzianas of the earliest fossiliferous rocks bear about them no "marks of mere possibility, or of vitality frustrated;" like the Orthoceratite and Pterygotus of the Bala and Caradoc limestones, they were *bona fide* animals, and are not to be compared in any argument from design with the "finger-bones which are packed into the hoofs of a horse, or the paps and nipples of a male animal." The author of the Essay, speaking of the universe tells us, "The universe is so full of

* Siluria, p. 469.

RUDIMENTS of things, that they far outnumber the things which outgrow their rudiments. The marks of possibility are much more numerous than the tale of actuality. The vitality which is frustrated is far more copious than the vitality which is consummated." So impressed is the author with this idea that he carries it to every orb and feature of astronomy, and the circle of that wide domain is filled with his "merry-go-rounds" in consequence.

The geologist, arguing on the forms of Cambrian and Lower Silurian life, and gathering evidence on the gradual increase of life as the platform is ascended, can hold no such opinions. For him those ancient forms have no such language. They were called into existence for some purpose they had THEN to fulfil, and to enjoy for their period the span of life allotted them.

The same light, air and elements of nature—the sun, moon and planets—were in being and in operation then as now. Life and the conditions of life, according to geologic evidence, were, as regards this planet, on a very different scale; but everything save the Creator MUST have a BEGINNING; and geology points to the evidence of such a beginning as rational observers would expect, and even hope to find, when engaged in tracing through remote antiquity, step by step, gradual but unceasing revelations of development, improvement, power, adaptation and design.

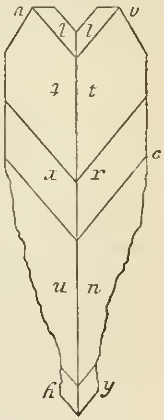
On the Chemical Composition of some Norwegian Minerals. By David Forbes, F.G.S., A.I.C.E., F.C.S. Part II.

III. *Yttrotitanite or Keilhauite.*

Since the publication of the first part of this communication, I have received a letter from Professor Miller of Cambridge, which contains some remarks on the crystalline form of this mineral, and of which, by his kind permission, I am enabled to communicate an abstract.—

"Your analysis shows that Keilhauite is a Sphene, but you have not noticed that its form, as well as it can be made out by observations with the hand goniometer, is the same as that of Sphene. Fig. 1. is your Fig. 4, with the faces marked with the same letters as the faces of sphene in the new edition of W. Phillips. The first column of the following table contains the angles between normals to the faces of Keilhauite. The second column contains the corresponding angles in sphene. The first six angles are those given by observation, the next from the angles computed by M. Hansteen. Your "*a*" is, I suppose, the same, as '*y h*.' The twins are the same as the ordinary twins of sphene.

Fig. 1.



	Keilhauite.	Sphene.
r c . .	33° 0′	33° 16′
l t . .	31 0	29 45
v c . .	55 0	53 34
y c . .	58 0	60 27
n r . .	26 30	27 15
y n . .	36 30	38 24
l y . .	39 18	40 40
t r . .	44 49	44 56
n c . .	36 26	35 7
r y . .	65 35	65 39
y h . .	122 0	120 54

"I do not exactly understand the position of the cleavage planes, as the angles they make with any other plane are not given. In sphene, the cleavages are parallel to the faces *r*, *c*, *l*, the angles between normals to two faces *l l′* is 133° 58."

With reference to the cleavage planes, the two best observed planes appear to correspond to *r* and *c*; and in one specimen a cleavage plane corresponding apparently to "*l*" was noticed.*

The blowpipe reactions of this mineral are the same as sphene. It is, however, about as easily fusible as garnet; and it must be here noticed that some mineralogists have placed Keilhauite amongst infusible minerals; which was not found to be the case, either with these crystals, or with some specimens from other localities.

In the last communication the percentage of titanic acid has, through a misprint, been stated as 28·84, whereas it should be 28·04.

IV. *Tritomite.*

This mineral has not as yet been thoroughly examined, and its crystalline form is very uncertain, as the crystal which has been described by Weibye, and subsequently figured by Phillips, Dana, &c., is very questionable as to composition; nor does it correspond in appearance to the tritomite analysed by Berlin or myself. From a personal examination of this very small crystal, or rather fragment, in M. Weibye's possession, it would appear to me more to resemble orangite than tritomite, and possibly also only a pseudomorph.

The tritomite here analysed was sent me by M. Wiborg of Brevig, labelled as thorite, which it also very closely resembled in appearance.†

On taking the specific gravity, however, of a small fragment weighing 8·99 grains, it was found to be only 3·908 It was consequently examined and found to be really tritomite.

The analysis was conducted as follows:—A quantity in fine

* The crystals of yttrotitanite described by Dana in last edition of Mineralogy as in possession of Mr Silliman, are unquestionably only cleaved pieces, which often present very perfect faces.

† Several specimens labelled as thorite, which I have since examined, have proved to be tritomite, and I have found it often difficult to distinguish the two minerals, except by chemical examination, or determination of specific gravity.

powder dissolved readily in hydrochloric acid; it was then evaporated to dryness, but not heated,—redissolved in water acidulated by hydrochloric acid, filtered from the silica, which was washed, dried, incinerated, and weighed.

This silica was now treated with hydrofluoric acid, sulphuric acid added, and digested until all silica was volatilized. There remained a white insoluble residue, which was filtered off, incinerated, weighed, and considered as tungstic acid,* although its small quantity prevented its being submitted to a very careful examination. The filtrate gave, with ammonia, a small precipitate of oxide of cerium, weighing, when ignited, 0·60 grains, but contained no lime.

The original filtrate from the silica was precipitated by ammonia, and oxalic acid then carefully added, until a very faint acid reaction was perceptible to litmus test-paper.

The precipitate which remained was filtered off, washed, ignited, and then treated with hydrochloric acid, in which it dissolved completely, and consequently contained no zirconia or thorina. This solution was now precipitated by ammonia, and filtered from the oxides of cerium, lanthanum, and yttria, which were then collectively ignited and weighed.

The filtrate contained lime, which was precipitated by oxalate of ammonia, and determined as usual. The ignited oxides of cerium, lanthanum, and yttria were now redissolved in a little dilute sulphuric acid, and these bodies separated from each other by means of a saturated solution of sulphate of potash, and by digestion in chloride of ammonium. The respective precipitates were washed, dried, ignited, and determined.

The solution, filtered from the original precipitate of oxalates, was now precipitated by hydrosulphide of ammonium, and the alumina, iron, and manganese determined in this precipitate.

The filtrate was evaporated to dryness, redissolved in water, when a small amount of manganese was separated by filtration, and added to that before obtained.

The magnesia and soda, now in the state of chlorides, were separated from each other by peroxide of mercury, as usual.

* With oxide of tin.

No potash could be detected either by bichloride of platinum or by carbazotic acid.

The amount of water present was determined on a separate portion of the mineral weighing 8·99 grains, which, upon ignition, was found to have lost 0·75 grains.

The results thus obtained were as follow:—

Mineral employed,	51·30 grains.
Silica, impure,	12·30 ...
Tungstic acid ($+ SnO_2$)	2·04 ...
Oxides of cerium, ... of lanthanum, ... of yttrium,	27·65 ...
Oxide of cerium, from silica,	0·60 ...
Carbonate of lime,	3·70 ...
Alumina and oxide of iron,	3·00 ...
Oxide of lanthanum,	6·37 ...
Sesquioxide of cerium,	19·71 ...
Yttria,	2·38 ...
Oxide of manganese,	0·61 ...
Peroxide of iron,	1·53 ...
Chlorides of magnesium and sodium	0·45 ...
Magnesia,	0·05 ...

and the percentage results, calculated from these numbers, will give the composition of tritomite as below:—

		Oxygen.
Silica,	21·16	11·74
Tungstic acid (with SnO_2),	3·95	·81
Alumina,	2·86	1·36
Lime,	4·04	1·15
Magnesia,	·09	·03
Soda,	·33	·08
Yttria,	4·64	·92?
Oxide of lanthanum,	12·41	1·80?
Sesquioxide of cerium,	37·64	7·72?
Protoxide of iron,	2·68	·59
... of manganese,	1·10	·24
Water,	8·68	7·72
	99·58	

The analysis of tritomite made by Berlin, which is here annexed, coincides so generally as to leave no doubt as to the identity of the mineral Berlin found in tritomite.

Silica, ...	20·13
Tungstic acid, with Mn, Cu, Sn, .	4·62
Alumina, ...	2·24
Lime, ...	5·15
Magnesia, ...	0·22
Soda, ...	1·46
Yttria, ...	0·46
Oxide of lanhtanum, . . .	15·11
Oxide of cerium, . . .	40·36
Protoxide of iron, . . .	1·83
Loss on ignition, . . .	7·86
	99·44

On account of the difficulty of ascertaining the degree of oxidation in which the metals are present, as well as the present uncertainty as to the correctness of the atomic equivalents of cerium, lanthanum, and yttrium, it is impossible to give a formula for this mineral which would safely express its composition.

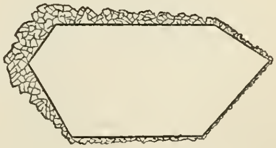
The formula $\dddot{\bar{R}}\,\dddot{S}, + 2\dot{H}$ has been advanced, and is probably as correct as any other which can be at present proposed, considering $R_2\,O_3$ as $= Ce_2\,O_3$, and reckoning the equivalent of cerium at 47·3. This formula will give the percentage composition of

Silica, . . .	24·93	=	SiO_3
Sesquioxide of cerium,	65·18	=	$Ce_2\,O_3$
Water, . . .	9·89	=	$2\,\dot{H}O$
	100·00		

V. *Green Garnet.*

This mineral occurs on the Island of Stokoe, in the Brevig Fjord, and is generally found inclosed in brevicite. On breaking the pieces of brevicite containing such garnets, it will be seen that the crystals of garnets are almost invariably arranged side by side, so as to form the outlines of certain regular figures.

Fig. 2.



The annexed woodcut shows one of these peculiar crystalline arrangements in its natural size. The contour line formed by the crystals of garnet being a hexagon, both the interior as well as exterior matrix is composed of a crystalline brevicite.

In order to see whether these figures were merely rows, or formed prismatic cylinders, I endeavoured to strip the external brevicite from the garnet figure; and found that they were really sections of hexagonal prisms, formed by a great number of regular crystals of green garnet, aggregated together so as produce this result.

There would appear to be some resemblance between this arrangement and the crystals of garnets found near Arendal, in which there is only an external rind of the dodecahedron garnet crystal; the interior being filled with calcspar, in which they also are imbedded. In this case, however, the rind, if it may be so termed, does not appear from my examination to consist of an agglomeration of distinct crystals, but rather as a hollow dodecahedron of garnet, and the interior as well as the exterior surface of which appears perfectly bright and close in texture.

The specimens I have procured of the green garnet have not enabled me to decide whether these hexagonal prisms have any terminal planes. It must, however, be remembered that this shape may be derivable from a section of a dodecahedron; and the brown garnets found at Roraas in Norway have the dodecahedron so elongated as to present the appearance of a six-sided prism, and give a section precisely analogous to the contour figure here shown.

The green garnets, when removed from this brevicite matrix, are found to be well-defined crystals, which are rhombic dodecahedrons, and form a fine leek-green colour. Hardness about 6; streak whitish-gray; and specific gravity, determined on 17·76 grs. of crystals at 60° F. found to be 3·64.

They were anhydrous, and 17·62 grains, on heating to redness, was found to have increased slightly (0·07 gr.), probably from oxidation of some protoxide of iron or manganese.

The powder was but slightly acted upon by hydrochloric acid; and the analysis was conducted by fusion with mixed carbonates of potash and soda; and a check analysis, by decomposition with hydrofluoric acid, was also made.

The other steps in the analysis were conducted in the ordinary manner, and gave the following results:—

22·22 grs. decomposed by fusion, .	gave	7·77	silica.
		5·10	sesquioxide of iron + oxide of manganese.
		1·94	alumina.
		17·24	sulphate of lime.
13·14 grs. decomposed by hydrofluoric acid,	gave	0·34	$Mn_3 O_4$
		2·67	$Fe_2 O_3$
		9·60	$Ca O S O_3$
11·65 grs. ditto, gave .		1·07	$Al_2 O_3$
		2·79	$Fe_2 O_3 + Mn_3 O_4$
		9·04	$Ca O S O_3$
16·66 gr., on fusion, gave .		5·64	grs. silica.

No potash was detected, but soda was present, as shown by antimoniate of potash. Chlorine appeared also to be present as a trace.

These results tabulated will give the following percentage composition:—

		Repeated.		Oxygen.	
Silica, . .	34·96	33·84	...	18·23	
Alumina, . .	8·73	9·18	...	4·05	18·82
Sesquioxide of iron,	20·55	20·31	23·94	6·16	
Protoxide of manganese,	2·40	...			
Lime, . .	32·09	31·92	30·14	8·61	
Magnesia, . .	trace.				
Soda, and loss, .	1·27				
	100·00				

The oxygen of the bases and acids are equal, and the formula will be that of an iron lime garnet, or

$$(3\,Ca\,O)\,Si\,O_3 + Fe_2\,O_3\,Si\,O_3$$

$$\text{or} = (\tfrac{1}{2}\,\dot{C}a^3 + \tfrac{1}{2}\,\dddot{F}e)\,\dddot{S}\ \text{according to Dana.}$$

Calculated from this formula, the percentage composition would be—

Silica, ...	35·61
Lime, ...	32·98
Sesquioxide of iron (alumina), .	31·41
	100·00

From this result it will be seen that, notwithstanding the light colour of this garnet, it is identical with melanite, or belonging to the iron lime garnets, and not a Grossular, as otherwise its external appearance would seem to indicate.

Introductory Lecture delivered to the Students of the Natural History Class, in the University of Edinburgh, at the opening of the Winter Session 1855–6. By Professor ALLMAN.

In the honourable position on whose duties I this day enter, the painful is largely mingled with the pleasing; and how can it be otherwise? How can it be that I may not grieve in the loss of one whose friendship I esteemed among my most valued possessions, a loss which no lapse of years can replace, and which is only felt the more poignantly now that I am called upon to continue the work on which he had so brilliantly entered? Painful, too, is the consciousness of how utterly impossible it is for any one to supply the place of Edward Forbes; to grasp as he did, with all his unrivalled versatility, the wide range of natural science, throwing over its truths the charms of an imagination which never interfered with the sound logic of his judgment. Forbes has passed from among us; he has changed the doubtful for the certain, the obscure for the clear, the trammels of matter for the eternal freedom of the spirit. He has passed from among us, but long will his memory be cherished in the halls of this University; and long will his successors profit by the impulse which he had impressed on the science which he loved, an impulse which it is for them to carry onwards in its accumulating force.

The subject with which we are to be engaged in the lectures this day commenced is Natural History—Natural History in one of its widest and most comprehensive aspects. We are to be occupied, in the first place, with the study of the whole animal creation in every point of view in which it is possible to contemplate it; and, secondly, we are to devote no small portion of our course to the examination of the existing structure of the earth on which we live, and of its history through past time. A field so wide will necessarily demand a large amount of our attention; but the close connection into which the varied subject-matter of the Natural History Chair is thus brought, will enable me to place before you a more comprehensive and grander picture of creation than would otherwise be possible, and will enable you to see in the organized and the unorganized world, not two entirely distinct and disconnected sets of facts, but one grand scheme, with all its parts mutually dependent on one another, and harmonizing into a perfect whole.

The framing of an introductory lecture is no easy task. It is expected that such a lecture must deal with generalities; and yet the generalities of science are not so varied but that they must have been already over and over again worked up in similar attempts. Perhaps, however, I cannot do better on this occasion than point out to you the nature and bearings of the subjects with which the present course is to be occupied, and the plan which it is my intention to pursue in their treatment.

The course of Natural History then, primarily and essentially, according to the universally received meaning attached to the term, involves Zoology. Zoology as a science, is one of wide-embracing comprehensiveness; the animal creation is its subject, but the animal creation viewed from a thousand varying points. In the first place, it will be my business to render you familiar with the *external forms* of the animated beings which surround us—with those prominent features which impress upon them an obvious character, by which they strike the eye even of the uninitiated. A correct knowledge of these external characters lies at the very foundation of all Zoology, and our attention must therefore be largely devoted to them. But to recognise their full value we must know their meaning,—we must seek for the key which is to interpret them, and this is only to be found in *structure* and *development.*

We are thus led to comparative anatomy, the life and soul of Zoology; without it I could bring before you nothing but a dry, uninteresting, and sterile mass of facts, presenting no mutual connection, and barren of ulterior consequence. It is by its aid alone that Zoology has become what it now is, and almost every step in that great progress which it has made during the last quarter of a century has been effected by the scalpel and the microscope. What analysis is to the mathematician, these are to the investigator of the laws of organized existence. Possessed of them we can construct, as it were, a great equation, involving as its unknown quantity the hidden essence of life. And though we may not yet, and probably never shall, succeed in the actual determination of this great mystery, we can at least approach to a solution—we can simplify the formula—we can get rid of all which unnecessarily complicates it, until, by successive eliminations, we ultimately arrive at that simplest expression for a living being, that elemental cell which, in the present state of our knowledge, we must accept as the grandest generalization of Biology. Here, however, we must pause, content to have at least substituted an actual truth for a scholastic hypothesis,—for those illusory phantoms over which our forefathers dreamed away their lives in groundless surmises and visionary speculations, leaving the world no wiser nor better than before, except in so far as they afforded an example to be avoided of time wasted and talents misapplied.

But the zoologist must not consider his knowledge of an animal complete unless he has rendered himself acquainted with much more than its external form and internal structure. Its particular mode of life, the manifestations of those instincts by which it is adapted to the various physical conditions which surround it, and enabled to fulfil its mission in the external world, present a fertile field for careful observation and philosophic study. It is difficult indeed to imagine a subject more deserving of the attention of the zoologist than the psychical endowments of the animated beings which surround us—their wonderful constructiveness, their mysterious migrations, their societies, and commonwealths, and governments, their almost human passions and emotions—strange foreshadowings of a higher nature—to all these a portion of our course must be devoted if we would wish to render complete our picture of animated nature.

But the objects of our study present in the vastness of their numbers a difficulty by which the young student is sure to be embarrassed, and which indeed at first must seem to him almost insurmountable. He looks abroad upon the world with its millions of living beings, as they throng upon his senses without order and without limit. He tries to study them *individually*, but feels that to obtain an adequate knowledge of any one, a lifetime would be needed. He attempts them in *masses*, but finds that he can make no general assertions of his ill-assorted groups. Lost amid the bewildering multiplicity of forms, he knows not where to turn, he is terrified at the labour which is before him, and is tempted to give up the study of nature in despair.

And this he might well do, were it not that there comes to his assistance an agent amongst the mightiest of all that have aided in the investigation of Truth—Classification lends to him a power by which, as at the utterance of a spell-word, the chaos which had surrounded him marshals itself in order, law becomes everywhere apparent, relations previously unseen weave themselves through all, and bind together the dissociated elements, and the external world, no longer a confused mass of uncorrelated objects and phenomena, now opens up before him as one beautiful harmonious whole.

To the principles, then, of a philosophic classification, and to the application of these principles to the animal kingdom, our attention must be largely devoted. The classificatory element of Natural History, indeed, is one which we cannot confine to any particular section or period of our course; it is one which must more or less extend itself through all the lectures to be delivered from this chair, as a pervading and regulating principle.

But the living beings which surround us are not scattered at random over the surface of the earth; we know that some are confined to one region, others to another, each finding in the place of its abode the physical conditions best suited to its organization. The labours of scientific travellers have now gathered together from almost every corner of the earth an immense accumulation of facts all bearing upon this most interesting subject of inquiry, and indications of certain great general laws regulating the geographical distribution of organized beings have been the result. The phenomena, therefore, of the geographical distribution of animals, and the elucidation of its laws, so far as these have been determined, will constitute another important section of our course.

For the exposition, however, of the laws of geographical distribution, there is needed an accurate knowledge of the physical conditions of the earth's surface—of those ever-changing phases of heat, and light, and moisture—of that infinitely varied conformation of mountain, and plain, and valley, of river, and lake, and torrent, and fen, of wastes of ice, and deserts of burning sand, of rock, and cliff, and island, and continent, and the great ocean rolling round them all—a variety to which that of organized beings is beautifully adapted, and by which their distribution over the earth is mainly limited and controlled. Physical geography, then, which renders us acquainted with this varied structure of the earth's surface, and with the meteorological conditions to which it is exposed, must find a place in a comprehensive course even of Zoology.

But organized beings are related to *time* as well as to space, and the phenomena of their distribution in time will constitute a topic of the very highest philosophical interest. We shall thus be led back to the remote ages of the past, to those early mornings of creation when beings altogether different from those which now dwell among us lived and multiplied amid primæval solitudes, and having performed their destined part in the economy of the universe, yielded up their places to others, which in their turn passed from among living forms, to be succeeded in other epochs by other races, until at last, in the great chain of succession, we are brought downwards to the days in which we are. But though those ancient tenants of our globe may have left behind no living representative, we have in their fossil remains an uncorrupted record from which the palæontologist can construct a history of the pre-Adamic ages of the earth. It is only by the study of this history, and of the strange beings which played their parts in the times which it records, that many a perplexing feature in the existing organic creation can be explained, and our view of living nature be rendered comprehensive and complete. Palæontology thus falls into Zoology and Botany as its proper sphere, and must therefore constitute a portion of the zoological section of our course.

But as the distribution of organized beings in *space* cannot be understood without a knowledge of the superficial conformation of our earth, so an accurate conception of their distribution in time will require from us a knowledge of the deeper structure of its crust, and of those changes which physical agencies have through successive periods of time effected in the disposition of its parts. Physical Geology, therefore, whose complete treatment must also include Mineralogy, claims your attention along with Palæontology; and thus, even though, in defining the duties of this chair, no special mention were made of any other subject than Zoology, I would deem those duties incompletely performed were the Professor debarred from the exposition to his class of the phenomena and laws of Geology.

From the general glance we have now taken at the nature and mutual dependence of the subjects which are to engage our attention during the ensuing lectures, it will be seen that Natural History is no mere pastime for the dilettante, no simple antidote to ennui; that it is a department of human knowledge which must be studied deeply and earnestly if we would master the truths with which it is conversant, and appreciate their significance. There was a time when a low appreciation of the Natural History Sciences might have been well pardoned, when a true philosophy had not yet given an impulse and direction to the pursuits of the naturalist. Like other immature phases in the development of knowledge, this state of things was never destined to endure, and at the present day, and before my present audience, I feel that our science needs no apologist. We have only to reflect on the intrinsic value of its truths, their beauty and marvellousness, the high philosophy of its method, and the mental training involved in its study, to render it no matter of surprise that it has begun to occupy a prominent position in our Universities, and that Government has recognized its claims for qualification in some of the most important posts in the public service.

It is not my intention to occupy you for any length of time by dilating on the advantages of such studies to the Medical Student, with whose special pursuits Zoology and Botany have from the earliest days of scientific medicine been linked in one inseverable brotherhood. I feel sure you all see as well as I do, the light which these studies must shed on a philosophic practice, by giving us enlarged views of organization, and of the great laws of universal life; and I know that it needs no laboured argument from me to convince you of how indispensable they must be as a preliminary curriculum to the more directly practical portion of your career; affording you an intellectual discipline where you are exercised in those habits which can alone make you great practitioners, and above all in habits of diagnosis, the very corner-stone of practical medicine, and of which the Natural History Sciences present the most complete gymnasium that ever has been or ever can be offered to the student.

The determination just adopted by Government, of introducing the Natural History Sciences into the examination for appointments in the civil service of India, is a thing altogether so new, and so full of ultimate results, that I cannot pass it over without an additional word or two. In a comparatively new and in many respects still unexplored country like India, where its advancement depends so much on our knowledge of its natural productions, it is manifestly of the very highest importance that the occupiers of public offices in that country should go out provided with such information, and trained in such studies as may enable them to assist in the discovery and development of these great natural sources of colonial wealth.

But independently of the direct application of Natural History knowledge to the development of the natural resources of our colonies, there is something in the intellectual training to which the candidate for a writership in the East India Company is thus subjected, and the peculiar habit of thought which results from a course of Natural History study, which must unquestionably prove of the highest value in the special duties of his office. And, indeed, for such duties we can scarcely too highly appreciate the habits which are thus acquired of enlarged, yet accurate and detailed observation, of the perception of the relative importance of attributes, and of the discrimination of closely-allied objects,—the power which is thus bestowed of perceiving at a glance the proper grounds of physical truth,—the exercise, in short, of all those faculties which are involved in a comprehensive power of comparison, and of rigidly logical induction; but, perhaps above all, the training in the principles of a philosophic classification, for which the Biological Sciences afford the grand

and almost exclusive school. In estimating the more purely practical tendencies of such studies, it should never be forgotten that Cuvier and Humboldt have been statesmen, and that no less an authority than Bentham has deliberately stated it as his belief, that were it not for Linnæus and Jussieu, and the other great masters of Natural History classification, the science of Codification, or the philosophic construction of the laws of a country, could never have arisen.

Upon the grounds, then, of simple utility, Natural History can put forth claims which all must recognise. Even though the immediate practical application of many of its truths be not at once apparent, this will afford no reasonable grounds for a cry of uselessness. Great truths, truths of mighty significance in the physical and social condition of our race, may be concealed within a fact apparently insignificant and unpregnant of result. Who could have dreamed of the import of that truth which quivered forth in the vibrating muscles of the dead frog's leg as it hung upon the wires of Volta? and who could have thought that there dwelt within those quaint old cups which are pointed out to the visitor of the Museum in Como, a promethean power which now strings the earth with a nerve-net and animates it with thought? Who could have pictured to himself the marvellous growth of that young giant force which your own Watt summoned into being, and which no sneer of the scoffer could destroy in its cradle?

But I am very far from believing that it needs any plea of mere utility, in the too generally accepted sense of this word, as synonymous with mere money value, to gain for Natural History studies a cordial reception from every lover of truth, and every well-wisher of the intellectual and moral advancement of his race. All honour be to those practical sciences which the stern reality of everyday life has called into existence, and which only yesterday received from my friend and colleague, Dr George Wilson, so eloquent and true an exposition; but "man does not live by bread alone;" the philanthropist deems it not enough to minister to mere physical wants; he sees, indeed, that his fellow man must be housed, and fed, and clothed, but he sees no less clearly that there are higher elements of his being, the intellectual, the moral, and the religious—elements which link him with a purer order of existence, which make him the heir of immortality, the aspirant to heaven. Science is not to be despised, if we do not find in it a value which may be estimated by coin. Truth must not be weighed in the scales of the money-changer. There is another balance in which the labours of the honest-hearted student who loves the truth for truth's own sake, will yet be tried, and in that balance they will not be found wanting.

And now, gentlemen, to you I look for aid in the development in this University of a great Natural History School. The chair which had been held for half a century by Jameson, and for a shorter time, alas! than one brief year by Forbes, must not, if we can help it, fall from the reputation which these great names had conferred upon it. But, gentlemen, with you, even more than with myself, does it rest to maintain that reputation; and I have too much faith in the young men of our Universities, and trust too surely in that love of knowledge and truth by which I know that they are animated, to suffer me to believe that my confidence in the aid and co-operation of my pupils is misplaced.

It will not do for you to remain contented with mere routine attendance on the lectures to be delivered from this chair. The very nature of a professorial chair renders it impossible for me in many cases to do more than indicate to you those paths which you are to follow out for yourselves; but in this you will have every facility, and in conjunction with study in the field, I would urge upon you as frequent visits to the museum as you can spare time for from other avocations. You may there spend many a profitable hour; the collection is large and varied, and worthy of this great University. We are now actively engaged in its arrangement, and in the disposition of the objects, so as to give it as much as possible of an illustrative and educational value; and though much still remains to be done, which it is impossible to carry out with advantage until the additional space promised to us by Government be placed at our disposal, you will yet find that sufficient has been already achieved, especially in those departments which bear evidence of the philosophical views and judicious but uncompleted labours of our much-lamented friend Edward Forbes, to afford you valuable instruction, and abundantly repay the time bestowed upon its study.

While, therefore, it will always be my duty and my great pleasure to help you onwards to the best of my ability, your main reliance must be upon your own exertions; you cannot delegate to another the microscope and the scalpel, the dredge and the collecting-box. Neither can you delegate to another your right to judge for yourselves as to the validity of the facts here adduced, or to form from these facts your own conclusions. Far would I be from desiring that my pupils should receive with implicit faith the teachings of this chair, as if a professorial authority had invested those teachings with peculiar sanctity, and deprived you of all right to question them. I know well how prone we are to adhere to a favourite view; I know well, when after days or months spent in laborious observation with the microscope and the dissecting knife, or in attempting to interpret some involved and obscure geological phenomenon, the naturalist has at last arrived at some apparent fact, the sole reward of his expended time and taxed mind—a fact, too, it may be, of grand significance, if real—I know well how difficult it is then not to cling to his precious discovery—and that, too, in all sincerity—amid argument which, to a less interested advocate, must bring conviction of a fallacy. I have too much experience in such things not to feel the danger, and it is, therefore, that I would heartily wish to see the student turn from the expositions of this chair to the searching test of personal observation: "Nec te moveat Galeni auctoritas, naturæ et occulis credendum est, non Galeno."

To the student of Natural History, few places afford such facilities as Edinburgh for carrying out by actual work in the field, the principles expounded to him in the lectures of the class-room. In the geological phenomena of the surrounding district, you have facts of the very highest interest, admirably adapted for the practical illustration of our lectures, and as affording examples of some of the most important agencies which have been at work in bringing about the present condition of our earth, presenting to the student a field for study of unrivalled instructiveness. Then for the zoologist there is the Forth, with its copious and most interesting Fauna, so immediately accessible to you; the Clyde now so easily reached in these days of rapid transit, with its beautiful lochs teeming with zoological treasures; and the innumerable other bays and islands of the Scottish coast as yet little examined, but well fitted to repay the trouble of a careful exploration,—a concurrence of advantages which altogether afford to the student of marine zoology, facilities possessed, perhaps, by no other university in the world. And then there are your glorious Highlands, with their lochs and tarns, and unsullied streams, and wooded glens, and lonely moors, where the botanist has so often filled his vasculum, and where, in their almost unequalled variety of habit the zoologist may expect a harvest no less productive.

It is no small advantage of the studies for whose promotion this chair has been created, that they so often separate us from the city, from its distracting occupations and unprofitable pleasures, and carry us away into the purer country, where we may breathe the free air of heaven, and with invigorated bodies and refreshed spirits, hold commune with the beautiful and the good around us; where we may read in that wondrous book "whose pen," as it has eloquently been said, "is the finger of God, whose covers are the fire kingdoms and the star kingdoms, and its leaves the heather bells, and the polypes of the sea, and the gnats above the summer stream."

It is a great error to suppose, as has been done, that there is danger to scientific truth from our indulgence of the love of the beautiful, or the exercise of our imaginative faculties; or, on the other hand, that these must necessarily be extinguished within the atmosphere of our academic halls. So far from this being the case, I am persuaded that each derives benefit from the other. The painter or the poet is a better painter or a better poet from being also a good naturalist; and to him the wide moor, and misty mountain, and ocean-worn cliff, will become invested with fresh beauty and fresh wonder when he has made himself familiar with the forms and the habits of the wild creatures which frequent them, and is no longer ignorant of those material laws which fling the mist over the mountain, and the heather over the moor, and have heaved up that granite mass, a barrier to the advancing billow, and a shelter to the sea-bird in its clefts. It is then he feels how full of thought is all this marvellous world; it needs not then the poetic fables of the Greek to people for him every glen and fountain, and wood and hill, with its appropriate genius, for the naturalist knows and feels, as none other can, the spiritual which is around him, and deep in his utmost soul rests for ever the unshaken faith, that on lonely mountain top, or barren shore, in the deep recesses of the silent wood, or on the boundless expanse of the never-tiring ocean, there dwells a Power and a Presence, dimly felt, it may be, through the gross medium of sense, but the true philosopher with hopeful, trustful confidence awaits the dispersion of the earth mist, knowing that in God's own time the twilight of conjecture must yield to the unclouded noontide of knowledge.

While by our noble schools of poetry and painting there is thus nothing but benefit to be gained from the scientific study of Nature, so, on the other hand, to the philosophic naturalist there is in the imagination a source of power which cannot be dispensed with. It is my full conviction that where the imagination is very deficient, there never can be a great naturalist. All experience is in favour of this view; some of the greatest discoveries in natural science, discoveries which have marked out great eras in its progress, have been made by men deeply imbued with poetic inspiration. The names Goethe and Chamisso will for ever link themselves with the highest philosophy of our science; and a Linnæus, an Oersted, a Humboldt, and a Forbes, are brilliant proofs of how largely the æsthetic faculty may dwell in minds which have made incursions the deepest and the widest into the realms of scientific truth.

I have thus, gentlemen, endeavoured to render you acquainted with the general plan and scope of the lectures to be delivered during the present session from the Natural History Chair of this University; I have dwelt as far as I was permitted by the limits within which it is necessary to restrict a single lecture, upon some of the special characteristics of the studies in which we are about to be engaged, and on the claims which they have upon your attention, not only as professional but as general students. I have also referred to some of the peculiar facilities which this University affords for their pursuit; and it now only remains for you to enter upon them with clear heads and active hands, but above all with loving hearts. The Natural History Chair differs from most others in this University, in the fact that while the larger proportion of the students who attend it are engaged in special medical studies, there is generally also a large number who are fitting themselves by the necessary academic exercises for other professions; while it is further probable that some of you will not have in view a preparation for any of the so-called learned professions, and will not be engaged in the pursuit of any special curriculum. One thing, however, is common to you all, that the close of your academic career only opens to you a world where not one of you can be inactive, a world of wide-embracing duties, of labour of the hand and of labour of the head. Underlying all the teachings of our chairs is this solemn fact: I trust we all feel it, both pupils and professors; and much would I grieve to think that the day which completed your attendance on these lectures terminated your relation to your professor, or that you would cease to consider him at all times ready to aid you in your further pursuit of those branches of knowledge into which you have been here initiated. And whether it be that in struggling onwards, the harsh realities of life may throng fast and thick upon you, and the world become too strong for your mastery, or on the other hand, that the well-earned rewards of study shall be yours, and professional honours come to you unasked, we would truly regret to think that you could forget that there are still those in your old University, who can surely sympathise, and who may advise you in your difficulties, and who take an interest and a pride in your success.

On the relations of the Silurian and Metamorphic Rocks of the South of Norway. By DAVID FORBES, F.G.S., F.C.S., A.I.C.E. [Plates II. & III.]

The observations forming the subject of the present communication were made during the summers of 1854 and 1855, as an attempt to establish a connection between the fossiliferous and crystalline strata, the mutual relation of which, especially in Scandinavia, has as yet been so little examined.

The investigation of the Silurian formations of this district was commenced at the request of Sir Roderick Murchison, and the few observations here introduced respecting them are only to be considered as an introduction to the subject, as, from the natural difficulties of the country, considerable time will be required to produce any detailed account of them, especially as regards their fossil contents.

The chart (Plate II., fig. 1) shows the geographical position occupied by the Silurian and Devonian formations, and is in a great measure constructed from personal observation, with the assistance of the boundary lines fixed by Keilhau for the northern part of the metamorphic and igneous rocks, and the extent occupied by the porphyry, which latter I have not examined.

On reference to this, it will be perceived that the entire boundary of the fossiliferous strata is formed by an extensive tract of igneous rocks, occupying the whole space between this and the Christiania Fjord.

The southernmost part of this, and most of the islands, is composed almost exclusively of zircon syenite; but further northward porphyry, granite, and syenite, make their appearance.

As might be anticipated from the proximity of such immense igneous masses, a large portion of the adjoining fossiliferous strata is found in a much altered condition, and generally to such an extent as completely to obliterate all traces of the fossils previously contained in them. Notwithstanding this, I have found a considerable number of fossils in a sufficiently determinable state, so as to leave no doubt as to the Silurian character of the greater part of this district, and am confident that on further examination, especially in the more northern and less altered part, a very large number of additional species will be obtained. The University of Christiania possesses a considerable number of fossils from this district; but as little attention seems to have been paid to localities, they are comparatively worthless in a geological point of view.

The only rocks which I have regarded as of Devonian age are one, or possibly two, sandstones, and some superposed beds of argillaceous shale, which are both in so highly altered a condition, that all fossils, if ever present, have been obliterated, and their beds can only be looked on as Devonian from their position.

They are not coloured separately on the chart, but if of a different colour, would show themselves as a narrow strip running along the edge of the igneous rocks.

As yet I have not obtained sufficient data to determine the thickness of the separate formations. The Devonian appears but of small development, probably not amounting to more than 500 feet. The Upper Silurian, generally much altered, may possibly reach even above 2000 feet in thickness in the southernmost parts; whereas the Lower Silurian, reckoning downwards to the bottom of the alum shale which rests upon quartzite, does not seem to be much above 100 feet in thickness.* All these seem to diminish in thickness as we proceed northwards; and at the most northern point I have examined they do not probably collectively reach 2000 feet.

In order to study the relations which these formations bear to the crystalline rocks in contact with them, which is the principal object of this communication, it was necessary to make a series of vertical sections across them, some of which I shall briefly describe.

The territorial portion of the formations will be seen on the chart: and as the general and very constant strike of the fossiliferous rocks was only a few degrees from N. to S., the

* The Lower Silurian is not separately coloured on the maps, but would appear as a thin strip between the Metamorphic and Upper Silurian formations.

vertical sections were carried more or less E. and W. according to local circumstances.

Commencing northwards, a section was made across the Boe River (Boe Elv) at Fossum, where, descending the hill slope over an alternating series of shales and limestones, we come to the alum shales at the river side, and separated from the gneiss below them by a thin bed of rock, which has been considered as eurite; it is, however, open to dispute as to whether it really be an igneous rock or not. This eurite follows the valley of the river, and outcrops on side of the western range of hills, which are composed of feldspathic and highly characteristic gneiss, often cut through by small veins of granite and trap, and possessing a pretty regular and distinct general foliation. Crossing this range we come to Jonsœter Dalen, and have mica schist appearing, but its extent has not yet been examined into.

All the beds superior to the eurite are fossiliferous, and have a general strike of 23° N.W., dipping 35° eastward, which is identical with the general strike and dip of the lines of foliation in the feldspathic gneiss on which they rest.

I have not continued this section eastwards across the Silurian beds, but am informed by Mr Dahl that, after crossing an alternation of limestones and shales, we arrive at a sandstone (Devonian ?), above which is an imbedded augitic trap, separating it from another (? same) sandstone, on which lies an altered clay shale, with a second imbedded augitic trap, parting it from a brown micaceous clay-slate or shale, more altered than the former, and in immediate contact with a large tract of syenite.

Being under the impression that the feldspathic gneiss, above described as occurring at the western end of this section, might possibly have originally been an igneous rock, with superinduced foliated structure, and not the normal stratum in succession below the alum shales, I made a section across a more central part of the Silurian basin, and was thereby confirmed in this opinion.

This section, running east and west from Krabra to Ombersnaes, is depicted, Plate III., sec. 1.

Commencing at the east, we have the Upper Silurian calcareous shales in an altered and hardened condition, nearly if not quite through their entire thickness, and up to their junction with the Lower Silurian, as seen at the water's edge: the only fossil remains sufficiently distinct to be recognizable were the stems of encrinites. Coming now to the Lower Silurian, we have a bed, of about 30 feet thick, of unaltered dark-coloured shale, in which Mr Kjerulf and myself found graptolites abundant (*Diplograpsus nodosus*),* *Lingula* (*attenuata ?*), and orthoceratites. Under this is a bed of calcareous shales, resting upon a thin bed of limestone, containing orthoceratites, and between which and the succeeding alum shales is an imbedded trappean rock, as shown in the section. The alum shales contain large nodules of anthraconite (carbonate of lime), and are probably about 50 feet thick, but are divided near their base by an imbedded gray trappean rock, about from 2 to 3 feet in thickness. The shales are only very slightly altered or disturbed by this intrusion, and immediately below recover their original character and regularity, and rest directly upon a distinctly bedded thick quartzite, the upper beds of which are of a smoky colour from an intermixture of carbonaceous matter.

This quartzite is evidently nothing but a Lower Silurian sandstone, altered by its proximity to the large dyke (*a*) of igneous rock, of a hornblendic trappean character, which divides and imbeds itself in the quartzite, and throws out a large branch (*b*), as seen cut through in the section.

As far as we have yet proceeded along this line, we have met with a series of regularly-stratified beds, with a strike of from 5° to 20° N.W., and dipping about 12° eastward; but upon crossing this trappean rock, we come to a considerable tract of metamorphic rocks, differing in character from any of the preceding strata.

The foliation of these rocks is totally at variance with the dip of the hitherto observed bedding, it being nearly vertical, and the strike is equally discordant and not constant. The

* I have to thank Mr Alport of Birmingham for revising the fossils mentioned in this communication.

following observations, taken at pretty equal distances along the line of section (from *b* to *c*), will sufficiently show this:—

Strike 108° N.W.	dip 20° southwards.
... 125° ...	... 80° ...
... 170° ...	... 87° ...
... 65° ...	... 80° ...
... 165° ...	... vertical.
... 65° ...	... do.
... 65° ...	... 75° southwards.
... 88° ...	... ?
... 140° ...	... ?
... 155° ...	... 80° southwards.
... 140° ...	... vertical.
... 108° ...	... 70° southwards.
... 118° ...	... 45° ...
... 118° ...	... 50° ...
... 98° ...	... ? irregular.
... 135° ...	... ? contorted.
... 140° ...	.. ? ...
... 135° ...	... ? ...
... 140° ...	... ? irregular.
... 130° ...	... ?
... 148° ...	... 80° southwards.
... 108° ...	... 80° ...
... 128° ...	... vertical.

This parallel structure was carried out in a very peculiar manner: the ground mass of the rock did not present any distinct foliation in itself, and was evidently a quartzite nearly identical with that before described. The foliated arrangement was visible from the occurrence of a series of stripes of dark hornblenditic nature, presenting a strong contrast to the grayish-white quartzic ground mass. These stripes were not continuous for any great distance, but were irregularly broken off and recontinued, and varied in breadth from less than one inch to more than two feet.

The appearance of this structure, which, viewed on the large scale, presented distinct features of general parallelism, was so striking that it at once annihilated the idea that this arrangement could have resulted from any alteration of the original lines of stratification; and the occurrence of miles of such vertically foliated rocks seemed to me incompatible with the idea of supposing them to represent originally horizontal strata tilted into a vertical position. After a careful examination of the subject, it seems to me much more feasible to regard these rocks as having originally been deposited as a moderately thick and nearly horizontal bed of sandstone (quartzite), conformable to the Silurian strata now above them, and that the foliated arrangement visible in them is due to their having been broken up (by the intrusion of granite veins and other agencies), and thus producing a series of cracks or joints, possessing a comparative regularity when viewed on the large scale; the mineral matter representing the hornblendic stripes having been subsequently filled in, most probably as a muddy sediment metamorphosed and foliated by the heat of the later trappean or other igneous eruptions.*

With the hope of finding a point where the contact of the Silurian rocks and crystalline schists was not disturbed by the large dyke (*a*), I examined the line of contact from sea to sea, but found that the dyke was continuous to the lake called Stokke Vand, and reappeared at the southern extremity of this lake, continuing quite to the sea at Rognstrand, although apparently not so broad as before. Here were also observed two small trappean veins imbedded in the alum shales corresponding to those found similarly situated at Ombersnaes.

Before examining the order of succession found below these rocks going westward, I shall direct attention to the geology of some of the eastern islands which were examined, in order to study the points of contact of the fossiliferous beds with the syenite. In 1854, I visited† nearly all of these islands, and found that they were composed entirely of zircon-syenite, with the exception of Store Aroe and Stokoe, on both of which islands other rocks likewise made their appearance.

To my astonishment considerable deposits of metamorphic crystalline schists showed themselves on both these islands, as

* Possibly, also, such cracks might be filled up by injection of igneous matter, but the above view seems to me the more likely.

† Amongst those visited, were Sandoe, Bjorkoe, Oxoe, Lovoe, Lille Aroe, Store Aroe, Stokoe, Sigtesoe, Bratholmene, Veaholm, Hesteholm, Trompetholm, Elizbetsholm, Smedholm, Ringsholmene, Kistcholm, Loven, Kaieholmene, Halveisholm, and a great number of rocky islets.

well as on several rocky islets at south end of Stokoe; and it was apparent either that these rocks occupied the position of the Devonian formation, as developed further north, or that the crystalline rocks of the western district extended round, and formed the southern boundary of the Silurian basin. This year, an examination of the more southern island, called Fugeloe, seemed to prove the former of these views to be correct; and on a visit to the island in company with Mr Kjerulf, it was found to be composed of Upper Silurian calcareous shales in a very hardened condition, and cut through by several large dykes of trap running nearly east and west, and sending out branches imbedded along the course of the strata. The trap dykes decomposing more readily than the surrounding rock, left deep chasms cutting completely across the island. The bedding of the strata here agreed with the general strike of the rest of the district, being 27° N.W. with a dip of 40° eastwards.

The fossils found here, on a very short examination, were *Favosites Gothlandica*, *Syringapora*, *Orthis* (?), *Atrypha* (*reticularis?*), *Stenopora fibrosa*, *Heliolites*, *Favosites* (?), *Stromatopora* (?), *Syringapora* (? new), *Euomphalus sculptus* (?).

It appeared evident, therefore, that the Silurian rocks were quite continuous, and that the metamorphic rocks seen at Aroe and Stokoe had no connection with the main western crystalline district. Their relations will be better understood upon referring to Plate III., section 2, where an attempt is made to exhibit a sectional view of all the more characteristic features of the district, the course of section being marked by a line on chart, Plate II., fig. 1.

Commencing on the mainland at Helgeraae, we find zircon-syenite, which likewise forms most of the small rocky islets in the vicinity. Arriving at Stokoe, the zircon-syenite shows itself breaking through a metamorphic schistose rock constituting the original mass of the island. This rock is of a perfect crystalline character, and consists of green-black hornblende associated with a small amount of a feldspathic mineral. At points of junction with the zircon-syenite it resembles gneiss, and contains some mica, but no quartz. A ground plan of the southern extremity of the island, with three small rocky islets, is given, Plate II., fig. 2, and shows the intrusion of the zircon-syenite. The strike of the schistose rock, or rather of its foliation, is here irregular from the disturbing action of the syenite; but where we find these beds extending across the narrow sound to Aroe, and continuing quite across that island also, they have a constant strike of 53° N.W., with a varying dip, although always at very high angles. At Aroe they bear much the same relation to the zircon-syenite, as will be seen from the section, Plate II., fig. 3, which is across part of the western side of this island; they also appear here to be of a browner colour, and contain a micaceous-looking mineral, and in both islands are broken through by imbedded veins of augitic trap. The junction between these schists and the quartzite above them is disturbed by the intruding zircon-syenite, which sometimes sends veins into the quartzite, and then generally contains quartz as an ingredient, which otherwise never enters into its composition. The quartzite is much hardened, and bedding obliterated, at the junction with the syenite.

On comparing the results of these sections with what has been previously said respecting the succession of the Devonian rocks further north at Fossum, it will be seen that there is good ground for entertaining the idea that these rocks are the equivalent of the Devonian series there found.

The mineralogical character of the hornblende schist is precisely identical with some similar beds which I have found in Espedalen, in central Norway, under circumstances where there can be no doubt of its having resulted from the alteration of shales (of about a similar age) from contact with the syenitic rocks of that district.

Advancing along the section, we now find, in descending order, the island of Gjeteroe, composed of Upper Silurian beds of calcareous shale, with occasionally thin interstratified limestones. The shales are much hardened, and the limestones converted into a loose, granular, white marble.

These beds almost everywhere, notwithstanding their altered condition, showed appearances of fossils. On the east side traces of a trilobite, *Terebratula reticularis* (?), *Encrinites*, and *Pentamarus*, all very indistinct; also *Murchisonia* (*corallii*?) and *Petraea*. On the west side, at the sea-side, *Favosites alveolaris*, *Heliolites* (?), *Heliolites tubulata*, all distinct.

Many trap dykes are visible, and send branches imbedding themselves to very great lengths in the surrounding shales. One of the largest dykes on the east side appeared to be the cause of a most regular series of joints parallel to it, and at first sight very liable to be mistaken for the lines of true bedding, although these were in reality very divergent.

Coming over to Langoe, the same shales continue, and strike 18° N.W., dipping 20° eastwards; they are much altered and hardened, and on the weathered slopes present the appearance of a network of a hard siliceous rock, filled with a crumbling white crystalline marble, which, being more easily acted upon by the weather, leaves the former very prominent. Only very indistinct traces of fossils (corals) were here observed. Starting from the town of Langesund, we have the same indurated shales continuing almost the whole way to Sandvig, with the exception of some beds of soft blue limestone seen at (*d*), and denoted by the crossed lines. In these beds were found,—*Encrinites*, *Spirifer*, *Leptoena sericea*, *Orthis* (*actonia ?*), *Echinosphrœrites punctatus ?*

Although the other beds contained very frequent traces of fossils, or corals, *Millepora repens*, *Favosites*, *Stenapora fibrosa*, *Encrinites*, *Orthoceratites* (?), several shells and others; they were altogether too indistinct to admit of serviceable recognition.

Arriving now at Rognstrand, the Lower Silurian strata appear to correspond to those before described at Ombersnaes, but as yet no fossils were discovered.

Under the alum shales, we have quartzite beds as before, and under this, a thin bed of a peculiar character, having a very distinct foliation, induced by a dirty-coloured chloritic mica, the rest of the rock appearing of an argillaceous grauwacke appearance.

Although this bed appears to be perfectly conformable to the strata above it, the direction of the foliation induced by the plates of mica in it is totally different. The stratification strikes 42° N.W., dipping 20° E., whereas the foliation runs

108° N.W., dipping 45° northwards. It appears to me probable that this peculiarity of structure is caused by the lines of foliation having arranged themselves along lines due to drift-bedding previously present in the rock.

This bed does not appear in Plate III., section 1, but is probably only concealed by the large mass of trap occupying its place at (*b*). At Tanvold, however, it shows itself, and is doubtless continuous.

We now come to a great extent of quartzitic metamorphic rocks, with nearly vertical foliation, and intersected by numerous veins of granite, and some few trap dykes. These rocks are somewhat similar in character to those described at Ombersnaes, but the darker stripes are not so distinct, much narrower, more contorted, and not so easily accounted for by the same suppositions ; sometimes also, there appears to be a faint tendency to micaceous foliation, but felspar seems invariably wanting, except when in close contact with some of the granitic outbursts.

The ground mass is invariably quartzitic, and at Elvig this rock changes almost insensibly for a short distance, to nearly an ordinary quartzite, which was also found to be the case at several places further westward than the limits of section permit of observing. The green colour in section shows the position of dark bluish-black crystalline hornblende schist, hard and compact. Further westward, on line or section (but not depicted), we have the whole country broken up as far as Bredvig by great outbursts of syenite, diorite, and granite, which break up the continuity of the schistoze rocks.*

If now, in studying the section here produced, we should set out with the supposition that the lines of foliation represent in this case the lines of original stratification, we shall have to suppose the tilting of beds many miles thick into a vertical position ; a conclusion which can hardly impress the mind with a belief of its own reality. On the contrary, should we

* The small uncoloured space of section on the heights between Evindsvig and Odegarden, is covered with shell-sand, which, from its position, being about 200 feet above the sea, becomes interesting. As yet I have not been able to compare the species with the recent ones of same coasts.

take it for granted (what I have elsewhere endeavoured to prove*) that the particles of matter in rocks may rearrange themselves at comparatively low temperatures, we shall have less difficulty in finding a more feasible explanation of the position of these rocks. Setting aside the direction of the lines of foliation as due to other causes, and keeping in view the character of the rock masses as a whole, we shall find that the dotted lines shown on Plate III., section 2, E to F, will represent phenomena analogous to those of everyday occurrence in the later formations, and present only a series of undulatory beds due to upheaval or subsidence. The upper one of these beds has doubtless originally been an ordinary impure sandstone, whereas the hornblendic schists represent an ordinary ferruginous argillaceous shale, and its ultimate chemical composition will hardly be found to differ from many shales occurring high up in the fossiliferous series, and altogether different in external mineralogical appearance.

Taking this view of the subject, I have no doubt but that it will be possible to analyze large tracts of the hitherto considered irresolvable and monotonous gneissic districts, both of Scandinavia and other countries.† I have already found that the district around Krageroe, and in fact an area of several hundred square miles between Langesunds Fjord and Österrisoer may be resolved into a comparatively small series of beds occurring in a series of flat basins, and evidently analogous to the sandstones and shales of newer formations, and most probably the equivalent of the Lower Silurian (Cambrian) strata of Wales.

* Quarterly Journal of Geological Society of London, 1855, pp. 166 to 185.

† I think it is also likely that the vertically stratified gneiss under the Silurian formation at Kinnekulla, in Sweden, as depicted in Sir R. Murchison's *Siluria,* p. 318, may admit of a similar explanation.

Contributions to Ornithology, by Sir William Jardine, Bart. *No. II., Professor W. Jameson's Collections from the Eastern Cordillera of Ecuador continued.—Expedition from Quito to the Mountain Cayambe.* (Plate IV.)

In the last Number of this Journal we gave a short description of a very interesting bird procured by Professor W. Jameson during an expedition to the mountain Cayambe. A sketch of the route has been sent to us, with a few notes relative to the country and its vegetation. These notes are now given, along with a figure of the bird, as promised. (Plate IV.)

"Viewed from Quito, the mountain Cayambe presents a singularly grand and beautiful appearance. It is covered with an immense glacier, from which, towards sunset, are reflected tints of various degrees of intensity, finally assuming a brilliant white, when the sun's rays are totally withdrawn. It is situate directly under the equator.

"Travelling from Quito to Cayambe, we cross the valley of Guilabamba, elevated from 7000 to 8000 feet above the sea level, and characterized by a vegetation of—

Mimosæ.	*Tillandsia, sp. variæ.*
Acaciæ.	*Tecoma sorbifolia.*
Cactus, sp. variæ.	*Schinus Molle.*
Croton.	*Hæmanthus dubius* (359.)
Dodonæa viscosa (396.)*	*Evolvulus incanus* (5.)
Ricinus communis.	*Aloe.*

"This is a deep valley, and separates the eastern from the western Cordillera. The upper part is called Chillo, the principal production of which is maize: lower down it takes the name of Guilabamba, where the temperature is sufficient to grow the sugar cane; and still lower down is Perucho, where the river Guilabamba is crossed by a chain bridge. The river there suddenly turns westward, and finally joins the Esmeraldas near the coast of the Pacific.

"On descending the valley, the heat becomes gradually quite oppressive from the reflection of the sun's rays from a rocky soil wholly destitute of verdure. The scanty and starved ve-

* The numbers refer to Jameson's *Plantæ Equatoriales.*

getation, composed principally of Mimosæ, affords no protection whatever. Next to these the plants that most abound are the Tillandsiæ, attached to the arid rocks, or suspended from the trees (*T. usneoides*).

"Crossing the Guilabamba by a stone bridge, we enter a village of the same name, the houses of which are constructed of Wattles. Here there is a considerable extent of level surface appropriated to the cultivation of the sugar-cane, from which spirits are exclusively obtained. The inhabitants of the cool table-lands entertain a natural dread of passing the night in Guilabamba, arising from the prevalence of intermittent fever, the origin of which is to be traced to a marsh in the immediate vicinity of the village."

In every new locality of this rich zoological and botanical country, although there may be a certain concordance in the prevailing species, yet we have also found where the aspects varied, that there were different, though allied or representing forms, and now and then some remarkable species will occur as the *Tetragonops ramphastinus* of the present notice. In the small collection of which this formed a part, most of the birds were well known Peruvian species, many of which seem to possess a very wide range, and are common to both the western and eastern Cordillera. We had now *Tanagra lunulata*, *Catamblyrhynchus diadema*, *Carpornis rubrocristata*, *Tyrannus fumigatus*, *Grallaria monticola*, *Triothorus unibrunnea*, *Merulaxis orthonyx*, all from the eastern range. The latter curious bird was accounted rare, but several specimens have lately reached us from both eastern and western ranges, and we suspect that it is the difficulty of being put up, as it runs and threads through the rank vegetation and never perches, which has given rise to its presumed scarcity.

The resemblance of the South American *Capitonidæ* in their habits to those of the Toucans, has struck several travellers who have had opportunities of observing them alive. They have even been likened to little Toucans, and some of them feed on fruit. The very remarkable Tetragonops noticed in last Number, p. 404, and of which we now repeat the description, presents several alliances of analogy, particularly in the powerful base of the maxilla, and the colour and distribution of the markings of the plumage.

Tetragonops ramphastinus is remarkable for the form of the bill, which is very powerful, and a section of the base would appear almost square. The base of the maxilla is more than usually strong, broad and projecting backwards at its lower angle. The tip of the mandible possesses also a curious structure, it is deeply bifurcated, and, when closed, the curved tip of the maxilla rests in the bifurcation. The colours of the whole bill are bright, the base yellow and orange, the apical half bluish-black. The distribution of the colours of the plumage is also somewhat peculiar; around the eyes, crown, nape and nuchal collar black; wings and tail grayish-black, the latter cuneated; back yellowish-brown; rump yellow; the upper tail covers dull green; from behind the eyes, and nearly joining upon the nape, there is a broad streak of shining white. The whole chin, throat, breast and sides of the neck are bluish-gray, and are separated from the belly by a band of dark vermilion, which colour continues along the centre of the belly, shading off at the sides into yellow; the flanks, vent, and under tail covers are grayish-green. Length 8·5; wings 4·1. Inhabits the eastern Cordillera of Ecuador.

Among the groups which are more than generally numerous in these regions is that of the Tanagers. Of one genus belonging to them, *Arremon*, we have at different times received several species. *A. spectabilis*, Sclat., from the river Napo. *A. rufinucha*, D'Orbig. *A. assimilis*, Boisd., Western Andes. *A. atropileus*, Quito; and another with the present collection, which we cannot reconcile with any description, and to which, if new, we give the name of *A. leucopterus*, from the very marked white spot at the base of the quills.

Arremon leucopterus, Jard. *Above*, blackish-gray, over the eyes and cheeks nearly black; at the base of the maxilla below the nostrils a white spot, inside which a narrow black frontal band; crown extending to the nape pale sienna; at the base of the second to the eighth quill inclusive a broad white band, very distinctly marked on the outer webs. *Below*, white, on the sides of the breast and flanks gray. Length 6, wing 2·8. Inhabits the Eastern Cordillera of Ecuador.

*On a remarkable pouched condition of the Glandulæ Peyerianæ in the Giraffe.** By T. Spencer Cobbold, M.D., Assistant Conservator of the Anatomical Museum, University of Edinburgh. (Plate V.)

Among the various modes of extension of the intestinal mucous element in vertebrate animals, we have several instances where the general absorbing surface is increased by the development of sacculi or pouches; but, so far as we are aware, no example has hitherto been placed on record of a similar kind of membranous reduplication specially involving Peyer's patches.

At a meeting of the Physical Society, held April 5, 1854, we offered a somewhat detailed account of the anatomical and pathological data furnished by the post-mortem examination of a Giraffe, and the facts then enunciated (except as regards the morbid changes) served merely to confirm a few of the numerous particulars which had been previously described in the admirable monographs of Professor Owen.†

After the lapse of more than a twelvemonth, we had occasion to overhaul the *parts* laid aside for future conservation and permanent display in the anatomical museum, and on carefully re-examining these, we detected at the root of the cæcum, and in portions of the small intestine, the peculiarities to be immediately noticed. The circumstance of their having hitherto escaped observation is easily accounted for, inasmuch as the sacculi, in the present case, were only rendered visible by repeated washings, and the removal of a thick layer of tenacious mucus which completely obliterated all trace of the foldings. During our temporary absence from the meeting of the British Association recently held at Glasgow, the preparations now before the Society were exhibited by Professor Allen Thomson to the Physiological Sub-section of that assembly,

* Read to the Royal Physical Society, November 28, 1855.

† On the Anatomy of the Nubian Giraffe, in Zool. Soc. Trans., vol. ii.; also a second Memoir in vol. iii., for 1838-1839.

and since then we have had an opportunity of privately calling the attention of Professor Kölliker of Wurtzburg to the subject; we feel confidence in stating, therefore, that the occurrence of the sacculi in question is certainly quite unusual, if not altogether absent in other mammalia.

In the first place, we observe that only a proportion of the composite glands proper to the small intestine presented any deviation from the ordinary type, and in consequence of our having retained only a few small sections of the tube detached indiscriminately from different parts of the gut, we were unable to form even an approximate notion as to the actual number of patches showing the following modification. Out of the eight or nine *glandulæ* examined by us, four of the masses, varying severally from half an inch to three inches in length, exhibited at their anterior or duodenal extremity a semilunar valve-like fold of mucous membrane. Each fold forms a sort of cul-de-sac, which in the two larger patches is capable of admitting the tip of the little finger; the exposed or convex surface exhibits the ordinary villous texture of the intestine, while the concave or inner aspect of the valve is, on the contrary, follicular.

It is to the last Peyerian patch that we wish to direct especial attention; for here we have developed an extremely complicated structure, consisting of from fifteen to twenty pouches, the whole forming a network of cells, and reminding us to a certain extent, of the water cavities of the *reticulum*. This large compound gland stretches itself continuously from a point anterior to the extremity of the small intestine, to rather more than two inches beyond the ileo-colic valve; and it is from the latter division of the patch that the anomaly (which is represented in the accompanying plate) proceeds. Seven of the pouches are complete, and bounded by extremely attenuated lamellæ projecting from two to four lines beyond the surface; they are more or less polygonal, the openings of the first five being large (Nos. 1, 2, 3, 4, 5), and nearly as broad as the calibre of the cavities internally; the other two (6 and 7) have contracted oval orifices, measuring only about half the width of the pouches, within. From the right wall of the cavity, marked No. 1, part of the tissues were removed, and subjected to microscopic examination, when the glandular substance showed appearances such as are ordinarily recognised in the agminated follicles, while beneath the submucous tissue muscular fibres were found, of the non-voluntary kind. Some of the cavities contain secondary sacculi, but these are generally small, and separated by very slightly developed septa ; at the upper part of the sacculus figured No. 5, is seen one of the secondary pouches of a triangular form, and well defined. The eighth, ninth, tenth, and eleventh spaces are represented by mere depressions bounded by rudimentary partitions scarcely raised from the surface ; the twelfth, thirteenth, and fourteenth are more decidedly saccular, especially the first-named, which is elongated, and shows traces of subdivision. Thus far all the folds are lined within and without by follicles characteristic of the compound intestinal glands ; the latter structures are fully developed at every part, but acquire greater conspicuity as they ascend the colon, in which situation they are less closely packed together, and of larger dimensions. Finally, it only remains for us to refer to six additional sacculi, which are more or less incomplete, and present scarcely any trace of the follicular element; two of them (15 and 16) are shallow, two rather deep (17 and 18), and two (19 and 20) comparatively insignificant.

Notice of the Leaf-Insect (Phyllium Scythe), *lately bred in the Royal Botanic Garden of Edinburgh, with Remarks on its Metamorphoses and Growth.* (Plates VI., VII., VIII.) By Andrew Murray, W.S., Edinburgh.*

The Royal Botanic Garden of Edinburgh has, during the past summer, possessed an attraction which has drawn great numbers of visitors.

A living specimen of one of the species of leaf-insect has, for nearly eighteen months, been an inmate of the hothouses; and the curiosity of the public to see this interesting animal had latterly become so engrossing, that Mr M'Nab, the curator of the Gardens, to whose care and judicious management the prolonged life of the insect is entirely due, found it necessary, for the health of the insect itself, to forbid its being shown on more than four days in the week.

For the greatest period of its life, it so exactly resembled the leaf on which it fed, that when visitors were shown it, they usually, after looking carefully over the plant for a minute or two, declared that they could see no insect. It had then to be more minutely pointed out to them, and although seeing is notoriously said to be believing, it looked so absolutely the same as the leaves among which it rested, that this test rarely satisfied them, and nothing would convince them that there was a real live insect there, but the test of touch. It had to be stirred up to make it move, or still more commonly was taken off the plant, and made to crawl on the finger of the attendant; and the excitement of this constant stirring up and handling was found to be so much the reverse of beneficial to the animal, that the above restriction on its days of receiving company was found indispensable.

The public owe the gratification of seeing this curious insect in its living state, to the amiable and accomplished wife of Major Blackwood, of the H.E.I.C.S., a name better known in Edinburgh in connection with "Maga."

It was she who, having been struck and delighted with what she saw of its economy in its native country, made successive attempts to introduce it alive into Britain, the third of which

* Read before the Royal Physical Society of Edinburgh, 28th Nov. 1855.

attempts was finally successful, in the case of the subject of the present memoir, a memoir which it has been thought might be interesting, as these insects have not only never before been seen alive in this country, but have never been bred, nor had their transformations watched by any naturalist.

The genus has been long known through a species named by Latreille and succeeding naturalists, *Phyllium siccifolium;* but the species properly entitled to this name, is still uncertain, it having been at first supposed, that there was only one species, and every specimen of a *Phyllium* having been referred to it. This confusion has been somewhat cleared up Mr George R. Gray, who, availing himself of the rich collection in the British Museum, published a Monograph of the genus, in the first volume of the Zoologist, in which he described thirteen species, nine of which were new. The genus seems peculiar to the Eastern world; three of the thirteen having come from the Philippine Islands, three from the East Indies and Ceylon, one from Java, one from Mauritius, and one from the Seychelle Islands. The locality of the remaining four species, (among which is the old *Ph. siccifolium*) is unknown. The species with which we have to do, was described by Gray, under the name of *Ph. Scythe,* but without giving a figure of it, a want which we have endeavoured to supply. It comes from Silhet, and the mountainous district of India adjoining Assam. Specimens of the female not unfrequently occur in the cases of insects sent from thence, but the male comes much more rarely.

Mrs Blackwood found both males and females, as well as the young insect in all stages, plentiful in the valleys below Cherrapoonjie in the Kasiah Hills, which form part of the southern boundary of the valley of Assam. A guava tree grew in the garden in front of her house, and on this she placed such specimens as she could secure, and when once placed on the tree they did not in general seek to leave it, at least until they assumed the perfect state, a convenient habit of which Mr M'Nab found the advantage in rearing his specimen. On returning to this country Mrs Blackwood endeavoured to bring some living specimens with her, but having found the trouble and attention they required too great she, after bringing them safely to Calcutta, entrusted them to a friend who shortly followed and brought them in good condition overland till they reached the Mediterranean Sea when they died,—even that genial climate apparently not having suited them.

Mrs Blackwood next tried to introduce them by eggs. She got a parcel of eggs transmitted to her by post, but as they had not come out at the period she expected, she left them behind on going out of town (despaired of as regards hatching but preserved as specimens), when to her mingled pleasure and regret on her return, she found that many of them had come out and died in the box in which she left them. Encouraged by this result, she again got a supply of eggs in the spring of 1854, and keeping a more careful watch upon them, she had the pleasure to find a pair come out on the 9th and 10th May : one or two followed every week till the end of May, when a week or so of cold weather occurred, during which no more came out; but when fine weather again returned in the beginning of June, they again began to come out in greater numbers. It was one or two of these which were entrusted to Mr M'Nab, and he succeeded in rearing to perfection the specimen which became such a favourite. He carefully noted down the periods of change in the insect, and such other circumstances regarding its habits as struck him, and he has been kind enough to furnish me with a note of these which I have embodied in the following paper.

On the young insects being hatched considerable difficulty was felt about their food. Of course the first thing thought of was the guava, and leaves of it as well as of various other allied Myrtaceæ were tendered them, but whether it was that the leaves having been plucked, and not growing on their stalk, did not suit them, or that some little time after their *eclosure* must elapse before they begin to feed, they would not settle to any of the delicacies that had been provided for them, and fears about their starving began to intrude themselves.

The first plant tried was a Fuchsia, but it was afterwards abandoned for the common myrtle, and this seemed to suit them well. Mr M'Nab's specimen never sought to leave the plant on which it was placed till it was full grown and furnished with wings, when it was found necessary to put a muslin bell-shaped cover over the plant, to prevent the insect flying away.

The temperature of the house in which it was kept was as nearly 55° as could be maintained.

I have been thus particular in mentioning the details of their introduction, in order to aid, by our past experience, others who may in like manner attempt to breed them, because from the interest which the present specimen excited, it is highly probable that such attempts will be made, and I should not be at all surprised if, in the course of a few years, the leaf insect should be as common an inmate of our conservatories, as the canary bird now is of our dwellings.

Having said this much as to their introduction, let us now turn to the insect itself, and take some note of its personal appearance and economy. We shall begin with the egg.

The egg is about the size of a small pea, barrel-shaped, and with six longitudinal ribs; it looks uncommonly like some seeds. As Mr M'Nab remarks, if the edges of the seed of the *Mirabilis Jalapa* were rubbed off, the seed might be mistaken for the egg. The ribs are all placed at equal distances except two which are wider apart, and the space between them flatter, so that on the egg falling it rolls over till it comes to this flatter side and there lies. The outside is rough and corrugated like the bark of a tree, and is penetrated by rows of largish longitudinal holes on each side of the ribs, and by rows of smaller holes between them. At the top there is a little conical lid fitting very tightly to the mouth. On the outside the lid is composed of the same bark-like structure as the outside of the body of the egg, and has its base surrounded by frill-like projections, which at first sight one might take for an apparatus for holding on the lid, but closer inspection shows they belong to the lid itself. On removing the lid we see a beautiful porcelain chamber of a pale French white colour, bearing a close resemblance to the texture of a hen's egg, but it is not calcareous, and has more the appearance of enamel. On holding this shell between us and the light, we see light spaces where the holes in the cortical outer covering terminate, and in the centre of each there is a darker space, as if it were a pore; but this conjecture I have not been able to verify. The substance composing the outer cortical covering is very curious. It is very thick. Looked at with the naked eye it seems of a spongy, reticulated, fibrous structure. But under the microscope we see that it is composed of cells, generally arranged in rows radiating outwards; some irregularly shaped, but most of them with a greater or less tendency to a pentagonal or hexagonal shape. In fact, in some parts both the substance and structure bear a most striking resemblance to a piece of honeycomb.

It seems not difficult to conjecture the purpose which the cellular texture of this outer covering serves. If it had been of a firm close substance, the embryo insect could not have received the amount of air and moisture necessary for its existence, and which, from what I shall presently detail, are more than usually necessary in this family of insects.

Having received from Mrs Blackwood one or two unhatched eggs, and the shells of others which had been hatched, I was enabled to make an examination of the interior. On breaking into the egg which had been hatched I found two pellucid membranes, one within the other, the outer one doubtless corresponding to the chorion. On breaking open an addle egg, I found first a pellucid membrane (the chorion), and within it a clear carmine-coloured capsule, flask-shaped at bottom, bu flat at the top.

This capsule might at first be taken for the dried-up yolk of the egg; but if our readers will give me their forbearance, I trust to satisfy them that it is something very different. In order to do so, I must take them a little way back into the elements of entomology. They are doubtless aware that the *Orthoptera* (to which order of insects the *Phyllium* belongs) are characterized by what is called a semi-complete metamorphosis, that is, that they quit the egg, not in the shape of caterpillars, but as six-legged insects, nearly similar in form to the perfect insect, but without wings, and, as will be afterwards shown, with some other parts only partially developed; that after so appearing they at no time go into a dormant chrysalid state, but, after casting their skin a certain number of times, the wings and other perfect forms of the parts of the insect make their appearance. The first stage of these insects after their appearance out of the egg has been treated by entomologists as a peculiar form of the larva state, which Westwood has characterized as "homomorphous," or "monomorphous," from its resemblance to the perfect insect after its first moultings; and when the wings begin to appear it was said to pass into the pupa state, and was called an active nymph, or pupa. Professor Owen, however, has pointed out that we ought not to look upon these "homomorphous" larvæ as true larvæ, but that the true larval condition is to be sought for in the egg. He states that "these insects" (the orthopterous and hemipterous) "are at one stage of their development apodal and acephalous larvæ, like the maggot of the fly; but instead of quitting the egg in this stage, they are quickly transformed into another, in which the head and rudimental thoracic feet are developed to the degree which characterizes the hexapod larvæ of the *Carabi* and *Petalocera;* the thorax is next defined, and the parts or appendages of the head are formed, at which stage of development the young orthopteran corresponds with the hexapod antenniferous larva of the *Meloe;* but it differs from all coleopterous larvæ in being inactive, and continuing in the egg almost until all the proportions and characters of the mature insect are acquired, save the wings."*

This philosophic view was, I believe, first enunciated by Owen. At any rate it has received his approval, and, I may add, the sanction derived from his personal observation; for in an after passage on the same subject, and which I have pleasure in quoting for more reasons than one, he says, "Metropolitan duties shut out much of the field of nature; but still she may be found and studied everywhere. I first learned to appreciate the true nature and relations of the nominally various and distinct metamorphoses of insects, by watching and pondering over the development of a cockroach (also an orthopterous insect), which quits the egg as a crustacean. I saw that it passed through stages answering to those at which other insects were arrested: there was a period when its jointed legs were simple, short, unarticulated buds, when its thirteen segments were distinct and equal,—when it was apodal,—when it was acephalous."† This statement, I think, not only entitles, but obliges us to hold, that it has been deter-

* Lectures on Invertebrate Animals, Ed. 1855, p. 424. † Ibid., p. 437.

mined by observation that the larva of orthopterous insects has been detected in the shape of a maggot passing the early portion of its life in the egg.*

Having arrived thus far, I was surprised to find Professor Owen stopping here. I thought the necessary consequence of assuming that the early stage of the orthopteran was a caterpillar in the egg, was, that it also passed the chrysalid state in the egg. I could quite understand the perfect jointed insect being eliminated at once out of the embryonic elements in the egg, in the same way that a chicken is hatched; but if the maggot is once hatched instead of the chicken, I know of no means, or no analogy, by which its vermiform character can be changed, except by passing through the dormant chrysalid state. To make this plainer to non-entomological readers, I should observe, that the process by which the caterpillar, in passing through the chrysalid state, is changed into the perfect insect, is not, as Kirby and Spence supposed, by all the subsequent forms being originally included under the skin of the larva, and that every successive operation was merely casting off an old coat, to appear, like the riders in a circus, in another one under it; but the process, as shown by the accurate observations of Herold on the changes and development of the organs during the pupa state, is, "like the ori-

* I am inclined to think that all insects pass a more or less considerable portion of their larval state in the egg. Except on this assumption, I am at a loss to account for the well-known fact of the exclusion of ichneumon flies from the eggs of various insects, for I find difficulty in accepting the proposition that these parasitic larvæ feed on the yolk of the egg. The whole economy of the ichneumon seems to me opposed to this. All those which we can watch require a living animated organism on which to feed, and although the yolk might, for a short period, retain its vital powers even after it has begun to be preyed upon by the ichneumon, I apprehend such a period could only be brief. The yolk would soon have its vitality destroyed by the intrusion of the parasite, which would perish along with the decaying mass which its presence had corrupted. It seems more consistent with their habits and economy, to suppose that those minute parasites feed upon the larva already formed in the egg, or, at the utmost, that they commence their ravages after the development of the yolk into the larva has commenced, and reach their chrysalid state as the yolk by its dying effort completes the larva, in the same way as the larger ichneumons devour the excluded larvæ, mining away their powers till they leave them only strength to pass into the chrysalid state simultaneously with themselves.

ginal processes of the development of the larva itself, the results of a transmutation, increase, and coalescence of primitive elements of the different tissues,—elements which consist of nucleated cells or nuclei, like those that result from the spontaneous fissions of the primary impregnated germ-cell,—elements which may be viewed as parts of the original germ-mass, retained to be successively metamorphosed into the successive larval skins, pupa skins, and imago."*

To give a more familiar illustration of this transmutation, &c., I may adduce an experiment familiar to most entomologists. Take a newly-formed chrysalis, break it in two, and we find the muscular fibre, &c., not much changed from that of the larva. Take it somewhat older, and break it, we find it full of a liquid like milk. The old fibre has been disintegrated before it can be made into the new form. Break a chrysalis at a more advanced period, and we find no longer this milky substance, but the form, figure, and organs of the perfect insect already stamped, and ready to appear at the proper season. It is like a paper manufactory,—the new paper cannot be made until the old rags are reduced into a pulp.

This transformation through the chrysalis, then, being the sole analogy which we have to argue from, I cannot conceive how we can evade the necessity of the egg-larva of the orthopteran also passing through a dormant chrysalid state, in which the disintegration and transmutation of the larva may take place. But if the jointed-legged insect be the pupa or chrysalis, we have no such period during which the dissolution and transmutation of the insect may take place. It cannot have its fibres and muscles dissolved into a homogeneous mass while it is actively walking about, as if nothing was the matter with its muscles; and we must have recourse to some new machinery not yet known in insect life, to account for such a state of things. Such being the case, I expected that Professor Owen would have taken the view, that the chrysalid state, as well as the larval state, was passed in the egg; but he does not do so. The nearest approach he makes to it is when he says, " The metamorphoses which the locust undergoes

* Owen's Lectures on the Comparative Anatomy of Invertebrate Animals, p. 434, Edition 1855.

in its progress from the potential germ to the actual winged and procreative imago, are nevertheless as numerous and extreme as those of the butterfly. The differences are relative, not essential; they relate to the place in, and the time during which the metamorphoses occur, and to the powers associated with particular transitory forms of the insect. The legs of the worm-like embryo-locust were once unarticulated buds, like the prolegs of the caterpillar; but the creature was passive, and development was not superseded for a moment by mere growth; these organizing processes go on simultaneously; or rather change of form is more conspicuous than increase of bulk. The six rudimental feet are put to no use, but constitute mere stages in the rapid formation of the normal segments, which attain their mature proportions, and their armature of claws and spines, before the egg is left. The first segment of the original apodal and acephalous-larva, is as rapidly and uninterruptedly metamorphosed into the mandibulate and antennate head, with large compound eyes."*

Now, although it is impossible to doubt, that the idea of the larva changing into a chrysalis in the egg, and there completing its transformation, must have crossed the mind of Professor Owen,—still, whether it be from thinking that his own observations did not justify him in promulgating such an opinion, or from whatever other cause, it appears clear that the above-quoted passage does not announce such a doctrine, and indeed the latter part would seem to contradict it, and to lead to the inference, that he considered the six-legged insect which emerges from the egg, to be "uninteruptedly metamorphosed" from the larva in the egg; and other passages and expressions, when speaking of the emerged insect before it acquires wings, show sufficiently that he looks upon that state as the pupa or nymph state. For instance, he says, "The active *pupa* of Orthoptera and Hemiptera are called 'nymphs.'" Again, speaking of the moulting of these so-called pupa or nymphs, he says: "When this active pupa or nymph again moults, the insect attains its perfect condition." And afterwards he adds: "Here then we see that the pupa stage, which in the butterfly was passive and embryonic, in the locust, is active and vora-

* Owen's Comp. Anat., p. 433.

cious; whilst their respective conditions in the larval state are reversed. The whole period of the life of the Orthopterous insect," he goes on, "from exclusion to flight, may, if its organization during that period be contrasted with that of the Lepidopterous or Coleopterous insects, be called an active nymphhood."*

The extracts which I have given on the authority of Professor Owen, are quoted from the last edition of his Lectures on the Comparative Anatomy of Invertebrate Animals, published in May 1855; and I am taking it for granted, that we may assume them to contain the latest recognised views of physiologists on the subject. We see, then, that the present opinion is, that the orthopterans pass the larval phase of their existence in the egg,—that they pass their pupa state in an active six-legged, but unwinged form, after coming out of the egg,—and that the perfect insect is only seen when the wings are developed.

Now, the proposition which I venture to submit after careful consideration of what I have observed of this leaf-insect, is, that both the larval and chrysalid states are passed in the egg, and that what has been called the homomorphous larva or the active pupa, is merely a phase of the perfect insect. The analogy on which I have just remarked speaks strongly in behalf of this view. The examination of the capsule found in the egg confirms it. This capsule has a distinct determinate form. It is covered with a pellucid membrane of its own, as can be seen in another specimen where the insect has passed out of the capsule and out of the egg, and where both the outer chorion and the skin of the capsule may be seen one within the other. These circumstances imply that the capsule is not a yolk; because if it had been a yolk surrounded by albumen within the chorion which had dried up, it would not have preserved a determinate form, and it would not have had a membrane round the capsule (quasi-yolk). A yolk has not a membrane round it like the chorion round the albumen; and the yolk or interior of the egg in drying up does not assume a determinate form. Farther, in the eggs of insects which emerge from the egg in the larva

* Owen's Comp. Anat., p. 436.

state, there is only found one membrane (the chorion), the same as in a hen's egg. I refer to a specimen of the egg of one of the largest coleopterous insects known (the longicorn, *Titanus giganteus*), where it will be seen that there is only a single membrane or chorion surrounding a dried amorphous mass. This capsule, then, not being the yolk or original contents of the egg, we are driven to look for some other explanation of its form and appearance; and these considerations tending to confirm the view suggested by the analogies of the subject, I do not hesitate to submit as an explanation, that the capsule in question is the chrysalis of the leaf-insect, and that the same physiological arrangement will be found in all orthopterous and hemipterous insects.

It cannot be urged as an argument against this view, that what I consider the perfect insect changes its skin a certain number of times. The larva changes its skin; and nobody thinks that on that account it has ceased to be a larva. The perfect crab changes its skin; and we still look upon it as perfect as before. That specialty, therefore, has no relevance. A more embarrassing fact is, that after emerging from the egg, changes take place on the form of the insect, and important organs are altered or appear. As I shall presently mention, an important alteration takes place in the antennæ; and large wings, which are wanting on the first appearance of the insect out of the egg, finally emerge. But it is to be observed that all these changes take place in the way of gradual growth, something like the appearance of teeth in the mammal. The wings begin to bud out of the back after the first change of skin; they are small short wings after the second change, and expand into their full size after the third and last. In the same way the alteration in the proportions and in the antennæ are gradual and progressive, and may be traced as the animal moults. Another circumstance which I must not overlook, although at first sight it seems to make against me, is, that in the young insect (that is, the insect excluded from the egg but not yet furnished with wings), the male and female sexual organs are not developed, or at least not fully developed; while in insects passing through what is called a perfect metamorphosis, they are as fully developed on emerging from the chrysalis as ever they are. But I would only class this with the other instances of growth, and rather use the analogy of the changes in our own species on attaining to puberty, to show that it is not an essential ingredient in metamorphic changes. Such changes are obviously not only of much less importance, but also of a totally different class of physiological development, than the change effected in the dormant chrysalis, and, it appears to me, are to be looked at as instances of growth in the perfect insect, not as a mode of metamorphosis at all.

In leaving this part of the subject, I have only farther to say, that I am quite alive to the meagreness of the observations on which I have ventured to build this hypothesis, and that my premises might have been more extended. Had I had more eggs, and had the opportunity of opening them at different periods, my premises *would* have been more extended. But as long as there was the chance of a leaf-insect being hatched from the eggs, they were too valuable to be broken. I have only examined one addle egg, and it chanced to be one with what I suppose to be the chrysalis in it. Some more fortunate individual will, I hope, ere long have the opportunity of settling the question; and if, on opening eggs at an early period, he find a maggot, and at later periods this capsule, I think I shall then be entitled to say that it has been settled in my favour.

