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ORIGINAL ARTICLES.

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I. THE CAMBRIAN ROCKS OF THE BRITISH ISLANDS, WITH ESPECIAL REFERENCE TO THE OCCURRENCE OF THIS FORMATION AND ITS FOSSILS IN IRELAND.

By WM. HELLIER BAILY, F.L.S., F.G.S., &c.,  
Acting Palæontologist to the Geological Survey of Ireland.

THE term *Cambrian* (from *Cambria*, the ancient name of Wales) was originally employed by the Rev. Professor Sedgwick to include a great series of fossiliferous and other rocks occurring below the Bala Limestone in North Wales. Sir Charles Lyell\* adopts to a certain extent this classification, dividing it into Upper and Lower Cambrian.

Sir R. I. Murchison alludes to this formation as the 'Cambrian or Basement Rocks of the Silurian Region,'† including under that designation those of the Longmynd Hills in Shropshire and their equivalents in North Wales. He explains his use of the term Cambrian to be 'as restricted by the late Sir H. de la Beche, and his associates of the Geological Survey, in applying it only to the lowest of these sedimentary rocks, which, like those of the Longmynd, underlie all the strata with Silurian fossils.' In accordance with this application of the term as being that generally adopted by geologists, I propose now to consider it.

The occurrence of Cambrian, and even perhaps Pre-Cambrian, or Laurentian, Rocks in Scotland appears to be well authenticated both by Sir R. I. Murchison and other observers; but the exact relations of the rocks believed to belong to these older formations in the north-west of Scotland and the Hebrides is at present undecided, and no fossils have yet been discovered in them.

The rocks of North Wales referred to the Cambrian formation, on

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\* Manual of Elementary Geology (6th edit.), pp. 106, 569, &c.

† Siluria (2nd edit.), p. 21, &c.

the authority of the Geological Survey, exhibit between Harlech and Dolgelly, according to Mr. Alfred Selwyn, 8,000 feet of thick beds of quartz-rock, sandstone, and clay-slates, the lower part of the series not being observable; and in the section by Professor Ramsay, across the Menai Strait, and over Glyder Fawr, to the north of Snowdon, the upper 5,000 feet of the Cambrian series in that part of the country is described as consisting of green and purple slates, grits, sandstones, and conglomerates; the Penrhyn and Llanberis slate-quarries being worked in a band of slate at the upper part of the series.\*

With respect to the occurrence of organic remains, the author of 'Siluria' observes, 'No fossils except marine plants or fucoids have yet been detected in these rocks of North Wales.'†

The Cambrian rocks of the Longmynd are described by the same eminent geologist as a range of round-backed hills flanking the western side of the road from Ludlow to Shrewsbury, and rising to heights varying from 1,400 to 1,600 feet, ranging from NNE. to SSW.; they stand boldly out from beneath the surrounding Silurian deposits, of which they form the mineral axis, the lowest beds being schists or clay-slates, with minute layers of silicious limestone, interrupted by bosses of eruptive trap-rocks, and overlain by a vast and regular series of hard purple or greenish and grey schistose flagstones and silicious grits, often finely laminated, on which the rippled surfaces are distinctly visible.‡

The thickness of this great series of strata is estimated by Mr. W. T. Aveline, of the Geological Survey, at more than 20,000 feet.§

Traces of organic life, although obscure, have been discovered in some of the fine-grained sandstones and shales of these ancient deposits by Mr. J. W. Salter, who describes them|| as consisting of the impressions or surface-holes and burrows of Annelides of, he thinks, two species, which he names *Arenicolites didyma* and *A. sparsus*: these he believes to have burrowed in sand like the Lob-worm (*Arenicola*) of the present day, mentioning their occurrence as being in the greatest profusion and distinctly in pairs, indicating the exit and entrance holes to the burrows. That palæontologist also describes broad undulations, which he considers to be wave-marks, such as may now be seen on the sea-shore, and smaller and finer ridges or rippled surfaces, which, according to his views, may either represent the quiet action of the surf on a level strand, or the agitation of the water by wind. Certain rounded markings scattered numerously over the surfaces of some of the rippled and other slabs he believes to be impressions from rain-drops; and other markings also of frequent occurrence on the fine sandstones he describes as 'sun-cracks' or 'sun-dried surfaces,' the effect of the sun's heat upon the ancient

\* J. B. Jukes, Student's Manual of Geology (1862), pp. 435, 436.

† Siluria (2nd edit.), p. 27.

‡ *Ibid.*, pp. 22, 23.

§ See sheets 34 and 36, Horizontal Sections of the Geological Survey of Great Britain.

|| Quart. Journ. Geol. Soc. of Lond., vol. xii. p. 248 (1856), and vol. xiii. p. 206 (1857).

mud. What he supposed to be the fragment of a Trilobite, or allied Crustacean, and described under the name of *Palæopyge*, appears to want that definition of character which would entitle it to be considered as of organic origin: we still have, however, in these the most ancient of the fossiliferous rocks, good evidence of the existence of organic life, and that not of the lowest type.