But to proceed with the history of the insect. After having reached the form of a six-legged jointed insect, it emerges from the egg by pushing off the lid. It comes out middle foremost, that is, its head and tail are packed downwards, so as to meet each other; the back between them first appears, and they are drawn out next; the legs are extricated last. The colour of the insect at this stage is a reddish-yellow, something of the hue of a half-dried beech leaf; for it is to be observed, that although the colour of the insect varies at different periods of its life, it always more or less resembles a leaf in some stages. When it has once settled to eat the leaves on which it is placed, the body speedily becomes bright green. Among the leaves of the common myrtle it cannot be distinguished by the colour of the body (the legs are browner); and its habit of carrying itself tends to add to the deception. It bears its tail generally curled up a little, just about as much bent as the myrtle leaf. As it bends its tail up, however, the curl would be the wrong way, unless the insect walked back downmost, which, in point of fact, is its constant habit, adhering to the under side of the leaves. This habit brings to light another beautiful contrivance for still farther heightening its resemblance to a leaf. The upper surface is opaque green, the under surface glossy, glittering green, just the reverse of the myrtle or guava leaf; so that, by reversing its position, it brings the glossy side up and the dull side down.* It is provided with tarsi to suit this upside-down mode of life. Between each of the claws there is a large spongy pad, which, as with flies walking on the ceiling, enables it to adhere firmly to the leaf; indeed it was always difficult to disengage its hold of anything it stuck to.

There are several differences between the form of the insect at this stage and as it finally appears. It has no wings now. The antennæ, whether the animal subsequently turn out to be male or female, have at present the form of the antennæ of the perfect female. On the other hand, the legs have the male form. The flat leaf-like appendages to the legs of the female are much broader and more expanded than those of the male; and as every example of the freshly-eclosed insect which I have seen has these appendages shaped like those of the male (while at the same time the antennæ bear the female stamp), I assume that this is the normal character at this period. The form of the segments of the abdomen are somewhat different. They taper to the tail from the third segment, instead of running parallel to each other, or nearly so, throughout the fourth, fifth, and sixth segments. There exist the same number of segments in the abdomen, and also of parts in the thorax; but when the wings afterwards appear, there is, of course, some difference. In some specimens I think I can see a swelling where the joint of the wing is to emerge; and there is a pinching up of the skin where the scutellum afterwards appears, for it is wanting in the young insect, though present in the full-grown one. As already mentioned, the sexual organs are not developed in the young specimen.

The leaf-insect is subject to three moults, as is generally the case with the Orthoptera. The insect reared by Mr M'Nab

* This peculiarity is much more distinctly seen in the young state and living insect, than in the dried specimens.

was hatched in the beginning of June 1854. Its first moult took place about ten months afterwards, viz., on 10th April 1855. During that time it had increased very gradually but not greatly in size. It was not an inch in length when hatched, and at its first moult it measured not much more than an inch. On this moult taking place, the change in its form and proportions was very trifling. The abdomen became relatively broader, and the swelling at the part where the wings afterwards burst out more decided. The most interesting change, however, was observed on the antennæ; and, as the circumstance has not hitherto been noticed, it is worthy of attention. A reference to the figure of the female antennæ will show that they are short and thick (scarcely one-eighth of an inch in length), and composed of nine joints, the third of which is considerably thicker, longer, and more bulky than the rest. On the other hand, the antennæ of the male are long and thin, about one and a quarter inch in length, and composed of twenty-four joints, and the third joint at the base is not thicker or larger than the rest; on the contrary, the joints get shorter and shorter as they approach the base, and the basal thirteen are decidedly smaller, and of a different form from the apical eleven. But the antennæ of all the young freshly-eclosed insects (whether male or female) are short like the female, and consist only of nine joints. They are perfect miniature representations of the full-grown female antennæ. After the first moult, however, a change was perceptible on the antennæ of the specimen bred; and that change can still be distinctly seen in the cast skin, which has been kept. The third joint has grown longer. No trace of division can yet be seen in it, but if we had the next skin (which we unfortunately want), I feel certain we should find traces of divisions in the joints. We have, however, the third and last skin which was moulted, and we see in it that a great change has taken place. The antennæ still bear the general short, thick, female form. They are only a little longer; but on counting the joints, we find that there are now eleven joints beyond the third, where before there were only six, as if each had been split in two except the terminal joint, and we find the third joint to contain within itself eleven more new ones. It has become elongated, and a series of striæ (they can scarcely yet be called joints) run across it, well defined on the interior side, but not so well defined on the exterior margin. These with the two basal joints, on which no change has taken place, make up the twenty-four joints of the male antennæ; and on the insect emerging from the last skin, they rapidly extend themselves to the full-grown size. I may observe, that the multiplication of parts by subdivision (although a mode often adopted by nature in other classes of living animals) is not the usual course followed in the case of insects; for instance, the *Iulus terrestris* (which may be taken as a type of the Myriapods) has, when it emerges from the egg, only eight segments. These are multiplied by the growth of new segments—six at a time; but the new segments are not formed by a division of the old, but by generation from the penultimate segment at the terminal space. The interesting skins preserved, in this instance, leave no doubt as to the means by which the segments of the antennæ have been increased.

As I have already mentioned, however, we have not the second skin; the insect ate it up before it could be secured. I am not aware whether this singular act of cannibalism has been observed in other insects after moulting. But Mr Thomas Bell, in his History of British Reptiles, records a similar instance in the toad. After describing the process of divesting itself of its skin, which he had watched in the common toad, he says,—"The whole cuticle was thus detached, and was now pushed by the two hands into the mouth in a little ball, and swallowed at a single gulp." But although it would seem to indicate a very morbid appetite in the toad, this piece of epicureanism does not strike us as so extraordinary in it, as it does in the leaf-insect. The toad lives on animal food; but this insect whose food is exclusively vegetable, has surely made a curious deviation from its instincts, unless we are to hold that the leaf-insect not only looks like a leaf, but also tastes like a leaf.

The second ecdysis or moult took place on the 16th of July, at 8 A.M.; indeed they all took place about that time of the day,—the first having been at 10 A.M., the second at 8 A.M., and the third at 9 A.M. After the second, the tegmina and wings made their appearance, but of small size. The third moult was on the 17th September, when the full-grown wings and antennæ were produced. The day previous to the casting of the skin, the insect was observed to be unusually lively, shaking and working about with its body, while the feet seemed firmly attached to the leaf. Before the moultings the insect became of a grayish tinge, doubtless caused by the skin having become loose, through the shaking process alluded to.

Its rapid increase in size after emerging from the old skin is most remarkable. An accurate observer in the East writing to Mrs Blackwood of the moulting of the locust, gives so graphic an account of it, and one so exactly describing the process that took place in our leaf-insect, that I cannot refrain from quoting it. He says—" The most extraordinary circumstance attending the process is the rapid or almost instantaneous growth of the animal as he emerges from his old covering, each limb on being freed being about a fourth longer and larger than the corresponding part of the case from which it has just been withdrawn. The wings you can see shoot out to their full length; they also come out of little cases of about a quarter of an inch long, and in the course of a few minutes attain their full growth of about two and a half inches long. The whole process does not take more than ten minutes. The animal now in its perfect form is at first very soft and tender, but in the course of half an hour's exposure to the atmosphere, he hardens and becomes strong and ready for flight." One would say that this description had been written for the leaf-insect,—so exactly does it represent the process in it.

After each of the first two moultings, the insect assumed a beautiful emerald-green colour, while after the last moult the body had a slight tinge of yellow round it. It subsequently gradually became yellower and brownish at the edge, passing through the different hues of a decaying leaf. Like the leaf it resembles and feeds upon, it seemed to decay on arriving at maturity; and it is to be observed that its sere and yellow leaf also occurred at the period of the year when the foliage assumes its autumnal tint, viz., in the end of September and beginning of October. How far the causes which bring about this result resemble each other in plants and animals, will be an interesting subject of inquiry to the physiologist, when we have a better supply of the insect to experiment upon.

On the Physical Geography of the Old Red Sandstone Sea of the Central District of Scotland. By Henry Clifton Sorby, F.G.S.

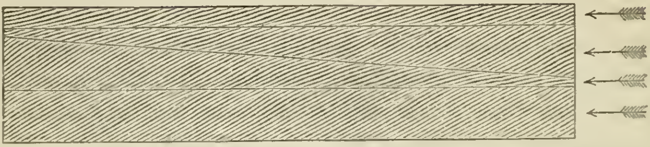
The facts I am about to describe have been observed at various times, when my attention was more immediately directed to the older rocks on which this sandstone rests, and I had not time or opportunity to study it in such complete detail as could be wished. However, they appear so very definite as to point clearly to a number of leading phenomena, and to enable us to arrive at some general conclusions with respect to the physical geography of the sea in which it was deposited. It is this that induces me to publish them, in the hope that others, who have the opportunity, may be led to work out the detail, which, I am persuaded, would be most interesting and instructive. My conclusions are, that in the old red sandstone period there extended across Scotland a branch of the sea, or strait, whose northern shore was somewhere in the line of the mica schist rocks which extend from Aberdeen to the mouth of the Clyde, and its southern, in the direction of the greywacke rocks that run across from St Abb's Head to Wigtownshire. In this, at the earlier part of the period, there were considerable tidal currents; but, when the upper beds were deposited, they were more or less completely absent, and there were present such as were chiefly due to the action of the wind.

Since the methods of inquiry I have adopted are, to a great extent, new to geology, I shall briefly describe them before entering on their special application. If a strait, such as I have named, communicated with the main ocean by a wide opening, the tidal currents would flow through it, alternately forwards and backwards, according to the state of the tide. The direction of the currents in different parts would depend on the configuration. Near the coasts they would run more or less closely parallel to them, and in the centre, in the general line of the axis of the channel. As a good illustration of these facts, I refer to those now present in the Irish channel, given by Captain Beechy in the *Phil. Trans.* for 1848.

In seas that do not communicate with the main ocean by a wide opening, such as the Baltic or Mediterranean, the currents are chiefly due to the action of the wind. This is a fact so well known to nautical men, and such very numerous examples of it are given in "Sailing Directions" for such seas, to which I am chiefly indebted for my information on the subject, that, were it not that it has been so very generally overlooked by geologists, I should have thought it unnecessary to do more than allude to it. When the wind blows strongly over the surface of the sea, the resistance which it experiences, not only gives rise to the waves, but also causes the surface water to be driven forwards in the line of its own motion. In many localities, such currents vary with the actual direction and force of the wind, and when it is calm there is little or none; and in all probability the disturbance extends only to a small depth. However, in other cases there is present a general current, moving in one particular direction, even when there is no wind; the velocity varying with its direction and force. Such *prevailing currents*, I think, may, in many instances, be referred to the action of the *prevailing winds;* and in all probability they extend to a considerable depth, so that, perhaps, though the wind may occasionally produce a counter current on the surface, yet at the bottom the motion may remain nearly as usual. In proof of these facts I could cite many examples, as, for instance, the Bay of Biscay near Bayonne, the Gulf of Lyons, the Gulf of Patras, the mouth of the La Plata, and many parts of the Indian ocean, particularly where acted on by the monsoons; as may be seen from Mr A. Keith Johnston's most instructive map of that ocean in his Physical Atlas. In navigating the modern seas, mariners find it necessary to make full allowance for these wind-drift currents; and I am persuaded that it will be found no less so in studying the physical geography of our ancient seas, and investigating the peculiarities of the deposits formed in them.

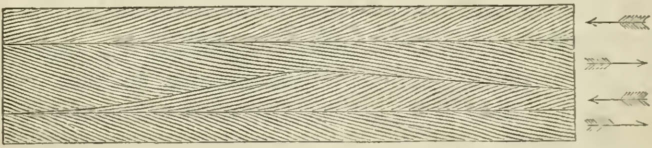
The directions and characters of the currents present during the formation of a deposit may very generally be determined from the resulting structures. It would occupy far too much space to do more than give a simple example of one kind, for which I have proposed the term "drift bedding," as shown in fig. 1.

Fig. 1.



This is formed by the current washing the material along the bottom until it is thrown down on the sloping end, where the depth becomes so much more that the current is reduced in velocity to such an extent as not to be able to wash it any farther. There is thus such a relation between its characters and the depth of the water that this may be often ascertained from it within narrow limits. The manner in which it is formed is indeed well illustrated by the formation of a railway embankment; and it of course shows the direction of the current, for it must have run towards the point to which the stratulæ dip; proper allowance being made for any subsequent movement of the rocks. If, then, the current was uniform and moved only in one direction, the structure would be somewhat as fig. 1, where the stratulæ in the various beds dip to one side; whereas, if it had run first from one direction and then from the opposite, as in the case in tidal currents, some would dip to one side and others to the reverse, as shown in fig. 2, where the arrows indicate the direction of the current for each bed.

Fig. 2.



The direction of a current can also be ascertained from the ripple marks; from that modification of them for which I have proposed the term "ripple drift," and by a peculiar linear graining on the surface of horizontal beds, when the current has not been such as to give rise to the other structures. All these present many interesting peculiarities, but to describe them fully would form a long communication of itself, and I therefore must merely indicate the manner in which I have arrived at the conclusions I am about to describe. Of course it would be expected that the current would vary somewhat in different beds. This is what is found to be the case; but, by making a number of observations in different parts, the mean direction can be ascertained with very considerable accuracy.

My general conclusions are that there is a most intimate connection between the physical geography of a sea and the currents present in it; and that, since their directions and characters can be ascertained from the structures produced in the deposits formed under their influence, therefore the physical geography of our ancient seas may be inferred within certain limits.

Besides such currents as I have alluded to already, there are also those due to the action of the waves of the surface. These only act when the depth is small, as for instance over a shoal or on a coast, because the motion of the water at greater depths is too little to produce any effect. Each of the waves as they proceed gives rise to a current moving in the line of their advance under their crests, and in the reverse direction under the intermediate hollows; thus producing a current oscillating forwards and backwards in a line perpendicular to the trending of their ridges on the surface, but having a preponderating action in the line of their advance. Whatever be the direction of the waves when the depth is considerable, yet when they approach a shelving coast or shoal, where it is such that the currents they produce would act on the deposits at the bottom, the resistance to their movement causes them to bend towards it in such a manner that, if there was an equal amount of waves from each quarter, the mean line of the oscillation of their currents would be nearly perpendicular to the direction of the coast or shoal. Therefore, since the tidal currents run nearly in the line of the coast, the directions of oscillation of the currents due to the tides and stranding surface waves would be nearly perpendicular to one another. The same is the case with respect to shoals, for they are usually considerably elongated in the line of the tide or prevailing currents. However, if a greater amount of effective waves came from one side than from the other, the mean line of stranding wave oscillation would not be perpendicular to the other, but inclined from the perpendicular towards the side from which this greater amount proceeded ; and this fact, coupled with the excess of action in the line of the wave's advance, is most valuable in determining the direction from which the roughest storms came in each locality.

In giving the directions of oscillating currents, I use the symbol for "varies as" (α) to represent "oscillating with," so that, if there was a current oscillating from north to south, I write it N. α S. ; and after each give the number of observations from each side, which often is a most important circumstance to take into account, as will be seen farther on.

Proceeding now to apply these general principles to the facts seen in the old red sandstone in the district under consideration, I will first call attention to the admirable section along the coast between Cockburnspath and St Abb's Head. All the directions given refer to *true* north. Passing from the older rocks towards the north, near the first surface of junction with the sandstone and conglomerate, I found the mean line of oscillation to be N. 18° W. (10 obs.), α S. 18° E. (10 obs.) At some distance from the older rocks the directions were N. 86° W. (19 obs.), α N. 52° E. (4 obs.) ; and still more north N. 84° E. (8 obs.), α S. 73° W. (4 obs.) Somewhat farther north, at the excellent junction with the older rocks at the Siccar Point, I found them to be N. 14° W. (10 obs.), α S. 9° E. (10 obs.) ; and at about $1\frac{1}{2}$ mile south of Cockburnspath station, some distance north of the older rocks, N. 72° E. (12 obs.) α S. 78° W. (11 obs.) These facts appear very clear and distinct. There are two lines of oscillation, nearly perpendicular to each other. The means of one set are S. 86° W. (34 obs.) α N. 70° E. (24 obs.), and of the other N. 16° W. (20 obs.) α S. 14° E. (20 obs.) ; these latter being in both cases over the surfaces of the older rocks ; and hence, I think, it cannot be doubted that they are such as were produced by waves stranding on a rocky shore, whilst the others were due to tidal currents. If so, we must conclude that the coast ran in a direction somewhat similar to them. The strike of the Greywacke rocks is very nearly N. 70° E., corresponding to the direction of the Lammermuir Hills, and therefore, I think, we cannot doubt that the coast-line of the period was determined by that direction of elevation. As will be seen, the line of tidal oscillation from the east side is exactly the same as this strike, but from the west is 18° to the west of it; which, however, can be easily accounted for by the action of the prevailing west wind. The facts given above show that the most perfect and equal tidal oscillation was, at some distance north of the older rocks, clear from their disturbing influence; whilst south of Siccar Point to the other junction and coast action, there is a part which, though having tidal oscillation, has on the south a preponderance of current from the west, and on the north from the east. This can be easily explained by supposing that the Siccar Point constituted a rocky shoal, and that between it and the main coast to the south there was a deep channel affected both by tides and a rotating eddy, due to the action of the prevailing west wind.

The juncture of the Red Sandstone with the older rocks at Stonehaven, south of Aberdeen, is not nearly so interesting as that just described; and the verticality of the beds renders it impossible to ascertain the directions of the current with precision. However, so far as I could ascertain, there is N. 60° E., α S. 60° W.: certainly most from the east side. This then indicates that the line of coast was much the same as the direction of the older rocks now.

On the west side of Loch Lomond, north of Balloch, I found the currents to be N. 82° E., (15 obs.), α S. 89° W., (15 obs.), which differs about 30° from the line of the older rocks; and since I saw no stranding-wave action, and the drift bedding indicates a depth of from twelve to twenty fathoms, I am disposed to think that the coast was some distance further north, probably running west through Tarbet towards Inverary.

These observations are all in the lower beds of the Old Red, and I think they clearly indicate that there was a decided tidal action; the currents running up and down in the same manner and with much the same velocities as they now do in the Irish Channel. However, when we examine the upper part of the Old Red, so far as I have seen, this tidal action was either absent or very much more feeble, and in its place there were currents due to the action of the wind, running in the same manner as now occurs in the Skager Rack. This is well seen at Dunbar. In one place there was a non-oscillating current from S. 83° W., and in another from N. 85° W., giving therefore a mean of S. 89° W., or very nearly west; whilst at Perth and Dumblane there was a similar current from near north-east.

Since to account for these facts, it is necessary to know to a certain extent the form of the coast, it will perhaps be well just to state what I think was its probable direction; though, since my observations are only limited, it must be considered only a first approximation. I think the north coast must have ran from somewhere near Aberdeen, through Dunkeld and Tarbet towards Inverary, whilst the south coast stretched from near St Abb's Head, through Peebles, south of Sanquhar to Port Patrick; if so, the general line of axis would be about N. 60° E. to S. 60° W., being within a few degrees of that of the Skager Rack, with which it would also agree very closely in size. To account for the absence of tide, it is necessary to suppose that some change took place in the physical geography, so as to cut off the communication with the main ocean, or so to alter it as to reduce the tidal *currents* to a very small amount, though the vertical *rise and fall* might still be considerable. Facts I have observed in the carboniferous strata of the north of England I think require for their explanation that we conclude that there was land then existing in the western part of what is now the North Sea. There are indications of this being partially elevated between the periods of the strata below and above the Coniston limestone, though very great changes occurred between that and the carboniferous epoch. If this land was raised up during the period of the Old Red, in such a manner as to convert the channel running across Scotland at its earlier part into a branch of the sea, more or less closed to the north-east, I think all the facts I have hitherto observed could be satisfactorily explained. The changes in physical geography would be much the same as if we were to suppose that at first the southern part of Sweden was submerged, in such a manner as to make a wide and free communication between the Skager Rack and the

Baltic, so that strong tidal currents would set through it. Then, if it was elevated, and if the northern part of the Cattegat was more completely blocked up than at present, or the east coast of Jutland joined to Sweden, the tidal *currents* would be very small, and in place of them the prevailing W.S.W. winds would produce, as now, in the Skager Rack a prevailing current running to the north-east on the coast of Jutland, and to the south-west along that of Norway.* I might here also say, that a very good case of a similar rotating current is met with in the Arafura Sea west of New Guinea, produced by the prevailing south-east monsoon.† As shown above, the currents present in the district under consideration, when the lower and upper beds of the Old Red Sandstones were deposited, were precisely similar to what would occur under these two conditions of the Skager Rack; and their velocity was generally not greater, for along the coast of Jutland it is now sometimes as much as four miles per hour.

As before named, the general line of the axis of this gulf would be from N. 60° E. to S. 60° W., and perhaps it would be well to show how the action of the winds of the present period would account for the direction of the current. The prevailing winds in this part of the globe are from W.S.W. or near, which preponderate very considerably over those from the east. However, since it is the gales and fresh breezes that would produce the effective currents, I think the best plan will be to examine their action on such a gulf. For this purpose I select those given on Maury's wind and current chart for the seas surrounding the British Isles. In the case of the gales there are five times the number blowing in such a direction as to drive the water towards the E.N.E. along the south shore, to those that would impel it in a contrary direction, and nearly twice as many in the case of fresh breezes. There are twice as many gales blowing so as to cause a current to run to E.N.E. along the south shore, than in the same direction along the north coast, and three times as many fresh breezes. Whence it will be seen that there is a great pre-

* Sailing directions for the Cattegat, the Sound, and the Belts, by Laurie; and for the Cattegat and Baltic by Norrie.

† Sailing directions for that sea by Geo. Windsor Earl.

ponderance of action on the south coast such as would produce along it a current running to the E.N.E.; and, since in such cases the coast on the north, which was probably high and mountainous, would protect the sea on that side, we may feel nearly sure that the water thus driven to the E.N.E. would return by a current setting along it to the south-west. Though very much less, and obscured by the tide, yet since there was a preponderance of current from the west along the south coast, and from the east on the north, it appears as though the same kind of current existed during the earlier period when the tidal action was strong. This would lead us to expect to find that the materials of the conglomerate near Stonehaven had been brought from the east, from land not now existing, which would agree with what Professor Nicol stated in his paper read at the Geological Society,* that boulders and pebbles of gneiss and mica schist are entirely absent there; whilst, according to my own observations, this is not the case south of Dunkeld.

These explanations rest on the supposition that the prevailing winds at the period of the Old Red Sandstone were much the same as now. The W.S.W. direction is apparently due to some general cause in atmospheric circulation, and is that for the zone of the globe of the latitude of Scotland, except where effected by winds of the character of monsoons. Though perhaps some other suppositions might account for the observed currents, if the prevailing winds at the Old Red period were somewhat different to what they are now, yet I think they can be so well explained in the manner described above, that it is better to conclude, provisionally, that they were much the same as at present. I have also observed numerous facts in the carboniferous series in the north of England which confirm this supposition; and, if farther researches proves its truth, I think we may hope to arrive at such data as will show whether or not there has been any such change in the axis of rotation of the earth, as has been supposed by some geologists.

I do not think the depth of the sea could have been considerable, and from what I have seen I concluded that it was not materially different from what is now found in many parts

* Quarterly Journal of Geological Society, vol. xi., p. 544.

of the North Sea, and that in some places there were shoals on which the surface waves acted, and over which the depth could not have been above a few fathoms. For instance, at Dunbar I saw in one place N. 30° W. (17 obs.), α S. 20 E. (12 obs.) Since this is nearly perpendicular to the direction of the general current, in accordance with the principles already described, this indicates the existence of a shoal, elongated in the line of the general westerly current, on which waves stranded. The line of oscillation being inclined from the perpendicular towards the north-west, and the excess being from that side, indicate that the largest waves came from that quarter, which would agree perfectly with the fact of the distance to the coast in that direction being so much greater than to the south-east, and with the westerly winds being the most prevalent, so that the stronger gales blowing over a greater expanse of sea should give rise to larger waves.

At Craigmillar Castle near Edinburgh the currents were in nearly all directions, as though due to waves passing across a shoal over which the depth was considerable ; but yet the resultant line of oscillation is S. 26° W. (46 obs.) α N. 49° E. (23 obs.), which would agree with what would be produced by waves coming chiefly from the south-west, acting on a shoal elongated in the line of the general current from W.S.W. This also is what would be expected, if the configuration of the coast was as I have described above.

My observations are not sufficiently extended to enable me to say whether the gulf was contracted somewhat on the west side, towards the latter part of the Old Red Sandstone period ; but some facts I have observed at Cleghorn Junction near Lanark tend to that conclusion ; for I saw proof of currents from N. 18° W. (12 obs.) and S. 4° E. (8 obs.) These might have been due to a shoal ; but it appears to me quite as probable, that they were such as set across the gulf in the same manner as is found to be the case in the Baltic east of Bornholm. Similar currents are indeed met with at the mouth of the Skager Rack ; but still, on the whole, I am disposed to think that the small tide and other facts are perhaps better explained by supposing that the gulf was a good deal blocked up to the westward. I much regret that my observations are so limited as to prevent me deciding this and many other facts. Indeed I feel that this communication is very rudimentary, and must only be looked upon as a very rough sketch compared with what could be ascertained by a complete application of the principles on which the observations have been conducted. My object has been more to point out what kind of results can be arrived at, than to give any such final conclusions as could be derived from more extended investigation; and I should not of course have ventured on such generalizations if I had not satisfied myself of their applicability, by far more extensive observations in other districts and formations.

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*Traces of Unity of Form in the Individual Bones of the Skeleton.** By G. Dickie, M.D., Professor of Natural History, Queen's College, Belfast.

It is admitted that the skeleton in every vertebrate animal is constructed according to a common plan, and the entire series of vertebræ of which it consists may be referred to one model. It appears to us that there is good reason for proceeding a step farther, and coming to the conclusion that unity prevails also in the elements of the typical vertebra and its appendages.

We may first examine the appendages or limbs as affording the most evident indications of such unity. If we take as the type or model a bone of the hand (metacarpal), or that of the foot (metatarsal), we shall find that a very striking resemblance to it pervades all the elements of every limb.

This typical bone may be described as having a sub-cylindrical shaft, but dilated towards both ends. The shaft may however vary in length. Now this is the prevailing form in all the principal bones of the limbs. In man, for example, such general character exists in the bones of the arm, fore-arm, hand, and fingers; in thigh, leg, foot, and toes. The short and

* Abstract of a paper read before the Belfast Natural History Society, November 28, 1855. The substance of these remarks was in writing, and communicated to others in December 1853.

irregular bones of the wrist and ankle present the greatest departure from the type; but in some cases the relation is obvious, for instance, in the frog certain bones of the ankle (calcaneum and astragalus) assume exactly the forms spoken of.

In the elements of the vertebra itself, as distinguished from its appendages or limbs, we shall find evident traces of similar conformity to a model.

The centrum or body of the vertebra presents a close approach to the type in the caudal and other parts of the skeleton. This is evident in a great number of instances. The extreme bones of the tail in the elephant consist of centrum only, and each very much resembles in shape a metacarpal or metatarsal bone.

The elements of the inferior or hæmal arch present very clear examples of conformity to the type. Pleurapophyses or ribs are not always curved and flat bones such as we see in man or most animals, as well as in many birds. In not a few instances, especially certain aquatic birds, &c., the guillemot for example, these bones are narrow and cylindrical (the same is true of the hæmapophysis), and not much farther removed from the type than the bones of the hand and fingers in the wing of the bat,* which they very much resemble. The ribs of serpents also present a transition to the model form.

The scapula is a pleurapophysis (sometimes with conjoined hæmapophysis—the coracoid); in man and mammalia generally it presents a wide departure from the model bone. But in many birds it is long and narrow, exactly like a rib; and since in the cases just mentioned the ordinary ribs very much resemble the model bone, we have thus transitional forms of scapula conducting us to the original type. In man the collar bone (hæmapophysis) presents the typical form, only it is curved; and in birds the coracoid (or hæmapophysis) is almost similar.

In the pelvis, intended to support important viscera, and give attachment to strong muscles, there is generally a wide deviation from the model; but in some cases the likeness reappears. In the frog, for example, the iliac bones exactly resemble it.

* These might be described as "linked *typicals* long drawn out."

In both rib and hæmapophysis the mere curvature of the part, so as to assist in the formation of an arch, cannot be considered as very materially affecting the conclusion to be drawn.

As regards the hæmal spine, it would not be easy to recognise any conformity to a model form in the sternum of man or of the bird; but in many animals, such as the lion, tiger, dog, &c., that part of the skeleton consists of a series of pieces, having an exact resemblance to the typical bone.

In the elements of the superior or neural arch, the departure from the model is generally greater than it is in the hæmal arch. The bones entering into the formation of the skull present a very wide departure from the type, but certainly not much greater than the scapulæ or iliac bones, all of which, as we have seen, may be traced to it. The very important functions of the cranium as a protector of the important parts within, necessarily imply great and constant departure from the model.

If we examine the principal elements of the neural arch (neurapophyses) in any large vertebra, as that of the sperm or baleen whale, we shall find that they may be referred to the same general form which ribs usually present, and these, as we have seen, can be traced to a model bone. The neural spine is indirectly referable to the same type and by similar steps. We observe it in ruminants and others attaining great length, and resembling a rib, only it is straight. In some of the vertebræ of the elephant, the large neural spine very much resembles our assumed model, being dilated at both ends, and narrower towards the middle part or shaft.

It is curious to observe that the same model form appears in plants—for example, in the petiole of the horse-chestnut, &c. The common petiole of the ash leaf resembles a series of phalanges like those of the bat's hand and fingers, and, like them, separable also at the joints.

On the Different Branches of Natural History, the Chairs which have been Instituted for their Illustration, and the Manner in which they should be Subordinated. By JOHN FLEMING, D.D., Professor of Natural Science, New College, Edinburgh.

The following remarks which are here offered for the consideration of the readers of this Journal were, in a condensed form, delivered by me, being the President of Section D. ("Zoology and Botany, including Physiology") of the British Association at Glasgow, 13th September 1855, as an opening address. Several individuals, in whose judgment I place confidence, requested me to communicate them for publication, in the belief that the views expressed were calculated to promote useful improvements in the mode of instruction in a very important, but much neglected branch of general education.

At the present time there seems to prevail a large amount of difference of opinion, or rather perhaps a confusion of ideas, respecting those departments of knowledge. ordinarily included under the term NATURAL HISTORY, and likewise as to the manner in which the different subjects should be subordinated.

The truth of this statement will become more apparent, by taking a view of the Chairs which have been instituted in our Universities, and the subjects which have been assigned to the several Professors. Among the earliest attempts to countenance Natural History, on the revival of learning after the dark ages, may be mentioned the appointment or royal diploma of Sir Robert Sibbald, by Charles II., 1682, to examine the productions of Scotland, in order to promote the progress of the Arts, Medicine, and Natural History.* In the execution of

* "Cum nos Regia nostra consideratione animadvertentes, Esse in antiquo nostro SCOTIÆ Regno abundantiam eximiarum et utilium Plantarum, Animalium, Quadrupedum, Volatilium, Piscium, et Insectorum ; et Mineralium, Metallorum et Substantiarum repertarum in et ejectarum a Mari : Quæ si nota essent et eorum natura, virtutes et usus, plurimum conducerent ad variarum Artium et Artificiorum profectum, et Medicinæ ac Naturalis Historiæ Scientias multum promovere possent, quæ adeo necessariæ sunt ad Ligeorum nostrorum conservationem."

this task, Sibbald published his *Scotia Illustrata sive Prodromus Historiæ Naturalis* (1684), and contemplated the objects which presented themselves, as capable of distribution into groups, nearly corresponding to the three KINGDOMS OF NATURE, the Mineral, the Vegetable, and the Animal, afterwards very generally recognised. In the first book of the *Prodromus* we have an account of the air, the waters, and the surface, or the leading features of Scotland's Physical Geography, including the prevailing diseases, and the most approved methods of cure. The second division of the work was devoted to the cultivated and indigenous plants, and *Horti Medici Edinburgensis Descriptio*. Then followed an account of the wild and domesticated animals of Scotland, and the history concluded with a notice of the minerals, rocks, metals, and marine products. We thus see that the notions entertained by Sibbald respecting the objects of Natural History were, generally speaking, those of the present day. He likewise instituted a class of Natural History at his own house in the spring of 1706.* The lectures were probably framed in accordance with the arrangement of the subjects in the *Prodromus*. We have not the means of determining by whom these lectures were continued until the appointment of Dr Walker, who, in 1775, succeeded a Dr Ramsay who, five years previously, had been nominated Regius Professor, but who never taught a regular course. From the period of Dr Walker's appointment may be dated the establishment, in Edinburgh, of Natural History as a branch of general education.

Before, however, proceeding to consider the duties of the Chair of Natural History, we must briefly advert to the condition of Botany. Sir Robert Sibbald and Sir Andrew Bal-

* The following advertisement appeared in the Edinburgh Evening Courant, 14th February 1706.

"Quod patriæ charissimæ, et in ea Philiatris, felix faustumque sit.

"Robertus Sibbaldus, M.D., Eques auratus, Deo auspice, Historiam Naturalem, et Artem Medicam, quam Dei gratiâ per annos XLIII. feliciter exercuit, docere in *privatis collegiis* incipiet, mensibus vernalibus hujus anni, MDCCVI.

"Monendos autem censet juvenes harum rerum curiosos, se non alios in Album suum conscripturum, quam qui callent linguas Latinam et Græcam, omnem Philosophiam et Matheseos fundamenta, quod chirographis preceptorum testatum vult."

four had exerted themselves, and succeeded, in establishing a Botanic Garden thirty years before the former delivered his course of lectures on Natural History. Botany, at this period, was chiefly occupied with an account of the herbs or simples used in medicine. The garden was termed "Hortus Medicus Edinburgensis," afterwards the Physic Gardens, and latterly the Botanic Garden.

It was thus, in connection with medicine, that the study of plants was recognised, the botanist and herbalist being synonymous terms, from Sutherland, the first professor of botany, through the Prestons, to Dr Alston. This intelligent individual is styled in *A Dissertation on Botany*, 1754 (a translation of the first 82 pages of the *Tirocinium Botanicum Edinburgense*), as "the King's Botanist for Scotland, and Professor of Materia Medica and Botany in the University of Edinburgh." His successors have been designated Professors of Medicine and Botany. This close connection between botany and medicine is at the present day far from obvious. When plants were used medicinally, in their recent or dried state, it was indispensable that the practitioner should be able to discriminate the genuine from the spurious. But the days of *simples* have passed away, and a more satisfactory acquaintance with morphia and quinine may be gained in the druggist's shop, than by the study of the raw materials in a physic garden. We are far, very far, from wishing the knowledge of plants (which we shall call PHYTOLOGY, rather than Botany) to be overlooked by the medical student, but we cordially join in an opinion which has been expressed, that "by the attachment of this science to the medical faculty parents are too frequently restrained from directing their youth-head to the study of an important branch of knowledge, with which every one laying claim to a liberal education should be acquainted."

Let us now return to the consideration of the chair of Natural History, as it has existed in the University of Edinburgh. The *Institutes of Natural History*, published by Dr Walker in 1792, as a text-book, gives a correct view of what the occupant regarded as the business of his class. He considered Natural History as consisting of the six following branches:— Meteorology, Hydrography, Geology, Mineralogy, Botany, and Zoology. Under the head of Geology, he embraced, chiefly, those subjects connected with the fabrication of the globe, the formation of strata, and the condition of the surface; while under the division Mineralogy, were discussed the characters of simple minerals, rocks, mines, and palæontology, under the then employed term, extraneous fossils. A chair of Botany had been instituted in the University, as we have seen, at a much earlier period, so that we may consider the term NATURAL HISTORY as intended to refer to the five remaining branches in the above enumeration.

If we proceed to Glasgow, the older University, we find that a chair of Natural History was instituted in 1807, and eleven years thereafter a chair of Botany was established. It was probably in consequence of these arrangements, formed in the belief that a class of Botany should exist in every medical school, that the Royal Commissioners of Inquiry into the state of the Universities of Scotland in 1831, *statute and ordain* that the candidate for the degree of M.D. shall attend the class of Botany, while they only *recommend* attendance upon a course of Natural History. Several years later, the Royal Commissioners recommended the institution of a single chair at Aberdeen for Natural History and Botany, to be comprehended in the medical faculty. When advocating the establishment of a University at Dumfries, and considering it inexpedient to institute any classes in the departments of Law, or Medicine, they did not recommend a chair of Natural History or Botany, evidently considering these subjects as forming no part of general education!

In the older English Universities, the term Natural History, as the designation of a chair, has no place; but in its stead we find the equally ambiguous one, Geology, distinguished from Mineralogy and Botany, to which separate chairs are assigned. A similar arrangement prevails in Trinity College, Dublin. When the University College of London was instituted, Natural History was not recognised, while Zoology, Botany, and Mineralogy, occupied its place. Three years later, chairs of Mineralogy, Geology, Botany, and Zoology, were instituted. This was a near approach to an arrangement by which the different branches of Natural History could be taught, with sureness. But, in the institution of the New Colleges in Ireland, a retrograde movement took place, under the sanction of the Imperial Parliament; for we find Natural History as a chair restored, and understood to include Zoology and Botany, while Mineralogy and Geology, conjoined, constitute the business of another class. We thus see that in Edinburgh and Glasgow, Natural History includes Zoology, Mineralogy, and Geology, to the exclusion of Botany; while in the Queen's Colleges of Ireland, Natural History includes Zoology and Botany, but excludes Mineralogy and Geology.

The Universities of Oxford, Cambridge, and Dublin, ignore the term Natural History, but recognise Mineralogy, Geology, and Botany, to the exclusion of Zoology; while in the Metropolitan School of Science applied to Mining and the Arts, Natural History is restored as a separate class, in company or of co-ordinate rank with Metallurgy, Mining, Mineralogy, and Geology.

More recently we have seen proofs of the false conceptions of Natural History pervading the public mind even in places where the proof of greater illumination might have been looked for. The examination of Assistant Surgeons, in the Service of the East India Company, embraces Anatomy and Physiology, together with Comparative Anatomy—likewise Natural History including Botany and Zoology.

Here we may ask, what would Natural History include, unless Geology and Mineralogy, if Botany and Zoology were excluded, and what is Comparative Anatomy, if detached from Zoology and Botany? Perhaps the individuals who framed these regulations had no higher notions of the study of animals and plants than might be expressed by the terms Zoography and Phytography.

In the examination of candidates for employment in the Indian Civil Service, we have Natural History, Geology, and Mineralogy, occupying co-ordinate rank. In the former case we have a Natural History with, apparently, Geology and Mineralogy, while here we have Natural History with, apparently, Zoology and Botany.

Such remarkable discrepancies, which must be obvious to every attentive observer, have derived their origin from various sources. Botany has been fostered because it has been united to medicine; Mineralogy must always occupy a respectable position in a mining country; while modern Geology has become popular in consequence of the revolutions which it discloses, and the vast amount of exciting food which it yields to the imagination. Zoology, alas, has been comparatively neglected—squeezed into contact, in one place, with Mineralogy and Geology; at another, with Botany; and at a third, deliberately excluded.

These strange circumstances have excited me to offer the few following remarks. Before, however, proceeding to the examination of any of the branches usually included under the term Natural History, the student should prepare for the task by attending to Natural Philosophy and Chemistry; for the intelligent inquirer in the present day seldom restricts himself to observation—he also experiments, and calls to his aid the balance and the crucible, the scalpel and the microscope. His subject has ceased to be Natural *History*, and now more frequently assumes the name of Natural *Science*, in contradistinction to Physical Science, which embraces Chemistry and Natural Philosophy.

In proceeding to contemplate the different branches of Natural Science, an obvious division presents itself into inorganic and organized beings—the dead and the living—the laws regulating each being essentially different. Viewing the inorganic kingdom in all its bearings, we would propose the following divisions:—1. Aerology, also known under the objectionable term Meteorology. That this branch should be studied after, not before, Natural Philosophy and Chemistry, must be evident to any one who considers that it treats of the contents, the pressure, the temperature, and the currents of the atmosphere. 2. Hydrology occupies an equally important place—embracing an examination of the sources, the contents, the temperature, the aggregations, and the motions of the waters, and requiring an acquaintance with Aerology, as well as of Physics, for the successful prosecution of the task. 3. Mineralogy is here contemplated as exclusively occupied with *mineral species*, whether occurring in the gaseous, liquid, or solid form. Chemistry must, in the first step of the process, make us acquainted with the nature of the materials and he states of combination before the building up of a mineral species can be contemplated. Let us take, as a familiar example, a crystal of calcareous spar. Chemistry tells us that before a rudimentary particle of the spar can exist, carbon, calcium, and oxygen must previously have been arranged—the carbon with the oxygen in the proportion to form carbonic acid, and calcium with the oxygen to form lime ; and then, by a similar law, the carbonic acid and the lime unite and form the materials referred to. The building process now begins, and if, under the influence of the homogeneous force of Cohesion, or crystallization, these rudimentary particles have been arranged in regular order, an individual crystal is produced, with a definite internal structure and a definite external form, bounded by planes meeting at definite angles. But the building process is frequently disturbed and restrained ; and we find the rudimentary particles simply aggregating under the influence of the heterogeneous force of Adhesion, and appearing as structureless masses of marl or chalk, slightly influenced by cohesion in compact limestone, and more individualized in granular marble. 4. PETRALOGY, or the study of rocks. Without a knowledge of Aerology, Hydrology, and Mineralogy, the study of rocks cannot be prosecuted satisfactorily. The inquirer may soon learn to call a particular mass *granite*, as he might designate a plantation a clump of *trees* ; but if he was not acquainted with the materials and the condition of arrangement in the three species, quartz, felspar, and mica, and the difference between the force which constructed the individuals and that which united the three very different species into one mass, he has proceeded but a short way in the study. In addition to a knowledge of mineral species requisite for the study of petralogy, the student must inquire after the origin of the materials of rocks, their state of aggregation, their structural character, and relative antiquity. Inorganic, or mineral species, constitute the air and the waters, while the rocks consist either of individuals of a single species, as marble, gypsum, and salt, or individuals of different species, as granite and greenstone. A chair to include all these branches of study —Aerology, Hydrology, Mineralogy, and Petralogy (Mineralogy taking precedence in the lectures)—should be established in every seat of learning ; and as all the subjects have many points of intimate relationship, the mind of the Professor need not be much distracted by discordant materials. There may be some difficulty in bestowing on such a chair an unobjectionable name; but we think the hybrid term Mineralogy, which has been frequently used, may still be advantageously employed.

The Organic kingdom, while obviously admitting of arrangement into plants and animals, or Phytology and Zoology, presents a field which may be regarded as common to both subjects, involving the consideration of the vital laws, the development of organisms and the distribution of species, usually denominated *Biology*.

PHYTOLOGY, or Botany, far too extensive a subject to be conjoined even with a kindred branch, Zoology, may constitute a chair, giving to its occupant abundant materials for the exercise of his talents and zeal. In studying this subject, the structure, functions, distribution, and classification of living plants should precede the study of the extinct races, or the present condition of the plants of the globe should be regarded as essential in preparing for an examination of the condition of vegetation during the anterior epochs of the earth's history, the relative antiquity of which the petralogist had previously determined. The expediency of adopting this mode of conjoining the study of recent and extinct plants seems apparent, being simply not studying the subject backwards, but beginning with the distinct, and passing to the obscure, and I rejoice to know that the present earnest and successful Professor of Botany in the University of Edinburgh is conducting his class under the influence of this conviction.

Zoology must be cultivated after the same manner in which we have recommended Phytology, namely, by studying the structure, functions, distribution, and classification of recent species preparatory to the examination of the extinct kinds. These views occupied my mind at a very early period (See *Phil. Zool.* ii., p. 105. 1822), and I in part reduced them to a practical form in my *British Animals*, published in 1828.*

* Copies of this work, with a spurious title page, were put in circulation by Mr Henry G. Bohn, a London bookseller, who having purchased some copies of the work, altered the original by introducing "Second Edition;" and instead of "Printed for Bell and Bradfute, Edinburgh; and James Duncan, London, 1828," substituted "London; Duncan and Malcolm, Paternoster Row, 1842." Conduct of this kind requires no comment.

Hence I rejoice to see the Zoological Chair in the University College, London, under the distinguished occupancy of Dr Grant, embracing the study of recent and extinct species.

With these convictions I would earnestly impress on those who can influence government patronage, the expediency of establishing in every University of the empire the three following Chairs, for the illustration of branches of knowledge connected with general education, in which all are interested :—

1. Mineralogy, including mineral species, airs, waters, and rocks, with the principles of mining and metallurgy.*

2. Phytology, embracing recent and extinct plants.

3. Zoology, embracing recent and extinct animals.

According to these views PALÆONTOLOGY will naturally be divided into two branches, and absorbed by Zoology and Phytology. In treating of plants and animals, the living and the dead being included, we may either contemplate the extinct kinds *systematically* as exhibiting many modifications of forms and structures, but imperfectly displayed in the living races, as among the Saurians, the Cephalopods, or the Brachiopods. Or we may view them *chronologically*, unfolding to us the condition of life on the globe during the different epochs of its history, primarily determined, as has been stated, by the order of formation and superposition of the beds in which their relics are enclosed.

Geology, as being undoubtedly identical with natural history, will become the expression of a number of different departments of knowledge, instead of being specifically regarded as at present, to indicate sometimes Palæontology, sometimes Mineralogy and Petralogy, or even all the branches which we have now been contemplating. To justify this remark I would take leave to state that in order to peruse intelligently either of the two most popular general treatises on geology in our language, viz. De la Beche's *Geological Observer*, or Lyell's *Manual of Elementary Geology*, the reader would require to be conversant, to some extent, with natural philosophy and chemistry, as well as with the leading truths of Aerology, Hydrology, Mineralogy, Petralogy, Phytology, and Zoology.

* Mineralogy should be taught in the summer session for the sake of excursions to adjacent quarries and rocks.

The truth seems to be that every writer on Geology, aware of the indefinite character of his subject, thinks himself justified in lugging in every conceivable, if *readable* matter, while the lecturer thinks he can fairly employ everything *speakable.* It may here be asked, how is this tolerated ? Why is the subject so popular ? In answer, we simply refer to a well-known fact, that the great majority of readers and hearers of scientific subjects, treated in a popular way, are delighted to wade in waters beyond their depth ; and this occasions no alarm, because they have always sufficient floating power to keep them at the surface.

In conclusion I would now very briefly advert to two terms, intended to express branches of knowledge intimately connected with the subjects which have been under consideration. The first is PHYSIOLOGY. In this Section of the British Association we have "Zoology and Botany, including Physiology." This division of our subject is to me incomprehensible. Few would encourage any one to study the structure of plants or animals, and leave out of view the functions of their different organs. Hence Physiology, apart from Phytology and Zoology may be regarded as a delusion ; so that I cordially adopt the opinion of Sir Benjamin Collins Brodie, in his evidence before the Parliamentary Medical Committee, in 1834, and in answer to the question, "Should Physiology be taught at the same time with Anatomy ?" when he said, "I do not understand the division between Anatomy and Physiology. You can no more separate them than you can separate the study of the stars from the study of their motions."

The other subject to which I wish to refer is HISTOLOGY, as it may be defined, the microscopic character of the webs or tissues of vegetable and animal organisms. The attempt to separate the study of structure on the small from structure on the large scale, seems, in every aspect, to be as objectionable as the title assumed. I cannot imagine any intelligent student willing to draw a line of distinction between the study of the structure of organisms by the aid of the knife and the eye, the study of the same organism with a lens, and lastly with the appliance of the microscope. It is an attempt at a subdivision of labour, in a peculiar form, thoroughly uncalled for, highly objectionable, and calculated, like Physiology, as a separate branch, to destroy the connection between the study of structure and functions.

Gentlemen, I have to apologize for this disquisition, which has greatly exceeded the limits I orginally contemplated, and, as an apology, I may state that, earnestly attached to the subject, I regard its true collocation as of real importance. In the course of ten years' experience in attempting to teach the whole range of the subject, I have frequently found individuals eager to study Mineralogy who had not attended to Chemistry—to study rocks before they knew simple minerals, and anxious to become acquainted with Palæontology before they had begun the study of recent plants or animals. With this experience, I trust you will excuse the length of my remarks, and the somewhat decided tone in which they have been expressed.

On the Metalliferous Deposits of Kumaon and Gurhwal in North Western India. By WILLIAM JORY HENWOOD, Esq., F.R.S., F.G.S., lately Chief Mineral Surveyor Hon. E.I.C.S., North Western Provinces.*

The district to which the labours of my assistants and myself were directed extends from the neighbourhood of Sirenuggur, the capital of Gurhwal, on the West, to the boundary of Nepal on the East; and from the plains on the South to the perpetual snows of Badrinath and Nundedevi (mountains of from 23,000 to 25,000 feet above the sea) on the Thibetian frontier, on the North.

Three separate patches of granite occur within the district —at Almorah, at Dwarra Hath, and in the Ledha, a tributary of the Surjoo. The first two are talcose, and near Dwarra Hath the felspar is in many places so much decomposed that its use in the manufacture of earthenware has been suggested. I fear, however, it is far too sparingly distributed to warrant an experiment of that kind. The granite of the third locality is hornblendic; traversed by numerous veins of quartzose felspar rock in which there are few or no traces of hornblende.

Gneiss overlies the granite, and is succeeded by talc-slate.

* Read before the Royal Geological Society of Cornwall, 19th October 1855.

In the bed of the Ledha both hornblende and talc enter into the composition of the gneiss, and both gneiss and talc-slate are traversed by veins of quartzose granite. At Almorah granite and gneiss alternate, but, whether the former may be considered to occur in beds or in veins, its boundary plains coincide with one series of the joints by which every formation is traversed.

The talc-slate formation is succeeded by clay-slate, for the most part closely resembling the metalliferous clay-slate (*killas*) of many parts of Cornwall and of Waterford and Wicklow. Near the boundary of the formations the talc-slate alternates with thin beds of clay-slate, and the clay-slate with small beds of talc-slate. Large deposits of limestone occur at Nynee Tal, Gunegolee Hath, and smaller ones in many other places. This formation abounds in caverns, and one at Buddar Kalee is of very great size and beauty.

Sandstones, for the most part very clayey, but occasionally quartzose, occur at the foot of the hills, and near Kaleegoongee, Huldwanee, and Jham, they contain a few isolated masses of iron-ore, of which some small patches are rich, but in general the ore (hematitic) is too thinly dispersed through the body of the rock and too capriciously disposed to be worth notice for practical purposes.

In the granitic and gneiss formations we found no metalliferous deposits, but in quartzose beds, which sometimes contained considerable proportions of carbonate of lime, a little copper pyrites occurs, at Goron near the Nepalese frontier, at Rai, and at Kurrye on the banks of the Surjoo; and in this last-named locality it was associated with purple copper ore. All these deposits are conformable to the lamination of the talc-slate in which they are found.

At the junction of the talc and clay slates of Pokree, between the Aluknunda and the foot of the snowy range, extremely thin, short beds of quartz, occasionally tinged with earthy, brown iron-ore (*gossan*), occur at intervals comformable to the *laminæ* of the rock; and in like manner, but perhaps in rather thinner, longer, and broader plates, copper pyrites and purple copper-ore are found.

At Seera, near Pethora Gurh, and at Al Agur on the Ramgunga, both copper pyrites and purple copper-ore are obtained from broad beds of quartz comformable in position to the lamination of the clay-slate.

At Dhunpoore a bed of highly siliceous limestone interlies the calcareo-siliceous slate formation nearly horizontally. Both slate and limestone are traversed by two series of divisional planes which may be more properly considered structural joints than veins, of which one bears about E. and W., and the other about ten degrees E. of N. and W. of S. For the most part they are nearly vertical but sometimes they have a slight inclination—indifferently to either side. The respective directions of these joints, and the position of the bed of limestone, divide the whole formation into obtuse rhomboidal masses. At a distance from their intersections these joints differ little from those of structure common to all rocks. Where they come into contact with each other and with the limestone, however, both the joints and the bed enlarge, sometimes to a thickness of several feet; and though they contain only a few specks of copper-ore when separate, the mass found at their union is thickly spotted with it, and veins of ore—chiefly the purple variety—sometimes as much as six inches in width, traverse the rocky mass in all directions. This enrichment sometimes prevails for 10, 15, or even 20 feet from the actual point of contact; but it gradually diminishes; the intersecting lines dwindle to their original dimensions, and poverty at the same time returns.

These enlargements do not attend every intersection, nor is it easy—if, indeed, it be possible, to determine why some of them should be productive whilst others are poor. Excepting these, however, and a few specimens long since obtained from Seera, we neither saw nor heard of anything worthy of notice in the copper deposits of the country.

Iron ores occur in great abundance throughout the clay-slate formation, and plentifully in some parts of the talc-slate series. Hematitic ore is by far the most common, but the micaceous and oxidulated ores are also found in large quantities. Hitherto they have been discovered only in beds which coincide with the schistose structure of the adjoining rocks, as well in direction as in dip.

In the talc-slate district, a bed of micaceous iron-ore of 10 or 12 feet in thickness has been very extensively wrought at Bunna, on the banks of the Punaar, a tributary of the Surjoo. In the Agur or Ramgurh district a bed of iron-ore has been traced in a south-easterly and north-westerly direction for at least seven miles. It varies in width from 3 or 4 to more than 12 feet, and has a constant dip towards the north-east. It traverses both the clay-slate and talc-slate formations, and whilst in the former it consists almost wholly of micaceous ore, in the latter it is composed of the oxidulated and hematitic ores only,—a change in mineral composition which, I believe, takes place everywhere else when a metalliferous deposit passes from one rock to another.

In the Gunnai or Khetsaree district a bed of hematitic iron-ore from 2 or 3 to more than 30 feet in thickness has been traced for more than 15 miles in length from south-east to north-west.

But besides these there are very many other deposits of iron-ore which have not been traced for any very considerable extent; but, as I have had the honour of representing to the Government of India, are still well worthy of further notice. Some are probably mere local enrichments of extensive quartz formation; while others—like those of Agur and Gunnai—though of variable dimensions and richness—as to a greater or smaller extent is the case in every metalliferous district—are perhaps everywhere productive of iron-ore.

In the 5th volume of the Transactions of the Royal Geological Society of Cornwall, I have shown the general fact that *bunches* of ore dip from the mass of the nearest granite formation. In the 6th volume I have mentioned that a similar law determines the deposits of gold in Brazil. In the Gunnai district the same rule seems to prevail, for the bunches of iron-ore all seem to dip from the granite of Dwarra Hath.

The talc-slate formation of Kumaon and Gurhwal have a very close resemblance to one series of rocks in the gold districts of Brazil: and, although the micaceous iron-ore of India contains but little manganese, it has, notwithstanding, a considerable similarity to the Brazilian Jacotinga formation; a formation in that country more productive of gold than any other. We were, therefore, gratified but not surprised at finding the natives obtaining small quantities of gold from the sands of several rivers.

Although the native miners of Kumaon and Gurhwal use both "picks and gads," they are so clumsily made, as to have little resemblance, except in object, to those of this country. Rocks too hard for these tools are, in civilized countries, blasted with gunpowder; the native method is, however, softening them by the application of fire; but in their small and ill-ventilated mines this mode is very ineffective, while the smoke and foul air, generated by the combustion, stop the work of every other person in the mine at the time. The imperfection of the tools and mode of working; the ignorance which prevails of the advantages of ventilation; of the economy of labour, by extracting the ore through passages large enough to allow the workmen unimpeded action; as well as the native smelter's inability to treat any but the richest and most fusible ores; render it, therefore, an object of paramount importance, in the view of the Indian miner, to avoid, by every possible device, the opening of large galleries. But the softer and more fusible ores are far less plentiful than those which are too refractory for the native smelting furnace; and the two varieties of ore are so intimately mixed in the beds, that it is impossible to extract the former without breaking still larger quantities of the latter also. In order, therefore, to obtain a supply for their furnaces, as well as to allow the miner the free use of his tools, large excavations are made, and a selection of ores, as far as practicable, is made underground, and that which is too refractory for use is heaped up within the mine, to such an extent as scarcely to allow sufficient convenience for the exit of the miner, and the removal of the ore. The ordinary mode of extraction is in bags of skin, tied to the person of the labourer, who crawls, when possible, on *all fours*, dragging the bag after him over the rough floor of the opening. But in many places the opening is too strait even for this, permitting passage only in a prostrate position, the sufferer propelling himself by writhing, and by the aid of his elbows on the sides and of his toes on the floor of the hole. In one mine, indeed, the opening is so small, except in the part wrought under the Goorkha rule, that we found children of only from 10 to 14 years old employed in the difficult and dangerous task of re-opening a communication through fallen rubbish in a gallery of which the sides were broken down. I have peculiar pleasure in recording one remarkable exception to the rude, laborious, wasteful, and unsystematic method of mining which elsewhere prevails. Seventeen or eighteen years since, Captain Wilkin, a native of Saint Agnes, in Cornwall, now of Wheal Trumpet, near Helston, was employed to superintend a trial of the *Pokree* mine already mentioned. We found the tools made under his direction still in use; his valuable practical lessons still gratefully remembered; and his injunctions still observed by the natives. The galleries are of convenient dimensions, and are kept in good repair, and the wooden props employed in them are fixed, if not in the very best, at all events in an efficient manner. The use of the wheel-barrow is recognised by the neighbourhood, and we saw it employed, not only in the mine, but in several Government works, by people who had been instructed by Captain Wilkin.

As, therefore, one boy with a wheel-barrow will accomplish more work in a given time through commodious galleries than two men with bags through the miserable and dangerous holes of the native miners, the Government of India has been pleased to sanction my recommendation that some of Captain Wilkin's pupils, at *Pokree*, should be employed in the mines about to be opened at Gunnai, to remove prejudices of locality and of caste, and to teach their countrymen the advantages of the Cornish method of mining.

Some of the native miners are represented to possess a little property, notwithstanding the ordinary wages of a man average only about (two annas) threepence per day; but nothing can be more squalid or miserable than their general appearance.

One result of my mission to India has been the commencement of iron smelting, as well as of mining, on the European system under the direction of assistants who remain in that country. Immediate results are not, of course, to be expected, but I do not doubt but that a few years will crown well-directed labours with entire success.

The iron mines and smelting works will be offered to individual speculation, as soon as the natives have been instructed in improved methods of working.

With a view to this and other sources of traffic between the Company's territory and Thibet, a magnificent line of road has been planned from the plains through this district to the boundary of British India. For although the iron and (surpassing as it may appear) the tea of Kumaon, as well as the cotton goods of Manchester and the iron ware of Birmingham, even now find their way through this country into the Chinese empire; it is by paths through the wilds, so narrow and so steep, that sheep and goats are now almost the only beasts of burden employed in the traffic.

REVIEWS AND NOTICES OF BOOKS.

Naturgeschichte der Vulcane und der Damit in Verbindung Stehenden Erscheinungen. Von Dr Georg Langrebe. Gotha, 1855. 8vo.

The author of this work is a Geologist who has long busied himself particularly with the subject of Volcanic Mineralogy and Geognosy, and his materials and published notices have increased so much upon his hands that he has been induced to publish them in a collected form, and so arranged and explained as not only to interest the scientific world but the educated public in general. Two sections are especially devoted to elementary information, so that the uninitiated need not have occasion to refer to other literary aids. The author has however to lament that several new and important works did not reach him till his MS. was in the publisher's hands; these however he hopes to make available on some future occasion. He mentions especially Hasskarl on Junghuhn's Travels in Java, Sartorius von Waltershausen on Iceland and Sicily, and the very recent treatise of Th. Scheerer on the Felspar family and other minerals connected with volcanic rocks.

The first division treats of the Characteristics of Volcanoes and their extent over the surface of the earth, and commences by assuming L. von Buch's definition of a volcano and his general principles as the grammar of Volcanic Science. Buch was a Prussian who wrote at Berlin early in the present century; he thus defines a volcano, "a mountain of a spherical form, which, by a chimney-like open tube, ascending from its interior to its top, affords an outlet to the gaseous melted, but consistent, eruptive matter developed in the bowels of the earth." He divided volcanoes themselves into central and serial volcanoes; the latter following the direction of great clefts in the earth, and the former that of the original hill formation, instancing as such the Lipara Islands, Ætna, Iceland, the Azores, Canaries, &c.: these form always the middle point of a great number of eruptions nearly of equal extent, working around them on all sides. The others, again, lie in a series behind each other, often pretty near, like chimneys upon one great chasm. Our author next gives a separate account of the various central volcanoes, for example take the extinct one on the Island of Felicudi. "This island was called by the ancients 'Phœnicusa,' and is about nine Italian miles in circumference, principally formed by a single conical hill of about 2853 Par. feet in height. On its summit two craters are to be observed, one of which projects over the other. In construction this island much resembles that of Salina; it consists principally of tufaceous matter and the subordinate lava layers bear quite the character of the felspar and porphyry lava of Salina, or the ancient portion of Lipari. Some of these lavas are very remarkable for a strong inclination to prismatic fracture, which is even observable in small fragments. No traces of recent eruption are to be found on Felicudi."

A long and minute account of Ætna follows, in which the author remarks that it is curious no allusion is made to any eruption in the poems of Homer, although Diodorus Siculus has mentioned one which must have occurred anterior to the Trojan War; so that it is even doubtful whether by the "Country of the Cyclops" Homer really meant Sicily. Pantellaria and Vesuvius are also fully described and traced from their earliest known existence. Vesuvius, as sketched by Dion Cassius, presents much the same appearance as at the present day; for he mentions more than one top, and the amphitheatre-like margin which the Somma still presents; and his opinion is that the mountain was cleft in the great eruption of A.D. 79, which was most likely handed down to him by those living at the time, as Dion Cassius flourished only about a century after. Dr Langrebe pursues his history of Central Volcanoes through the Azores, Canary Islands, Galapagos, Society and Friendly Islands, to those of the Southern Polar Seas.

An excellent description of the New Shetland Islands, Bridgeman and Deception Islands succeeds; and the history of the Central Volcanoes is thus concluded:—"All these arise in the midst of basaltic environs, although their cones in most cases consist of trachytic rock; any trace of other rock formation, particularly primitive, is seldom found, or they are very distant, and do not stand in immediate connection with the volcano.

The Serial Volcanoes, to which the latter half of the first volume is devoted, arise either immediately from the interior of the primitive rocks, and up over the ridge of the chain of mountains itself, or granite and similar rocks occur in their neighbourhood, perhaps even close to the slope of the volcano, when the series only accompanies the foot of the mountain chain, or edge of the continent. This is the most interesting part of the volume, as it treats mostly of the less known regions of later discovery. The Serial Volcanoes commence with the Greek Islands ; thence our author passes to the West Australian series, where, from the meridian of New Zealand, all the islands in the South Sea assume a character which is easily distinguished from the other islands lying in it ; for, instead of their high-towering conical shape, they rise towards the west as narrow, high, long islands, like mountain chains, adorned with gigantic Cocos palms, and all tending in the same curved direction, so that they must of necessity be viewed as a united whole, it being evident that New Zealand is continued by New Caledonia, the New Hebrides, the Solomon Islands, and the Louisiade Archipelago, as far as New Guinea, and by that as far as the Moluccas ; which view appears more clear when we observe that this curve repeats exactly the form of the coast of New South Wales. From New Zealand, basalt islands are of rare occurrence, while primitive rocks appear almost everywhere, and even in the small and isolated Norfolk Island. On New Caledonia are found serpentine and mica, the latter rich in garnets ; in the New Hebrides and Tanna mica and quartz are found ; the great circuitous New Zealand is chiefly composed of primitive rock. On Cocos Island, at New Ireland, there is a calcareous mountain 460 feet high, and at Carterets Harbour there is a running chain of 1380 feet, which stretches to the hills in the interior, which are above 6000 feet in height, and very probably slopes down from them. The volcanoes no longer appear as the head of a group, but on the outer margin of this West Australian series, and always in that neighbourhood, as it were at the foot of the chain of hills.

The series of the Sunda Islands comes next, beginning from the smaller ones eastwards of Java, and proceeding in a westerly direction towards Java, Sumatra, and the Andamans, then the Moluccas. There, as well as in Java, the volcanic series comprises nearly the whole breadth of the islands. The Philippines, Marianas, Carolines and Japan Islands follow, where the small islet of Firando has been burning constantly for many centuries, like a fire in the middle of the sea. The Kurile Islands stretch like a bow to Kamtschatka ; their geognostic construction and volcanic mountains are, however, but very imperfectly known. The volcanic phenomena in the peninsula of Kamtschatka itself are highly interesting, from the extraordinary height of the mountains, which are only surpassed by the Andes, and from a species of rock composed of natro-felspar and hornblend, first discovered in American volcanoes, which has also been found in Kamtschatka by A. Erman.

On the Aleutian Islands, volcanoes are found in still greater number than on Kamtschatka; they are, however, as yet only known by name. These form the junction between Asia and America, and it is very probable that their volcanoes are all connected beneath the bottom of the sea. On the top of a small, steep, lofty island, called Kassatotsohy, is a crater filled with water. On the island of Atkha, one of the largest of the Aleutian group, there are three powerful volcanoes in action, in one of which several small craters throw up, at regular intervals of a minute, a viscous seething slime, smelling strongly of sulphur, and emit at the same time a hollow subterranean sound.

Dr Langrebe gives a curious and interesting account of the rise in 1796 of a volcanic island as seen by a Russian hunter, named Kriukof, and its progress to the present time; it is called "Joanna Bogosslowa," or "Agaschagokh," situated under 53° 56′ N. Lat. and 170° 18′ W. Long. from Paris. There are three springs upon it, close beside each other, one nearly at the heat of boiling water, the second less warm, and the third quite cold. The Aleutian islanders assert that their temperature is apt to change.

Upon the volcanic appearances in America, our author remarks: "Of all parts of the world America presents the most numerous, the highest, and at the same time the most destructive volcanoes, and one of the longest volcanic lines in the known world, extending, with a few breaks on the northern half of this hemisphere, more than 2,500 miles, beginning at Terra del Fuego, stretching through South, middle, and North America, up to California, thence to the Oregon region, and Russian North-West America, as far as the Algaska Peninsula, and there uniting with the Aleutian volcanoes. In this immense space it follows through all zones westward the great mountain range of the Cordilleras de los Andes. In the first degree of North lat. a very considerable branch, composed of plutonic and volcanic rocks, runs out in a north-east direction, passes over the Lesser Antilles, and appears through the Greater Antilles, to unite again with the highest chain in the region of Mexico, where the volcanic series of the Andes meets it, in an altered direction, first ascertained by A. Von Humboldt, so that the whole Caribbean Sea is surrounded by a girdle of volcanic hills. The extensive tracts of land in the southern half of America, lying on the east side of the Cordilleras, and certainly those from Patagonia to the banks of the Orinoco, are now free from active volcanoes. Yet on their east coasts occasional submarine eruptions do occur, and pseudo-volcanic phenomena are sometimes met with, both on the continent and neighbouring islands." The serial volcanoes are next minutely traced from south to north, and through the West India Islands, Central America, Mexico and North-West America, with which this volume closes.

The first portion of the second volume is devoted to earthquakes, their action, direction, duration, connection with the atmosphere, temperature, season, electricity, magnetism, and volcanoes. With regard to the influence of the atmosphere on such convulsions, our author observes: "For more than 2000 years the question of the connection of earthquakes with atmospheric phenomena has been a matter of dispute. In all those regions where they are of frequent occurrence, popular opinion is in favour of such a connection; and even in the north of Switzerland, not so often subject to such visitations, 'earthquake weather' is a common term,—especially when in winter a south-west wind produces a mild temperature; however, no certain results have yet been attained as to atmospheric influence.

"In many countries earthquakes have been connected with the scarcity of rain: for example, the year before the Lisbon earthquake was a remarkably dry one, but in the summer of 1755 the rain in Portugal began to fall most abundantly, and extended over a great part of Europe, particularly in countries where such convulsions were wont to occur; and this remark was even made in Norway.

"A similar circumstance occurred in Calabria at the great earthquake in 1783, only with this difference, that the rainy weather preceded, and the dry weather followed, it. It is elsewhere stated of this year, that 'a dry fog obscured the heavens over about one-half of the globe for nearly a month; and on the 18th August, one of the largest and most brilliant meteors, coming from the direction of the Northern Ocean, described a track of at least a thousand miles over the surface of the earth.' Shaw also remarks, that earthquakes on the north coast of Africa, particularly at Algiers, almost always take place a day or two after heavy rains. In Spanish America, on the contrary, and particularly in Caracas, similar observations have been made as at Lisbon, for the earthquake which destroyed that city was preceded by a season of unprecedented drought, and for a long while not a drop of rain fell in all Venezuela. A. Von Humboldt mentions that when Cumana suffered from a fearful convulsion in 1766, it was preceded by fifteen months of dry weather,—dry seasons are much dreaded in these quarters. Earthquakes, occurring after long drought, are generally followed by rich and copious rains; and the withered vegetation becomes so much refreshed, that in the Spanish Colonies, earthquake years are remarkable for their fertility. In Europe also the same effects have been perceived, for Vincenzio testifies to it after some violent concussions felt at London in February and March 1749, and after the earthquake which accompanied the eruption of Vesuvius in 1779, the vines and fruit trees in Campania blossomed for the second time in August, and produced ripe fruit. To this, however, the observations of Tschudi are opposed; for in his recent journey in Peru, he remarked in several places, that districts which had before been remarkable for fertility, after the visitation of earthquakes, were changed into sterile lands, and did not again recover their fertility. We think it best, however, in respect to atmospheric influence, to follow the opinion of A. Von Humboldt, that the commotions of the earth are in general independent of the condition of the atmosphere, which coincides with that of the best-informed and least-prejudiced observers in those countries which are the scenes of such commotions."

The effects of earthquakes on animals are next described. The noxious and unrespirable gases and vapours developed in most earthquakes, may be assumed as the cause of that restlessness which affects many animals on their approach, especially those which burrow under ground. Le Gentil has remarked, in his Indian travels, that rats, mice, lizards, and snakes leave their underground habitations, and run restlessly up and down before an earthquake. Insects also, which live under ground, feel its influence. Humboldt mentions that in the Llanos of Venezuela, the alligators leave their marshes, and rush to dry land with a loud noise, on the approach of an earthquake. Poli in his memoir of the earthquake of 26th July 1805, at Naples, has remarked of insects, especially ants, that they left their holes several hours before the commotion commenced, and the winged ones flew about in the rooms of houses during the night, and the locusts went in great swarms through Naples to the sea coast. Even the dwellers in the sea had a foreboding, for the fishes swam toward the shore, and were easily caught in great numbers. The birds were also restless, and hens and geese uttered loud cries; Caldcleugh in the great convulsion in Chili on the 20th February 1835, observed great flocks of sea-birds flying wildly and promiscuously from the coast to the Cordilleras. At Naples, the mammalia anticipated most evidently the approaching mischief. Goats and sheep bleated and rushed about in confusion, those confined in pens endeavoured to escape —bullocks and cows lowed loudly, horses raged in their stalls and tried to get free, those in the streets stood suddenly still, and snorted in an extraordinary manner—dogs howled fearfully, and in some cases, forcibly awaked their masters some minutes before the earthquake, as if warning them of the approaching danger. On the Chili coast the dogs ran off and hid themselves, for on the morning before the catastrophe, all traces of them were gone. Pigs are most sensible to the influence of earthquakes, and in countries where they are apt to take place, the inhabitants pay particular attention to the behaviour of these animals, and take their measures accordingly. At an earthquake at Melfi, the asses showed very great foreboding; they brayed in a most unusual manner, and the dogs, swine, and fowls joined in chorus.

In the human race it has been observed, that before an earthquake, people are much predisposed to qualms, giddiness, headache, and similar ailments; and it is easy to be conceived that these symptoms should increase during its continuance. At the earthquakes at Cadiz and Gibraltar, shortly before the destruction of Lisbon, many of the inhabitants of these towns were so affected an hour before the least trace of commotion could be felt, some became stunned and fell down, others became unwell, both on foot and on horseback, although they were not aware of the slightest convulsion.

The next portion of this volume is entitled Pseudo-Volcanic Phenomena, which are thus defined.

We class under this head various phenomena which cannot be easily brought under one general definition. To simplify our view, we may bring them under the following divisions—1st, the Solfaterræ, 2d, the Air and Mud Volcanoes, 3d, the Subterraneous Fires.

The Solfaterræ are formed in regions which bear more or less traces of volcanism, generally crater-like or chink-shaped depressions, out of which, through pores and clefts, vapours and gases ascend, without any strong explosion, mingle with the atmosphere, partly thicken and fall down as a deposit, and partly become lost in the currents of air. The mud and air volcanoes are generated by vapours and gases, which burst forth from the surface of the ground, in a radiated form, generally mixed with a salt slimy earth, and deposit their materials in the neighbourhood of the openings, mostly in the shape of low cones, having the appearance of small volcanic balls, but never throw out lava or analogous fluid fiery substances. The subterraneous fires are often in union with these mud volcanoes. They consist of an almost constant exhalation of hydrogen gas, more or less pure, mixed with carbonic acid and carburetted hydrogen, which sometimes spontaneously kindles, or may be readily set on fire.

These various phenomena in the different quarters of the world are next described.

With regard to the cause of volcanic phenomena, Dr Langrebe laments our faulty and insufficient knowledge. Without entering upon the many earlier theories which were rapidly taken up, and rapidly thrown aside, he tells us shortly, that volcanic phenomena of the earth comprehend, according to A. Von Humboldt, the *circuit* of all re-actions of the interior of our planet proceeding towards its crust and surface. According to this hypothesis we must assume that the kernel of the earth consists of a fiery-fluid mass, which, at the part where it borders the firm crust of the planet, gradually condenses, so that the shell of the earth constantly becomes thicker. The circumstance that fluid bodies with very few exceptions, suffer a diminution rather than an increase in volume, from condensation, appears at first sight to oppose this view ; but we must consider that the physical laws which prevail in the alteration of thickness in bodies in the inmost part of the earth, where we place volcanism, will manifest themselves differently from those on the surface. It is therefore perhaps more than probable that the matter found in the bosom of the earth, on account of the monstrous thickness of the mountain masses which press upon it, will undergo a considerable thickening, and it may therefore easily happen, that all the fiery-fluid material, which, on the inner side of the crust of the earth comes gradually to a stiff condition, during this change, is subject to an increase of its volume. If this actually takes place, during the slow condensation that follows, a lessening of the capacity of the firm crust of the earth must ensue, that is, the space enveloped by it, and filled with the fiery-fluid centre will become smaller, by which means the fluid contents suffer an increase of pressure, and from this again results a re-action towards the crust of the earth. The next effect of this is, that the equipoise produced by gravitation and rotation is destroyed, and if the mountain masses which form the outer part of the globe were everywhere equally yielding, or equally dense, and so completely closed, a struggle would take place to lessen the oblateness of the earth at the poles ; but since, as is generally known, it is composed of different sorts of mountains of various strength, and so possessing various degrees of resistance, and also already penetrated in many places by the chimneys of volcanoes ; so a portion of the accumulated fluid material in the volcanic fireplace is pressed up to the surface, as lava, sometimes in one, sometimes in another channel of eruption, so long as the pressure of the lava column maintains an equipoise to the pressure working in the interior ; in this way the origin of volcanic eruptions can be very well explained. Angelot was of opinion that the fiery-fluid material which we suppose to form the centre or nucleus of the earth contained a great quantity of vapours and gases in union. These become free in the further process of condensation of the fluid mass. They collect together at certain points or along certain lines, and there caused, (either by their tension, often extreme, or by their alteration of position, struggling sometimes in one direction, sometimes in another) so long a fluctuation of the fiery-fluid centre of the earth, that they at length succeeded, at spots perhaps not of homogeneous construction, or more or less cleft, or not so strong as the contiguous rocks, in breaking a course for themselves, and in this way reaching the surface of the earth. Angelot further supposed, and G. Bischof agrees with him, that the waves of the ocean might reach the fiery mass by the clefts and chinks which penetrate the crust of the earth, and there become changed into vapours of the very highest tension, and perhaps, in consequence of the enormous heat, undergo decomposition, and thereby occasion powerful eruptions, explosions, and destruction.

The opinions of other geologists are also quoted in this chapter. "That water plays an important part in the production of volcanoes is a very old opinion, and has been also adopted by later geologists. As we find volcanoes most numerous upon islands or sea-coasts, the sea-water is very likely to exercise its influence on them, though fresh water may do so also, in those volcanoes which are met with inland. If the water come in contact with the lava boiling in the volcanic fire-place, it becomes suddenly changed, at the moment of meeting, into vapour whose tension will be very high, and so press out the uppermost part of the lava column going up and down in the volcanic chimney, and be scattered far and near in the shape of loose refuse.

"It is possible, and even very probable, that in such meetings the water is not merely changed into vapour, but may even become decomposed into its component parts. Not long ago we were averse to believe in such a decomposition, because free hydrogen was not to be found in the neighbourhood of active volcanoes. Bunsen has however lately discovered this gas in no inconsiderable quantity in Iceland, in volcanoes where some smoky activity was still observable."

The work concludes with a long and elaborate chemical analysis of the mineralogy and geognosy of volcanoes, perhaps the driest portion to the general reader, but the reverse, no doubt, to the scientific. It is alphabetically arranged from Abrazite to Zurlite, which is supposed synonymous with Humboldtilite, though according to Scacchi Ramondinis, Zurlite is merely Melilite in intimate union with Augite.

We have had great pleasure in perusing Dr Langrebe's volumes, which are written throughout in a clear unostentatious style, of good classical German, not deformed by those intricacies of composition, and obscurities of diction, with which so many German scientific works abound, and which always convey to our mind the impression that their authors are but indifferently acquainted with the subject upon which they intend to enlighten the world, and are mere pretenders to science. We have long been inclined to believe that a large amount of philological knowledge is necessary for a distinct scientific writer, and that knowledge Dr Langrebe seems to possess. He certainly originates no new views, nor startling theories, but he gives us an excellent, plain, interesting, and consecutive summary of all that is known on the deep subjects of which he treats, laying for all attentive readers a fair and firm foundation, upon which he rears a superstructure at once intelligible to any reflecting mind, and agreeably instructive to any man of literary taste. We rejoice in having made the acquaintance of Dr Langrebe, as an ornament to science, philosophy, and literature.

Meteorological Essays. By François Arago, Member of the Institute; with an Introduction by Baron Alexander Von Humboldt. Translated under the superintendence of Col. Sabine, R.A., Treas. and V.P.R.S.

The names of the three eminent men which appear on the title-page of this work offer an irresistible argument in its favour. Arago, from the versatility of his genius and the breadth of his character, stood out during the latter years of his life as the index of the science of France. His writings embrace a wide range of subjects—Biography, Astronomy, Optics, Electro-magnetism, Physical Geography, Meteorology, and General Physics,—and he is great in all. We rejoice then to see the first volume of his collected works in an English dress, brought out under the care of such men as Col. Sabine, Admiral Smyth, Professor Baden Powell, and Mr Robert Grant.

The volume before us contains five essays—1. On Thunder and Lightning. 2. Electro-magnetism. 3. Animal Electricity. 4. Terrestrial Magnetism. 5. The Aurora Borealis. The first of these occupies more than half the volume, and contains a multitude of facts gathered from every available quarter, and grouped under a variety of heads, so as to form a tolerably complete encyclopædia of the subject. We will endeavour to convey some idea of the nature of this portion of the work by selecting one of the topics, and describing the author's mode of treating it.

Lightning he divides into three classes. 1. Zigzag lightning. 2. Sheet lightning. 3. Globular lightning or fire-balls. The third class differs from the former two in this, that whereas the duration of zigzag and of sheet lightning is momentary, that of the fire-ball may extend to one, two, or even ten or more seconds of time. We doubt very much whether these phenomena ought to be regarded as lightning at all, although they are included in the definition which, in the essay before us, is adopted from the Dictionary of the French Academy. In the *Annuaire du Bureau des Longitudes* for 1837, M. Arago had called attention to some well authenticated facts concerning this remarkable form of meteor, the result of which was, that communications flowed in on him from various quarters, out of which he has made a selection, exhibiting a few extraordinary examples: for instance, M. Butti, Marine Painter to the Empress of Austria, addresses him from Trieste:—

"In the year 1841 . . . . I was staying at Milan. It was near six in the afternoon, rain was falling in torrents . . . . . I was sitting quietly smoking my cigar, and looking at a distance through the open window, when I heard in the street the sound of running feet, and several voices of men and boys calling out *guarda! guarda!* (look! look!) . . . . . . I ran to the window, and turning my head to the right, from whence the sound proceeded, the first thing which met my view was a globe of fire at the level of my window, moving in the middle of the street, not horizontally, but sensibly slanting upwards. Eight or ten persons, still calling out *guarda! guarda!* with their eyes fixed on the meteor, kept up with it, by following at the pace which the soldiers call accelerated. The ball of fire passed quietly in front of my window, so that I was obliged to turn my head to the left to look after it. The next moment, fearing I should lose sight of it behind some houses which were not in the same line with the one in which I was, I hastened down stairs and into the street, which I reached in time still to see the meteor, and to join with the rest of the curious spectators who were following it. It moved still with the same slowness, but in its oblique upward march had already risen considerably, and in three minutes more it struck the cross of the steeple of the church Dei Servi, and disappeared. Its disappearance was accompanied by a sound like that of the discharge of a 36-pounder gun, heard at a distance of thirteen or fourteen miles with a favourable wind."

Such a meteor as this is not seen often, but it has little to remark on in comparison with another, the description of which is probably familiar to many of our readers, as it was communicated by M. Babinet to the Academy of Sciences, in July 1852. Imagine a Parisian tailor sitting quietly at his table in the month of June. A visitor makes his appearance by the unusual route of the chimney, gently throwing down the chimney-board, and slowly rolling into the room, in the shape, not of a fiery dragon, but of a fiery kitten, coiled up in a ball as kittens are wont to coil themselves when warm and sleepy. With charming playfulness it seeks to rub itself, as terrestrial kittens do, against the tailor's legs. This is too familiar, and not by any means to be permitted, but the gentle tailor, instead of kicking the intruder down stairs, simply moves his feet aside, and waits the end. The fire-ball rises, and takes its departure through a hole above the fireplace, carefully unpasting the paper with which it is covered without tearing it, has just time to reach the roof of the house, and then explodes and scatters the fragments of the chimney in all directions. These, and similar relations, we are inclined to think, are the record of *facts* with the addition of a little colouring. We were at one time disposed to consider the evidence on which they are supported insufficient, and to retort on M. Arago the rule of judgment laid down by himself during the first meeting of the British Association in Edinburgh. When it was proposed to decide a certain optical phenomenon by taking the votes of the spectators, M. Arago jumped up in the section and cried out, "Evidence of this kind should be estimated by weight, not by measure." We are bound to add, that whatever may be thought of the tailor's story, most of the facts which illustrate the present essay rest on responsible authority.

It would far exceed our limits to give even the briefest summary of the fifty-seven chapters into which this treatise is divided. The very circumstance of such minute subdivision adds greatly to its value, by marking accurately the different classes of phenomena which merit attention relative to this subject. In many respects this essay is calculated to serve as an index to the statistics of thunderstorms. Even the meagreness of many of the chapters may help to indicate the direction to which attention should in future be turned. Scarcely a month passes without the occurrence of some kind of storm. Whilst we write, there appears the following paragraph in the newspapers:—"During a thunderstorm which passed over Osborne a few days ago, a little land shell, called *Zua lubrica*, common under stones and among moss all over the north of Europe, fell in an enormous quantity." A register of the accounts of such phenomena, with some attempt at verification, would be of the greatest service to this branch of science, and the very headings of M. Arago's chapters may serve to indicate the class of facts which are worthy of being noted down.

The last essay, on the aurora borealis, is of the same character as the first, though not so fully worked out. The main point to which the author's attention was directed is the evidence for the disturbance of the magnetic needle produced by the aurora. On this subject we quote a note of Col. Sabine, which is much to the purpose: "The intelligent reader will have remarked that all that the *facts* cited by M. Arago can be considered to *demonstrate* or *establish*, is the *coincidence* of magnetic disturbances at Paris with auroras visible in other parts of the globe. Of this coincidence the facts cited leave no doubt; and corresponding facts in regard to the cotemporaneous occurrence of auroras in one place, and magnetic disturbances in another, have been very extensively observed elsewhere. The observations at the British Magnetic Observatories have manifested that magnetic disturbances sometimes continue without intermission for several days together, even for seven or eight days together, the continuity throughout being shown by one or other of the magnetic elements, sometimes by one, and sometimes by another. By M. Arago's supposition, viz., that the magnetic disturbance is *caused* by an aurora either at the place itself, or in some other place, it would be necessary to suppose that during the whole of such lengthened periods of disturbance, auroras are visible in some part or other of the earth's surface. This it would manifestly be very difficult either to prove or to disprove. But even were it proved, it would not demonstrate or establish that the aurora is the *cause* of the magnetic disturbance, &c."

The essays on electro-magnetism and animal electricity are brief. The former will probably be considered as valuable in the history of the science. The remaining essay on terrestrial magnetism is a posthumous publication, as are some of the others. A considerable portion of it was evidently written some twenty or thirty years ago, and had not the benefit of the author's corrections. Whilst, therefore, it contains much that is valuable, evidencing the admirable sagacity of M. Arago in anticipation of the resolution of many difficulties, a considerable portion of the treatise must be regarded simply as a link in the history of the science. The establishment of magnetic observatories in distant quarters of the globe, such as Toronto, St Helena, and Hobart Town, has furnished materials for the solution of many of the problems which M. Arago proposed to himself. Much of what has been done is due to the editor of this work, Col. Sabine, whose valuable papers, in the Transactions of the Royal Society, place him amongst the foremost contributors to this branch of knowledge. We confess we read his notes to this treatise, which are pretty copious, before we had made much advance in the text, and we doubt not many others will do the same. But let it not be inferred that we undervalue the text. Quite the contrary. It supplies much valuable information, and is, besides, a testimony to the keen foresight and extraordinary perseverance of the author. The editors of his magnetic observations from 1820 to 1830, remark—"Most commonly M. Arago made, on an average, eleven observations each day, beginning at seven in the morning, and ending at eleven at night. Sometimes we find him observing from hour to hour until half an hour after midnight, and then rising so as to begin the same work again at four the next morning. Under some circumstances we find the observations succeed each other every five or even every three minutes, and there are then more than 150 of them in the same day. The total number of observations is 52,599."

One valuable conclusion from this series of observations is the confirmation of a connection which had been inferred to exist between the variation in amount and frequency in different years, of the *solar spots*, and a corresponding variation in period and epoch in all those magnetic influences which, by their dependence on the hours of solar time lead us to recognise the sun as their primary cause.

The years of maxima in the solar spots have been 1828, 1837, and 1848; the years of minima 1833, 1843. The observations at the British Observatories had shown that in all cases of magnetic variation or disturbance in which a dependence on solar hours was traceable, a maximum of disturbance showed itself in 1848, and a minimum in 1843; the changes before and after being in accordance with this decennial wave. M. Arago's observations supply the information from 1820 to 1830, and the law appears to hold good; the maximum being in 1829, and the minimum in 1823.

We cannot conclude our notice of this work without one word as to its suggestive character. In recording what has been accomplished, the author has not lost sight of the question what remains to be done. We cordially agree with his remark that "to point out gaps which require to be filled up, is even more useful than to record discoveries." Just a century ago, Helsham, in his lectures, published his opinion that the mechanical sciences were complete. Could he rise from his grave and see those sciences as they emerged from the hands of Laplace and Lagrange furnishing a light whereby an unseen planet has been tracked in space, from its mechanical influence on the other bodies of the system,—could he see the varied and to him undreamt-of phenomena of polarization, brought under the dominion of the laws of motion, he would wonder more at his folly in thus fixing the limits of the science, than at the vast regions of discovery which he would find to have been opened up since he wrote. The conviction that fresh fields of light lie behind each cloud inspires the lover of truth with confidence and patience to watch and wait; and it has its reward.

A History of the British Marine Testaceous Mollusca distributed in their Natural Order. By WILLIAM CLARK. London: Van Voorst. 1855.

The literature of a philosophic Natural History is, in this country, sadly deficient. In many of its most important departments it is in a condition anything but satisfactory, and notwithstanding many good and able workers, it is still full of wide gaps and unsightly chasms. In the work now before us we can see no tendency to a better state of things; so far from this being the case, we find excellent observations spoiled by an unphilosophical classification and incorrect views of affinities, and the student has reason to complain, that in many respects it only renders darker what was already obscure, and confuses what few definite ideas of natural grouping had begun to shape themselves in his mind. It is greatly to be regretted that in a book on which so much labour had evidently been bestowed, and to which a manifestly honest worker, with the love of truth really in his heart, had devoted so many good years of his life, should yet be so lamentably deficient in an appreciation of the real grounds of natural classification, and of the true affinities of organic forms.

Indeed, it can scarcely be otherwise when we find the author assuming, as the basis of his whole system, the allegation that the progressive advance of generative organization is the true index of natural arrangement in the whole animal kingdom, and when we find him, accordingly, compelling his groups to shape themselves into the narrow limits which this exclusive view must necessarily impose upon them.

As the result of making any single set of characters the absolute grounds of a natural history classification, we cannot but expect forced separations and unnatural alliances, but how greatly is the evil aggravated when, as in the present instance, we frequently find a total misconception of the assumed characters, and meet with views of structure in entire discordance with the results of the most careful dissections of the best anatomists.

Starting from such grounds, we cannot be surprised at finding such instances of violent grouping as the placing of the pulmoniferous genus *cyclostoma* apart from *helix* and the other non-operculate pulmonata, and even from some of the operculate in a distinct *primary* division of mollusca; the reducing of the *pteropoda* to a mere family of hermaphrodite gasteropoda; and the separation of *valvata* in a distinct primary division from *paludina*, in order to place it in the same family with the very differently constructed *trochus*.

But when we find that besides all this, the very assumptions on which this departure from the established grouping of the mollusca has been grounded are in many cases totally untenable, that animals, without any doubt truly unisexual, are assumed as hermaphrodite; when we see the author basing his groups on a generalization altogether unwarranted, namely, that all gasteropoda with circular spiral opercula are hermaphrodite; when we find him asserting that the *palliobranchiata* and *lamellibranchiata* are universally hermaphrodite, in direct opposition to all that is best known of their structure; when we find him maintaining that the *palliobranchiata* form an intermediate link by which the *cirripedia* are connected with the *lamellibranchiata*, and founding this most unphilosophical view upon the resemblance of the arms of a terebratula with the articulated appendages of a lepas, thus entirely misconceiving every homological relation, and subverting the very basis of zoological classification; when, in short, we find these grievous errors lying at the very foundation of his system, and therefore necessarily pervading the entire work, we cannot but wish that the author had confined himself to the publication of the really valuable part of his labours. He would here have had no difficulty in filling a volume even larger than the present;

for since the days of Montagne few men have done so much as Mr Clark in this department of Natural History; and his varied and copious observations on the habits and structure of the mollusca of the South Devonshire coast have added largely to our knowledge of these animals, and been of positive good to science. It is, therefore, the more to be regretted, that the weight of his well-earned authority should be given to views so much at variance with sound zoology as those contained in the present work. Apart from all this, however, there is much good matter to be found in it, honest and earnest observation which the reader will soon learn to separate from the false system with which it is unhappily combined.

What is Technology? An Inaugural Lecture delivered in the University of Edinburgh on November 7, 1855. By GEORGE WILSON, M.D., F.R.S.E., Regius Professor of Technology in the University, and Director of the Industrial Museum of Scotland.

The Board of Trade having resolved to establish an Industrial Museum for Scotland in Edinburgh as the metropolis, have elected Dr George Wilson to be the director of it. This museum is to embrace everything which can be included under the term of Industrial Arts,—those arts which minister to the physical wants of man, and are necessary for his existence. "The most degraded savage must practise them, and the most civilized genius cannot dispense with them. Whatever be our gifts of intellect and fortune, we cannot avoid being hungry and thirsty, and cold and weary every day, and we must fight for our lives against the hunger and thirst and cold and weariness which wage an unceasing war against us."

Government have also thought proper to establish a connection between this museum and the University of Edinburgh, by making the director Professor of Technology. Thus, while the new museum will be truly national and available for all the purposes of art, and while the director will, in connection with it, deliver lectures to the working-classes at suitable hours, and for a suitable fee, he will also, as Professor in the University, render it available for the instruction of a higher class of pupils who follow science for its own sake. We know no one better qualified for the situation than Dr G. Wilson, uniting, as he does, extensive scientific knowledge with a remarkable power of conveying information in a clear and popular manner. It is by no means, we believe, determined that the director shall in all time coming be a chemist. There may be changes in this respect at different times. We can conceive that occasionally a physicist or Natural Philosopher may be made director, and thus variety may be imparted to the lectures at different epochs.

The chair of Technology being new to the British universities, Dr Wilson has felt it necessary to explain its object. This he defines as "the Science, or Doctrine, or Philosophy, or Theory of the Arts. Its object is not art itself, *i.e.* the *practice* of art, but the principles which guide and underlie art, and by conscious or unconscious obedience to which the artist secures his ends." In his introductory Lecture he places the matter in a very clear light, and points out the bearing of this Chair on the arts of life. He distinctly shows, that while it has a connection with various subjects already taught in the University, it steers a course distinct from all, has a province of its own, and will not, as some have thought, interfere with the duties of any other professor. Science is one connected whole, and there is no department which does not, to a certain degree, trench upon another. Dr Wilson remarks on this subject, "Every professor of the Faculty of Medicine is continually discussing, to a greater or less extent, the subject specially taught from all the other medical chairs. Anatomy, Chemistry, Physiology, Pathology, are more or less expounded by them all. The professor of Chemistry and Natural Philosophy must largely consider the same phenomena and laws. Light, heat, electricity, magnetism, actinism, are included within the domain otherwise peculiar to each; and it must be left greatly to the judgment of each professor, and to mutual arrangement among them all, to determine how much or how little of their common subjects any one will appropriate."

After showing the necessity for the cultivation of the industrial arts by man, and pointing out the difference between him and the lower animals in this respect, Dr Wilson proceeds to state that "the first step which man takes towards remedying his nakedness and helplessness is in a direction where no other creature has led the way, and none has followed his example. He lays hold of that most powerful of all weapons of peace or war, *fire*, from which every other animal, unless fortified by his presence, flees in terror, and with it alone not only clothes himself, but lays the foundation of a hundred arts."

Dr Wilson's lectures will be necessarily in connection with the Industrial Museum, the contents of which will afford the text of bis prelections. Systematic courses of lectures, the first of which is in progress of delivery, will be given on the application of science to the industrial arts. Such subjects as the following being discussed:—economic production and application of heat, light, and electricity, metallurgy, building materials, glass-making, pottery, textile manufactures, food, &c.

We believe that this New Chair is an important addition to the University, and that in the able hands of the present professor it will be conducive to the best interests of science and art.

Report on some of the Products contributed to the Madras Exhibition in 1855.

This valuable report has been forwarded by Dr Cleghorn, Professor of Botany at Madras. The Madras Exhibition has been a very successful one, and promises to act most beneficially in developing the resources of India. It has received the warm support of the Governor, Lord Harris, who has shown himself to be an enlightened promoter of science. The following is a short analysis of that part of the report which has been transmitted :—

Class II. *Report on Chemical and Pharmaceutical Processes and Products generally.*—This class contains a very large number of raw materials used in medicine, and a smaller number of the products of chemical manufacture. The specimens prove that Southern India is abundantly supplied with remedies well adapted for the treatment of tropical diseases.

Class III. *Report on Substances used for Food.*—Of the cerealia commonly cultivated in Southern India, viz., rice, cholum, maize and the millets (together with the European grains more sparingly met with, wheat, barley, &c.), the jury inspected 500 samples. A list of the grains and pulse is given with the botanical and native names. In this class are also included coffee, cocoa, spices, condiments, arrow-root, and various kinds of starch, sugar, &c.

Class IV. *Report on Vegetable and Animal Substances chiefly used in Manufactures, as Implements and for Ornaments.*—This class comprehends gums and resins, caoutchouc, oils, dyes and colours, tanning materials, fibrous substances, timber and ornamental woods. A very extensive and varied collection of fibrous substances was contributed from all parts of the Presidency, proving that materials exist in Southern India for every description of textile manufacture, from the coarsest packing-cloth to the finest cambric, lawn, or muslin. Under the head of endogenous plants yielding fibre are classed,—palms, aloes and agaves, Yucca or Adam's needle, Sanseviera zeylanica or marool, Fourcroya gigantea or gigantic aloe, Ananassa or pine-apple, Musa or plantain, Pandanus or screw-pine, rushes, grasses, sedges, &c. The exogenous fibrous plants embrace those yielding cotton and silk cotton, flax and its substitutes,—Calotropis or Yercum, Tylophora asthmatica, Cryptostegia grandiflora or Palay, Damia extensa or Ootrum, Cannabis sativa or hemp, Corchorus olitorius or Jute, Crotalaria juncea or Sunn or Junapum, Hibiscus cannabinus or Ambaree, Abelmoschus esculentus or Bendee, Abutilon tomentosum or Toothee; also barks of trees, including varieties of Ficus, Bauhinia, Grewia, Dalbergia, Isora, Butea, and Vernonia.

In this class there is also given an arranged list of woods, native or grown in the Madras Presidency. The following are some of the woods which are authorized to be used as railway sleepers:—Tectona grandis or Teak, Vatica robusta or Saul, Dalbergia Sissoo or Sissoo, Pterocarpus indicus or Pedawk, Zizyphus glabrata, Terminalia glabra, Terminalia alata, Bauhinia diphylla, Pterocarpus Marsupium, Terminalia Chebula, Soymida febrifuga, Acacia odoratissima, Prosopis spicigera, Inga xylocarpa, Acacia speciosa, Artocarpus integrifolia or Jack, Bassia longifolia, and Acacia arabica.

We shall have occasion to notice in the Scientific Intelligence, from time to time, some of the products alluded to in this report. Meanwhile, we call attention to it as a most valuable contribution to our knowledge of Indian products, and as highly creditable to the managing committee, and to the parties who have been engaged in the work. We trust that it will lead to most important results by pointing out the capabilities of Southern India, by encouraging the industrial arts, and by showing the necessity of preserving the forests which yield such valuable timber.

Researches upon Nemerteans and Planarians. By CHARLES GIRARD. I. *Embryonic Development of* Planocerea elliptica. Philadelphia, 1854. 4to.

Mr Girard assisted Professor Agassiz in his microscopical observations. The subject of the Memoir of which we have given the title was investigated in 1849, and the results appeared partially in the Proceedings of the American Association for the Advancement of Science and in the Proceedings of the Boston Society of Natural History. The author has now considered it best to publish his views completely and independently, in a separate series of Numbers, of which this is the first.

Mr Girard removes the Planarians and Nemerteans from "the class worms," and has placed them "in the division Mollusca, and more particularly in the class Gasteropoda," because the "division of the vitellus in *Polycelis variabilis*, seems almost an exact copy of the same phenomenon in *Acteon viridis*, of the coast of France. In *Planocerea elliptica*, the division of the yolk does not apparently differ from the same phenomenon in *Acteon chloroticus* of New England, and likewise in several species of *Eolis* and *Doris*, as well as *Triton*.

"The vitellus as a whole, transforms itself into an embryo; there being no embryonic layer distinct from any other portion of its mass. The embryos move within the egg, and their body is surrounded by fibrillæ, both in Planarians and Nudibranchiata, and during the earliest period of their existence they resemble each other most. Planarians and Gasteropods undergo a larval life, during which they assume forms or shapes, very different from those of the adults. There is now the state of chrysalis, which has not yet been observed among Gasteropods."

In the last part of this memoir, the opinions and observations of authors on the subject are to be discussed. This part is illustrated with three beautifully worked plates.

The General Structure of the Animal Kingdom. By T. RYMER JONES, F.R.S., Professor of Comparative Anatomy, in King's College, London. 2d Edition, 1855.

The want of a satisfactory text-book is the principal obstacle which the Student of Comparative Anatomy has to encounter. If he selects a work in which the organs are described systematically, he soon finds that among the multitude of animals, parts of which are referred to, the species he is dissecting, or even a form allied to it, is not once alluded to; or if so, only in a manner so fragmentary as to afford him no continuous information. He finds at last that the work, however valuable it may be to those already advanced in the science, is not fitted for elementary systematic study. If he afterwards adopts a work arranged zoologically, he discovers that although he is saved much time formerly lost in turning over the leaves, and has the topics of his present study submitted to him in a more condensed and consultable form, he may find, nevertheless, no continuous structural information, no guidance afforded in his dissections.

The best form of an elementary work on Comparative Anatomy would be one in which the descriptions should be confined to the structure of species easily procured, and selected as typical forms of natural groups more or less extensive. The description of the anatomy of each selected species or typical form should be preceded by a general statement of the zoological characters and the conditions of existence of the group which it represents. The anatomical description itself should be drawn up so as to be at the same time a guide to dissection and a description of the structures displayed. Some information should be given as to how specimens of the species should be procured; the best mode of depriving them of life—no unimportant matter in reference to the future dissection; in what liquid they should be preserved and dissected; how and with what material the vessels should be injected; and finally, the most judicious modes of displaying the different parts and organs as preparations for the museum,—for no one need expect to become a comparative anatomist who does not plan his dissections as far as possible with a view to future preparation and conservation. A monographical description of this kind would be still more useful if it gave the title of any published anatomical monograph of the species; or description of any of its parts, or of closely allied forms; and detailed references to the points of its structure described in the systematic works on the science.

A manual on this plan, would at once induce and facilitate a course of training such as has been instinctively gone through by every true comparative anatomist; and should therefore be opened up and arranged for the general student.

The elementary study of Comparative Anatomy by the thorough examination of judiciously selected typical forms is a method which need not and ought not to be confined to the structural department of the organical sciences. In undertaking the study of the animal or vegetable kingdom, there are three attainments which should be steadily kept in view. *Firstly*, facility in detecting the presence, and of determining the value, of those external characters of a plant or an animal by which, provisionally at least, its position in the system is to be determined. *Secondly*, the power of perceiving those external relations or conditions of existence on which depends the presence of the plant or animal in the particular locality in which it is found. And, *thirdly*, the structure and functions of the plant or animal, and the relations of these not only to those of other organisms, but also to the external conditions of its existence. Each of these three departments of organical science may, to a certain extent, be prosecuted independently. But no profound, or at least no satisfactory attainment can be reached in any one of them, without considerable time and labour bestowed on both the others. The science is, however, too extensive to admit of this triple study being carried on to any great extent by any single individual. It becomes therefore important to determine by what method of elementary study a knowledge of the general principles and typical facts of the three departments of organical science can be most satisfactorily obtained. There can be no doubt that the examination of typical forms in their threefold relations, classificatory, structural, and cosmical, is the course of study the most philosophical in method, as it is the most economical in time and labour.

"The General Outline of the Organization of the Animal Kingdom" by Professor Rymer Jones, is arranged on the second of the two plans above alluded to. Its author describes the anatomical structure which characterizes the successive divisions, and their primary groups in the ascending series of animals. In following out this plan, the author has judiciously introduced zoological illustration, and much monographical anatomical description. The smaller groups are almost invariably so fully illustrated by the structure of typical forms, as to afford in a very satisfactory manner that kind of information so much to be desired in a "Manual of Comparative Anatomy." From the preponderance of monographical matter, and its judicious selection, as well as from the exclusion of topics the consideration of which would interfere with its proposed object, Professor Jones' work is one which has hitherto been, and in its present extended form will continue to be, essential to the Student of Natural History and Physiology.

The recent edition has been fully brought up to the present state of the science, without interfering with the original plan of the work, or disturbing the well-balanced arrangement which characterized the first edition. There are, however, a few omissions. No allusion is made to the stationary or retrogressive phase of the Polygastrics, or to the remarkable form of the male in certain Cephalopods.

The present edition like the former, is characterized by the profusion and perfection of its woodcut illustrations; and takes its place in the beautiful and truly valuable series of Natural History works, for which we are indebted to the liberality and enterprise of Mr Van Voorst.

CORRESPONDENCE.

The Vegetable Productions of the Plains of Quito; the Eastern and the Western Slopes of Pichincha and the Nevado of Cayambe. From Professor W. Jameson's Letters to Sir William Jardine.

The numbers refer to the dried specimens of Jameson's *plantæ æquatoriales*, a complete set of which is now in the Herbarium of the University of Edinburgh.

Plains of Quito, 9500 *feet.*

Prunus salicifolia		Cynanchum serpyllifolium .	306
Myrtus Arayan		Hypochæris	
Rubus		Mentha	
Euphorbia Latazi		Pancratium aurantiacum	
Salvia rubescens		Ionidium parviflorum . .	29
Duranta triacantha . .	315	Tacsonia tripartita	
Brugmansia sanguinea		Peperomia, sp. variæ	
Calceolaria lavandulæfolia		Baccharis Chilco	
floribunda . .	59	Artemisia	
chelidonioides .	174	Ranunculus Bonplandianus .	126
Cassia		Monnina	
Dalea	304	Solanum. sp. variæ	

Xanthium catharticum	
Tradescantia gracilis	2
Cyperaceæ	
Pourretia pyramidata	
Agave americana	
Hypericum	354
Hedyotis nitida	303
Margyricarpus setosus	302
Melastomaceæ (shrubby), sp. var.	
Bidens delphinifolia	
Lamourouxia virgata	305
Bystropogon mollis	61
Alchemilla	
Castilleja	308
Senebiera	
Clematis sericea	
Geranium	25
Andromachia igniaria	178
Tagetes	
Stellaria cuspidata	268
Alstrœmeria Caldasii	402
Gentiana limoselloides	464
Erodium	480
Gramineæ, sp. var.	
Sedum quitense	

On the Eastern Slope of Pichincha, above Quito, at 11,000 feet of elevation, there is a zone of shrubs characterized by the following :—

Melastomaceæ, sp. var.	
Thibaudia acuminata	230
Gaultheria, 2 sp.	84, 196
Escallonia myrtilloides	
Barnadesia spinosa	
Fuchsia triphylla	42
Hypericum laricifolium	65
Mutisia	171
Siphocampylos giganteus	
Berberis	293
Rubus glabratus	74
Cacalia, sp. variæ	
Eupatorium glutinosum	130
niveum	46
Oxalis lotoides	127
Valeriana	
Vaccinium	
Atropa flexuosa	
Citharexylon ilicifolium	314
Lantana rugulosa	324

Above these, 12,000 to 14,000 feet, is the region of grasses, in which we observe also the following :—

Valeriana rigida	
Ranunculus peruvianus	36
Swertia asclepiadea	4
Senecio nubigenus	
Baccharis odorata	137
Ribes	
Homoianthus pungens	255
Lathyrus gladcatus	462
Calceolaria ericoides	133
Lupinus	
Carex pichinchensis	290
Werneria nubigena	301
Thymus nubigenus	217
Eryngium humile	
Epilobium Bonplandianum	134
Ottoa œnanthoides	32
Sibthorpia pichinchensis	67
Sisyrinchium	143
Geranium acaule	270
Lycopodium pichinchense	469
Juncus andicolus	470
Andromachia acaulis	295

Passing the central zone of shrubs, we enter the region of *pajonales*, as they are termed, characterized by long wing-leaved grasses (47, 48, 56, 159, 238, 284), constituting the pasture ground of the Andes. On the savannahs bordering the coast, there are also numerous herds of cattle. Thus of the two extremes of temperature, in two distinct climates, cattle are reared in localities uninterfered with by agricultural pursuits.

Near the snow limit, 14,000 to 15,676 feet, we observe the following :—

Chuquiraga insignis	401	Draba aretioides	31
Valeriana plantaginea		alyssoides	263
Saxifraga andicola	3	Eudema nubigena	33
Culcitium reflexum	161	Arenariæ	96
Gentiana	82	Sida pichinchensis	282
Baccharis thyoides	131	Gentiana	
Aster rupestre	49	Alchemilla	141
Lupinus, sp. var.		Ribes frigidum	504
Alstrœmeria glaucescens	283	Arabis	292
Berberis		Plantago	259
Draba grandiflora	291	Werneria rigida	146
Silene	30	Culcitium nivale	173
Gentiana sedifolia	213	rufescens	
Conyza pusilla	149	Astragalus	
Baccharis	274	Cerastium	139

On the western slope of Pichincha, commencing at Pichau, 12,986 feet, we meet with the following:—

Osteomeles ferruginea	80	Polylepis	73
Loranthus		Calceolaria perfoliata	256
Solanum (arborescent)	271	Cestrum vestitum (Hook.)	12
Melastomaceæ (arborescent)		Tradescantia hirsuta	1
Compositæ (arborescent)		Besleria	
Gentiana Jamesonii (Hook.)	151	Stelis, sp. variæ	
Acæna argentea	129	Fragaria vesca	120
Baccharis genistelloides	116	Columellia sericea	170
Cremolobus peruvianus	13	Dumerilia paniculata	197
Loasa	135	Eccremocarpus longiflorus	286
Altensteinia paleacea	257	Acæna lappacea	261
Weinmannia			

The air on the western side of Pichincha is frequently obscured by dense fogs, occasioned by the intermingling of ascending currents from the coast, with the cool dry air of the elevated table land. The vegetation becomes consequently more luxuriant, and trees grow on the western flank of Pichincha at an elevation of nearly 14,000 feet. Arborescent ferns extend from the coast to a height of 10,000 feet. On May 19, 1855, on the Nevado of Cayambe at the foot of the snow, 16,217 feet elevation, where I passed the night, I observed the following plants. The thermometer at 6 A.M. stood at 36°, and at 1 P.M. at 51°.

Hypericum	505	Alchemilla, 2 sp.	506, 507
Valeriana plantaginea		Bolax	
Aster rupestris	49	Bartramia	511
Cacalia		Alstrœmeria glaucescens	283
Ribes frigidum	504	Andromachia acaulis	295
Jamesonia cinnamomea	503	Gentiana	414
Asplenium		Luzula	
Calcitium reflexum		Thymus nubigenus	217
sp. nov.	502	Calcitium nivale	173
Chuquiraga insignis	401	rufescens	
Saxifraga andicola	3	Cerastium	
Draba alyssoides	263	Lupinus, 3 sp.	
Apium	298		

Letter from J. H. Gladstone, Ph. D., London, to Professor Anderson, M.D., F.R.S.E., &c.

My dear Sir,—In the *Edinburgh New Philosophical Journal* for last January, you were kind enough to insert a letter from me containing a description of several substances which exhibit the phenomenon of fluorescence. Since writing that letter, I have had the advantage of repeating some of the experiments with Professor Stokes, which has convinced me that I was not warranted in drawing all the conclusions in the communication referred to. My more deliberate opinion is, that in the case of the different *red* substances examined, the peculiar surface blue was to be attributed to opalescence, and not to fluorescence. Indeed, it is remarkable how very evident the slightest opalescence is rendered by a red background. I have repeatedly observed this with liquids, and on one occasion I noticed it where only solids and the atmosphere were concerned. I happened to be in one of the law-courts of this city; a ray of bright sunshine was streaming down between where I sat and the scarlet cloth canopy over the judge's bench; the court was very dusty, and the white motes floating in the air produced a strongly-marked blue colour against the red back-ground.

In the case of the solution of ferrocyanide of iron in oxalic acid, the diminution of the remarkable blue where sulphate of quinine was interposed in the incident ray, arose, I believe, simply from the form of the apparatus employed. By the use of a very large proportion of oxalic acid, a blue solution may be obtained which exhibits no peculiar surface blue, but which may form a valuable means for examining fluorescence, as pointed out in my former letter.

Through the kindness of Mr Perkins of the Royal College of Chemistry, I am able to add another substance to the list of those which are fluorescent, namely, paranaphthaline. The crystals exhibit the phenomenon, though not very clearly in ordinary daylight; but their alcoholic solution has a very remarkable blue fluorescence. Since describing that most beautiful lilac which makes its appearance in phosphate of phenyle, I have examined it by a prism, and found that it is produced by the violet and the extra-spectral rays. It may also be worthy of remark, that different specimens of ottar of roses exhibit a very different degree of fluorescence, some indeed not manifesting any.

Professor Stokes observed that on adding a drop of hydrochloric acid to a warm solution of the non-fluorescent neutral sulphate of quinine, it exhibited the peculiar blue, while the addition of a larger quantity destroyed that appearance. This is ascribed, and doubtless with reason, to the simultaneous formation of bisulphate and hydrochlorate of quinine in the first instance, and to the more complete combination of the base with the hydrochloric acid afterwards. That the decomposition of the sulphate is never absolutely complete, whatever amount of hydrochloric acid be added, I have shown reasons for thinking in a paper recently communicated to the Royal Society. On repeating the fore-mentioned experiment with common salt in place of the acid, I found a similar production and subsequent destruction of the fluorescent appearance, though the blue was much fainter in character. Evidently the same explanation will not hold good; but on examining the possible products of the reaction, I find that the double sulphate of quinine and soda, which is analogous in its constitution to the acid salt, is also fluorescent, though to a smaller degree. The maximum amount of this double salt was not produced where one equivalent of chloride of sodium was added to two equivalents of sulphate of quinine, as would be the case were the decomposition capable of being represented by the formula—2 (Quin, HO, SO_3) + Na Cl = Quin HCl + (Quin, HO, SO_3 + NaO, SO_3), but it appeared when about $2\frac{1}{2}$ equivalents of the chloride were added to 2 of the organic salt. This was perfectly in accordance with what might have been anticipated from my previous experiments, and indicated the simultaneous presence in the solution of some portion of each of the original salts. The addition of further chloride of sodium reduced the blueness, but that did not entirely disappear even when 95 equivalents had been added, showing that the conversion into the non-fluorescent hydrochlorate was not even then complete. If sulphate of soda be added to a solution of hydrochlorate of quinine, a faint fluorescence becomes perceptible, increasing with the amount of sulphate added, and arising doubtless from the formation of the double sulphate of quinine and soda. The double potash salt does not appear to be equally fluorescent.

Should you be able to find space in your Journal for these modifications of some of my previous remarks, and for these additional experiments, it will greatly oblige, my Dear Sir,

Yours very faithfully,

J. H. Gladstone, Ph.D.

21 Tavistock Square, London,
1st *December* 1855.

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 3d December 1855.—Right Rev. Bishop TERROT in the Chair.

The following communications were read :—

1. *On the Occurrences of the Plague in Scotland during the* 16*th and* 17*th Centuries.* By ROBERT CHAMBERS, Esq.

In this paper the author adduced from contemporary chroniclers and diarists, all the visits of the Pest or Plague which occurred in Scotland after 1560; namely, in the years 1568, 1574, 1585, 1587, 1597, 1607, 1622, and 1645. He cited, from the same sources of information, the notable instances of scarcity and famine; namely, 1563, 1568, 1574, 1578, 1587, 1596, 1598, 1612, 1622, 1642-3. It thus appeared that, while there were several instances of famine not followed by the Pest, there was scarcely one instance of the Pest which was not immediately preceded by a famine. So far the opinion of modern medical writers, that deficient nutrition in the community is one of the predisposing causes of pestilential fevers, may be considered as borne out by facts.

2. *On a Problem in Combinations.* By Professor KELLAND.

This was a problem proposed some years ago by Professor Forbes, when discussing the question of the distribution of the stars. Simple as it is, no prior notice seems to have been taken of it, nor is the author aware that the full solution has yet been given. The problem is this :—"There are n dice, each of which has p faces, p being not less than n : it is required to find the number of arrangements which can be formed with them; 1*st*, so that no two shall show the same face; 2*d*, that no three shall show the same face, and so on." The only part of this problem of which the solution has yet appeared is the first; and the result is $p(p-1) \ldots (p-n+1)$. The author supplies the solution of the remaining portions.

3. *Occurrence of Native Iron in Liberia, in Africa.* From a Letter of Dr A. A. HAYES, Chemist, Boston, U.S., to Professor H. D. ROGERS.

Dr Hayes states that there is evidence establishing the fact that *pure native* iron exists abundantly in the country back from the central part of the colony of Liberia. Early travellers state that the natives of Africa find iron *ore* so pure that they heat and hammer it into form. Explorations by the Liberians show that the inhabitants of towns are engaged in manufacturing iron, and an intelligent native has recently shown how it is done. Last year a mass was sent home by a working blacksmith, who cut it with a chisel from a mass of larger size connected with rock. This proved to be native iron, malleable and ductile, yet unequal in its molecular structure. The general arrangement of the particles is unlike that of any artificial iron known, and there are among the iron particles of crystalline and transparent quartz, octahedral crystals of magnetic oxide of iron, and one of the silicates of soda and lime. No traces of carbon exist in connection with it, and no piece of artificial iron has yet reached Dr Hayes which *does not contain carbon.* When analysed by Dr Hayes's mode of electrolysis, it rapidly shows points which are positive to the surrounding portions, and, the action proceeding, the mass becomes honeycombed in texture, while the final chemical result is—

Pure iron, ...	98·40
Quartz, magnetic oxide iron, and silicate lime,	1·60
	100·

The positive points are the crystalline aggregates of the simple minerals, the iron in immediate contact being more open in texture, and always positive in relation to the crystals which are negative.

Professor Rogers supported the view taken by Dr Hayes of the genuineness of the alleged native iron from Africa, by testifying to the experience of that chemist in the technical examination of manufactured iron, and by the statement of his belief, derived from a comparison of many analyses, that the presence of carbon in an iron is the best test of its having been artificially brought to the metallic state. The reputed telluric iron of Canaan in Connecticut, is almost the only instance in which an alleged native iron has been reported to have been met with, not in loose masses but in the form of a mineral lode, that of Canaan being stated to be a true vein two inches thick in mica slate. The detection of carbon in this iron proves the specimens to be spurious, and confirms an impression long prevalent among American mineralogists, that the original statement about this vein was founded either in mistake or fraud. An examination of the best authenticated records of native telluric iron tends certainly to reduce the number of the genuine instances, if we accept the carbon test, yet the authorities for the existence of such are too many and too respectable to justify the general incredulity in regard to the presence of native iron on our globe. The statement that this African iron is manufactured in seven villages, is an intimation that it exists in considerable quantity, more than would be compatible with the supposition that it is merely a large mass of meteoric iron. But the fact, particularly significant, against its being native meteoric iron, is the total absence of nickel from its composition, as shown in the full analysis given by Dr Hayes. The absence of carbon indicates it not to be of human fabrication ; that of nickel proves it not to be meteoric. Should it really be shown by further exploration to exist in quantity, its occurrence on the frontier of a Liberian colony, by presenting another incentive to the settlement of that region by civilized men pursuing the arts of peace, cannot but be regarded as full of good omen for the cause of humanity in Africa.

Monday, 17th December. Dr Christison, V.P., in the chair.

The following communications were read :—

1. *Geological Notes on Banffshire.* By Robert Chambers, Esq.
2. *On the Physical Geography of the Old Red Sandstone Sea of the Central District of Scotland.* By Henry Clifton Sorby, F.G.S. Communicated by Professor Balfour. (This communication appears in the present number of this Journal.)

Royal Physical Society.

Wednesday, November 28, 1855. Professor Fleming in the Chair.

1. Professor Fleming delivered an opening Address.
2. *Notice of the Leaf Insect lately bred in the Royal Botanic Gardens.* By Andrew Murray. Esq. (The specimen was exhibited.) (This communication appears in the present number of the Journal.)

3. *On a Remarkable Pouched Condition of the Glandulæ Peyerianæ of the Giraffe.* By T. Spencer Cobbold, M.D. (This communication appears in the present number of the Journal.)

4. *Notice of the Occurrence of Meteoric Lead in Meteoric Iron from Tarapaca, Chili.* (Specimen exhibited.) By M. Foerster Heddle, M.D.

A description of this iron, with analyses and a notice of the occurrence of *Lead* in its cavities, having been inserted in the July number of the Philosophical Journal, I have, on the present occasion, little left me except to exhibit the specimen.

Mr Greg having observed globules of a bluish metal filling up small nests in the iron, sent them to me for examination; and it was a singularly interesting circumstance that Professor Shepherd, of America, who has devoted so much attention to meteoric bodies, was inspecting my collection when the chips of metal reached me, and witnessed the preliminary investigation which introduced lead as one of the elements of those mysterious bodies which visit us from parts unknown.

By as careful and complete an analysis as the small quantity of metal at my disposal enabled me to institute, I was able to detect no substance in these chips but metallic lead. When these portions of the globules which had been in contact with the iron were examined, small quantities of iron and alumina, with traces of magnesia and phosphorus were likewise found.

Two supposed new mineral substances which occur in this iron are in my hands for examination; the analyses of these when completed I will lay before the Society.

Slices of the iron which contains this meteoric lead have the high value which is always attached to unique specimens; and it is satisfactory to know that, through the generosity of Mr Greg, one of the slices is now in the College Museum.

Botanical Society of Edinburgh.

Thursday, 8th November 1855. Professor Balfour in the Chair.

I. *On the Batrachian Ranunculi of Britain.* By C. C. Babington, M.A., F.R.S.

The author opposes the view of those botanists who conceive that there is only one species of Batrachian Ranunculus, and adopts the opinion of Fries, Koch, Godron, Cosson, and other continental botanists who divide *Ranunculus aquatilis* into several species. After stating the characters upon which the species ought to be founded, he proceeds to arrange the species in the section Batrachium into three subsections.

1. Submersed leaves twice or thrice trifurcate, with filiform segments spreading in the form of a section of a sphere, rarely wanting; receptacle hispid. This includes *R. trichophyllus*, Chois., *R. Drouetii*, Schultz, *R. heterophyllus*, Fries, *R. confusus*, Godron, *R. Baudotii*, Godron, *R. floribundus*, Bab., *R. peltatus*, Fries, *R. tripartitus*, DC.

2. Submersed leaves not like those of the first subsection; receptacle hispid. This includes *R. circinatus*, Sibth., *R. fluitans*, Lam.

3. No submersed leaves; receptacle not hispid. This includes *R. cœnosus*, Gun., and *R. hederaceus*, Linn.

II. *Note on Linaria sepium, Allman.* By C. C. Babington, M.A. F.R.S. In this paper the author stated that seeds of *L. sepium* sent from Bandon, produced,—1. The proper *L. sepium*. 2. Plants closely resembling *L. repens.* 3. Plants slightly differing, between *L. repens* and *L. vulgaris.*

III. *On the influence of last Winter on Trees and Shrubs at Aberdeen.* By G. Dickie, M. D., Professor of Natural History, Queen's College, Belfast. In this paper the author gave a series of meteorological observations made by Professor Gray, at Aberdeen; and he then proceeds to notice various facts respecting the damage occasioned to trees and shrubs by the frost of the winter of 1855. The observations were made in gardens and nurseries near Aberdeen. He then remarks on the injury occasioned to such wild plants as whin and broom, and finally contrasts the results at Aberdeen with those observed at Belfast.

IV. *Notice of the flowering of the* Victoria Regia *in the Royal Botanic Garden, Glasgow.* By Mr Peter Clark, Curator of the garden.

V. *On the structure of* Victoria Regia. By Mr George Lawson. In this paper the author remarks that there is a great paucity of vascular tissue in the *Victoria,* and a vast abundance of cellular tissue, and that throughout the latter there are numerous lacunæ, many of which are remarkably large, and some of them are furnished with internal stellate hairs. Stomata of a circular form occur in abundance on the green surface of the leaf, and not on the red surface of the upturned margin. An ordinary leaf four feet in diameter, with a surface of 1850·08 square inches, contains 25,720,937 stomata. The under surface of the leaf is clothed with flexuous hairs. The thinner parts of the leaf are perforated with numerous minute holes, which the author considers as being produced by a non-development of parenchyma, similar to that which occurs in *Ouvirandra* and other aquatic plants.

VI. *Continuation of Notice of some of the Contents of the Museum at the Botanic Garden.* By Professor Balfour.

VII. *Report on Donations to the Botanic Garden and Museum.* By Mr M'Nab.

Thursday, 13th December 1855.

I. *Report on the State of the Society's Herbarium.* By Dr G. S. Blackie, Curator.

II. *Account of an Excursion to Ben Lawers and other Mountains in Perthshire in August* 1855 *:—*

1. *General Account of the Trip, with Remarks on the Phanerogamous Plants collected.* By Professor Balfour.

Among the interesting plants enumerated are the following :—*Cystopteris montana* found in large quantity on Ben Lawers and Corrach Uachdar; *Pseudathyrium alpestre* on Ben Lawers, Craig Chailleach, Mael Ghyrdy, and Corrach Uachdar; *Pseudathyrium flexile?* on Ben Lawers; *Hieracium senescens* of Backhouse on Mael Ghyrdy. The following were also mentioned on the authority of Mr Hugh MacMillan: *Bartsia alpina* on Ben Lawers and Mael Ghyrdy ; *Saxifraga rivularis* and *Azalea procumbens* on Ben Lawers; and *Carex ustulata* on a mountain to the south of Mael Ghyrdy. Dr Balfour also noticed the profuse flowering of the alpine plants last season, especially as seen in the case of *Saxifraga cernua.*

2. *On the Musci collected during the Trip.* By Dr Greville and Mr W. Nichol.

Among the mosses may be noticed the following :—*Distichium capillaceum, Br.* and *Sch., var. β. brevifolium,* new to Britain, probably a new species, *Encalypta rhabdocarpa, Orthotrichum Lyellii, Zygodon lapponi-*

cus, Z. Mougeotii, Fissidens adiantoides, Hypnum sarmentosum, H. abietinum, and *H. hamulosum*.

3. *On the Lichens of Ben Lawers.* By Mr Hugh MacMillan.

4. *List of Desmideæ collected during the Trip.* By Mr Hugh G. Stewart.

5. *List of Diatomaceæ collected during the Trip.* By Professor Gregory.

6. *General Remarks on the Geology of the District.* By Mr Hector.

III. *Notice of the Discovery of* Arum italicum *in the Isle of Wight.* By Albert J. Hambrough, Esq. of Steephill Castle.

This plant is said to grow abundantly in some parts of the Undercliff between Ventnor and Niton, and Mr Hambrough is disposed to think that it is truly indigenous.

IV. *Continuation of Account of some of the Contents of the Museum of the Botanic Garden.* By Professor Balfour.

V. *Report of recent Additions to the Botanical Museum.* By Professor Balfour and Mr M'Nab.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

Hybridity—Fringilla cœlebs and montifringilla.—Hybridity among animals or birds in a wild state very rarely takes place; at the same time instances sometimes occur, but their influence, from their very rarity, has not been much observed, and we do not know whether it is ever continued beyond the first pair. Among birds Hybridity has probably been more frequently observed than among mammalia. It occurs among the *Anatidæ.* The *Rasores* most frequently exhibit instances, though in some of these the individuals have been placed in peculiar or *half-artificial* positions. The *Tetrao hybridus* is a very remarkable instance, where the presumed hybrid progeny is always *exactly similar* in plumage; this is not known to go beyond one generation. *Corvus corone* and *cornix* now and then breed together, but the one species is generally migratory, and the union can almost always be traced to individuals of the migratory birds being forced to remain and mate accordingly. We know of no instance where the cross has gone beyond the first pair. In the *Revue et Magazin de Zoologie* for 1853 M. Jaubert has written some very good remarks on this subject, and he lays down the following axioms:—

1. Hybridity in a wild state occurs only between species very closely allied (" *extrêmement voisines.*")

2. It is necessary that one of the species at least should be *rare* in the locality where the connection takes place.

3. In a wild state and in captivity hybridity is unfruitful.

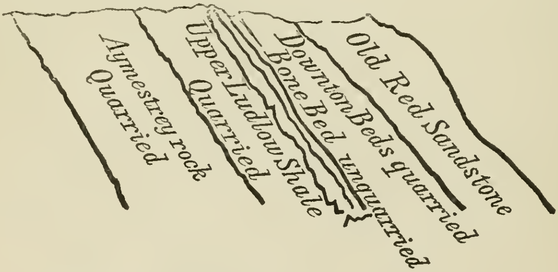
M. Jaubert mentions two instances of hybridity which recently occurred to his own notice, the one between *Fuligula ferina* and *nyroca;* the other between *Fringilla cœlebs* and *montifringilla.* The specimen of the latter was taken in a fowling-net near Marseilles, and exhibited intermediate plumage, which was particularly marked by the green rump of the hybrid, and by the note, which was entirely that of the chaffinch; in other respects the resemblance was greater to the mountain finch.

In the number for September 1855 of the same magazine, M. Jaubert records the occurrence of a second hybrid between these same finches. It attracted attention among a large flock of *F. montifringilla* by its green rump, but presented otherwise nearly the same appearances as the specimen of 1853. M. Jaubert has, we think, improperly given this hybrid the name of *F. media*. At the same time, the recurrence of the fact a second time is of importance, and should make us look closer into some *rare* species which show an alliance or resemblance to others well known, but which now stand in our systems as *real species*.

GEOLOGY.

On the Upper Ludlow Bone Bed near Malvern. By the Rev. W. S. Symonds, F.G.S.—I have great pleasure in announcing the discovery of this interesting deposit in the Malvern district. Professor Phillips mentions the detection of Ichthyodorulites "rarely and locally" in the upper Ludlow rock near Mathon Court and Hales End, on the west flank of the Malvern range. It is very certain, however, that the actual "bone bed" had never been discovered until the enterprise and exertion of the vice-president of the Malvern Field Club (the Rev. F. Dyson) revealed the important fact that this stratum, with its remains of fish, crustaceans, and land plants, occupies exactly the same position as the well known "bone bed" of Ludlow, Hagley near Hereford, Woolhope, Gamage Ford, May Hill, and Pyrton Passage, on the Severn.

The spot at which this discovery was made is at the back of Brockhill copse, where the upper Ludlow rock and the Downton sandstone (tile stones) were both quarried to a considerable distance. A considerable thickness of deposits, just at THE POINT where the upper Ludlow shale is joined by the yellow Downton sandstones, was left unremoved, owing probably to the softness and inutility of the stone. The quarry presented the following rough section:—



It will thus be seen that the point of junction remained unquarried, and on this portion Mr Dyson employed a number of men for several days. He was rewarded by detecting the "bone bed," supposed by so many excellent geologists to be wanting in the Malvern district. I was honoured by the first communication of his success, and, being well acquainted with many other localities of this interesting deposit, I immediately visited the section in company with Mr Bunbury, the well-known fossil botanist.

The position of this "bone bed" is identical with that of every other locality in which I have hitherto examined it, and does not vary a hair's breadth; an important fact when we remember the vast number of square miles over which the "bone bed" is now ascertained to be continuous! We did not discover any of the seed-vessels of Lycopodiaceæ found at Gamage Ford by Mr Strickland, but our search was necessarily limited. The Malvern Field Club intend examining the deposit in detail, in hopes of yet adding to the many interesting facts connected with the transition between two great epochs, the Silurian and Devonian.

BOTANY.

Fossil Floras of Scotland. By HUGH MILLER.—Scotland has its four Fossil Floras—its Flora of the Old Red Sandstone, its Carboniferous Flora, its Oolitic Flora, and that Flora of apparently the Tertiary age, of which His Grace the Duke of Argyll found so interesting a fragment, overflown by the thick basalt beds and trap-tuffs of Mull. Of these the only one adequately known to the geologist is the gorgeous Flora of the Coal Measures,—probably the richest, in at least individual plants, which the world has yet seen. The others are all but wholly unknown; and the Association may be the more disposed to tolerate the comparative meagreness of the few brief remarks which I purpose making on two of their number—the Floras of the Old Red Sandstones and the Oolite—from the consideration that that meagreness is only too truly representative of the present state of our knowledge regarding them, and that if my descriptions be scanty and inadequate, it is only because the facts are still few. How much of the lost may yet be recovered I know not; but the circumstance that two great floras—remote predecessors of the existing one—that once covered with their continuous mantle of green the dry land of what is now Scotland, should be represented by but a few coniferous fossils, a few cycadaceous fronds,—a few ferns and club-mosses,—must serve to show what mere fragments of the past history of our country we have yet been able to recover from the rocks, and how very much in the work of exploration and discovery still remains for us to do. We stand on the further edge of the great floras of by-past creations, and have gathered but a few handfuls of faded leaves, a few broken branches, a few decayed cones.

The Silurian deposits of our country have not yet furnished us with any unequivocal traces of a terrestrial vegetation. Professor Nicol of Aberdeen, on subjecting to the microscope the ashes of a Silurian anthracite which occurs in Peeblesshire, detected in it minute tubular fibres, which seem, he says, to indicate a higher class of vegetation than the algæ; but these may have belonged to a marine vegetation notwithstanding. I detected some years ago, in the Trilobite-bearing schists of Girvan, associated with graptolites of the Lower Silurian type, a vegetable organism somewhat resembling the leaf of one of the pond-weeds,—an order of plants some of whose species, such as Zostera, find their proper habitats in salt water. It is not impossible that the Silurian vegetable may have belonged to some tribe of plants allied to *Zostera;* and if so, we can easily conceive how the Silurian anthracite of our country may be altogether of marine origin, and yet may exhibit in its microscopic tubular fibres vestiges of a vegetation higher than the algæ.

Associated with the earliest ichthyic remains of the Old Red Sandstone, we find vegetable organisms in such abundance that they communicate often a fissile character to the stone in which they occur. But, existing as mere carbonaceous markings, their state of keeping is usually so bad that they tell us little else than that the antiquely-formed fishes of this remote period had swum over sea-bottoms darkened by forests of algæ. The prevailing plant was one furnished with a long, smooth stem, which, though it threw off, in the alternate order, numerous branches at least half as stout as itself, preserved its thickness for considerable distances without diminution,—a common fucoidal characteristic. We find its remains mixed in the rock, though sparingly, with those of a rough-edged plant, knobbed somewhat like the thong-like receptacles of *Himanthalia lorea*, which also threw off branches like the other, but diminished more rapidly. A greatly more minute vegetable organism of the same beds, characterized by its bifid partings, which strike off at angles of about sixty, somewhat resembles the small-fronded variety of *Dictyota dichotoma*, save that the slim terminations of the frond are usually bent into little hooks, like the tendrils of the pea just as their points begin to turn.* Another rather rare plant of the period, existing as a broad, irregularly-cleft frond, somewhat resembling that of a modern *Cutleria* or *Nitophyllum*, betrays at once, in its outline and general appearance, its marine origin, as does also an equally rare contemporary, which, judging from its appearance, seems to have been a true *Fucus*. It exists in the rock, as if simply drawn in Indian ink, for it exhibits no structure, though, as in some of the ferns of the Coal measures, what was once the curl of its leaflets continues to exists as sensible hollows on the surface. It broadens and divides atop into three or four lobes, and these in turn broaden and divide into minor lobes, double or ternate, and usually rounded at their terminations. In general appearance the plant not a little resembles those specimens of *Fucus vesiculosus* which we find existing in a diminutive form, and divested of both the receptacles and the air-vessels, at the mouth of rivers. With these marine plants we occasionally find large rectilinear stems, resolved into a true coal, but retaining no organic character by which to distinguish them. As I have seen some of these more than three inches in diameter, and, though existing as mere fragments, several feet in length, they must, if they were also plants of the sea, have exceeded in size our largest Laminaria. And such are the few vegetable organisms, of apparently aquatic origin, which I have hitherto succeeded in detecting in the Lower Old Red Sandstone of Scotland. Their individual numbers, however, must have been very great, though, from the destructible character of their tissues, their forms have perished in the stone. The immensely developed flagstones of Caithness seem to owe their dark colour to organic matter mainly of vegetable origin. So strongly bituminous, indeed, are some of the beds of dingier tint, that they flame in the fire like slates steeped in oil.

The remains of terrestrial vegetation in this deposit are greatly scantier than those of its marine Flora; but they must be regarded as possessing a peculiar interest, as the oldest of their class, in at least the British islands, whose true place in the scale can be satisfactorily established. In the flagstones of Orkney there occurs, though very rarely, a minute vegetable organism, which I have elsewhere described as having much the appearance of one of our smaller ferns, such as the Maidenhair, Spleenwort, or dwarf Moonwort. It consists of a minute stem, partially covered by what seems to be a small sheath or hollow bract, and bifurcates into two fronds or pinnæ, fringed by from ten to twelve leaflets, that nearly impinge on each other, and somewhat resemble in their mode of arrangement the leaflets of one of our commonest Aspleniums,—*Asplenium Trichomanes*. One of our highest authorities, however, in such matters (Professor Balfour of Edinburgh), questions whether this organism be in reality a fern, and describes it, from the specimen on the table, in the Palæontological chapter of his admirable Class Book, simply as "a remarkable pinnate frond." We find it associated with the remains of a terrestrial plant allied to Lepidodendron, and which in size and general appearance not a little resembles one of our commonest club-mosses,—*Lycopodium clavatum*. It sends out its branches in exactly the same style,—some short and simple, others branched like the parent stem,—in an arrangement approximately alternate, and is everywhere covered, stem and branch, by thickly set scale-like leaflets, that, suddenly narrow-

* [This may perhaps resemble the curvations at the extremities of the fronds of species of Ceramium.—Ed. *Phil. Jour.*]

ing, terminate in thorn-like points. It has, however, proportionally a stouter stem than Lycopodium; its leaves, when seen in profile, seem more rectilinear and slim; and none of its branches yet found bear the fructiferous stalk or spike. What seems to be an early representative of the Calamites occurs in the same beds. Some of the specimens are of large size,—at least from nine inches to a foot in circumference,—and retain their thickness, though existing in fragments several feet in length, with but little diminution throughout. They resembled the interior casts of Calamites in being longitudinally furrowed; but the furrows are flatter, and are themselves minutely striated lengthwise by lines as fine as hairs; and, instead of presenting any appearance of joints, there run diagonally across the stems, interrupted and very irregular, lines of knobs. Another apparently terrestrial organism of this formation, of, however, rare occurrence, very much resembles a sheathing bract or spathe. It is of considerable size,—from four to six inches in length, by from two to three inches in breadth, of a broadly elliptical and yet somewhat lanceolate form, deeply but irregularly corrugated,—the rugæ exhibiting a tendency to converge towards both its lower and upper terminations, and with, in some instances, what seems to be the fragment of a second spathe springing from its base.

But the vegetable organism of the formation indicative of the highest rank of any yet found in it, is a true wood of the cone-bearing order. I laid open the nodule which contains this specimen, in one of the ichthyolite beds of Cromarty, rather more than eighteen years ago; but though I described it, in the first edition of my little work on the Old Red Sandstone in 1841, as exhibiting the woody fibre, it was not until 1845 that, with the assistance of the optical lapidary, I subjected its structure to the test of the microscope. It turned out, as I had anticipated, to be a portion of a tree; and on my submitting the prepared specimen to one of our highest authorities,—the late Mr William Nicol,—he at once decided that the "reticulated texture of the transverse section, though somewhat compressed, clearly indicated a coniferous origin."* I may add, that this most ancient of Scottish lignites presents several peculiarities of structure. Like some of the Araucarians of the warmer latitudes, it exhibits no lines of yearly growth; its medullary rays are slender, and comparatively inconspicuous; and the discs which mottle the sides of its sap chambers, when viewed in the longitudinal section, are exceedingly minute, and are ranged, so far as can be judged in their imperfect state of keeping, in the alternate order peculiar to the Araucarians. On what perished land of the early Palæozoic ages did this venerably antique tree cast root and flourish, when the extinct genera Pterichthys and Coccosteus were enjoying life by millions in the surrounding seas, long ere the Flora or Fauna of the Coal measures had begun to be?

I may be here permitted to mention, that in a little volume, written in reply to a well-known and very ingenious work on the Development hypothesis, I described and figured this unequivocally genuine lignite, in order to show that a true wood takes its place among the earliest terrestrial plants known to the geologist. I at the same time mentioned,—desirous, of course, that the facts of the question should be fairly stated, whatever their bearing,—that the nodule in which it occurred had been partially washed out of the fish bed in which I found it, by the action of the surf; and my opponent, fixing on the circumstance, insinuated, in the answer with which he honoured me, that it had *not* belonged to the bed at all, but had been derived from some other formation of later date. He ought, however, to have taken into account my further statement, viz., that in the same nodule which contains the lignite there occurs part of another fossil, the well-marked scales of *Diplacanthus striatus*,—an ichthyolite restricted, like the Coccosteus (a specimen of which occurred in a neighbouring nodule), to the Lower Old Red Sandstone exclusively. If there be any value whatever in Palæontological evidence, this Cromarty lignite must have been deposited in a sea inhabited by the Coccosteus and Diplacanthus: it is demonstrable that, while yet in the recent state, a Diplacanthus lay down and died beside it; and the evidence in the case is unequivocally this, that in the oldest portion of the oldest terrestrial Flora yet known, there occurs the fragment of a tree quite as high in the scale as the stately Norfolk Island pine, or the noble cedar of Lebanon.

It is a curious circumstance that the Old Red Flagstones which lie along the southern flanks of the Grampians, and are represented by the gray stone known in commerce as the Arbroath Pavement, have not, so far as is yet known, an organism in common with the Old Red Flagstones of the north. I at one time supposed that the rectilinear, smooth-stemmed fucoid already described occurred in both series—as the gray stones have also their smooth-stemmed, rectilinear, tape-like organism; but the points of resemblance were too few and simple to justify the conclusion that they were identical, and I have since ascertained that they were entirely different plants. The fucoid of the Caithness flagstones threw off, as I have said, in the alternate order, numerous ribbon-like branches or fronds; whereas the ribbon-like fronds or branches of the Forfarshire plant rose by dozens from a common root, like the fronds of Zostera, and somewhat resembled a scourge of cords fastened to a handle. Contemporary with this organism of the gray flagstone formation, and thickly occupying the planes on which it rests, there occur fragments of twisted stems, some of them from three to four inches in diameter (though represented by but mere films of carbonaceous matter), and irregularly streaked, or rather *wrinkled* longitudinally, like the bark of some of our forest-trees, though on a smaller scale. With these we find, in considerable abundance, irregularly-shaped patches, also of carbonaceous matter, reticulated into the semblance of polygonal, or, in some instances, egg-shaped meshes, and which remind one of pieces of ill-woven lace. When first laid open, these meshes were filled each with a carbonaceous speck; and from their supposed resemblance in the agggregated form to the eggs of the frog in their albuminous envelope, the quarriers term them "puddock spawn." The slab in which they occur, thickly covered over with their vegetable impressions, did certainly remind me, when I first examined them some fifteen years ago, of the bottom of some stagnant ditch beside some decaying hedge, as it appears in middle spring, when paved with fragments of dead branches and withered grass, and mottled with its life-impregnated patches of the gelid substance, regarding which a provincial poet tells his readers, in classical Scotch, that

> "Puddock-spue is fu' o' een,
> An' every ee's a pu head."

Higher authorities than the quarriers—among the rest the late Dr Mantell—have been disposed to regard these polygonal markings as the fossilized spawn of ancient Batrachians; but there now seems to be evidence enough from which to conclude that they are the remains, not of the eggs of an animal, but of the seed of a plant. Such was the view taken many years ago by Dr Fleming—the original discoverer, let me add, of fossils both in the Upper and Middle Old Red Sandstone of the south of Scotland. "These organisms," we find him saying, in a paper published in *Cheek's Edinburgh Journal* for 1831, "occur in the form of circular flat patches, not equalling an inch in diameter, and composed of numerous smaller contiguous pieces. They are not unlike what might be expected to result from a compressed berry, such as the bramble or the rasp. As, however, they are found adjacent to the narrow leaves of gramineous [looking] vegetables, and chiefly in clay slate, originally lacustrine silt, it is probable that they constituted the conglobate panicles of extinct species of the genus *Juncus* or *Sparganium*." From specimens subsequently found by Dr Fleming, it seems evident that the nearly circular bodies (which in all the better preserved instances circumscribe the small polygonal ones) were set in receptacles somewhat resembling the receptacle or calyx of the strawberry or rasp. Judging from one of the specimens, this calyx appears to have consisted of five pieces, which united in a central stem, and were traversed by broad irregularly diverging striæ. And the spawn-like patches of Carmylie appear to be simply ill-preserved specimens of this fruit, whatever its true character, in which the minute circular portions, divested of the receptacle and stem, had been thrown into irregular forms by the joint agency of pressure and decay. The great abundance of these organisms —for so abundant are they, that visitors to the Carmylie quarries find they can carry away with them as many specimens as they please,—may be regarded as of itself indicative of a vegetable origin. It is not in the least strange, however, that they should have been taken for patches of spawn. The large grained spawn of fishes, such as the lump-fish, salmon, or sturgeon, might be readily enough mistaken, in even the recent state, for the detached spherical seed-vessels of fruit, such as the bramble-berry, the stone-bramble, or the rasp. "Hang it!" I once heard a countryman exclaim, on helping himself at table to a spoonful of caviare, which he had mistaken for a sweetmeat, and instantly, according to Milton, "with sputtering noise rejected"—"Hang it, for nasty stuff! I took it for bramble-berry jam."

Along with these curious remains, Dr Fleming found an organism which in form somewhat resembles the spike of one of the grasses, save that the better preserved sheaths terminate in fan or kidney-shaped leaflets, with a simple venation radiating from the base. It is probably a fern, more minute in its pinnules than even our smaller specimens of true maiden-hair. Its stipes, however, seems proportionally stouter than that of any of the smaller ferns with which I am acquainted. But the state of keeping of the specimen is not good, nor do I know that another has yet been found. Further, in the same beds Dr Fleming found a curious nondescript vegetable, or rather part of a vegetable, with smooth narrow stems, resembling those of the smooth-stemmed organism of the Caithness flagstones, but unlike it in the circumstance that its detached nearly parallel stalks anastomose with each other by means of cross branches, that unite them in the middle, somewhat in the style of the Siamese twins. This formation of the gray flagstones has furnished one vegetable organism apparently higher in the scale than those just described, in a well-marked specimen of Lepidodendron, which exhibits, like the Araucarian of the Lower Old Red, though less distinctly, the internal structure. It was found about sixteen years ago in a pavement quarry near Clockbriggs,—the last station on the Aberdeen and Forfar Railway, as the traveller approaches the latter place from the north. I owe my specimen of this ancient Lepidodendron to Mr William Miller, banker, Dundee, an intelligent geologist, who has taken no little trouble in determining its true history. He has ascertained that it occurred deep in the rock, seventy-one feet from the surface; that the beds which rested over it were composed in the descending order,—first, of a conglomerate thirty feet thick; secondly, of a red rock four feet thick; thirdly, of twenty-eight feet of the soft shaly substance known to the quarriers as caulm; and fourthly, of more than nine feet of gray pavement, immediately under which, in a soft, argillaceous stratum, lay the organism. It was about four feet in length, bulged out at the lower end into a bulb-like protuberance, which may have been, however, merely an accidental result of its state of keeping, and threw off, at an acute angle, two branches about a foot from the top. It was covered with a bark of brittle coal, which is, however, wanting in all the fragments that have been preserved, and was resolved internally into a brown calcareous substance of about the hardness of ordinary marble, and very much resembling that into which the petrifactive agencies have consolidated the fossil trees of Granton and Craigleith. From the decorticated condition of the surviving fragments, and the imperfect preservation of the interior structure, in all save the central portions of its transverse sections, it yields no specific marks by which to distinguish it; but enough remains in its irregular network of cells devoid of linear arrangement, and untraversed by medullary rays, to demonstrate its generic standing as a Lepidodendron.

Above this gray flagstone formation lies the Upper Old Red Sandstone, with its peculiar group of ichthyic organisms, none of which seem specifically identical with those of either the Caithness or the Forfarshire beds; for it is an interesting circumstance, suggestive surely of the vast periods which must have elapsed during its deposition, that the Great Old Red System has its three distinct platforms of organic existence, each wholly different from the others. Generically, and in the group, however, the Upper fishes much more closely resemble the fishes of the Lower, or Caithness and Cromarty platform, than they do those of the Forfarshire and Kincardine one. The vegetable remains of the Upper formation in Scotland are both rare and ill-preserved. I have seen what I deemed fucoidal markings dimly expressed on the planes of some of the strata, not in the carbonaceous form so common in the other two formations, but as mere coloured films of a deeper red than the surrounding matrix. I have, besides, detected in the same beds, and existing in the same state, fragments of a striated organism, which may have formed part of either a true Calamite, like those of the Coal measures, or of some such striated but jointless vegetable, as that of the Lower Old Red of Thurso and Lerwick. With these markings ferns are occasionally found; and to one of these—from the light which it throws on the true place in the scale of a series of deposits in a sister country—there attaches no little interest. I owe my specimen to Mr John Stewart of Edinburgh, who laid it open in a micaceous red sandstone in the quarry of Prestonhaugh, near Dunse, where it is associated with some of the better-known ichthyic organisms of the Upper Old Red, such as *Pterichthys major* and *Holoptychius nobilissimus.* Existing as but a deep red film in the rock, with a tolerably well-defined outline, but without trace of the characteristic venation on which the fossil botanist, in dealing with the ferns, founds his generic distinctions, I could only determine that it was either a Cyclopteris or Neuropteris. My collection was visited, however, by the late lamented Edward Forbes only a few weeks before his death, and he at once recognized in my Berwickshire Fern, so unequivocally an organism of the Upper Old Red, the *Cyclopteris hibernicus* of those largely-developed beds of yellow sandstone which form so marked a feature in the geology of the south of Ireland, and whose true place, whether as Upper Old Red or Lower Carboniferous, has been the subject of so much controversy. I had been previously introduced by Professor Forbes, in the Museum of Economic Geology in Jermyn Street, to an interesting collection of plants from these yellow beds, and had an opportunity afforded me of examining the only ichthyic organism hitherto found associated with them, and was struck, though I could not identify its species, with its general Old Red aspect; but the evidence of the Cyclopteris seems greatly more conclusive than that of the fish; and we may, I think, legitimately conclude that in Ireland, as in our own country, it was a contemporary of the great Pterichthys—the hugest, and at least one of the last, of his race—and gave its rich green to the hill-sides of what is still the Emerald Island during the latter ages of the Old Red sandstone, and ere the Carboniferous period had yet begun. The *Cyclopteris hibernicus*, as shown both by the Prestonhaugh specimen and those of Ireland, was a fern of very considerable size, apparently bipinnate, though there are indications that, were the entire frond preserved, it might be found to show, like our common hillside brake, yet another division. Its pinnæ, though nearly opposite, seem really alternate; and its leaflets, which are of a broadly oval form, and so closely ranged as to impinge on each other, are at least generally alternate in their arrangement. It were very desirable that we had a good monograph of the Irish plants, its contemporaries,—the completest and best-preserved representatives of the Middle Palæozoic Flora yet found. Sir Roderick Murchison has figured a single pinnæ of this Cyclopteris in his recently published "Siluria," and Sir Charles Lyell, in the last edition of his "Elements," both that and one of its contemporary Lepidodendra. These interesting fragments, however, serve but to excite our curiosity for more. When urging Professor Edward Forbes on the subject, ere parting from him for, alas! what proved to be the last time, he intimated an intention of soon taking it up; but I fear it represents only one of many works, important to science, which his untimely death has arrested for mayhap long years to come.

In the uppermost beds of the Upper Old Red formation in Scotland, which are usually of a pale or light-yellow colour, the vegetable remains again become strongly carbonaceous, but their state of preservation continues bad,—too bad to admit of the determination of either species or genera; and not until we rise a very little beyond the System do we find the remains of a Flora either rich or well preserved. But very remarkable is the change which at this stage at once occurs. We pass at a single stride from great poverty to great wealth. The suddenness of the change seems suited to remind one of that experienced by the voyager when,—after traversing for many days some wide expanse of ocean, unvaried save by its banks of floating sea-weed, or where, occasionally and at wide intervals, he picks up some leaf-bearing bough, or marks some fragment of drift-weed go floating past,—he enters at length the sheltered lagoon of some coral island, and sees all around the deep green of a tropical vegetation descending in tangled luxuriance to the water's edge,—tall, erect ferns, and creeping Lycopodiaceæ; and the Pandanus, with its aërial roots and its screw-like clusters of narrow leaves; and, high over all, tall palms, with their huge pinnate fronds, and their curiously aggregated groups of massive fruit. In this noble Flora of the Coal measures much still remains to be done in Scotland. Our Lower Carboniferous rocks are of immense development: the Limestones of Burdiehouse, with their numerous terrestrial plants, occur many hundred feet beneath our Mountain Limestones; and our list of vegetable species peculiar to these lower deposits is still very incomplete. Even in those higher Carboniferous rocks with which the many coal workings of the country have rendered us comparatively familiar, there seems to be still a good deal of the new and the unknown to repay the labour of future explorers. It was only last year that Mr Gourlie of Glasgow added to our Fossil Flora a new Volkmannia from the coal-field of Carluke; and I detected very recently in a neighbouring locality, though in but an indifferent state of keeping, what seems to be a new and very peculiar fern. There is a Stigmaria, too, very ornate in its sculpture, of which I have now found three specimens in a quarry of the Coal measures near Portobello, that has still to be figured and described. In this richly-ornamented Stigmaria the characteristic areolæ present the ordinary aspect: each, however, forms the centre of a sculptured star, consisting of from eighteen to twenty rays, or rather the centre of a sculptured flower of the composite order, resembling a garden daisy. The minute petals,—if we are to accept the latter comparison,—are ranged in three concentric lines, and their form is irregularly lenticular. Even among the vegetable organisms already partially described and figured, much remains to be accomplished in the way of restoration. The detached pinnæ of a fern, or a few fragments of the stems of Ulodendron or Sigillaria, give very inadequate ideas of the plants to which they had belonged in their state of original entireness. Portions of *Sphenopteris bifida*, for instance, a fern of the Lower Carboniferous rocks, have been repeatedly figured; but I have a beautiful specimen which exhibits what seems to be the complete frond of the plant, and which will give, I doubt not, fresh ideas respecting the general framework, if I may so speak, of this skeleton fern, to even those best acquainted with the figures; and a rather elaborate restoration of its contemporary, *Sphenopteris affinis*, which I completed from a fine series of specimens in my collection, will be new, as a whole, to those most familiar with this commonest of the Burdiehouse fossils. From comparisons instituted between minute portions of this Sphenopteris and a recent fern it has been held considerably to resemble a Davallia of the West Indies; whereas it will be seen from the entire frond, that it was characterized by very striking peculiarities, exemplified, say some of our higher botanical authorities to whom I have submitted my restoration, by no fern that now lives. Independently, too, of the scientific interest which must attach to restorations such as these, they speak powerfully to the imagination, and supply it with materials from which to construct the vanished landscapes of the Carboniferous ages.

In 1844, when Professor Nicol of Aberdeen appended to his interesting "Guide to the Geology of Scotland," a list of the Scottish fossils known at the time, he enumerated only two vegetable species of the Scotch Oolitic system, *Equisetum columnare* and *Pinites* or *Peuce Eigensis*—the former one of the early discoveries of our distinguished President, Sir Roderick Murchison, the latter, of the late Mr William Nicol of Edinburgh. Chiefly from researches in the Lias of Eathie, near Cromarty, and in the Oolites of Sutherland and the Hebrides, I have been enabled to increase the list from two to rather more than fifty species—not a great number certainly, regarded as the sole representatives of a flora; and yet it may be deemed comparatively not a very small one, when it is remembered that in 1837, when Dr Buckland published the second edition of his Bridgewater Treatise, Adolphe Brongniart had enumerated only seventy species of plants as occurring in all the Secondary formations of Europe, from the Chalk to the Trias inclusive. In a paper such as the present I can of course do little more than just indicate a few of the more striking features of this Scottish Flora of the middle Secondary ages. Like that of the Carboniferous period, it had its numerous coniferous trees. As shown by the fossil woods of Helmsdale and Eigg, old Oolitic Scotland, like the Scotland of three centuries ago, must have had its mighty forests of pine; and in one respect these trees seem to have more nearly resembled those of the recent pine forests of our country than those of the coniferous forests of the remote Carboniferous era. For while we scarce ever find a cone associated with the coniferous woods of the Coal measures—Lindley and Hutton never saw but one from all our British coal-fields—cones of at least three different species, more probably of four, are not rare in our Scottish deposits of the Lias and Oolite. It seems not improbable that in the Carboniferous genera Pinites, Pitus, and Anabathra, which approach but remotely to aught that now exists, the place of the ligneous scaly cone may have been taken, as in the junipers and the yews, by a perishable berry; while the pines and Araucarians of the Oolite were, like their cogeners in recent times, in reality coniferous, *i. e.*, cone-bearing trees. It is another characteristic of these Secondary conifers, that while the woods of the Palæozoic periods exhibit often, like those of the tropics, none of the dense concentric lines of annual growth which mark the reign of winter, these lines are scarce less strongly impressed on the Oolitic woods than on those of Norway, or of our own country in the present day. In some of the fossil trees the annual rings are of great breadth; they seem to have sprung up in the rich soil of sheltered hollows and plains, and to have increased in diameter from half an inch to three quarters of an inch yearly. In other trees of the same species the yearly zones of growth are singularly narrow—in some instances little more than half a line in thickness. Rooted on some exposed hill-side, in a shallow and meagre soil, they increased their diameter during the twelvemonth little more than a line in the severer seasons, and little more than an eighth part of an inch even when the seasons were most favourable. Further, whether the rings be large or small, we ordinarily find them occurring in the same specimens in groups of larger and smaller. In one of my Helmsdale specimens, indicative generally of rapid growth, there are four contiguous annual rings, which measure in all an inch and two-twelfths across, while the four contiguous rings immediately beside them measure only half an inch. "If at the present day," says a distinguished fossil botanist, "a warm and moist summer produces a broader annual layer than a cold and dry one, and if fossil plants exhibit such appearances as we refer in recent plants to a diversity of summers, then it is reasonable to suppose that a similar diversity formerly prevailed." The same reasoning is of course as applicable to *groups* of annual layers as to *single* annual layers; and may we not venture to infer, from the almost invariable occurrence of such groups in the woods of this ancient system, that that ill-understood law of the weather which gives us in irregular succession groups of colder and warmer seasons, and whose operation, as Bacon tells us, was first remarked in the provinces of the Netherlands, was as certainly in existence during the ages of the Oolite as at the present time? Twigs which exhibit the foliage of these ancient coniferæ seem to be less rare in our Scotch deposits than in those of England of the same age. My collection contains fossil sprigs, with the slim needle-like leaves attached, of what seem to be from six or seven different species; and it is worthy of notice that they resemble in the group rather the coniferæ of the southern than those of the northern hemisphere. One sprig in my collection seems scarcely distinguishable from that of the recent *Altingia excelsa*; another, from that of the recent *Altingia Cunninghami*. Lindley and Hutton figure in their Fossil Flora a minute branch of *Dacrydium cupressinum*, in order to show how nearly the twigs of a large tree, from fifty to a hundred feet high, may resemble some of the "fossils referrible to Lycopodiaceæ." More than one of the Oolite twigs in my collection are of a resembling character, and may have belonged either to cone-bearing trees or to club-mosses.

Among conifers of the Pine and Araucarian type we mark the first appearance in this system, in at least Scotland, of the genus Thuja. One of the Helmsdale plants of this genus closely resembles the common Arbor-vitæ (*Thuja occidentalis*) of our gardens and shrubberies. It exhibits the same numerous slim, thick-clustered branchlets, covered over by the same minute, sessile, scale-like leaves, and so entirely reminds one of the recent Thuja, that it seems difficult to conceive of it as the member of a flora so ancient as that of the Oolite. But not a few of the plants of the Scotch Oolite bear this modern aspect. The great development of its Cycadaceæ, an order unknown in our Coal measures, also forms a prominent feature of our Oolitic Flora. Several of the Helmsdale forms of this family are identical with those of the Yorkshire coast already named and figured, such as *Zamia lanceolata* and *Zamia taxina*; a well-marked Zamia which occurs in the Lias of Eathie appears to be new. Its pinnate leaves were furnished with a strong woody midrib, so well preserved in the rock that it yields its internal structure to the microscope. The ribbon-like pinnæ were rectilinear, retaining their full breadth until they united to the stem at right angles, but somewhat awry, and, like several of the recent Zamiæ, they were striped longitudinally with cord-like lines. Even its mode of decay, as shown by the abrupt termination of its leaflets, exactly resembled that of its existing cogeners. The withered parts of the pinnæ of Zamia drop off as if clipped across with scissors, and in fossil fronds of this Zamia of the lias we find exactly the same clipped-like appearance. With these leaves we find in the Eathie Lias cones of a peculiar form, which, like the leaves themselves, are still unfigured and undescribed, and which could scarce have belonged to any coniferous tree. In one of these, the ligneous bracts or scales, narrow and long, and gradually tapering till they assume nearly the awl-shaped form, cluster out thick from the base and middle portions of the cone, and, like the involucral appendages of the hazel-nut, or the sepals of the yet unfolded rose-bud, sweep gracefully upwards to the top, where they present at their margins minute dentations. In the other species the bracts are broader, thinner, and more leaf-like; they rise, too, more from the base of the cone, and less from its middle portions, so that the whole must have resembled an enormous bud, with strong woody scales extending from its base to its apex. The first described of these two species seems to have been, if I may so express myself, more decidedly a cone than the other; but it is probable that they were both connecting links among the Cycadaceæ, between such seed-bearing flowers as we find in *Cycas revoluta*, and such seed-bearing cones as we find exemplified in *Zamia pungens*. Another class of vegetable forms of occasional occurrence in the Helmsdale beds seems intermediate between the Cycadaceæ and the ferns,—at least so nearly do they approach to the ordinary fern outline, while retaining the stiff ligneous character of Zamia, that it is scarce less difficult to determine to which of the two orders of plants they belonged, than to decide whether some of the slim graceful sprigs of foliage that occur in the rocks beside them belonged to the conifers or the club-mosses. And I am informed by Sir Charles Lyell that, as some of the existing conifers bear a foliage scarce distinguishable from that of Lycopodiaceæ, so a recently discovered Zamia, which is creating at present quite a sensation among the botanists, is furnished with fronds that scarce differ from those of a fern.

We recognise another characteristic of our Oolitic Flora in its simple-leaved fronds, not a little resembling those of the recent Scolopendrium or Hart's-Tongue fern, a form regarded by Adolphe Brongniart as peculiarly characteristic of his third period of vegetation. Some of the Helmsdale specimens are of great size. From, however, a description and figure of a plant of evidently the same genus, a Tæniopteris of the Virginian Oolite, given by Professor W. B. Rogers of the United States, I find that some of the American fronds are larger still. My largest leaf from Helmsdale must have been nearly five inches in breadth, and if its proportions were those of some of the smaller ones of the same kind from the same locality, it must have measured about thirty inches in length. But fragments of American leaves have been found more than six inches in breadth, and whose length cannot have fallen short of forty inches. The Tæniopteris, as its name bears, is regarded as a fern, which in one of its species, *T. major*, is said very closely to resemble Scolopendrium From, however, the leathern-like thickness of some of the Sutherland specimens—from the great massiveness of their midrib, from the rectilinear simplicity of their fibres, and withal from, in some instances, their great size—I am much disposed to believe that in our Scotch, mayhap also in the American species, it may have been the frond of some simple-leaved Cycas or Zamia. But the point is one which it must be left for the future satisfactorily to settle, though, provisionally, I may be permitted to regard these leaves as belonging to some Cycadaceous plant, whose fronds, in their venations and form, resembled the simple fronds of Scolopendrium, just as the leaves of some of its cogeners resembled the fronds of the pinnate ferns. The true ferns of the formation are, however, numerous—proportionally a large part of them identical in species with those of the Oolite of England. Among these there occur *Pecopteris Whitbiensis*, *Pecopteris obtusifolia*, *Pecopteris insignis*, *Neuropteris recentior*, *Neuropteris arguta*, and several others. It has, besides, its ferns that seem to be new,—that are at least not figured in any of the Fossil Floras to which I have access,—such as a well-defined Pachypteris, a large-leaved Neuropteris, and what seems to be a Phlebopteris. The Equisetaceæ we find represented in the Brora deposits by *Equisetum columnare*, a plant the broken remains of which occur in great abundance, and which, as remarked by Dr Fleming many years ago, must have entered largely into the composition of the bed of lignite known as the Brora coal. We find associated with it what seems to be the last of the Calamites—*Calamites arenarius*—a name, however, which seems to have been bestowed both on this Oolitic plant and a resembling Carboniferous species. The deposit has also its Lycopodites, though, from their resemblance in foliage to the conifers, there exists that difficulty in drawing the line between them to which I have already adverted. To yet another vegetable organism of the system—an organism which must be regarded as at once very interesting and extraordinary, occurring, as it does, so low in the scale, and bearing an antiquity so high—I shall advert, after a preliminary remark on a general characteristic of the Flora to which it belongs, but to which it furnishes a striking exception.

From the disappearance of many of those anomalous types of the Coal measures which so puzzle the botanist, and the extensive introduction of types that still exist, we can better conceive of the general features and relations of the Flora of the Oolite than of those of the earlier Floras; and yet the general result at which we arrive may be found not without its bearing on the older vegetations also. Throughout almost all the families of this Oolitic Flora, there seems to have run a curious bond of relationship, which, like those ties which bound together some of the old clans of our country, united them, high and low, into one great sept, and conferred upon them a certain wonderful unity of character and appearance. Let us assume the ferns as our central group. Though less abundant than in the earlier creation of the Carboniferous system, they seem to have occupied, judging from their remains, very considerable space in the Oolitic vegetation; and with the ferns there were associated, in great abundance, the two prevailing families of the Pteroides—Equiseta and Lycopodia—plants which, in most of our modern treatises on the ferns proper, take their place as the fern allies. Let us place these along two of the sides of a pentagon: the Lycopodia on the right side of the ferns, the Equiseta on the left; further, let us occupy the two remaining sides of the figure by the Coniferæ and the Cycadaceæ, placing the Coniferæ on the side next the Lycopodia, and the Cycadaceæ as the last added keystone of the erection, between these and the Equiseta. And now let us consider how very curious the links are which give a certain wonderful unity to the whole. We still find great difficulty in distinguishing between the foliage of some of even the existing club-mosses and the Conifers; and the ancient Lepidodendron genus is very generally recognised as of a type intermediate between the two. Similar intermediate types, exemplified by extinct families, united the conifers and the ferns. The analogy of *Kirchneria* with the *Thinnfeldia*, says Dr Braun, is very remarkable, notwithstanding that the former is a fern, and that the latter is ranked among conifers. The points of resemblance borne by the conifers to the huge Equiseta of the Oolitic period seem to have been equally striking. The pores which traverse longitudinally the channelled grooves by which the stems of our recent Equiseta are so delicately fluted, are said considerably more to resemble the discs of pines and Araucarians than ordinary Stomata. Mr Francis does not hesitate to say, in his work on British Ferns, that the relation of this special family to the Coniferæ is so strong, both in external and internal structure, that it is not without some hesitation he places them among the fern allies; and it has been ascertained by Mr Dawes, in his researches regarding the Calamite, that in its internal structure, this apparent representative of Equiseta, in the earlier ages of the world, united "a network of quadrangular tissue similar to that of Coniferæ to other quadrangular cells arranged in perpendicular series," like the cells of plants of a humbler order. The relations of the Cycadacean order to ferns on the one hand, and to the Coniferæ on the other, are equally well marked. Like the ferns, the venation of its fronds is circinate, or scroll-like; they have in several respects a resembling structure; in at least one recent species, they have a nearly identical form; and fronds of this fern-like type seem to have been comparatively common during the times of the Oolite. On the other hand, the Cycadaceæ manifest strong relations to the conifers. Both have their seeds originally naked—both are cone-bearing—both possess discs on the sides of their cellules; and in both, on the transverse section, these cellules are subhexagonal, and radiate from a centre. Such were the very curious relations that united into one great sept the prevailing members of the Oolitic Flora; and similar bonds of connection seem to have existed in those of the still earlier ages. But in the Oolite of Scotland, I have at length found trace of a vegetable organism that lay, if I may so express myself, outside the pentagon, and was not a member of the great family which it comprised. I succeeded about four years ago in disinterring from the limestones of Helmsdale a true dicotyledonous leaf, and what seems to be a fragment of another leaf of the same class, though of a different genus—the first precursors, in Scotland at least, of our great forest-trees, and of so many of our flowering and fruit-bearing plants; and which seem to occupy the same relative place in advance of their contemporaries as that occupied by the conifer of the Old Red Sandstone in advance of the ferns and Lycopodiaceæ with which I found it associated. In the arrangement of its larger veins, the better preserved Oolitic leaf somewhat resembles that of the buckthorn; but though its state of keeping is such that it has satisfied our higher botanists regarding the great class to which it belongs, it has failed to leave its exterior or circumscribing outline in the stone.