In Ireland, rocks referred to the same series as those of North Wales occur immediately opposite Anglesea and Caernarvon, at the Hill of Howth near Dublin, Bray Head and other places in the northern part of the county of Wicklow, as well as a large district which includes the Forth Mountain in South Wexford. These rocks consist of a great series of sandstones or gritstones and slates, often interstratified with large masses and veins of quartz-rock.\*

At the promontory of Howth, in the county of Dublin, the Cambrian rocks extend over a small area of only about two miles, consisting of large masses of quartz-rock, interstratified with green grits and green and purple slates; the beds being often highly inclined, contorted, and so confused that it is impossible to make out any continuous section.† Only very faint traces of organic life have been met with at this place; and for these we are indebted to the perseverance and untiring zeal of the late Dr. J. R. Kinahan, a young naturalist of great promise, whose loss has been severely felt amongst scientific men in Ireland. The specimens he discovered and presented to the Geological Survey are included amongst their collection of fossils in the Museum of Irish Industry, Dublin, and afford (although few in number) tolerably good evidence of the occurrence of that remarkably characteristic fossil of the Irish Cambrians, the *Oldhamia*, so abundant at Bray Head, in the county of Wicklow, and hereafter alluded to. These specimens, and another since collected by Mr. C. Galvan, of the Geological Survey, appear to be correctly referred to *O. antiqua*: the impressions are, however, somewhat indistinct and sparingly distributed. The beds from which they were obtained are situated on the north shore, at what is called Puck's Rocks, and are composed of a yellowish slate, readily splitting into fine laminæ, very similar to the brown laminated schists of Carrick Mountain, in the county of Wicklow (hereafter alluded to), which are often covered by impressions of the same species of *Oldhamia* in much better preservation.

From beds immediately overlying those containing the *Oldhamia*, Dr. Kinahan also procured slabs with tortuous markings like tracks.

On consulting the maps of the Geological Survey of Ireland,‡ it will be seen that the Cambrian district of North Wicklow commences about two miles north of the town of Bray, extending southwards to

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\* For a description of the geology of this district, see a memoir by Messrs. Jukes and Haughton, 'On the Lower Palæozoic Rocks of the South-east of Ireland,' Trans. Royal Irish Academy, vol. xxiii. p. 563, &c. (1859).

† Vide sheets 112 of the one-inch scale, Maps of the Geological Survey of Ireland, and Explanations to sheets 102 and 112 (1861).

‡ Sheets 121 and 130.

Wicklow, a distance of about seventeen miles, with a breadth of about seven miles at its widest part. It includes masses of quartz-rock, which contribute much to the beauty of the scenery, and form the most elevated peaks, such as those of the Great and Little Sugar-loaf Mountains, the former being 1,659 and the latter 1,120 feet in height.

There are two small slightly detached districts in North Wicklow, that nearest Dublin, at Shankill, being about one mile and a half long, following the direction of the granite axis N. and SW., and about the third of a mile broad at its widest part. A hill of quartz-rock called Carrickgolligan rises from it to an elevation of 912 feet. No fossils have yet been detected within this area.

The other, a larger and more important district, on account of its fossils, is situated to the south-east, near Rathdrum, and about five miles south-west of Wicklow; it is six miles long and nearly one broad at its widest part, including masses of quartz-rock; and rising to a height of 1,260 feet, it forms Carrick Mountain, some of the shales upon which, easily separating into laminæ, are seen to be covered with very distinct impressions of *Oldhamia antiqua*: there are also tracks and burrows of Annelids in the sandy beds, amongst them some with double openings like *Arenicolites didyma*, Salter.

Occupying a considerably larger area than either of these is the Wexford Cambrian District, which extends from the east point of Bannow Bay, about four miles east of Waterford Harbour, to Roney Point, six miles north of Wexford, having a total length of thirty-six miles and a breadth of about seven miles at its widest part, near Wexford. No fossils have yet been discovered in this district.

It is, however, to the rocks at Bray Head and the neighbourhood, we would direct the attention of those who are desirous of studying this series of deposits in connection with the interesting fossils they contain, as they are here found in the greatest abundance, and may be regarded as examples of the most ancient forms of life with which we are acquainted.\*

The rapidly improving sea-side town of Bray, twelve miles south

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\* This conclusion does not appear to me to be affected by the reputed discovery by the Geological Survey of Canada, as announced by Sir William Logan, the Director, at the last meeting of the British Association, of a fossil named *Eozoön Canadense*, referred by Dr. Dawson to the group of Foraminifera, and said to be from rocks below the Cambrians, in strata of the Laurentian series (alluded to in former numbers of this Magazine, viz., No. 1, p. 47; No. 5, p. 205 &c.; and No. 7 of vol. ii. p. 3 &c.). The specimens exhibited on that occasion I had the opportunity of examining before the meeting; and from that inspection and subsequent observation I feel considerable doubt as to its being an organic structure, and still more as to *Eozoön* belonging to so high a group as that of the *Foraminifera*; for, supposing it could be satisfactorily proved to be a fossil, its alliance would rather seem to have been with the Protozoa, or Sponges. It struck me, however, as being nothing more than a peculiar mechanical condition of the rock; which was a variety of serpentine, a mineral known to be of aqueous origin, and to be for the most part composed of the débris of other rocks; and, from the mode of its deposit, often exhibiting, when polished, wavy or contorted laminæ, and having occasionally a vesicular or irregularly cellular appearance, such as these specimens of Canadian Serpentine appeared to me to show.