The curtain drops over this ancient Flora of the Oolite in Scotland; and when, long after, there is a corner of the thick enveloping screen withdrawn, and we catch a partial glimpse of one of the old Tertiary forests of our country, all is new. Trees of the high dicotyledonous class, allied to the plane and the buckthorn, prevail in the landscape, intermingled, however, with dingy funereal yews; and the ferns and Equiseta that rise in the darker openings of the wood approach to the existing type. And yet, though *eons* of the past eternity have elapsed since we looked out upon Cycas and Zamia, and the last of the Calamites, the time is still early, and long ages must lapse ere man shall arise out of the dust, to keep and to dress fields waving with the productions of yet another and different Flora, and to busy himself with all the labour which he taketh under the sun. Our country, in this Tertiary time, has still its great outbursts of molten matter, that bury in fiery deluges, many feet in depth and many square miles in extent, the debris of wide tracts of woodland and marsh; and the basaltic column still forms in its great lava bed; and ever and anon as the volcanic agencies awake, clouds of ashes darken the heavens, and cover up the landscape as if with the accumulated drifts of a protracted snow-storm. Who shall declare what, throughout these long ages, the history of creation has been? We see at wide intervals the mere fragments of successive Floras; but know not how what seem the blank interspaces were filled, or how, as extinction overtook in succession one tribe of existences after another, and species, like individuals, yielded to the great law of death, yet other species were brought to the birth, and ushered upon the scene, and the change of being was maintained unbroken. We see only detached bits of that green web which has covered our earth ever since the dry land first appeared; but the web itself seems to have been continuous throughout all time; though ever, as breadth after breadth issued from the creative loom, the pattern has altered, and the sculpturesque and graceful forms that illustrated its first beginnings and its middle spaces have yielded to flowers of richer colour and blow, and fruits of fairer shade and outline; and for gigantic club-mosses stretching forth their hirsute arms, goodly trees of the Lord have expanded their great boughs; and for the barren fern and the Calamite clustering in thickets beside the waters, or spreading on flowerless hill-slopes, luxuriant orchards have yielded their ruddy flush, and rich harvests their golden gleam.—*Read before the British Association, Sept.* 13, 1855.

CHEMISTRY.

Occurrence of Vanadium and Titanium in Sphærosiderite from the neighbourhood of Bonn. By Professor Bœdekir.

The author selected the largest nodules from this locality, and found that they all contained vanadium. The powdered mineral is fused with nitre, silica, and alumina separated by carbonate of ammonia, and the greater part of the potash removed by crystallization. The solution is then boiled with sulphuret of sodium, and the green precipitate of oxide of vanadium slowly dissolves, forming a brown solution, from which the brown sulphuret of vanadium was precipitated by an acid and converted into vanadic acid by roasting. By heating with bisulphate of potash, extraction with cold water and boiling, a precipitate was obtained, in which the presence of titanium was distinctly ascertained.—(*Annalen der Chimie und Pharmacie,* vol. xciv., p. 355.)

MISCELLANEOUS.

On the Injurious Effects of Cedar Wood Drawers. By Dr John Fleming, Professor of Natural Science, New College, Edinburgh. (Read before the Royal Physical Society, 11th December 1852.)—Last spring, when looking over the conchological collection of Lady Agnew, my attention was particularly attracted to the condition of the epidermis of several specimens. Its texture was in appearance changed on certain portions of the surface, and rendered so sticky as to suggest the idea that a coating of dissolved caoutchouc had been applied. On my expressing surprise at an appearance then new to me, her ladyship stated that Dr Greville attributed the change which the epidermis had undergone to the in uence of the cedar wood of a cabinet in which the shells had been kept. I lost no time in consulting my esteemed friend on the subject, and found that he had been a sufferer to some extent from having employed Havannah cedar as the material for the drawers of a cabinet.

Having been myself entirely ignorant of this pernicious property of cedar wood, and finding, from conversation with several friends who were collectors, that its harmlessness was not suspected, I determined to make further inquiry ; and I now lay the result before the Society, in the belief that the subject is one with which every possessor of specimens in natural history should be acquainted.

The experience of Mr Bryson, the possessor of the valuable collection of the late Mr Nicol, could not furnish me with any illustrative facts ; but he pointed out to me some valuable notices in the "Minutes of the Proceedings of the Institution of Civil Engineers, 27th April 1847," in connection with the reading of a paper by Charles Frodsham, Ass. Inst. C.E., "On the Laws of Isochronism of the Balance-Spring as connected with the Higher Order of Adjustments of Watches and Chronometers," Mr Valliamy mentioned the following circumstance :—" His Majesty George III. was in the habit of having small articles of cabinet-work made at the Royal Observatory, Kew Gardens. The drawers of one of these were made of cedar wood ; and in them several watches were placed, with the intention of keeping them going. In a very short time they all came to rest. The experiment was, however, repeated, but with the same result ; and on examining the watches, the oil was found to have been completely changed into a substance resembling gum."—Vol. vi. p. 247. Afterwards Mr Farey stated "that he had observed, many years ago, that cedar wood was unfit for cases in which delicate objects were to be kept. The late Mr William Strutt, of Derby, showed him a small collection of the minerals of Derbyshire, part of which had been locked up in a new cabinet with close fitting cedar wood drawers. On opening them for the first time after some months, the minerals were found covered with a gummy matter, having a strong odour of cedar, and which was troublesome to remove ; it gave to the bright surface of the crystals the appearance of having been varnished in an irregular and unskilful manner. It was obvious that the cedar had emitted a vapour which had become condensed upon the surfaces of the minerals, and the same would no doubt have happened with watches, or other articles of metal. Whether other wood, such as deal, would have the same effect, should be inquired into." Vol. vi. p. 248.

Shortly after gaining the information now recorded, I had a conversation with Lady Harvey on the subject, who, as possessing a varied and extensive collection, I conjectured might furnish me with additional particulars. The following memoranda have in consequence been kindly communicated to me :—

" In 1819, Sir John Harvey brought from Bermuda some logs of cedar, which he soon after had made into a bedstead with turned posts. In 1842, Lady Harvey removed to Edinburgh from the Oake, Upper Deal. The bedstead was removed, but the person who took it down had great difficulty in removing the screws, as they were so corroded by the gum that came from the cedar. It was put up again in Edinburgh immediately after : it still retains its smell, but the post next the fire has still a good deal of the gum attached to it, which has become hard. A young friend of Lady Harvey's, now the Marchioness of Hastings, had a little cedar cabinet in which were some minerals ; she found some of them spoiled, in the crystals being covered with a substance which would not come off. The late Sir Thomas Troubridge had also many minerals spoiled by being kept in cedar drawers, from the same thing. It was mostly the earthy minerals that were affected ; only a few of the metallic ones."

Accidentally meeting my respected friend Alexander Thomson, Esq. of Banchory, and the possessor of an extensive and valuable collection of various objects in the arts and natural history, I ascertained that his experience as to cedar wood confirmed the results of all my previous inquiries; and he kindly complied with my request, in furnishing me with the following statement:—

"*Banchory House, by Aberdeen,*
17*th November*, 1852.

"My dear Sir,—You asked me to give a memorandum of my experience of cedar wood as a cabinet.

"About ten years ago I received from Halifax several roots of cedar tree, said to be *very* beautiful. I had one cut up in one-fourth and half inch boards, and made a small cabinet of it, with ten shallow drawers.

"I put a parcel of coins and medals into some of them, and a few months after I was much surprised on opening the cabinet to look at the coins, to find here and there *one* to all appearance *deliquescing!* of course, on examination, it immediately appeared that it was a deposit on the coin, and on taking them up they stuck fast to the fingers, as if covered by a very thick gum-arabic. I was much struck by this fact, viz., that it was only *here* and *there* a coin that was affected,—not in groups or in rows,—and copper and silver equally; gold apparently less affected; but then there were comparatively few of that metal. The small drawers are made entirely of cedar.

"In one of the drawers I had laid a few microscopic objects, mounted in Canada Balsam. On taking them out (after some months' absence) I was amazed to find the Canada Balsam in a fluid state, and the covers of thin glass loose, and two or three slips of fossil wood entirely detached from the glass, which, when put aside, were as firm as Canada Balsam could be. The cabinet stood near a fire-place, and was occasionally *warm*, but not steadily so.

"Notwithstanding what had happened, it never occurred to me that the cedar was particularly to blame, but rather its having been occasionally made very warm, when there was a larger fire than usual in the room.

"We resolved, therefore, to empty it of its contents, clean it all thoroughly, and remove it permanently to other quarters, where it would not be exposed to occasional heat; and, unfortunately, we also resolved to devote it to holding a collection of Roman casts in plaster of Paris.

"On looking at them one day, after they had been perhaps two years in the drawers, we found, as with the coins, here and there one changed from *white* to *brown*, and the whole set nearly ruined.

"I was now fully satisfied that the cedar wood was the culprit, but not till too late to save my casts.

"I have just looked at the whole cabinet. The exterior, where polished and varnished, is all right; and the brass hinges are covered by a gummy deposit, and the whole unpolished drawers, &c., are as sticky as possible; and where there are small *knots* in the wood there are minute drops of gum, and the lock works so stiffly, that I think it must be *filled* with gum on the wards;—the key came out covered with it.

"Such is my experience of cedar wood, and certainly it is the last time I shall use it for any purpose in the Museum.

"The mode in which it acts is singular. Why does it continue to throw out this gum, or rather essential oil, after being so long cut up, and so thoroughly dried to all appearance? Why does it deposit itself on one coin or cast rather than on another? and how did it act on the Canada Balsam? I presume, in the latter case, it acted like turpentine in the form of vapour."

From inquiries made in various quarters, I am inclined to believe that the more resinous firs and pines, as well as junipers (which yield the wood usually termed cedar), cannot be safely employed in the construction of drawers for the reception of objects of natural history. I can, however, testify that the white American fir is perfectly harmless, while it is singularly insensible to the influence of moisture or dryness.

When this subject first attracted my notice, I made inquiry at one upholsterer in Edinburgh respecting the employment of Havannah cedar in cabinet work. He assured me that some years ago it was much used, but that of late it had been abandoned. Another upholsterer gave me a very different view of the matter, by stating that in Edinburgh it was very much used in cabinet work as a substitute for mahogany.

As I feel deeply interested in the safe keeping of objects of Natural History, these remarks have been brought together for the benefit of those who wish to have drawers to preserve, not to spoil, their specimens, and are not intended to excite the slightest alarm in the minds of the possessors of cedar cabinets as wardrobes or book-cases.

P.S.—Since the above was written, I have observed the following interesting communication to the Linnean Society, 15th March 1842, in the *Annals and Magazine of Natural History*, No. 63, for December 1842. "Mr R. H. Solly exhibited a cabinet of microscopic objects made of cedar wood, the specimens contained in which, consisting of thirty ground sections of fossil wood cemented on glass, had become covered with a very adhesive varnish. Where the fossil wood was quite sound, and the cement (probably Canada Balsam) did not project beyond its edges, very little of the varnish was deposited; but where the fossil wood was cracked or unsound, or where the cement projected beyond the edge, it was found in considerable quantity; and on the specimens not cemented to glass, it was deposited chiefly in the pores or cracks which had imbibed some of the oil used in polishing the surface. The cabinet was quite new when the specimens were placed in it; and Mr Solly supposes that the air contained in the drawers had become loaded with vapour from the cedar wood, which, coming into contact with the oil or resin, combined with it to produce a varnish."

Keith Prizes.—The Council of the Royal Society of Edinburgh has awarded the Keith Prize for the biennial period, ending April 1855, to Dr Thomas Anderson, Professor of Chemistry in the University of Glasgow, for his papers on the Crystalline Constituents of Opium, and on the Products of the Destructive Distillation of Animal Substances, both of which are printed in the Transactions of the Society.

The Royal Scottish Society of Arts has awarded the Keith Prize to Dr George Wilson, Professor of Technology in the University of Edinburgh, for his papers on Colour Blindness.

Note on Plate of Malapterurus Beninensis, figured in Vol. II. Plate II. of this *Journal*. By Andrew Murray, W.S.

Large and apparently full-grown specimens of this fish have been received from Old Calabar since the figure given was lithographed. That figure is taken from a young fish, and the older specimens show one or two differences which it is proper to mention. The size of the largest specimen is seven inches (double that of the specimen figured). Its relative dimensions are nearly the same—perhaps somewhat broader at the thickest part, immediately behind the pectoral fins. The principal differences are, that the light-coloured band at the tail has disappeared, or very nearly so, and the black spots scattered over the body have also almost disappeared. A small black speck may be traced here and there, but on a cursory view the fish appears entirely of a blackish olive hue above, with a pale belly.

(List of Publications Received and other Intelligence postponed from want of space.)

G.H. Ford ad nat lith.

MALAPTERURUS BENINENSIS. Murray

Ford & West Imp.

MERIONES ACADICUS. Daws
1855

Ford & West Imp.

Edinburgh New Philosophical Journal Vol. III

Fig 1.

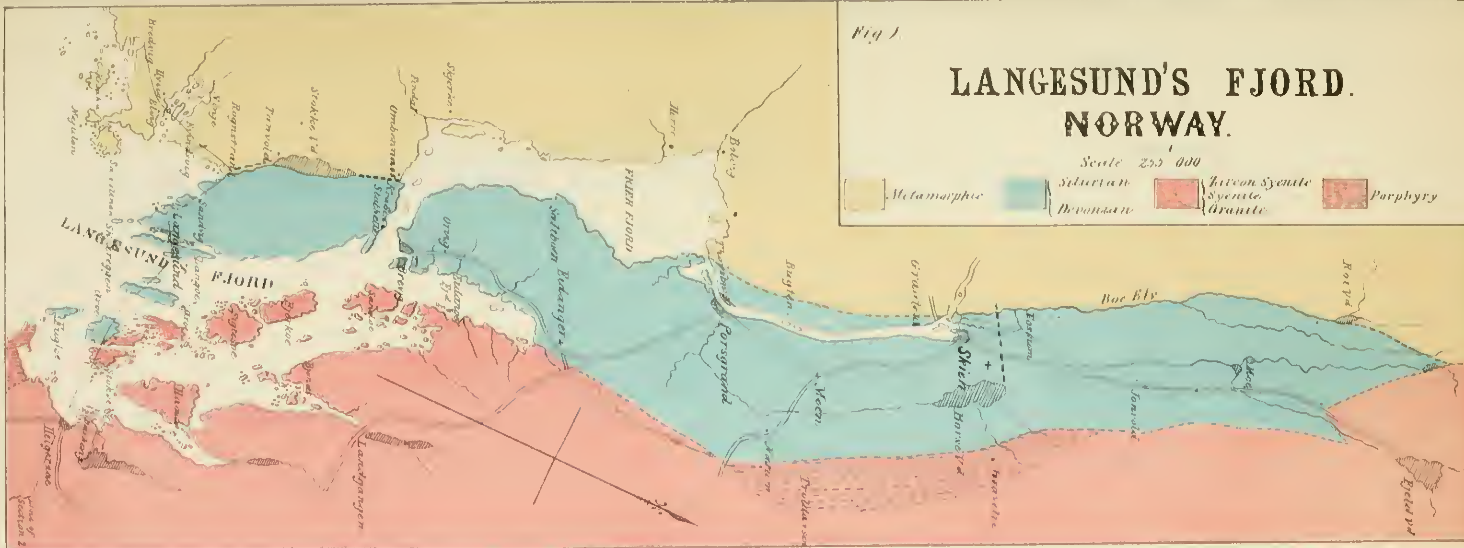
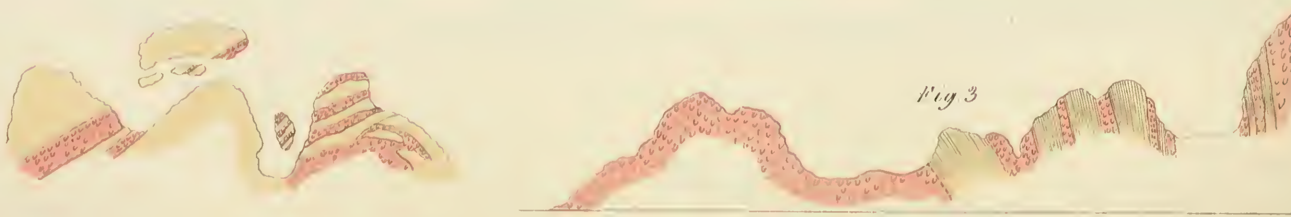
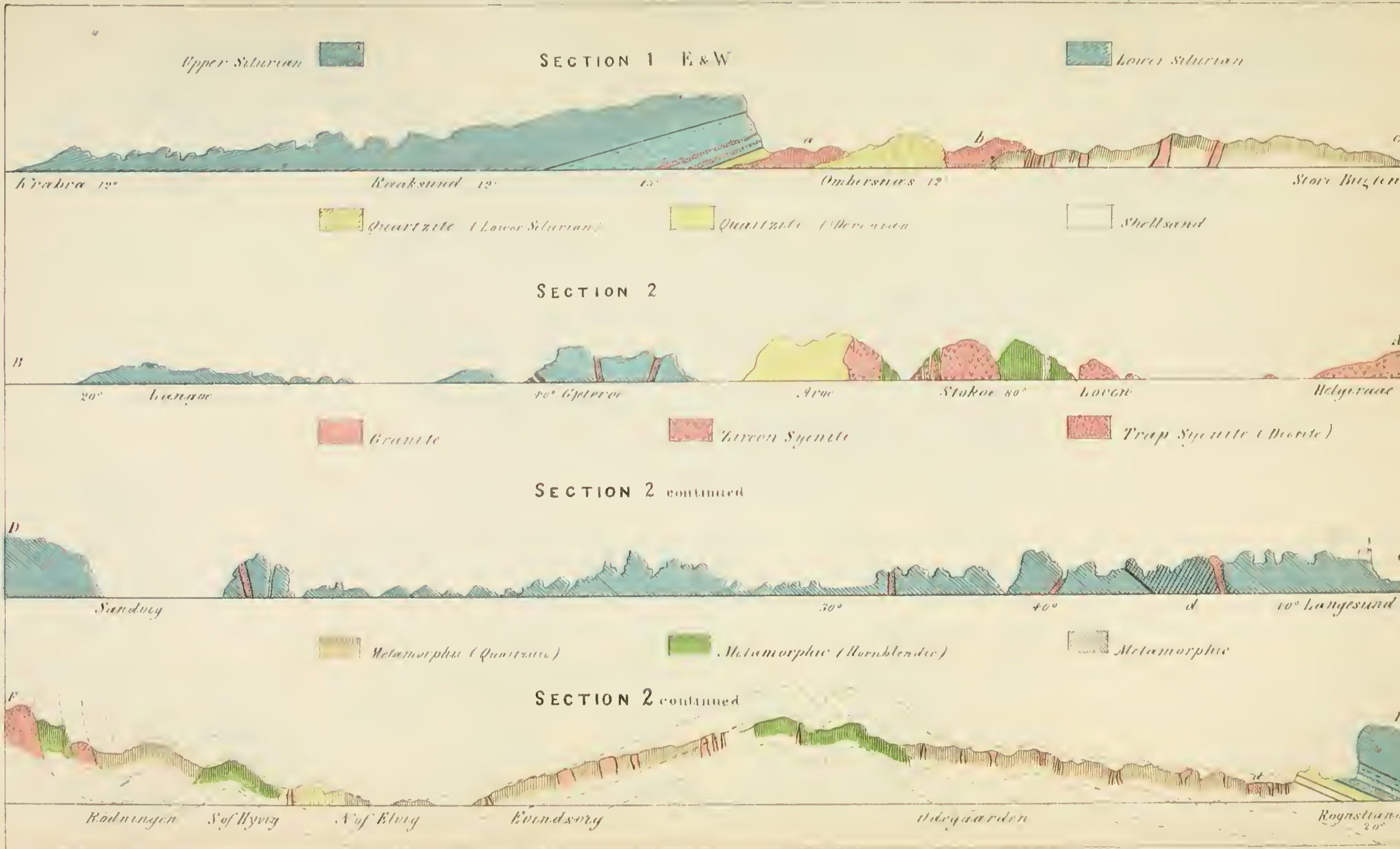


Fig 2.

Fig 3.




SECTION 1 E & W
Upper Silurian
Lower Silurian
Krabra 12°
Raaksund 12°
15°
Ombersnæs 12
Store Bugten
a
b
c
Quartzite (Lower Silurian)
Quartzite (Devonian)
Shellsand
SECTION 2
B
A
20°
Langøe
10° Gjeterøe
Arøe
Stokøe 80°
Løvøe
Helgeraae
Granite
Zircon Syenite
Trap Syenite (Diorite)
SECTION 2 continued
D
C
Sandvig
30°
40°
d
10° Langesund
Metamorphic (Quartzite)
Metamorphic (Hornblende)
Metamorphic
SECTION 2 continued
F
E
Rødningen
S. of Hyvig
N. of Elvig
Evindsvig
Ødegaarden
Rognstrand
20°

TETRACONOPS RAMPHASTINUS. Jard

1855

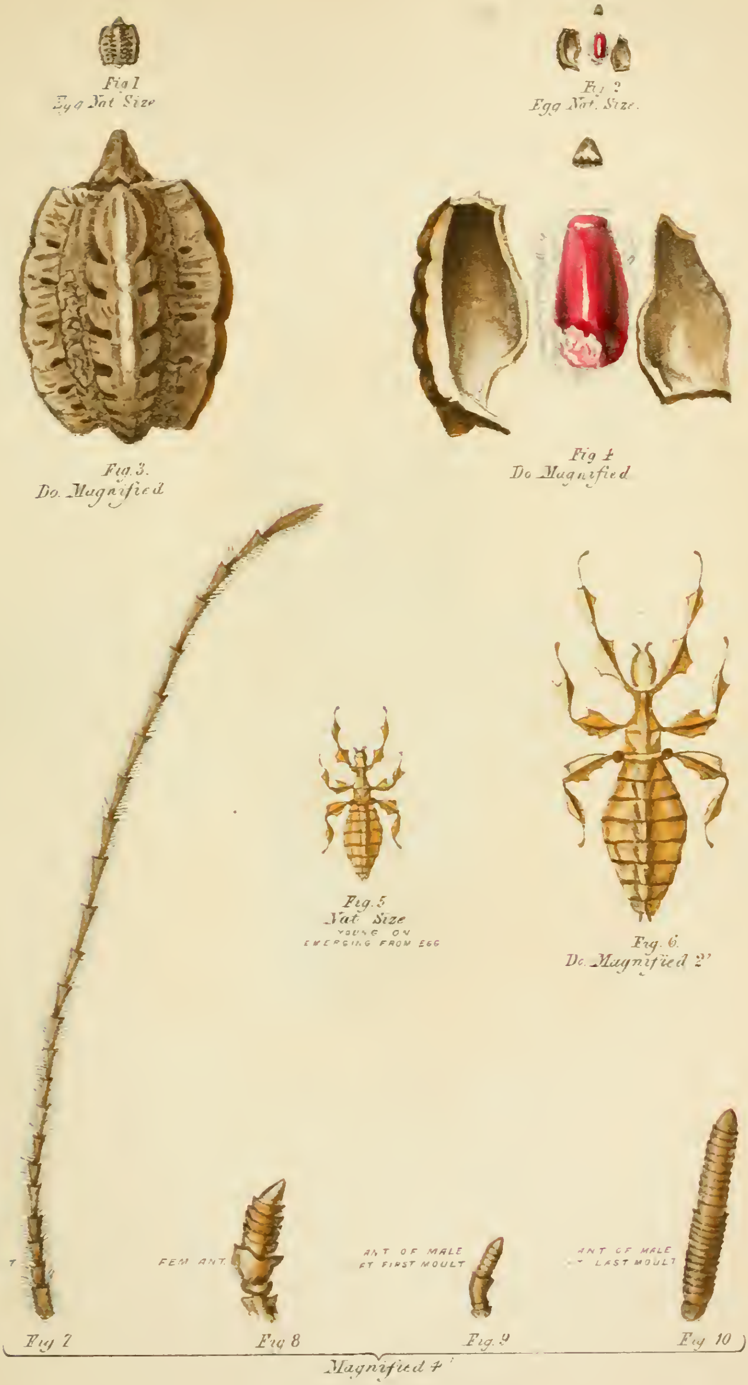
Ford & West Imp

PLATE V.

POUCHED PEYERIAN GLAND.
(CAMELOPARDALIS GIRAFFA)

W. H. LIZARS LITH. EDIN.

Edinburgh New Philosophical Journal Vol III



PHYLLIUM SCYTHE
DETAILS

A PERRICAL DELT

PRINTED IN COLOURS BY W H LIZARS

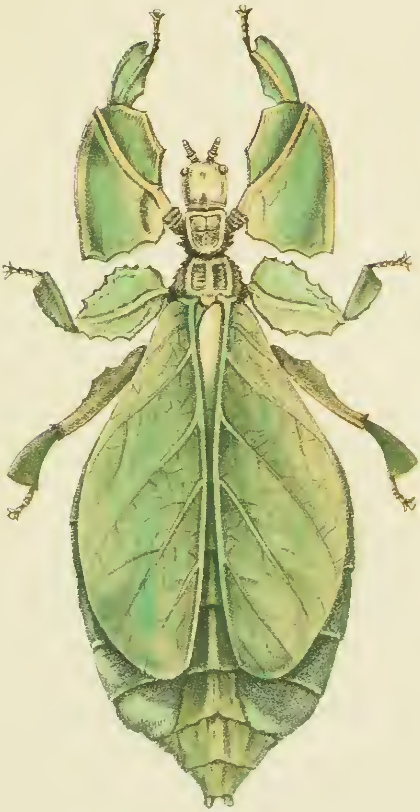
Edinburgh New Philosophical Journal Vol III

PHYLLIUM SCYTHE
(MALE)

A PERRIGAL DEL^T

PRINTED IN COLOURS BY W H LIZARS EDIN^R

Edinburgh New Philosophical Journal Vol. III.



PHYLLIUM SCYTHE
(FEMALE)

A PERRIGAL DELT.

PRINTED IN COLOURS BY W H LIZARS EDINR

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ZOOLOGY.

GEOLOGY.

CHEMISTRY.

BOTANY.

ERRATUM IN No. 5.

Page 55, line 12 from the bottom, *for* progressive *read* vestigian.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On the Geological Relations of the Secondary and Primary Rocks of the Chain of Mont Blanc.

By JAMES D. FORBES, D.C.L., Corresponding Member of the French Institute, and Professor of Natural Philosophy in the University of Edinburgh.* (Plate IX.)

I have hesitated before making any remarks on an ingenious paper by Mr D. Sharpe, "On the Structure of Mont Blanc and its Environs,"† for three reasons: *first*, because my studies being at present differently directed, I would rather have passed over the matter in silence; *secondly*, because the facts controverted by Mr Sharpe, mainly rest on the authority of professed geologists, nearly all of whom are now living, and well able to maintain their own views if correct; *thirdly*, because, as far as the ultimate appeal to facts is concerned, I have no expectation at present of being able to add to those which I have already collected on the subject, or of correcting my impressions (if erroneous) on the spot.

On the other hand, I find reasons for putting on record my convictions on the interesting geological question re-opened by Mr Sharpe, first, On account of the prominent way in which he has cited my name in connection with the views now generally maintained on the structure of the chain of Mont Blanc; a citation which he has made in terms only too flattering to the share which I have had in fixing the opinions of geologists

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† Quart. Journal Geol. Society of London, Feb. 1855.

on this important matter; secondly, Because he has denied statements of which I thought that I had given sufficient proof; but much more, thirdly, Because, in criticising the conclusions of several eminent geologists, as well as my own, he has used a sort of argument which appears to me to be extremely unusual, and even dangerous to the progress of science.

The principal fact supposed to be recognised in the structure of the chain of Mont Blanc, but which Mr Sharpe undertakes to controvert, is this;—that there is a real superposition of the primitive or *granitoid*, to the secondary or *argillo-calcareous* rocks. Mr Sharpe appears also, in a more emphatic manner, to deny that there is a conformity (as alleged) between the stratification or bedding of the former and the latter rocks, where they approach to contact.

This "monstrous superposition," as it was in one instance termed by De Saussure, was a thing so abhorrent to the Wernerian views of his time, that it is impossible to doubt that it could have been admitted by him and his successors (including his grandson, M. Necker) but with the extremest reluctance, and consequently only after the most careful investigation. The dip of the calcareous beds at Chamouni, under the granite or *protogine* of Mont Blanc, is a fact now received after reiterated observations by De Saussure, MM. Necker, Favre, Studer, and myself. The corresponding relations of the two rocks on the opposite or Italian side of the same chain has been more sparingly noticed, and perhaps first prominently brought forward in my *Travels in the Alps*, as cited by Mr Sharpe; but the chief circumstances through which my name has been brought forward in this matter are these,—that I pointed out the symmetry of the two sides of the chain, the conformity of the inward dip of the calcareous rocks in either case towards the central granitic mass, and the coincidence of it with the lamination of the primitive rocks which constitute that "fan-shaped structure" of those masses to which attention has of late years been so much directed. I also pointed out the analogy of the granitic outbreak of the Mont Chetif, on the Italian side of the chain, with that of the Aiguilles Rouges at Chamouni. The section, Plate IX., fig. 2, from my *Travels in the Alps*, will illustrate, at the outset, the general facts as assumed, but which is now called in question. I take this opportunity of stating that the broad distinction indicated in this section of granite from limestone, without the specification of intermediate varieties or transitions, was adopted solely to simplify the task of the lithographer (no colour being used), and to direct attention to the singularity of the *general* arrangement.

Mr Sharpe's refutation of the alleged facts consists of, I think, two parts: *first*, he charges those who preceded him with mistaking cleavage for stratification; *secondly*, he characterizes the conclusions from observation of all his predecessors as unjustified assertions, drawing himself opposite results from the facts which he supposes them to have seen, and denies, in the most positive manner, that they *could* have seen what they have affirmed and represented by figures. It is this last mode of criticism which I have ventured to call "unusual and dangerous." Mr Sharpe employs it quite as freely in discussing the elaborate conclusions of De Saussure, MM. Necker and Favre, as in the case of my own, so that I feel that I am blamed in good company; and I wonder chiefly at the boldness of a tourist who spent, by his own account, but a few days on ground most difficult to traverse, and far more difficult to understand, in setting aside at once the facts and the inferences recorded by men so laboriously familiar with the ground. Fig. 7 of Plate IX., being part of one of Mr Sharpe's sections, when compared with fig. 2, will at once illustrate the difference between our opinions.

Mr Sharpe must be well aware that an extensive geological section is seldom or never a precise copy of nature, capable of verification at each and every point. In all cases of difficulty or of extended investigation, it is a *real induction* from numerous insulated facts, by means of which the geologist draws a general conclusion.* The general dip of limestone under gneiss on the S.E. face of the Valley of Chamouni, is a fact of this kind. If Mr Sharpe had recollected the intensity of the evidence which alone could have convinced De Saussure and M. Necker of so improbable, and apparently "monstrous,"

* The sections which accompany Mr Sharpe's own memoir, have so strikingly this character, as to make it unnecessary to insist on the fact.

an arrangement,—if he had recollected the difficulty of finding, in the course of a few hurried rambles, the critical spots which geologists, equally able, had perhaps been in search of for weeks,—if, finally, he had considered the presumption of deciding a fact *negatively*, in opposition to such authority; he would probably have paused before writing some parts of his present paper. I shall proceed to quote some sentences from the successive geological authorities on the subject, and display some of their drawings of what they at least *believed themselves to have seen.*

I. De Saussure has nowhere given a section of the relative position of the crystalline and secondary rocks at Chamouni. From his short descriptions of these rocks (*Voyages*, vol. ii., chap. xxii.) we collect the following observations.—(1.) At Mont Lacha, at the S.W. extremity of the valley, calcareous beds lie conformably to the position of the lower members of the primitive series which he had already described in § 656, as gradually increasing in dip *towards* the centre of the chain as he ascended the heights of Blaitière, immediately to the south of the village of Chamouni. As he adds that the same arrangement continues throughout the whole extent of the valley, it is not doubtful that the dip of the strata at Mont Lacha are, if De Saussure be correct, conformable to that of the gneiss rocks overhanging them to the S.E. (2.) The gypsum and calcareous tufa at Tacconay, § 707, intermediate between Mont Lacha and Chamouni, presented to De Saussure no contact with the primitive rock, and no fixed plane of stratification; such as appeared being rather discordant. (3.) At Biolay, immediately to the south of the village of Chamouni, and beneath the rocks of Blaitière, is the most important section described by De Saussure, § 708, in the following words:—" Les couches sont situées precisement comme celles de la montagne primitive *à laquelle elles sont adossées;* elles courent de N.E. au S.W. et font avec l'horizon un angle de 45° en présentant leurs escarpements à la vallée de Chamouni." The rock is described as one " qui tient aussi de la nature du tuf." (4.) The calcareous strata of the *Côte du Piget*, an insulated hill near the source of the Arveiron, are described in § 709 as resembling those of

Biolay, and generally conformable to the primitive rocks, rising from 28° to 30° towards the N.W.

Summing up his conclusions from these observations in § 712, De Saussure very philosophically infers that the slates, as well as the bluish-black limestones, are anterior to the revolutions which have modified the configuration of the chain, have partaken of the fate of the primitive strata, and taken an analogous position. The gypsums and tufaceous limestones he considers as more modern, and not to have partaken of the symmetrical arrangement of the primary rocks. An exception to this, he says (in the last paragraph of chap. xxii.), is to be found in the rocks of Biolay (which he had described as tufaceous), inasmuch as they conform to the position of the blue limestones and primary slates. This passage has been strangely misunderstood by Mr Sharpe, who (p. 16) represents De Saussure as saying that *all* the limestones are more modern than the crystalline rocks, and as citing the quarry of Biolay as an exception, "which," Mr Sharpe adds, "the previous description [of De Saussure himself] by no means justifies;" the exception really being that the mineralogical character of the limestone of Biolay was "tufaceous," and therefore seemed to De Saussure to be more modern than the "blue or blackish limestones." Resting on this evidence of the great naturalist of the Alps contradicting himself in less than three pages, Mr Sharpe puts his testimony on one side.

II. Next in order we have M. Necker, who still lives to connect the views of his illustrious grandfather with those of our own day. Like De Saussure himself, he has observed far more than he has published, and has done so with the accuracy characteristic of the school of geology of which De Saussure was in some measure the founder, and the traditions of which descended through Théodore de Saussure to the present Honorary Professor of Geneva, M. Necker. We may be quite assured, therefore, that what M. Necker states to be a fact, he has seen with his own eyes, and registered on the spot. In a very remarkable Memoir on the Geology of Valorsine,* read 17th April 1828, he points out the great in-

* Memoires de la Société d'Hist. Nat. de Genève.

fluence of the granitoid masses connected with the Aiguilles Rouges and the Valley of Valorsine on the configuration of the secondary beds. He also gives a section of the strata between Valorsine and the Col de Balme, in which the mineralogical series of superposed beds is described, and the whole shown to dip at a high angle under the primary slates and the protogine of the main chain. This observation is fully confirmed by M. Studer.* Mr Sharpe's assumption, that his predecessors have mistaken cleavage planes for bedding in this instance, is a question of fact, which must rest on the authority of the respective observers, and on the pains which they bestowed on their observations. I suspect, however, that Mr Sharpe has not seen this paper of M. Necker, nor examined his sections, otherwise I can hardly imagine that he would have represented, as he has done in his section No. 3, the bedding of the slaty rocks as lying in perfect conformity with the bounding *surface* of the primary nucleus, or, as in section No. 2 (at the Tête Noir), abutting against the same surface at right angles.

But in the paper I have quoted M. Necker has likewise given a section—which I have copied, Plate IX., fig. 1—of the mountains to the south-east of the Valley of Chamouni, showing the fan-shaped structure, and the gradual increase of the dip of the strata as we ascend their slopes. About the middle region the inferior strata (marked A in the figure) are, he says, generally primary slates; but at the two extremities of the valley, near the Col de Balme and Mont Lacha, they are calcareous. At the latter point, he expressly says (p. 32), that the secondary slates are *evidently covered* by the protogine. In his more recent work,† he states that the talc slates, gneiss, and superb protogine, " peuvent être observées avec la plus grand evidence, recouvrant immédiatement, sur une longueur de plusieurs lieues des couches de gypse, du lias, et du calcaire . . . . . comme cela a lieu dans toute la Vallée de Chamouni." Mr Sharpe cites this page; yet he dismisses M. Necker's conclusions, thus deliberately recorded after an interval of thirteen years from his first publication of the facts, in *three lines and a half!*

* Geologie der Schweitz, vol. i., pp. 170, 359.

† Etudes Géologiques sur les Alpes, vol. i. (1841), p. 138.

III. I now come to my own observations made in 1842. I must repeat that Mr Sharpe has mentioned my work with so much courtesy, that I am convinced that only the force of preconception could have led him, and that unintentionally, to complain of want of precision, or of sufficient evidence for facts which I unquestionably saw and proved, but which he, either from haste or some other cause, has been unable to verify. Besides, he has only treated my distinct averments with the same liberties which he has used towards abler and professed geologists; and so far I have no *special* ground of dissatisfaction.

To touch on every point on which Mr Sharpe differs from me would extend this paper too far, and might seem to give an undue importance to my own share of the generalization. The chief points are these,—both connected with the symmetry of arrangement of the granite and lias on the two sides of the chain of Mont Blanc, as compendiously shown in my figure introduced in Plate IX., fig. 2.—(1.) the superposition of granite in the Valley of Chamouni; (2.) that in the Valley of Entrèves, near Courmayeur.

I cannot think that my descriptions are liable to the charge of indefiniteness of reference to the *precise points* where the alleged facts may be ascertained, as stated especially at pages 66 and 210 of my *Travels in the Alps*.

(1.) At Chamouni, p. 66 of *Travels*—" If we continue our survey of the glacier, ascending the ancient moraine of Lavanchi, we reach the rock a little higher than the Pierre de Lisboli, and the rock here is limestone, as already mentioned;" [viz., at page 63, where it is added, " . . . at the foot of the Aiguille du Bochard, on the path leading from the village of Lavanchi to the Chapeau. There is there a lime-kiln, and it is burned for use."] " IT IS JUST IN CONTACT WITH THE GNEISS, WHOSE BEDS LIE SLOPING SOUTHWARDS EXACTLY AT THE SAME ANGLE WITH THE LIMESTONE,—NAMELY, ABOUT 30°. This limestone is no doubt of the same formation with that which has been noticed in other parts of the Valley of Chamouni, and especially by De Saussure, as underlying the gneiss of the Aiguilles opposite Chamouni, towards the hamlet of Blaitière." How, then, does Mr Sharpe treat this specific statement of facts? Could he possibly have missed the way to a point so minutely specified? "On the path,"—a mule-path, too, so he might ride to it; "at a lime-kiln,"—a mark not to be overlooked in a country where lime-kilns are rare; and in proof that the narrator could not have mistaken the nature of the rock, "*it* is burned for use." As to the superposition of the gneiss, can words more expressly affirm that the limestone was *seen* to dip under it, than those which I have printed in small capitals,—the dip of the whole being 30° towards the centre of the chain? But all this goes for nothing with Mr Sharpe, who, it is to be presumed, did not attempt to reach the spot described, but applies to this description his usual flat negative,—"The assertion that the limestone dips under the granite in the Valley of Chamouni is several times repeated by Professor Forbes, but the only points especially mentioned at pp. 63 and 66 *do not justify this conclusion*." There is no possibility of arguing against mere assertions.

I may add, however, that, having referred to my journal, carefully written at the time, I find the section in question twice specially referred to and figured, on the 23d and 28th September 1842. Under the latter date I find the symmetry of the two sides of the Alps indicated by a drawing, of which I give a *fac-simile* in fig. 3, where, as Mr Sharpe will see, I have not neglected to indicate the gneiss interposed between the protogine and limestone. The entries in my journal fully bear out the assertion in my book. They cannot do more.

But, to conclude this head, Mr Sharpe, who quotes Professor Favre of Geneva on the same page, could not but know that, in the very paper which he there cites, M. Favre *had found and verified my section at the lime-kiln under the Aiguille of Lochard*. For connection's sake, I detach this from the other parts of M. Favre's evidence, and I cite it textually in a note.* From this passage it clearly appears—*first*, that M.

* "Dans cette localité . . . . . la structure en éventail est frappante, les couches sont inclinées, comme indique M. Forbes, d'environ 30° au S.E.; les schistes crystallins paraissent plouger sous les roches de crystallisation, et *reposer sur les calcaires dont les couches présentent la même inclinaison*. A la limite des schistes crystallins et du calcaire, on trouve le calcaire cellulaire magnésien, nommé Cargneule, et entre la Cargneule et le schiste crystallin se trouve une

Favre found the junction in the locality indicated; *secondly*, that the dip of the limestones *under* the primary rocks was correctly stated; and, *thirdly*, that the precise contact of the rocks, one superposed on the other, was perfectly apparent, and *that* for some space, since M. Favre describes the minute mineralogical peculiarities observable "along all the line of contact."

(2.) Passing to the similar superposition on the Italian side of the chain, as indicated in my sections, fig. 2 and fig. 4, one of the localities where it was seen by me is thus specifically described at p. 210 of my *Travels*:—"I obtained an excellent section by passing the moraine of the glacier of La Brenva, to the west of Entrèves, and ascending the ravine marked on the sketch, between that village and the glacier. There is there *a complete superposition of gneiss to lias shale*, forming a precise counterpart to that described at p. 67 as occurring under the Aiguille du Bochard. . . . . . In the ravine now mentioned *the junction may be traced for a long way towards the centre of the chain*, the line of contact between the limestone and the overlying protogine or gneiss being inclined in the higher part of the section 38° to the horizon (dipping N.W.), and in the lower part of the section 50°. The strata are therefore bent at the junction, but at a little distance they have a pretty uniform dip of 38°. There is no difficulty in reaching the junction. The limestone-shale is altered and crystalline near the contact. The gneiss is altered also."

How does Mr Sharpe reply to this most articulate statement? In the first place, by telling us what he saw, or at least "satisfied himself of," in a *different* ravine from that indicated,—a ravine, namely, beyond Entrèves, not to the west, and between it and the glacier. "I climbed the ravine," he says, "on the north* side of the village of Entrèves, far enough to satisfy myself that the slates rest against a steep wall of gneiss" (*Memoir*, p. 22). From this it is at least

couche peu épaisse, d'une sorte de kaolin blanc ou verdatre. Cet arrangement se voit sur toute la ligne de contact."—Favre, *Recherches Géologiques dans les Environs de Chamonix*, Bibliothèque Universelle, Avril 1848.

* That is, N.E. from Entrèves, my section being to the S.W. See sketch-map facing p. 210 of *Travels in the Alps*.

evident that Mr Sharpe did not ascend to the point of contact. He does not even say that he saw it. In the next place, after reference to the preceding and other similar passages in my book, he thus disposes of the evidence they contain:—"I can only conclude that this dip of the beds towards the gneiss, coinciding in direction with the dip of the planes of foliation of the gneiss itself, has led our distinguished countryman to a belief in the actual superposition of the gneiss over the slates." How far such a supposition of negligent observation or prejudiced inference on my part is compatible with the precise description of the extract above cited, the reader may judge; but, for Mr Sharpe's satisfaction, I give, in fig. 4, a copy of a sketch made *on the spot* in my pocket-book, under date 12th July 1842, which tallies so precisely with the published account, and is so clearly replaced by it, that I thought it superfluous to introduce the figure in my work. I have an equally distinct section of the junction at Mont Frety, on the ascent of the Col du Géant; but, as it was observed in early twilight, and sketched from memory in my journal a day or two afterwards, I refrain from producing it as evidence stronger than what I have given in the printed account of the ascent; it is also substantially embodied in the section facing p. 210 of my *Travels*.

I shall not enter upon Mr Sharpe's criticism of my description of the granitoid rocks of the Montagne de la Saxe, near Courmayeur, and which, be it remembered, I traced for several miles to the westward at the Col de Checruit, and several miles eastward to the Croix de la Bernada. Mr Sharpe confines his description and criticism to the section close to the high road, concerning which, again, we are not agreed; but as I am substantially supported by the descriptions of De Saussure and of M. Studer,* I shall leave the exactness of Mr Sharpe's comments to be discussed by competent observers on the spot.

* Mr Sharpe finds fault with my calling this mass granitic. I have already observed, that for the convenience of the lithographer, and intending to represent the leading facts only, I did not distinguish granite from gneiss in my plan and section; but at page 211 I have described it as "a great tabular body of imperfect granite, greenish and slaty, and containing an excess of quartz." De Saussure, § 857, calls it "un roc de granitoïde, ou de roche feuilletée semblable

IV. We now come to the remarkable testimony of M. Favre, Professor of Geology at Geneva, as to the position of the secondary rocks at Chamouni. It is contained in a short memoir printed in the *Bibliothèque Universelle* for April 1848, from which I have already cited the confirmation of my own description of the junction below Le Chapeau. In this luminous paper M. Favre gives the results of his most laborious researches on the secondary rocks of the Valley of Chamouni, on *both* sides, and in its entire length. It is not to my present purpose to speak of his interesting and arduous discovery of the anthracite and Jurassic formations on the very summit of the all but inaccessible *Aiguille Rouge*, and of the natural superposition of the latter to the former in the Valley of Chamouni itself, showing that the strata have not been tilted over beyond the position of verticality by the elevatory action of the great chain, but that they were elevated, as M. Necker* believed, by the sole action of the chain of the *Aiguilles Rouges*, and that, strange to say, the influence of the chain of Mont Blanc on the position of these beds has been *simply nothing*.† Of all

à un granit." M. Studer calls it "Felspathschiefer," and, in one place, "unvolkommen Gneiss," and distinctly states that it is a *bed*, "Einlagerung," placed conformably between the calcareous slates, as shown in his figure, p. 175 of the first volume of his *Geology of the Alps*, which quite resembles mine; yet, from the details of the description, it is evidently drawn from his own observations. As to Mr Sharpe's criticism on my description of the beds dipping under Mont Blanc as "limestone," [the term which I used was "limestone shale"] being in fact blue lias containing much clay, and considerably altered, it is really unworthy of notice.

I would invite the attention of geologists to the Mont Chetif. I have not found any description of it beyond the short notices in my work. It seems probable that it is a tabular mass of granite, like its prolongation at La Saxe, that it is connected with the main chain (as shown in the ground-plan in my book), though the union cannot be traced. The junction of limestone and granite might possibly be traced above the Chapel of Berrier, on the north face of the Mont Chetif. Altogether the circuit of this hill from Courmayeur by the Col de Checruit is one of the most interesting and beautiful excursions which can be made.

* I cannot help here noting that, since the publication of M. Favre's paper, M. Necker showed me, at his residence in the Isle of Skye, a drawing, which he had made on the spot, of the summit of the Aiguille Rouge, which he indicated as composed of horizontal secondary beds. But he had been unable to reach them.

† M. Favre's Memoir, p. 23.

this I cannot now speak, but every page of the paper bears witness to the exhaustive nature of M. Favre's researches, and the consequent dependence to be placed on his conclusions. The section (in its south-eastern portion) is copied in Plate IX., fig. 5. As to the superposition of primitive rocks to limestone, he says (p. 8) that he has " examined the junction of those rocks from the Forclaz of Martigny to Mont Lacha, near Les Ouches" [S.W. of Chamouni]. " This junction," he adds, " is visible in a *very great number of localities* [très grand nombre], amongst others, on the right bank of the Glacier des Bois." . . . . He then proceeds to detail my section as quoted above, p. 196, and adds,—" *Cet arrangement se voit sur toute la ligne de contact.* Je l'ai retrouvé au Torrent de la Gria, au Col de Balme, etc., etc." The arrangement is, in fact, the superposition in question.

How, then, does Mr Sharpe eliminate the testimony of the Geneva professor here upon his own ground, and speaking with all the weight due to his great acquirements and industry ? Why, thus ;—" It is evident from these passages that *M. Favre has* NOWHERE SEEN *the crystalline schists of Mont Blanc lying upon the sedimentary beds in the manner represented in the section which accompanies his Memoir !*"

It was this statement, which I will not trust myself to characterize, which, more than any criticism on myself, impelled me, unwillingly, to write these remarks. I leave it to the judgment of competent geologists.

V. M. Studer of Berne, the geologist, of all now living, who has most comprehensively studied the structure of the Alps, published, in 1851 and 1853, a comprehensive work on the Geology of Switzerland, which is quoted by Mr Sharpe. M. Studer professes to borrow his information from all available quarters, and he cites his authorities with becoming precision. But, as Mr Sharpe is probably aware from knowing M. Studer personally, he is no granter of propositions. There is perhaps not an important statement in the book just mentioned, nor an important geological section, which has not been verified by the laborious diligence of the Swiss professor, during more than twenty summers of consecutive travelling amongst the Alps. M. Studer may, therefore, be cited as a competent judge both of the grounds on which the authorities whom he quotes based their conclusions, and of the accuracy of the more important facts which have been at least verified by himself. As we have seen that the force of Mr Sharpe's arguments mainly depend upon showing that previous observers drew conclusions unsupported by sufficient evidence, M. Studer's views are the more important.

To dwell on M. Studer's account of the Valley of Chamouni, would be to repeat unnecessarily what has been already stated at length. I shall cite but one passage. After describing the fan-shaped structure of the mountains to the south-east of Chamouni, he adds,—" Not only does the gneiss dip under the superimposed granitic mass of the higher mountains, but under the gneiss at the foot of the hill lies dipping in the same direction a great series of strata of black slate, *rauchwacke*, gypsum, and dark limestones, and these formations dip also to the south-east; *upon them lies the gneiss, and upon the gneiss the granite.* Also on the opposite side of the chain, from the Glacier of La Brenva far up into the Val Ferret, we find exactly similar relations of the strata. From the foot of the mountain up to about the fourth part of its height, [we find] black slates and limestones, which dip towards N.W. within the hill, and over it protogine with a similar dip, of which the strata become constantly steeper, until at last, at the Col du Géant and in the summits of the chain, they become vertical."* The subsequent passage concerning the environs of Courmayeur (pp. 173–5) has been already referred to, and the observations which it contains are clearly original. The whole is illustrated by the section which I have copied in fig. 6, which clearly enough expresses M. Studer's opinion on the disputed points.

I have thus shown the unanimous consent of geologists, from the time of De Saussure to our own day, as to the super-

* B. Studer, Geologie der Schweitz, vol. i., p. 171–2.

position of the primary to the secondary rocks of Mont Blanc. The progress of observation has merely added to the number of instances, and to the completeness of the proof. Mr Sharpe's determination to see things otherwise is the more surprising, since the phenomena in question are not limited to this part of the Alps, and since, therefore, the theoretical difficulties which they no doubt involve are not to be removed unless Mr Sharpe can also counteract the testimony of geologists as to many parts of the chain both east and west of Mont Blanc.

The superposition of granitoid rocks to limestone in the Bernese Alps had been noticed early in this century by Escher and Studer, fathers of the present eminent Swiss geologists, and studied by MM. Hugi and B. Studer, who published their observations in 1828 and 1829. In fig. 8 I have given M. Hugi's section of the cliffs of the Jungfrau, taken from his *Alpenreise*. About the very same time M. Elie de Beaumont described similar facts occurring in the district of Oisans in Dauphiné, where the character of the rocks approaches very closely indeed to those of Mont Blanc, the granite having a more crystalline structure than in the Bernese Alps. M. Studer's sections in the Urbachthal, at the Mettenberg and Jungfrau, with others equally remarkable, may be found in his *Geology of Switzerland*, vol. i., p. 178, 186 ; vol. ii., p. 167 : M. Elie de Beaumont's, in the fifth volume of the third series of the *Annales des Mines*, from which I borrow one section of the contact of limestone and granite (Plate IX., fig. 9), at Villard d'Areine in Dauphiné. In these various sections the stratification of the limestone rock is almost invariably parallel to its plane of junction with granite, and the superposition of the secondary beds to one another is well defined. Mr Sharpe may indeed affirm, if he please, that these are mere cleavage planes, but it is difficult to believe that the most eminent living geologists are as ignorant of the distinction as his descriptions would infer.

Any one, indeed, is entitled to controvert opinions, however reiterated, put forth on authority however eminent. But he is bound to make out a *primâ facie* case by proving that he has studied the writings of his predecessors with impartiality, and that he has examined the facts adduced by them with a care and industry equal to their own. I submit that Mr Sharpe has done neither. On the second page of his Memoir he informs us that "the time at his disposal only allowed him to take a hasty view of the principal phenomena," and that he in fact only "devoted *ten days* to the environs of Mont Blanc." It is not too much to affirm that M. Necker must have spent at least as much time in the examination of the Valorsine sections alone as Mr Sharpe did to the whole of Savoy. I can say for myself that I spent in *one summer* out of several in which I have visited Courmayeur a considerably longer time in examining the environs of that place; and I think I may venture to affirm that M. Favre has spent as many weeks as Mr Sharpe occupied days in the region about Chamouni. When we farther remember that the circuit of Mont Blanc is reckoned at about forty leagues of the country; and when we see in Mr Sharpe's paper transverse sections to the extent of nearly sixty English miles across some of the most rugged and geologically intricate country in Europe,—all executed within these ten days,—we must own that he has improved upon De Saussure's warning, with which he concludes his essay,—"Ce n'est pas avec des microscopes qu'il faut observer les montagnes."

EDINBURGH, 1*st January* 1856.

On a Specimen of Native Iron, from Liberia, Africa. By A. A. Hayes, M.D., Assayer to the State of Massachusetts.*

It is with pleasure that I submit to the inspection of the Academy, a specimen of native iron from Liberia, believed to have been taken from the tract of country bordering on St John's River, recently acquired by the New Jersey Colony. This specimen was placed in my hands for examination by the Rev. Joseph Tracy, Secretary of the Massachusetts Colonization Society, and its physical characters at once arrested my attention, as differing from those of any artificially-produced iron. As I deem the discovery of native iron existing unalloyed a matter of much interest to naturalists and chemists, it is proper that the evidence on which the statement rests should be submitted somewhat in detail. In the *African Repository*, vol. xxx., No. 8, August 1854, at page 240, is a letter from Rev. Aaron P. Davis, a resident missionary at Bassa Cove, from which the following extracts are taken.

"I send you a piece of African *ore*, in the state in which it is dug from its native bed, or broken from among rocks. I have seen and conversed with a number of natives, who affirm that it is actually the pure ore, as taken from its native bed. I obtained a piece from Hon. Geo. L. Seymour, who had tried in vain to analyse it, and he brought it to my shop for that purpose. When he brought it, it appeared like a craggy rock, of a yellowish colour on its surface, and, with a very small exception, it could not be separated but by heat, and hard pounding with my largest sledge-hammer, and a chisel prepared for the purpose. I also send you a tea-spoon which I made of some of the ore, which, in its crude state, is superior to the iron brought here for sale by the English merchant vessels.

"I am told by the natives that it is plentiful, and that about three days' walk from our present place of residence (Bassa Cove) it is got by digging and breaking rocks. It is also said to be in large lumps. In these parts the natives buy no

* Read before the American Academy of Sciences.

iron, but dig it out of the ground, or break the rocks and get at it, as the case may be."

The larger specimen before you, when received by me, bore on one side the impress of the chisel, the coarse fracturing of a tough metal, and marks of oxidation by fire; it was further identified by Wm. Coppinger, Esq., of Philadelphia, as the piece received with the letter of Mr Davis. Mr Coppinger gave the specimen to Rev. H. M. Blodgett, who sent it to Rev. Joseph Tracey, from whose hands I received it. Soon after I had expressed to Mr Tracey my belief that it was native iron, he placed before me a large amount of written evidence, showing that malleable iron, sufficient in quantity to meet the wants of the natives, is obtained by heating and then by fracturing the rocks of the country. The writers use the term *ore* incorrectly, as Mr Davis does, apparently in the belief that iron ore increasing in richness becomes malleable. Their metallurgical knowledge is so limited, that they are unable to produce copper from the carbonate of copper (malachite), which they carry five or six hundred miles as a medium of traffic; while their weapons of iron, which I have examined, show the characters of native iron after it has been heated and hammered.

Physical Characters.

On developing the internal structure of the mass of iron, by immersion for a few moments in strong nitric acid, and immediately after washing in a mixture of lime and water, it was apparent that the minute crystalline particles were arranged in a manner closely resembling those of the pure iron in meteoric iron, and entirely unlike the particles in artificial iron.*

* The character which is here noted has a higher value, in a research of this kind, than would have been inferred from a cursory examination. In a description of the remarkable meteoric iron, published in the American Journal of Science, Nov. 1844, I alluded to the fact, that these masses are not made up of iron alloyed with nickel and other metals, but consist of *pure iron*, through which are mixed portions of an alloy of nickel and iron, and iron and nickel, and other bodies, as distinct *electro-negative matter*, in relation to the pure iron.

The Texas meteoric mass, and the small particles of the Weston meteorolite, Where the mass had been heated, and had received blows, there was an approach to the appearance presented by artificial iron; but the internal parts, and nearly the whole of the mass, showed no marks of percussive or laminating action. By the more complete development of the structure, certain points appeared, which were evidently extraneous matter. Under the microscope these points showed crystalline minerals, which, when separated, proved to be quartz and octahedral oxide of iron. A mineral with a lime and soda base was also found. The iron was most readily acted on by chemical agents where it was in contact with these minerals: exposure of a surface to the action of an acid, not only brought them to view, but produced cavities at the points where they existed, showing degrees of porosity, influenced by their number. The specific gravity of the most compact portion was 6·708. Its

had the same mechanical constitution. Since the first publication of my results, the researches have been extended, so as to include the metals of commerce, and the well-known alloys. The numerous analyses made of these forms of matter have not yet shown an exception to the condition, that the metal existing in the largest proportion is in part pure, while one, two, three, or more alloys may exist distributed through it. When we take the results furnished by a mass of crude iron in the state of pig-iron, and by portions of the less and more malleable iron of the different steps of the manufacture, we not only pursue the constituents chemically, but the mechanical state of the iron is at the same time open to view. A mass of pig-iron thus becomes associated with meteoric iron, in the mechanical arrangements of its parts, and generally consists of perfectly pure and malleable iron, disturbed in the arrangement of its crystalline particles, by the interposition among them of a compound of iron and carbon, and of graphitic carbon, besides sulphides, phosphides, and arsenides, of the alkaline metals. In the ductile iron, these bodies have been nearly all removed by heat and mechanical operations, and new features impressed upon the metal. By simply removing the interposed foreign matter, by chemical means solely, crude iron is left malleable, and its particles then show their sub-crystalline forms, but not as they exist in the pure iron of the more perfect meteoric masses. All manufactured iron presents them arranged in lines, and interlaced by the action of the hammer, or extended in bundles, in the act of drawing, while the laminating mill breaks them down, shingling them over, and felting together their serrated edges, in striking analogy of effect to the operations of textile manufacturing. The mechanical texture of a mass of iron cannot be shown fully by the simple step of immersion, as above given; but this is sufficient to enable one to observe whether the crystals have arranged themselves as aggregates, or have been broken up and disturbed by violence; and often will serve to show the kind of mechanical action employed.

colour lighter gray than any sample of artificial ductile iron I have seen. Repeated bending back upon itself did not separate one fragment, but generally flaws would appear, and these portions break when doubled close. The presence of the minerals embedded is felt, when we file or saw the metal; but when heated and hammered, these fuse into slags, and the metal spreads and draws off like the best irons, yet showing the cavities and flaws where the simple mineral had existed.

Chemical Characters.

It dissolves with effervescence in diluted hydrochloric acid, and if the acid and water are perfectly pure, the evolved gas has no odour. I dissolved 200 grains in hydrochloric acid. The hydrogen gas was passed through pure alcohol, kept cool, and was then allowed to bubble through an ammoniacal solution of nitrate of silver. The alcohol had not acquired odour, nor was there any coloration or change in the silver solution.

The solution of iron was turbid, but soon deposited suspended matter, which was light-gray coloured; some heavy, white, sandy grains, and some dark, nearly black, particles had fallen. After collecting and drying these substances, they were placed under the microscope, which showed the heavier bodies to be quartz, with some facets and fragments of octahedral crystals, proved to be magnetic iron ore. The light body was silicic acid, rendered gray by iron oxide.

Chlorine was passed into the filtered iron solution, which, after being heated and cooled, was precipitated in a partly-closed flask, by gaseous ammonia passed into it in excess. After being heated by a vapour-bath, the precipitate was separated by filter and washed.

The filtrate and washings evaporated were reduced to a dry mass, which afforded a minute quantity of soda and lime; no other substance was present.

Separate parcels of the precipitate by ammonia were used for the detection of phosphorus, arsenic, and boron, alumina, and other earths and oxides; a little silicic acid only was found.

Fifty grains of the filings of the iron were wet with a few drops of perfectly caustic soda solution, mixed hastily with crystals of pure nitrate of soda and chloride of potash, and heated (twenty minutes) in a nearly-closed platinum crucible, rapidly to bright redness, no deflagration occurred, and the fused salts were colourless. The crucible after cooling, digested in a close vessel with recently-boiled pure water, gave its soluble part to the water. After subsidence, the clear fluid was added to a dilute saturated solution of lime in ammonia in one vessel, and to a dilute solution of baryta in another. These vessels were closed and left twelve hours, and then presented nearly transparent solutions; no precipitates had fallen, but both showed the presence of silicic acid.

The absence of sulphur and carbon was thus proved, and other trials confirmed these results.

Analysis.

In the following analysis, and in repetitions, different slabs of the metal were used, so as to obtain an average per-centage composition of the mass.

A solution in pure water of about 150 grains of pure sulphate of copper was used as a medium, in which the iron dissolved replaced, by electrolysis, the copper deposited on the negative electrode of platinum, connected with a small constant battery; 26·30 grs. of iron solved in the fluid, and 29·78 grs. of copper were deposited on the platinum, while 0·32 of matter was precipitated. The equivalent of pure iron being 28·0, the deposit of copper should have weighed 29·71, an accordance as near as the experiments allow. 0·32 grains of matter consisted of angular portions of quartz, fragments of crystals of magnetic iron ore, and a flock of silica; no trace of carbon was observed under the microscope. 26·60 grs. were the total loss from the iron. The partly-ferruginous solution, decomposed by an excess of hydrosulphuric acid, evaporated, and calcined, afforded barely traces of lime and soda, which, in every case, have been known to result from the solution of this iron. A sample of 100 parts of this iron, therefore, consists of—

Pure iron, ...	98·87
Quartz, iron ore, and silicate, . . .	1·13
	100·

Another sample, more nearly an average, from the centre of the mass, afforded in 100 parts—

Pure iron, ...	98·40
Quartz crystals, magnetic iron ore, and silicate of soda and lime, ...	1·60
	100·

The little slabs, which had been the positive electrodes, had not disengaged a bubble of gas, which always occurs when the metals affording alkaline bases are alloyed. They also exhibited, in their substance, the cavities which had contained the mineral bodies found.

I was desirous of making some comparative experiments on a specimen of iron, having the characters of native iron, as distinguished from meteoric iron. My friend Prof. B. Silliman jun., kindly supplied me with two slips, from the specimen well known as having been found at Canaan, Connecticut. He expressed to me, at the time, a doubt respecting the certainty of this mass being native iron. On subjecting this specimen to analytical trials, it was soon determined that it is an alloy, consisting of iron, iron and carbon, and pure graphite. 100 parts afforded—

Pure iron, . . .	93·057
Iron and carbon, . .	2·666
Iron from carbon, . .	1·361
Graphite, . . .	2·916
	100·

In the arrangement of the alloy of carbon and iron and the lamina of graphite, it differed in no respect from "kisky" iron, which has been allowed to repose in a heated state, and is unquestionably an artificial iron, a product of the blast furnace.

16 Boylston Street, Boston,
July 1855.

On the form of the Curve resulting from the binocular union of a Straight Line with a Circular Arc, or of two equal Circular Arcs with one another. By Professor WILLIAM B. ROGERS.

A. Binocular resultant of a Straight Line and a Circular Arc.

Assuming the optical centres of the two eyes L and R, figs. 1 and 2, as fixed during the act of combination, it is evident that the centre of the eye directed to the circular arc *ab* or AB may be regarded as the vertex of a cone whose surface includes all the positions of the optical axis of that eye as successively directed to the different points of the arc. This cone will of course be right or oblique according to the direction, in relation to the plane of the paper, of the line joining the optical centre with the centre of the circle of which the arc is a part. The axis of the other eye in ranging from end to end of the vertical line *cd* or CD vibrates in a plane RCD, which, during the binocular combination, intersects the conical surface in an attitude depending on the distance between the optical centres, the place of the diagrams and the relative position of the component lines *ab*, *cd*, or AB, CD.

The two optical axes directed each moment to corresponding points of the vertical line and the arc, as *m*, *n*; *a*, *c*; *b*, *d* or M, N; A, C; B, D, &c., meet in the conical surface, forming optically a series of resultant points *v*, *s*, *r*, &c., which together constitute the binocular resultant curve. *This curve must therefore be a conic section*, the nature of which will depend on the direction of the cutting plane in reference to the conical surface. The effects of the several conditions of the experiment will be seen more clearly by considering separately each of the following cases, which, taken together, include all the variations that can occur.

First, When the arc is *convex* towards the right line, and the two are combined by directing the optic axis *beyond* the plane of the diagram.

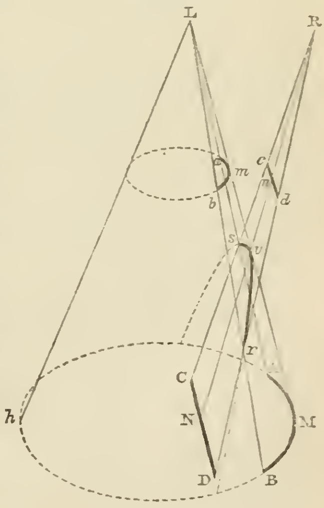
These conditions are represented in the upper part of fig. 1. Here the arc *ab* and right line *cd* have for their binocular resultant the curve *rvs*. Since the points *m* and *n* unite optically at a less distance behind the diagram than any other pair of corresponding points in *ab* and *cd*, it follows that the vertex *v* in which they combine must be the point of the resultant curve nearest to the observer, and as this curve lies wholly in the plane RCD, it must therefore present its convexity *obliquely forwards.*

According to the proportions assumed in the figure, the line R*v*N is more steeply inclined than the line L*r* to the base of the cone, and in these conditions therefore the curve *rvs* is an hyperbola. But by placing *ab* and *cd* a little nearer one another we may cause RN to become parallel to L*h*, in which arrangement the resultant will be a parabola; and if we bring *ab* and *cd* still nearer together so as to make RN converge downwards towards L*h*, we transform the curve *rvs* into an arc of an ellipse. In the conditions included in the first case therefore the binocular resultant may have the form of either of the curves just mentioned.

Second, When the circular arc is *concave* towards the right line, and the two are united in *front* of the plane of the diagram.

This case is represented in the lower part of fig. 1. Here the component lines are the circular arc AB and the right line CD, which by cross-vision are made to unite in front of the plane in which they are placed during the experiment. The resultant curve *rvs* will evidently vary in form according to the distance between AB and CD. As shown in the figure this curve is an hyperbola, but by increasing the interval between AB and CD it may be converted into a parabola or into the arc of an ellipse. Thus in the conditions of the second case also the binocular resultant may have the form of either of these curves.

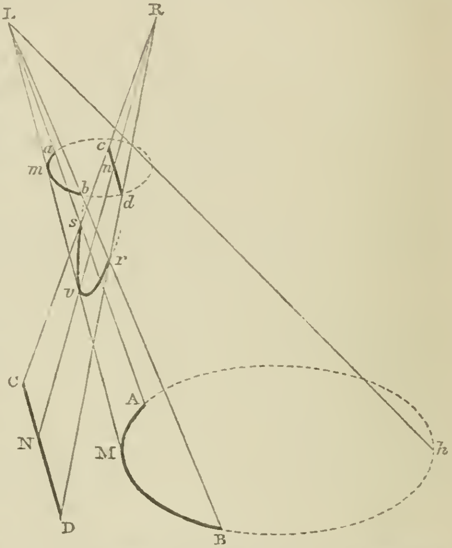
Fig. 1.



Third, When the circular arc is *concave* towards the right line, and the two are binocularly combined *behind* the plane of the drawing.

The combination here specified is shown in the upper part of fig. 2. In this case the vertex of the resultant curve *rvs* being formed by the optical union of the two points *m* and *n* of the component lines which are farthest apart, must be at a greater distance behind the plane of these lines than any other point of the resultant. Hence, and because the curve *rvs* lies entirely in the plane of RCD, it must always turn its convexity *obliquely away* from the observer. As the optical conditions here supposed require that R*n* produced shall intersect L*m* produced, it follows that the plane R*cd* when extended will pass entirely through the cone. In this case therefore the resultant curve can never be either an hyperbola or parabola, but must be an elliptic arc, varying in form according to the interval between *ab* and *cd*. Where the visual cone is oblique, as is most likely to happen, the curve *rvs* will, of course, become an arc of a circle whenever the cutting plane takes the position of the subcontrary section.

Fig. 2.



Fourth, When the circular arc is *convex* towards the right line, and the two are combined in *front* of the plane of the diagram.

The conditions here referred to are exhibited in the lower part of fig. 2. In this case AB and CD are the component arc and right line, and *rvs* is their binocular resultant, formed by cross-vision in front of the plane in which they are presented to the observer. Since in this mode of combination the optic axes are required, for all points of the resultant, to intersect somewhere between the plane of ABCD and the eyes, it is evident that the plane RCD must pass entirely through the cone. Hence the resultant curve *rvs* must be an arc of an ellipse. As in the preceding case the form of the ellipse will vary with the distance between AB and CD, and it will become circular in the position of the sub-contrary section.

These various effects of the binocular union of a right line with a circular arc may be thus summed up :—

(*a*). When the arc is *convex* to the right line and the union is effected *beyond* the plane of the diagram, or when the arc is *concave* to the line and they are combined *in front* of the diagram, the binocular resultant may be either an *ellipse*, a *parabola*, or an *hyperbola ;* but in either case it will turn its *convexity obliquely towards the observer.*

(*b*). When the arc is *concave* to the right line, and they are united *beyond* the plane of the diagram, or where it is *convex* to the line, and they are combined *in front* of the diagram, the binocular resultant is always an *arc of an ellipse* turning its *convexity obliquely away from the observer.*

B. *Binocular resultant of two Circular Arcs.*

In this as in the preceding combinations the optical centres are to be regarded as immoveable during the experiment. Each eye, while viewing the successive points of the arc presented to it, revolves in such manner as to carry its optical axis around in a conical surface. Thus two conical surfaces are generated, having for their respective apices the centres of the two eyes, and including all the directions which the optical axes assume in combining the successive pairs of corresponding points of the circular arcs. In general terms, therefore, *the binocular resultant in all such cases may be described as the curve line in which the surfaces of the two visual cones intersect one another.*

It is only, however, under special conditions that the resultant thus formed is a *plane curve;* when the circular arcs presented to the two eyes are of unequal curvature, the visual cones, by their intersection, produce a curve which cannot be included in a plane, but lies in an inflected surface, and this accordingly is the form which the resultant takes whenever circular arcs of unlike curvature are combined either with or without a stereoscope.

In what follows the figure and position of the resultant will be considered under the simplest conditions, viz., when the circular arcs have equal curvature, and are so placed that the intersecting conical surfaces are precisely alike.

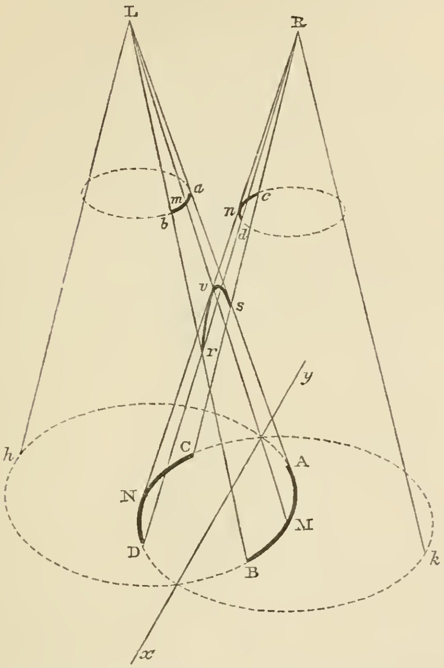
These conditions are represented in figs. 3 and 4, where the circular arcs *ab* and AB are respectively of the same length and curvature as *cd* and CD, and are supposed to be so placed that the visual lines directed to the several points of one arc shall be equal to those which are directed to the similar points of the corresponding arc; thus making L*a*, L*m*, L*b*, &c., respectively equal to R*c*, R*n*, R*d*, &c.; and in like manner LA, LM, LB equal to RC, RM, RD.

From this construction it follows that the corresponding or intersecting visual lines LA and RC, LM and RN, &c., are equally and oppositely inclined to the plane of ABCD or *abcd*. Hence each point of the resultant curve, as *r*, *v*, or *s*, is placed at the apex of an isosceles triangle D*r*B, N*v*M or C*s*A, formed by the lower segments of the visual lines.

Let us now assume a line *xy* midway between M and N, and parallel to tangents at these points, and let us imagine a vertical plane, including this line, to extend indefinitely upwards. Since *v* is vertically over the middle of MN, and *r*, *s* and the other points of the resultant *rvs* are similarly situated in regard to lines parallel to MN and connecting the two arcs, it follows that *v*, *r*, *s*, &c., are situated vertically above the line *xy*, and, therefore, that the *resultant curve* lies in the before-mentioned *vertical plane.*

In combinations of this kind, as in the case of the right line and circular arc before explained, the particular form and attitude of the resultant will depend on the aspect in which the two arcs are presented to one another, and the place, in regard to the plane of the diagram, in which they are combined. In fig. 3 we have the resultant as produced either by

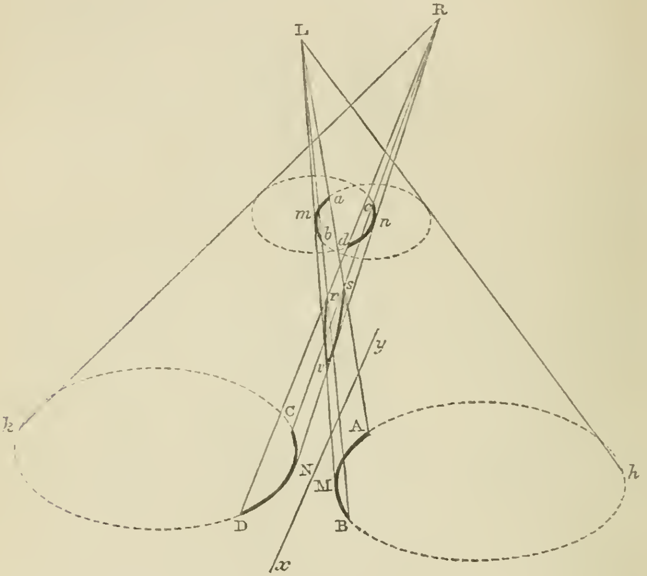
Fig. 3.



the union of mutually convex arcs beyond the plane in which they are situated, or of concave ones in front of it. In fig. 4 we see the resultant of mutually concave arcs behind or of convex ones in front of the plane of the components.

In the former case, the resultant curve as represented in the figure, is an hyperbola. But if we suppose the component arcs to be so placed that the outer sides L*h*, R*k* of the visual cones are vertical, the resultant becomes a parabola; and if we imagine this change to be carried so far as to make these sides converge downwards, the resultant takes the form of an arc of an ellipse. As *m* and *n* are the points of the upper component arcs which are nearest together, their resultant point *v*, the vertex of the resultant curve, must be nearer the observer than any other part of the curve; and the same conclusion follows from considering *v* as the binocular resultant of M and N, the points of the lower component arcs which are farthest from one another. Hence in both cases the resultant curve must be convex towards the observer.

Fig. 4.



In the conditions of union represented in fig. 4 the vertical plane extending upwards from *xy* must necessarily pass entirely through both of the visual cones. Hence the resultant curve *rvs*, which is at the same time the line of intersection of the two conical surfaces with one another, and that of the vertical plane with each surface, cannot be a parabola or hyperbola, but must always be an arc of an ellipse. From the construction, it is evident that *v*, the resultant of *m* and *n*, the points of the upper component arcs which are farthest apart, must be the point of the resultant curve *rvs*, which is most distant from the observer, and, therefore, that this curve will present its concavity towards the observer.

These several effects of the binocular union of circular arcs of equal length and curvature may be thus summed up:—

(*a.*) When the arcs are *convex* to one another and they are combined *behind* the plane of the components, or when they are *concave* to one another and combined *in front* of this plane, *the resultant may be either an hyperbola, parabola or ellipse, but in either case it will be convex towards the observer, and situated in a vertical plane.*

(*b.*) When the arcs are *concave* to one another and are combined *behind* the plane of the components, or when they are *convex* to one another and combined *in front* of this plane, *the resultant is always an arc of an ellipse concave towards the observer, and situated in a vertical plane.*

It is scarcely necessary to add that, in either of these cases, as in the combination of the right line and circular arc, whenever the resultant curve takes the position of the sub-contrary section, it becomes the arc of a circle.

Astronomical Contradictions and Geological Inferences respecting a Plurality of Worlds.

Conclusion.

So numerous and varied are the phenomena to be examined from the close of the Palæozoic epoch, to that period when man and his contemporary animals appear upon the scene, that it is impossible to do more with the question before us, than review, very shortly, a few of the leading principles and inferences to be derived from a consideration of Neozoic Geology.

Whatever may be the truth of Professor E. Forbes's theory of "polarity," there are, without doubt, very striking general modifications in the various orders of animal and vegetable existences that flourished in different epochs. Once pass the PALÆOZOIC zone, and, in the succeeding geological eras, all the SPECIES both of plants and animals are changed. The fish, crustaceans and molluscs, of the Triassic epoch are all *new*, and the vegetation altogether dissimilar to that of the Palæozoic periods. The quadripartite arrangement of the lamellæ of Palæozoic corals is succeeded by the sextuple arrangement of the Neozoic type, "only one exception having as yet occurred of a quadripartite coral in a Neozoic formation."—(Lyell's *Manual of Geol.*, 5th Ed., 408.) The Graptolite, Trilobite, Orthoceratite, and Heterocercal type of fish, with the Palæozoic plants, vanish from the scene. The Vestigian theory respecting the development of organic life has long since been demolished, for both plants and animals of high organization occur in strata of very high antiquity, and it is probable that many more will be discovered. Many of these animals possess a physical structure as wonderful as our own, and furnish as certain evidences of DESIGN. The Earth, the seat of animal life *millions* of years before the secondary types of life appear, affords evidence of the same principles of structure, the same unity of purpose, and bears the impress of the same Almighty hand. Periods arrived when the existing order of things was changed. Races very closely resembling, but by no means identical, peopled this earth, in the places of those that were gone, while other tribes of beautiful and highly organized creatures were from period to period introduced. We have evidence that when the surface of this planet was fitted to sustain animal life, animal life was created; and that even the primeval solid framework, the consolidated crust, had its evident *Adaptation* and *Design*.

The Palæozoic periods, and myriads of Palæozoic animals, passed away. Physical changes went on; the solid rock was ground down, deposited in ocean depths, and again consolidated and upheaved; continents became ocean beds, and ocean beds were elevated into dry land. The forests of Palæozoic ages are converted into coal; they fulfilled their purpose for the periods during which they existed, and were succeeded by the Voltzias and Equisetites of the Trias, and the Cycads and Conifers of the Oolite. The Virginian coal-measures of America belong to the age of the Oolite; and the steamer that crosses the Atlantic with its human freight is impelled by the remains of Oolitic acrogens, as well as those of Palæozoic ferns. The brown coal of Germany is of the Eocene and Miocene epochs, and the molasse coal of Switzerland has been determined by M. Heer of Zurich, and M. De la Harpe of Lausanne, to be made up of species of plants allied to our oak, beech, willow, and ash. Thus the remains of vegetable worlds, separated in time by myriads of years, contribute their fossil fuel to the wants and comforts of man.

We pass by the revelations of the microscope respecting the polieschiefer of Bohemia, and mountains of chalk and indusial limestones, made up entirely of animal remains. These are old tales, known to every tyro in geology, and the author of the Essay would consider them only fit for VENUS! One word, however, on the Tertiary epochs, when thousands and thousands of beautiful and active creatures of the highest organization enjoyed their appointed life, long before man was formed of the dust of the ancient earth.

What shall we say of the accumulated changes in the creation of animals and vegetables *since* the deposition of the Eocene strata, the tribes of magnificent and gigantic quadrupeds that have become extinct? What of the Megatheroid animals—the megatherium, megalonyx, and scelidotherium? What of the toxodon, that enormous gnawer, whose size equalled the elephant and megatherium; or the mylodon, or macrauchenia, or any one of those nine magnificent quadrupeds whose remains Mr Darwin found imbedded "within the space of about 200 yards square."—(See Darwin's *Journal of the Beagle.*) Animal life was on the *grandest* scale between the Eocene and recent periods. The dinotherium and mastodon, and the restored pachydermata of Cuvier, and a thousand others, were created for some purpose or other, besides that of exercising the genius of an Owen or a Cuvier! Are we to believe, with the author of the Essay, that all these splendid developments of Creative Power were merely "brutes" that "can hardly be said to have lived?" On the contrary, we cannot but re-echo the words of Sir D. Brewster, in his paper "On the Triple Spectrum," read at Glasgow:—"How strange is it that individuals are found who rejoice in the subversion of scientific doctrines which they never have examined, and by the truth or incorrectness of which neither their feelings nor their characters are affected!" Thus, when the geologist is told that he is to consider this planet an "abortive world" until man's creation, it is no great wonder if he doubts the author's astronomy, opens his eyes wider and wider at his PECULIAR ideas of Divine design, and joins in the pleasantry of the writer in the *Times*, when he remarks, that our author shows "agility and fun," "in calculating the force of gravity in Jupiter," and, "the extreme inconvenience which would be felt by a stout gentleman in that planet when the horrible fact burst on him THAT HE WAS BEING MULTIPLIED BY TWO AND A HALF." Seriously, stripped bare of its verbosity, what does common sense tell us is the tendency of the author's doctrine? Nothing more or less than an arrangement such as follows:—

Palæozoic and Neozoic Creation,	*The Universe,*
with the exception of the human race, "Brutes that can scarcely be said to have lived."	with the exception of this earth, "slag," or perhaps masses, with "pulpy, watery creatures."

This leads us to a consideration of the doctrine of "waste."

That the existence of all living creatures up to man's creation is of very small account, and the material universe, with the exception of our planet, only "stone and vapour," is certainly most vividly expressed in the Essay. We are, however, told, that when the author speaks of "wasted means in the works of creation—of failure in some parts of its plan—of several sketches of which only one has been completed;" "such expressions imply the ignorance and blindness of man," and "they do not imply any imperfection in the Almighty's works." "Consistently with the attributes of God," "corals and oysters and sponges" may be regarded "as good employment of a spot of land or water." "All the planets, all parts of the universe, we have good reason to believe, are pervaded by attraction, by forces of aggregation and atomic relation, by light and heat. Why may not these be sufficient to prevent the space being wasted in the EYES OF THE CREATOR?" "Is waste of this kind considered as unsuited to the character of the Creator?"—"we have the like WASTE in the occupation of this earth;"—"all its previous ages, &c., have been wasted upon mere brute life." We are then asked, "Can it surprise us that we do not fully understand this work?" Yet, strangest of all the inconsistencies of this Essay, we are told in another place, "THAT THE MIND of MAN has some community WITH THE MIND of GOD; and however remote and imperfect this community may be, it must be real!" All the "slag," and "brute life," in the eyes of the author, is not real waste in the EYES OF GOD; it is only in OUR opinion, only as far as WE can see, that every other planet IS wasted, and that this HAS BEEN wasted upon corals, sponges, &c., for millions of years. What CAN the author mean by the mind of man having community with the mind of God? Is that which the author believes to be waste—downright waste, and nothing else—PERFECTION in the eyes of the Almighty? Alas for the "*noble*" and "*spiritual*" creature!

What, we ask, CAN be the condition of man upon earth, what the "condition of his intellectual progress," upon which the author insists so vehemently—where the much-talked-of "special guidance and governance" exercised over the race by the Author of his being—if the brightest intellects the world ever saw believe in a universe crowded with splendour and filled with the energy of the Most High, believe in other worlds of life and intelligence, and other celestial orbs teeming with animation, when they ought to believe them to be the VERIEST RUBBISH of the volcano's vent?

Again, as regards the geology of the Essay, we should like to see the geologist who can explain one iota of the records of his science with such ideas as the author presents to our minds. "Can the pious man see plainly how EVERY THING has its use?" Will the author favour us with indicating any SINGLE CREATED THING, from the animalcule to the elephant, independent of man, that had its use or purpose according to his theory?

He has indeed advocated the doctrine of waste! There is geological waste and astronomical waste; and turn the expression as you please, waste and failure, as regards every created animal or created world, save man and this planet, is the doctrine of the *Essay on the Plurality of Worlds.*

Fortunately for us all, there are astronomical contradictions; and great men and wise men and good men differ *in toto et extremis* from the author! Nevertheless, without a vast improvement in telescopes and astronomical apparatus, it does not seem very probable that astronomers, differ as they may, will ever settle for us whether the planets, &c., are inhabited or not. When we refer, however, to the past history of our own planet, and reflect that for myriads of years this earth has been the dwelling-place of living things—that with the first evidences of land and water, the first evidences also of organized creatures make their appearance—that different races of animals were adapted to different climates and different physical circumstances—it is impossible to avoid the conclusion, especially when we recall the almost universal belief and statements of astronomers, that there *must* be a certain analogy between this earth and the other planets as regards their adaptation to life and their progression in time. Suppose we agree with the author of the Essay "that this earth, until the existence of man, was a world of mere brute creatures," our geological knowledge would at once prevent our drawing the author's inferences as regards other planets.

If the "slag" of this planet was adapted to the earliest creatures, it would be surely contrary to analogy to argue that the "slag" of every other orb was adapted to *nothing!*

Supposing that all the previous ages of this earth were "wasted in brute life," our teaching from geology would lead us to expect an analogous introduction of brute life on other spheres, if the conditions of life were there. If we are to argue from analogy at all, we must have LIFE for our sister planets, if nine-tenths of what astronomers teach be true. LIFE once granted, we believe geology, in conjunction with astronomy, will furnish powerful arguments for the creation of intellectuality also.

Geological Inferences on the Argument from Design.

"The proof of design," says our author, "as shown in the works of creation, is seen most clearly, not in mere *physical arrangements*, but in the structure of organized things, in the constitution of plants and animals."

"The evidence of design in the inorganic world, in the relation of earth, air, water, heat and light, is to most persons less striking and impressive, than it is in the organic creation." Nevertheless, whatever may have been the first conditions of the solar system, whenever or however created, these physical elements probably had a date previous to the creation of animal life. No astronomer questions the fact that the solar system, the fixed stars, and the binary system, in short, the universe, were in existence before the first organisms of earth.

One hundred million of stars, as seen by the telescope, are believed by many astronomers to be the suns of other systems whose planets are invisible from their distance.—(*More Worlds than One*, p. 163.)

We must consider, then, these "physical elements," and trace this enormous history of the heavens—we must reflect on this awful grandeur of the *material* universe—before we speculate on the organisms of our own globe; and we say that we must learn to trace the highest proofs of design as shown in the creation of celestial bodies—design in "mere physical arrangements"—before we can expect to read the history of a single plant or animal of earth.

"A planet," we read, "as to its brute mass, has really nothing in common with a seed or an embryo. It has no organization or tendency to organization; no principle of life, however obscure." Nevertheless, it is certain that the Creator thought fit to fill space with unnumbered and MATERIAL structures, and to light many of those of our own system with gorgeous satellites, before he clothed our own "brute mass" with vegetables, or stocked it with animals.

"No accumulation of material grandeur, even if it fill the universe, has any dignity in our eyes, compared with moral grandeur." By MORAL GRANDEUR, we suppose the author of the Essay to mean the moral nature of man, as he allows no other intellectual being. Man is of *very* recent creation, compared with very recent geological changes; equally recent therefore must be the author's *moral grandeur*.

"If there be a world of mind, that, according to all that we can conceive, must have been better worth creating; it must be more worthy to exist, as an object of care in the eyes of the Creator, than thousands and millions of stars and planets, even if they were occupied by a myriad times as many species of brute animals as have lived upon the earth since its vivification." We know that thousands and millions of stars and planets were created. We know that this earth, at least, was occupied by myriads of animals for unnumbered ages before man's creation.

We are told that "the majesty of God does not reside in planets and stars, in orbs and systems; which are, after all, only stone and vapour, materials and means." The majesty of God cannot either reside in "brute animals." With our geological knowledge, as to the introduction of the human race, perhaps the author of the Essay, who has written so boldly upon creation, would kindly inform us IN WHAT the majesty of God did reside for the eternity that is past?

We THANK the author for his Essay. We believe that no book that ever was penned is more calculated to promote a belief in the "plurality of worlds," at least among geologists. There *must have been a world of mind;* there must have been intelligence; there must have been beings to adore and in a degree comprehend the glorious Most High. The infinite skill that produced such variety of life has not been lost; the works and ways of God have not been "wasted" ever since creation's dawn, and the Maker of the universe has not left creation without MIND. But we know that such intelligence was not here on our earth until within a very late period; there WERE no beings who could recognise the Creator, ON THIS PLANET. The geologist has learned too much of the ways and works of God, to allow him for a moment to concentrate all the energies of his Maker upon himself and the little period of the human race. A light from the contradictions of astronomers sheds its gleam upon his path! Among the thousands and millions of stars and planets, *some* must have been WORLDS OF MIND. "One star differeth from another star in glory." We are not bound to believe that Jupiter and his Moons, Saturn and his Rings, Mars with his "continents, oceans, and green savannahs," are all "merry-go-rounds," just because the author thinks so! One of our geological INFERENCES, therefore, from the author's chapter on "Design," is, that as some of the celestial orbs are considered, by ninety-nine out of one hundred astronomers, of superior construction to our own planet, and possibly of earlier creation, it is more than probable they are tenanted by INTELLECTUAL beings, and that the Great Eternal Mind did not leave the universe blank of intelligence until the creation of the human race. We have several times alluded to the proofs of DESIGN even in the mineral masses of the earth's crust, but have not advanced one hundredth part of what might have been urged respecting the design evidenced in the different animal creations revealed by geology; much more than our limited space would fail us, if we entered upon this subject in all its fulness.

As geologists, we see no reason why the same design, the same development, the same progress, we are taught by our science was bestowed upon our own planet, was not bestowed upon every other planet in our system. We would, however, shortly revert to our author's arguments, and distinctly protest against his comparing the primary planets with "male teats," "images of breasts," "paps and nipples of a male animal," or the "finger bones which are packed into the hoofs of a horse." A male teat is not a male animal—nor a horse's hoof, a horse: it would be more fair, and quite as delicate, if our author had compared the horse with Jupiter, and the teat with one of his satellites.

The author, having disposed of the solar system, says—"Perhaps it may be said, that to hold this, is to make nature work in vain; to waste her powers; to suppose her to produce the framework and not to build; to make the skeleton, and not to clothe it with living flesh," &c. "We reply," he says, "that to work in vain, in the sense of producing means of life which are not used, embryos which are never vivified, germs which are not developed, is so far from being contrary to the usual proceedings of nature, that it is an operation which is constantly going on, in every part of nature. Of the vegetable seeds which are produced, what an infinitely small proportion ever grow into plants. Of animal ova, how exceedingly few become animals." "It is an old calculation, which used to be repeated as a wonderful thing, that a single female fish contains in its body 200 millions of ova." And to which WE reply that the author's account of the universe is precisely the case of a fish which produces 200 millions of ova, and but one embryo of all these 200 millions becomes a FISH. Among our fossil or recent fishes we cannot match the author's analogue!

"If any number of the fixed stars were also found to be barren flowers of the sky—objects, however beautiful, yet not sources of life or development—we need not think the powers of creation wasted or frustrated." We have no hesitation in saying that such ideas of waste in nature are more than unprecedented, they are *ridiculous.* Fish with one lively ovum, and syngenesious plants with one fertile seed, are worthy of such arguments. Our geological INFERENCES respecting the UNINHABITED portions of this planet's surface, as compared with those that are tenanted, differ entirely from those of the author, when he argues as follows:—"It is sometimes said that it is agreeable to the goodness of God that all parts of the creation should swarm with life." "To leave a planet without inhabitants, would, it is thought, be to throw away an opportunity of producing happiness." "To say nothing of the vast intervals between planet and planet, which, it is presumed, no one supposes to be occupied by living things; how large a portion of the surface of the earth is uninhabited, or inhabited only in the scantiest manner?" He then instances the desert tracts of Africa and Asia, and the snow regions of mountain-ranges. Again, "there are many uninhabited islands, and were formerly many more. The ocean, covering nearly three-fourths of the globe, is no seat of habitation for land animals or for man; and though it has a large population of the fishy tribes, is probably peopled in smaller numbers than if it were land, as well as by inferior orders. We see in the earth, then, which is the only seat of life of which we really know anything, nothing to support the belief that every field in the material universe is tenanted by living inhabitants."

In the first place, the passage respecting the intervals between the planets should have been omitted. There can be no analogy between blank space and the surface of the earth, between air and vapour and matter. The author tells us he "SAYS NOTHING" of these vast intervals! On referring to the earlier pages of the same chapter (p. 338, 339), we find a strong predisposition to make as much as possible of "blank space." We remember the male pap and the planet! Our author is far too good a theoretical geologist not to be aware that it never was the will of the Creator that all parts of our own planet should at the *same time* "*swarm with life.*" There always *have* been *fallow* places, barren for a time, and probably there always *will be.* But the sands of the African deserts rest upon the ruined haunts of man; and a portion of that desert waste was the home of civilization within the period of man's history. Again, before the human period, within a late geological epoch, the desert tracts both of Africa and Asia were the bottom of an ocean bed, and the abode of every order of marine organisms. Every geologist knows that the highest mountain ranges, if deserted and untenanted now, were not always so; the heights of the Andes and the Himalaya bear upon their flanks myriads of fossil animals that lived in former geological epochs, and bear witness to the time when the site they now occupy was anything but a desert or WASTED field.

"There are many uninhabited islands, and were formerly many more."

The author, when sneering at the idea of the planetoids being inhabited, might also have remembered several INHABITED islands of *our earth* that afford PECULIAR and ESPECIAL evidence. There is St Helena, with a flora so peculiar, that out of 30 native species of the phænogamous class, only ONE OR TWO are to be found in any other part of the globe—St Helena is about 30 miles in circumference ; Vesta is 250 miles in diameter, and Ceres 163.

Madagascar forms, with two or three small islands in its immediate vicinity, a zoological province of itself, all the mammalian species except two, and nearly all the genera, being PECULIAR. The archipelago of the Galapagos, so admirably described by Mr Darwin, has its fauna and flora PECULIAR, so much so that he calls it "a little world within itself, or rather a satellite attached to America." "One is astonished at the amount of creative force displayed on so many small, barren, and rocky islands, and still more so, at its diverse, yet analogous action on points so near each other." (Darwin's *Journal of the Beagle.*)

The Galapagos have been only inhabited by man within the last few years ; indeed, Charles Island is still the only colony. St Helena was first discovered in 1501, and was then uninhabited by man. The author appears to have no insuperable objection to the theory of different centres of creation. Now, if the Galapagos, St Helena, and Madagascar, have thus been saved from "being wasted" by special creations, why not Saturn, Jupiter, and Uranus ?

Again, we read, "The ocean, covering nearly three-fourths of the globe, is no seat of habitation for land animals or for man, and though it has a large population of the fishy tribes, is probably peopled in SMALLER numbers than if it were land, as well as by INFERIOR ORDERS."

In answer to this we merely quote a passage from Sir C. Lyell's *Principles* :—"The human race, fitted as it is, by its bodily constitution and intellectual resources, to spread very widely over the earth, is far from being strictly cosmopolite. It is excluded both from the arctic and antarctic circles," and "from three-fourths of the globe covered by WATER, where there are large areas VERY PROLIFIC in animal life, EVEN IN THE HIGHEST ORDER OF THE VERTEBRATE CLASS." Now we geologists have certain inferences respecting Cambrian oceans, Silurian oceans, and a great many other oceans, and our investigations of the earth's structure and history compel us to believe that an ocean *void of life* is contrary to every principle of analogy. This planet has been the theatre of constant change, and the bed of the sea at one epoch has become the verdant plain, sandy desert, or mountain top of another. The author's argument, therefore, on the waste places of earth would apply so far, and no farther, to every other planet and celestial sphere. Probably no other planet has remained UNALTERED from its creation; and if we are to draw any analogy from our own, every other material orb MUST have undergone various transformations. It would be ridiculous in any geologist to suppose that the hills and valleys, lakes and seas of Mars had undergone NO CHANGE since our own Silurian or Devonian ages. And if we can depend upon the statement of astronomers that other planets have their seas and lakes, and hills and valleys, it is very unlikely the geologist will believe that throughout all time they have either been uninhabited or tenanted by identical animals and plants. We believe in PROGRESS as regards our earth; and this leads into a few thoughts as regards the probable PROGRESS of the rest of the solar system.

Universal Diffusion of Species, and Progress of Creation.

We perfectly agree with Sir C. Lyell, when he warns the geologist against taking for granted "that the date of the creation of any family of animals or plants, in past time, coincides with the age of the oldest stratified rock in which the geologist has detected its remains."

The climatal hypothesis of Sir Charles is, without any exception, the grandest and most correct theory ever propounded by geologists; it affords a key to many a difficult problem, and it also affords powerful arguments in favour of the remarkable and harmonious PROGRESSION of this planet throughout myriads of past ages. The successive creations of different forms of animals is an established truth, and particular animals appear to have been adapted to varying physical conditions of the earth.

The *universal* diffusion of Silurian forms is well known to geologists.

Trilobites, Orthides, and Orthoceratites range over enormous distances. The *Pentamerus galeatus* of our Upper Ludlow rock is the principal constituent of the Niagara limestone, while *Pentamerus oblongus* of our Lower Silurians is a common fossil of Scandinavia and Russia.

The Chinese invalid swallows *Calymene Blumenbachii*, when rolled into a ball like the woodlouse, and imagines it a panacea for a disordered liver; while the Arctic sailor carried home a Phacops, from amid eternal snow, "in the tail of his shirt."

The grand Asterolepis and Holoptychius of the Old Red Sandstone frequented waters as distant as are the sites of Herefordshire, Scotland, and Archangel; while the Brachiopoda and shells of Devon, and the fishes of Cromarty and Herefordshire, are found in Russia in the same strata.

The TERRESTRIAL plants of the carboniferous epoch must have had a vast geographical range, for the *same species* extend from Arctic regions to widely separated districts in Europe, America, Asia, and Australia; while the same carboniferous "species of MARINE animals lived, from the latitude of Spitzbergen to the parallels of Peru and Australia."—(*Siluria*, p. 477.) We compare the fossils of the Himalaya with the oolitic remains of Yorkshire and Gloucestershire, and are often unable to distinguish the one from the other. The Arctic Ichthyosaurus of Sir E. Belcher could not have existed under the present climatal associations of the frigid zone; and we have ourselves heard Professor E. Forbes declare the Pectines and Ostrea of Carpentaria in Australia to be identical with those of the inferior oolite of the Cotteswoldes. That different regions of the globe are NOW inhabited by entirely DISTINCT animals and plants, is a fact which is familiar to all naturalists; and this seems to indicate a progress in creation throughout all TIME.

We find also very eminent geologists insisting on similar progress, as regards the introduction of life itself. What says the Knight of Siluria! "Putting aside theory, and judging solely from positive observation, we may fairly infer, first, that during very long epochs the seas were unoccupied by any kind of fishes; secondly, that the earliest discoverable creatures of this class had an internal framework almost incapable of fossilization, and so left in the strata their teeth and dermal skeletons only; and, thirdly, that in the succeeding period the oldest fishes having bony vertebræ make their scanty appearance, but become numerous in the overlying deposits. Are not these absolute data of the geologist clear signs of a progress in creation?" "Let the reader dwell on the remarkable facts which the labours of geologists have elicited in the last fifty years. Let him view them progressively, and in the order indicated by Nature herself. Let him execute a patient survey from the lower deposits upwards, and he will find everywhere a succession of vertebrated creatures rising from lower to higher organizations."* Again, "The reasoning brain was not produced until the scene had undergone a slow but thorough process of change, during which, at each progressive stage, it had furnished a platform for higher and yet higher life."†

If, then, any inferences may be drawn by the geologist from data furnished by the earliest stages of this planet, and applied to other planets of our system; progress and improvement must be the LAW of the Creator throughout the universe. We have no other evidence furnished by the researches of the geologist; and the knowledge of progressive creation on this planet must always furnish arguments from analogy, and militate against the "slag" theory of the author.

If there were seas of Jupiter contemporary with those of the Silurian epoch, it is surely contrary to analogy to suppose that they were not furnished with inhabitants; if Mars had land during the carboniferous epoch, it would be contrary to all analogy derived from a consideration of the earth at that period, to suppose that a terrestrial flora was confined to this planet. If progress in creation be the rule, as far as we can

* Siluria, p. 462. † Footprints of the Creator.

read the revelation of the Creator, why limit that progress to a planet with one satellite, when there are others furnished with eight?

Much as we object to the theory of the Essay, and contrary as we believe its doctrines to be to every geological analogy and astronomical truth, there are many arguments employed by the author, setting aside his astronomy and geology, which must always command the attention of the reflective and thoughtful. Far be it from us to attempt to fix an *odium theologicum* upon a work which, however we believe it to be mistaken, bears the stamp of an honest and conscientious spirit.

The principle that pervades the whole of the Essay has been rightly characterized as "the glorification of man."* Man's history and position is unique. Man is so special and pre-eminent, born to so high a destiny—such a "wonderful, social, political, spiritual creature"—that the author sacrifices every other created thing, in his endeavour to support his human idol. All former life is "*brute.*" The universe all "merry-go-rounds," and man's period, though "only a moment in the ages of animal life, the only period of intelligence, morality, religion." The arguments of the Essay all converge in MAN; and to account for his Redemption is the moral of the song. This is the question upon which every argument turns, and to which every application of deep reasoning power and much logical disputation has been devoted. The author evidently thinks, that a belief in modern astronomy leads many to doubt in the truth of the great scheme of Redemption; the consequence is, that he has strained at a gnat and swallowed a camel; while in his attempt to demolish the doctrine of every other astronomer, he has given publicity to a very "unique" book, which inculcates very queer ideas of creation and its purposes.

The geologist must always regard the creation of man as an era in the MORAL and not the PHYSICAL world. Probably very few physical features on the face of the planet have changed since his introduction. That hyenas, elephants, and hippopotami inhabited the British isles contemporaneously

* *Times,* Dec. 26, 1855.

with our present species of land and fresh-water shells is a well known fact, and the "*Macacus pliocenus*" roamed in our forests myriads of years before his more intellectual successor was called into being. It is a wondrous book the book of nature, "whose pen," as it has been eloquently said, "is the finger of God, whose covers are the fire kingdoms and the star kingdoms, and its leaves the heather bells and the polypes of the sea, and the gnats above the summer stream." The same may be said of geology and its history of myriads of ancient tenants of our globe, which have left no living representative behind. That science teaches her votaries truths of mighty significance, and which no sneer of ignorance can destroy; teaches the simple truth that this planet has advanced from a more simple to a more perfect state; that progress has been the law of our earth, and is, we suspect, the law of the universe.

THE PHYSICAL LAWS WHICH GOVERN THIS EARTH ARE THE SAME THAT GOVERN THE PLANETS, and the law of progression, so evident to the geologist, operates in all sober probability on the other orbs that roll around us. The phenomena and the results may be the same in kind, though different in form; and as astronomers object to a universe of "merry-go-rounds," the geologist objects equally to denominating *Pre-Adamic* animals as "brutes that can hardly be said to have lived;" rather does he agree with Dr Chalmers, that "the same God, who sends forth an upholding influence among the orbs and the movements of astronomy, can fill the recesses of every single atom with the intimacy of his presence, and travel, in all the greatness of his unimpaired attributes, upon every spot and corner of the universe he has formed." Progress, then, we believe, was the LAW, and was evinced on this planet most especially by the creation of a moral and accountable creature; and if there BE other regions of the mighty universe, as astronomers tell us *there are*, physically MORE HIGHLY developed than our own, our geological inferences must lead us to expect that there are HIGHER SPIRITUAL INTELLIGENCES. That there are other material worlds, we are taught to believe in Holy Writ. Enoch, Elijah, and the blessed Saviour went from hence with MATERIAL BODIES: where could they have gone, but to some higher and nobler material and moral system than our own? In the words of a powerful writer in the *Times*,—"All this time we have before us the one grand and awful fact, that a body, which angels attended in its life, its death, and its rising, was seen by steadfast eyes to go up from the earth, ascending higher and higher into the sky—a body which had walked, which had spoken, which had eaten, which had been handled. We have before us the assurance of Inspiration, that this body is now present among, or beyond, the stars; living, breathing, moving; seeing, and sympathizing with human cares and trials, and having the scenery of earth, and the deeds of its inhabitants, mirrored in one bright and unbroken reflection."

The Essay speaks of man as an intellectual, moral, religious, and spiritual creature. Alas! we wish we were, what we sincerely believe the author himself most heartily wishes men to be. Men would be very different from what they are, what they ever have been, or what, *while on earth*, we suspect they ever will be! Rational, reflective, and progressive, as far as worldly wisdom goes, we do not doubt that man is. Religion and spirituality are, however, most assuredly his exception, not the RULE. We also conceive that the author of the Essay excessively exaggerates the POSSIBLE progress of the human race. "In man, the possible progress from generation to generation, in intelligence and knowledge, and we may also say in power, is *indefinite*." The following warning of Mr Hugh Miller strikes us at once as applicable to most of the Essay, and the arguments upon the moral nature of man—"Man, though he has been increasing in knowledge ever since his appearance on earth, has not been improving in faculty; a shrewd fact, which they who expect most from the future of this world would do well to consider. The expectation of any great advance in the present scene of things, great, at least, when measured by man's large capacity of conceiving the good and fair, seems to be like all human hope when restricted to time, an expectation doomed to disappointment. There are certain limits within which the race improves; civilization is better than the want of it, and the taught superior to the untaught man." "Science is cumulative in its character; and so its votaries in modern times stand on a higher pedestal than their predecessors. But though nature produced a Newton some two centuries ago, as she produced a Goliath of Gath at an earlier period, the modern philosophers, as a class, do not exceed in actual stature the worse informed ancients, the Euclids, Archimedeses, and Aristotles." "Since genius first began unconsciously to register in its works its own bulk and proportions, there has been no increase in the mass, or improvement in the quality of individual mind. As for the dream, that there is to be some extraordinary elevation of the general platform of the race, achieved by means of education, it is simply the hallucination of the age, the world's present alchemical expedient for converting farthings into guineas, sheerly by dint of scouring; not but that education is good—it exercises, and, in the ordinary mind, developes faculty; but it will not anticipate the terminal dynasty. Yet, further—man's average capacity of happiness seems to be as limited and as incapable of increase as his average reach of intellect: it is a mediocre capacity at best; nor is it greater by a shade now, in these days of power-looms and portable manures, than in the times of the old patriarchs."

We can easily apprehend that the soul of man, in its essential attributes, is of more consequence in the eyes of God than any star or sun, or than all stars and suns put together; but it is not HERE below that the "intellectual, moral, and religious creature" is to be PERFECTED; and therefore the statement that man's nature and place is "unique," and incapable of repetition in the scheme of the universe, is as incomprehensible to us as to Sir D. Brewster. Man's existence IS to be repeated in some more glorious and MATERIAL world, if we are to believe in Holy Writ. Strange is the doctrine, then, which inculcates that there are no other worlds BETTER than our own. God forbid that we should depreciate the race for whom the Saviour suffered; truth however compels us to agree with Sir David, that the history of the human species has NOT been a moral or a religious progressive history. The author of the Essay dwells upon the medals and coins in which the antiquary finds the "records of reigns and dynasties." "How much does a coin indicate? Property, exchange, government, a standard of value,—the arts of mining, assaying, coining, &c." Did no other thoughts ever enter into his mind upon the same subject—thoughts also connected with vice and sorrow, outrageous cruelty and torture, tyranny, suffering, and sin? We are informed that man is characterized by the "possession of language." Could not the author also characterize his idol as a creature equally remarkable for his DIFFERENCE OF OPINION on religious subjects? How many years have passed away since the Inquisition tortured Galileo? Are there no Jesuits of the present day, who would glory in the administration of the faggot and the rack?

Difference as regards religious opinions! Why, every religion partakes of it, and scarcely ten men think alike!

"Religious controversy has lost somewhat of its bitterness, and the indirect imputation of bad motives is falling into disuse." Nevertheless, men's opinions are as strange as ever, as regards our common Christianity. And the thought should even teach us CHARITY. But when we are told that man is "such a religious and spiritual creature," we cannot refrain from inquiring in WHICH DIRECTION the apex of spiritual and religious progress lies? Shall we find it towards the horizon of Rome, or in the doctines of Calvin and St Augustine? Would the author recommend the tenets of Wesley and Whitfield, of Mr Gorham or Dr Pusey? Will he, the champion of the "glorification of man," indicate the lines which "converge" towards the saint or the fanatic, the sage or the fool?

Religious truth to one mind is often folly, nay worse, to another; and the popular belief of thousands of "religious and spiritual" creatures is altogether different from that of thousands of their fellow-men on many very striking and important points.

That such is the *fact* as regards religious opinions in general, few will be disposed to deny. The author has *his*, we have *ours;* may we be allowed to state them?

Putting together the facts of geology, with the general belief of astronomers, we have no faith in the arguments of the Essay, or that there is the slightest ground for believing this earth anything more than the insignificant portion of the *uni-*

verse it has generally been believed to be. *Progress* has been the history of this planet; and in due time God thought fit to introduce an intellectual creature; that creature, we are informed, fell through sin, and hence his successors have to undergo a probation and preparation for another and higher lot *hereafter*. Man is represented in Holy Writ as a rebellious and fallen race, and *hence* the great fact of his *Redemption*. That very redemption proves of what consequence man and his undying soul are in the eyes of the Creator; but it should always be remembered that it affects him principally as regards the life to come, and as respects an existence in *another* world. We believe, also, that when we enter upon such subjects as the Incarnation and Redemption, we are mooting questions "where the wisest of all philosophy is the philosophy of silence, and a profession of ignorance is the best evidence of a solid understanding." We are told that these are subjects which "angels desire to look into." Yet is it not on these very points that bigots dogmatize, and such a fertile brood of dissensions, questionings, and disputations arise? Much that is to be believed cannot be explained; and there should be, we humbly think, on such high subjects a submission to the will of Him who made us, without that morbid straining after investigation and explanation of His mysteries, which has been the tendency of every people and of every age. It is nevertheless true, that the great truths of God's Word are so plain "that he may run that readeth;" and that perverse disputations usually originate with those who desire to be wise above that which is revealed. There are also revealed WORKS which we may everywhere legitimately study, and that "carry us away into the purer country, where we may breathe the free air of heaven, and with invigorated bodies and refreshed spirits, hold commune with the beautiful and the good around us;"—WORKS that are untainted by the cruelty of priests and the blood-stained fanaticism of superstition, and the cultivation of which in a proper spirit would, we believe, tend much to overcome religious prejudices, dissensions, and heart-burnings.

If the investigation of the Creator's *works* was duly held forth to the popular mind, men would become familiar with the grandeur of creation, and we should have fewer theories which pretend to analyze the Most High. Man, with all his boasted knowledge, knows but little of the material world, and it ill becomes him to dogmatize concerning the spiritual; it is, therefore, with extreme regret that we find the author of the Essay introducing the mysteries of Christian faith into a philosophical discussion upon the STARS. There are some, no doubt, who will believe in the author's doctrines, as there always are some who believe ANY THING. It must not be, however, among philosophers, astronomers, geologists, or naturalists of any class, that the author can look for the disciples of a "Slag" Universe; they turn from his expositions to the searching test of their own experience through personal observation, and can have no faith in doctrines so contrary to those they learn from a Higher Teacher, on the grandeur, beauty, and marvellousness of His Creation, and his revelations to his creatures of "Progress, Adaptation, and Design."

Contributions to Ornithology. By Sir WILLIAM JARDINE, Bart. No. III. *Ornithology of Eastern Africa.—Natal Collections.**

The interest and importance of a correct knowledge of the geographical distribution of animal life is becoming daily more and more acknowledged. To accomplish this a record of authentic facts is essential. In ornithology we have attained these in part, by the "Ornithologies" of countries and districts which have from time to time been published, and which have in most instances been kept quite restricted, either from some local interest of the author, or as a natural boundary within which to confine the work. These, however, were not originally published with a view to geographical knowledge: this has been of late much more assisted by the local lists, both

* For this interesting collection we are indebted to the exertions of Mr M. M'Ken, now residing in Natal, and actively investigating the natural products of that district.

continental and insular, which have been given from time to time in the periodicals of this and other countries; but to get at the real position of our knowledge, these lists, as well as the complete "Ornithologies," require to be analyzed or reported upon.

Africa has had a great deal done for its geographic ornithology. Le Vaillant, though he mixed up much that was non-African in his works, gave a tone and precedence to African ornithology, and to that of the south in particular; and the subsequent labours of Dr Andrew Smith and the Brothers Verreaux have made the ornithology of South Africa comparatively well known. The works of Rüppell, A. Smith, Ehrenberg, Lichtenstein, Hartlaub, Malherbe, Muller, Swainson, Strickland and Sclater, with the local collections sent home by Fraser, Stanger, Andersen, Gordon, Petherick, Leyland, &c., have given us a great mass of materials for ascertaining the range of species on the north, south, and west, and partially in the interior; but from the eastern coasts and regions of this continent we are yet much in want of information. What we possess is detached, and our ornithological collections have been very limited: our conveniences for commerce, and the consequent facility of more easily procuring information, have not hitherto extended continuously in an eastern direction; and our communication with that side of Africa and with the Mozambique Channel has been very restricted,—scarcely extending northward of Delagoa Bay. We are aware that M. Bianconi has commenced a *Fauna Mozambicana;* but this has not proceeded far, and ornithology has not yet been much touched upon. Mr Vigors, in an early number of the *Zoological Journal*, described some birds from the Natal district; Dr A. Smith has introduced some eastern species in his *South-African Zoology;* MM. Verreaux have described a few species; and there is a very interesting account given by Mr Strickland* of a small parcel collected by Mr James Daubeny upon the African shores of the Red Sea, which included some new forms. There are also other notices of eastern birds; but we have no de-

* Contributions to Ornithology.

tailed list, such as that prepared by Dr Hartlaub for those of the western side of the continent. Although the collection at present received is of small extent, containing only between fifty and sixty species, it is nevertheless authentic; and our object in recording its contents is with the view of making a systematic beginning to the knowledge of East African ornithology,—of giving, as it were, a point to which information can be sent. And we take this opportunity of requesting that anything bearing upon this subject may be communicated to us; and we have little doubt, when attention is once directed to it, that materials will rapidly accumulate, and enable us to give an extended list, and to make comparative observations.

Our knowledge of the Eastern ornithology will be of great interest and importance. Regarding geographic range, we expected the southern and eastern regions to run into each other, as they do; but we should not have expected to find so many West-African birds extending across the continent. This will be so far seen by the limited list we have given, and which we have thought best to confine now to the collection before us. Other birds, known as almost cosmopolite, range apparently indiscriminately over a great part of Africa; this is the case with the *Falco peregrinus*, which we find at the Cape of Good Hope, Algeria (Malherbe), Conducia Bay, Mozambique (Mus. Jard.). Some species, again, which have their capitals eastward, stray to the south, and have been enumerated in the southern fauna—as, for example, the *Vidua axillaris* of our list; so also *Pyrenestes frontalis*. Of the last, Smith says—" The only specimens observed within the limits of the colony were discovered in the forests upon the eastern frontier. About Natal the bird is not so rare." This is clearly an eastern species. "*Mirafra africana* is principally confined to the eastern districts of the colony;" its limits southward. We have others, again, which are only known as eastern species; and as our researches extend, these will be extended also. *Caprimulgus natalensis*, *Cossypha natalensis*, *Turdus guttatus*, *Dicrurus Ludwigii*, are yet known only to occur eastward. *Turacus porphyreolophus* is characteristic of the east, as some of the beautiful *Musophagæ* are of the west. The eastern ornithology will be of much interest on another account—that of the proximity of the great island of Madagascar, and the peculiarity of its fauna, as well as that of the other smaller islands that are situate off this coast. Of 113 species of birds known in Madagascar, 45 only are known to be common to Africa, while at the same time some continental species are not found in the island. The alliances of Madagascar ornithology have been thus summed up by Hartlaub :—"It has a tendency to exhibit the African model, but bears clear and characteristic traces of an affinity with the Indo-Australian fauna." In all probability, we shall be able to trace a modification at least of the same characters in that of the forms of the eastern continental coasts—and we have specifically an example of an Indian bird mentioned by Ehrenberg, and occurring in the present collection, which agrees so closely, that although we have kept Ehrenberg's name to mark the African form, we can with difficulty separate them.

All the species enumerated in the succeeding list are from the immediate Natal district, a short distance east or west, or to the interior—and their range elsewhere, with the authority for it, is placed after each.

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1. *Spizäetus occipitalis*, Daud.; South Africa, Caffraria (Strickland, O. Syns.); Abyssinia and Sennaar (Rüppell); Abyssinia (Bruce), as the Black Eagle.
2. *Tinnunculus rupicolus*, Daud.; South Africa, Cape Colony (A. Smith, &c.); Damara Country (Strickland and Sclater); North-east Africa (Rüppell).
3. *Accipiter minullus*, Daud.; South Africa, Cape Colony (A. Smith, &c.).
4. *Milvus forskahli*, Gmel.; Arabia (Forskahl); South Africa (Le Vaillant); Damara Country (Strickland and Sclater); West Africa, Island of St Thomas (Hartlaub); Old Calabar River (Mus. Jard.)
5. *Hirundo cuculata*, Bodd.; South Africa (Mus. Jard.)

6. *Halcyon fuscicapilla*, Lafresn. South Africa (A. Smith); South-west Africa (Leyland, Mus. Jard.)

7. *Ceryle rudis*, Linn.; Persia; South Africa, to a certain extent northward upon both sides; North-east Africa, generally distributed (Rüppell).

8. *C. maxima*, Pall.; South Africa (A. Smith).

9. *Alcedo semitorquata.* South Africa, (Mus. Jard.); Great Fish River (Swainson); North-east Africa, Schoa (Rüppell).

10. *Alcedo cristata*, Linn.; South Africa (A. Smith).

11. *A. picta*, Bodd.; West Africa (Hartlaub); Old Calabar River (Mus. Jard.) We only have hitherto known this species from Western Africa, and it seems rare there, as it does not frequently occur in collections sent to this country.

12. *Merops ægypticus*, Forsk. The range of this species is very great, if we are correct in referring to it *M. persicus*, Swain. B. of West Africa. Asia, Persia, Candahar; Africa, Egypt, Tripoli, Senegal; Europe, Italy.

13. *M. erythropterus*, Lath. Abundant during the year in Abyssinia, Kordofan, Sennaar (Rüppell.)

14. *Coracias garrula*, Linn.

15. *Oriolus monachus.* Abundant in Abyssinia, as *O. moloxitta* (Rüppell.)

16. *Muscipeta perspicillata*, Lath. South Africa (A. Smith (Mus. Jard.) This is the species having the tail of the same colour with the upper plumage.

17. *Lanius collaris*, Lath. Agrees with specimens from the Cape district, but has a few sienna feathers above the white covering the shoulders; Abyssinia (Rüppell); Damara Country (Strickland and Sclater).

18. *Edolius musicus.* S. Africa (A. Smith).

19. *Malaconotus olivaceus*, Vieill. West Africa (Swainson); Kordofan (Rüppell).

20. *M. sulphureopectus*, Less. = *M. chrysogaster*, Swains. This bird has a very extensive West African range; Cape Coast (Gordon); Gambia (Hartl.; Mus. Brem.); Ilha das Rollas, Fernando Po, St Thomas (Hartl.). We have it also in Abyssinia (Rüppell), and now from Natal.

21. *M. gutturalis*, Daud. = *M. viridis*, Vieill. West Africa (Hartlaub, "Malimbe," Perrein); Sierra Leone (Afzelius). Not an uncommon West African species, and not unfrequent also on the south-eastern side, as Hartlaub records it from Natal; and there is a specimen in Mus. Strickl. from the same locality.

22. *Telephonus senegalus*, Linn. Kordofan (Strickland); Damara (Strickland and Sclater); South Africa, Cape Colony (A. Smith); West Africa, Elmina (Mus. Hamb. Hartlaub).

23. *Dryoscopus ferrugineus*, Lath. South Africa, Cape Colony (A. Smith).

24. *D. cubla.* S. Africa, Cape Colony, common (A. Smith); Damara Country (Strickl. and Sclat.); North Africa, Abyssinia, Sennaar (Rüppell).

Frequents "wooded pastures." We have received this species from as far east as Conducia Bay, procured by Lieut. William Jardine when in the Mozambique Channel. In West Africa it is represented by a closely-allied bird, *D. gambensis*, Licht. = *Malaconotus mollissimus*, Swains.

25. *Drymœca stangeri ?*

26. *Parus niger.* South Africa, Cape Colony (A. Smith); Damara Country (Mus. Jard.). This Titmouse seems represented on the western side by *P. leucopterus*, Swains. = the Abyssinian *P. leucomelas*, Rüpp. Are they not all local races? They are very closely allied, differing chiefly in the presence or absence of white on the outer tail-feathers.

27. *Lamprotornis phœnicopterus.* South Africa, Cape Colony (A. Smith).

28. *L. morio.* South Africa, Cape Colony (A. Smith). Numerous in Abyssinia (Rüppell).

29. *L. leucogaster.* Abyssinia (Rüppell); Western Africa (Swainson, Hartlaub).

30. *Ploceus spilonotus*, Smith. West Africa, as *P. flaviceps* (Swains.), with which Smith and Hartlaub make it =. There are slight variations.

31. *P. subaureus*, Smith. South Africa (A. Smith).

32. *Eupodes xanthosomus*, Jard. and Selby. West Africa, (Mus. Jard.); West Africa, Sierra Leone, Senegal (Hartl.)

33. *Vidua ardens*, Bodd. = *V. rubritorques*, Swains. West Africa, Senegambia (Hartlaub).

34. *V. axillaris*, Smith. We have little knowledge of the locality of this comparatively rare species. It is described by Dr A. Smith in the South African Zoology, but can scarcely be placed as a really South African bird. He says, "there is reason to believe this species of Widow Bird occurs but rarely in South Africa. The individual which our figure represents was obtained upon the south-east coast, between 700 and 800 miles to the eastward of Cape Town, and at the time it was shot, was perched upon some rushes growing out of some marshy ground in Caffreland." Mr M'Ken's locality for the species is "marshy places near Tongaat." We have never received it with southern collections, and it is one of those more truly eastern species, which have allies in the south and west resembling each other in their seasonal changes.

35. *Estrelda æstrild*, Linn. South Africa (A. Smith).

36. *Fringillaria flavigastra*, Rüpp. Kordofan (Rüppell).

37. *Crithagra flava*, Swains. West Africa (Swainson). Agrees with the description, &c., of Swainson's bird, and differs, on comparison, from specimens of the South African *C. sulphurata*, in the under parts being more uniformly yellow, the olive pectoral band not distinct, and the yellow space on the throat not insulated or defined. The yellow streak above the eye extends completely over the auriculars.

38. *Macronyx capensis*. South Africa (A. Smith).

39. *Nectarinia natalensis*, Jard. This bird is one of the more peculiarly eastern species, and represents *N. senegalensis* of the western coast. These two can be easily separated, if mixed together. They are at once distinguished by different shades of colour, and by the form of the coronal and gular patches. There is another bird, however, described by Rüppell from North-eastern Africa more difficult to separate; it is the *N. cruenta* of that ornithologist. That mentioned in the Naturalist's Library as *N. natalensis*, from the collection of the Zoological Society, to which it was presented by Dr Rüppell, was the north-eastern bird, and then considered by us as =. *N. natalensis*, certainly, so far as our in-

formation reaches, does not extend its range southward or to the western coast.

40. *N. collaris*, 41. *N. olivacea* (Smith), 42. *N. famosa*, are all southern, extending in their range considerably to the northward.

43. *Pogonius torquatus*, Less.; South Africa (Burchel, A. Smith, Temminck), not uncommon.

44. *Campathera abingoni*, Smith.; South-west Africa, Damara Country (Strickland and Sclater).

45. *Dendrobates fuscescens*, Vieill.; South Africa (Le Vaillant); South-west Africa, Damara Country (Strickland and Sclater).

46. *Turacus porphyreolophus*, Vig. Algoa Bay (Vigors). This fine species seems characteristic of the Natal portion of the eastern coast: we have not yet ascertained its range northward.

47. *Cuculus nigricens*, Swains.; West Africa, Senegal (Swainson, Hartlaub). The specimen in the present collection was procured in April.

48. *Oxylophus pica*, Ehrenb. In his "Symbolæ," Ehrenberg describes a white-bellied oxylophus from Nubia under the above name, and states that it corresponds very closely with the Indian *O. jacobinus*. In the Petherick Kordofan birds, described by Mr Strickland, the white-bellied Nubian species is mentioned as *O. jacobinus*. A specimen in M'Ken's collection agrees very closely with specimens from India, and we would only desire to compare a few more together before discarding Ehrenberg's name, which we have used provisionally now to mark the African form. Its range in Africa seems to be eastern and northward.

49. *Chrysococcyx auratus*, Gmel.; West Africa (Swainson); Senegambia, Gold Coast (Hartlaub).

50. *C. cupreus*, Shaw; Abyssinia, (Rüppell). Swainson has described a bird from Western Africa, very closely allied, under the name of *C. smaragdineus*. The differences are the *very* "*pale* tint" of the under parts of the southern bird, and the white under tail covers banded with green; while in the western bird the under parts are "bright yellow," the under

tail covers being also yellow and unspotted; in the bird before us from Natal the under parts are *bright yellow*, but the tail covers are white and banded as described by Swainson. These seem characteristic, but the depth of the yellow tint does not seem constant, and the banding of the under tail covers is the chief distinctive mark. Are these birds only local races?

51. *Centropus senegalensis*, Linn.; South Africa, Cape Colony (Mus. Jard.); marked, "scarce bird, found in the vicinity of water." West Africa (Swainson); Senegal, Gold Coast, Cape Palmas (Hartlaub); Cape Coast (Gordon).

52. *Columba guinea.* Kordofan, Sennaar (Strickland); Damara (Strickland and Sclater); Kordofan, Sennaar, Abyssinia (Rüppell).

53. *Turtur vinaceus*, Gmel.; Kordofan (Strickland and Sclater); Gambia (Rüppell).

54. *Peristera afra*, Linn.; Damara (Strickland and Sclater).

55. *Treron calva*, Temm.; West Africa (Swainson, Hartlaub), as *T. abyssinica*, Kordofan and Abyssinia; (Ruppell), as *T. abyssinica*; East Africa, Port Natal (Verreaux).

56. *Francolinus subtorquatus?* This specimen is marked ♀, but it is furnished with spurs 5″ long. The entire head and nape, chin and throat are sienna, with no marking of the bands seen in the ♂ of *F. torquatus.* The fore-part of the neck and the breast is distinctly and strongly marked with broad black bars; altogether, we are not satisfied that this bird is = to the species indicated with a ? Our opportunities at present do not admit a more extended comparison.

57. *Scopus umbretta.* A very generally distributed species. South Africa generally (A. Smith); Northern and North-east Sennaar and Abyssinia (Ruppell); Central Africa (Denham and Clapperton); Leyland's Collections (Mus. Jard.); Western Africa, Turkey, Voy. Zaire (Hartlaub); Island of Madagascar (Hartlaub).

Remarks on Professor Baden Powell's Views respecting the Recent Origin of Man upon the Earth, and the Skeleton found in excavating Mickleton Tunnel. By ALEXANDER THOMSON, Esq., of Banchory.

We have no inclination to go over the various matters introduced by Professor Powell into the volume of Essays lately published by him; and it seems the less necessary to do so, that the work is principally composed of hypothetic theories which have long been before the scientific world, and, as we imagined, had been conclusively disposed of by Sedgwick, Miller, Hitchcock, and others.

So far as we have apprehended their meaning, the Essays are a reproduction of the dreary speculations of Laplace, Lamarck, Oken, and the author of "The Vestiges,"—clothed in popular and attractive language, but not better sustained by facts and arguments than when we last encountered them.

We must confess we did not expect to see them so soon reappear, and least of all that they should come forth from the pen of a Clergyman of the Church of England, and a Professor of Geometry in the University of Oxford.

If Professor Powell's theory of creation be true, and can be proved to be true, then there is an end of all revealed religion, and of all natural religion too,—there cannot be an Almighty personal God creating and sustaining all things. Perhaps the most painful and the most dangerous part of the book to common readers is the mixture of arguments tending to destroy all religion, with professions of respect for Christianity. Surely the author cannot be ignorant of the tendency of his own reasonings.

It is true that ordinary religious belief in the most instructed and enlightened minds, depends on a class of facts and arguments wholly unconnected with scientific cosmogenies; but it is equally true, that by false views of creation, the student of science may be led to conclusions inconsistent with the existence of a personal Deity, and suddenly find himself deprived of all his religious belief, by the separation of himself from the basis of original truth on which the whole must rest,—viz., the existence of a Supreme Intelligent Being, by whom all things were made and are sustained.

We wish here, then, to draw the attention of our readers to a portion of one of the Essays,—that on the "Philosophy of Creation," in which the author forsakes the laborious path of the inductive philosophy, and indulges in flights of unrestrained imagination.

Of these the boldest, and perhaps the most remarkable which ever appeared in a work professing to be scientific, occurs in connection with the question of the date of man's appearance upon earth.

"To the same kind of misapprehension may be traced—but even with less appearance of reason—the zeal with which the belief in man's *recent origin* on the earth has been maintained, and the suspicion and animosity excited by even a hint or conjecture at any possible higher antiquity of the race. The prevalent belief in the very recent origin of man, geologically speaking, depends wholly on negative evidence. And there seems no reason, from any good analogy, why human remains might not be found in deposits corresponding to periods immensely more remote than commonly supposed, when the earth was in all respects equally well suited for human habitation. And if such remains were to occur, it is equally accordant with all analogy to expect that they might be those of an *extinct* and *lower species*. The only real distinction in the history of creation which marks a supposed "human epoch" is not the first introduction of the *animal man*, in however high a state of organization, but the endowment of that animal with the gift of a moral and spiritual nature. It is a perfectly conceivable idea, that a lower species of the human race might have existed destitute of this endowment."—(Pp. 464, 465.)

The Professor here complains of the zeal with which the doctrine of man's recent origin upon earth is maintained, and the animosity excited by even a hint at the possibility of the higher antiquity of the race.

We have no wish to defend animosity on any subject,—it does no good; but we cannot think the zeal misplaced or misdirected which protests against baseless theories, the effect of which, if established, would obviously be to overturn the whole scheme of Christianity.

We admit that we do not find a perfect system of philosophy, either moral or scientific, in the Holy Scriptures. They were given to man for a higher and more important purpose than to teach abstract knowledge. But we do not admit that there is one word or statement in Scripture inconsistent with sound philosophy, or opposed to it; and we go a step farther and maintain that the steady progress of *Truth* in every department,—be it Biblical criticism, mental philosophy, physical science, or antiquarian research,—is rapidly adding to the proofs, already innumerable, that the Bible contains the words, while all nature displays the works, of the Almighty Creator and Preserver of all things, and that His words and His works are ever in perfect harmony—they cannot contradict each other.

Now, if there be any statements clearly made in Scripture, they are these: that " In the beginning God created the heavens and the earth;" and that " The Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life, and man became a living soul;" and, " In the day that God created man, in the likeness of God created he him;—male and female created he them, and blessed them, and called their name Adam, in the day they were created." —Gen. ii. 7; v. 1, 2.

On these two assertions, that God made all things, and that he made one man and one woman the progenitors of the whole human race, every Christian feels that the whole scheme of salvation, as revealed in Scripture, clearly depends, and Professor Powell need not be much surprised if assaults on these doctrines are not always received with perfect equanimity. It is no question, as he hints, p. 465, of doubtful Hebrew chronology—the precise period is of no consequence to it—the real question is, Did God make man, or did man make himself, or did he grow because he could not help it?

Our author complains that the proof of man's recent origin, "geologically speaking, depends wholly on negative evidence."

We confess we cannot see what other evidence applicable to the point in dispute can possibly exist.

The assertion is, that man did not exist on earth contemporaneously with the Ichthyosaurus, Pterodactylus and Belemnite, or even with the Anoplotherium and Palæotherium of a more recent epoch of animal life on the globe—or in other words, that man began to exist long after many races of plants and animals had passed away; and the proof is, that although myriads of the remains of these older beings have been discovered, no coeval trace of fossil man has been found.

What other proof can we have? True it is a negative proof—but does the case admit of any other? What *sort* of proof does the Professor expect? or what can we give but the fact that not one solitary fossil bone of man has ever been discovered, and until one be produced we are entitled to hold our negative proof as perfectly satisfactory.

The author, however, does not seem satisfied with complaining of the want of positive proof of the non-existence of man in ancient geological eras; he quits the regions of fact, and conveys his readers into the realms of fiction, and suggests the hypothesis of the existence of a race of animal men "destitute of the gift of a moral and spiritual nature."

The hypothesis is so monstrous that it is really difficult to deal gravely with it. There is scarcely any limit to the excursions of the human imagination—scarcely anything so ludicrous as not by possibility to enter at some time into a human mind.

It requires no great stretch of imagination to conceive of the possible existence of Lord Monboddo's men with tails, or Swift's inhabitants of Brobdignag or Lilliput—but these would be matters of fancy not of science, and until specimens of them be produced to us we shall feel perfectly warranted in denying their existence, and shall confidently rest our disbelief on the negative proof.

There is something very repulsive in finding such a mixture of fancy and philosophy in a work professing to treat of so great, so holy a subject as Creation.

There is another objection to Professor Powell's conception of a non-spiritual man—he is very ingeniously confusing two distinct things, and treating them as if they were one and the same.

What is the distinctive characteristic of *man* as a genus? nothing other than the inseparable combination of moral and spiritual nature with a body; and we must confess our imagination is not powerful enough to enable us to conceive of a being of whatever form, without moral nature, being a member of the human race—it is a gross solecism to speak of a man in such a condition, to call a creature without this moral nature a man of a "lower species"—*man* it cannot be, a *monkey* it may be. We cannot reason about such a being—we might as well attempt to discuss the merits of the learned Professor's book without the letter press, and call it in this state a most valuable contribution to solid science, as argue about the existence of this figment of the imagination.

Suppose for a moment that the fossil remains of such a being were to be found, how are we to recognize it, what are the peculiarities of the skeleton of an animal man? Shall we find the bones of the foot and hand to indicate plantigrade or prehensile members? or may we confidently expect the intermaxillary bone to be distinctly separate from the jaw as a proof of inferiority? No time should be lost in informing the scientific world after what objects their researches ought to be directed.

Had this subject occurred only in the passage quoted, it might scarcely have deserved our notice, and might have been allowed to pass as a mere idle flight of fancy, or at worst as one of those ephemeral visions which occasionally afflict and annoy the scientific world, for in the text there is no allegation of fact to support it.

In the appendix, however, an attempt is made to supply this want—not positively, but rather suggestively—not as a certain fact, but as a something which may possibly turn out to be the desired fact, and yet so expressed, we think, as to lead many readers into the supposition that there is a presumable basis for the soulless theory.

Every maker of theories is on the constant outlook for facts which suit his purpose; and it is a great misfortune that mere theorists, sometimes very clever and amusing, have a strong propensity to make facts bend to their theories, instead of accommodating their theories to ascertained facts.

We can conceive of Professor Powell glancing from one to another of the thousands of ascertained geological facts, but looking in vain for one which might serve as a basis, however slight and unstable, for his theory. Probably he looked to the Guadaloupe man ; but he has long occupied his true place in the geological world, and would loudly protest against any soulless theory being erected on his bones.

At last, he seems to have remembered (for though the most important assertion in the whole book, it is thrown into the appendix), that certain human remains had been found in excavating Mickleton Tunnel in 1852, and this is the solitary fact he has to produce in support of his theory, and even this he does not exactly bring forward as a fact, but rather as a possibility.

He states, p. 501, that the discovery appeared to call for a much more close examination of the case than it appears to have received.

We entirely concur in this desire, and to assist in this examination we applied to Mr Gavey, the engineer, who executed the works at Mickleton Tunnel, for information regarding it, and we have the pleasure of laying before our readers his simple statement of the facts.

Professor Powell refers to a paper by Mr Gavey, and a section of the ground, which appeared in the Quarterly Geological Journal for 1853, and from them he draws the distinct conclusion that these bones must have been deposited previous to a very long series of physical events (p. 503). This, in geological parlance, means long prior to the creation of Adam.

Professor Powell leaves us altogether in the dark as to whether he regards these bones as those of a perfect or of an inferior man, whether a specimen of the *Homo sapiens* of Linnæus, or of the *Homo non sapiens* of Powell.

Mr George Edward Gavey, who was on the spot, and seems to have observed all the details with great accuracy, and without any thought of preconceived theories on the subject, comes to the very opposite conclusion, and, as we think, for unanswerable reasons assigned by him. The following is the letter received from Mr Gavey, dated

Langford, near Heytesbury, Wilts,
January 7, 1856.

" I will try to answer your questions, and give you all the information that I am possessed of respecting the skeleton found at Mickleton Tunnel.

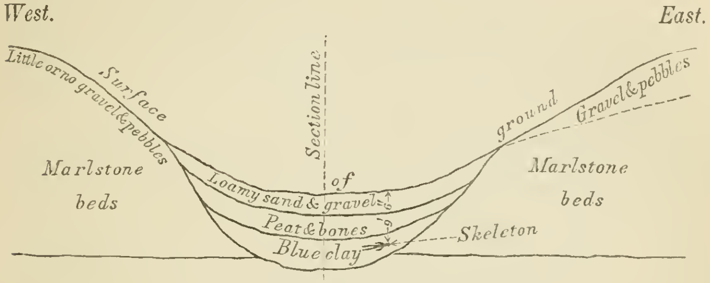
" I am not acquainted with Professor Baden Powell, nor have I seen his Essays; but if he brings forward the skeleton (mentioned by me in a paper on the Mickleton Tunnel) as a proof that man was in existence previous to Adam, he is greatly at fault, and can know but little of the great, though often imperceptible changes, which are continually taking place on the surface of the earth.

" The spot where the skeleton was found was, at no very distant period, covered with water, of about a quarter of an acre in extent; and the springs which issued out of the surrounding hills supplied this pond with water. One of these springs was still flowing when I was there, and the only outlet for the water was to the north into the Vale of Evesham.

" The hills which surrounded the pond on the three sides were at one time covered with timber, the remains and roots of which were seen during the excavation of the cutting; and the fern roots were found to have penetrated through the peat and into the blue clay, to a depth of nine feet below the surface.

" As to the existence of a pond, there can be no doubt; for, in the first place, we have the presence of light-blue clay, which is almost always found at the bottom of ponds, &c.; and, second, the remains of a large quantity of *recent fresh-water shells*, lying between the blue clay and the bed of peat, chiefly Planorbis and Pisidium, which are now to be found in the neighbouring ponds. During the excavation of the blue clay, the workmen discovered the remains of a HUMAN skeleton lying in a slanting position, the head to the west, and raised about two feet out of the horizontal. The head, arms, and thigh-bones were preserved; they were quite sound, and of a dark-brown colour. The skull and bones were examined by my friend Mr Cooksey, surgeon, of Chipping-Campden, and he pronounced them to be those of a man. The skull was small, but beautifully formed, having the *organ of Veneration* well developed. The thigh-bones would indicate that his stature was rather below the average height of men of the present day. There were five feet of blue clay *above* the skull, and four feet six inches of peat and loamy gravel resting on the clay; this will make the position of the skeleton to have been 9 ft. 6 in. below the surface; so that the unlucky Druid, returning from his sacrificial rites, must have fallen into the pond.

"In process of time the pond became more shallow, the formation of peat commenced, and being surrounded by timber and underwood, it became a resort for animals of various species, such as wild boars, deer, oxen, and foxes, the bones of which I found embedded in the PEAT, more or less broken. By degrees, gravel, loam, and drift pebbles were washed down from the hills above, and covered the peat to a depth of three feet. I therefore conclude that the time required to effect these changes of surface after the individual was drowned would not exceed 1800 years. The question may be asked, How was it that the gravel and pebbles were not washed down into the pond before the formation of the peat? To which I answer, that as the hills were at that period covered with underwood, it would very naturally retard the action of the elements upon the surface of the land; after the underwood which had helped to form the peat had ceased to grow upon the hills, from some physical cause, the surface of the country became exposed to the action of the weather, and becoming decomposed, was soon washed down from the neighbouring heights, and formed the superincumbent alluvial deposit covering the peat. I carefully examined the clay above the skeleton, and could not perceive that it had been disturbed, for the fern-roots which had penetrated into the clay were all in a perpendicular position. The skull, when found, was filled with blue clay; I did not perceive any fat, nor was the clay discoloured by animal matter. The peat above the clay was full of animal matter, and when burning gave out a very peculiar odour, differing from the smell of peat in general. The following is a section of the ground.



Shales of the Lower Lias.

"Such, my dear Sir, are the facts which I have collected, and my opinion on the subject; and I shall leave it with you to draw your conclusions respecting the skeleton, and its position in the clay. I shall be glad to know how far your opinion agrees with mine."

Mr Gavey has also sent the following communication from Mr Cooksey:—

Campden, 11*th February* 1856.

"The skull discovered at the Mickleton cutting was imperfect when it came into my hands; in fact, I have only the calvarium. Its dimensions, carefully taken, are,—from posterior edge of foramen magnum to insertion of nasal bones over the crown, $15\frac{3}{16}$ inches. From upper edge of one meatus auditorius to upper edge of corresponding meatus over crown, $13\frac{8}{16}$ inches, and the circumference taken in a line over the greater occipital protuberance, and just above the supraorbital prominences or ridges, $20\frac{4}{16}$ inches. The skeleton was that of a person beyond the middle age, judging from the density of the bones of the skull, the state of the sutures, and of the styloid processes of the temporal bones. No teeth came into my possession. Two or three days after its discovery, I went to the cutting with the intention of securing any remains I could discover, but I found the bones in so fragmentary a state, evidently the result of recent violence, that I did not remove them. As far as my remembrance serves, they were those of a person of average height, and this is, I think, in some measure borne out by the dimensions of the calvarium. The jaw and part of the skeleton of a sheep were found in close juxtaposition to the human remains. All the bones were in good preservation, as far as freedom from decay is concerned, presenting much the appearance of some which were known to date from the battle of Worcester, and which were exhumed about eighteen years ago, having lain in a dry and gravelly soil, but not inclosed in any coffin. I fancy the pre-Adamite was a drunken sheep-stealer who slipped into the pool or morass. The position of the body agreed, I think, with the incline of the sides of the punch-bowl shaped hollow.* I should tell you, that in the interior of the skull there was next the bone, but not extending over the whole cavity, a layer of fine sandy silt, and the remainder was filled with blue clay. Sundry of the small foramina had fibrous roots remaining in them, which appeared to me to have grown there."

After a very careful study of the diagram given by Professor Powell, and also of what he terms his six observations, but which we would rather call his six unsupported assertions, we could see no ground to think that even any considerable portion of the Adamic period had elapsed since this skeleton was deposited; all the alterations of soil, even as stated by Professor Powell, might well have occurred in two or three centuries. The facts now stated so clearly and distinctly by Mr Gavey and Mr Cooksey are at complete variance with the observations of Professor Powell, and fatal to the use which he wishes to make of the man of Mickleton Tunnel.

It is unnecessary to make any comments on these letters.

* The bones were in a slanting direction.—G. E. G.

Mr Gavey allows more time for the accumulation of the peat and detritus than appears to be necessary. Both accumulate under favourable circumstances with great rapidity. Mr Cooksey, from the appearance of the bones, compared with others of known age, points to a much more recent date. The exact age, even within two or three thousand years, is of no consequence as to the matter in dispute.

It scarcely requires the exercise of imagination to suppose that a man stumbling into a quagmire with a bottom of soft blue clay, would necessarily reach the bottom and sink a short distance into it, and the presence of *recent* shells now occurring in the neighbourhood, immediately above the clay and below the peat, the ordinary position of shell marl, is conclusive of the whole matter, and a *positive* proof that the whole accumulation is of very recent date, and probably not exceeding a few hundred years.

On the Rare Lichens of Ben Lawers. By Hugh Macmillan, F.B.S.E. †

Cryptogamic plants, and especially lichens, for very obvious reasons, are more widely diffused over the surface of the earth than phanerogamous plants. The extreme simplicity of their form and structure fitting them to endure an amount alike of heat and cold sufficient to destroy all vitality in more perfectly organized plants ; the minuteness and profusion of their germs of reproduction ; the facility with which these can be transported from place to place, and from one country, or even continent, to another, by the winds and waves, and various other agencies ; and their strong persistent vitality, by reason of which they possess, unimpaired for centuries, the power of germinating when the few simple circumstances necessary for that purpose are present ;—all these qualify them in a peculiar manner for carrying on their office as precursors or pioneers of vegetation in every region of the globe. Many of the lichens which grow on our own rocks and trees, are precisely identical with those found in similar situations on the continent, and in various localities both in Asia, Africa, and America ; and some species,

† Read before the Botanical Society, December 6, 1855.

and even genera, are cosmopolitan. Indeed, so widely are the same species diffused, that a flora which should represent all the lichens of one particular country, would, generally speaking, comprehend most of the species found in any other. It is worthy of remark, however, that, unlike all other plants, lichens are more widely distributed in proportion as they are higher in organization, and more complex in structure; all the British species of the genera Usnea, Sticta, Stereocaulon, Sphærophoron, Ramalina, and Cenomyce, which exhibit the highest development of lichenose vegetation, being found in one or other of their numerous protean forms, under almost every condition of latitude, altitude, and climate, although it is only in the more southern regions, where the humidity and temperature are more uniform, that we find them in constant fructification.

Although, however, lichens are so amenable to the different climatal conditions, and their zones of distribution in consequence wide and indefinite, the lichenist will find, from numerous examples, that they also, to a certain extent, obey the ordinary laws prescribed by nature for the diffusion of plants. Many species are confined to particular altitudes on the great mountain ranges of the globe; and their position at such fixed altitudes is to be accounted for by the same agencies and geological circumstances concerned in the migration of foreign flowering plants to the same localities. The lichens, for instance, which occur on the summits of the loftier Highland hills, and especially those of the great Breadalbane range, have as good a right to be considered arctic and Norwegian species as the flowering plants which bloom beside them; and hence the very ingenious and plausible theory which the late Professor Edward Forbes advanced with regard to the origin and distribution of our alpine phanerogamous vegetation,—and which is too well known to need repetition here,—is equally applicable to the lichens, for the same agencies were employed, and precisely at the same period of time, in the transmission of both. Other lichens, though sometimes very erratic in their choice of habitats, generally display a particular and remarkable attachment to certain kinds of rocks and certain soils, and follow these occasionally over extensive regions, and are found covering them in other countries, when all other circumstances are favourable; while many species affect particular trees, and are found only in countries where these are produced. The amount of heat, light, shade, and moisture, as well as other circumstances, in particular regions, are also to be taken into account, as operating considerably in the restriction or wide distribution of the lichens; for that they are as much sensible to these as the flowering plants, is abundantly shown, among many other proofs, by the varying quality and quantity of the dyes yielded by such of them as are possessed of colorific principles, according to the nature of the locality and the circumstances in which they are developed. All these conditions, then, of limitation or general distribution, furnish the student of geographical botany with sufficient data for the construction of lichen regions, which, if not so definite and well-marked as those of phanerogamous plants and the higher cryptogamia, is perhaps owing more to our extremely limited information with regard to the range of particular species in other countries, than to the actual vagueness and confusion of these regions in nature itself.

With these general remarks, by way of preface, I proceed to the more immediate object of this paper—the description of the rare lichens gathered during a recent botanical excursion to Ben Lawers. The importance and interest attached to this hill, as, upon the whole, the best botanical locality in Great Britain, producing a remarkably rare and peculiar alpine vegetation, are amply evinced by the frequent visits paid to it by botanists from all parts of the kingdom, who seem to regard it as a sort of Mecca, to which some time or other in their life, their science enjoins them to make a pilgrimage. These visits, however, in most cases, have been entirely devoted to the collection of the rare flowering plants and ferns with which the hill abounds, and to which ample justice, in the way of description, has been repeatedly done; while the lichens and mosses which it produces in equal if not greater profusion, have been very much overlooked, and but briefly and cursorily noticed, even by those who have made these obscure but deeply-interesting departments of botany the subjects of their particular and favourite study. That the claims of Ben Lawers to our notice, as a garden of rare cryptogamic plants, however, are great, is abundantly proved by the fact, that a great many lichens and mosses are found on its sides and summit which occur nowhere else in Britain, and one or two species nowhere else in the world, except in similar situations on the more elevated peaks of the great range of which it forms a part. The following list contains a slightly detailed account only of those species which are peculiar to the hill, or which occur only at a high elevation on the Scottish mountains, and which, from their rarity, their peculiarities of form, structure, and geographical distribution, or the fact of their being little known to botanists generally, would appear to possess especial claims upon our attention.

Bæomyces roseus, Pers. In great profusion on turfy banks at the foot of the hill. This lichen is very generally distributed throughout Sweden, Britain, Germany, and Switzerland; and is also very abundant on sterile clayey soils and sands in North America. The thallus forms very wide white pulverulent patches, covered with innumerable subrotund granulations of a larger size, sometimes slightly tinged with red, which seem to be the rudiments of apothecia. The stipes, unlike the podetia of the Cladoniæ, which they somewhat resemble in shape, are destitute of a cortical stratum. They produce on their summits subglobose flesh-coloured mycinæ, the whole surface of which forms a seminal layer, in which the naked spores are imbedded, their interior being formed of the substance of the stipes, and becoming at length empty and araneous. In the structure of its stipes and mycinæ, and in the peculiar odour which it exhales, this lichen bears a remarkable resemblance to several species of Hymenomycetous Fungi, particularly to some minute Leotia or Helvella. The presence of a crust, and the peculiar situations which it affects, alone prevent it from being included among the Fungi. Dr Küttlinger has a very valuable and elaborate paper upon its structure in the "Allgemeine Botanische Zeitung," 1845, pp. 577—584, and t. vi.

Verrucaria Hookeri, Borr. Abundant on the bare soil, composed of comminuted schist, and in the crevices of rocks, in the hollow near the summit. This peculiar lichen has been found nowhere else in the world than on the tops of the more elevated peaks of the great Breadalbane range and on Mynydd-y-Myfyi, one of the Welsh hills, where the Rev. T. Salwey states that he once collected a few meagre specimens. The form of the perithecium resembles that of Sagedia, a genus formed by Fries, in order to receive those anomalous lichens which form the connecting links or gradations between the genus Endocarpon and Verrucaria. The peculiar form of the thallus, however, consisting as it does of an aggregation of small tumid scales of a white colour, internally green, and the black, spongy, and somewhat hygrometric substratum upon which it rests, and in which the ampulliform tubercles are immersed, warrant us in giving to it what we imagine to be its proper and natural position in the genus Endocarpon, to one or two species of which it is certainly more closely allied than to any known Verrucaria. The sporidia, as Mr Leighton observes, and as I myself have ascertained by a careful microscopical examination of several admirable specimens, consist of two cone-like bodies, set base to base, with their sides somewhat contracted, or rather excavated, marked by one, three, or five, dark brown septa. The number of septa which I have found to occur most frequently is three ; and, in some cases, as when a sporidium has discharged its contents, only one is visible. There is another terricolate species of Verrucaria described by Acharius, under the name of *spongiosa*, which is possessed of a thick, green, spongy thallus, and immersed ampulliform apothecia, marked by a scarcely prominent ostiole ; but from the rude figure of it which he annexes, it appears to me to differ widely from the Ben Lawers plant.

Endocarpon laete-virens, Turner. At an elevation of about 2000 feet, on the east shoulder of the hill, growing along with *Lecidea icmadophila*, on broken banks of peat, or covering decayed masses of *Dicranum glaucum*. I have frequently observed this lichen, sometimes at a very low elevation, on turfy spots among the Breadalbane mountains ; and I possess specimens from Merionethshire, Shropshire, Sussex, Northumberland, Yorkshire, and Derbyshire. It is therefore, I think, more generally distributed over Great Britain than is commonly supposed. From its peculiar habit and appearance, as well as its total want of apothecia, I feel disposed to consider it the primordial thallus, or rather the metamorphosis of the squamules of some species or other of that very irregular and protean genus Scyphophorus, and not a distinct species at all. Schaerer, who often gathered it during his wanderings among the Alps, and who enjoyed more favourable opportunities of studying the development of lichens in their native haunts than perhaps any other botanist, considered it a young undeveloped state, somewhat altered by circumstances of situation and exposure from the normal appearance, of *Solorina saccata*, to which indeed it offers many striking points of resemblance. I have frequently observed minute, blackish, elevated, somewhat gelatinous points on the surface of the thallus. These resemble in external appearance the tubercles peculiar to the genus Endocarpon, but when examined under the microscope, they are found to exhibit a very different structure, being, in fact, nothing else than the Itzigsohnian corpuscles, or spermagoni, so ably described by M. Tulasne, in his elaborate paper upon the reproductive organs of lichens, in the *Comptes Rendus* for March 24, 1851, and which are very common on the surfaces of various species of lichens, and especially of such as rarely produce their more normal organs of fructification, such as ascigerous apothecia, gonidia, gemmæ, &c. They bear a close resemblance to the Ascomycetous Fungi, and especially the Coniomycetous forms Cytispora, Septoria, &c., consisting, as they do, of little cavities or utricles opening on the summit by an orifice, and filled with a thin transparent mucilage, in which are contained a number of linear filaments of extreme tenuity, and somewhat curved, which vibrate slowly in every direction, perhaps only with that molecular movement so universally observable in extremely minute bodies, whether living or dead, lying in a fluid. These bodies were regarded by Major Von Flotow as young undeveloped spores; while Itzigsohn considered them animalcules endowed with a movement of translation, and capable of developing themselves, like spermatozoids in the lenticular cells of lichens. By the majority of botanists they are supposed to be the analogues of the spermatozoids produced in the antheridia of the Algæ and Muscineæ, and to perform the same functions.

Sagedia cinerea, Fries. On the summit, on rocks covered with earth, on the bare micaceous soil, or on decayed mosses, very sparingly. This interesting lichen, the *Endocarpon tephroides* of Acharius, of which several specimens were gathered during a late trip, is much more common on the mountains of Sweden, Lapland, Germany, and Switzerland, than in Britain, where only a few stations have been recorded for it. The thallus, which is usually pruinose, somewhat foliaceous at the circumference, and cinereous, although it varies very widely during its different stages of growth,—is very often broken and cracked, revealing the pale yellow or whitish medullary layer, which, under the microscope, is found to consist of slender linear cells, closely packed together, and with few air-passages. It rests upon a dark, spongy, very compact hypothallus, attached to the soil by numerous articulated fibres. The membranaceous spheroidal exciple is remarkably slender, and terminates at the apex in a very minute pore, for the ultimate discharge of the narrow, oblong, uniseptate sporidia, eight of which are generally contained in each ascus.

Endocarpon sinopicum, Ach. On masses of yellow hone schist built into the walls at the foot of the hill. This rare and beautiful species invariably affects this kind of stone, looking as if coloured with the oxide of iron, which it contains. It occurs in a very fine state, and in great profusion, on the moorland dikes above Aberfeldy. In North America, according to Tuckermann, it is frequent on the alpine and subalpine rocks of the higher mountains. It is also found on the Lapland and Swedish hills, and on the Alps and Pyrenees. Fries was disposed to regard both this species and the *E. smaragdulum*, which is also very common on the same walls on Ben Lawers, merely as states of *Patellaria badia*, in which the areolæ are dispersed and squamaceous, and the apothecia not being sufficiently developed, subimmersed, and punctiform. The appearance and colour of the thallus in normal specimens of *Patellaria badia* are certainly widely different from those of these two species of Endocarpon; and the difference is still greater between the polished black apothecia of the one, the disk of which is furnished with an entire persistent thalline margin, and the minute, depressed, and immersed tubercles of the other. There is one circumstance, however, which seems to confirm the apparently unfounded opinion of Fries, (provided it be proved in addition by specimens exhibiting all the gradations, that the thallus and apothecia of the Patellaria become so degenerated as to assume the appearance which these Endocarpa present) and that circumstance is the presence, in *E. sinopicum* and *smaragdulum*, of curved and somewhat branched paraphyses, of which the section of a tubercle shows an immense number, arranged among the oblong obovate asci, in the peculiar manner which we observe in the patellulæ of Parmelia, Lecidea, &c., it being proved by Leighton and other investigators, that in the true Endocarpa there are no paraphyses intermingled with the asci.

Lecidea sanguinaria, Ach. On pine trees at the foot of the hill on the east side, in a very fine state, and in great profusion. This lichen is very common on trees and stones throughout Europe and North America. A vertical section of the black, convex, tumid apothecia, exhibits a bright blood-red stratum beneath. The spores are ellipsoid, unilocular, very thick, and are generally solitary in every theca.

Lecidea muscorum, Ach. On mosses at a considerable elevation, abundant. It is this lichen which springs up on flower-pots when kept moist and warm; the pulverulent crust which it at first forms on the mould becomes gradually more solid, till at last the plane, black, hemispherical patellulæ appear. Acharius' variety β *geochroa*, distinguished by its much thicker leprous-tartareous crust, also occurs sparingly on the hill.

Lecidea flavo-virescens, Borr. On the turfy tops of walls, and on rocks covered with moss and earth at the foot of the hill, common. The *Lecidea citrinella*, var. β *scabrosa* of Acharius, is the true *Lichen flavo-virescens* of Dickson; and the present species, therefore, should bear the name originally given to it by Acharius. Two varieties were well distinguished by Schaerer, under the names of α *vulgaris* and β *alpina*. The former grows upon the bare earth, and on sandy soils on the tops of old dikes, and has a somewhat pulverulent, bright yellow crust, sprinkled with an immense number of minute black apothecia; while the latter encrusts decaying mosses, especially of the genus Andraea, on dry rocks, and is distinguished by a thicker and more tartareous crust, of a greener colour, and by larger, more confluent, and tumid apothecia.

Lecidea fusco-lutea, Ach. On decayed mosses on and near the summit, very sparingly. This rare lichen, also found at considerable elevations on the Swiss Alps, and on mosses in Arctic America, forms a very thin irregular leprous or tartareous film of a dirty gray colour, encrusting the bare earth, or running over mosses and decayed alpine plants; and may easily be mistaken, when found destitute of fructification, for the *Lecanora tartarea*, var. γ *frigida*, which affects the same kind of situation, and is very common on the hill. The dull yellow apothecia, however, are very peculiar and characteristic, and serve to render the plant sufficiently conspicuous. They vary considerably in colour, according to the more or less exposed nature of the situation in which they are produced, and are surrounded by a narrow border formed of their own disk, and of the same hue. They are first developed in the form of minute yellow spherules, marked at the apex with a small opening or ostiole; these increase in size, the margin becoming gradually thinner, until at length in the mature individuals, which are about two lines in circumference, it becomes very slender and flexuose, and is sometimes even entirely concealed by the concave or tumid disk. The apothecia often occur in all these stages of growth on the same individual plant, some of them scarcely visible, others fully developed—some deeply immersed in the thallus, others so superficially inserted on its surface that they seem to be connected only by a minute point in their centre—some furnished with an even and naked border, and others assuming almost a crenate appearance from the thin leprous particles of the thallus which adhere to them. Fries suspected this plant to be a state of *Biatora ferruginea;* and Schaerer considered it the variety α of *Lecidea aurantiaca* of Flörke. The synonymy of these lichens, however, is involved in almost hopeless confusion; and it would be very desirable that the Rev. Mr Leighton would pay particular attention to it in the Monograph of the British Lecideæ, upon which he is at present engaged. Although I have affixed Acharius' name to the present species, I am not quite sure that the plant which he described, at least his variety α, is precisely identical with the plant found on Ben Lawers.

Lecidea polytropa, Ach. Most abundant on stones built into dikes at the foot of the hill. This lichen appears to be merely a saxicolate variety of *L. Ehrhartiana*, for the sporidia are the same in both. These sporidia are very minute, broadly-linear, pale-yellow ; each ascus containing eight. On the Pyrenees, Desmoulins found this species at a height of 9000 feet; and Liebmann gathered a few specimens on the Mexican volcano Orizaba, at an elevation of 14,800 feet,—about 200 feet above the highest phanerogamous plant. Saussure also brought specimens of it, along with *L. confluens*, from the highest point of Mont Blanc.

Lecidea geographica, Ach. This most beautiful and ornamental lichen is very common on Ben Lawers, and on all the other mountains of the Breadalbane range. On the British hills, it occurs on granite, mica slate, and quartzose rocks, from an elevation of 500 or 600 feet upwards. It extends northward to Arctic America, and southward to the Antarctic regions. It was found by Agassiz at an elevation of 14,780 feet on Mont Blanc ; by Dr Hooker at a height of 19,000 feet on the Himalayas ; and it occupied the last outpost of vegetation, formed the last effort of expiring nature which gladdened the eyes of the illustrious Humboldt, when within a few hundred feet of the summit of Chimborazo in South America. I have been particularly struck with its immense profusion and its extreme beauty on the smooth quartzose rocks on the broad level ridge near the top of Schiehallion, which appears as green with it as a meadow with grass.

Lecanora frustulosa, Ach. Forming scattered irregular patches on the rough weather-worn micaceous rocks near the summit ; abundant in the hollow where *Saxifraga cernua* grows. This lichen is found nowhere else in the world than on the summits of the higher Breadalbane mountains. Dickson, its discoverer, in his description of it, speaks of a black hypothallus ; but it is evident that he here confounds it with the *Verrucaria Hookeri*, specimens of both of which he may have found intimately associated together, as they sometimes are. Acharius fell into the same mistake, for he says,—"*Crustæ stratum duplex; inferius rugosum nigrum latius expansum, superius centrum thalli magis occupans diffractum ex areolis difformibus albidis lævibus.*" The true *Lecanora frustulosa* is composed of numerous tartareous fragments of a pale greenish-white colour, internally white—varying in size from the fourth of a line to an inch in diameter, and separated frequently by wide intervals from each other. The apothecia, when they occur on the crust, are small, circular, and of a dark brown colour, with a plane, tumid, sometimes irregular and crenate border, formed of the thallus. Sometimes they are aggregated or clustered together, as many as four or five occurring on a single wart, not more than two or three lines in breadth; they are oftener, however, found in a solitary state, or scattered here and there on the rock without a morsel of crust adhering to them. The figure in English Botany is admirably characteristic. My own conviction, however, is, that it is not a distinct species at all but merely an alpine saxicolate state of that very protean lichen, the *Lecanora subfusca*, assuming a scattered frustulose appearance from the rugged and irregular surface of the rocks upon which it grows. The apothecia of both are precisely similar, and equally variable in colour; in some states closely approaching those of *L. atra*.

Lecanora tartarea, γ *frigida*, Ach. This lichen, common on decaying mosses at a considerable elevation on the front of the hill, was well distinguished by Swartz, Smith, and Dickson, and presents a peculiar and easily recognisable appearance. It differs considerably from the more common and abundant form, β *upsaliensis*, both in the diminutive size and circular shape of its apothecia, the deeper yellow of the disk, the peculiar nature of the bristles of the crust, and in its less thick and tartareous structure. It is a form peculiar to the Highland mountains, where it occurs only at an elevation of from 2000 to 3000 feet.