of Dublin, may be reached by either of two lines of railway, which converge before entering the town. That through Kingstown, starting from the Dublin terminus in Westland Row, skirts the south coast of the beautiful Bay of Dublin; the other and most direct route being by the Dublin, Wicklow, and Wexford Railway from the terminus in Harcourt Street. In either case these railways commence in the Upper Carboniferous Limestone, upon which Dublin is built, continuing to run for about four miles over that formation. They then enter the boundary of the great granite-area, which is the largest display of that rock on the surface in the British Islands, crossing it at its northern extremity,—in one case, between two and three miles from the coast, for a distance of nearly six miles—in the

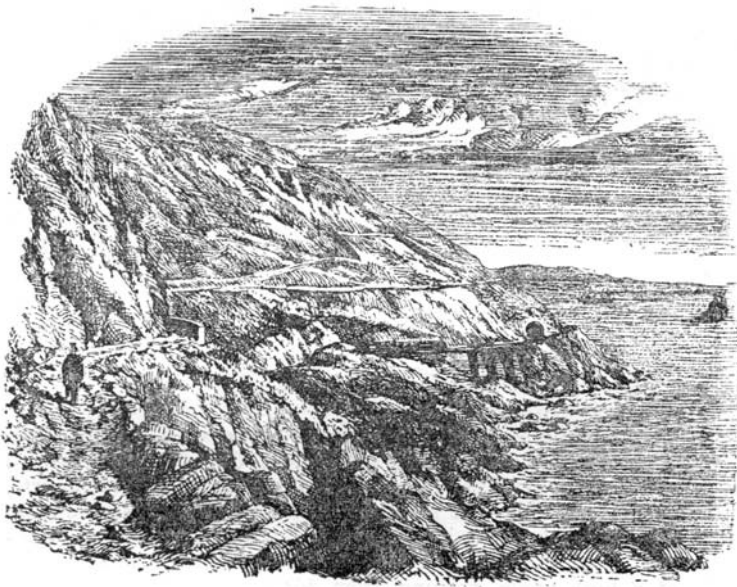


FIG. 1.—BRAY HEAD, WICKLOW. (Looking North.)

other, following to some extent the curvature of the coast to Kingstown, celebrated for its fine harbour, then proceeding about half a mile inland, until it again reaches the sea opposite the southern extremity of Dalkey Island, a distance of nearly five miles, where it enters upon the comparatively narrow belt of metamorphic rocks which flank the granite-axis, and forms the commencement of the Lower or Cambro-Silurian formation. These rocks continue for about another mile to the south side of Killiney Bay, where is believed to be the commencement of the Cambrian district of North Wicklow, about a mile north of the town of Bray; the shore and interior of the country, up to a certain height on the flanks of the hills,

being covered with drift of sand and gravel, so as to conceal the underlying rocks.\*

From the Bray Railway station, a walk along the shore of about a mile brings us to the commencement of the series of rocks forming the bold and picturesque promontory of Bray Head, which rises in sombre majesty from the sea to a height of nearly 800 feet. The railway is continued through this apparently impenetrable mass of rocks by several short tunnels and cuttings, passing over the chasms by bridges or viaducts, and aiding the geologist, as it generally does, by exposing fine sections of the strata, exhibiting occasional breaks or *faults* in its continuity, and the variety of inclination or *dip*, curvature or contortion, to which the beds have been subjected, as well as adding considerably to the picturesque effect of this prominent part of the coast when observed from the sea.

The sketch on the preceding page (fig. 1) may serve to give some idea of the appearance these rocks present, with the general configuration of the hill towards the sea.

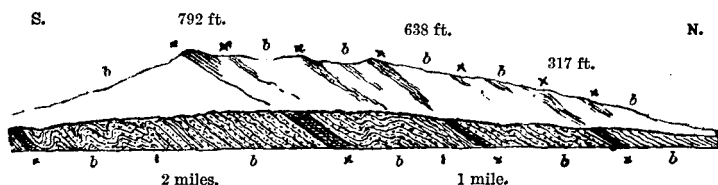


FIG. 2. DIAGRAMMATIC SECTION OF THE CAMBRIAN ROCKS AT BRAY HEAD.

\* Quartz Rock.      b. Cambrian grits and slates.  
(General dip, about  $45^{\circ}$  to  $80^{\circ}$  N.E. Horizontal scale, about  $1\frac{1}{2}$  inches to the mile; vertical scale, twice that of the horizontal.)

A diagrammatic section of this part of the coast is given above (fig. 2), showing in a rough way the general dip of the strata with their convolutions, and the interpolation of irregular masses of quartz, on a scale (horizontally) of about one and a half inches to the mile, the vertical scale being twice that of the horizontal. The beds, consisting of green and purple grits and slates, mostly dip towards the N.E., at a high angle, varying from  $45^{\circ}$  to  $80^{\circ}$ , are often much contorted, and occasionally interstratified with veins and masses of white and yellowish quartz. This rock forms the most prominent parts of the hill, and some of the beds may be traced down to the section exposed on the shore (they are represented in fig. 2, at \*, by crossed lines). It is in these grits and slates, at several places along this part of the coast, that the remarkable little branching or plant-like fossils called *Oldhamia*, before alluded to, have been met with, sometimes occurring in great profusion, although they have never yet been found in England or Wales.