Squamaria leucolepis, Hook. On rocks near the summit, on the west shoulder of the hill. The localities, however, where it most abounds, appear to be the rugged precipitous cliffs immediately above the head of Loch-na-cat, and the rocks where Professor Balfour's party discovered the *Cystopteris montana;* but even there only a few isolated specimens occur, and cover the rocks in such a manner, the thallus running across the cleavage, that only small and very unsatisfactory fragments can be detached by the chisel. This is another of the lichens only found on the Breadalbane mountains in Britain, where, as in Norway, it sometimes encrusts dead alpine mosses of the genera *Trichostomum* and *Grimmia.*

Squamaria gelida, Delise. On the bare earth, and on detached micaceous blocks near the summit. This lichen occurs not unfrequently at very low altitudes on the Breadalbane mountains, always growing on micaceous rocks and on granite boulders; and the apothecia are not unfrequent. It has a very wide geographical distribution, inhabiting Northern Europe and Iceland, occurring at a high elevation on the Norwegian, Scottish, and Swiss Alps, and is very common and fertile in New Zealand. Specimens of the common British form have been gathered by Dr Hooker on Kerguelen's Land during the antarctic voyage, and others of a variety which he denominates *β vitellina*, from the pale yellowish colour of the thallus; both very abundant. The reddish-brown radiate warts, which occur about the centre of the thallus, afford a prominent mark to distinguish this species from every other lichen. The apothecia are very beautiful in wet weather, the disk being of a bright rose or flesh colour. The lamina proligera, however, is very thin, and almost invariably falls out in old specimens, or where the lichen is very much exposed to the light and heat of the sun, leaving behind a dark-coloured rugged cavity.

Squamaria lentigera, Decand. On turfy banks at the foot of the hill, rare. This lichen is characteristic of a calcareous soil.

(*To be continued.*)

On the Germinating Spores of Cryptogamic Plants.

By CHARLES JENNER.*

There are no subjects in the whole range of botanical inquiry more interesting in themselves, or the investigation of which promises more important physiological results, than the nature of spores, and their relation to the plants which give them origin. The bodies which bear this name are produced under circumstances so diverse, are of structure so different, and serve such varied purposes in the economy of cryptogamic reproduction, that it may be said with truth, that, for the student of vegetable physiology, there is no term more necessary to be understood in all its applications than the word *Spore.*

Our elementary works on Botany still define a spore to be "the ultimate germinating cell of cryptogams;" and this definition so thoroughly corresponds with the original idea of the body, that if, to the extent of our knowledge, the use of the phrase was restricted in its application to such a body alone, nothing could be more unobjectionable. It is quite clear, however, that *all* the bodies which bear the general name of spore, have not this simple character.

The free germinal cells of the Algæ, Lichenes, Fungi, and Musci; also those of Filices and Equisetaceæ, and the complex primitive structures of the Lycopodiaceæ and the Marsileaceæ, all still receive the common name of spore, although it is indisputable that there is a most essential difference between the simple spore of Vaucheria and the prothallial spore of a Selaginella.

This inexact application of the word spore has arisen from the imperfect knowledge in earlier times of the process of reproduction among the lower plants; and the term can only be regarded as having had a negative meaning. The embryo, with its integuments, having been defined as a seed, those bodies which separated from the parent organism, and gave origin to new plants, yet came not within the definition of seeds, and still were not buds, were all roughly associated together under the name of *Spores.*

* Read before the Botanical Society of Edinburgh, Feb. 14, 1856.

Before the introduction of the microscope our powers of observation were wholly inadequate to the successful study of minute structures. The possession of this instrument enabled us to pursue investigations far beyond the narrow limits to which we had before been confined, and it was soon successfully applied to the examination of the processes of vegetable reproduction.

We have already, in these comparatively early days, such a rich accumulation of well observed and carefully recorded facts, relative to the development of vegetable tissues, and the generation of new vegetable organisms, that encouragement is given to hope that the time is not very far distant, when it may be possible to establish for vegetable physiology, laws as exact as those demonstrated to prevail in physics. Physiology will only, correctly speaking, have become a science, when the laws are fully established by which the development of vital organisms are governed.

The application of the powers of the telescope to the investigation of the nature and motions of the heavenly bodies, has resulted in the determination of the laws which regulate these motions. Astronomy has thus become a science based upon laws, and its exactitude mainly determines its high rank among other sciences, and also constitutes its chief worth to man. The value of the telescope, as an aid to such issues, can scarcely be overrated, and yet it promises to be transcended in importance by the service of the microscope in the investigation of vital phenomena.

Among the later results which this instrument, in able hands, has secured to us, is a knowledge of the details of the process of fertilization and germination in the higher cryptogamic plants. By the indefatigable and wisely directed labours of Nägeli, Zuminski, Unger, Mohl, Hoffmeister, Bischoff, Mercklin, Henfrey, and others, we have been put in possession of a series of facts which determine generally the process by which new individuals arise in these families of the vegetable kingdom. The inquiry into the origin of the germ of a new life must always remain the subject of highest interest to man, but the subject second only in consideration to him, is the process by which the new organism attains to an independent existence. We have now sufficient knowledge to enable us to take a comprehensive view of the nature of the various bodies by means of which the generation of new plants, and of their establishment in freedom, is effected in the higher cryptogamia. With our present knowledge of the structural differences of the spores of the cryptogamic plants, the retention of the present general simple name for them *all*, is hardly defensible; and it seems at this time possible and appropriate, at least to indicate by name the prothallial spores from those that do not develop prothallia. Although the nomenclature adopted in this paper does not entirely express the structure and functions of the spores (to do which would be the highest excellence of new names for them), still it will serve, in the meantime, to separate the thalloid spores from others whose structure and course of development are essentially different.

Notwithstanding the great diversity in the size and form of seeds, and in the nature and structure of their contiguous tissues, there is still such a general conformity in the essential character of the embryos enclosed within them, as to justify, in a great measure, the application to seeds of a common name. The multifarious kinds of fruits with which seeds are associated, and the very general development of them in a collected form, disturbs the idea of uniformity, with which otherwise we should be impressed. Thus, the varieties of seeds are of quite a different character from the varieties of spores. Indeed it may be said of seeds that they are of a homogeneous character, always possessed of the same relative importance to the whole life of the plant, independent altogether of the structures with which they are in relation; whereas spores are truly heterogeneous, there are absolute distinctive differences between them, some have a different history of development from others, and they vary from each other in the purposes they subserve in the economy of the life of the plant.

If we subtract from the vegetable kingdom, all the seed-bearing plants, or those which develop a more or less complete embryo in funicular attachment with the parent plant, there remain the vegetable organisms which Linnæus and others have named Cryptogamia, and the reproduction of all of which, from Algæ to Marsileaceæ, is said to be by spores.

This series of plants consists, according to the arrangement of Lindley, of two great classes, Thallogens and Acrogens.

The *Thallogens* include three of his Alliances, *Algæ*, *Fungi*, and *Lichenes*. Although the mode of reproduction even throughout these three alliances, is not of a uniformly simple character, and although the germinating cells which result from coalescence are not distinguished from those of strictly partheno-genetic origin, still it is not my design to enter upon the consideration of the spores of Thallogens at this time. We shall therefore pass over these comparatively primitive germinal cells as being beyond the immediate purpose of this paper.

The plants that remain to be considered, are those which Lindley groups together in his class *Acrogens*. We may observe that these are likely to be better known in future as the Higher Cryptogams.

The *Acrogens* are arranged under three Alliances,—*The Muscal Alliance*, *The Lycopodal*, and *The Filical*. Lindley includes the *Equisetaceæ* in his Muscal Alliance, but the history of the development of this order has shown that they fall rather to be classed with Filices; and under that head we must place them.

Having regard, then, to the morphological import of the spores of Acrogens, we shall first divide these three alliances, with reference to their spores, into two great groups—one great group having *Athalloid* spores, or spores which do not develop prothallia; the other group having *Thalloid* spores, or spores which in germination develop prothallia. The first will include the whole of Lindley's Muscal Alliance, exclusive of the Equisetaceæ; the other will consist of the Filices, with the Equisetaceæ, the Lycopodiaceæ, and the Marsileaceæ. The latter, or the Thalloid group, we shall subdivide into two classes,—*Exothalloid* and *Endothalloid*.

The Filices and Equisetaceæ will constitute the Exothalloid division, as in germination the spores of these plants develop their prothallium *external* to the spore-cases. The Lycopodiaceæ and the Marsileaceæ will constitute the Endothalloid class, as the spores of these plants develop their prothallium *within* the enclosure of the spore-case. Thus :—

Athalloid Spores.	The Muscal Alliance.	Hepaticæ.	Ricciaceæ.
			Marchantiaceæ.
			Jungermanniaceæ.
		Musci.	Andræaceæ.
			Bryaceæ.
Thalloid Spores.	The Lycopodal Alliance.	Endo-thalloid Spores.	Lycopodiaceæ.
			Marsileaceæ.
	The Filical Alliance.	Exo-thalloid Spores.	Equisetaceæ.
			Ophioglossaceæ.
			Polypodiaceæ.
			Danæaceæ.

Throughout the plants comprising the Muscal Alliance there is a general uniformity in the process by which spores are developed, and also in the manner of their germination. The spore gives origin to a vegetative axis, either directly, or indirectly by a protonematoid or filamentous extension. The vegetative axis is creeping or erect, leafless or leafy, and it bears in axils, or at its terminal point, upon the same plant, or upon different plants, *Antheridia* and *Archegonia*. In the basal cavity of the archegonium, before communication is established with the outer space, a spherical nucleated germ-cell is formed. By the absorption of the central cells of the papillæ of the archegonium, a channel is established by which an antheridian filament or phytozoid finds ingress to the germ-cell, and it is believed becomes confluent with the germ-cell. Development ensues at once—the germ-cell divides itself into two portions by an oblique septum, the hemispherical upper portion divides itself by a vertical cross septum, and a second septum follows at right angles to this. The superior hemispherical portion of the germ-cell is thus quarternately divided. A horizontal division now takes place, and the four upper cells become eight cells. The body at this time consists, of course, of nine cells, the inferior half of the germ-cell having undergone no change. Transverse divisions, parallel to the first horizontal division, follow, and thus there is formed a cylindrical column with a hemispherical summit crucially divided. The superior third of this body becomes the capsule, the middle third becomes the peduncle ; and in the Jungermannia the lower third becomes the involucre. It is only necessary here to trace to its development that section of this body which goes to form the capsule and its contents. The peripheral cells of this portion commence independent division, and by a series of septa, perpendicular to and parallel with the surface, there is formed a thin layer of tabulated cells, the future wall of the capsule. The central cells do not participate in this act of division ; they simply enlarge, and become the parent cells of spores, and also of elaters, when elaters are present. The cells from which spores are to be formed, assume a spherical shape. By a process of bulging, this spherical cell becomes tetragonal. The result of further constriction is the formation of four egg-shaped sacculi, connected with each other by their narrow ends ; within each sacculus is formed a delicate vesicle, with a central nucleus —a mother-cell of spores. Two lateral nuclei are next established within this vesicle, and the central nucleus is absorbed. Each of these lateral nuclei becomes a central nucleus, and each of these, in its turn, gives place to other lateral nuclei, and becomes absorbed. A repetition of this process results in the formation of a great number of nucleated cells, which secrete cellulose upon their surface, become invested with a coloured dense membrane, and constitute the spores.

The subsequent ripening of these spores, the elongation of the setæ, the development of the calyptra and of the peristome, &c., are mere accessory conditions, varying in different genera, and are not to be regarded as in any way really essential. If any analogy is to be established between the sporocarp of a moss and the frond of a fern, it must be shown to exist at this early stage.

Having thus detailed (although necessarily in a very cursory manner) the nature of the athalloid spores of the plants of the Muscal Alliance, I pass on to the consideration of the thalloidal spores.

In our narrative of the development and germination of the athalloid spores, we started with the formation of a free germ-cell within the basal cavity of an archegonium seated upon the main vegetative axis of the plant. This germ-cell, after fertilization, as it is called, by an antheridian seminal filament, commenced a course of cell-increase, which resulted in the independent division of some cells as the capsule, and in the isolation of others from which spores are evolved. The spores are the direct result of a fertilized germ-cell, and before new spores can be developed on the leafy axis of a moss, a new archegonium has to be formed, and a fresh process of fertilization must take place.

In the plants which produce thalloid spores, however, the spores are Partheno-genetic or virgin-born; they are not the result of fertilization, they do not originate within an archegonium. For although spores borne upon a frond or stem which directly emanates from the fertilized germ-cell of a prothallium, may be called the indirect product of a fertilized germ-cell, yet in all those Ferns in which the fronds are perennial, in the Lycopodiaceæ and in Marsileaceæ, new fruit axes are formed, season after season, bearing their new clusters of spores, independent altogether of any antheridia or archegonia. In fact, neither new antheridia nor new archegonia are necessary to the production of new spores in the Filicales and Lycopodales. This seems to constitute a distinction between the thecigerous seta of a moss and the sporangiferous frond of a fern, which has not been sufficiently dwelt upon. And it would appear to set at rest all question of homological relation between them, or the spores they respectively bear.

In the Filicales and Lycopodales we have seen that the spore originates independently of any archegonial organ or fertilizing influence. Indeed, it is the spore in germination which develops the structure upon which the fertilizing organ and the organ to be fertilized are situated. To trace the development and germination of the athalloid spores in Muscales, we began with the archegonial germ-cell; but to trace the development and germination of the thalloidal spores, we must go back to a period anterior altogether to the existence of an archegonial germ-cell, for the archegonium is borne upon a structure emanating from the spore itself.

I shall briefly narrate the formation and germination of the spores of Ferns in illustration of the spores which I have termed *Exothalloid.*

Upon the frond of a Fern, at a point corresponding to the termination of a vascular bundle, a few cuticular cells are up-raised from their connection with the cellular tissue below. Into the lacuna so formed a few cells of the elongated tissue which accompanies the vascular bundle, bulge upwards, forming small ovoid projections. A septum is then formed across each cell, parallel with the surface of the frond, and as the apical cells continue to enlarge and elongate, new septa parallel to the first continue to form themselves. The terminal cell of each cellular column becomes nucleated and assumes a spherical form. By the formation of successive septa at varying angles of divergence, the terminal cell becomes divided into a peripheral layer of smaller cells, surrounding two or three large cells, each with a central nucleus. The peripheral layer becomes the wall of the sporangium, and the nucleated central cells give origin to the spores. Two lateral nuclei appear in each of these central cells, the central nucleus becomes absorbed, and a septum is seen to form itself across the cell. A frequent repetition of this process takes place. Around the later-formed nucleolar centres, a coloured cellulose membrane (the epispore) is formed, and the endospore is subsequently perfected within it. The *spore* of the fern thus formed, is prepared for dispersion, and when sown in a humid atmosphere at a somewhat high temperature, the inner membrane of the spore forces open the brittle outer coat, and a clear delicate vesicle bulges out, chlorophyll is formed in this vesicle, and a few (less or more) transverse divisions take place; then follow some longitudinal walls, which as they increase diverge more and more from the longitudinal line of the axis, until they are ultimately at right angles to it.

The flattened layer of cells thus formed is the prothallium. Its outline is at first somewhat circular, but it soon assumes a bilobate shape. Upon this thalloid structure are formed the antheridia and the archegonia. As we have only here to do with the relation of the spores to the development of the new plant, we shall confine our remarks to the formation of the archegonium, and the subsequent development from within it. At the base of the indentation which separates the two lobes of the prothallium, some cells of the under surface undergo division by horizontal septa; a flat cushion of cellular tissue is thus formed upon the lower surface of the prothallium. Some cells in this cushion, distinguished from the others by their more grumous contents, give origin to archegonia. A cell so destined divides itself by a horizontal septum into two portions; the superior or superficial portion of this cell gives origin to the superstructure of the archegonium, the inferior or deeper portion becomes the germ-cell. At a subsequent period a channel of communication is established, leading to the basal cavity of the archegonium which contains the germ-cell, and by this channel an antheridian seminal filament obtains ingress, and it is believed coalesces with the germ-cell. Active cell-development at once ensues, and, by a continually multiplying process of cell-division, the frondose stem or leafy axis of the fern arises.

The development of the Equisetaceæ corresponds in all essential particulars with that of the Filices.

To illustrate the character of the *endothalloid* spore, we shall narrate the formation and germination of the large spore of Selaginella.

Spores are developed in the Selaginella on special branchlets, differing from the vegetative branchlets. The spores arise in the axils of the leaves. In some species, sporangia and oophoridia (small spore-capsules and large spore-capsules, microspores and macrospores) are irregularly interspersed on the fertile branches; in others, the undermost capsule only in each fruit-branch becomes an oophoridium. Hoffmeister notices no difference in the early development of the fruit-capsule, whether it is destined to become a sporangium with small spores, or an oophoridium with large spores. It is only requisite here to narrate the development and germination of the large spores, those that produce prothallia in their interior. The first appearance of fructification is indicated by the division of a cell at the periphery by a wall perpendicular to the surface, followed by a succession of walls, at angles varying from 45° to 90°. The nascent sporangium soon appears as a hemispherical swelling, consisting of a peripheral layer of cells having a large central cell resting on a vertical line of cells. The peripheral layer becomes the wall of the oophoridium, the vertical line of cells the peduncle, and the central cell is the primary mother-cell of the large spores. The cells of the peripheral layers divide themselves repeatedly by perpendicular walls, and twice by walls parallel with the surface, thus becoming a triple layer; the cells of the peduncle also divide by walls perpendicular to and parallel with the line of its axis and the *central cell appears as the uppermost of a central line of cells which passes through the peduncle.* The central cell multiplies itself by divisions in all directions, and soon assumes the form of a central group of globular cells, with grumous contents and large nuclei. When large spores only are destined to be developed, *one* of this central group of cells undergoes further division. The four large spores which the oophoridium afterwards contains, are formed by division of this one cell by three double walls diverging from the centre of the cell at an angle of 120°. The primary mother-cell is thus divided into four daughter-cells of a tetrahedral form; these are the special mother-cells of the spores. In each of these four cells there immediately appears a delicate-walled cell—*the spore.* These cells are soon left free by the dissolution of the wall of the mother-cell, and then they assume a globular form. Soon after the separation of the spores, the outer spore-case is formed, and an interior hyaline membrane is next seen within. The spores at this time float freely in the fluid contents of the oophoridium, along with the numerous unchanged sister-cells of the one cell, which, by division, became the mother-cell of the spores. These sister-cells subsequently disappear. The prothallium has its origin upon that part of the surface of the hyaline membrane within the spore-case, where the four cells were in contact with each other, as they lay within the mother-cell. The prothallium appears as a cellular expansion of a circular form lying upon the interior spore-membrane. In the course of its development, it becomes much thicker at the centre than at the borders. The contents of the inner space of the inner spore-membrane consists of albuminous and oily matter. So constituted, the large spore falls from the oophoridium.

When the large spore is shed from the oophoridium, the prothallium consists only of a single layer of cells; but a few weeks after sowing in a humid atmosphere, at a somewhat high temperature, further development of the prothallium takes place by division-walls, formed perpendicular to and parallel with the surface. The increase of cells commences at the centre, and proceeds thence towards the periphery. Archegonia form themselves before the second division, by transverse walls. The first archegonium is formed at the apex of the prothallium, by division of one of the cells into an upper and an under cell by means of a horizontal wall. The upper cell is next divided by a perpendicular wall, and in each portion there is subsequently formed a transverse septum, at right angles to the perpendicular wall. The four narrow cells which thus overtop the basal cell are again divided by a transverse wall, and the topmost cells arch themselves up above the surface of the prothallium. The papillæ thus formed separate a little from each other, so as to open a channel of communication with the basal cell of the archegonium, in which a nucleated germ-cell has formed itself. After fertilization,—effected, it is presumed, by the ingress of a spermatic filament,—there is immediate division of the germ-cell. Rapid multiplication of cells by division-walls in every direction follows, and the young plant, with its stem, root, and leaves, is evolved in connection with the prothallium, while it is yet contained within the spore-case.

In all particulars essential to the purpose of this paper, the formation and the germination of the spores of such of the Marsileaceæ as have hitherto been made the subject of investigation, resemble that of Selaginella.

It thus follows that there are in the higher Cryptogams three classes of spores, possessing sufficiently distinctive differences to justify, if not to necessitate, the application to them of distinctive terms. I have used the phrases *athalloid* and *thalloid*, *exothalloid*, and *endothalloid*, but I am by no means prepared to say that these are the best terms to be found for them. These names suggested themselves to me during the preparation of this paper, as expressing, in a plain and simple manner, the differences on account of which I urge a distinctive nomenclature. I do not apprehend that any difference of opinion will arise as to the diverse character of the spores; for there is a common acquiescence as to the general structure of them; and the whole course of their formation and germination is patent to the observation of the youngest student, who has attained to tolerable skill in manipulation, is in possession of a fair microscope, and has the necessary stock of patience and perseverance.

An Account of an Earthquake-Shock on the 30*th of May* 1855; *and of an Extraordinary Agitation of the Sea on the* 6*th of June* 1855, *in Penzance; with observations on the cause of the latter.* By RICHARD EDMONDS Jun., Esq.*

On the 30th of May 1855, about three o'clock in the afternoon, some houses in Chapel Street opposite the gates of St Mary's Churchyard, and part of the boundary of Penzance harbour, experienced a sudden shaking, like that occasioned by a heavily-laden waggon passing over a rough pavement. This continued not less than sixty seconds, being very sensibly felt by all in these houses. Whilst it lasted, glasses standing on a tray were heard to strike against each other. No carriage of any kind was then passing.

In the afternoon of the 6th of June 1855, the day before the moon's last quarter, an extraordinary oscillation of the sea occurred in the tidal harbour of Penzance, the sea rushing in and out several times like a very strong tide, alternately floating and leaving dry boats which drew three feet of water. It was attended with a great eddy at the pier-head. In no other part of Mount's Bay or elsewhere does the agitation appear to have occurred. As usual on these occasions the barometer was at a minimum—the minimum at 3 P.M. being 29·63, which is lower than it had been for ten days before and six days afterwards. The time occupied by each efflux, as well as by each influx, appears to have been about five minutes; but whether the agitation commenced with an efflux, as is generally the case, or with an influx, I have been unable to ascertain.

Authors have endeavoured to maintain that these agitations of the sea, unless accompanied with known earthquakes, are occasioned by storms or mere atmospherical causes;† but that now described was unaccompanied with any storm, and as I consider them to be the effects of submarine shocks of earthquakes, I will, on this hypothesis, endeavour to account for some of their most striking phenomena.

* Read before the Royal Geological Society of Cornwall, Oct. 19, 1855.

† Edinb. Trans., vol. xv., p. 609.

In reference to the agitation of the sea at Penzance on the 6th of June last, it is necessary to state that at the mouth of Penzance harbour the depth at low water is one fathom, which depth towards the S.E. and S.S.E. (the most open part of Mount's Bay), gradually increases until at the distance of about one mile it becomes ten fathoms, as I find by the chart published by the Admiralty in December last.

It is proper also to state that a shock passes through wood of different kinds on an average about 15,000, through baked clay about 10,900, and through the sea about 4738 feet per second, which last is about four times the velocity of sound through air. Therefore a violent shock from a horizontal portion of the basin of the sea proceeding upwards vertically, would, on striking the bottom of a floating ship, cause her to rise a foot or two above her water line, and afterwards to oscillate perpendicularly until the equilibrium was restored. If the deck were covered with loose pieces of timber or anchors the shock would be transmitted to *them*, and they would be jerked up from the deck to heights proportioned to the violence of the shock ; on one occasion, forty leagues west of St Vincent, the men were thrown "a foot and a half perpendicularly up from the deck."* If the shock, instead of proceeding from a horizontal spot at the bottom of the sea, were to proceed from the inclined plane of the shore, it would reach the ship obliquely with sufficient power suddenly to arrest her progress and to make all on board suppose she had struck on a rock. Of these different effects of submarine shocks instances have been recorded. On such occasions, doubtless, the surface of the water is likewise dashed up, but without forming any sensible wave on the surface, owing to the vast area over which the shock extends.

Hence if the inclined bed of the sea, extending a square mile outside Penzance harbour towards the S.E., were to receive a violent shock vertically from the interior of the earth, a surface of sea of equal extent would be instantly dashed with great velocity in that direction ; and if the shocks were repeated every second for half a minute, as is frequently the case in earthquakes, a considerable body of water would be

* Lyell's Geology, vol. ii., p. 241, 3d edit.

thus driven seaward. To replace this the water would flow rapidly from the N.W. and thus the harbour of Penzance would be drained. The reaction follows the reflux, beginning from the S.E. (as was actually the case here on the day of the great earthquake of Lisbon*), the alternating current continuing until the equilibrium is restored.

Here I may suggest a reason why, during the oscillation in this bay in 1755, recorded by Borlase, the sea rose ten feet on Newlyn pier, whilst in Penzance harbour, one mile east of it, it rose only eight feet. The shore extending southward from Newlyn to Mousehole forms the western arm of the inmost part of Mount's Bay, and the depth of the sea increases so rapidly from this shore that within the distance of half a mile it is not less than ten fathoms at low water. Now, if a submarine shock occurred all over the bay, the current proceeding from this western arm would soon meet that proceeding from the northern part of the bay; and these two currents to the east and south uniting at right angles, would then proceed in the diagonal of the parallelogram representing their forces, which, if equal, would be towards the S.E., and the united current in returning would flow towards the N.W., that is, towards Newlyn pier, with greater velocity than either of them possessed before their union. Hence in the anchorage outside Newlyn pier, the alternating current on 1st November 1855 moved even "in the decline of the commotion at the rate of seven miles in an hour," as ascertained by the log of a vessel then anchored there. This explanation applies not only to the N.W. corner of Mount's Bay but also to the fact observed by Mr Darwin, that these agitations are greatest at the heads of large shoaling bays such as at Callao, whereas places situate on the open sea like Valparaiso, although shaken by the severest earthquakes have never suffered any serious damage from them.†

If my hypothesis respecting the cause of these oscillations be well founded, the waters of inland lakes must be acted on similarly to those on the sea-coasts. Submitting it to this test, let us suppose that on the day of the great earthquake in Lisbon, shocks were experienced in every part of Great Britain,

* Phil. Trans., vol. xlix., p. 373. † Researches, p. 378.

for although they were *not generally perceived* yet they were felt in Berkshire,* in the Scilly Isles,† in different parts of Cornwall, and in Derbyshire. In fact, whilst only one shock was perceived on the surface of the mines in Derbyshire Peak, *five* were felt there underground between 11 and 11·20 A.M. of that day;‡ and it is well known that shocks have been often felt on shores, low grounds, and in mines, without having been perceived at higher levels.§ Assuming therefore that shocks occurred on that day in most parts of this island, on its submarine coasts, and the beds of its lakes, and that their direction was vertical, the effect on each of its lakes would be to drive the waters resting on its inclined shores towards its centre. Hence the waters of Loch Ness "swelled up like a mountain," by which expression I understand that the waters resting on its inclined shores were, by the shocks, driven towards its centre, and there accumulated to an astonishing height.‖ The effect on a canal would be to drive the water from its sides towards the centre, where it would rise into a long ridge parallel with the sides, as occurred in the Surrey Canal on the day of the great earthquake of 1755.¶ Hence we may infer that the fact of the waters of different ponds having oscillated in different directions on that day was owing —not to the directions in which the shocks travelled, as many imagined—but to the different forms and peculiarities of the basins of those ponds.

A phenomenon similar to what occurred at Loch Ness took place in Lake Ontario on the 20th of September 1845, when "the waters suddenly moved in a mass out of the rivers, bays, coves, harbours, &c.," to a depth of two feet, and then returned to an equal height above their previous level. As this happened on both sides of the lake, a great elevation must have been thus produced at or near its centre, as occurred at Loch

* Phil. Trans., vol. xlix., p. 365. † Troutbeck, p. 40.

‡ Phil. Trans. vol. xlix., p. 398.

§ Humboldt's Personal Narrative, vol. ii., pp. 222, 224.

‖ This is recorded to have happened on the day of the second great earthquake of Lisbon in 1761; but as the shock of the earth and oscillations of the sea and lakes were in most places on this day very similar to those on the day of the first earthquake, it is probable that Loch Ness was similarly affected on both occasions.

¶ Phil. Trans., vol. xlix., p. 353.

Ness. Professor Dewey attributed this to a tornado and thunder-storm, which then passed across the lake, attended with waterspouts and large hail; but I have elsewhere* endeavoured to show that it resulted from an unperceived shock throughout the basin of the lake during the passage of the thunder-storm,—earthquakes and thunder-storms having frequently occurred together. Indeed the first earthquake that Humboldt witnessed in Cumana was during a severe thunder-storm, and he remarks that "at the moment of the strongest electric explosion there were two considerable shocks of an earthquake."†

As these phenomena have thus been witnessed on lakes and sea-coasts, in the finest weather, as well as in storms, and as those which occur in the absence of perceived earthshocks are precisely similar to those occurring during known earthquakes, there is every reason to ascribe them all to earthquake shocks, perceived or unperceived, in the basins of the sea or inland waters over or near which the disturbances are observed; such shocks being generally unaccompanied with any upheaving, subsidence, fracture, or dislocation of any part of such basins. The oscillation of the sea in Penzance on the 6th of June last, like the earthquake shock there a week before, was very partial, and no one can suppose that *it* was occasioned by a storm, inasmuch as no disturbance of the sea was observed in any other part of Mount's Bay.

The irregularities observed in oscillations of the sea and inland waters may arise from the inequalities, the different inclinations and configurations, and the different degrees of elasticity or shock-transmitting power in the rocks or other ground on which the waters rest. Frequently, too, they must result from subsequent shocks interfering with the effects of preceding ones, for a repetition of shocks on the days of earthquakes is very usual; and this interference may occasion those high crested waves which, as Mr Darwin remarks,‡ occur, not at the very instant, but some little time after a shock has been felt; for these "mountainous breakers" (like

* Trans. of the Penz. Nat. Hist. Society, vol. i., p. 169; Edinburgh New Phil. Journal for July 1848, p. 107.

† Humboldt's Personal Narrative, vol. iii., p. 316.

‡ Researches, p. 378.

bores or returning tide-waves in rivers) might be produced by the current resulting from a second shock overcoming and driving back the less powerful current resulting from a former one.

Since writing the above I have read Mr Mallet's "*First Report on the Facts of Earthquake Phenomena*," wherein he states that he had "been struck in several instances with notices of sudden recessions, and as sudden subsequent unusually high risings of the sea in various places where there was no account of any accompanying earthquake, either there or anywhere else at the same time. Thus, of the Thames at London in 1762 and in 1767, of the sea at Malaga and at Leghorn in 1774, and in several other tidal rivers and estuaries, small but unusual fluctuations have been recorded some of these occurred in great earthquake years, but there are no recorded shocks occurring anywhere at the times given for these fluctuations. I am disposed, therefore," continues Mr Mallet, "not to attribute such to earthquake shocks at all, but to the sudden slippage under water of large masses of submarine banks of sand and mud."* Mr Mallet's hypothesis, however, is inapplicable to the following facts. When an extraordinary oscillation of the sea has been noticed in Mount's Bay, a similar occurrence has been generally observed at Plymouth. And those which happened in Mount's Bay, Falmouth, Fowey, and Plymouth, on the days of the two great earthquakes of Lisbon, when there were earthquakes in all parts of our island, were of precisely the same character as those which happened at the same places on the 28th of July 1761, 31st of May 1811, 5th July 1843, and 30th of October 1843, when no earthquake was felt.

* British Association Report for 1850, p. 61.

On the Chemical Composition of the Cleveland Ironstone Beds. By William Crowder, F.C.S., Newcastle-on-Tyne.

Within the last few years a discovery of mineral wealth has been made in the Cleveland Hills (Yorkshire), which bids fair to constitute that district the seat of one of the most important branches of manufacture.

It has been found that these hills contain a series of ironstone beds varying from a few inches to several feet in thickness, and which, alternating with shales, constitute a stratum of nearly 20 feet in thickness.

Scarcely have five or six years elapsed since the discovery was made known, and there has already sprung up a little colony engaged in mining and manufacturing operations. Immense quantities of the stone have already been obtained, a large number of furnaces have been erected, and are in blast, many more are in course of construction, and there is no doubt that, in the course of a few years, the neighbourhood of Cleveland will become one of the largest iron-producing districts in Great Britain, rivalling, if not excelling, the manufactures of Staffordshire and South Wales.

Not only has the stone been used in the manufacture of pigs, but large quantities have also been converted into malleable iron, suitable for bars, rails, and other similar purposes. All that appears to be required for future success is time, and the more complete introduction of railways for the conveyance of the materials and products of manufacture.

During the past summer I visited the district with the view of gaining some information upon the subject, having been, on several occasions, applied to professionally respecting the chemical composition and general characters of the ironstone. With this view, I collected specimens of the various beds in regular order from top to bottom, and I have subjected the whole to careful chemical analysis. I also collected one or two samples of the ironstone after calcination, in order to obtain some idea of its composition in that state. It is not my intention here to detail the geological features of the country, this work having already been done by Phillips, in his "Geology of Yorkshire." I may content myself with the statement, that the stratum is about twenty feet in thickness, and consists of a series of beds of ironstone and shale, in all about twenty-seven or twenty-eight, some of which are not more than a few inches, whilst others are two or three feet, resting upon other beds of an almost equal thickness. The beds vary in thickness as well as in number, according to local circumstances, but the identity of the stone, so far as chemical composition is concerned, obtains over a very wide district. The order of superposition of the various strata, as found at the mines at Hutton Low Cross, near Guisboro', is given below.

Section of Ironstone Beds, showing their relative thickness at Hutton Low Cross, near Guisboro'.

		Feet.	Inches.
Ironstone (Nodules),		1	4
Doggers, mixed with shale,		1	2
Pyrites,		0	2
Ironstone,		0	2½
Ironstone block,	The Drifts.	3	5
Ironstone and shale,	The Drifts.	0	5
Ironstone,	The Drifts.	2	8
Shale,		0	8
Ironstone,		0	4
Shale,		0	8
Ironstone,		0	3
Shale,		0	3
Ironstone,		0	3
Shale,		0	3
Ironstone,		0	6
Shale,		0	3
Ironstone,		0	4
Shale,		0	4
Ironstone,		0	6
Shale, parting,		—	—
Ironstone,		1	0
Shale,		0	2
Ironstone,		1	6
Shale,		2	0
Ironstone,		0	4
Shale,		0	2
Ironstone,		1	6
		20 ft.	7 in.

It will be seen from this section that the principal beds of ironstone lie near the top, there being one of 3 feet 5 inches, and another of 2 feet 8 inches, separated only by a parting of shale 5 inches in thickness. These three are the principal beds which are at present mined. The work is carried on by drifting into the hill-side in various directions.

A bed of iron pyrites overlies the ironstone, which, I believe, is now being worked and used for the manufacture of oil of vitriol at Newcastle. In some places there are two beds of pyrites overlying each other; in other cases only one is found. This product I have also examined, and the result will be found in the present paper.

The stone consists essentially of carbonate of protoxide of iron, mixed with varying proportions of silica, alumina, lime, and magnesia. Sulphuric and phosphoric acid are also present, with invariably small quantities of iron pyrites.

Annexed are the results of analyses of the ironstone beds in regular order of descent, omitting the shales. (See next page.)

From these analyses, it appears that the general proportion of silica is about 15 per cent., although it is sometimes as high as 20 per cent., and in one or two cases as low as 7 and 8 per cent. I have calculated the iron as peroxide, although, in reality, a great part exists in the state of protoxide. This, however, has been done to facilitate reference, the object of my analysis being rather of a practical than a theoretical character.

In the principal drifts the proportion of metallic iron is about 35 per cent., whilst in many of the lower beds the quantity does not rise higher than 25 per cent. Lime is present in the stone in variable quantities of 3 to 6 per cent., and in a few cases still higher. The magnesia generally ranges at about 3 to 3½ per cent.

Sulphuric acid (as sulphate of lime) occurs in small quantity in every case.

Phosphoric acid is absent entirely, or nearly so, in some specimens, whilst in many others it is present in considerable proportion, more especially in Nos. 6 and 7, which contain respectively 7·78 and 4·10 per cent. The circumstance of the presence of phosphoric acid in so large a quantity in an iron ore is very unusual, and will, I anticipate, produce some material modification in the properties of the iron; and I am at present engaged on a series of analysis which I expect to throw some light on that point. Its general tendency is well known to be that of producing the defect of cold shortness.

Analyses of Ironstone Beds at Hutton Low Cross, near Guisboro'.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Silica, . .	16·25	15·70	12·85	9·35	15·10	15·25	14·45	10·75	18·30	20·50	12·25	21·00	26·60	13·05	21·05	7·40
Peroxide of iron,	38·65	43·21	52·92	51·21	46·50	34·92	35·71	38·14	38·14	42·57	42·35	38·35	35·71	36·64	36·14	36·92
Alumina, .	2·55	9·64	—	0·76	6·65	10·25	11·54	5·48	10·52	5·88	8·10	10·75	12·84	13·33	12·84	7·45
Lime, . .	10·44	3·92	2·83	3·22	3·22	12·29	8·40	11·39	6·83	5·46	7·25	5·10	3·56	9·02	4·22	12·78
Magnesia, .	2·48	3·03	3·82	5·10	3·62	2·38	2·92	4·22	3·41	3·66	3·75	3·56	1·55	3·98	1·05	2·25
Sulphuric acid,	0·17	1·30	0·75	0·30	0·65	0·48	0·15	0·24	0·24	0·18	0·13	0·24	0·34	0·20	0·13	0·68
Phosphoric acid,	2·30	1·88	1·44	1·18	trace	7·78	4·10	1·08	0·99	trace	trace	trace	trace	2·43	0·32	2·88
Sulphur, . .	0·224	0·176	0·350	0·380	0·120	0·352	0·226	0·284	0·350	0·432	0·380	0·226	0·604	0·520	0·056	0·016
Loss by heat, .	26·94	21·15	25·04	28·50	24·14	16·30	22·51	28·42	21·22	21·32	25·79	20·82	18·80	20·83	24·20	29·63
	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·
Metallic iron, .	26·93	30·24	37·04	35·84	32·55	24·44	24·99	26·70	26·70	29·80	29·64	29·84	24·99	25·65	25·30	25·84

The proportion of sulphur as iron pyrites is exceedingly small, especially in those beds which have already been mined.

The bed marked in the section "Pyrites," contains 30·25 per cent. sulphur, which is equal to 56·71 per cent. bisulphuret of iron, and is about the same quantity as is found in the Wicklow pyrites, used on the Tyne in the manufacture of oil of vitriol.

The item "loss by heat" is the proportion of loss sustained by calcination. It includes water and carbonic acid, and the two bodies have been determined together (by difference), the object being to show the weight of calcined stone produced by a given quantity of the raw ore. It is scarcely necessary to remind the reader that it does not represent the actual quantity of water and carbonic acid, because when carbonate of iron is ignited, the protoxide of iron is converted into peroxide, so that the loss by heat really gives the quantity of these substances minus the oxygen absorbed by the protoxide of iron. This, however, makes no difference in calculating the analysis, because whatever quantity is lost by the carbonic acid and water is gained by the protoxide of iron in its conversion into *peroxide*, in which state the whole of the iron results have been calculated.

In the above samples the iron and alumina were determined in the usual manner by precipitation with ammonia, and weighing together, but in the separate estimation of these two bodies, the iron was determined by standard solution of permanganate of potash, and the alumina by the difference in the two numbers.

The following is a similar series of analyses, the principal difference being that the interposing shales have also been examined, and have yielded highly satisfactory results. It has not been thought necessary to determine the proportions of sulphur and phosphorus, as in the preceding case sufficient has been done to indicate the general proportion of those constituents.

The determination of iron and alumina have in this case been made by precipitation with ammonia, and subsequent separation by potash, previously weighing the two substances together.

The other constituents were determined in the usual manner.

Analyses of Ironstones and Shales from the Mines at Hutton Low Cross, near Guisboro.'

	Doggers.	Stone. 2 ft.	4 in.	Stone. 2 in.	Stone, 3 ft. 9 in.	Stone. 2 ft. 9 in.	Shale. 2 ft. 4 in.	Stone. 8 in.	Shale. 3 in.	Stone. 4 in.	Shale. 7 in.	Shale. 5 in.	Stone. 1 ft.	Stone. 1 ft. 1 in.	Shale. 3 in.	Stone. 6 in.	Shale. 1 ft. 6 in.	Stone. 1 ft.	Shale. 4 in.	Stone. 1 ft. 6 in.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
					The Drift.															
Silica,.............	22·15	35·50	Iron pyrites.	8·35	11·65	11·05	18·15	18·00	39·10	19·05	32·65	25·60	13·00	13·30	25·50	17·35	74·80	22·85	35·50	18·50
Peroxide of iron,	10·80	36·60		54 75	47·60	52·45	44·70	40·65	35·00	46·80	41·50	40·00	47·65	47·45	40·90	40·80	10·05	43·05	36·80	49·50
Alumina, ...	0·85	2·70		1·60	8·15	1·35	7·50	9·35	8·00	5·20	7·00	8·85	3·80	3·40	4·95	8·10	3·85	6·20	9·70	—
Lime,.............	30·95	2·45		3·60	5·70	3·05	5·70	6·15	1·75	4·75	1·48	5·00	7·60	6·85	4·75	7·35	0·60	4·45	1·40	5·35
Magnesia,.........	2·30	2·15		1·75	3·00	4·70	2·85	0·15	1·50	1·10	1·35	2·10	2·30	1·50	1·70	2·00	0·80	4·40	0·45	4·95
Loss by heat, ...	32·95	20·60		29·95	23·90	27·40	21·10	25·70	14·65	23·10	16 02	18·45	25·65	27·50	22·20	24·40	9·90	19·05	17·15	21·70
	100·	100·		100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·
Metallic iron,.....	7·56	25·62	...	38·32	33·32	36·71	31·29	28·45	24·50	32·76	29·05	28·00	33·35	33·21	28·63	28·56	7·03	3·3	25·76	34·65

It will be seen from the foregoing analysis, that with one or two exceptions, both ironstones and shales have an almost equal value, indeed it is my own impression that the beds may be worked irrespective of the distinctions of ironstone and shale. At present, however, the separation is made with some degree of care, as I found when lately visiting some of the furnaces, that the persons connected with the works were weathering the ironstone, *i.e.* exposing it to the action of the air in order to cause the shale to detach itself from the ironstone. I collected some of this shaly matter which was peeling off, and subjected it to analysis, with the following results :—

Analysis of Shaly Ironstone.

Silica,	23·75
Peroxide of iron,	42·00
Alumina,	9·65
Lime,	3·83
Magnesia,	1·26
Loss by heat,	19·51
	100·00
Metallic iron,	29·40

From this analysis it will be seen that the shale contains a large proportion of iron, and should not hastily be thrown aside as worthless.

The following are analyses of similar stones from the same district :—

Silica,	13·00	15·95	11·90	17·50	31·15
Peroxide of iron,	60·20	45·70	46·85	42·90	38·55
Alumina,	—	7·05	5·45	6·85	7·45
Lime,	1·06	2·52	6·16	5·71	3·81
Magnesia,	1·37	1·27	6·56	2·87	1·06
Loss by heat,	24·37	28·20	23·08	24·80	20·10
	100·00	100·69	100·00	100·63	102·12
Metallic iron,	43·40	31·99	32·79	30·03	26·98

The remarkable similarity in the general composition of the beds from different parts of the district is well shown by the following series of stones collected by myself during the summer of 1855, at a place called Scugdale, about twenty miles from Hutton Low Cross.

The stone is not yet worked, in consequence of the absence of railway communication, but there is no doubt that sooner or later this will be supplied, and the beds be profitably worked. The specimens were taken from out of the hill-side, which consisted of a series of beds of stone and layers of nodules, many of them 8 or 9 inches in diameter. Their disposition was as follows :—

At Top, . . .	A bed of nodules.
No. 1 stone, . .	2 feet thick.
No. 2	5 ... ...
No. 3	14 ... ...
No. 4	7 ... ...
No. 5	1 ... (nodules).
No. 6	2 ... post.
No. 7	9 ... (nodules).
No. 8	From Scarth Nick.

The last sample (No. 8) was obtained at about a quarter of a mile distant from the other specimens, at the foot of the hill. It is doubtful whether this is the outcrop of a bed which could be drifted profitably, and it has been suggested to me that it may only be a trouble which would be lost sight of after excavating any distance. The question, however, remains an open one until the district has been properly surveyed. It is, however, exceedingly curious to observe the great similarity in composition of these stones with those I have already given, showing clearly the identity in chemical composition of many of these beds with those at Hutton Low Cross.

Analyses of Ironstone Beds at Scugdale (Swainby).

Thickness of beds.	Nodules.	2 ft. No. 1.	5 ft. No. 2.	14 ft. No. 3.	7 ft. No. 4.	1 ft. Nod. No. 5.	2 ft. No. 6.	9 ft. Nod. No. 7.	No. 8.
Silica, ...	20·14	19·43	22·15	10·50	9·45	14·94	19·50	17·85	13·98
Peroxide of iron,	42·72	59·88	38·84	19·00	31·59	17·26	20·10	38·50	61·70
Alumina, . .	8·09	3·01	7·14	4·50	1·47	5·93	4·20	2·40	3·98
Lime, ...	1·55	1·33	8·96	30·08	23·25	28·00	26·49	14·61	1·79
Magnesia, . .	0·30	0·79	3·26	3·41	5·13	0·55	1·97	2·20	0·75
Loss by heat, .	26·47	16·25	20·18	33·59	30·55	30·56	27·52	24·84	16·88
	99·27	100·69	100·53	101·08	101·44	97·24	99·78	100·40	99·08
Metallic iron, .	29·90	41·91	27·19	13·30	22·11	11·08	14·07	26·95	43·19

In these analyses a curious fact is observable, viz. that the three top and two bottom beds have a similar composition to those at Hutton Low Cross and other places, whilst the middle beds are very poor in iron and rich in lime. In fact, the agriculturists in the neighbourhood formerly burnt this substance under the impression that it was a true limestone, but the plan was of course abandoned so soon as it was discovered that instead of obtaining quicklime, a semifused slag was produced. No doubt, if the beds Nos. 1 and 2 were smelted together along with a portion of Nos. 3 and 4, a mixture might be made which would not require the use of limestone in the furnace. The same be said of No. 8, if obtainable in any quantity.

The following are analyses of other samples of Cleveland ironstone from Rosedale, a few miles from Gainsborough, where I understand it is found in considerable quantity.

Analysis of Ironstone from Rosedale.

	No. 1.	No. 2.
Silica,	10·30	30·35
Peroxide of iron,	52·60	39·90
Alumina, .	7·40	5·60
Lime, .	3·78	4·23
Magnesia, .	1·26	1·47
Loss by heat,	24·66	18·45
	100·00	100·00
Metallic iron, .	36·82	27·93

The appearance of No. 1 was oolitic, of a light sandstone colour, and quite different in that respect from the Gainsboro' stone. No. 2 was similar in appearance and colour to that obtained from the Hutton Mines. It will be seen, that although the composition of these two stones differ widely from each other, still their counterparts are to be found in other districts. Thus, No. 1 corresponds pretty closely with No. 5 at Hutton Low Cross. No. 2 is very similar to No. 11 of the same series. There is another kind of stone found in Rosedale, which is different in appearance from No. 1, being of a black colour, the oolitic structure is however still apparent.

This last is exceedingly soft and friable, whereas the former are materially hard and consistent. The analysis was as follows :—

Analysis of Black Ironstone from Rosedale.

	No. 3.	No. 4.
Silica, .	5·70	—
Peroxide of iron,	64·90	79·30
Alumina, .	9·25	—
Lime, .	3·53	—
Magnesia, .	0·99	—
Loss by heat,	16·15	—
	100·52	—
Metallic iron, .	45·43	55·51

The two samples, it will be seen, are of great value; and I understand it is already successfully worked, but the want of railway communication here as in other places, has hitherto prevented its extensive consumption. The following are two or three samples of Cleveland stone which have been calcined. I shall give here the Rosedale sample No. 1, and the same calcined, from which it will be seen that the quantity of increase in the proportions of iron, lime, &c., are almost exactly what they should be if we calculate off the quantity of loss by heat from the raw sample.

Rosedale No. 1, Burnt from Hutton Mines.

	Burnt.	Unburnt.	The Small Dust.	Masses.
Silica, .	14·90	10·30	—	37·85
Peroxide of iron,	65·00	52·60	53·35	56·10
Alumina, .	11.00	7·40	13·00	—
Lime, .	5·29	3·78	—	—
Magnesia, .	3·81	1·26	—	—
Loss by heat,	—	24·66	—	—
	100·00	100·00	—	—
Metallic iron,	45·50	36·82	37·34	39·27

I add also an analysis of an ironstone collected at Eston

Nab, near Middlesborough, by Mr Hugh Taylor, and analysed by him.*

Analysis of Ironstone from Eston Nab.

Silica, ...	7·257
Protoxide of iron, ...	47·818
Alumina, ...	6·499
Lime, ...	5·803
Magnesia, ...	3·504
Manganese, ...	traces.
Sulphuric acid, ...	traces.
Carbonic acid, ...	24·939
Water of combination and a little organic matter,	13·15
Chloride of potassium and a little chloride of sodium,	1·052
	100·023
Metallic iron, ...	36·951

From a consideration of the foregoing analyses, I think the following conclusions may be deduced.

1. That that part of the stone which is already worked is the richest in iron.

2. That the maximum quantity of iron yielded by the principal part of the stone at present worked, is about 37 or 38 per cent., and the minimum about 29 or 30 per cent., but that the greater portion ranges in quality at about 35 per cent.

3. That there is a large quantity of poor stone containing 25 to 30 per cent., which is not at present worked.

4. That many of the beds of shale contain from 25 to 30 per cent. metallic iron.

5. The existence of great similarity in composition between the beds of stone taken from widely-separated localities.

I have to acknowledge the assistance of my pupil, Mr E. C. Northcott, who has rendered me material aid in conducting several of the preceding analyses.

Newcastle, March 1856.

* Reports of the Northern Institute of Mining Engineers.

On an improved Method of preparing Siliceous and other Fossils for Microscopic Investigation, with a Description of a New Pneumatic Chuck. By Alexander Bryson, F.S.A. Scot., F.R.P.S., &c.*

The art of slitting stones and other hard substances by the method of impacting diamond powder into the edge of a thin iron plate, seems, in this country at least, to be an ancient one. I have failed to discover the date of its introduction or invention; but most lapidaries who have expressed their opinions on the subject, concur in believing the art to be at least two hundred years old.

On the Continent the art seems to have been but lately practised. In a series of fossil woods sent to me from Paris by the celebrated Brongniart, some bear evidence that, in the capital of France, this method was not practised until within a few years ago, as some exhibit unequivocal traces of having been cut by the slow process of slitting by a copper wire with emery. Sisyphus rolling his stone and a Parisian lapidary slitting one by such a slow method seem almost synonymous.

In India and China the natives slit the hardest gems by a copper wire stretched on a bow, the wire being constantly fed with corundum powder moistened with water. This corundum stone, which is the adamant of Scripture, is cheap and plentiful both in India and China. In the Calcutta market, it only commands the low price of 8d. sterling per pound, yet strange to say, although much harder than either the emery of Smyrna, or that harder still found at Naxos, it has been very much slighted by the British lapidaries. The difference of price may, however, be to them the great objection; but to the amateur, whose consumpt is reckoned only by pounds instead of hundredweights per annum, the corundum is to be preferred.

The method of preparing fossil woods and other hard organic substances for examination under the microscope had its origin in this city. But as the claims of two or three emi-

* Read before the Royal Scottish Society of Arts, December 10, 1855.

nent individuals (all deserving praise) are mingled in this improvement, I refrain from considering them.

The usual mode of proceeding in making a section of fossil wood is simple, though tedious. The first process is to flatten the specimen to be operated on by grinding it on a flat *lap* made of lead charged with emery or corundum powder. It must now be rendered perfectly flat by hand on a plate of metal or glass, using much finer emery than in the first operation of grinding. The next operation is to cement the object to the glass plate. Both the plate of glass and the fossil to be cemented must be heated to a temperature rather inconvenient for the fingers to bear. By this means moisture and adherent air are driven off, especially from the object to be operated on. Canada balsam is now to be equally spread over both plate and object, and exposed again to heat, until the redundant turpentine in the balsam has been driven off by evaporation. The two surfaces are now to be connected while hot, and a slow circular motion, with pressure, given either to the plate or object, for the purpose of throwing out the superabundant balsam and globules of included air. The object should be below and the glass plate above, as we then can see when all the air is removed, by the pressure and motion indicated. It is proper to mention that too much balsam is more favourable for the expulsion of the air-bubbles than too little. When cold, the Canada balsam will be found hard and adhering, and the specimen fit for slitting. This process has hitherto been performed by using a disc of thin sheet-iron, so much employed by the tinsmith, technically called *sheet-tin*. The tin coating ought to be partially removed by heating the plate, and when hot rubbing off much of the extraneous tin by a piece of cloth. The plate has now to be planished on the polished *stake* of the tinsmith, until quite flat. If the plate is to be used in the lathe, and by the usual method, it ought to be planished so as to possess a slight convexity. This gives a certain amount of rigidity to the edge, which is useful in slitting by the hand; while by the method of mechanical slitting, about to be described, this convexity is inadmissible. The tin plate, when mounted on an appropriate chuck in the lathe, must be turned quite true, with its edge slightly rounded and made perfectly smooth by a fine-cut file. The edge of the disc is now to be charged with diamond powder. This is done by mingling the diamond powder with oil, and placing it on a piece of the hardest agate, and then turning the disc slowly round; and holding the agate with the diamond powder with a moderate pressure against the edge of the disc, it becomes thoroughly charged with a host of diamond points, becoming, as it were, a saw with invisible teeth. In pounding the diamond, some care is necessary, as also a fitting mortar. The mortar should be made of an old steel die, if accessible; if not, a mass of steel, slightly conical, the base of which ought to be 2 inches in diameter, and the upper part 1½ inch. A cylindrical hole is now to be turned out in the centre, of ¾ths of an inch diameter, and about 1 inch deep. This, when hardened, is the mortar; for safety it may be annealed to a straw colour. The pestle is merely a cylinder of steel, fitting the hollow mortar but loosely, and having a ledge or edging of an eighth of an inch projecting round it, but sufficiently raised above the upper surface of the mortar, so as not to come in contact while pounding the diamond. The point of the pestle ought only to be hardened and annealed to a straw colour, and should be of course convex, fitting the opposing and equal concavity of the mortar. The purpose of the projecting ledge is to prevent the smaller particles of diamond spurting out when the pestle is struck by the hammer. But even with this precautionary ledge, some small pieces of the diamond will try to assert their liberty; and I have found it economical, when giving the *coup de gras* to a lump of diamond, to place below the mortar a sheet of unglazed black paper, so that the straying particles may be easily recovered. It is not necessary to give many blows in reducing the diamond to powder; after being merely mealed by the hammer, the pestle should be used in the slightly-rotatory crushing method ordinarily employed by the apothecary. In regard to the mortar in its first use, I must warn the amateur lapidary, that should he put in two carats weight of diamond, and expect to get the same weight out, he will be most grievously disappointed. This is evident when we consider that the diamond being so much harder than the steel, the mortar becomes in its first use, thoroughly charged and impacted with the diamond powder; so that, in his first experiment, he will find he has lost nearly a carat in making his steel mortar—that it becomes, both in fact and name, a diamond one. All this is preliminary labour to be gone through, whether working by the usual method, or by that to be described.

Most lapidaries who have availed themselves of water power, have used directing methods, by which the stones to be slit are pressed slightly against the slitting-plate by mere gravitation, acting in a determinate plane. The lapidaries of Germany have long practised this method, favoured as they are by so many streams in the midst of the rocks from whence they obtain their pebbles. My first idea of slitting fossils by these means for microscopic observation was obtained by observing the excellent method employed by Mr Gavin Young, where, by the aid of a water-wheel, he has employed a considerable number of self-acting slitting-plates to perform an amount of cheap and flat work, hitherto a desideratum in Edinburgh. I have in my collection a Scotch jasper, slit and polished by Mr Young with this apparatus, measuring 100 square inches—certainly a *chef d'œuvre* of lapidary work. The method I have contrived, by which the sections now on the table were prepared, is very simple, speedy, and certain in its action.

The instrument is placed on the table of a common lathe, which is, of course, the source of motion. (*See Woodcut.*) It consists of a Watt's parallel motion, with four joints, attached to a basement fixed to the table of the lathe. This base has a motion (for adjustment only), in a horizontal plane, by which we may be enabled to place the upper joint in a parallel plane with the spindle of the lathe. This may be called the azimuthal adjustment. The adjustment, which in an astronomical instrument is called the plane of right ascension, is given by a pivot in the top of the base, and clamped by a screw below. This motion in right ascension, gives us the power of adjusting the perpendicular planes of motion, so that the object to be slit passes down from the circumference of the slitting-plate to nearly its centre, in a perfectly parallel plane. When this adjustment is made accurately, and the slitting-plate well primed and flat, a very thin and parallel slice is obtained. This jointed frame is counterpoised and supported by a lever, the centre of which is moveable in a pillar standing perpendicularly from the lathe table. Attached to the lever is a screw of three threads by which the counterpoise weight is adjusted readily to the varying weight of the object to be slit and the necessary pressure required on the edge of the slitting-plate.

The difficulty first apparent in this self-acting slitting, was to obtain an easy method of fixing the object to the machine. Cements of all kinds were objectionable. Any cement requiring heat for its adhesion to the glass on which the object was already cemented by the Canada balsam, would, of course, destroy its condition; and any cold method involved a loss of time in drying, as at once to be discarded. I therefore was determined to try a pneumatic method, by which the pressure of the air against the surface of a chuck might give me a speedy method of adhesion, without risk of injuring the Canada balsam. This pneumatic chuck gave me the utmost satisfaction. It consists of an iron tube, which passes through an aperture on the upper joint of the guiding-frame, into which is screwed a round piece of gun-metal, slightly hollowed in the centre, but flat towards the edge. This gun-metal disc is perforated by a small hole communicating with the interior of the iron tube. This aperture permits the air between the glass plate and the chuck to be exhausted by a small air syringe at the other end. The face of this chuck is covered with a thin film of soft India-rubber not vulcanized, also perforated with a small central aperture. When the chuck is properly adjusted, and the India-rubber carefully stretched over the face of the gun-metal, one or two pulls of the syringe-piston is quite sufficient to maintain a very large object to the action of the slitting-plate. By this method no time is lost; the adhesion is made instantaneously, and as quickly broken by opening a small screw, to admit air between the glass-plate and the chuck, when the object is immediately released. Care must be taken, in stretching the India-rubber over the face of the chuck, to make it very equal in its distribution, and as thin as consistent with strength. When this material is obtained from the shops, it presents a series of slight grooves, and is rather hard for our purpose. It ought, therefore, to be slightly heated, which renders it soft and pliant, and in this state should now be stretched over the chuck, and a piece of soft copper wire tied round it, a slight groove being cut in the periphery of the chuck, to detain the wire in its place. When by use the surface of the India-rubber becomes flat, smooth, and free from the grooves which at first mar its usefulness, a specimen may be slit of many square inches, without resort being had to another exhaustion by the syringe.

But when a large, hard, siliceous object has to be slit, it is well for the sake of safety to try the syringe piston, and observe if it returns forcibly to the bottom of the cylinder, which evidences the good condition of the vacuum of the chuck.

After the operation of slitting, the plate must be removed from the spindle of the lathe, and the flat lead *lap* substituted. The pneumatic chuck is now to be reversed, and the specimen placed in contact with the grinder. By giving a slightly tortuous motion to the specimen, that is, using the motion of the various joints, the object is ground perfectly flat when the length of both arms of the joints are perfectly equal. Should the leg of the first joint on the right-hand side be the longer, the specimen will be ground hollow; if shorter, it will be ground convex. But if, as before stated, they are of equal length, a perfectly parallel surface will be obtained.

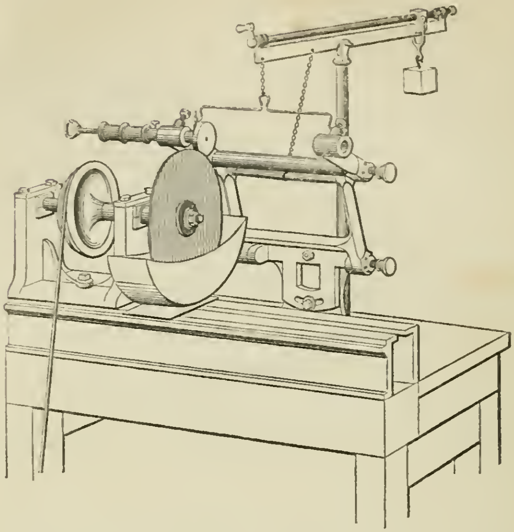
In operating on siliceous objects, I have found soap and water quite as speedy and efficacious as oil, which is generally used; while calcareous fossils must be slit by a solution of common soda in water. This solution of soda, if made too strong, softens the India-rubber on the face of the pneumatic chuck, and renders a new piece necessary; but if care is taken to keep the solution of moderate strength, one piece of India-rubber may last for six months. The thinner and flatter it becomes, the better hold the glass takes, until a puncture occurs in the outer portion, and a new piece is rendered necessary.

Before concluding, I must warn the amateur lapidary against the belief that all hard stones are equally easily slit by diamond powder. As a general rule, the hardest stones are easiest slit (this does not, however, include calcareous ones); but some fossils on which I have operated, though not so hard as others, have completely resisted the action of the diamond powder. For instance, the Yu stone of China, which is by no means so hard as corundum, is much more difficult to slit, and consumes an amount of diamond powder which renders it the horror of the lapidary. This peculiarity is easily understood. If, for instance, we should attempt to saw lead or copper with our diamond slitting-plate, we shall find that the diamond powder becomes thoroughly impacted into the latter, because the softer metals, when instead of the original plate becoming the operator, it is operated on. In the same way with a soft tenacious fossil, the diamond is taken out of the plate and impacted in the stone, and no work is accomplished. The method of operating on such specimens is to use emery by the usual method, by which much more speed will be obtained.

The polishing of the section is the last operation. This is performed in various ways, according to the material of which the organism is composed. If siliceous, a *lap* of tin is to be used, about the same size as the grinding *lap*. Having turned the face smooth and flat, a series of very fine notches are to be made all over the surface. This operation is accomplished by holding the edge of an old dinner-knife almost perpendicular to the surface of the *lap* while rotating; this produces a series of *criddles*, or slight asperities, which detain the polishing substance.

The polishing substance used on the tin lap is technically called Lapidaries' Rot-Stone, and is applied by slightly moistening the mass, and pressing it firmly against the polisher, care being taken to scrape off the outer surface, which often contains grit. The specimen is then to be pressed with some degree of force against the revolving tin *lap* or polisher, carefully changing the plane of action, by moving the specimen in various directions over the surface.

To polish calcareous objects, another method must be adopted as follows :—



A *lap* or disc of willow wood is to be adapted to the spindle of the lathe, three inches in thickness, and about the diameter of the other laps (10 inches), the axis of the wood being parallel to the spindle of the lathe, that is, the acting surface of the wood is the end of the fibres, or transverse section.

This polisher must be turned quite flat and smoothed by a plane, as the willow, from its softness, is peculiarly difficult to turn. It is also of consequence to remark, that both sides be turned so as that the *lap*, when dry, is quite parallel. This *lap* is most conveniently adapted to the common face chuck of a lathe with a conical screw, so that either surface may be used. This is made evident, when we state that this polisher is always used moist, and, to keep both surfaces parallel, must be entirely plunged in water before using, as both surfaces must be equally moist, otherwise the dry will be concave, and the moist surface convex. The polishing substance used with this *lap* is putty powder (oxide of tin), which ought to be well washed, to free it from grit. The calcareous fossils being finely ground, are speedily polished by this method. To polish softer substances, a piece of cloth may be spread over the wooden *lap*, and finely-levigated chalk used as a polishing medium.

REVIEWS AND NOTICES OF BOOKS.

A Manual of Elementary Geology, or the ancient changes of the Earth and its Inhabitants, as illustrated by Geological Monuments. By Sir CHARLES LYELL, M.A., F.R.S. Fifth Edition. Murray, London. 1855.

There are two kinds of valuable geological Manuals. In one the writer well versed in his subject merely collects and digests the scattered facts and principles, which, in the course of time, have been eliminated by original investigators; in another the author not only thoroughly appreciates, describes, and applies such established truths, but in addition brings to bear upon them much valuable matter in the shape of original investigations, or, by the depth of his views and the breadth of his combinations, he imparts an original value to his work, interesting to the most matured student, as embodying the deliberate convictions of an author who regards the subject from a high point of view, and whose authority carries with it a weight which may influence the opinions, and direct the labours of the rising generation of geologists. To the latter class eminently belong the Manuals that have at various times been published by De la Beche, Phillips, and Lyell. We have ever looked on De la Beche's Manual of Geology (long out of print) as, in its day, a model of arrangement and treatment of the subject. We may also, in passing, advert to the Manual lately published by Professor Phillips, in all respects a remarkable work, clearly and beautifully written, and so full of matter admirably arranged, that it may be safely recommended as a text-book to every student of geology. In the work before us by Sir Charles Lyell, we have new proofs, not only of personal investigations in the field, but of that ever-wakeful industry which allows no valuable novelty to escape, and which, from a high and philosophical point of view, combines the whole so as to bring vividly before the reader most of the known essential points that bear on the study of rocks, their disturbances, metamorphisms, and chronological classification.

Throughout this book, as well as in Lyell's yet greater work, the "Principles of Geology," we mark the workings of the mind of one of the profoundest thinkers that the geological world has yet produced. In spite of the warning voice of the great Hutton, it was, and still is, with some authors, the fashion to build up systems of creation and invent processes of action as if our knowledge of fact and circumstance were alike complete. Such writers are ever apt to assume, down to the latest epochs, the existence of special forces of a kind and intensity more suited to the contracted notions of time still prevalent with the many, than to those sober and sublime ideas which we believe are taught by a more modest interpretation of the still imperfectly understood facts that a study of the earth's crust has revealed to us. The evidence is perfect in past times of the long duration and slow extinction of species, genera, and whole classes of animals; of the slow accumulation of all the ancient strata in the sea, in lakes, and at river mouths, in the same manner that similar beds are found at present; and of the sinking of old sea bottoms, and the submergence and emergence of lands as slowly as the subsidence in these later times of the coral islands of the Pacific. All this can be *demonstrated*, and much more besides; whereas the advocates of spasmodic theories are often less happy in their demonstrations, since (to take one instance) no amount of contortion and inversion of strata proves that this was the result of one act of violence. You may bend a bow so slowly that it is only at intervals the eye can detect the increasing curve. The author of this manual, and those who, like him, most insist on the average uniformity of existing forces in old geological epochs, are, however, often spoken of as theorists *par excellence*, while in reality, as it appears to us, they form the least theoretically inclined portion of the geological community. They do not invent theoretical Titanic powers to explain all those wonderful phenomena of disturbance of rocks, and extermination of races which mark the varied strata, but simply accept what they see and know, that the whole existing economy of nature is ever changing by slow and sure degrees; and he is a bold theorist who asserts that, in the long lapse of geological time, repetitions of seemingly small forces may not produce accumulated results, equal in magnitude to those assumed revolutionary powers which, if they existed, marred the face of nature, and spread ruin and devastation over a world for long periods of time. Avoiding such imaginations, Sir Charles Lyell in his writings constantly insists on the fragmentary state of our knowledge of the history of the earth. He is content to wait and watch till chance or diligent research may reveal to us other lost leaves and chapters of the great book which it is the business of the geologist to decipher. This "is only the last of a great series of pre-existing creations, of which we cannot estimate the number and limit."*

The first six chapters of the Manual deal with the aqueous and igneous characters of rocks, the composition of the rocks, their various forms and peculiarities of stratification, their consolidation, the arrangement and petrifaction of fossils, the elevation and disturbance of strata, and the various effects and results produced by denudation. The 7th explains the mode of the formation of alluvium, and the 8th and 9th the principles of the chronological classification of rocks. From the 10th chapter to the 27th, the author describes the position and structure of the formations from the higher Tertiary to the Cambrian rocks in descending order, copiously elucidating the subject by description and by pictorial illustration of the varied organic forms that

* P. 640.

characterized the successive stages of the world's history. From the 28th to the 33d chapter the author treats of volcanic rocks, their structure and composition, their different ages, and the effects they produced by melted contact with stratified deposits. In the 33d and 34th chapters, he explains the nature of granite and other allied plutonic masses, with their various ages and relations to volcanic rocks, and in the 35th, 36th, and 37th chapters, he proceeds to develop the theories of cleavage, foliation, and other points connected with metamorphism, and to show that these remarkable phenomena are common to rocks of all geological epochs. The last chapter is de-devoted to the subject of mineral veins.

The whole work is alike profound and explicit, and written in a style so interesting, that, apart from its scientific value, it is a pleasure to read the book, and no tyro in geology can rise from its intelligent perusal without at least having his eyes opened to the general scope of the subject. At the same time, we think it would have been better if in the account of the formations, the descriptions had followed the ascending instead of the descending scale. As it stands the order of nature is so far reversed that the history begins in times that geologically immediately preceded our own epoch, and traces events backward to the earlier ages of the world, thus sometimes necessitating allusion to facts with which the reader is yet supposed to be unacquainted, rendering it more difficult for the author to point out, and for the inexperienced reader to understand, the relation of cause and effect in the chronological history of events. For instance, the palæozoic rocks were in places heaved up into lands and mountain ranges, before the deposition of later strata which were formed from their waste; but unless the reader prematurely refer forward to succeeding chapters, he knows nothing of these details. Again, the Purbeck and Wealden strata, and the Eocene rocks of France and England were in great part formed at the mouths of rivers, and the territories through which they flowed consisted, in the first case, of land formed of oolitic and other secondary plains, and also of more ancient hilly palæozoic strata ; and, in the second instance, the tertiary waters wasted the chalk, and the Eocene rivers flowed through more ancient rocks of many ages, of which as yet the student is supposed to know nothing. We are well aware, that in proving the aqueous origin of strata and the nature of their fossils, it is essential to follow the example long since set by Steno,* who, reasoning from the known to the unknown—from the strata of to-day to those of ancient epochs —thus proved their general identity of structure, and the analogies in the manner of occurrence of their organic contents. But this being done in the opening chapter of a manual, just as in the obscure history of ancient empires we endeavour to follow events in their order of succession, so, in the history of the earth, it is most instructive and intelligible to trace the order of events as they oc-

* Prodromus to a Dissertation concerning Solids within Solids, 1671.

curred, showing the successive upheavals and depressions of continents and islands, the newer strata that were formed from their denudation, the disappearance of old forms of life and the approximate entrance on the world's stage of new genera and species during different epochs. While thus describing the rocks in ascending order, the occurrence of lost passages in the history are, it seems to us, not only more readily comprehended, but also it is easier to impress on the mind of the student the nature of those grand operations on the earth's surface that most probably conduced to the existence of local blanks.

The arrangement adopted doubtless arises from the circumstance, that the present volume is an extension of previous editions, the first of which originated in an amplification of the fourth book of the first five editions of the Principles of Geology, a work specially intended to demonstrate the relation of the world as it is, to the world as it has been in ancient geological epochs. With this special end in view, it was undoubtedly natural to adopt the arrangement employed in the "Manual of Elementary Geology," as long as it formed a portion of the "Principles;" but when it was found expedient to divide that work, it might, for the reasons we have stated, have been better to have followed the natural order of succession in describing the strata. Let no one suppose, however, that the arrangement adopted materially interferes with the utility of the book. In its own manner the order is so clear, and the descriptions so lucid, that beginners who have all to learn, and experienced geologists who wish to consult it on special topics, will here find a succinct summary of most of the leading points exhibited by the rocky masses ranging downwards from the comparatively recent times of the glacial drift, through Crag and Miocene sediments, Eocene, Cretaceous, Oolitic, Triassic, Permian, Carboniferous, Devonian, and Silurian systems, till he reach the unfathomed depths of the venerable Cambrian slates and grits which in all the British isles nowhere authentically exhibit their base reposing on any older set of rocks, whether igneous or aqueous.

To criticise the subjects treated of in detail, would occupy a space as large as the volume itself, and we shall therefore only offer a few remarks on two or three of the themes brought before us.

In the third chapter, the fresh-water and marine origin of upheaved strata is shown to depend on the generic character of imbedded fossils. At the present day it requires no very profound knowledge of forms to distinguish between the few genera of fresh-water shells and their marine contemporaries; and as we recede in time through the tertiary and secondary periods, the generic forms of the fresh-water molluscs, and a vast number of those found in marine beds, are so closely related to those that still exist, that there is no difficulty in referring some strata to a fresh-water, and others to a marine origin. If a man find oysters, cockles, nautili, and volutes, grouped together, he knows at once the stratum to be marine; and if he find in another *cyclas*, *planorbis*, *paludina*, and *lymnea*, he is sure of its fresh-water origin.

When, however, we come to the palæozoic rocks, the number of extinct genera is so great that in many rich fossiliferous formations, a collector might work for a week without disentombing one existing generic form. Even then, however, we are not without sure guides, for prolonged search has shown that these are sometimes mixed with marine shells that, like the *nautilus* and *lingula*, have inhabited the seas of the world through the larger portion of known time, or again the extinct shells are associated with corals and sea-lilies, which only exist in sea water. Apart from this special knowledge, were some of these ancient palæozoic forms placed in the hands of the palæontolgist for the first time, he might be puzzled (as he still is in the case of some fishes) to give a reason why he should consider them as necessarily marine. Even, however, were there no guiding associations of genera and families, judging from present analogies, the immense areas over which most of the formations occur would of itself solve the question; for, formations that, like the Silurian, Devonian, and carboniferous limestone, stretch across whole continents, cannot have been formed in fresh water. This point being clear, it is a curious subject of inquiry what has become of the fresh-water deposits, which, we presume, were in parts of the world through all time, formed contemporaneously with marine beds. If, indeed, as Mr Henry Rogers supposes, the absence of rock salt from the primary rocks is to be attributed to excess of rain-fall during primary times, then indeed we ought in these earlier periods to have had larger rivers than even the mighty Amazons or the Mississippi, more laden with sediment, and forming deltas of correspondingly ampler magnitude. But not throughout all the aggregate eight miles of thickness of the Cambrian, Silurian, and Devonian strata in the British isles, nor yet in any other region, do we find evidence of a delta, except in a doubtful case in a small part of the Old red sandstone of Ireland. It is not till we come to the Carboniferous rocks that we can with decision speak of fresh-water beds at all; and there are living geologists of unusual timidity or boldness, who even consider these as doubtful. What, then, has become of the fresh-water rocks of the palæozoic age—older than the Carboniferous—and why, in the secondary and tertiary epochs, are they of more frequent occurrence?

From the lowest Cambrian to the recent rocks inclusive, there are twelve great groups, including thirty-five well-marked European formations.

In the (1.) Recent, (2.) Post-Pliocene, (3.) Pleistocene, and, (4.) Older Pliocene epochs, we have respectively of fresh-water beds named in the Manual, 1st, The lake deposits and deltas now forming; 2d, The Loess of the valley of the Rhine, the bluffs of the Mississippi (probably also of the Amazons and many other rivers); 3d, The fluvio-marine beds of the Norwich Crag; and, 4th, The

Aralo-Caspian beds (which are, however, like the bottom of the modern Caspian, of brackish-water origin), together with the indications of rivers afforded by the presence of fresh-water shells in the marine deposits of blue marl, that make part of the sub-Apennine formations near Parma. The Miocene rocks contain fresh-water beds in part of the Molasse of the Alps, and it is doubtful whether or not the lacustrine mammalian beds of the Sewalik hills in India may not be classed as of the same age. Wide tracts of the Eocene strata in the London, Hampshire, and Paris basins, in Belgium, Hanover, on the Rhine, and in other parts of Europe, are in great part composed of fresh-water fluvio-marine and marine interstratifications, and some of these marine strata in one place are doubtless contemporaneous with the fresh-water beds of another. The base of the Cretaceous series is distinguished by the presence of the Wealden fluviatile rocks, and these are directly linked with or merge into the Purbeck limestones and clays which form the topmost part of the Oolites. All the other six great British divisions of the Oolites are undistinguished by fresh-water strata, excepting certain beds that occur in the great Oolite of Yorkshire, marked by the presence of Equisetums, Unios, and Cyprides. In some spots at the base of the Lias, there also occur trifling estuarine deposits. The red Keuper marls and the New red sandstone are, by all geologists, considered to be true marine formations. The whole of the vast palæozoic masses, with the exception of part of the Carboniferous, and perhaps a small part of the top of the Old red sandstone in Ireland, are altogether marine.

The above enumeration gives a tolerably respectable list of fresh-water strata of very different ages, but, at the same time, it must be recollected that throughout the whole range of old geological time, there are only *known* three great estuary deposits, 1st, The Carboniferous; 2d, the Purbeck and Wealden; and, 3d, part of the Eocene formations.

The true history of the first of these is still in many respects a mystery. As a general rule, it is certain that nearly all coal beds lie on the under-clay soil, where the plants grew and decayed probably in swamps and marshy territories. In Shropshire, for instance, we find beds of marine shale, with ironstone, containing Productas and Limuli, alternating with strata full of fresh-water Unios and under-clay (the soil), on which rest beds of coal.* In Scotland there are beds of marine limestone, charged with Productas and Spirifers supporting similar soils, on which rest beds of thin coal, formed of plants, the roots of which still indent the under clay, and every where in this coal field, under various modifications, there are indications of alternations of sea, fresh-water, and land, pointing apparently to a deltoid origin. But there were probably special conditions then in action, of which we have now no actual example in progress. Consider the 12,000 or 14,000

* Prestwich Geological Transactions, vol. ii., pp. 5, 413.

feet of coal measures at the South Joggins in Nova Scotia,* and in South Wales, and it would be difficult to show that we know anything of any other rocks formed or forming under precisely similar circumstances. Consider also the vast extent of these deposits. In the British isles the coal fields are but fragments, for once they probably spread over the whole of the limestone district of Ireland; and in England many now isolated were once united, the existing fragments having been saved from the great planing process of denudation, only by the accident of these portions having been curved downwards into great and small basins, during the contortion of the strata. Consider, again, the prodigious areas occupied by the coal fields of North America, larger than some entire kingdoms of the Old World, and which, in the opinion of the best American geologists, were once united. But though we may allow their deltoid origin, it is not therefore to be supposed, that, (for example) the American coal fields were in any time, however long, formed at the mouth of one great shifting river, though we can easily fancy a state of things by which the structure we now witness in the Coal measures might, by the agency of rivers, have been partly brought about. Suppose a flat continental territory, partly bounded by the sea, and through which many great rivers wandered, similar to those that now traverse the plains of Siberia; then if these, instead of emptying themselves into an icy ocean, formed their deltas in a "moist and equable climate," and if, as the land slowly sank and oscillated, they often shifted their channels, and enlarged their deltas in width, length, and thickness, we can understand how great accumulations of alternate sea, fresh-water, and terrestrial strata might be formed over areas of unusual size. With a vigorous and rapid growth and decay of plants fitted for the purpose, thick accumulations of decayed vegetable matter would be formed, sometimes over large continuous areas, sometimes separated by broad unproductive spaces, or again in little patches repeatedly interrupted. On the whole, all the evidence leads to the conclusion that rivers and marshes had, at all events, much to do with the origin of coal.

That the Purbeck and Wealden strata were deltoid and not lacustrine there can be little doubt, for beds containing plants, insects, and fresh-water shells, alternate with marine bands, showing occasional eruptions of the sea, due either to sudden depressions of the land, or the sweeping away of river bars. With the exception of the lacustrine strata of central France, the same estuarine character belongs to the Eocene beds of England, France, and Germany. If we might imagine the Loess of the Rhine and the bluffs of the Mississippi thrown far back in time and *fossilized*, they would probably be classed but as lower subdivisions of deltas, the modern deposits formed by these rivers constituting higher members, each subdivision being of no more value than the beds of lower, middle, and upper

* Dawson and Logan, Geological Journal, vol. x., p. 39.

Purbeck, in that formation. Eliminating therefore these late tertiary deltas, as we have already stated, we have as yet only discovered three great deltas throughout all the vast abyss of past geological time, and yet at the present day there are about twenty-five first-class deltas on the shores of the four continents, besides a multitude of smaller ones, many of them of considerable importance. Suppose that the eleven great groups that lie between Pliocene and Cambrian rocks had each an equal average number of deltas, then had they been by happy accidents preserved, we might expect to find a large proportion of 275 great deltas, were they all accessible to research, in addition to the multitude of smaller ones which we may be pretty certain contemporaneously existed, if, as we believe, the general economy of land, rain, rivers, lakes, and seas, resembled, in old times, the arrangements of to-day. But (supposing this rough kind of hypothesis to be admissible) we underestimate the argument if we only calculate the probabilities for 11 great geological periods, for no man who knows anything of geology will believe that this mere point in time that we call *recent*, is comparable, for instance, to any one of the great periods indicated by the Silurian, Oolitic, or Cretaceous formations. The Oolitic period is divisible into three distinct groups of formations, or four, if, with some geologists, we include the Lias, and even in the subdivisions of any one of these groups, (as for instance between the lower and upper Lias, or the inferior and Bath Oolite, or the Bath Oolite, and the Cornbrash,) there are differences in fossil contents far greater than those which mark the molluscous faunas of the glacial and recent epochs. One main cause of the difference between the marine fauna of the drift epoch, and that of the present day, is easily traced to change of climate and other physical conditions. During the glacial epoch we are certain that the greater proportions of the continents of Europe, Asia, and America, —sometimes one part and sometimes another,—were submerged and again upheaved into dry land, and in this fact we discern but one passage of many phases of physical geography that elapsed between glacial and recent times. But were the drift and recent formations grouped together, and thrown far back in geological time, they would be considered but as minor subdivisions of one formation, and nevertheless during the existence of the lower subdivision alone, submergences and emergences of continents slowly progressed, sufficient to alter, obliterate, and, with important changes, perhaps reconstruct many of the great river systems of the world. Roughly considering each of the Oolitic formations as of equal value in point of time, we find them divided into ten or twelve subdivisions, each zoologically having differences as important or indeed of more value than the distinctions between the molluscs of the glacial and recent epochs. When there are marked differences in the mollusca of two formations, one of which appears immediately to succeed the other in time, if we adopt the hypothesis that in a given area the disappearance and appearance of new species (apart from special creations) are due to ordinary physical causes, then it is impossible to deny that the Oolitic subdivisions may not have witnessed modifications of climate, and revolutions of continental areas, equal to that recorded of the glacial epoch, with corresponding variations of continental drainage.

Taking all these things into consideration, it appears that with the number of formations the probability of the ancient existence of a number of large deltas (now lost) increases in a remarkable ratio, and the structure of the rocks themselves helps us to this conclusion.

Neither Silurian nor Cambrian rocks show any traces of the beginning of geological time. They are old, and have suffered all those repeated contortions and metamorphisms that old age in rocks frequently implies, but the deepest strata of Cambria are conglomerates formed of pebbles, that might, from their appearance, have been derived from Wales, as it now stands, though, except in the water-worn fragments, all trace of the old lands that yielded them is gone.*

We know nothing of the geography of the land whence these fragments were derived, and it is therefore in our opinion an assumption alike rash and unwarrantable, to hold, with some, that in the earlier geological periods the world was a world of islets. The greater proportion of the enormous masses of broad-spreading Silurian strata are the measure of an equal amount of more ancient land destroyed, wherewith to form them, and the original muddy character of much of these (the lower Silurian strata of Wales, for instance and the upper Silurian mudstones of Murchison), confutes the idea that they were principally formed by the coast waste of scattered islands. It seems more natural to attribute, in part, the origin of the mud to the action of great rivers carrying it out to sea, where it gradually accumulated, for, with rivers like the Ganges, the Mississippi, the Amazons, and the Nile, a large portion of the sediment is carried by ocean currents far beyond the limits of their deltas. The same kind of reasoning that applies to the Silurian mudstones might be applied to the Old red and Keuper marls and the clays of the Lias and Oolites, and most geologists, without difficulty, grant that great part of the carboniferous rocks were directly derived from river sediments. We are sure of the fluviatile origin of most of the Eocene clays. Let it not be supposed that we wish to undervalue coast waste; on the contrary we believe it to be one of the mightiest agents that are for ever

"Sowing the dust of continents to be."