In walking along the shore from Bray towards the Head, the first

\* *Vide* sheet 121, one-inch scale, Maps of the Geological Survey of Ireland.

rocks containing these fossils accessible at low water are what are called the Periwinkle Rocks, consisting of a greenish fine-grained grit with irregular joints crossing the numerous layers of deposit. On striking off a piece of this rock, it will be seen to exhibit a wrinkled appearance; and, on closer inspection, this will be found to have been caused by numerous irregular star-like markings radiating from a centre, which preserve a certain amount of uniformity, and appear to permeate the whole mass of rock, every one of the numerous

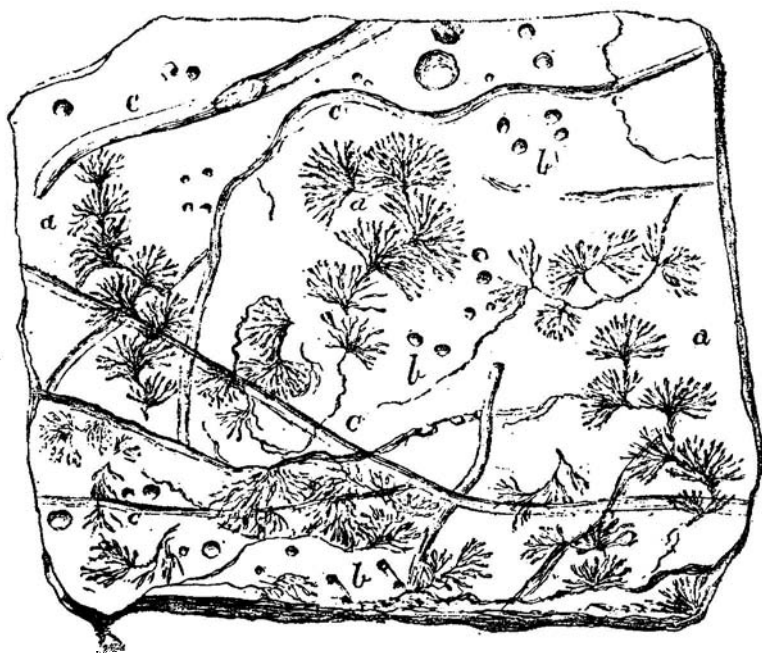


FIG. 3.

*Oldhamia antiqua* (a) with burrows of Annelids, *Arenicolites didyma* (b), and surface-tracks (c).  
CAMBRIAN GREEN SHALES, BRAY HEAD, COUNTY OF WICKLOW.

laminae, where exposed, exhibiting a surface covered by these peculiar little fossils. The above wood-engraving (fig. 3) gives a representation of the appearance presented by a fragment of rock full of these characteristic fossils. This, the most abundant species, which is found at several other stations in these cliffs, has been named *Oldhamia radiata*.

A second species, called *Oldhamia antiqua*, occurring, like the former, in both green and purple shales and grits, has been also met with at various places along the shore, as well as in the rocks exposed on the side of the hill; but the two kinds seldom if ever occur together in the same bed. The latter species, consisting of

an assemblage of fan-shaped rays, arranged in alternating series, is shown at fig. 4, p. 394.

The first published account of these fossils was given by Dr. Thomas Oldham, then Curator of the Geological Society of Dublin, and Professor of Geology in Trinity College (now Superintendent of the Geological Survey of India), who, with the keen discernment of a naturalist, saw in them something more than mere markings; and, in a paper read before the Geological Society of Dublin, 'On the Rocks at Bray Head,'\* observed, 'that he had not as yet been successful in finding organic remains in the slate-rocks of Bray Head, *with the exception of some small zoophytic markings*, which did not appear referable to known genera.' Some years afterwards, that eminently gifted naturalist, the late Professor Edward Forbes, when Palæontologist to the Geological Survey, threw still further light upon them by a communication made to the same Society, entitled 'On *Oldhamia*, a new genus of Silurian Fossils.† After alluding to the rarity of organic remains in the Cambrian or oldest portion of the Silurian strata, he says, 'The earliest fossils which have yet been discovered seem to be certain plant-like impressions or casts discovered by Professor Oldham at Bray Head, in Wicklow, and referred to by him in his communication to this Society in 1844. These bodies present the appearance, in most specimens, of a central filiform axis, with fasciculi of short radiating branches proceeding from its sides at regular intervals, or of bundles of such filiform rays without an axis. A close examination of them shows that each branch is formed of a series of articulations marking the positions of minute cells. The entire body presents a striking resemblance to the arrangement of parts in certain Zoophytes, as in *Sertularia cupressina*, but are also consistent with those exhibited in many *Bryozoa*, as in *Gemellaria* and *Cellaria*, an alliance more in accordance with the minute structure.' He also observes, 'I propose the name *Oldhamia* for these remarkable fossils, in honour of their discoverer, who has in them made us acquainted with what in all probability is a group of *Ascidian Zoophytes*, or rather, compound *Tunicated Molluscs*, in stratified rocks of very early date, and has thus furnished an additional and important fact in contradiction of the crude notion that the earliest forms of animals are the most rudimentary.'

No further details respecting these fossils were published, or figures of any consequence given, until the late Dr. J. R. Kinahan, a young naturalist of great ability, directed his attention to the investigation of rocks ascribed to the Cambrian formation in Ireland; his perseverance and zeal being rewarded by the discovery of the *Oldhamia* in the cliffs of Howth, county of Dublin, and the recording of several additional stations for it in those of Bray Head and Greystones, county of Wicklow, where he collected more distinct and perfect specimens, and obtained some other forms of animal

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\* Journ. Geol. Soc. of Dublin, vol. iii. p. 60 (1844).

† *Ibid.*, vol. iv. p. 20 (1848).



remains. These additions to the Cambrian fauna he described in papers read before the Geological Society of Dublin, and published in their Proceedings.\*

That much-lamented gentleman, in his frequent search amongst these hard and apparently unyielding grits, obtained better specimens of the *Oldhamia* than those examined by the late Professor Forbes; so that he was enabled to write an elaborate treatise, with descriptions of the different forms assumed by the genus, illustrated by excellent woodcuts, which was published in the Transactions of the Royal Irish Academy.† In that treatise, presuming that Professor Forbes's leaning was towards their alliance with the Polyzoan Molluscoids, he professes to dissent from that view of their relations, expressing his opinion 'that they were more probably the polypidoms of extinct *Hydrozoa*, than cœnicia of *Polyzoa*' (p. 561). It will be seen, however, that he only reiterates the opinion of Professor Forbes, as the descriptive card, in Professor Forbes's own handwriting, which was attached to the specimens in the Geological Survey Collection (Museum of Irish Industry), of which the following is an exact copy, will testify:—'*Oldhamia* (Forbes). The most ancient fossils yet discovered: believed to be the remains of marine animals belonging either to *Hydrozoa* (Corals) or *Polyzoa* (Compound Mollusca).'

In his paper, Dr. Kinahan supplies scientific descriptions of the species named *Oldhamia antiqua* and *O. radiata* by Professor Forbes, and, in addition, describes what he considers to be a third species, under the name of *O. discreta*, from Carrick Mountain, a locality from which some of the most distinct specimens of *O. antiqua* were obtained, of which species I believe this to be merely a variety.

There remain, then, only the two well-marked species, originally named by Professor Forbes *Oldhamia antiqua* and *O. radiata*. The first of these, *O. antiqua*, is most frequent in the shales, and occurs as clearly defined impressions in beds of either a red or green colour at Bray, and in the brown and purple shales of Carrick Mountain, county of Wicklow, and less distinctly and more rarely in the brown laminated shales of the northern coast of the peninsula of Howth, in the county of Dublin. This species is less abundant than *O. radiata*, and does not occur in dense masses like the latter, but usually as isolated and distinct branches scattered over the surface of the beds. It is more uniform in character than *O. radiata*, as, instead of radiating from a centre like that species, the branchlets are fan-shaped, and arranged in an alternating manner at regular distances upon a zigzag axis. Fig. 4, *a*, is a representation of this species, showing several branches of different sizes, as impressed upon a slab of green fine-grained laminated shale from Bray Head:

\* 'On Anneloid Tracks in the Rocks of Bray Head,' Journ. Geol. Soc. Dublin, vol. vii. p. 184, pl. 5, figs. 1-5; and 'On the Zoological Relations of Bray Head and Howth, with an Account of the Fossils of Irish Cambria,' Journ. Geol. Soc. Dublin, vol. viii. p. 68, pl. 7, figs. 1, 2.

† 'The Genus *Oldhamia*, its Characters, &c.,' Trans. Roy. Irish Academy, vol. xxiii. (1858).

on the same surface of this thin bed are horizontal tracks of various sizes and burrows of *Arenicolites*, with double openings resembling *A. didyma*, represented on the same figure at *b*.\*

Varieties of this species occasionally accompany the ordinary form, particularly in the shales of Carrick Mountain. In some of these, the fans of branchlets are more closely arranged upon the axis, and are more wavy and intermittent, the fasciculi being denser: this is the variety (before alluded to) which was believed by Dr. Kinahan to constitute a third species, and to which he applied

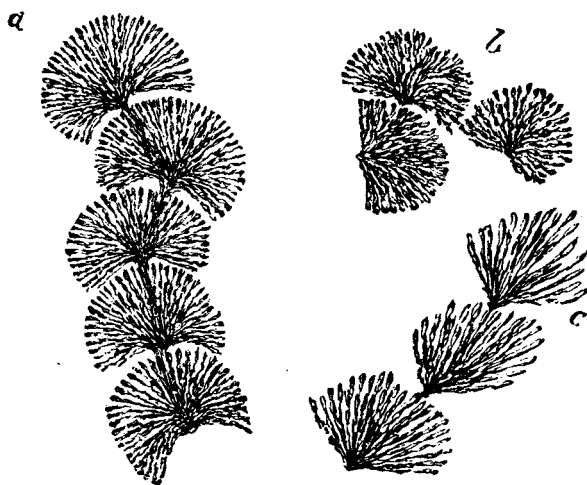


FIG. 4.—*OLDHAMIA ANTIQUA*, FORBES, CAMBRIAN, CARRICK MOUNTAIN, COUNTY OF WICKLOW.

*a*. Ordinary form at this locality.

*b*. Var. (*O. discreta*, Kinahan).

*c*. Elongated variety.

All natural size.

the name of *O. discreta* (fig. 5, *a*). Another and more attenuated form is generally present on the opposite side of the same slabs: in this, the fans of branchlets are less dense, and appear to be drawn out of shape, probably by the effects of cleavage (fig. 5, *b*). The specimens of *Oldhamia antiqua* from this locality occur in brown and buff-coloured shales, easily separating and more argillaceous than those of Bray.

The localities for this species are various stations in the rocks of Bray Head and Carrick Mountain, county of Wicklow, and Howth, county of Dublin, in beds generally distinct from those containing *O. radiata*; although Dr. Kinahan remarks that scattered forms of *O. antiqua* sometimes occur, though rarely, in the beds of *O. radiata*.