We only claim, for rivers past (though lost) as well as for rivers present, their true value. True, it is easy to surmise that in old times great muddy formations might have accumulated with a rapidity unknown in modern days; how, through warmth and moisture, incessant rains, and excess of carbonic acid in the air the decomposition of the felspars of primeval granitic islands took place with unexampled facility; but this and such like notions we look upon as belonging to

* Ramsay Geological Journal, vol. ix., p. 168.

the wide category of inventions, unsupported and insupportable by true inductive philosophy, and little more deserving of attention than such exploded ideas as that the wavy layers of gneiss were deposited in a boiling sea.

But if numerous deltas, both great and small, existed in olden times, how does it happen that in all the long list of geological formations, only three great ones and a few small traces of others have been discovered ? This is due to a variety of causes. First, it must be recollected, that at the present day there are vast ocean tracts like the Pacific, where no large deltas exist, though chalk-like calcareous deposits from Java to the low Archipelago are everywhere forming. 2dly, There are many long continental coasts absolutely destitute of great deltas, like the west coast of America, the north coast of Africa west of the Nile, and the major part of the south and east coasts of that great continent, where there are no rivers of first-class importance. In some cases certain marine deposits in old periods may have accumulated under conditions like those above cited, but it is in the highest degree unlikely that they should apply to all. 3dly, If during older periods the lands were frequently subject to oscillations of level, equal to that which marked the epochs between the beginning of the drift and recent times, (a safe conclusion), then we might expect that many deltas being made of most perishable stuff (loose sand and mud), would at such times be especially liable to destruction, before a happy set of circumstances occasionally admitted of a delta being preserved; and, 4thly, even if consolidated, many (especially the smaller ones) must have been destroyed, for it most frequently happens with disturbed marine formations, that *their present margins have been formed by denudation*, and are removed to unknown distances from the original coasts where contemporary rivers debouched, and under these circumstances, in consequence of repeated disturbances of rocks along the same great lines, accompanied by constant denudations, *the greater the age of a formation the less chance is there of its contemporary deltas being preserved.* When the geology of other parts of the world is as accurately analyzed as that of England, and some other parts of Europe and North America, more deltoid formations will doubtless be discovered, but for the reasons above stated, they will never bear the same proportion to the marine formations of any period that existing deltas do to the marine deposits of the recent epoch.

In accordance with these views we might expect a more frequent occurrence of fresh-water strata in the later than in the earlier epochs of the world's history. An approximate result of an analysis of this subject is given in the following table, in which the letter F signifies that fresh-water strata are found *in some part* of the formation or group that it is placed opposite, the evidence of the occurrence of these fluviatile beds being always of a decided kind.

Table showing the Geological Epochs, Groups of Formations, and Single Formations, in which Fresh-water Strata occur.

Periods.	*Epochs.*	*Groups.*		*Formations.*	
Post-tertiary, Tertiary, or Cainozoic.	Post-tertiary F		F	Recent	F
				Post-pliocene	F
	Upper Tertiary F		F	Glacial Drift, &c.	0
				Norwich Crag	F
				Red and Coralline Crag	0
	Miocene F		F	Miocene	F
	Eocene or Lower Tertiary F	Upper Eocene	F	Hampstead Beds (Isle of Wight)	F
		Middle Eocene	F	Bembridge Beds	F
				Headon Beds	F
				Headonhill Sand and Barton Clay	F
				Bagshot and Bracklesham Beds	0
		Lower Eocene	F	London Clay	0
				Plastic Clay, &c.	F
				Thanet Sands	0
	4 F in all.	6 F in all.		In all 14 9 F, or 9-14ths.	
Secondary, or Mezozoic.	Cretaceous F	Upper Cretaceous	0	Chalk	0
				Upper Greensand	0
				Gault	0
		Lower Cretaceous	F	Lower Greensand	0
				Weald clay and Hastings sand	F
	Oolitic F	Upper Oolite	F	Purbeck beds	F
				Portland Oolite	0
				Kimmeridge clay	0
		Middle Oolite	0	Coral rag	0
				Oxford Clay	0
		Lower Oolite	F	Great Oolite	F
				Fullers' earth	0
				Inferior Oolite	0
		Lias	F	Upper Lias	0
				Marlstone	0
				Lower Lias	F
	Triassic or New Red Series 0	Upper Trias	0	New red marl	0
		Middle Trias	0	Muschelkalk	0
		Lower Trias	0	New red sandstone	0
	3 in all— 2 F, or 2-3ds.	9 in all— 4 F, or 4-9ths.		In all 19 4 F, or 4-19ths.	
Primary, or Palæozoic.	Permian 0	Permian	0	Magnesian Limestone	0
				Sandstone, marl, and conglomerate (Rothlingendes)	0
	Carboniferous F	Upper Carboniferous	F	Coal measures	F
		Lower Carboniferous	F	Carboniferous limestone and shale (with Coal, &c., in places)	F
	Devonian or Old Red Sandstone F	Upper Devonian	F	Upper Devonian	*F
		Lower Devonian	0	Lower Devonian	0
	Silurian 0	Upper Silurian	0	Tilestone	0
				Ludlow rocks	0
				Wenlock rock	0
				Caradoc sandstone	0
		Lower Silurian	0	Llandeilo flags	0
				Lingula flags	0
	Cambrian 0	Cambrian	0	Cambrian	0
	5 in all— 2 F, or 2-5ths.	8 in all— 3 F, or 3-8ths.		In all 13 3 F, or 3-13ths.	

* By some the fresh-water beds at the top of the Old red are considered as of Carboniferous age. This would strengthen the view adopted in this notice.

The result of the foregoing table may be stated as follows, if, in the column of *groups* of strata we consider Post-tertiary, Upper Tertiary, and Miocene respectively, to be of no greater palæontological value than any one of the three divisions of the Eocene strata.

	Proportion of SINGLE formations containing fresh-water strata.	Proportion of GROUPS of formations containing fresh-water strata.	Proportion of EPOCHS containing fresh-water strata.
Post-tertiary and Cainozoic or Tertiary	$\frac{9}{14}$ths = 0·6428	All = 6·0000	All = 4·0000
Mesozoic or Secondary	$\frac{4}{19}$ths = 0·2105	$\frac{4}{9}$ths = 0·4444	$\frac{2}{3}$ds = 0·6666
Palæozoic or Primary	$\frac{3}{13}$ths = 0·2307	$\frac{3}{8}$ths = 0·3750	$\frac{2}{5}$ths = 0·4000

From this it will be seen that in regard to the proportional number of rocks containing fresh-water strata, if we consider the SINGLE FORMATIONS, the primary rocks have a slight advantage over the secondary (0·0202), and the tertiary have a great advantage over both. In the GROUPS of *formations*, the secondary rocks have a slightly greater advantage over the primary (0·0694), than the primary have over the secondary in the previous column, and *all the six groups* of the tertiary rocks contain fresh-water strata. In the column for EPOCHS, the secondary rocks have a decided advantage over those of primary age (0·2666), and of course all the four tertiary epochs exhibit fresh-water strata.

Notwithstanding our very imperfect knowledge of the detailed structure of the greater proportion of the globe, from such data at these, some might argue that in the earlier stages of the world's history there was perhaps less rain than at present, and others, that though there was as much or more rain, there were no large continents to give birth to delta-forming rivers; while others, like ourselves, might think it most probable that the later the epoch, group, or formation in time, the greater is the chance of its more local or fresh-water deposits being preserved.

Two of the most interesting chapters in the Manual are the 11th and 12th, in which are described the phenomena of the icy-drift and boulder-clay formations, and the evidences of the ancient existence of glaciers in the mountain regions of the British isles. These subjects have attracted much attention among able observers, but long after Playfair had indicated the ice-borne character of the Alpine boulders that rest on the Jura, there was a powerful reaction among geologists, the true doctrine fell into discredit, and most writers adhered to the dogma that the heterogeneous mixtures that cover great part of the surface of the northern continents, were the result of mighty sea waves which rushed from the north across Europe, Asia, and America, scattering rocky fragments as they went, which polished and grooved the rocks over which they passed. A few able workers, in England and America, yet adhere to this hypothesis; while on the continent of Europe it is still a universal favourite. In England, however, for some years it has been steadily losing ground, and we believe it will ere long altogether pass into the limbo of exploded theories, and be regarded as scarcely less chimerical than some of the strange old fantasies of Moro, Woodward, and the imaginative Burnet. We recollect well the unbelief and ridicule that greeted the announcements of Agassiz and Buckland in 1840–41, that glaciers once occupied the greater valleys of the Highlands of Scotland and of Wales, and how sceptics and shallow wits, whose geology perhaps rarely extended beyond the precincts of turnpike roads, attributed the grooving and striation of the rocks to cart-wheels and hobnailed boots; and the ice-polished surfaces, to the sliding of the caudal corduroys of Welshmen on the rocks, to slickensides and sea-waves, and to every cause indeed but the true one. Saner views, however, at length prevailed, and there are now few geologists who have studied the effects of ice in the Alps, or are familiar with its action in rivers, or who have carefully perused the writings of Arctic voyagers, but will readily recognize the familiar indications of ice, and more especially those of glacier action in the Highlands of Scotland, in Cumberland, Wales, the south-west of Ireland, and the mountains of the Vosges.

Without criticising the details adduced by Sir Charles in his summary of this interesting question, it is now perhaps universally allowed that all the more important general contours of hill and valley in the continents of the old and new worlds were the same as now previous to the glacial epoch. The land was then slowly depressed beneath the waves, and as it sank its minor features were somewhat modified, for terraces were formed on old shores, and icebergs drifting from the north, and pack ice on the coasts, as they grounded and grated along the shores and sea bottoms, smoothed and striated the rocky surfaces over which they passed, and deposited, in the course of many ages, clay, gravel, and scattered boulders over wide marine areas that had once been land. The grooves and striations on the ice-smoothed rocks (except where locally deflected) still bear witness to the general southward course of the winds and ocean-currents that bore the ice from its birthplace into milder climates.* Evidence of this is abundantly found both in North America† and Europe, and in southern latitudes the same agency of icebergs has transported boulders far northwards over the low lands of South America.‡ In many parts of our own islands it is sufficiently obvious, as for instance on the shores of the Clyde, and the Firth of Forth at Granton, North Berwick, Tyninghame, Skateraw, &c., where, in quarries

* Manual, p. 127.
† Lyell, Journal of the Royal Institution. 1855.
‡ Darwin's Naturalist's Voyage, 1852, 247.

newly cleared of till, the smooth surfaces and the ice-ploughed furrows are often as fresh as they might be were a part of Baffin's Bay heaved up to sight and stripped of its overlying mass of modern boulder-clay. These localities are only mentioned as examples of what is common over much of Scotland, both in the plains and high on the summit of Salisbury Crags, the flanks of Arthur Seat, the Pentlands, and many a hill "in the great central valley between the Firth of Forth and the Firth of Clyde."* The same phenomena are visible throughout the length and breadth of Ireland, in the north of England, and over many parts of Wales, from Anglesea to Pembrokeshire. In Anglesea, which is a low country, the whole of the contours of its undulations speak of the moulding effects of ice, and, when freshly denuded of their covering of turf, heath, clay, or gravel, the rocks, like those in Scotland, are often beautifully smoothed, the striations running on an average from 20° to 25° E. of N., transverse to the courses pursued by the great glaciers that contemporaneously descended to the N.W. from one side of the Snowdonian chain.† On the coast also of that island frequent cliffs occur of stiff roughly stratified boulder-clay, with its complement of travelled blocks and well-scratched stones.

In Pembrokeshire, though the phenomena are less marked, the experienced eye has no difficulty in detecting the effects of ice in the peculiar rounded contours of the hills between St David's Head and Fishguard. True, the tooth of time is surely effecting their ruin, but this only renders the origin of their peculiar forms more apparent, in the marked contrast their mammillated forms occasionally present to the broken outlines produced by subsequent ordinary atmospheric disintegration. That the winter climate of the time was intensely cold, is witnessed by the fact, that between the south coast of Cardigan Bay and St Bride's Bay, the low country is covered with great boulders, derived from the higher greenstone hill-tops that rise bare above the drift between Carn-Llidi and Strumble Head.‡ They are neither foreign to the district, nor were they transported on far-travelled icebergs, but resting on, or being mixed with the native drift that forms the smooth slopes of the low lands, they must certainly have been floated and scattered by coast ice that in winter gathered round the low islets, seeing that isolated hills of a few hundred feet high never could have given birth to anything deserving the name of glaciers and large icebergs. This is but one example of what is common in Wales, where it is stated such drift-deposits rise on the mountains in the north to the height of more than 2000 feet.§

* Maclaren, Edin. New Phil. Journal, 1849, p. 161.

† Ramsay, Geological Journal, vol. viii., p. 374.

‡ See De la Beche's Map of Pembrokeshire. Geological Transactions, Ser. 2, vol. ii., p. 1.

§ Ramsay, Geological Journal, vol. viii., p. 374.

The same kind of evidence is conspicuous on and around the hills of Charnwood Forest in Leicestershire, from whence long trains of greenstone granite and syenite have been borne southwards, dotting the drift-covered country as far south as Rugby. The highest hill in the Forest is about 800 feet. The whole of Shropshire, Cheshire, and Staffordshire, are speckled with boulders of granite and greenstone, some of them transported, it is said, from the mountains of Cumberland; and on the Derbyshire hills the drift rises to the height of 1500 feet, while further south, in the valley of the Trent, and on the Lias clay and tabulated Marlstone hills near Market Harborough (and many other places), we find polished and striated fragments of Derbyshire Mountain limestone and Millstone grit mingled with chalk flints, and fragments of Lias and Oolitic limestones. The same indications of travelled drift are familiar to the geologist in Northumberland and Cumberland, in the Silurian valleys and hill-sides in the south of Scotland, in the broad spreading boulder clays and sandy gravels of Ayrshire, Argyllshire, Dumbartonshire, and on the lower flanks of the mountains of Arran, where the smoother swells that in places rise well up on the mountains, mark with a clear outline the average limits of the glacial drift. Near Glasgow, it rises in places to the very summits of the Campsie hills; and in the Lothians, it lies on the slopes of the Lammermuirs, and the Pentland hills;* and in many other parts in Scotland, from north to south, too numerous to name. Indeed, over the larger part of the British isles, its presence, or indications that it has been present, form the rule, its absence is exceptional, and even such debateable land as that which lies between the Cotswold hills and the Severn is not without some hint of ice.

The intensity and the wide-spreading effects of cold, in what are now temperate climates, is one of the greatest marvels of geology. It has been suggested, that if the Isthmus of Panama were submerged, the current that crosses the Atlantic from the Cape to the Caribbean Sea would find its way into the Pacific, and there would be no gulf stream abnormally to raise the temperature of the west of Europe. But even this would not cause cold sufficient to originate glaciers in the Highlands and in Wales; and besides it is known that the mollusca on the opposite shores of the Isthmus of Panama are generally distinct, which would not be the case if a communication had been open so late as the glacial epoch, the shells of which are almost all of existing species.† In the present state of our knowledge, therefore, the suggestion made by Sir Charles Lyell at p. 147 is perhaps the best that has yet been offered, viz. that "if in both of the Polar regions a considerable area of elevated dry land

* Maclaren.

† There is some kind of evidence that this Isthmus was open during Miocene times; for, according to Mr John Carrick Moore, there are Miocene shells found fossil in St Domingo, some of which still live in the Indian Ocean.—*Geological Journal*, vol. vi., p. 39.

existed, such a recurrence of refrigerating conditions in both hemispheres might have created for a time an intensity of cold never experienced since; and such probably was the state of things during that period of submergence to which I have alluded."

It must, however, be remembered that this is but a suggestion, and though there can be no doubt of the long duration of an intense state of cold, still, before the whole mystery is cleared up, much remains to be done; for it must not be forgotten, that from the Gulf of Finland to the White Sea, and on the flanks of the Scandinavian chain, there are traces of the glacial sea, and yet further north in the icy regions lately traversed by arctic voyagers, deposits with marine shells have been observed at heights, which, at some tertiary period, would indicate considerable depression of the northern regions, though, whether that depression was contemporaneous with or subsequent to our glacial epoch, no precise evidence has yet been afforded.

Sir Charles only devotes a short paragraph (p. 137) to the subject of ancient British glaciers; but were the scattered information that is afloat on the subject, respecting this and other quarters of the world, collected, condensed, and printed, it might well claim an extended notice in Manuals from all who appreciate the full importance of glacial geology. It might be well to enumerate and give special instances of the perfect nature of the proofs that indicate the past existence of glaciers in regions where now the snow in mild winters scarcely falls, and in the severest never lies for half the year. Such proofs are to be found in the polishing, scratching, grooving, and deep furrowing of the rocks over which the glaciers flowed, magnificent examples of which occur in many a Highland valley, in Cumberland, Wales, the south-west of Ireland, and the mountains of the Vosges. The bottom of a glacier is covered with fine sand, and dotted with imprisoned stones and blocks, which polish, scratch, and groove the rocky floor over which its weighty mass progresses; and wherever a tributary stream of ice flows into the greater glacial river of the main valley, there the grooves will at first slightly diverge from those made by the sweep of the main current, and as we recede from the point of union of the two streams, the furrows will at length curve fairly round and accommodate themselves to the trend of the tributary valley. In fact, wherever tributary glaciers flow into a main valley, a series of lines will be formed, branching from the general direction of the grooves that mark the bottom and sides of the main valley. This is what takes place at present in all glaciers; and if in Wales any man will ascend the pass of Nant Francon in Caernarvonshire, and examine its tributary valleys, he will find that in the main valley the striæ follow its course (about 20° to 25° west of north), and in the tributary valleys the striæ run east and north-easterly according to their curves, while in entering Cwm Idwal from Nant Francon they curve gradually round from E.S.E. to N.N.E.* The same is equally striking in the neighbourhood of Snowdon, where, in the Pass of Llanberis, the grooves and striæ first strike from 30° to 35° south of east, and gradually curve round to the south, as a portion of them pass into the high tributary valley of Cwm Glas; or again, in Nant Gwynant, where in the main valley they strike to the south-west and branch off first to the north-west, and gradually curve round to the north in the higher part of Cwm-y-llan, and in another instance generally to the west in the vast rocky amphitheatre of Glaslyn and Llyn Llydaw. "In the higher parts of such minor tributary valleys, the grooves converge towards the hollows, at acute angles to the main direction of the valley, in the manner that might be expected from ice pressing or flowing downwards to feed the main icy streams."†

Again, if a great valley be filled with ice nearly to the brim, and if there are short tributary valleys at its sides, bounded by lower spurs that branch inwards from the crested ridges that flank the main valley, the great stream of ice that fills the whole will in its flow over-ride the whole depression, forming its striations on the rocky floor, often transversely to the minor valleys, or in accordance to the course of the average direction of the slope of the whole mass. But if by amelioration of climate the glacier gradually decrease in size, then we shall find *roches moutonnées* and striations (as in Switzerland now), at far higher levels than the surface of the existing glacier. The lower spurs that branch into the valley from the bounding crests will then stand out denuded of ice, the high hollows between them will contain tributary glaciers, and form new striations transverse to those that were formed, when from ridge to ridge the whole great valley was full of ice. Such transverse striations actually crossing each other, are observable in parts of Nant Francon and the Pass of Llanberis; and in other cases close to the mouths of the tributary valleys the grooves on the steep hill sides of the main valleys are often at much greater elevations than many of the striations that, transversely to these, follow the course of the tributary valleys almost to the point where their brooks unite with the principal stream. There is indeed proof in the longitudinal grooves and striations on the hill sides, that in the Passes of Nant Francon and Llanberis the ice once attained the enormous thickness of about 1300 feet; unless indeed, as has been supposed by Dr Hooker, many valleys have been to a considerable extent deepened by glaciers themselves. In this case the *present bottoms* of the Welsh passes would be lower than the *original floors* over which the glaciers flowed when they formed the longitudinal striations that are now 1300 feet above the river in Nant Francon and the stream that feeds Llyn Peris, in the Pass of Llanberis. However this may be, by degrees they

* See Darwin, Phil. Mag., ser. iii., vol. xxi., p. 180; and Ramsay, Geological Journal, vol. viii., p. 371.

† Reports of the British Association, 1854, p. 95.

decreased in size, and there is still beautiful evidence of their gradual decline in the retreating moraines concentrically arranged one within another, as, for instance, in the long mounds on the west side of Cwm Idwal, and also in Cwm Glas and the upper part of Cwm Brwynog on the sides of Snowdon, till at length we find only the last relics of the ice in the remains of tiny moraines far up amid the innermost recesses of the mountains.*

In many of the Vosges, Highland, and Welsh valleys, the moraines are as perfect as those of the Glaciers du Bois and of the Rhone at the present day. In proof of this we would cite the beautiful illustrations of glacial phenomena in the Vosges published by MM. Henri Hogard and Dolfuss; or, to come nearer home, the moraines in Glen Falloch, above Loch Lomond, and those of the Cuchullin Hills, mentioned by Professor J. D. Forbes; or of Ben More, Coigach, and Glen Messan, noticed by Mr Robert Chambers and Mr Maclaren,† or that of Llyn Idwal described by Mr Darwin, or of Cwm Graianog‡ in Nant Francon, or of Llyn Llydaw, together with others at the upper end, of Cwm-y-llan, Cwm-y-Clogwyn, Llyn-du-'r-Arddu, and Cwm Glas, on the flanks of Snowdon, and of Cwm Orthin, near Ffestiniog, where there is a small but well defined moraine less than quarter of a mile below the lake. From the peak of Snowdon the educated eye at once perceives the moraine-shaped form of the semicircular mound, that below one of the lakes stretches partly across Cwm-y-Clogwyn; and he who wishes to see a perfect British terminal moraine may ascend Cwm Glas from the Pass of Llanberis, till he get beyond the great *roche moutonnée* that lies half a mile south of Blaen-y-Pennant. There a long curved ridge of earth and large stones crosses the valley, almost as regular in form as the huge mounds of chalk that form the boundary dykes of any one side of the deep trenches of Old Sarum.

Another proof of glaciers is, that in Wales terminal moraines frequently constitute the confining barriers of mountain lakes and tarns. There are numerous cases of this kind in Switzerland and the Himalayah,§ and the same causes have been at work in the mountains of the Vosges.‖ In Caernarvonshire, Llyn Idwal forms a striking example of this phenomenon, as also does Llyn Llydaw on the flank of Snowdon. In some cases, as in Cwm-Llafar below Carnedd Llewelyn, the ice has first ploughed a long narrow channel through the terraced drift from end to end of the valley, then, the decreasing glacier formed a moraine near its upper end, which, when the ice melted, confined a lake, till the

* Ramsay, Report of the British Association, 1854, p. 94.

† Edin. New Phil. Journal, Mr Maclaren, vol. xl., xlii., xlvii.; Mr R. Chambers, vol. liv.

‡ Ràmsay, Geological Journal, vol. viii., p. 375.

§ Hooker, Himalayan Journal, vol. ii., p. 119.

‖ Coup d'œil sur le Terrain erratique des Vosges, par Henri Hogard, 1848, accompagnée d'un Atlas de 32 planches publiée par Dolfuss-Ausset, 1851.

stream that flowed from it cutting a passage to the base of the moraine, the tarn was thoroughly drained. There are other cases of a like nature. Other moraines dam up lakes in a more peculiar manner. The mouth of a valley is surrounded by a high mound, or a series of united mounds curving outwards, formed of earth, angular, subangular, smoothed, and scratched stones and blocks (some of them as large as a small cottage), so arranged that their origin, and the places whence they came, are unmistakeable. A deep clear lake lies inside, and the drift of the glacial sea (also full of boulders), with a long smooth outline, slopes right up to the outside base of the moraine, showing that the glacier descended to the sea-level, and, pushing for a certain distance out to sea, formed a marine terminal moraine, while the ordinary drift detritus of small sediment and boulder stones (partly scattered by floating ice) was accumulating beyond. In the meanwhile the space on and below the sea-level occupied by the glacier was kept clear of debris, and when the land arose, and the climate ameliorated, the hollow within the terminal moraine became replenished with the water-drainage of the surrounding hills, just as in earlier times it was filled with a drainage of snow. Such in Carnaervonshire are the lakes of Llyn Dulyn, Melynllyn, Ffynnon Llugwy, Marchlynmawr, and Marchlyn-bach; and in Scotland it might not be difficult to give parallel cases.* Judging by the present average elevation of these Welsh lakes, when the moraines that confine them were formed, the highest parts of the mountains of Caernarvonshire (the snow drainage of which gave birth to the glaciers), could not have been more than from 1400 to 2000 feet above the sea. The average great intensity of cold may be inferred from this circumstance, for the sea then flowed through some of the greater valleys between the Menai Straits and Cardigan Bay, across the present watersheds. The principal of these are the vale of Conwy, the valley between Bangor and Capel Curig, the Pass of Llanberis, opening into Cwm Gwynant (about 1300 feet high at the watershed), and the valley of Afon Gain, between Caernarvon and Beddgelert. The country was thus broken up into a group of islands, each one of which in great part had its permanent covering of snow and ice.

Another sign of the past occupation of these valleys by glaciers occurs in the *roches moutonnées* (already mentioned), in which they abound. These are not merely "rounded bosses, or small flattened domes of polished rock;"† for, though often small, sometimes they are of such dimensions, that they rather deserve the names of polished hills than of bosses, rivalling as they do in magnitude some of those immense isolated mammillated surfaces which rise in the middle of the valleys of the Aar, of the Rhone, and of Chamouni, marking the former great extension of the Alpine glaciers. In all the British regions where glaciers once existed, they may be

* Phil. Journal, vol. liv., p. 231. Chambers.
† Manual, p. 137.

found of the most various dimensions. In the south-west of Ireland they are almost everywhere amid the mountains. The sides of the Gairloch, Loch Long, and other sea lochs described by Mr Maclaren (often far above the sea-level) are marked by their presence. Some of the rocks of Loch Lomond, that only show themselves when the lake is low, are rounded, polished, and striated; and the scattered isles that gem its surface present on a larger scale all the smoothly curving outlines of ice-worn *roches moutonnées*, although many may find it difficult to believe that the icy stream that once flowed down Glen Falloch ever expanded into the broader space that lies between Ben Lomond and the Luss and Tarbet shore. Similar forms have been described by Mr Chambers and Mr Bryce in Cumberland; and in Wales they may be counted by the hundred; in Merionethshire on the flanks of Aran Mowddwy, in the estuary of the Mawddach between Dolgelli and Barmouth, by the lake in Cwm Orthin, and in Cwm Croesor and Nant-y-mor between Ffestiniog and Beddgelert, and also in Traeth-mawr and Traeth-bach. In Caernarvonshire they are common in almost all the greater valleys of the Snowdonian chain — in Cwm Eigiau, and on the banks of Avon Llugwy and its tributary valleys, on the N.W. slope of Moel Siabod, and also in Cwm Gaseg, Cwm Llafar, and especially in Nant Francon. Magnificent examples occur in this valley above the famous Penrhyn slate quarries, another small one lies opposite Ty gwyn, others described by Mr Darwin at Llyn Ogwen and in the slopes between Llyn Idwal and the waterfall by the bridge, where the whole side of the hill has been mammillated by the grinding ice that descended from Cwm Idwal to Nant Francon. Others not less striking, at the base of Snowdon skirt the shores of Llyn Padarn and Llyn Peris; and further up the Pass, some of large dimensions, plentifully sprinkled with great blocks of stone (*roches perchés*), amaze the passing tourist, who cannot understand how masses rolled from the neighbouring mountains have so frequently been arrested on precarious points from whence they should naturally have made a final bound into the lower depths of the valley, while the well-pleased eye of the experienced glacialist at once divines that they were gently deposited where they lie by the final thawing of the glacier that slowly bore them from the higher recesses of the mountains. Cases scarcely less beautiful occur by Llyn Llydau, and in Cwm Dyli, Cwm-y-Llan, at Llyn-y-Gader, and Beddgelert, where the curious visitor may see in the hall of the hotel framed record of an imperfectly polished and grooved locality in the vicinity, in the writing of the illustrious Buckland.

In some of the valleys *roches moutonnées* peep here and there from underneath a covering of drift, as for instance in Nant Gwryd, and between Llyn Ogwen and Capel Curig. These may have possibly been formed by floating ice when the country was deeply submerged; but from the form of the valleys, it seems to us equally likely that they sometimes indicate a set of glaciers that existed before the deposition of the drift, which, (the cold still continuing) was afterwards deposited in the valleys during their submergence. If this were the case when the land subsequently emerged, the cold did not cease, and glaciers, ploughing through the narrower valleys which drained large and lofty areas of snow, cleared them of drift in the manner first suggested by Mr Darwin, in his Description of the glaciers of Cwm Idwal and Nant Francon.

We must add a few words about the appearance of the polish on rocks and the weathering of glaciated surfaces. In the Alps, when the glacier ice is freshly removed, the rock underneath, whether of limestone, gneiss, granite, or even quartz, though striated, often possesses the polish of a sheet of glass. In our own country, when the impervious covering of till has been taken away, the surfaces of limestones (as at North Berwick), though grooved and striated, are often beautifully smooth. In a country so low, this may have been due to the grating of icebergs. In other cases, as in some parts of Wales, when the turf and glacier debris is lifted, the underlying surfaces of slate still retain a perfect glassy polish, marked sometimes by flutings, and sometimes by numerous scratches as fine as if they had been made by the point of a diamond. After long exposure these finer markings disappear, and though the general rounded form perfectly remains, the surface becomes roughened, and the planes of the highly-inclined cleavage present on their edges a slightly serrated aspect. The deeper flutings, however, often for a long time remain, but even these at length disappear, though it is not for long after this has been effected that the general rounded form of the *roches moutonnées* is entirely obliterated. Phenomena of the same general nature are observable in the igneous uncleaved rocks over which a glacier may have passed. The original polished surface, on exposure, becomes roughened by atmospheric disintegration; but the general form remains to attest its glacial origin, and in no case is there any danger of the experienced eye confounding this with those forms produced by spherical decomposition about which so much used to be said by Von Buch, and latterly by the Messieurs Schlagintweit. Finally, in the long lapse of time, the air, water, and repeated frosts tell their tale, the rock splits at its joints, it crumbles, masses fall off, and it assumes an irregular and craggy outline altogether distinct from the glaciated surface produced by the long-continued passage of ice; and thus it happens, that on the very summit of some tower-like crag, the sides of which have been rent by the frosts of untold winters, the student of glacial phenomena sometimes finds yet intact the writing of the glacier, while below on its sides all trace of the ice-flood has long since disappeared. These things may seem almost incredible to those who are unaccustomed to read the records of many terrestrial revolutions in the rocks; but, nevertheless, of these extinct glaciers it is true, that just as a skilful antiquary, from the mere wrecks of some castle or abbey of the middle ages, can, in his mind's eye, conjure up the true semblance of what it was when entire, so the geologist, from the fragmentary signs before him, can truthfully restore the whole systems of glaciers that once filled the valleys of the Vosges, the Highlands, or of Wales.

It would be something could we form any idea of the years that have elapsed since, in these latter days of geological time, the glacial markings were made on the rocks. But of this we can have no approximate guess; and the only hint may be inferred from Sir Charles Lyell's remark that it probably took 30,000 years to excavate the deep ravine that lies below the Falls of Niagara, and that this was done since the deposition of certain fresh-water marls that lie above the cliffs, and which are of later date than the American *drift.** There being no doubt that this drift was in general terms contemporaneous with our glacial period, and if Sir C. Lyell's calculation be correct, then the seemingly slight glacial markings on our rocks have endured for a like period—who can tell how much longer?—for no data exist by which we can estimate how long the marls were formed before the excavation of the ravine began, or, farther, how long a period elapsed between the close of the accumulation of the drift, and the commencement and deposition of the fresh-water strata. We may be sure that these passages consumed no mere minute fragment of time, for whole races of mammals were created, lived their appointed time on earth, and disappeared between the close of the drift and the commencement of the human epoch.

One interesting point still remains of this fascinating subject. Though the veteran Von Buch, in conversation, to the last denied that the glaciers of the Alps had ever been materially larger than at present, it is now almost universally admitted that many of them once extended down the valleys 20, 30, or even a greater number of miles beyond their present limits, and that they then were of much greater thickness. The same holds true of the glaciers of the Pyrenees and the Scandinavian chain,† and, according to Dr J. D. Hooker, of the glaciers of the Himalaya, which in places once descended to levels of only 9000 feet above the level of the sea, or 5000 feet below their present limits.‡ Was it during the presence of glaciers in the British isles and in the Vosges, or, in other words, during part of the Newer Pliocene epoch, that these glaciers attained their greatest magnitude? We believe it is susceptible of proof that this was the case.

Another important point to ascertain is the true nature of many of the superficial deposits that lie on the flanks of the Alps, and in some of the wider valleys and watersheds,—a good example of which occurs

* Manual, p. 145.
† Professor James D. Forbes's Travels in Norway.
‡ Himalayan Journal.

on the route between Meyringen and the Grindelwald by the Scheidegg Pass. There, near the base of the Wetterhorn, at heights between 4000 and 5000 feet above the sea, stretching to the southwest, is a broad, smooth slope, covered with comparatively small detritus, not dissimilar to the shell-bearing clays and stony beds which occur in some of the Welsh slopes, on the seaward flanks of the Snowdonian chain, at heights of from 1000 to 2000 feet above the sea. On the Alpine surface are scattered large limestone blocks from the Wetterhorn, arranged in rude lines. At lower levels, the upper and lower glaciers of the Grindelwald invade this territory; and in older times the glaciers have cleared the valley below of the drift-like detritus, just as in the Passes of Nant Francon and Llanberis the ancient glaciers swept out the drift, and left untouched the marine deposits that lie on the high grounds between Aber and the lower part of Nant Francon, from thence to Llyn Padarn, and on the slopes between Llyn Padarn and the river Ceunant. Are the deposits above the Grindelwald, and similar beds in other parts of the Alps, of marine origin, and were the blocks of limestone that lie on them arranged on or near an old sea margin by drift or pack ice? If so, perhaps they were deposited at the same time that the granite and gneiss blocks on the Jura, according to Playfair, were transported from the region of Mont Blanc, and that other boulders between the glacier of the Rhone and Martigny were borne westward and left on the mountain sides, when the Rhone above the Lake of Geneva was an arm of the sea, and glaciers descended to its level, according to the hypothesis of Sir Roderick Murchison.* Numerous blocks of granite and gneiss that lie on the Italian side of the Alps, scattered around the Lakes of Como and Lecco, were doubtless carried southward at the same period.† However this may be, it is much to be desired that geologists would search the drifts (if such they be) above the Grindelwald, and similar suspicious deposits for shells; and that if these were found, investigations were entered into to show the probable amount of depression that the Alps sustained during the glacial epoch.‡

We have already exceeded the limits we proposed to ourselves when this notice was commenced, otherwise we would fain make some remarks on the probable physical geography of the country through which flowed the river that deposited the Wealden and Purbeck strata; and also on the much vexed question of the denudation of the Weald itself, taken in connexion with other denudations of the Chalk and Oolites, of a like character but far larger in amount. Something more, too, might be profitably said of the Bunter and Permian rocks of Britain (subjects not yet clearly understood), and also on various more purely theoretical points, such as the anatomy (so to

* Geological Journal, vol. vi., p. 65.

† De La Beche's Manual, 1833, p. 195.

‡ Since the above was written, we have been informed that Mr Daniel Sharpe has produced a paper on this subject.

speak) of palæozoic volcanoes, the geological history of special areas of metamorphism, and the manner in which deep fissures or lodes have been filled with metalliferous and other more ordinary minerals, but for the present we must take leave of these subjects and of the book the perusal of which suggested them. The *Manual* itself requires no commendation of ours. The rapid editions that Sir Charles Lyell's *Elements* and *Principles* pass through are the best tests of their popularity, a popularity of the solid kind that makes his works essential to every student of geology, wherever the name of science is known.

Analytical View of Sir Isaac Newton's Principia. By HENRY LORD BROUGHAM, F.R.S., Member of the National Institute of France and of the Royal Academy of Naples; and E. J. ROUTH, B.A., Fellow of St Peter's College, Cambridge.

We have have not forgot the fright we experienced two or three years ago, in turning up, on a friend's table, a little treatise on the Ellipse, *for the Use of Schools*, by His Grace the Duke of Somerset. Farewell to our occupation, thought we: who shall enter into the lists against such noble blood? Is it not enough that a prime minister has taken on himself the drudgery of correcting the press, for the life of a writer whose claim to national gratitude rests on nothing higher than the power of elevating sentimental verse almost into poetry, but that the House of Peers shall furnish treatises for the use of our little children? The shock soon subsided, the alarm wore off, and we have since learnt to view with complacency the competition which has thus arisen, believing that it has tended to exalt rather than to supplant the labours of our humblest compilers. Accordingly, when we took up the Analytical View, we experienced no pangs of jealousy; so far from it, that had Lord Brougham announced on the title-page his intention of giving lessons on the Principia at a reasonable fee, we verily believe we should have locked up our ferule for a couple of months, and taken a ride to the south, to get indoctrinated with deeper views of this, the noblest effort of the mind of man. Indeed, we have not given up the hope that we may yet do so; for we infer that, at any rate, one of the editors has had an experimental class of an unacademical kind, for the purpose of ascertaining how the work will answer as the basis of teaching. We are informed in the Introduction, that "two classes of readers may benefit by this Analytical View; those who only desire to become acquainted with the discoveries of Newton, and the history of the science, but without examining the reasoning; and those who would follow the reasoning to a certain extent, and so far as a knowledge of the most elementary parts of geometrical and analytical science may enable them to go. *It has been found upon trial*, that readers of both descriptions have been able to peruse the work with advantage; even readers of the second description. These have easily followed, not only the commentary upon the gradual progress of discovery, and the state of the science before Newton; but, passing over the exposition of the differential calculus, have pursued the demonstration of the fundamental law of gravitation, and even apprehended the proof of its universal action, according to the inverse proportion of the squares of the distances." And to the same effect at page xxvi.

The work is, therefore, we presume, a treatise adapted for teaching; not a simple comment or exposition, such as may be found in the writings of Pemberton, M'Laurin, Emerson, and others of former days; nor merely the results of the Principia brought out by the processes of Laplace and Lagrange, as in the writings of Whewell, Pratt, and others of our own times; but the Principia itself translated into the language of analysis, and illustrated by or compared with the conclusions of succeeding philosophers.

We turn to the work, and find its object stated to be twofold: "*First*, to assist those who are desirous of understanding the truths unfolded in the Principia, and of knowing upon what foundation rests the claim of that work to be regarded as the greatest monument of human genius; *secondly*, to explain the connection of its various parts with each other, and the subsequent progress of the science." This is as it should be, and we enter hopefully on the inquiry how it has been effected, proposing however to confine ourselves principally to the first object. We begin with an examination of the *Method of Demonstration.*

Every one knows, that after having given two very valuable preliminary chapters under the respective heads of definitions and axioms, wherein the laws which govern the motion of bodies are, for the first time, distinctly enunciated, the illustrious author of the Principia commences to lay the foundation of his reasoning, by means of eleven introductory propositions, with the somewhat inexpressive title of Lemmas. Whether in this term Newton referred to the logical form of major propositions, or whether he understood the word lemma simply to imply something which may be *received* as the basis of reasoning, it is unimportant to inquire. It is certain that these lemmas are a masterpiece of skill, and form an appropriate foundation, not for the Principia alone, but for all geometric demonstrations in which continuous change is an element; and indeed some of these lemmas are the best foundation of an analytical system too. Reflecting on this, we turned with almost breathless anxiety to see how one great mind would be the interpreter of another. Judge of our mortification at discovering that Lord Brougham has altogether ignored the existence of this work of genius, and has supplied its place by some (we can hardly help calling them) garbled selections from Newton's other writings, in which the methods of infinitesimals, indivisibles, fluxions, and prime and ultimate ratios are mingled together in glorious confusion. We hope we may be excused if, for the benefit of our own readers, as well as those of Newton, we endeavour to set the matter of this first section in its right light.

Whenever we are dealing with magnitudes or motions, which are subject to continual change, it is very evident that we are compelled, by the nature of the case, to reason on forms which exist only in definition, and to apply our conclusions, by some process or other, to things as they are. Thus, for instanee, when a stone falls from the hand to the ground, its velocity is continually increasing, so that we cannot strictly say that at any instant it *moves* with any particular velocity; for every instant of its motion sees a change of its rate of speed. Under these circumstances, we are compelled to have recourse to the artifice of defining velocity by reference to a state of things *different* from that which actually exists; viz., by imagining the gravity of the earth for an instant to cease acting. The hypothetical state, however, approaches nearer and nearer to the real, as the time during which the hypothesis holds is smaller and smaller; so that if the velocity, when uniform, be the quotient of the space by the time, the velocity in the case we have supposed will differ from that quotient less and less, as the time becomes smaller and smaller. This velocity, which is not the real ratio of the space by the time, is under these circumstances called by Newton its prime or ultimate ratio. The words "prime" and "ultimate" have reference to this approach of the hypothetical to the real; but they are at the best indifferent interpreters of the idea—and have given rise to numerous misconceptions, and an infinity of quibbles. The word *evanescent*, too, which Newton used, formed a tangible handle to the real or pretended objector. Bishop Berkeley avails himself of it in his Analyst, when he says (§ 85), "And what are these same evanescent increments? They are neither finite quantities, nor quantities infinitely small, nor yet nothing; may we not call them the ghosts of departed quantities?" Newton is not altogether guiltless of having done his part towards the creation of this confusion of ideas. His very 1st lemma, which is the *definition* of ultimate equality, or, if you please, the statement of the conditions under which it may be predicated to exist, is marred by a sort of demonstration, although we believe it was intended only as an aid to the better understanding of the meaning of the phrase employed. Besides this, Newton has put down something either wrong or unintelligible in a corollary or two, thereby causing nightly fermentation in the brains of some of his less-gifted followers. For example, in the first corollary to the 3d lemma, speaking of a polygon inscribed in a curvilinear figure, he says, that the two will ultimately coincide *omni ex parte*, which phrase Motte, in his Translation, renders "in all parts," but which Newton probably understood to mean "part by part." However that may be, we cannot comprehend how his own university can tolerate such inconsistencies as his followers fasten on him. In an edition of the first three sections, of the date 1837, there occurs a beautiful piece of reasoning in a circle, complete in all its parts. The editor supposes Newton to assert in the 3d (4th) corollary to Lemma 3, that the perimeters of the two figures are equal in *length*, and therefore of necessity equal part by part. From this he proves the 5th Lemma (a mere definition or statement of fact in Newton), and thence the 7th, the very equality with which he started! We forbear to say how many editions this has gone through. Happily the recent publication of a few sections by Mr Frost expunges the libel on Newton's memory, we hope for ever To return. This system of ultimate equality is the broad foundation on which the Principia rests; and, however much modern writers have extended and simplified its application, they have not, and we believe never will cause it to be superseded. The 7th Lemma, for instance, to which we have just referred, and without which no system, geometrical or analytical, is possible, has never yet been satisfactorily proved otherwise than by Newton's process. That process, which is a model of elegance and ingenuity, consists in magnifying the figure in such a way that the magnified representation of one of the lines whose ultimate equality it is required to prove, shall always continue the same. Thus, as the arc and its chord and tangent become smaller, their magnified likenesses continue finite, and prove the existence of their ultimate equality, as tested by the conditions of Lemma 1. The demonstration is irresistibly convincing.

It is a remarkable fact that this proposition, which is the key-stone of the bridge that connects the simple geometry of Euclid with the more complex curvilinear geometry of the moderns, should be found only in a Treatise on Mechanics. A distinguished writer, Lagrange, attempted, not unsuccessfully, to soften the road to the higher analysis, by excluding as much as possible the idea of indefinitely small quantities. In 1797 he published his treatise, entitled *Théorie des fonctions analytiques*, in which, with admirable skill, he sought to reduce every demonstration to the domain of simple algebra. The proposition of the ultimate equality of the chord, arc, and tangent (Lemma 7) was supposed to be steered clear of by means of a new demonstration of another proposition. Subsequently he published his *Calcul des fonctions*, which he regarded as a commentary on and supplement to his former work. The edition of 1806 is before us; the author has abandoned his former demonstration, and has adopted a mode of evading Newton's lemma, which is singularly ingenious. We give his own words (p. 42), "*Il est demontré rigoureusement par les théorêmes d'Archimède, que le sinus est* *toujours moindre que l'arc, et que la tangente est plus grande que l'arc, du moins dans le premier quart de cercle.*" Now, if we are to translate the word "par" as usual by the English word "by," we are thrown on the curious logical difficulty of proving a thing to exist by the open assumption of the fact of its existence; for these *are* Archimedes' theorems, neither more nor less. This is as bad as making a man jump down his own throat. But if we give the benefit of the doubt, and admit that the French idiom allows us to translate "par" by "in," we shall find ourselves referred back to Archimedes himself for the demonstration of his theorem. Now, Lagrange ought to have known that, although Archimedes is not alive to plead his own cause, he has left behind him an immortal work, his treatise *De sphæra et cylindro.* Amongst the axioms prefixed to that treatise, but without one word of demonstration, are the theorems in question. Some unfortunate individual had been meddling with these theorems a century or two before. Barrow says, in connection with them, *Vide Rivaltum et stupe.* We have not taken the trouble of looking up this gentleman's works, having already experienced the gratification promised in the word *stupe*, from Lagrange and Barrow.

We have stated that Lord Brougham omits the first section altogether, and presents his readers, in place of it, with some illustrations rather than expositions of other methods of demonstration. We have an opinion as to the sufficiency of these illustrations for the use of persons not previously conversant with analysis: we are inclined to fear that few will attempt to travel by this royal (or we should say noble) road. Happily, his Lordship does not quite desert the old paths; and we rejoiced to recognise the familiar and simple demonstrations of Newton in the earlier propositions.

Of his success in the work of simplification, we are not disposed to speak at any length, but we are safe in asserting that he is more at home in the matter of history. As might be expected, the exhibition of the controversy which arose out of individual problems, when presented along with the discussion of the problems themselves, forms an interesting element in the work. We trust we shall not be thought captious if we enter a caution to the reader even here. The author's anxiety (laudable enough in itself) to do justice to, or at least to deal with, every writer who has contributed his share to the progress of knowledge, sometimes causes him to do great injustice to Newton himself. For example, when speaking of the demonstration of Kepler's third law, at p. 60, he states that, to the useful propositions before given from the Principia, "Demoivre added a theorem of great beauty and simplicity, respecting motion in an ellipse;" which theorem is in reality a demonstration of Kepler's third law, based on the assumption of the first. Now, an uninformed reader might be led from this to infer that Newton either had left that law undemonstrated, or had given an imperfect or faulty demonstration of it; neither of which inferences would be in any degree correct. For beauty, simplicity, and completeness, Newton's demonstration in Props. 14 and 15, based on the law of force according to the inverse square of the distance, is unrivalled. We take great exception, then, to the conclusion of the paragraph which commences with the name of Demoivre (p. 61),—"so that all Kepler's three laws have *now* been demonstrated *a priori* as mathematical truths; first, the areas proportional to the times, if the force is centripetal; second, the elliptical orbit; and third, the sesquiplicate ratio of the times and distances, if the force is inversely as the squares of the distances, or, in other words, if the force is gravity." If there be any thing demonstrated clearly, simply, and completely in the Principia, it is these three laws, subject, of course, to limitations, which did not form elements for consideration in the earlier sections.

The treatment of the ninth section, on the motion of the apsides, is as satisfactory as any portion of the work before us; and to the eleventh section, we are not disposed to take great exception. The attempt has been made to engraft on Newton's brief expositions, reasonings a little more conclusive, drawn from the results of the *Mécanique Céléste.* With what success this has been done, those who make their first acquaintance with the subject from those pages will best determine. For our own part, greatly as we admire the Corollaries to the 66th Proposition, we confess that we do not think it possible to get at a thorough knowledge of the lunar inequalities or planetary perturbations except through the complete analytical investigation. To combat such giants as secular variations, with nothing but the smooth pebble from the brook, requires the cunning arm of a David. The astronomer-royal, Airy, has attempted it in his "Gravitation;" but whether he has slain the giant or been slain by him, we pretend not to determine. The exceeding speciousness of fallacy in popular arguments may be judged of from a foot-note in Herschel's large Treatise on Astronomy, edition 1851. He is discussing what is called the great inequality of Jupiter and Saturn. Their distances from the Sun are such that five periods of Jupiter and two of Saturn differ only by the comparatively small amount of 146 days, or about $\frac{1}{150}$th part of the whole. As a consequence of this approach to a simple proportion, the analytical investigation at once exhibits the existence of a considerable mutual disturbance of the one planet by the other. The period of this disturbance, during which it goes through all its phases, is 917 years, the one planet experiencing a gain, whilst the other sustains a loss. Sir John Herschel remarks at p. 472, "That an acceleration in the one planet must necessarily be accompanied by a retardation in the other, might appear at first sight self-evident, if we consider that, action and reaction being equal and in contrary directions, whatever momentum Jupiter communicates to Saturn in the direction PM, the same momentum must Saturn communicate to Jupiter in the direction MP. The one, therefore, it might seem to be plausibly argued, will be dragged forward whenever the other is pulled back in its orbit," &c. He adds in a note: "We are here reading a sort of recantation. In the edition of 1833, the remarkable result in question *is* sought to be established by this vicious reasoning. The mistake is a very natural one, and is so apt to haunt the ideas of beginners in this department of physics, that it is worth while expressly to warn them against it." We were, therefore, not sorry to find an expectation held out that the discussion of the problem of three bodies would be conducted on a platform inaccessible in the days of Newton, when the methods of which he was the inventor had not attained any thing like perfection. The right mode of treatment we conceive to be analytical demonstration, accompanied by full illustrative popular exposition. The author of the Analytical View has taken the opposite course, as regards this portion of the Principia, giving popular demonstrations, illustrated and filled up by the forms and conclusions of the *Mécanique Céléste.* Perhaps he had no alternative; whether or not, his task was a difficult one, and it would be unreasonable to expect too much from its accomplishment. We cannot, however, help feeling, as we read on, that the subject is too extensive for the Treatise. We see Lord Brougham, like another great and ambitious man,

> "bold
> In slender book his vast design unfold,"

and we are "held awhile misdoubting his" success. In reference to this "great inequality" of which we have been speaking, the story of the problem, which the author appears to have gathered from the *Système du monde*, has, for the sake of brevity, been mixed up with that of another remarkable investigation relative to Jupiter's first three satellites, whereby no little confusion has been created. It would seem as if the writer had felt himself overwhelmed with an excess of materials. And however adroitly he may throw off the burden, the reader is in danger of being left in a state of considerable bewilderment. Relative to the problem of which we have been speaking, the impression likely to be received is (p. 120), that the motion of Saturn is always retarded, and of Jupiter always accelerated; whereas, the planets changed hands in 1790, and will pursue the opposite course of action for four centuries and a half from that date. We cannot refrain from quoting here another sentence from honest Andrew Marvell:—

> "I liked his project, the success did fear,
> Through that wide field how he his way should steer;
> Lest he perplexed the things he would explain,
> And what was easy he should render vain."

We regret that our limits compel us to break off at this point; the more so, because we have an inward consciousness that our remarks may appear too disparaging; but as they are made in sincerity, and from no captious spirit, and as Lord Brougham needs no eulogy from us, we have thought it our duty to caution those who shall do us the honour to seek our guidance in this matter, lest they, coming to this Analytical View, as to a book of "Reading made easy," shall founder in their studies, and for ever lose the gratification of mastering the reasoning upon which the law of attraction, whereby the worlds are held together in a bond, has been established. We heartily applaud the devotion of our noble author to the cause of truth; we cordially admire the untiring energy of a man, who, instead of sitting down in his retirement at Cannes, to rest from the labours of three quarters of a century, employs his leisure hours in torturing the sunbeams of the south to bring back the image of his early love, in the shape of diffracted fringes. It falls to the lot of few men to give to the world new experiments in confirmation of others published fifty-seven years before; and whatever posterity may say of Lord Brougham as a politician, there will be many mementos of his unchanging love of science, and of his patronage of its humble supporters, which will stand out in sharp and beautiful relief as the best and the last phases of his varied career, when time shall have worn down the more prominent but less enduring features of his character.

Historia Fisica y Politica de Chile, segun Documentos adquiridos en esta Republica, durante Doce Años de Residencia en ella y Publicada bajo los auspicios del Supremo Gobierno. Por CLAUDIO GAY. Zoologia. Paris & Santiago, 1847. 8vo & 4to.

We cannot better describe the work of Claudio Gay than by translating some of his observations in the short introduction to the first number of the Vertebrata. The book is published in Divisions, any one of which can be subscribed for and procured separately. That devoted to the Vertebrata generally bears out what is promised. The plates are partly engraved and partly lithographed; are well executed, and some of them are devoted to osteological and other anatomical details. These are of a 4to size; but the letter-press, as has lately been practised in some of the foreign illustrated works, is printed in 8vo, which is certainly an improvement, and is more convenient than the large folio or quarto, otherwise often very desirable for the illustrations. A short Latin character is given with each species; next the detailed descriptions and measurements; and in a lesser type, as notes, the author's observations relating to the habits of each. These latter, as indeed the entire work, except the specific characters, are written in Spanish. When completed, this will be a fine addition to the natural history of those rich divisions of the New

World. The Invertebrata are also in progress, and some advance has been made in the Botanical department of the undertaking.

"The part of our work which we now publish, with the title of *Chilian Zoology or Fauna*, is the most complete catalogue we can give of the animals which inhabit this great republican state, classified according to the natural system; to which are added descriptions and specific characters sufficient to distinguish them, some notices regarding their manners and habits, as well as the relations they bear to other species. A work of this class is very useful to science, pointing out to naturalists the geographic zoology of a district; and also to the inhabitants of the country, to whom it greatly facilitates the study of this fine branch of natural history, no less interesting than botany, for the infinite wonders which every species offers to the inquiring observer. To arrive at this result, it is necessary that the naturalist should examine minutely the greater part of the country which he wishes to make known; that he should pass more or less time in each province, and study carefully under their comparative, and especially their geographical relations, whatever objects he may obtain. Only thus can the fauna of a country be well ascertained. But unfortunately travellers, always desirous to augment their collections, or to describe the greatest possible number of objects, only remain a very short time in each kingdom, continually moving to other regions in search of new forms, to satisfy their desire and ambition. Perhaps it is owing to this decided inclination to amass large collections, that science possesses so few fauna of extra-European countries; considering America alone, there are only some provinces of the United States which afford such examples. Since 1815 all the other republics were diligently visited by collectors and able naturalists, who on their return made known the result of their discoveries. Thus New Granada was studied by Boussingault, Goudot, &c.; Guiana by Schœnbrun, Leprieur, &c.; Brazil by Prince Max. Von Neuwied, Aug. St Hilaire, Spix and Martius, Claussen, Lund, and an infinity of naturalists no less accomplished; Paraguay by Renger and Delongchamp; La Plata and Bolivia by D'Orbigny, Darwin, Ausene, &c.; Peru by Tschudi, and many other scientific travellers, contenting themselves with describing the objects encountered, without giving to their works a character of unity such as might enable them to be compared with the great results of physical geography. Chili has also attracted the attention of naturalists; it is some time since historians, such as P. Ovalle and Figueroa, and the travellers Anson, Frezier, and Feuillée, had given some information regarding a small number of animals; and even the Abbé Vidaurre published a treatise upon some of its productions, in which he speaks of their qualities, and the uses which the inhabitants or natives make of them; but no one has examined this subject with so much attention and information as the Abbé Molina, in his *Compendium of the Geographical, Natural, and Civil History of the Kingdom of Chili*—a work which modern naturalists do not sufficiently appreciate, and against which such acrimony has been manifested, that at times it has almost degenerated into injustice.

"Notwithstanding, Molina's work is deserving of general gratitude among naturalists, since it gives an extensive idea of some sections of Chilian zoology, principally of the first two classes, Mammalia and Birds. No doubt very frequently the genera are equivocal, and the descriptions almost always incomplete; but, considering the time and the circumstances in which he published, it will be perceived that this author, endowed with a penetrating genius, is worthy of the greatest indulgence. Molina was scarcely twenty-two years of age when he left his own country in 1768; his knowledge of natural history was great for the time, and he prosecuted his labours with infinite care, hoping one day to bequeath to his country all his discoveries and observations; unfortunately he was expelled as a Jesuit, and sought refuge in Italy, where he employed the hours of recreation in the study of the fine arts, to which in Chili he had dedicated himself without masters, and almost without books; his rapid progress enabled him to avail himself advantageously of a manuscript upon the productions of his country, which chance presented to him, and assisted by an active correspondence which he maintained with some of his countrymen, he undertook the printing of his work, in which are found a large number of species quite new to science, and described for the most part so as to be easily distinguished; we trust we shall receive favourable consideration when, for the sake of justice, we have sometimes preserved the names given by this learned and diligent Chilian, always provided they are conformable to the rigorous rules which science exacts.

"In 1810 the second edition of his *Natural History* was published, using in it, with the greatest care, the labours of Cavanilles, and of Ruiz and Pavon. Novelties were confined to the Botanical part only, so that the Zoology remained nearly the same as in 1788. South America had been until then under the influence of a petty policy which forbade foreigners to penetrate into these coveted regions. The many naturalists sent from Spain occupied themselves with the plants only, leaving aside the animals, which remained almost unknown. But as soon as independence called foreigners to search distant regions, which the general peace made accessible, then was manifested the greatest enthusiasm for such travels, which soon extended itself to all European nations, exciting a portion of their *savans* to expatriate themselves in search of whatever might contribute to the advancement of the sciences. Chili at this time began to be explored, first along the coasts by the naturalists who were employed in voyages of circumnavigation, such as Lesson, Gaudichaud, Soleyer, and particularly Darwin, who has contributed so greatly to the knowledge of Chilian Mammalia; afterwards by diligent individuals, who spared no effort, however troublesome and expensive, in order to make large collections; among these last, we will cite Mr

Cuming, so well known for his zeal and ardour in search of whatever might relate to the natural history of this beautiful region.*

"Whilst, by dint of labour and immense expense, these travellers were forming the numerous collections which are now the most precious ornaments of the principal European museums, those *savans* whom circumstances obliged to remain in their respective countries were occupied in studying, classifying and describing all the objects collected, enriching our libraries with a prodigious multitude of descriptions well digested indeed, but wanting in that interest which the unity of a formal work affords. It is, then, with such a scarcity of faunas that we venture to undertake that of Chili. Fortunately the materials which we possess for so arduous an undertaking are sufficiently numerous and important, and are all the fruit of more or less time spent in each province, and of the continual wandering journeys which we made, always seconded by zealous hunters, who so ably assist investigations. To carry out so long and minute a labour, we have obtained the co-operation of various distinguished zoologists, who have kindly assisted us, charging themselves with those divisions of the subjects which each has more particularly studied.

"The Birds were confided to M. Desmurs, an advocate in the Royal Court of Paris, and the continuator of the work of MM. Laugier and Temminck, which is that of the illustrious Buffon.

"M. Guichenot, a member of the Scientific Expedition to Algiers, and assistant naturalist of the Museum of Natural History in Paris, has undertaken the Reptiles and Fishes.

"The Arachnidæ and Crustacea have been undertaken by M. Nicolet, who has made an especial study of these animals, and is the author of an interesting work upon the great family of the Poduræ. M. Gervais, Professor in the Academy of Montpellier, will assist in the arrangement of the Myriapodes and of the greater part of the Apterous Insects.

"The Coleoptera are confided to M. Solier, a captain of engineers, so well known for his vast entomological knowledge, and for the exactitude of his descriptions.

"The Hemiptera and Hymenoptera will be described by M. the Marquis Spinola of Genoa, one of the principal entomologists of our age, and the one who has best studied those great orders of insects.

"The Mollusca by M. Huppé, a naturalist of the Museum, and exclusively charged with the collection and classification of these shells.

"Lastly, the remaining orders will be treated of by different *savans*; and more especially by M. Blanchard, author of a Treatise on Entomology, and of many academic memoirs, much esteemed in the scientific world."

* "In the geological, botanical, and zoological view which will be given of Chili, and which will serve as an introduction to the natural history of this work, we will include a historical *resumè*, with notices of those who have travelled over the territory of the republic, and of the respective merits of their labours and discoveries."

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 7th January 1856. Dr Christison, V.P., in the Chair.

Professor Christison delivered the Keith Medal to Dr Anderson of Glasgow.

The following Communications were then read:—

1. *Geometry, a Science purely experimental.* By Edward Sang.

After remarking that the perfect strictness of the demonstrations in Geometry is generally admitted, the author of the paper cited the almost universal belief in the soundness of Euclid's reasoning as a notable example of wide-spread credulity. He then enunciated and illustrated the proposition that our knowledge of the truths of geometry is altogether derived from experience.

2. *Notice respecting recent Discoveries on the Adjustment of the Eye to Distinct Vision.* By Professor Goodsir.

The question as to the arrangement by means of which the eye is adapted for distinct vision at different distances has for two centuries strongly attracted the attention of physiologists. The numerous hypotheses, and untenable theories which have been advanced on this subject are all, however, more or less unsatisfactory. They are severally based on—1. The mere structure or form of the refractive humours of the eye; 2. A presumed process connected with change in the direction of the axis of vision; 3. The movements of the iris; 4. Change in the position of the retina; 5. Change in the position of the lens; 6. Change of form of the cornea; 7. Change of form of the lens.

This important question has now been definitively determined by the researches of Dr Cramer of Groningen, detailed in a prize treatise submitted to the Dutch Association for the Advancement of Medical Science in 1851; but, which, except in the form of a short abstract at the time, was only published at a later period. In 1853, Helmholtz also announced to the Berlin Academy the same discovery, reached independently, and by a method more complex than that employed by Cramer.

The entire question had been previously simplified by the conclusion to which Volkmann had come, that the eye, when in a passive condition, is adapted for the vision of distant objects, the foci of convergent pencils being then situated in the retina; that when it requires to be adjusted for a near object, an active process of accommodation is set up, which brings the foci forward to the nervous membrane; and that the return to the passive condition, which again adapts the eye to distant objects, is a passive process, following on the previous effort.

Cramer had therefore only to determine the nature of the active change, by means of which the foci, for a near object, are brought forward to the retina. Now, as Helmholtz had shown that the adaptation of the eye to distance must depend upon a change of some kind in the refractive condition of the humours of the organ; and as Senff had previously proved that no change takes place in the curvature of the cornea; and as the ingenious theories of Ludwig and Stellwag had in no way removed the difficulties involved in explaining how the lens can be moved forward; there remained only, as a basis for investigation, the hypothesis of a change of form of the lens. This hypothesis, as Volkmann had stated, could only be objected to as insufficient; but not as involving any contradiction of fact; and might be verified by more careful and extended observation.

The question, therefore, which Cramer had to determine, was this—Is the form of the lens changed in the adaptation of the eye to near objects?

Cramer was indebted to Donders for the fundamental idea on which he proceeded in the solution of this question. Donders had previously entered on the investigation, but had failed in his observations. He is entitled, however, to the credit of having suggested the employment of the experiment of Purkinje in this inquiry; and of having subsequently elucidated its successful results.

Cramer has discovered that in the adjustment of the eye for a near object, there takes place a change in the form of the lens, consisting of an increase in the curvature of its anterior surface, produced by the iris and ciliary muscle, but without alteration in the position of the lens itself; while the return to its original form for the vision of a distant object is the effect of its own elasticity, which in proportion to the pressure applied, had co-operated in producing the increase of its anterior convexity. He ascertained the occurrence of this alteration of form by watching, through an arrangement of his own contrivance, magnifying from 10 to 20 diameters, the change which takes place in the image of the flame of a candle reflected from the anterior surface of the lens during the adjustment of the eye to a near object. The eye having been adjusted to a distant object, and the erect image from the surface of the cornea having been brought nearly to the margin of the iris in the pupil, the erect image from the front of the lens will be observed deeper and less distinct, a little beyond the centre of the pupil, and the small distinct inverted image from the back of the lens will be close to the opposite margin of the iris. The eye being now adjusted to a near object, the deep erect image advances, diminishes, becomes more distinct, and moves across the centre of the pupil to the immediate neighbourhood of the corneal image.

This change in the relative position of the three images was correctly considered by Cramer as a distinct evidence of an increase in the curvature of the anterior surface of the lens. It would appear, however, that he was not entitled to conclude, as he did, from the immobility of the inverted image, that no change occurs in the posterior curvature of the lens. Donders, in reference to this has asserted, that the immobility of the inverted image affords satisfactory evidence that a change does actually occur in the curvature of the posterior surface of the lens; and Stellwag has demonstrated that a change of this kind must necessarily take place. That there is a contemporaneous increase in the curvature of both surfaces of the lens must be admitted, from the consideration that if such a change did not occur in the posterior surface, the increased curvature of the anterior would necessarily produce a change in the position of the inverted images; which is not the case. The optical effect of the increase of anterior curvature marks the slight movement of the inverted image.

The alteration in the curvature of the posterior surface is, however, so slight, that we may safely assume that the essential alteration takes place in the anterior surface.

Helmholtz has proved that the anterior curvature of the lens is increased during adjustment of the eye to near objects, by measuring accurately the distance between the images of the flames of two candles reflected from that surface, in the active and passive conditions of accommodation. According to his calculations the radius of curvature of the anterior surface is, for distant vision, from 10 to 11 millimetres; for near vision about 5 millimetres.

A change in the form of the lens having thus been ascertained to be the mode of adjustment of the eye to distances; the next point to be determined is the mechanism by which the change of form is effected.

It may be stated generally, that although the structures which act upon the lens have been ascertained, the details and arrangements of the process itself still require elucidation.

Cramer removed the eye of a seal immediately after the death of the animal, and exposed a portion of the surface of the vitreous body at the back of the organ. He then introduced the electrodes of an electro-magnetic rotation apparatus into the opposite attached margin of the iris. The flame of a candle at the distance of 35 centimetres from the cornea was distinctly observed on the vitreous surface, with a microscope magnifying 80 diameters. At each passage of the electrical current through the organ, the pupil contracted, the image of the flame became broader, less distinct, and less definitely outlined. This effect was visible to the naked eye, and indicated the probability of the form of the lens being altered by the contraction of the muscular structures in the interior of the eye. Cramer ascertained that the iris is at least the principal agent in producing the change; for when a cataract needle was introduced so as to divide the iris, and produce a complete coloboma, the focus was no longer affected by the electrical current. Cramer also removed the cornea, annular ligament, and iris, after which the electrical current produced no change in the adjustment; although the ciliary processes were observed to be put upon the stretch. The lens was also shown by numerous experiments to be incapable of changing its own form. It is not muscular; for when the recent lens was removed from the eye, and the flame of a candle brought to a focus through it, on a piece of oiled paper, the electrical current produced no change in the adjustment.

Cramer concludes, in this department of his subject, that the iris and ciliary muscle alter the form of the lens. The ciliary muscle contracting pulls the ciliary processes forward, and so prevents the lens from receding under the pressure of the iris. The latter produces the change in the anterior curvature, by a primary contraction of its circular fibres; followed up by contraction of its radiating fibres, which, from being curved forwards, become straight, and thus pressing on the marginal portion of the anterior surface of the lens, force the central portion forwards. Cramer's explanation of the action of the iris on the lens is based on Stellwag's recent assertion, that the posterior chamber has no existence, but that the iris rests immediately on the front of the lens, the ciliary processes, and the zonule of Zinn, so that it projects like a dome into the anterior chamber. The pressure is thus communicated by the iris to the lens through the medium of the ciliary processes, zonule of Zinn, and contents of the canal of Petit, the lens being supported and kept forward by contemporaneous contraction of the ciliary muscle. Donders is inclined to believe that a very thin layer of fluid is interposed between the iris and the structures behind it; but practically Cramer's opinion appears to be correct.

Hueck, in attempting to explain ocular adjustment by the movement of the lens by the iris, had stated that when viewed in profile, the iris is seen to project into the anterior chamber during vision of a near object. Volkmann denied this; but the fact is undoubted; and Helmholtz has ascertained that the protrusion is about one-third of a millimetre.

Ruete has objected to Cramer's conclusion as to the agency of the iris in altering the form of the lens, on the ground that in cases of congenital deficiency of the iris the power of adjustment is not deficient. In such instances some compensating arrangement must exist.

Senile Presbyopia mainly depends, according to Cramer, on the diminished muscular contractility of the iris and ciliary muscle ; myopia, again, on diminution of the elasticity of the capsule of the lens, which disables the lens from regaining its normal form after each act of adjustment. He denies that the curvature ef the cornea is increased in myopia, and states that the apparent increase is due to the continued increased protrusion of the iris into the anterior chamber.

Monday, 21st January 1856. Colonel MADDEN, Councillor, in the Chair.

The following Communications were read :—

1. *Memoir of Rear-Admiral Sir John Franklin.* By Sir JOHN RICHARDSON, C.B. Communicated by Professor BALFOUR.
2. *On the Geological Relations of the Secondary and Primary Rocks of the Chain of Mont Blanc.* By Professor FORBES. (This paper appears in the present Number of this Journal.)

Monday, 4th February 1856. Right Rev. Bishop TERROT, V.P., in the Chair.

The following Communications were read :—

1. *On the Turkish Weights and Measures.* By EDWARD SANG, Esq.

In this paper a short account was given of the comparison of the oka with the imperial grain weight, and of the arsheen with the inch. The oka was stated to be 19,807 grains, so that 18 cantar of 44 oka each make one ton one pound. The length of the arsheen was determined by comparison with the ebony standard of Sultan Selim. The extreme length, as obtained by contact, was 29·890 inches, but the ends had evidently been tampered with ; on that account the divisions of the rod were referred to ; these gave results varying from 29·944 to 29·949, and therefore the mean, 29·946 inches, may be taken as the true length of the Turkish arsheen.

2. *Observations on* Polyommatus Artaxerxes, *the Scotch Argus.* By Dr W. H. LOWE.

Polyommatus Artaxerxes, or the Scotch Argus, is an insect not only of great local interest, but has attracted, and continues to attract, the notice of entomologists all over the world. Among the English, and still more among the foreign students, who annually throng our University, there are always a considerable number who arrive in Edinburgh anxious to see "the rare butterfly from Arthur's Seat," or who are commissioned by entomological friends to obtain it. Besides, there are the still more destructive emissaries from the London and provincial dealers in insects, who infest the hill during the season in which it is found. But although the situation in which this insect is principally taken is extremely circumscribed, I am not aware that its numbers are materially diminished by this continuous drain upon them. The new road now in contemplation beneath "Samson's Ribs," and through the village of Duddingston, will, I fear, go far to exterminate it, as it will pass, I believe, through the exact spot upon which it is found, and to which it is in a singular degree limited.

The first published account we have of this insect is by Fabricius, in his *Systema Entomologiæ*, 1793, under the name "*Lycæna Artaxerxes*," in which he states its habitat to be "Anglia," but without any special reference to Scotland. He does this on the authority of Mr Jones of Chelsea, in whose cabinet a specimen then existed ; but it would appear that Fabricius himself never saw the insect, as it was at that time a frequent custom to insert in entomological cabinets a painted piece of card, to supply the place of an insect then believed to be too rare to afford much probability of its being obtained. I may here mention, that naturally feeling some interest to know who this Mr Jones of Chelsea (so often quoted by authors) was, I applied to Mr James Wilson of Woodville, who most obligingly wrote to Mr Adam White, of the British Museum, and through whom we find that Mr Jones had an excellent collection of native insects, and also a number of illustrations, coloured by himself, which are still in existence; but from the higher degree of excellence now attained in such delineations, of course greatly diminished in pecuniary value, however interesting they may have been at the time alluded to. It was no doubt one of these illustrations which Fabricius availed himself of in his *Systema Entomologiæ*. We find this insect next mentioned as *Papilio Artaxerxes* by Lewin (1795), a fellow of the Linnean Society, who, like Fabricius, refers to Mr Jones' specimen, but adds, that it was taken in Scotland. In the *Natural History of Insects*, by Donovan, in 1813, we have the first full account of this insect; and his description is so animated and enthusiastic, that the naturalists of the Society, if not the other fellows, will excuse my making one quotation from him:—"To the great astonishment of our English collectors of natural history," he says, "*Papilio Artaxerxes*, an insect heretofore of the highest possible rarity, has been lately found in no very inconsiderable plenty in Britain. For this interesting discovery we are indebted to the fortunate researches of our young and very worthy friend, W. E. Leach, Esq., who met with it common on Arthur's Seat, near Edinburgh, and also on the Pentland Hills." It will not be uninteresting to the fellows of this Society to know that Mr Wilson was with Dr Leach on this occasion, and joined him in his entomological researches at that time. As I have entered so far into the history of this insect, I must now in fairness state, that the same authority (Donovan) mentions the existence of a specimen in the "extensive and valuable" cabinet of Mr Macleay, taken in Scotland, previous to Dr Leach's discovery. It is the same Mr Macleay whose name is associated with another interesting, but much more widely-distributed insect, the *Erebia Blandina*, or Arran Argus. Donovan concludes with the remark—"As these insects fly in the day-time, there can be little doubt they may be sought for by the collectors with success on the hilly spot called Arthur's Seat, near Edinburgh."

Polyommatus Artaxerxes, thus established as a well-known British insect appears successively in the works of Mr Stephens, 1828; Rennie (*Conspectus*), 1831; Duncan, 1837; Wood (illustrated catalogue), 1839; Westwood, 1841; and Captain Brown, 1843; but I do not think there is in these works any important addition to the information I have thus thrown together.

Having endeavoured to trace rapidly, and in a manner as little tedious as possible, the history of *P. Artaxerxes*, I may remark, that great as is the interest this insect has excited among naturalists, its habits, and especially its transformations, were until recently entirely unknown. Mr R. Logan, who resides almost on the spot on which it abounds, endeavoured some years ago, I believe, to obtain its larvæ by inclosing a number of the perfect butterflies beneath a glass frame in his garden, in the hope that the eggs might be deposited; but as at that time it was generally believed to feed on the *Ulex europæus*, amidst which it may be seen to flit, the eggs, if deposited at all, naturally perished for want of their proper nidus; and this laudable experiment of course failed. The same accurate and patient observer, however, subsequently arrived at the belief that the insect preferred the *Helianthemum vulgare*, which grows luxuriantly on the south side of the hill, remarking, that while the *Ulex europæus* abounded all over the hill, the butterfly did not, but was confined to the south, and only where the *Helianthemum* grew, frequently indeed in conjunction with the *Ulex*.

This inference has since proved correct. So lately as 1851, Mr Logan, in an article in the *Naturalist* for March in that year, after describing the *P. Artaxerxes*, as they may be seen gaily flitting over the banks of Arthur's Seat in the sunshine, or resting on the tall culms of grass and other plants while quiescent, remarks: "Strange to tell, no one knows anything of their history; where they lay their eggs, or what the larva feeds on, and where the inactive chrysalid passes the long, cold months of winter, are all in mystery;" and adds, "the discovery of the caterpillar and chrysalis is a point much to be desired." Struck with these remarks, published, too, just before the insect might be expected to make its accustomed annual appearance, I determined to go to Arthur's Seat for the express object of finding this long-looked-for chrysalis. I spent several hours diligently examining the stems of different plants, particularly the *Ulex europæus* and the *Helianthemum vulgare*; the latter of which, I frequently tore up bodily, and examined piecemeal. I did this in the belief that all the Polyommati attached their chrysalids to the stems of plants, as is indeed the usual habit of this genus, and was ignorant that any of them burrowed in the ground. My time and patience being nearly exhausted, I now began to dig in the loose earth which lies beneath the bushes of furze, the shade of which precludes anything from growing beneath them. Here I was also unsuccessful, but seeing some tufts of *Helianthemum* overhanging some barren patches of earth, I continued my examination there also, and almost immediately found several chrysalids, the appearance of which left me no doubt that they were those of *P. Artaxerxes*. The day was now declining, and I was anxious to show my acquisitions to Mr Logan, to whose house I immediately repaired. That gentleman showed the greatest interest in the discovery, and, like myself, expressed his surprise that one of the genus *Polyommatus* should bury its chrysalis in the ground instead of attaching it to the stem of a plant. He further requested me to place the chrysalids in his keeping, that he might figure them for a work upon which he has long been engaged, and to which this Society has become a subscriber. A few days after, I received the said chrysalids from Mr Logan, and he at the same mentioned that, acting on the information I had given him, he had pursued the search for the chrysalids, and had found them in considerable numbers. Those I had in my own possession emerged from the chrysalis, either that day or the following; and since that time it has, of course, become easy to note the habits of *P. Artaxerxes*, and a beautiful delineation of it in all its stages of development will appear in Mr Logan's book, whenever its appearance shall realize the expectations of his numerous subscribers.

To go further into the descriptions of its transformations at this point, would be to trespass on the subsequent but as yet unpublished observations of Mr Logan, and I shall therefore leave it now, to say a few words in conclusion on *Polyommatus Agestis* and *P. Salmacis*, two insects so nearly allied to the one before us that they have been at different times considered to be one species. On looking at the drawings of these three closely-allied insects, for which very faithful and beautiful illustrations I am indebted to my friend Mr Dallas, we perceive that *P. Artaxerxes* is readily enough distinguished by the conspicuous white spot in the angle of the upper wing, while *P. Agestis* has a black one in nearly the same position. These markings, though affording in themselves but slight grounds for specific distinction, are nevertheless permanent in their character, and even before we were acquainted with the caterpillars of the respective insects, gave great probability to the opinion that the two were distinct, especially when taken in conjunction with the fact that *P. Artaxerxes* is confined to Scotland and the north of England, and *P. Agestis* as exclusively to the southern counties of England. Still this was matter of opinion, and it is only now that we are enabled by our own observations in Scotland upon *P. Artaxerxes*, and almost at the same time by similar observations by Mr Harding and Mr Stainton in London upon *P. Agestis*, to determine, as I think, finally the specific difference of the two insects. The gentlemen I have just named have bred *P. Agestis* from the caterpillar, and find that it feeds upon *Erodium cicutarium*, a plant in natural affinity and every other respect widely removed from *Helianthemum vulgare.* When, therefore, to the slight but permanent differences of its external markings and habitat is added the fact that the caterpillar of the one feeds upon a plant so different from the food upon which the other is found, that probably the food of the one would poison the other, it appears to me that the specific distinctions between the two insects may be regarded as established.

We have, however, *P. Salmacis* still remaining undetermined, its caterpillar and chrysalis not having as yet been found. The chief distinction to be remarked in its external character is the slight but peculiar areola of white scales which surround the black spot, occupying an exactly similar position in the upper wing as in *Agestis.* Although Mr Doubleday regards this insect as a variety of *P. Artaxerxes* I have always felt and still believe it to be much more closly allied to *P. Agestis.* During last year (1855) I visited Castle-Eden-Dene, the habitat of *P. Salmacis*, and bearing in mind my observations on Arthur Seat, felt sure I should, by digging in similar places under the tufts of *Helianthemum*, find the chrysalids. In this I was unsuccessful, although the *Helianthemum* was most abundant. The spot on which *P. Salmacis* is found faces the sea (the German Ocean), and the ground is a stiff wet clay, with dense, coarse herbage, both ill suited for burying its chrysalid, if that be its habit; nor is the *Helianthemum* the *prevailing* plant there. Mr Wailes observes, that he has never found it more inland than a quarter of a mile from the sea; and although the *Helianthemum* is most abundant in the upper part of the Dene, Mr Tristram, the clergyman of the district, and other residents, assured me it was never seen except on the spot I have named, by a high cliff of clay overhanging the sea. This certainly suggests the idea of its being dependent on some littoral plant growing only within a certain range of the salt water. I observed the *Anthrocæra filipendula* and *Procris statices* flying in great numbers together with *P. Salmacis*, and their chrysalids attached to the stems of plants were abundant. I did not at the time know of Mr Harding's observations, and that *P. Agestis* fed upon *Erodium cicutarium*, and, consequently, did not particularly note whether that plant grew there; but having been accustomed to botanical observations all my life, I think I should certainly have noticed it if it had been the prevailing plant,—a thing moreover, which the stiff clay soil renders improbable. What I did notice was the *Geranium sanguineum* in great quantity (the flowers filled with Ceutorhynchus geranii), a plant not far removed in natural affinity from the one I have just named. Altogether, I feel inclined to predict that *P. Salmacis* may be found to feed on *Geranium sanguineum*, and to attach its chrysalids to the stems; but this is mere surmise, and until its transformations have been observed, it must still remain, as it now is, an undetermined species.

3. *On Solar Light, with a Description of a Simple Photometer.* By MUNGO PONTON, Esq. Communicated by Mr SWAN.

The first part of this communication was occupied with a detail of some observations, made in the course of last summer, on the quantity and intensity of Solar light, as compared with familiar sources of artificial flame. The instrument employed for these observations was a simple monochromatic photometer, whose construction was minutely described.

The results obtained were stated to be, that a small surface, illuminated by mean solar light, is 444 times brighter than when it is illuminated by a moderator lamp, and 1560 times brighter than when it is illuminated by a wax candle (short six in the lb.),—the artificial light being in both instances placed at two inches' distance from the illuminated surface. It was then pointed out, that as the electric light may be easily obtained of a brilliancy equal to 520 wax candles, three such electric lights, placed at two inches from a given small surface, would render it as bright as when it is illuminated by mean sunshine.

It was thence inferred, that a stratum occupying the entire surface of the sphere of which the earth's distance from the sun is the radius, and consisting of three layers of flame, each $\frac{1}{1000}$th of an inch in thickness, each possessing a brightness equal to that of such an electric light, and all three embraced within a thickness of $\frac{1}{10}$th of an inch, would give an amount of illumination equal in quantity and intensity to that of the sun at the distance of 95 millions of miles from his centre.

It was then shown, that were such a stratum transferred to the surface of the sun, where it would occupy 46,275 times less area, its thickness would be increased to 94 feet, and it would embrace 138,825 layers of flame, equal in brightness to the electric light; but that the same effect might be produced by a stratum about nine miles in thickness, embracing 72 millions of layers, each having only a brightness equal to that of a wax candle.

The various possible causes of the light proceeding from the luminous envelope of the sun were then considered; and an attempt was made to show, that the shining particles in that envelope may possibly be minute luminiferous organisms, floating in an elastic atmosphere, each emitting only a small amount of phosphorescence, the enormous flood of splendour emanating from the surface of the medium being due to the combined action of these individually feeble agents.

Monday, 18*th Feb.* 1856. Right Rev. Bishop Terrot in the Chair.

The following Communications were read :—

1. *On certain cases of Binocular Vision.* By Professor William B. Rogers. Communicated by Professor Kelland. (This Paper appears in the present Number of this Journal.)

2. *Theory of the Free Vibration of a Linear Series of Elastic Bodies.* Part I. By Edward Sang, Esq.

Monday, 3*d March* 1856. Dr Christison, Vice-President, in the Chair.

The following Communications were read :—

1. *Observations on the Diatomaceous Sand of Glenshira.* Part II. Containing an Account of a number of additional undescribed Species. By William Gregory, M.D., F.R.S.E., Professor of Chemistry in the University of Edinburgh.

The author, after referring to his former paper on this subject, stated that he had continued the investigation, and that the number of undescribed forms besides those formerly figured had proved so large, that the present paper does not conclude the subject, but that a good many forms remain for a future communication. He added, that even now, after he had explored 600 slides of it, new forms were occasionally found.

He then gave a list of about thirty additional *known* species, which had been noticed since the former paper was read, many of them having been last year described by himself as new fresh-water species, and others not having been yet described, but to be described and figured in vol. ii. of Smith's *Synopsis*. These are:—

Amphora membranacea.
„ hyalina.
„ salina.
Cymbella sinuata.
Amphiprora paludosa
Campylodiscus Ralfsii.
Actinocyclus radiatus.
Actinocyclus (sp.?) This is a species to be figured in Vol. II. of the Synopsis, but I do not know how it is named.
Actinoptychus duodenarius (new to Britain?)
Nitzschia bilobata.
Eupodiscus tenellus, Bréb. (new to Britain?)
Navicula Westii.
„ Hennedii.
„ Pandura, Bréb.
„ rostrata.
Pinnularia megaloptera.
„ biceps.
„ linearis.
„ subcapitata.
„ gracillima.
Pleurosigma distortum.
„ intermedium.
Gomphonema subtile.
Diatomella Balfouriana.
Orthosira spinosa
„ mirabilis.

He stated that he had actually found and sketched the last two forms in this deposit three years ago, but had not been able to study them fully, till after they had been found and named, the former by Drs Greville and Balfour, and Professor Smith, the latter by Mr Okeden. He had also found both these forms in soils from South America, and gave his reasons for suspecting *O. mirabilis* to be an abnormal state of *O. spinosa*.

He then proceeded to describe the following new species, of which very exact drawings by Dr Greville were exhibited:—

1. Navicula rhombica, n. sp.
2. Navicula maxima, n. sp.

Both of these had been figured in the former paper, but were now better understood. *N. rhombica* occurs in packs, like packs of cards.

3. Navicula formosa, n. sp.
4. „ pulchra, n. sp.
5. „ macula, n. sp.
6. „ latissima, n. sp.
7. „ quadrata, n. sp.
8. „ solaris, n. sp.
9. Navicula Hennedii, Sm., of which the deposit yields very fine specimens.
10. Navicula angulosa, n. sp.
11. „ Pandura, Bréb.?
12. „ nitida, Sm.?
13. „ splendida, n. sp.
14. „ incurvata, n. sp.

Nos. 11, 12, 13, and 14, form a very remarkable panduriform group, the first two having entire costæ, like *Pinnularia alpina*, the last two moniliform striæ. The author, on this account, names the first, No. 11, *Navicula*, after De Briberson, and the second doubtfully, as no description of *N. nitida*, Sm., has yet appeared. The two others are quite new. The author here stated that he had found in this deposit, *N. didyma* with costæ, so that he considers it possible that all these forms may belong to only one species, but the point requires investigation.

15. Navicula clavata, n. sp.
16. Pinnularia longa, n. sp.
17. „ fortis, n. sp.
18. „ Ergadensis, n. sp.
19. „ inflexa, n. sp.
20. „ acutiuscula, n. sp.
21. Stauroneis amphioxys, n. sp.
22. Cocconeis distans, n. sp., inaccurately figured in Part I.
23. Cocconeis costata, n. sp., a more characteristic specimen than that figured in Part I.
24. Cocconeis radiata, n. sp.
25. „ lamprosticta, n. sp.
26. Amphora elegans, n. sp.
27. „ rectangularis, n. sp.
28. „ obtusa, n. sp.
29. „ lineata, n. sp.
30. „ plicata, n. sp.
31. „ biseriata, n. sp.
32. „ crassa, n. sp.
33. „ Grevilliana, n. sp.

The last three form a very remarkable group, either a subgenus or a new genus. To this group belongs also *Amphora Arcus*, of which a part is figured in Part I.

34. Campylodiscus simulans, n. sp.

The author showed that this form so much resembles, in its markings, *Surirella fastuosa*, as figured in Part I., that these two genera probably form but one.

35. Campylodiscus bicruciatus, n. sp.	38. Nitzschia socialis, n. sp.
36. Nitzschia distans, n. sp.	39. Amphiprora minor, n. sp.
37. „ insignis, n. sp.	40. „ recta, n. sp.

The remaining forms will be described on a future occasion.

2. *Theory of the Free Vibration of a Linear Series of Elastic Bodies.* Part II. By Edward Sang, Esq.

Royal Physical Society.

Wednesday, December 26. Robert Kaye Greville, Esq., LL.D., in the Chair.

The following Communications were read:—

1. *Notices of the Saury Pike* (Scomberesox Sauris, Penn.), *taken in the Firth of Forth.* (Specimens were exhibited.)

Mr R. F. Logan referred to the immense influx of the Saury Pike, *Scomberesox Sauris*, which visited the Firth of Forth in the beginning of November. With regard to its food, he had not been able to find any direct statement in our Ichthyological authors, but suspected it must consist of delicate marine *Annelides*, possibly of the genus *Nereis* and its allies, which the fish snaps across the body with its long beak, and swallows at its leisure. The earliest notice of its occurrence in Scotland seemed to be that of Pennant, who mentions that great numbers of these fish were thrown ashore at Leith after a storm in November 1768; and the Rev. Mr Low, in his "Natural History of Orkney," says, that in 1774, such a glut of them set into Kerston Bay that they could be taken by pailfuls, and heaps were flung ashore.

Dr J. A. Smith read an extract from the *Alloa Advertiser*, showing the extraordinary abundance of these fish:—"On the afternoon of Monday (29th October), but especially on Tuesday, and partially on Wednesday (31st,) vast shoals of fish, of the genus *Scomberesox*, technically known by the name of Saury Pike, ascended the river Forth, and were gladly welcomed by the citizens of Alloa, more especially by the humbler classes of the community. The river Forth, betwixt Kincardine and Alloa, during the days above mentioned (particularly Tuesday), was literally swarming with these fish, and millions of them have from first to last been captured. Hundreds of people lined both banks of the river on successive days, and came away with bags, baskets, and boxes, laden with the herrings; hundreds of yonng people, while wading along the margins of the river, picked up armsful of the fish; parties cruizing about on the river gathered up the herrings as rapidly as they chose with their hands, from the sides of their small boats; parties in Alloa, Kincardine, Kennet, Alva, Tillicoultry, and Stirling, obtained cart-loads of them, and sold them to ready purchasers; and numbers of the fish were destroyed by the paddles of the Stirling steamers." He believed they had been found generally along the coasts of the Firth; the great body of fish, however, appeared at the upper part, which was narrow, and perhaps, from confining the shoals, brought them more distinctly under the notice and reach of the people. A. Whyte, Esq., Queensferry, sent him several specimens, and in a note, dated the 14th November, refers to them having entirely and suddenly disappeared a short time before. One old fisherman had known them for upwards of fifty years, but only once (about forty-five years ago) had he seen them in such quantities as this year. A few specimens were next taken about the 19th of November, and on the 22d a considerable number were caught in the herring-nets off Queensferry. The east or north-east wind was very prevalent before and during the first appearance of these fish; it then veered to the westward, and the fish disappeared; and, on its again changing to the east, we had their recurrence at the latter part of November, to which he had just alluded; after which they finally disappeared. Dr Parnell, apparently, had never met with them. *Vide* "Essay on the Fishes of the Forth," published in 1838.

2. *On the Galactite of Hardinger; with Analysis of Scottish Natrolites.* By M. Forster Heddle, M.D.

After submitting six analyses of *Galactite* (from the following localities—two from Glenfarg, red and white; from Campsie; two from Bishoptown, white and pink; and from Glenarbuck), Dr Heddle showed that this substance was merely *Natrolite;* lime, in proportions from ·16 up to 4·312, replacing a portion of the soda, giving to the mineral its characteristic whiteness and opacity, and doubtless preventing its assuming the definite form, which the pure mineral, under favourable circumstances, adopts.

Dr Heddle next submitted an analysis of a green mineral from Bowling Quarry, Cochney, and Bishoptown, which has been sold under the name of "*Stellite*," and which Professor R. D. Thomson considered *Pectolite;* this was shown to be also *Natrolite;* lime was here present, as also magnesia and oxide of iron as impurities.

The analysis of a specimen from Dumbarton Moor also showed 3·76 per cent. of lime, so that out of six localities, no specimen was free of this base.

The Bin above Burntisland and North Berwick were also mentioned as localities of this mineral; no analysis of specimens from these places were however submitted.

At Glenfarg alone in Scotland does this mineral occur distinctly crystallized, the form being *o m* of Brooke and Miller.

3. *Notice of a variety of Cod, termed the "Lord Fish."* By T. Spencer Cobbold, M.D.

This variety consisted in a remarkable shortening of the body, arising from the coalescence of a great number of the vertebræ immediately succeeding the bones of the head. In the present example, twenty-one were united together, and the shortening thus produced had given to the animal a curiously grotesque appearance. The middle dorsal fin was shortened, and the lateral longitudinal line arched very suddenly over the pectoral fins. Length, about 20 inches; depth, 8 inches. It corresponded very closely with the figure and description of this variety given in the second edition of Yarrell's "British Fishes," vol. ii., p. 229. The notice was accompanied with a preparation of the spine, and a coloured wax cast representing the external characters.

Mr George Logan exhibited a drawing of a smaller specimen of the same variety, which he had obtained several years ago from the Firth of Forth, near North Berwick.

4. *Notice of a Curious Habit of the Common Seal.* By Mr William M'Intosh. Communicated by T. Spencer Cobbold, M.D.

This communication, from an eye-witness, minutely described the manner in which the common seal caught and devoured its prey,—in this instance, a ballan wrasse, which the seal held in its fore-paws, and carefully denuded of its skin before devouring.

5. *Notice of the Ferruginous Duck, or White-Eyed Duck* (Nyroca leucopthalmos, Flem..) *recently shot near Musselburgh.* By John Alex. Smith, M.D.—(The specimen was exhibited).

The bird, an adult male, measured $16\frac{3}{4}$ inches from the point of the bill to the tip of tail; and $27\frac{1}{2}$ inches in breadth from point to point of its extended wings. Its weight was 17 ounces. The trachea, showing its peculiar expansion in the middle part, was exhibited; the stomach, a strong and muscular gizzard, was filled with seeds of the oat, mixed with small pieces of quartz and gravel. The bird is an occasional winter visitant of England, but appears to have been very rarely seen in Scotland.

6. Dr J. A. Smith mentioned that, during the months of November and December, several flocks of the Mealy Redpoll, *Linota canescens*, Yar., had been observed in the neighbourhood of Edinburgh, and numbers had been taken by the bird-catchers. These birds were larger in size than the Lesser Redpoll, *Linota linaria*, Yar., none of which had been taken along with them. Specimens were exhibited, varying in brightness of colour: in some, the cheeks, breast, and the white or greyish rump, were tinged with rose-red; some had the plumage much edged with white. They had not been found in such abundance in this neighbourhood for many years. A collector informed Dr Smith he had tried in vain to get specimens from all the bird-catchers for the last two or three years.

Dr Smith also exhibited a Crested Grebe, *Podiceps cristatus*, recently killed in the estuary of the Tay.

Wednesday, January 23. William H. Lowe, M.D., President, in the Chair.

1. *Note on the Late Stay of Swallows in* 1855. By Robert F. Logan, Esq.

The late stay of the swallow tribe in this country during the past autumn had, Mr Logan stated, considering the earliness and severity of the winter, been somewhat remarkable. It was well known that the ordinary period of the departure of the red-fronted or chimney swallow (*Hirundo rustica*), was the end of September or beginning of October, and that of the house martin (*Hirundo urbica*) about the same time, or a few days later; but last autumn numbers remained during October, and towards the end of the month a small flock of martins were to be seen every morning, briskly hawking for insects, over the village of Duddingston. He saw some of them so late as the 10th of November, flying high in the air, and circling about with as much apparent ease as in the middle of summer. In previous years, both species had occurred in England quite as late, and in some instances later, than the cases now cited; but it was rarely they were seen so late in Scotland. Mr Logan quoted instances on record of these birds having been seen in England during each of the winter months, and considered that it became a curious and difficult question to decide whether or not any of these might have been instances of reanimated hybernation. At all events, the facts went very far to prove that swallows could occasionally remain in this country through the winter.

2. *Notice of the Arctic Skua* (Lestris Parasitica, Tem.), *shot in Skye in the Summer of* 1855. By Peter A. Dassauville, Esq.

The specimen on the table was procured in Skye by John Richardson, Esq., Pencaitland. It appeared to be in the adult summer plumage. The two centre tail feathers gradually tapered to a point, and exceeded the others by eight inches. The season at which this specimen was taken was not a little remarkable, as it was not known to breed even on our most northern stations, and in the sparing notices of its occurrence it had appeared in the autumn or winter.

3. *On Mesolite ; Faröelite (Mesole) ; and Antrimolite.* By M. FORSTER HEDDLE, M.D.

By a series of analyses of these minerals, Dr Heddle showed that *Mesolite* and *Mesole* were not only distinct from *Scolezite* and *Natrolite*, but also from each other ; the *Antrimolite* of Thomson he referred to *Mesolite*, under which mineral also he considered that the *Harringtonite* of Thomson would fall.

The nomenclature of these zeolites seemed to be in a sad state of confusion. We had *Mesotype, Mesolite, Mesole.* Dr Heddle proposed that the unmeaning *Mesotype* be dropped for the expressive *Natrolite* : that *Mesolite*, as being in reality the intermediate mineral, be retained, and that *Mesole* give place to *Faröelite*, from the locality whence we obtained the choicest specimens of this substance.

From their composition, these minerals rank as follows :—

Natrolite, $Na\,O,\ Si\,O_3 + Al_2\,O_3,\ Si\,O_3 + 2\,HO$.
Faröelite, $(Na\,O,\ Ca\,O^2)\ Si\,O_3{}^3 + 3\,Al_2\,O_3,\ 2\,Si\,O_3 + 8\,HO$.
Mesolite, $(Na\,O,\ Ca\,O^2)\ Si\,O_3{}^3 + 3\,(Al_2\,O_3,\ Si\,O_3) + 8\,HO$.
Scolezite, $Ca\,O,\ Si\,O_3 + Al_2\,O_3,\ Si\,O_3 + 3\,HO$.

4. *Mr David Page exhibited specimens of the* Woodocrinus Macrodactylus, *a new genus of Encrinite recently figured and described by M. de Koninck.* This rare and beautiful crinoid had as yet been found only in the upper beds of the carboniferous limestone in Yorkshire, and had been named by M. de Koninck after its discoverer, Edward Wood, Esq., Richmond, one of the most zealous and indefatigable of English collectors. The distinguishing features of the new encrinite were—its perfect symmetry of arrangements, the body and arms, when extended, presenting a remarkable resemblance to the free-floating star-fishes. Its base consisted of five pieces, which, branching into ten sub-basals, again subdivided into twenty tapering fingers elegantly fringed with minute plumules. The stem was also peculiar in its jointings, the pieces being of equal size in the young stage, alternately large and small in the growing stage, and in the mature form presenting a double alternation of larger with smaller jointings. In few genera of the family were the parts so elegantly and symmetrically disposed ; and from the peculiar construction of the cap and fingers, there was little difficulty in distinguishing the Woodocrinite from other species. As yet it had been found only on the upper verge of the limestone, and immediately under the millstone-grit of Yorkshire ; but he (Mr Page) had little doubt that the Scottish mountain limestone (which had yielded all the English forms) would also be found to contain the Woodocrinus. At all events, the *Petalodus*, which appeared to be a regular accompanying fossil in Yorkshire, had been found both at Carluke, at Bathgate, and in Fifeshire.

5. *Mr Page next exhibited some new Crustacean Forms from the Forfar flagstones, or base of the Old Red Sandstone in Scotland.* The first of these forms presented a remarkable union of phyllopod and isopod characters ; was a small creature found in shoals among the fragments of fucoid or aquatic plants ; and, from its curious caterpillar-like aspect, he proposed to name it provisionally *Kampecaris Forfarensis.* The second was a larger and still more remarkable form, presenting phyllopod, pœcilipod, and xiphosarus characters. To the head of a eurypterus was united the body of a lobster, and to this lobster-like body was attached

the sword-like tail of a king-crab. Its organs of motion were a pair, on each side, of long-jointed arms; and from fragments found on the slabs, it appeared to be furnished with minutely serrated jaw-feet, like the king-crab and fossil *Pterygotus*. This fossil appeared to be quite new to Palæontology; and Mr Page proposed to name it provisionally *Stylonarus Powriensis*, in allusion to its style-shaped tail, and after its discoverer, Mr Powrie of Reswallie. A third form which Mr Page exhibited was from the shaly mudstones of Upper Lanark, a series of strata apparently on a somewhat different horizon, but containing, like the Forfarshire beds, pterygotus, eurypterus, and other undescribed crustacea. This form Mr Page proposed to erect into a new family (*Slimonia*, after the discoverer of these Lanark crustacea); but as he intended to bring the subject before the next meeting of the Society, in conjunction with what was now being done in London by Messrs Salter and Huxley, he would not dwell longer on these new discoveries than merely remark—*first*, that they opened up altogether new views of crustacean affinities and arrangements; and, *second*, that their discovery established in Britain a great zone of crustacean life, either on the upper verge of Siluria or on the lower verge of Devonia, hitherto unknown to geology.

6. *On recent Discoveries in Helminthology.* By James Wardrop, Esq.

Mr Wardrop gave a resumé of all that was known on this interesting and difficult subject.

Botanical Society of Edinburgh.

Thursday, 10th January 1856. Col. Madden, President, in the Chair.

The following Papers were read:—

1. *On some species of Epilobium.* By Charles C. Babington, M.A., F.R.S., &c.

The author directed attention chiefly to the plants included under the names of *Epilobium tetragonum* and *E. alpinum*. Under these have been embraced several species which require to be separated. The characters to be considered in the arrangement of Epilobia are founded on the stigmas, whether divided or undivided, and the mode of extension of the plants from year to year. The following is the arrangement of British Epilobia, as proposed by the author:—

I. Turionate; that is producing radical suckers.

1. *Epilobium hirsutum.*

II. Stoles autumnal, rosulate. Stem erect.

a. Stem mostly round. Stigma 4-cleft.

2. *E. parviflorum.* 3. *E. montanum.* 4. *E. lanceolatum.*

b. Stem with raised lines. Stigma entire.

5. *E. roseum.* 6. *E. tetragonum.*

III. Stoles æstival, long-jointed throughout, with small leaves. Primary stem erect. Stigma usually entire.

7. *E. obscurum.*

IV. Stoles æstival, long-jointed, with small leaves, ending in autumnal bulbs, which become detached. Base of stem cord-like.

8. *E. palustre.*

V. Stoles æstival, leafy, not rosulate.

9. *E. alpinum.*

VI. Stoles æstival, leafy, not rosulate.
10. *E. anagallidifolium.*

VII. Stoles æstival, scale-bearing, not rosulate.
11. *E. alsinifolium.*

The author then enters upon full details of the characters, and describes the following species :—*E. tetragonum*, L., *E. obscurum*, Schreb., *E. virgatum*, Grenier and Godron, *E. alpinum*, L., *E. anagallidifolium*, Lamarck, and *E. alsinifolium*, Vill.

Finally, he calls attention to the occurrence of the *Epilobium rosmarinifolium* of Hæncke in Perthshire, the station for it, as given by Mr John Robertson, being " inaccessible rocks that overhang the Tarf, a mountain stream in Glen Tilt."

2. *Observations on the Pollen Tube, its growth, histology, and physiology.* By P. Martin Duncan, M.B., Lond., F.G.S., &c., Colchester.

3. *Notes on the Chaulmoogra seeds of India.* By Charles Murchison M.D., M.R.C.P.L.

These seeds are furnished by the *Chaulmoogra odorata*, Rox., or *Gynocardia odorata.* The plant is referred by Lindley to the Natural Order Pangiaceæ, which, by some, is considered a section of Papayaceæ. The seeds are sold in the bazaars in India, at about 13s. 4d. per cwt. The tree is poisonous, but the seeds yield, by expression, a bland fixed oil having a peculiar smell and taste. The seeds are used by the natives of India in various cutaneous diseases. For this purpose, they are beaten up with ghee or clarified butter, and applied to the diseased cutaneous surface. The expressed oil is prized in the treatment of leprosy in India. The surfaces of the ulcers are dressed with the oil, while a six-grain pill of the seed is given three times a day. The dose of the latter is gradually increased to twice the original quantity. The expressed oil is sometimes given internally in doses of 5 or 6 minims. Too large doses are apt to produce nausea and vomiting. The Chaulmoogra is also prized by the Chinese.

4. *On the Gutta Percha Plant of India.* By Dr Cleghorn.

Professor Balfour read the following extracts from a letter from Dr Cleghorn at Madras, dated 27th November 1855 :—" In the accompanying *Madras Athenæum* of 22d November, you will find further particulars regarding Peninsular Gutta Percha. Besides the specimens forwarded from Travancore by General Cullen, and from the Neilgherries by Col. Cotton, I have received samples from two coffee planters in Malabar, showing that the tree extends from Trevandrum to Tellicherry, and with 200 trees growing in one locality, it may reasonably be supposed that the Isonandra is found along the whole line of Ghauts."

The following is an extract from the Jurors' report on the Madras Exhibition :—

" From different parts of the presidency valuable specimens have been received possessing the useful properties of Caoutchouc and Gutta Percha, in a greater or less degree. The exhibition of the inspissated gum elastic juice of a number of trees, from different localities, and prepared in different ways, renders it probable that there are a number of similar vegetable productions, which may be advantageously introduced into commerce.

" General Cullen has forwarded a drawing and description of a large forest tree, abounding at the foot of the Ghauts, N.E. of Trevandrum. The plant delineated is evidently one of the Sapotaceæ, and the Malayan name is '*pauchonthee.*' The product, of which a good sample is forwarded, on examination bears a strong resemblance to Gutta Percha, both in external appearance and mechanical properties. It appears to the Jury, that this gum elastic is possessed of valuable properties."

The editor of the *Madras Athenæum* remarks :—

"We have seen the product which General Cullen has sent to Madras Museum, and it resembles the best of the crude gum imported from the Straits. Its outer surface is brownish-red, and mottled, but this deep tinge may probably have been given to it by the plantain leaf which it was wrapped in ; a fresh fracture has a cream-yellow colour, slightly tinged with red. The fracture is smooth but conchoidal, and it is plastic under the heat of the hand. It has been ascertained to be a perfect non-conductor, and, possessing this quality, could be applied to all the uses for which the true Gutta Percha is adapted for isolating the wires of the electric telegraph," &c.

5. *Notice of the Flowering of an American Aloe* (Agave americana). By Joseph Lister, F.R.C.S.E. Communicated by Prof. Balfour.

A large American aloe, which there is good reason for believing to be at least fifty years old, growing at Upton in Essex, this year (1855) sent up a flowering stem about 20 feet in height, the flowers of which attained their full perfection in the latter part of September, about three months after the first appearance of the stem. Up to the present season the growth of the plant had consisted in the annual unfolding of a few leaves from the central bud, while at the same time a small offshoot was occasionally sent out from the portion of the stem below the surface of the ground ; these offshoots resembling their parent in their mode of growth when transplanted into separate pots. This year, however, the aloe flowered, as aforesaid, with a mighty effort, which appeared to exhaust all its energies, so that the huge fleshy leaves, which before stood firm and erect, gradually shrunk, shrivelled, and drooped as the process of inflorescence advanced, and the plant became a mere ghost of its former self, except as regarded the addition of the magnificent flower-stem. Some weeks ago a small offshoot appeared above the earth in the pot, and, on examining this when in England a few days since, I observed, to my great surprise, that instead of being, like its predecessors, a small leafy repetition of its parent, it bore no leaves, but two flowers like those produced a few months previously by the central stem. As it was evident that the effort of flowering had so completely exhausted the aloe that it would not live another season, it was determined to destroy it ; and, the flower-stem having been sawn off, the plant was turned out of the pot, so as to afford me an opportunity of tracing the flowering offshoot to the part from which it sprung. Below the surface this offshoot consisted of a succulent under-ground stem, about 10 inches long, connected with the under-ground part of the main plant. It now further appeared that there were about a dozen or more other offshoots struggling upwards through the earth towards the surface, which they had not yet reached, terminated by pale green buds, which I found to contain, in the case of two which I dissected, rudimentary flowers within the scales of the buds. Thus, the whole constitution of the aloe appears to have been remarkably affected with a tendency to flowering ; and just as the part above ground, instead of producing, as usual, a few leaves, shot forth this year a stem with a multitude of flower-buds, so the under-ground portion of the plant, instead of sending out, as usual, a few (one or two) sprouts, terminating in leaf-buds, this year produced many (a dozen or more) offshoots ending in flower-buds, and destitute of leaves.

Professor Balfour remarked that several specimens of American aloe had bloomed in England last year. The first *Agave americana* which grew and blossomed in the open air in Britain was in the garden of the late James Yates at Salcombe, Devonshire, about the year 1814. In 1855 four plants of the *Agave* are stated to have bloomed in different localities at Salcombe.

6. *On the Flowering of Plants, &c., in the Isle of Wight.* By Dr T. Bell Salter.

7. *List of Plants in Flower in the open air in the neighbourhood of Ryde, Isle of Wight, in November* 1855. By Dr T. Bell Salter.

8. *On the Flora of Sleaford and the neighbourhood.* By John Lowe, Esq.

9. *Notice of the occurrence of Silene dichotoma*, Ehrhart, *in the neighbourhood of Gainsborough.* By John Lowe, Esq.

The plant was gathered by Mr Lowe on the Trent Bank at Morton, near Gainsborough, in 1853, and was then referred by him to a variety of *S. nutans*, but it has since been ascertained to be *S. dichotoma*, and Mr Babington confirms this view. It has probably been introduced with foreign corn or linseed, and may be placed in the same category with such plants as Echinospermum Lappula, Amaranthus Blitum, &c.

Thursday, 14*th February* 1856. Colonel Madden in the Chair.

Professor Balfour exhibited specimens of a spherical lichen sent by Sir Walter Trevelyan, and read the following letter from that gentleman on the subject:—

"I send you specimens of a remarkable form of *Parmelia saxatilis*, which I met with on the exposed chalk downs of Dorsetshire, where I had found it many years ago; and my attention was again drawn to it on seeing in the Paris Exhibition specimens of *Lecanora esculenta*, to which it struck me that what I had before found in Dorset bore much resemblance. I therefore took the opportunity, soon after my return to England, of going again to the spot to search for specimens, and on the 14th of last December I collected a considerable number on Melbury Hill, near Shaftesbury. I have not had an opportunity of comparing them with specimens of *Lecanora esculenta* and *affinis* of Lindley's *Vegetable Kingdom*, and Berkeley in the *Gardeners' Chronicle*, but I have little doubt that those and similar plants mentioned by other authors as occurring on the elevated plains of Tartary, America, Siberia, &c., are to be accounted for in the same way, viz., that a small piece of lichen (in this case of *P. saxatilis*) carried by the wind from a tree or rock at a distance, is lodged amongst the short grass of the doune or elevated plain (steppe), and there continues to vegetate, and, being liable to be rolled about by the wind, forms a nucleus, round which the plant increases on all sides, and thus forms the globular masses. Their appearance in great quantities, as described by some writers, and esteemed sometimes by the natives of the countries where they are used as food as miraculous, is to be explained by their being carried together by a high wind prevailing for many hours or days in one direction. The day on which I collected them was very stormy, and I observed many instances of their being rolled along the grass by the wind. I have sent specimens of them to Dr Lindley, Mr Berkeley, and Sir W. Hooker. I do not know what conclusions the two former have come to, but I am satisfied that Sir W. Hooker is correct in considering it a form of *P. saxatilis.* I at first thought they were formed round the droppings of sheep, but on more careful examination this does not appear to be the case, there being no foreign substance in the interior, as was, I think, also observed to be the case by Eversmann in Tartarian plants, as quoted in last edition of Lindley's *Vegetable Kingdom*, which, however, I have not here to refer to."

Professor Balfour stated that a paper on this subject had since been published in the *Gardener's Chronicle*, in which the Rev. Mr Berkeley refers the lichen to a very curious form of *Parmelia cæsia*, of which he can find no trace in any work to which he has access.

The following Communications were read, viz. :—

1. *On Spores.* By Charles Jenner. Esq. (This paper appears in the present Number of this Journal).

2. *On the Effects of the Frost in the Winter of* 1855 *on the Furze and Broom.* By Dr Gilchrist, Royal Lunatic Asylum, Montrose.

In early spring, the author observed that in the eastern part of Forfarshire, lying between the sea and the Grampians, the common furze was so completely withered, that in a journey of 12 miles scarcely a green twig was seen, even where acres of ground were covered with the plant. Where the furze was protected by hedgerows and plantations, the destruction was equally complete.

In the same district, the broom did not suffer at all from the effects of the frost. On Montrose Links (close to the sea), the furze escaped without injury, which may be accounted for by the fact that the thermometer there did not fall so low in winter by 10° or 15°, as in the more inland district above referred to.

3. *Note on the Connection between the Chemical and Morphological Characters of Plants.* By J. Wardrop, Esq.

Plants are arranged by the systematist into a variety of groups, the principle of division being their morphological characters. But their sensible properties and medicinal virtues afford other principles of division by which they may be. and have in some sense been, classed into groups, which, generally speaking, coincide with those formed on the morphological principle. This result indicates a correspondence of chemical composition and morphological structure in the economy of the vegetable kingdom ; for the different sensible properties of plants and their varying influence on the physiological action of animal tissues are to be held due to distinctions in their constituent matter.

May we then expect, in addition, to find that the distinctions determined by the unscientific but crucial tests of sense and medicine are satisfied by the rigorous results of analysis, reducible to scientific expression ? Can we establish a consilience of chemical and morphological constitution by formulating the distinctive chemical composition of groups, and presenting the formulæ as chemical characters coinciding and coordinate with the morphological ? This is a question of the perfectibility of chemical science, but already the attempt to obtain a general and distinctive chemical expression for a morphologically distinct group, and to show that a definite form is associated with a definite composition, has been initiated with a success, which, if small, is at least promising.

The possibility of obtaining a generic or ordinal chemical character depends on one of two conditions. 1. On the presence of some one identical constituent in every individual of the group, in which case the empirical formulæ of the common constituent would present itself in the common chemical character of the group producing it. This may be expected to occur the more frequently the less extensive is the group, *i.e.* the fewer kinds of plants it contains, and may hence be the rule in genera. Veratrine in the Colchicaceæ, Myrosine in the Cruciferæ, and Ericoline in the Ericaceæ, are examples in the natural orders. 2. It depends on the ability of chemical theory to detect, where it exists, the same rational constitution in different constituents, and thus to generalize their different empirical formulæ into a common rational formula. The general theoretical formula would be the chemical character of the group as a whole, the individual formulæ, the respective characters of its subordinate members. This condition may be expected to be the more frequently necessary, the more extensive is the group, and hence it may be the rule in the natural orders. The series of chemical principles whose constitution is thus generalized into an ordinal character would have a representative substance in each species or genus of the order, though in each it may be one different from all the others. Were the bases of the Solanaceæ, for instance, ultimately found to have the same compound radical, to be homologous with each other, to be typologous with each other, or convertible into each other by substitution, or, by some other theory, to be reducible to a common expression, while each genus would possess a distinctive chemical character in the particular base found in it, all the bases together would concur in one general formula to furnish a combining and distinctive character of the order. Similarly with the Labiate oils. In neither of these cases indeed is this result as yet realized, because the constitution of neither the bases nor the oils is as yet known. But that it may be realized, we are warranted by analogy to expect, for in what analysis has already effected in other groups, there are indications that the artificial productions of the laboratory, allied by homology, &c. into series, actually find a parallel in related natural constituents distributed through a group of allied plants. The successive genera of an order do sometimes, in their analyses, present a series of constituents, not identical, but analogous in properties, which, when rationalized, form a chemical series not empirically, but theoretically the same in constitution. The general formula expressing what is common to the whole series of constituents stands in the character of the order throughout which they are found; while the particular formula expressive of an individual member of the series is the character of the corresponding genus by which it is secreted. The Tannines of the Rubiaceæ, according to Rochlæder's analysis, have the same carbo-hydrogen radical, with quantities of oxygen varying with the different genera. Those of the Ericaceæ repeat the same phenomenon, their radical having two equivalents less of hydrogen.

The establishment of the coincidence of a particular chemical composition with a particular morphological structure would have important results:—

(1.) It would afford the strongest evidence of the "naturalness" of genera and of the falsity of development hypotheses.

(2.) It would aid the systematist in proportion to the discrimination and certainty of the chemical processes and results.

(3.) The study of chemical constituents, on which so many changes are rung by nature, through a series of allied plants, would be calculated to reveal their rational constitution in at least not a less degree than their artificial metallic and other compounds, now so much and so deservedly investigated.

(4.) When the correspondence of form and composition has been finally established as an empirical law, and its details worked out, it will then be more seasonable than it is now for the venturous speculator to inquire, if there be not thereby supplied some grounds on which he may speculate a physical theory of the second causes of organic forms.

4. *Continuation of Notice of some of the contents of the Museum at the Royal Botanic Garden, Edinburgh.* By Professor Balfour.

Thursday, 13*th March* 1856. Professor Balfour, V.P., in the Chair.

The following Communications were read :—

1. *Notes on the Flora of Perth.* By Dr W. Lauder Lindsay.

2. *On the Occurrence of Cladophora repens* (J. Agardh) *in Malahide, near Dublin.* By A. C. Maingay, Esq.

"The plant to which I have to direct attention is one of great interest, not only from the very small number of specimens hitherto obtained on the British Coasts, but also from the connection in character between these specimens and the Mediterranean form of the plant, described by Agardh in his *Algæ Mediterraneæ*, and quoted by Dr Harvey as being doubtfully identical with the British form. Harvey first described the plant as British, from a specimen in the Herbarium of Trinity College, Dublin, one of four plants obtained by Miss Turner on the shores of Jersey in 1846, adding to his description the remark, that since that time the plant had not been noticed, and that to Miss Turner was due the credit of having added the plant to the British Flora. It appears, however, from the specimen now exhibited, that Mr M'Calla collected the plant in Ireland in 1841, and that to him, therefore, is due the credit of its discovery in this country. When he gathered it, he considered it as *Conferva Brownii*, and communicated specimens to Professor Balfour under that name. The specimens are now in the Herbarium of the University of Edinburgh.

"Harvey, in his *Phycologia Britannica*, speaking of the Mediterranean form of the plant, says,—'Possibly the reference to the Mediterranean *Conferva simplex* of J. Agardh may be incorrect, and yet I have little hesitation in uniting our plant with that species. They agree in every respect, except the length of the joints, which, in the Mediterranean plant, are shorter than in ours, and the slight discrepancy seems scarcely sufficient to separate plants so closely allied in so many remarkable features.' This slight doubt as to the British form of *Cladophora repens* being the same species as that described by J. Agardh, is entirely dispelled by the specimens now shown from Ireland, in which the articulations, although variable, are in general shorter than in the Jersey specimens, and intermediate in size between Agardh's plant and that described by Harvey.

"I have to thank Dr Greville for his kindness in communicating to me the result of his examination of the plant, which confirmed the opinion I had previously formed concerning it."

3. *On the British species of Arctium.* By Charles C. Babington, M.A., F.R.S., &c.

The author thinks that we possess five well-marked species of Arctium in this country, namely, *A. tomentosum*, *A. majus*, *A. intermedium*, *A. minus*, and *A. pubens*. In describing these species, the points to be chiefly attended to are, the arrangement of the capitula, particularly on the central stem of the plant, the form of the heads and their size, the shape and direction of the phyllaries in the inner and outer rows, the proportion between the upper and lower part of the tubular florets, and the relative length of the phyllaries and florets.

(1.) *Arctium tomentosum*, Pers. *Heads subcorymbose, long-stalked,* *spherical*, and closed in fruit, much webbed (purplish), phyllaries falling short of the florets, subulate, inner row longest, and broad, *inflated upper part of florets* a little shorter than the lower part. *A. Bardana*, Engl. Bot., t. 2478; *A. Lappa*, β Linn. Fl. Suec.; *A. Lappa*, Fl. Dan., t. 642.

(2.) *A. majus*, Schkuhr. *Heads* subcorymbose, long-stalked, *hemispherical*, and open in fruit, *glabrous* (green), phyllaries equalling or exceeding the florets, subulate, inner row shorter than the others, *subcylindrical upper part of florets* more than half as long as the lower part. *Lappa officinalis*, Reich. Icon. Fl. Germ., xv. 54, t. 812.

(3.) *A. intermedium*, Lange. *Heads racemose, subsessile, ovate*, closed in fruit, slightly webbed, phyllaries equalling or exceeding the florets, subulate, inner row lanceolate, shorter than the others, subcylindrical upper part of the florets equalling the lower part. Reich. fil, Icon. Fl. Germ., xv. 54, t. 812.

(4.) *A. minus*, Schkuhr. *Heads racemose*, shortly-stalked, *spherical*, slightly contracted at the mouth in fruit, slightly webbed (greenish), *phyllaries* falling *short of the florets*, subulate, inner row equalling the others, *subcylindrical upper part of the florets* about equalling the lower part. *A. Lappa*, Engl. Bot., t. 1228; Reich. Icon. Fl. Germ., xv. 53, t. 811.

(5.) *A. pubens*, Bab. *Heads subracemose, stalked, hemispherical*, and open in fruit, much webbed (green), phyllaries equalling the florets subulate, *inner row equalling the others* and gradually *subulate*, subcylindrical upper part of the florets equalling the lower part.

4. *Suggestions for Observations on the Influence of the Poison of Epidemic Cholera on Vegetation.* By Dr W. Lauder Lindsay.

5.—*Register of the Flowering of certain Plants in the Royal Botanic Garden, from 14th February to 13th March 1856, as compared with the five preceding Years.* By Mr M'Nab.

	1856.	1855.	1854.	1853.	1852.	1851.
Galanthus nivalis, . .	Feb. 14	Mar. 2	Jan. 24	Jan. 24	Jan. 28	Jan. 17
Eranthis hyemalis, . .	... 14	... 2	... 26	Feb. 1	... 31	.. 15
Corylus Avellana, . . .	... 15	... 21	Mar. 10	Mar. 9	... 25	... 16
Erica herbacea, . . .	... 15	.. 5	Feb. 20	Jan. 28	... 24	... 16
Hepatica triloba, . . .	... 16	... 7	Jan. 20	Feb. 2		
Rhododendron atrovirens,	... 16	Apr. 6	Feb. 18	... 1	Jan. 14	... 2
Garrya elliptica, . . .	.. 18					
Crocus Susianus, . . .	... 18	Mar. 5	Feb. 14	Mar. 8	Feb. 3	Jan. 26
Daphne Mezereum, . .	... 19	Apr. 6	... 18	Feb. 1	Jan. 21	... 28
Arabis albida, ...	... 24	... 8	... 15	Mar. 15	Feb. 18	Feb. 7
Tussilago alba.	... 24	Mar. 15	... 14	... 1	... 27	Jan. 26
Crocus vernus, vars., . .	... 24	... 6	... 4	... 15	... 18	Feb. 3
Sisyrinchium grandiflorum, ...	... 25	... 5	... 14	... 3	... 3	Jan. 27
Symplocarpus fœtidus, .	... 26	... 20	Mar. 3	... 16	... 20	Feb. 4
Leucojum vernum, . .	Mar. 1	... 3	Feb. 15	... 21	... 21	Jan. 20
Aubretia grandiflora, .	... 1	Apr. 8	... 17	Feb. 1	Mar. 18	Mar. 1
Nordmannia cordifolia, .	... 8	... 9	Mar. 1	Mar. 24	... 10	Feb. 20
Dondia Epipactis, . . .	... 10	... 9	... 11	... 25	... 8	Jan. 4
Anemone Pulsatilla, .	... 10	... 11	... 14	Apr. 3	Feb. 21	Apr. 15
Pulmonaria angustifolia,	... 11	... 20	... 19	Mar. 20	Mar. 1	
Symphytum caucasicum,	... 12	... 10	... 11	... 26	Feb. 2	Mar. 23
Tussilago Farfara, . .	... 12	... 11	... 14	Apr. 4	... 21	Feb. 19

6. *Continuation of Account of some of the contents of the Museum at the Royal Botanic Garden, Edinburgh.* By Prof. Balfour.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

Distribution of British Land-Shells.—The French have ever been remarkable for their attention to natural history, even under the most disadvantageous circumstances. Examples of this are recorded in the history of the great expedition to Egypt under Napoleon I., and of the more recent French expedition to Algeria. We have now, in the Revue et Magazin de Zoologie, for December 1855, a contribution to Crimean zoology by Dr L. Raymond, known by his researches made during the Algerian expedition. These are published by M. Bourguignat in his "Amenités Malacologiques," and consist of a list of the land-shells of the genera Helix and Bulimus, observed during the last winter in the East, among which some new species are described. The following British species occur in the localities given below :—

H. carthusiana. Very common at Gallipoli, Constantinople, Balkan, Varna.

H. pisana. Constantinople, in the cemeteries, Silivri, on the shores of the Sea of Marmora.

H. virgata. Gallipoli, Constantinople, Bosphorus generally. (*H. maritima*, Drapardn. with the preceding very common).

H. ericetorum. Around Constantinople, Adrianople, &c., Varna.

Bulimus acutus. On all the coasts of the Sea of Marmora and Black Sea.

B. obscurus. Near Constantinople.

Habits of the Walrus.—While encamped during one of the boat expeditions, and waiting the return of Commander Richards, Sir Edward Belcher shot four Walruses, and thus notices the conduct of these warm-blooded animals on being wounded :—"The father, mother, and cubs were of the party. On the death of the mother, or rather on her receiving her wound in the neck, it was painfully interesting to notice the action of her young. One literally clasped her round the neck, and was apparently endeavouring to aid in staunching the blood with its mouth or flipper, when, at a sudden convulsive pang, she struck at her infant with her tusks, and, repeating this several times with some severity, prevented its farther repetition. The male, with a very white beard (strong horny bristles), came up repeatedly in a most threatening attitude and snorting aloud his vengeance; and well satisfied was I that the floe was my safeguard; doubtless he would have wreaked his vengeance on the *Hamilton*, and we should have met our punishment. Another, finding that she could not swim, deliberately hauled herself up on the floe to die. Now, with all due deference to anatomists, who may afford us full proofs of the capability of these animals to walk like flies on our ceilings, I must protest, from frequent observation, against the use of the flipper of the Walrus for this purpose. It does not appear to be of greater aid than that of the seal is to that animal; and, strangely, its nails are placed on the upper side of the flipper, some inches within its margin. That the power of exerting the vacuum exists I doubt not. But here, within a few feet, deliberately did I watch the progress of the animal in effecting its purpose. In the first place, the tail and fins, exerting their full power in the water, gave such an impetus that it projected about one-third of the body of the animal on to the floe. It then dug its tusks with such terrific force into the ice that I feared for its brain, and, leech-like, hauled itself forward by the enormous muscular power of the neck, repeating the operation until it was secure. The force with which the tusks were struck into the ice appeared not only sufficient to break them, but the concussion was so heavy that I was surprised that any brain could bear it."—*Captain Sir E. Belcher, C.B.*

Cheiramys Madgascariensis, Cuvier.—A living specimen of the singular animal, the Aye-Aye, a native of the west coast of Madagascar, has lately been brought to Paris, and an account of its habits has been read before the Académie des Sciences de Paris, by Dr Vinson. Some of the more remarkable peculiarities are as follows:—

The fore-feet of the Aye-Aye are very slender, and the long fingers are terminated by hooked nails; the longest of these is the ring or third, next the middle finger. This last, black, slender, resembling the foot of a large spider, is distinguished from the others, not by its form alone, but also by the purposes to which it is applied. The animal climbs trees, hangs upon them by its ordinary fingers, but with the slender one it takes its food, carries it to its mouth, searches for larvæ in the bark of trees, and with this filiform finger it drinks, which it never does with its lips directly. When drinking, it dips the long finger into the liquid, and passes it rapidly through the mouth, in a manner licking it with its tongue; the form of its lips, flattened horizontally, being wonderfully adapted for this operation, which the animal repeats with great rapidity.

The most remarkable attitude of the Aye-Aye is that of repose. Squatting upon its hinder legs, it places the head between the fore-feet, and brings over it the thick and bushy tail, of which all the hair is then expanded, and by degrees it covers itself entirely up as with a cloak.

It was at first wild and fierce, endeavouring to hide itself from the presence of any one, but in the space of two months it became tame, remaining at liberty, and not attempting to escape. It was extremely fond of "café au lait" and "eau sucré," drinking by means of its long finger, which it passed and repassed from the vessel to its mouth with incredible agility. Soon after its arrival it one day escaped, and was with difficulty recovered. It exhibited the activity of a monkey on the trees, leaping from branch to branch, and crossing wide spaces with an ease and agility equal to that of the "Lemur catta."—*Rev. et Mag. de Zool.*

Artificial Breeding of Fish.—M. Coste brought before the Académie des Sciences de Paris, a curious physiological fact, as well as one of some importance in an economic point of view. A lake trout, *Salmo lemanus* Cuv., reared from ova artificially impregnated, and hatched in his ponds in the College of France, has spawned naturally on the 12th November, upon a bed of gravel, previously prepared, at a particular part of the reservoir, where it was wished to make it deposit its ova. This trout, reared in the narrow fish-ponds devoted to the experiments of M. Coste, was two years and a half old, 35 centimetres in length, weighed 750 grammes, and produced 1065 ova. These have now been impregnated by the male of a common trout (*Salmo fario*) of the age only of nineteen months.—*Rev. et Mag. de Zool.*

M. Charpentier. Helix pomatia and *arbustorum*.—Conchology has lost an active and venerable member by the death of M. Charpentier, on 12th September last, at Dévens, near Bex, Canton de Vaud.

Jean de Charpentier was born at Freyburg in Saxony. His public life was spent in the management or directorship of mines. His leisure was devoted to Natural History, and especially to Geology and Mineralogy, Conchology and Botany, and he published various works and memoirs, both separately and in the scientific periodicals. He has bequeathed to the Museum of Lausanne his herbarium of 30,000 species, indigenous and foreign, as well as his collection of land and fresh water mollusca, containing nearly 6000 species, made out and arranged. His favourite branch appeared to be Conchology; and he has left a MS. catalogue of the collection above mentioned ready for the press, of which it is to be hoped his friends will not long delay the publication. In the "Journal de Conchyliologie" he has published (1852) an "*Essai d'une classification naturelle des Clausilies*," a very elaborate monograph; and previously (1837), separately, in 4to, the "*Catalogue des Mollusques terrestres et fluviatiles de la Suisse.*" It is in this last that the remarks upon the two species indicated in our title occur. *Helix pomatia* is found from the plains to an elevation of 5000 feet above the level of the sea, and in an inverse scale to the other species it increases in size according to the elevation attained. He mentions a specimen found near Jorogne, at about 4000 feet elevation, which measured 50 millimetres in diameter by 58 in height. A variety of *Helix arbustorum* (*H. alpicola*) reaches a higher elevation than any other. He has found it at 7000 feet.—Drouet, *Rev. et Mag. de Zool.*, 1855,

GEOLOGY.

Syenite of the Malvern Hills altered by the Heat of the Malvern Bonefire, compared with Syenite in contact with Trap-Dykes.—"The president of the Malvern Naturalists' Field-Club, in his annual address to the members, 18th February, called their attention to an interesting specimen of vitrified 'Rowley rag,' sent by the Rev. J. H. Thompson to their secretary. The Rowley ragstone was an ancient basalt, and, when melted in a powerful furnace and quickly cooled, became a beautiful black vitreous mineral, which could be run into moulds, and thus made to form exquisite mantel-pieces, and other works of art; but, when slowly cooled after melting, it assumed its original basaltic character. This led him to a curious circumstance in connection with 'the great Malvern bonfire,' for though 'an ill wind' had prevented the rising column of flame that had been generally anticipated, yet it had thrown out an unexpected 'geological light,' that illustrated the old well-approved proverb. Sir William Jardine had written to him to examine if the rocks on the summit were vitrified by the fire, as was the case in some parts of Scotland where ancient fire-beacons had been kindled. Although the Malvern summit was NOT vitrified, yet he found that the heat from the fire had been so concentrated upon the foundation rocks by the powerful wind bearing down the flame, that they were much roasted and altered. Now, a quarry at the back of News Wood, at the western base of the Herefordshire Beacon, which he had recently visited with M. de la Harpe, a distinguished Swiss geologist, displayed a remarkable section of trap or greenstone dykes intersecting syenite, and the syenite in contact with the greenstone was not to be distinguished from that *roasted* by the Malvern bonefire, thus showing the heated state of the greenstone when intruded among the syenite."—*Worcester Journal, February* 23, 1856.

CHEMISTRY.

On Acrylic Alcohol and its Compounds. By MM. CAHOURS, HOFFMAN, BERTHELOT, DE LUCA, and ZININ.

The discovery of a simple process for the preparation of the iodo-propylene by Berthelot and De Luca, has directed the attention of chemists to the possibility of obtaining, by means of this substance, a class of compounds analogous to the ethers. Zinin commenced the inquiry by the discovery of the acetate and benzoate of the radical, which he called propylenyl, and by digesting these compounds with potash he obtained a pungent fluid, which was in all probability the corresponding alcohol, although he did not substantiate this point by analysis. MM. Cahours and Hoffman have investigated the whole subject, and have given to the alcohol the name of acrylic alcohol, for the purpose of connecting it with acroleine and acrylic acid, which obviously bear to it the same relations that aldehyde and acetic acid do to common alcohol. By treating the iodide of propylene with oxalate of silver, the oxalate of acryl $C_6 H_5O CO_3$ is obtained as a colourless fluid, heavier than water, having an aromatic odour, and boiling at 404° F. When treated with dry ammonia, it is transformed into oxamide and acrylic alcohol $C_6 H_6 O_2$, which is a colourless mobile liquid, with a pungent odour resembling that of mustard, and boiling at 217°. It burns with a luminous flame, and is miscible in all proportions with water. It forms with potassium a compound corresponding to ethylate of potash, and this, when treated with iodide of acryle (iodo-propylene), gives iodide of potassium, and produces the *acrylic ether* $C_{12} H_{10} O_2$. By similar treatment with iodide of ethyl, a mixed ether containing both these radicals can be obtained. The chloride, iodide, and bromide of acryl are easily produced by distilling the alcohol with the chloride, iodide, and bromide of phosphorus. Acrylic alcohol dissolves in oil of vitriol, and forms a coupled acid, which gives a soluble baryta salt, $Ba O SO_3 C_6 H_5 O, SO_3$. By distillation with anhydrous phosphoric acid it gives a gas, which burns with a luminous flame, and is no doubt $C_6 H_4$. Treated with oxidizing agents, it gives acroleine and acrylic acid. All the compounds corresponding to the common ethers can be obtained; and the authors have examined a large number of them. *Oxamate of acryl* is obtained by adding ammonia cautiously to the oxalate; it forms magnificent crystals soluble in alcohol. The *carbonate of acryl* is prepared by the action of sodium upon the oxalate. The *benzoate*, $C_6 H_5O C_{14}H_5 O_3$, is obtained by Cahours and Hoffman by the action of chloride of benzoil upon the alcohol. Zinin prepares it by distilling iodide of acryl (iodo-propylene) with benzoate of silver. It is heavier than water, boils at 428°, and has an aromatic odour like that of benzoic ether. The *acetate*, $C_6 H_5O C_4H_3 O_3$, is obtained by the action of acetate of silver on iodide of acryl. It is a limpid fluid, boiling at 217°, and having a smell similar to that of acetic ether.

Cyanate of silver is rapidly acted upon by iodide of acryl, the heat produced being sufficiently great to distil over the greater part of the product, which is the cyanate of acryl, $C_6 H_5O C_2 NO$. It is a colourless, limpid fluid, boiling at 179°, has an extremely penetrating odour, which produces a copious flow of tears. Treated with ammonia, it rapidly disappears, and on evaporation the fluid gives magnificent crystals of acrylic urea, $C_2 (H_3 C_6 H_5) N_2 O_2$, which only differs from thiosinnamine by containing oxygen in place of sulphur. When heated with water, cyanate of acryl solidifies into a mass, which has all the properties of sinapoline,—that is, of diacrylic urea, $C_2 [H_2 (C_6 H_5)_2] N_2 O_2$. MM. Berthelot and De Luca have prepared the tartrate, butyrate, and sulpho-cyanide of acryl—or allyl, as they designate it—for the purpose of recalling its relations to the oil of garlic, and they have also obtained the radical itself—acryl or allyl. It is got by acting with sodium upon the iodide, and is a highly volatile liquid, with a pungent odour like that of horse-radish. It boils at 138°. Its specific gravity is 0·684, the density of its vapour 2·92, and its formula is $C_6 H_5 = 2$ vols. It is acted upon by bromine and iodine, and forms crystalline compounds with the formulæ $C_6 H_5 Br_2$ and $C_6 H_5 I_2$.—Zinin, *Bulletin de l'Academie de St Petersburg*, vol. xiii., p. 360; Cahours and Hoffman, *Comptes Rendus*, vol. xlii., p. 217; Berthelot et de Luca, *Comptes Rendus*, vol. xlii., p. 233.

Action of Phosphate of Soda upon Fluor-Spar at a Red Heat.
By A. Briegleb.

By fusing together tribasic phosphate of soda ($3 Na O PO_5$), or a mixture of pyrophosphate and carbonate of soda with three equivalents of fluor-spar, a highly crystalline mass is obtained. The crystals are insoluble in water, and are apatite, various modifications of the crystalline form of that mineral being visible under the microscope. When the fused mass was boiled in water, a small part of it slowly dissolved, and the fluid gave a strong reaction of hydrofluric acid, and when evaporated fluoride of sodium was deposited in crystalline crusts with all its ordinary characters. By various modifications in the proportion of the ingredients, attempts were made to attain complete conversion into fluoride of sodium, but without success. When the fused mass is not boiled, but digested on the water bath for some hours, the fluid filtered, concentrated, and allowed to stand, fine transparent and colourless regular octahedra are deposited. These crystals are hard, difficultly soluble in water, and have a disagreeable alkaline taste; when heated they melt in their water of crystallization, and their solution when boiled for a long time, and then evaporated, deposits fluoride of sodium. They were found to have the formula $3\ NaO\ PO_5 + NaF + 24\ HO$. The specific gravity of the crystals is 2·2165, and they require for solution 8·3 parts of water at 77° Fahr., and 1·74 at 158°. This salt may also be obtained by digesting pounded cryolite with a mixture of phosphate of soda and caustic soda for some days, and evaporating the filtered fluid. No corresponding potash salt exists. When arseniate of soda and fluor-spar are found together, a double arseniate and fluoride is obtained in octahedral crystals soluble in 9·55 times their weight of water at 77°, and 1·99 at 167°. Their formula is $3\ NaO\ AsO_5 + NaF + 24\ HO$.—*Annalen der Chemie und Pharmacie*, vol. xcvii. p. 95.

BOTANY.

On the Varieties of "Chiretta" used in India. By HUGH CLEGHORN, M.D., Madras Medical Service.—I have frequently been struck with the evident dissimilarity between bundles of "Chiretta," as received through the commissariat, at different stations in the Madras Presidency; and although the stalk, when chewed, possessed the characteristic quality of pure bitterness, and exhibited the many-seeded capsule, the tetragonal stem, and opposite, sessile, exstipulate leaves by which the Gentian family is recognised, I could not help thinking that the supplies furnished on indent contained several distinct plants. The collection of native drugs brought together at the time of the Madras Exhibition furnished me with an opportunity of testing the accuracy of my previous opinion, and it occurs to me that a short notice of two distinct plants used in Southern India may not be unacceptable.

I will premise by stating that the properties of the Indian species of *Gentianaceæ*, with the exception of two or three of the Himalayan ones, do not seem to have been at all investigated. After a diligent search in the medical literature of India, I can find not a single notice of their therapeutic action, although the remarkable property of bitterness exists in the four genera *Exacum*, *Ophelia*, *Halenia*, and *Adenema*, as well as in all the indigenous species which I have met with.

1. *Exacum bicolor* (Roxb.) Wight, Ic. Pl. Ind. Or. t. 1321. Stem 4-angled; leaves sessile, ovate, sub-acute, 3–5-nerved, with smooth margins; calyx deeply 4-cleft, segments subulate, with ovato-lanceolate wings; corolla white, tipped with blue, lobes elliptic, oblong, cuspidate, three times longer than the tube, which is a little shorter than the calyx. Corolla large, nearly two inches in diameter, cymes terminal sub-contracted; middle internodes usually shorter than the leaves.—Griseb. in *Decandolle Prod.*, ix., p. 45.

Neilgherries, below Kotagherry, rare; in pastures about a mile below Nedawuttim abundant; flowering during the autumnal months. This plant is well figured in Wight's *Spicilegium Neilgherrense*, t. 163.

Cuttack, *Roxburgh*; Neilgherries, *Baron Hugel*; Malabar Ghauts, *Cleghorn*.

A bundle of the dried stalks of this plant was forwarded to the Madras Exhibition from Mangalore, marked "Country Creyat," price 1 anna 6 pie per lb. The name shows that it is used as a substitute for Creyat (*Andrographis paniculata*). In this species, which enamels the sward of the Western Ghauts with its beautiful blossoms, the same bitter stomachic qualitities occur for which the *Gentiana lutea* is so much employed, and I believe that it may be used with advantage for medicinal purposes.

2. *Ophelia elegans,* Wight, Ic. Pl. Ind. Or., t. 1331. Erect, ramous above, obsoletely 4-sided; leaves sessile, narrow, ovate, lanceolate, tapering to a slender point, 3-nerved; lateral nerves close to the margin; branches ascending, slender, bearing at each joint lateral few-flowered cymes, forming together a large many-flowered leafy panicle; calyx lobes narrow, lanceolate, acute, about two-thirds the length of the corolla; lobes of the corolla obovate cuspidate; foveæ bound with longish coarse hairs; flowers pale blue.

Pulney Hills, flowering August and September. A very handsome species when in full flower, forming, as it does, a rich panicle of light blue flowers, streaked with deeper coloured veins. It seems very distinct from all the other species. (Wight).

This plant grows plentifully in the Jeypoor Zemindary of Vizagapatam, and is largely exported as "Silaras" or "Selajit," the amount being valued at about 2500 rupees a-year. It is preferred by the hukeems to the genuine Himalayan Chiretta, and is considered febrifuge. (Honourable W. Elliott *in literis*).

The samples of the drug which I have seen as exported are about 16 inches long, and 4 inches deep, and are always tied up with the tough bark and large leaves of *Bauhinia Vahlii* (W. and A.), which abounds in the northern Circars.

Equal quantities of the two plants above mentioned, and of the Chiretta of the medical stores (which on examination was found to contain some stalks of the *Ophelia elegans*), having been infused in the usual manner (ʒ ij. to a pint), four competent parties were requested to give their opinion on the respective qualities of the infusions. The result was the unanimous opinion that the cold infusion of *Exacum bicolor*, although a pure bitter, was much milder than that of *Ophelia elegans*, which possesses a powerful bitterness, remaining for several minutes in the mouth. Frequent trials confirm the belief that it exercises a tonic influence on the digestive organs, thereby improving the general health, while it appears also to have a febrifuge property.

Adenema hyssopifolia, Chota Chirayita, Hind., common in various parts of South India, as at the mouth of Adyar, is likewise very bitter, and is much used by the natives as a stomachic, being also somewhat laxative.—*Indian Annals of Medical Science,* No. V.

Ceylon Botanic Garden.—Mr G. H. K. Thwaites, the able superintendent, in his Annual Report for September 1854 to August 1855, inclusive, writes: That the cultivation of the West India ginger in Ceylon has been successful, and that it is likely to prove ere long an important article of commerce; that the vanilla succeeds in the gardens, and has produced abundance of fruit; that the cochineal insects did not thrive. The Manilla hemp, the China grass cloth plant, and the Durian trees, were growing well. There are several oils which might be exported from the island. Among these he notices—*Keena oil,* obtained from the seeds of different species of *Calophyllum; Meeriya oil,* yielded by the seeds of several species of *Isonandra;* and *Madol oil,* from the seeds of a species of *Garcinia.* The resin called Doon-Doommalle is also likely to be a valuable article of commerce. Attention is being directed on the island to the preparation of fibres from species of Musa.

Extracts from Jurors' Reports of the Madras Exhibition, 1855.—*Woods grown at Madras.*—*Cedrela Toona,* the *Toon tree, Toon marum,* Tam.; *Toona,* Hind.; *Tundu,* Can.—A valuable tree of large size, wood reddish-coloured, used all over India in cabinet-making, scarcely inferior to mahogany, but lighter and not so close in the grain, often sold here under the general name of "Chittagongwood." It is the most valuable of the woods known by that commercial name. It is said to be abundant in Travancore. *Chloroxylon Swietenia*, Satin-wood tree, *Kodawah porsh*, Tam.; *Billu kurra*, Tel. This tree grows abundantly in the mountainous districts of the Presidency, but seldom attains a large size; occasionally, planks from 10 to 15 inches in breadth may be procured. The wood is very close-grained, hard, and durable, of a light orange colour, takes a fine polish, and is suited for all kinds of ornamental purposes, but is somewhat apt to split. For picture frames, it is nearly equal to American maple. The timber bears submersion well; in some instances it is beautifully feathered. There is this peculiarity, satin-wood loses its beauty by age, unless protected by a coat of fine varnish. —*Dalbergia Sissoo, Sissu*, Tel. Introduced from Bengal at the recommendation of Dr Wallich; grows to a large size; has been planted on the banks of the Toomboodra, and is thriving wonderfully; it is growing extensively in the cantonment of Masulipatam as an avenue tree, and has been planted in some places on the banks of the Kistnah Annicut. There are few trees which so much deserve attention, considering its rapid growth, its beauty, and its usefulness. Wood hard, strong, tenacious, and compact, whilst its great durability combines to render it one of the most valuable timbers known. The tree grows rapidly, is propagated and reared with facility, and it early attains a good working condition of timber. It is used in Bengal for gun carriages.—*Tectona grandis, Teak*, Eng.; *Taek marum*, Tam.; *Tek Chettoo*, Tel. A native of the mountainous parts of Malabar and the country bordering the Godavery, the Moulmein, and Rangoon forests. This well-known and far-famed tree grows straight and lofty, with cross armed panicles of showy-white flowers. It seems to require eighty years to attain perfection. The wood is very hard, but easily worked; it is soon seasoned, and being oily, does not injure iron, and shrinks little. It is probably the most durable timber known, hence its value in ship-building. The Malabar teak is considered the *best*, and is always most valued in our Government dock-yards. A valuable report by Dr Falconer, on the teak forests of the Tenasserim Coast, was published lately among the selection of records of the Bengal government. The price of teak wood at present is three rupees per cubic foot, double the ordinary rate. It is matter of regret, considering the vast importance of teak timber to England as a maritime nation, that the preservation of the teak forests was so long disregarded.

Orchids in Brazil.—Pinel states that in soils in Brazil cleared of original forests, the following epiphytic orchids appear:—*Comparettia coccinea, Oncidium flexuosum, O. pumilum, O. odoratissimum*; also the following terrestrial species:—*Neottia orchioides, Govenia Gardneri, Oncidium Pinelianum*, and various species of *Phaius*. In Brazil orchids are epiphytes on dicotyledons; it is very rare to meet with them on monocotyledons. Out of 200 species, Pinel only met with *Zygopetalum rostratum* on the great tree-fern, and on that alone it existed. *Lælia epidendroides* lived only on Vellozia. *Psidium* is favourable for the growth of certain orchids, as *Ionopsis paniculata, Burlingtonia venusta, candida*, and *picta*.—*Gardener's Chronicle.*

Ailanthus glandulosus.—This tree yields an excellent wood for furniture. In some respects it resembles satin-wood. The tree thrives in Britain.

Fossil Fruits.—Dr Joseph Hooker has noticed the occurrence of *Carpolithes ovulum*, a minute seed-vessel, in the Eocene beds of Lewisham. It is probably allied to the sporangium of a fern. He has also observed *Folliculites minutulus*, a small seed-vessel in Bovey Tracey coal (tertiary). It seems also to be a filicoid sporangium.

Scirpus lacustris.—In South America *Scirpus lacustris* (Bullrush) is used for making balsas or boats. This rush serves to form both the hull and the sails. The boats can only sail with a fair wind.

Vegetation in Brazil after burning the Forests.—When a forest in Brazil is burnt down there succeeds a different kind of vegetation from that previously on the soil. First come up ferns and herbaceous plants, *Sonchus oleraceus*, some *Solanaceæ*, grasses, *Lobeliaceæ*, and several *Campanulaceæ*. In the second, third, and fourth years the vegetation attains its final growth and dies. Then appear undershrubs. *Abutilon esculentum*, species of *Cassia*, and other *Leguminosæ*, *Strychnos pseudo-quina*, &c. After these, some of which die out in ten years, succeed tall fruit trees of the genera Anona, Cerasus, &c.—(*Pinel, Gardener's Chronicle.*)

Plants of Victoria.—Mueller mentions an Umbellifer in Victoria having five petaloid sepals. It belongs to the genus *Dichopetalum*. He also notices a peculiar Malvaceous genus, having a closed calyx, which bursts only when the fruit becomes ripe. The little corolla never expands, and sees consequently no daylight until long after fecundation.

Ouvirandra fenestralis, Water-Yam.—The cells of the parenchyma of this curious plant are very delicate, full of fluid and granules of green chlorophyll. There is a central rib of a few long green tubular cells, surrounding several very slender spiral vessels in the main ribs, but a single one in the secondary veins. There are no air-cells in the substance of the leaf, nor on the apex of the petiole. The apex of the scape bears a small lid which falls off, and seems to be composed of two gamophyllous bracts.—*Hooker, in Botanical Magazine.*

Listera ovata.—The rostellum of *Listera ovata* is divided by parallel septa into a series of longitudinal elongated loculi, which taper from the base upwards. and end in two opake cellular spots, one on each side of the apex of the rostellum. The loculi become distended with a viscid grumous fluid full of chlorophyll granules. At the period of impregnation the slightest irritation of the rostellum causes the sudden and forcible discharge of the contents of these loculi (through the rupture of the cellular tissue at the apex of the rostellum) and its protrusion in the form of two viscid glands which coalesce into one, after which the rostellum rapidly collapses and contracts.

The pollen masses fall naturally upon the rostellum; they are retained there by their viscid gland-like contents, and breaking up, the pollen grains become (by the contraction of the rostellum) applied to the subjacent stigmatic surfaces.—*J. D. Hooker.*

MINERALOGY.

Fall of Meteorites in the Bremervörde, Hanover.—On the 13th of May last, about 5 P.M., a fall of meteoric stones occurred, accompanied by a sound like the firing of cannon, followed by a rattling and rushing sound. The noise appears to have been so loud as to have greatly terrified the peasants by whom it was heard. The sky at the time was cloudy, which probably accounts for the fact that no meteor was seen. The largest mass which fell weighed about 6 lbs., has an elongated form, and is covered with the usual black crust. In its interior it has much the appearance of the meteoric stones of Mezö-Madaras, and contains metallic iron, and sulphuret of iron. Several other stones are said to have fallen at the same time, and two others have been found, one of which weighs 3 lbs. The largest stone has been deposited by Professor Wöhler in the Museum of Göttingen Academy, the two others are in the collection of the Mining School at Clausthal.—*Poggendorff's Annalen*, vol. xcvi., p. 626.

Analysis of a Meteoric stone which fell in Norway.—This meteoric was sent by the finder to the University of Christiania, with the statement that, on the 27th December 1848, in the evening, and when the sky was clear, a loud noise like the firing of many shots was heard, and a very bright light was seen. Two days afterwards the stone was found lying on the ice, in which it had sunk to the depth of about half an inch, the hollow having evidently been produced by the ice having been melted. In a direction south-east of the spot on which the stone was found, two depressions were observed in the ice, into one of which an angle of the stone fitted, so that it must have rebounded more than once before coming to rest. The stone is nearly as large as a child's head, and weighed 850 grammes. Externally its colour is brownish-black. The interior has a greyish-white colour and granular texture. Its specific gravity is 3·539. The stone was composed of several different minerals which could be separated partly by the magnet, and partly by the action of different reagents. The composition of the different substances was :

Magnetic Portion.		Silicate decomposable by Hydrochloric Acid.		Undecomposable Portion.	
Fe	84·20	$Si\,O_3$	37·80	$Si\,O_3$	57·10
Ni	14·42	$Mg\,O$	31·68	$Mg\,O$	19·46
Fe S	0·49	$Ca\,O$	3·08	$Ca\,O$	1·47
		$Fe\,O$	27·44	$M_2\,O_3$	5·62
				$Fe_2\,O_3$	14·72
			100·00	Chrome iron, Tin stone.	Traces.

The decomposable silicate may be expressed by the formula $3\,RO\,Si\,O_3$ and is therefore olivine. The undecomposable silicate may be most nearly represented by the formula $2\,R_2\,O_3$, $7\,RO$, $8\,Si\,O_3$. The composition of the entire stone is given below, along with that of the stone which fell at Blansko in 1833, and which approaches it very closely in composition.

		Blansko.
Nickel iron, . . .	8·22	17·15
Sulphuret of iron, . .	4·32	—
Olivine, ...	49·00	42·67
Undecomposable silicates. .	38·20	39·43
Chrome iron and tin stone.	0·26	0·75
	100·00	100·00

—*Poggendorff's Annalen*, vol. xcvi., p. 341.

METEOROLOGY.

A remarkable meteor was observed in the Isle of Wight on the 7th January 1856. The following are the remarks of Dr Robert James Mann in regard to it :—

" The accounts given of the appearance of the meteor of the 7th inst. at Sevenoaks and Blackheath, suggests to me the propriety of placing one or two facts regarding its aspect at Ventnor on record in your columns. At the instant of its dashing through the terrestrial atmosphere I chanced to be passing along an open space, with my side towards the sea. The sky was perfectly cloudless, excepting for a low fog bank resting on the horizon, and the twilight was so strong that it was scarcely a departure from daylight. Nevertheless, the light of the meteor was so intense that it startled me as a vivid flash of lightning would have done. My first impression was that it was a very brilliant rocket ; and it was only when I had had time to make the reflection that it was going the wrong way, that my attention was sufficiently fixed to enable me to notice carefully what was occurring. This, however, gave me abundant opportunity to observe that the descending luminary was of a bluish-white tint, and had a very large apparent diameter, certainly not less than from seven to eight minutes of angular measure. It fell exactly as is mentioned in Mr Rogers' description. For an instant it left behind it a vividly incandescent line, very much resembling the track of a Roman candle, but much more finely and strongly defined against the sky. My attention was very closely given to this part of the phenomenon. Gradually I perceived the fine line of incandescence was acquiring breadth. In three minutes I could distinctly see that it was a broad column of reflective vapour illuminated by the rays of the sun, then below the horizon. But there was an interval before this, when I could not satisfy myself, by the most exact inspection, whether the line was emitting or reflecting light, whether it was a fire streak or a streak of illuminated vapour. It is my impression that it very gradually passed from the one condition into the other.

"The burst of blaze was so sudden and instantaneous that it attracted my observation on the instant, and quite involuntarily. I fancied that I was sensible of a distinct hissing sound, but, being at the moment deeply engaged on a far different train of thought, I could not command the trustworthy evidence of my senses for two or three seconds. Upon reflection afterwards, I was very doubtful whether it was not simply the first involuntary idea of a sky-rocket having been fired, that carried with it by association the notion of the sound always accompanying such an incident. If I had been asked previously to this reflection whether I had done so, I should unhesitatingly have said I did hear a rush. Now, I am simply in doubt whether I did or did not.

"The apparent dimensions of the vapour column, however, grew gradually less as it suffered dispersion. Before it faded entirely it was diminished in apparent length by more than one-half. It evidently drifted rapidly upwards and outwards as it faded. The form of the vapour column was exactly that which Mr Kimber describes—wand-like with taper extremities; then its ends began to drift opposite ways, and its general outline to become more and more sinuous. It was visible here for twenty minutes after the first burst of the meteor. The column continued to grow broader for several minutes before it began to contract its dimensions; then it afforded obvious indications of the "approach of dissolution." I think, however, that the rapid descent of the sun beneath the horizon had as much to do with its final disappearance as the dispersion of the vapour."

Dr Mann further states that the meteor was first seen at Ventnor, as a very minute star within 15 degrees of the zenith. The path was in a plane nearly parallel with the earth's polar axis. It began to throw out a luminous tail at an altitude of about 32 degrees above the horizon, and it was lost to sight in a low cloud bank, 7 degrees above the horizon. The path of the meteor was slightly inclined towards the east, and very slightly curved. The general bearing of its tail from Ventnor was about 3 or 4 degrees east of the true meridian. No doubt, the form of the path from Havre or Cornwall (seen in profile) would have been a parallel curve. From Sevenoaks the top of the tail had an altitude of about 17 degrees, and the general azimuthal bearing was about 21 degrees west. From Havre it was seen over Cape de la Héve, a little north of west. From Liskeard, Cornwall, its bearing was east. The aërolite probably struck the earth somewhere near the meridian of Isigny or Bayeux, and about 10 miles within the Norman coast. This assumes that the parabola of the fall had very nearly approached the perpendicular when within an altitude of 30 degrees. The difference of the latitudes of Ventnor and Sevenoaks is 48 miles, estimated by the map, and the difference of the longitudes is 60·8 miles. From these elements, the distance of the top of the permanent tail of the meteor comes out as about 93·62 miles from Ventnor, and 151·44 miles from Sevenoaks, and the length of the fall, from the commencement of the permanent tail to the surface of the earth about 61 miles.

ABSTRACT OF THE METEOROLOGICAL REGISTER FOR 1855,

Kept at Arbroath by ALEX. BROWN, Hon. Member of the Literary and Philosophical Soc., St Andrews; and Observer for the British Meteorological Soc., London.

Latitude, 56° 34′ N. Longitude, 2° 35′ W. Distance from the Sea, ⅜ths of a mile.
Height of the Barometer above the Sea, 50 feet; height of the Thermometer from the Ground, 11 feet, and of the Rain-Gauge 3 feet.
The number of "Rainy Days" includes those days on which snow or hail fell.

1855.	BAROMETER. Corrected for Capillarity, &c., and Reduced to 32°.		THERMOMETER.							Days Ther. below 32°.	Rain in Inches.	HYGROMETER.		Fair Days.	Rainy Days	WINDS, AT 8½ A.M.									
	8½ A.M.	10 P.M.	8½ A.M.	7¾ P.M.	Mean	Mean Max.	Mean Min.	Mean	Spring Water.			Mean Dew Point.*	Degree of Humidity (complete Sat. 1·000.)			N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	Total.
			°	°	°	°	°	°	°			°													
Jan.......	30·14	30·14	34·5	34·2	34·3	39·6	31·0	35·3	46·0	19	1·399	29·4	0·837	18	13	3	2	4	2	1	1	6	9	3	31
Feb.......	29·83	29·84	26·1	28·2	27·1	34·8	22·0	28·4	46·0	26	1·483	16·2	·700	16	12	11	3	3	—	—	1	2	7	1	28
March...	29·61	29·63	34·8	34·8	34·8	43·0	29·4	36·2	45·0	29	3·073	29·0	·815	18	13	9	1	5	2	5	2	3	3	1	31
April	29·95	29·96	44·8	43·1	43·9	52·8	34·1	43·4	46·0	15	0·588	35·4	·717	22	8	1	3	—	2	3	1	5	11	4	30
May......	29·89	29·89	45·2	43·8	44·5	52·5	35·5	44·0	46·0	7	1·632	36·3	·740	23	8	10	2	3	1	4	3	2	5	1	31
June......	29·94	29·94	57·0	56·4	56·7	63·9	44·9	54·4	47·5	—	1·609	48·5	·749	20	10	3	1	2	8	7	—	4	1	4	30
July......	29·87	29·86	61·5	60·6	61·0	69·4	50·7	60·2	47·5	—	1·577	53·8	·774	22	9	2	—	2	10	8	6	—	—	3	31
August...	29·85	29·86	58·7	57·3	58·0	67·5	49·0	58·2	48·0	—	3·727	50·8	·774	14	17	4	—	—	6	4	6	3	4	4	31
Sept......	30·10	30·09	52·3	50·8	51·5	61·4	43·0	52·2	50·0	—	0·450	44·7	·772	24	6	5	2	—	—	3	8	5	4	3	30
October..	29·51	29·51	44·1	43·3	43·7	52·3	37·3	44·9	49·5	10	1·952	38·5	·827	16	15	5	1	2	2	3	4	3	8	3	31
Nov......	30·03	30·01	38·2	39·5	33·8	44·8	34·2	39·5	48·5	14	1·282	33·0	·841	21	9	7	3	2	3	2	1	2	7	3	30
Dec.......	29·73	29·75	33·9	34·6	34·2	40·2	30·0	35·1	46·0	22	2·254	30·0	·874	17	14	2	1	2	5	2	2	6	10	1	31
										sum	sum			sum	sum										
Mean.....	29·87	29·87	44·2	43·9	44·1	51·8	36·8	44·3	47·2	142	21·026	37·1	0·793	231	134	62	19	25	41	42	35	41	69	31	365
Do. 1854.	29·83	29·83	46·3	46·4	46·3	54·1	38·6	46·3	48·3	95	20·818	40·8	0·836	219	146	17	23	20	40	34	51	89	69	22	365

Barometer at 8½ A.M. was highest on 24th September, 30·65. Wind N.W.
.... was lowest on 3d March, 28·63. Wind N.W.
Barometer at 10 P.M. was highest on 12th January, 30·63. Wind calm.
.... was lowest on 2d March, 28·58. Wind S.W.
Thermometer at 8½ A.M. was highest on 11th August, 67°. Wind W.
.... was lowest on 16th February, 7°. Wind N.W.
Thermometer at 7¾ P.M. was highest on 11th August, 66°. Wind W.
.... was lowest on 16th February, 10°. Wind N.W.
Therm. in night, highest 22d July, 59°; lowest 16th and 17th Feb., 4°.
Therm. in day, highest 22d July and 11th Aug., 80°; lowest 16th Feb., 20°.
Coldest day, 16th Feb., when average of Ther. was 12° for day and night.
Hottest day, 22d July, when average of Ther. was 69½° for day and night.
Coldest month of the year, February; hottest, July.
Wettest month of the year, August; driest, September.
Mean temperature of the year, 44·2 degrees.
Mean temperature of twelve years, 45·506 degrees.

For nine years the average daily temperature at 8½ A.M., at 7¾ P.M., and the mean of the daily extremes, are as follow, viz.:—

	8½ A.M.	7¾ P.M.	Mean of Extremes.
1847	45·°6	44·°7	45·°9
1848	45·1	44·4	45·
1849	45·1	44·4	44·7
1850	45·5	44·9	45·5
1851	45·7	45·4	46·3
1852	46·	45·9	46·2
1853	45·4	44·9	45·6
1854	46·3	46·4	46·3
1855	44·2	43·9	44·3

The average temperature of the six months of chief vegetation, viz., those from April to September inclusive—for eight years, is as follows:—

1848 ...	51·°7	1851 ...	52·°	1854 ...	53·°5
1849 ...	50·2	1852 ...	53·	1855 ...	52·1
1850 ...	51·7	1853 ...	53·4		

NOTE.—The mean annual reading of the Barometer for the year 1855 at the level of the sea, 29·927 inches. The correction for Diurnal Range, as given by Mr Glaisher in his paper, published in the "Philosophical Transactions" of the Royal Society, London, Part I., 1848, has not been applied to the quantities in the above Table.

* The dew-point thus found is obtained from observations of the Wet and Dry Bulb Thermometers, and deduced by Mr Glaisher's Hygrometrical Tables. The observations

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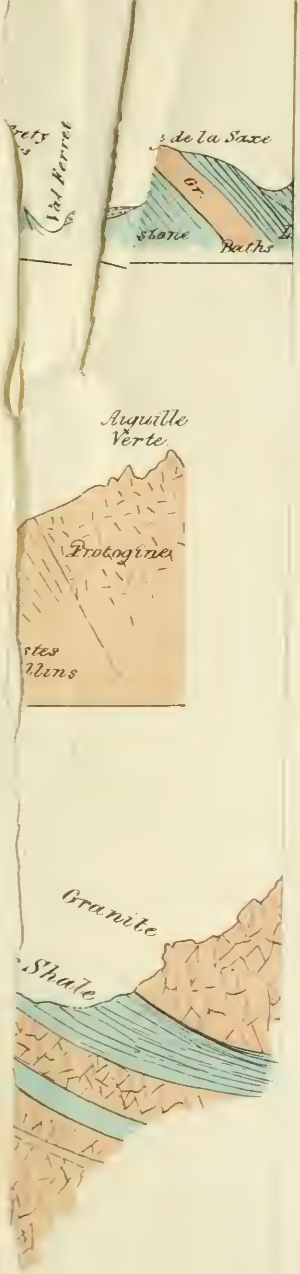

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H. LIZARS LITH. EDIN

PLATE IX

FIG 1 M HECKER
1828

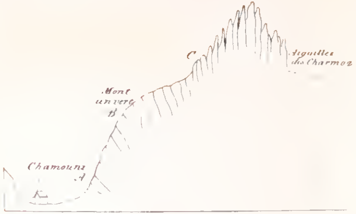


FIG 2 J D FORBES
1842

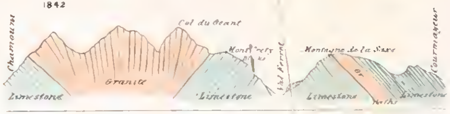


FIG 3 J D FORBES
1842

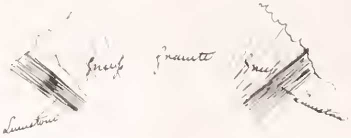


FIG 4 J D FORBES,
1842

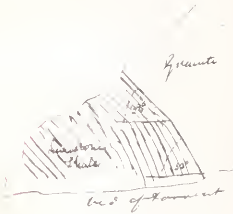


FIG 5 M FAVRE
1848

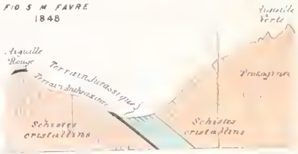
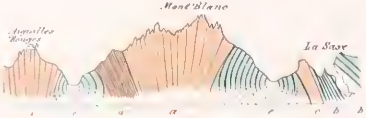


FIG 6 M STUDER
1851



Protogin a Crystall Schiefer c Feldspathschiefer b. Anthracitschiefer
Schwarzer Kalk u Schiefer

FIG 7 Mr D SHARPE
1855

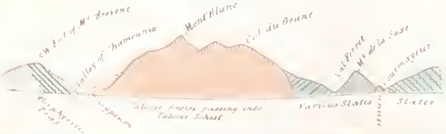


FIG 8

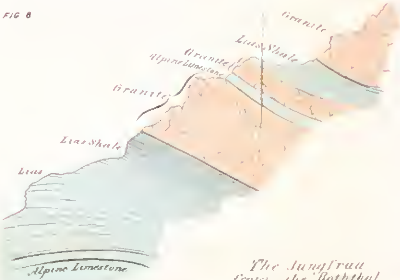


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FIG 9

Villard d'Arene
Dauphiné
M Elie de Beaumont