The second species, *Oldhamia radiata*, is the most abundant one

\* I have noticed similar double markings occurring on some of the fine-grained laminated grits at Carrick Mountain. From the same locality was also procured a large worm-cast resembling those of the *Histioderma*.—W. H. B.

in the rocks of Bray Head ; and at Greystones, on the coast, four miles farther south, it occurs in a precisely similar rock to that called the Periwinkle Rock of Bray Head, and was the only species observed by me at that locality. Dr. Kinahan has evidently mistaken it for *O. antiqua*, the figures he gives under that name in the paper before quoted (figs. 9 and 10, p. 559) being unquestionably those of *O. radiata*. It has not been observed at Howth, Carrick Mountain, or any other locality than the two I have mentioned. The most ordinary form is that shown in the woodcut, fig. 3, *a*, p. 391.

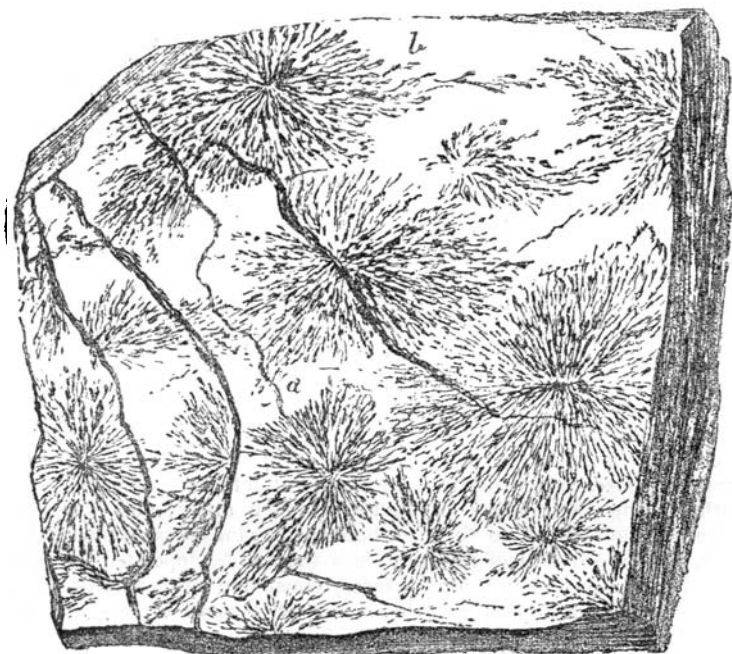


FIG. 5.—*OLDHAMIA RADIATA*, FORBES, SHOWING SUCCESSIVE LAYERS.

*a*. Ordinary form.

*b*. Plumose variety.

Cambrian (green grit) Periwinkle Rocks, Bray Head, County of Wicklow.

The general appearance presented by this species is that of a stellariform mass of filaments or branchlets, of variable length, which often divide into two, becoming wavy and intermittent, or jointed, all the separate tufts radiating from a central point or axis.

The star-like form is more or less complete in consequence of the variable length of the branchlets: sometimes one or more of these are very much elongated, giving the fossil a more plumose appearance, as shown on fig. 3, at *b*.

The principal, and, I believe, only localities for this species, are those of Bray Head and Greystones, county of Wicklow, at both of which places it is met with in the greatest profusion, occurring

sometimes as a dense and matted mass, which appears to permeate the rock in every direction where fractured, and to spread over the surface of the numerous beds in successive layers. The beds which contain it are sometimes several feet thick, and generally harder and more compact than those in which *O. antiqua* are found; they occur in either purple or green grits, most frequently perhaps in the latter, and on separating the laminae the fossils are seen to be slightly in relief on one surface, whilst the opposite bears a corresponding indentation.

Some difference of opinion has been expressed, more particularly by men of science in other countries, as to whether these fossils should properly be referred to the animal or vegetable kingdom; some Continental writers having figured and described them as fossil plants—others again have even doubted their being organic at all, considering them merely to be markings caused by a peculiar mechanical condition of the rock. By the majority of Palæontologists in this country, their zoological affinity appears to be accepted, in accordance with the eminent men who have published their views as to the animal origin of these fossils; and, considering them in the same light, their alliance with the Sertularian Zoophytes—which they resemble so closely—as first suggested by the late Professor Edward Forbes, appears to be the most reasonable conclusion as to their relationship we can arrive at. On the other hand, their resemblance to certain jointed marine plants, such as the lime-secreting *Nullipores*, would incline us to hesitate before pronouncing with certainty as to their animal origin. As to their being organic, and not a mere mineral condition of the rock, there can, I think, be no question, because we find the representatives of each species, although often varying in shape and size, presenting the same general definite characters, notwithstanding their being isolated from each other; and although sometimes appearing to form an homogeneous mass permeating the rock, yet the surfaces of the beds show them to be deposited in horizontal layers between those surfaces, consisting occasionally of a few scattered examples, at other times of a more or less matted assemblage.

The articulated character of the branchlets, which was considered by Professor Forbes to indicate the position of minute cells, and the presumed discovery by Dr. Kinahan of 'reproductive cells,' do not appear to me to be satisfactorily established, as, after an examination of the original and a number of other specimens, the only conclusion I can arrive at being that the jointed appearance they often exhibit is analogous to the structure presented by the *Nullipores*, or lime-secreting plants, before alluded to.

That there is a general similarity of *Oldhamia antiqua* to certain recent *Hydroid Polypes* (popularly known as Corallines), such as the arborescent forms of *Sertularia cupressina* and *argentea*,\* is very evi-

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\* For excellent figures and descriptions of both these varieties, see Johnston's 'British Zoophytes,' pl. 15 and 16, vol. ii. pp. 79, 80; vol. i. pl. 14, fig. 3, and 15 and 16, vol. ii.

dent, both of these species or varieties being abundant at the present day on the same (east) coast of Ireland. To the former—*S. cupressina*—it is said by Professor Forbes to present a striking resemblance, whilst Dr. Kinahan considers its nearest comparison to be with *S. argentea*: either of which conclusions may be correct, when we consider the probability of their being merely varieties of one species; a question upon which Dr. Johnston makes the following remark: ‘Pallas thinks they constitute but one species, his *cupressina*.’\*

No comparison having hitherto been made known between *Oldhamia radiata* and any living forms, I have endeavoured to trace out its nearest alliance, in accordance with the views of Professor Forbes, as to the probability of its being related to the *Sertulariadae*, and find this species bears a considerable resemblance to some of the frondose or bushy examples of that family, particularly to *Cellularia plumosa*, which is said by Dr. Johnston ‘in habit to be something like *S. argentea*’ (a species previously alluded to as comparable with *O. antiqua*): the fossil is, however, more tufted and bushy, although not very unlike in form what we may suppose such a recent species would assume if spread out and subjected to pressure, as these fossils must have been.

With reference to the remark made by Dr. Kinahan, ‘that it is questionable whether it would not be more convenient to place these two kinds of *Oldhamia* under separate genera,’† I would observe that, in the absence of any satisfactory evidence as to the presence of reproductive organs, we can, I think, only consider them as being specifically and not generically distinct; for although differing in the mode of arrangement of their parts, they appear to be sufficiently alike in general character to justify our retaining them under the same generic appellation. The specific distinction is also supported by the difference in the condition of the deposit in which the two kinds occur; *O. antiqua* being most frequently met with in the softer or shaly beds, whilst *O. radiata* is abundant in the more compact and gritty beds, the two species, as before observed, being seldom if ever found together.

Accompanying the *Oldhamia*, at all the localities mentioned, are unmistakable evidences of other marine animal life, in the numerous tracks and burrows often found intermixed with them in the same beds, and sometimes occurring in distinct ones in their immediate neighbourhood.

These tracks are of various forms and sizes; some of them nearly straight, some slightly curved, and others more or less tortuous, resembling very much those produced by sea-worms belonging to the *Annelida* on sandy shores at the present day. Some of them occur in pairs of double openings, the tubes from which pass vertically through the beds; they appear to be identical with those from the Longmynd described by Mr. Salter, and named by him *Arenicolites didyma*. These double orifices, fig. 4, *b*, are seen to be inter-

\* British Zoophytes, vol. i. p. 341, and pl. 16, fig. 1.

† Treatise on *Oldhamia*, p. 551.

mixed with *Oldhamia antiqua*, and tracks of large and smaller diameter (c) proceeding in a horizontal direction on the same surface.

Tubular markings of a larger size and tortuous form, usually found in distinct beds of a coarser and more sandy character, have been referred to Mollusca by Dr. Kinahan.\* In the absence, however, of any more certain evidence of the existence of this important class during the Cambrian period, such as their fossil shells would present, we cannot, I think, do otherwise than refer them with the other tracks to the class *Annelida*.

To the late Dr. Kinahan's perseverance we are indebted for the discovery of a fossil he has described under the name of *Histioderma Hibernicum*.† Several examples of the large tubular casts of this fossil, which he considers to have been an Annelidan worm, were obtained by him from the compact greenish grits overlying the Old-

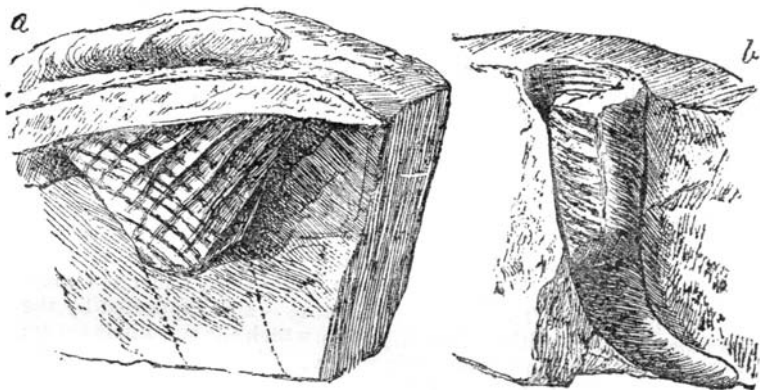


FIG. 6.—*HISTIODERMA HIBERNICUM*, KINAHAN, NAT. SIZE.

a. Opening of burrow and commencement of tube.

b. Lower portion, or curved extremity.

Cambrian (green grits), Bray Head, County of Wicklow.

hamia-beds of Bray Head and Greystones. Their appearance on the surface of the beds is that of a slightly raised mound of about one inch and a half in diameter, having a depression in the centre forming the orifice. These tubular burrows pass vertically through the bed for a distance of about one and a half to three inches, gradually decreasing in size, and slightly curving; they terminate by a rounded extremity which turns upwards, assuming a kind of trumpet-shape, the cast of its upper portion being marked by several ridges crossing each other at irregular distances, as represented in fig. 6, which is reduced. Dr. Kinahan describes this fossil as 'a tentacled sea-

\* Journ. Geol. Soc. Dublin, vol. vii. p. 184, pl. 5, figs. 1-5; and Trans. Royal Irish Academy, vol. xxiii. p. 56.

† Journ. Geol. Soc. Dublin, vol. viii. p. 71.

worm, evidently cephalo-branchiate, and not very dissimilar from the common Lug-worm (*Arenicola*) of our present seas.

The same author also collected and described\* what he believed to be another addition to the Cambrian fauna, under the name of *Haughtonia pœcila*, but in which, as he states, 'the organic character is not so evident or satisfactory:' he supposes it to be the 'traces of an aggregation of tubes constructed by gregarious tubicolous worms belonging to the *Annelida*, and allied to *Sabella*.' It was found by him on the upper surface of a coarse reddish grit near the 'Periwinkle Rocks' of Bray Head, and shows a peculiar and regularly mottled appearance; what he supposes to be the tubes are white, and the interspaces red, and a vertical section exhibits a series of these tubes filled up with sand. The author, in acknowledging the difficulty of establishing the claims of such mere traces to be considered as fossils, expresses himself as follows,—upon 'the importance of recording every organic trace which tends to throw a light on the habits of the animals which lived at so early a period of the world's history as the Cambrian;' an observation with which I fully concur: at the same time, I must confess, I do not consider the specimen sufficiently definite, as to its organic nature, to warrant its receiving a name or being included amongst the fossils of the Cambrian formation.

In concluding these remarks, which are merely intended as a sketch of all that is at present known respecting the value of the fossil-evidence derived from the large masses of stratified rocks known in the British Islands as the Cambrian formation, it will have been seen that the only reliable proof of the remains of organic life is furnished by strata, referred to this series, in Shropshire and the South-east of Ireland; the former yielding merely tracks and burrows of marine animals, probably Annelids; the latter, a more varied and important assemblage, consisting of those well-marked and characteristic forms of *Oldhamia* believed to be the remains of zoophytic animals, and similar Tracks and Burrows to those found in the rocks of the Longmynd, with the addition of a large tubæform cast called *Histioderma*, resembling that of an Anneloid worm.

Some of the finer grits and more argillaceous beds, like those of the Longmynd, often display ridged and wrinkled surfaces, such as may be seen on the sea-shore at the present day, and which were probably due to the same causes, namely, the quiet action of the advancing or receding wave, or the agitation of the water by wind over a shallow shore.

From these results of the labours of investigators as to the Fossils of the Cambrian Rocks, we get tangible evidence of the existence of marine forms of life bearing a considerable resemblance to those of the present day, although the variety we are at present acquainted with is small. There may, possibly, as suggested by other writers, have been a more varied assemblage, including marine plants, and some of the softer kinds of Zoophytes, Mollusca, or other Invertebrate

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\* Journ. Geol. Soc. Dublin, vol. viii. p. 116.

Animals, of which no record remains, either from the perishable nature of their structures, or from their obliteration during the process of change or consolidation of the deposit in which they were embedded, whether chemically or otherwise. This, however, is merely conjectural, and must not be allowed, in the absence of facts, to exercise any influence upon our opinion with regard to the value of the fossil evidence which *has* been obtained from the series of strata now under consideration.

And here I may be excused pausing to reflect with admiration upon the remarkably perfect manner in which the fossils of these and other ancient rocks are preserved for our inspection and study by the covering up or superposition of one layer upon another; and although this assemblage occurs only as casts or impressions, the original organic substance having disappeared, we have disclosed to our view, with the greatest distinctness, tracks and markings of the delicate and fragile animals which then existed, accompanied by traces of phenomena of a similar character to those of our own times.

The importance of such imperishable monuments of the past cannot be too highly estimated, as by their study we get an insight into the conditions which prevailed during these remote periods of the world's history; and although we do not presume to assert that fossils may not eventually be discovered in strata of Pre-Cambrian age—until that is satisfactorily established (which does not appear to be the case at present), we maintain that this assemblage of fossils from the Cambrians is still entitled to be looked upon as the most ancient evidence of organic life with which we are acquainted.

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NOTE.—For detailed descriptions of *Eozoön Canadense*, and the evidence upon which it is asserted to be an organic structure, see the two very excellent papers by Dr. W. B. Carpenter, F.R.S., and Prof. T. Rupert Jones, F.G.S.; the former of which appeared in the 'Intellectual Observer,' vol. vii. p. 278, and the latter in the 'Popular Science Review' for April 1865. Both these papers are beautifully illustrated.—EDIT.

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AN EXTINCT GIGANTIC ARMADILLO.—There has just been added to the National Collection in the British Museum, plaster casts of an entire carapace with the tail attached, and portions of the skeleton, of one of the extinct gigantic Armadillos from South America. The original is preserved in the Museum at Dijon, France, and was described by L. Nodor (*Compt. Rend.*, 1855, xli. 335–338), and named *Schistopleurum* (*Glyptodon*, Owen) *typus*. The carapace and tail united are 8 feet in length, the carapace 3 feet high. It was found in the Pampas of Buenos Ayres.—W. D.

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