

37. *On the Discovery of some REMAINS of PLANTS at the Base of the DENBIGHSHIRE GRITS, near CORWEN, NORTH WALES.* By HENRY HICKS, Esq., M.D., F.G.S. *With an Appendix* by R. ETHERIDGE, Esq., F.R.S., Pres. Geol. Soc. (Read May 25, 1881.)

[PLATE XXV.]

IN August 1875, when searching for fossils in the Pen-y-Glog slate-quarry, which is situated about two miles to the east of Corwen, I noticed some carbonaceous-looking fragments and markings on the shales in association with the massive grit beds towards the top of the quarry, which I thought at the time might possibly be plant-remains. Last summer I had another favourable opportunity of examining these beds; and I was fortunate enough to discover undoubted plant-remains scattered very abundantly over their surfaces. I submitted these for further examination to Mr. Carruthers, of the British Museum, and had the satisfaction to find that he entirely confirmed my views as to their nature. He said they were undoubtedly "angular fragments of plants," but that the specimens were not in a sufficiently satisfactory condition to determine the actual plants to which they belonged. I decided, therefore, not to bring the matter before the Society until I had another opportunity of visiting the quarry and of endeavouring to procure more perfect specimens. This I was able to do lately; and the additional materials now found have proved to exhibit structures sufficiently well marked to enable a very clear identification of several distinct plants to be made out. The specimens have been generally examined by Mr. Carruthers, and some specially by Mr. Etheridge and Mr. Newton, of the Jermyn-Street Museum. Amongst them have been found numerous small spherical bodies identical in general appearance, and in internal structure, with the *Pachytheca* described by Sir J. D. Hooker, from the bone-bed at the top of the Ludlow series. These are supposed to be the remains of spore-cases of land plants belonging to the order Lycopodiaceæ; other specimens are supposed by Mr. Carruthers to be the microspores, and others to be fragments of the stems of the same plants. Some of the specimens would indicate the presence also of plants belonging to the genus *Psilophyton*. These, though tolerably abundant, occur chiefly as carbonaceous markings, and show little evidence of structure. The combined results are sufficient to make it clear that we have here a terrestrial flora of a tolerably high order. The majority of the fragments, however, belong to a curious plant not hitherto found in Great Britain. It was first discovered by Sir W. Logan in the Devonian rocks, in the peninsula of Gaspé, Lower Canada, and described by Dr. Dawson, of Montreal, in the Quart. Journ. Geol. Soc. for 1859, under the name *Prototaxites*. Dr. Dawson described it as a land plant of large size, belonging

to the Coniferæ, but yet differing from any Conifer known to him "in the cylindrical form and loose aggregation of the wood cells, as seen in the cross section, in which particular it more nearly resembles the young succulent twigs of some modern Conifers than their mature wood." He maintained, however, that it was an "exogenous tree, with bark, rings of growth, medullary rays, and well-developed though peculiar woody tissue"*.

Mr. Carruthers subsequently examined the same plant and re-described it in an elaborate paper in the Monthly Microscopical Journal for October 1872, and gave numerous reasons for excluding it not only from the Coniferæ, but from land plants altogether, and for placing it in preference among the Algæ. In doing so, however, he said it was an "anomalous Alga, and, indeed, that with the materials known, it was not possible to correlate it with certainty with any known group of Algæ." The identity of our plant with the above mentioned, which was re-named by Mr. Carruthers *Nematophycus*, is placed beyond doubt by the following note kindly given me by Mr. Carruthers:—

"The slides prepared by Mr. Newton show clearly that his determination of the fragments of charcoal and petrified remains of plants in the Silurian rocks which you have found, belong to the same type of plants as that discovered by Logan at Gaspé, in beds which he considered to be of Devonian age. This was described by Principal Dawson in the Quart. Journ. Geol. Soc. (vol. xv.) under the name *Prototaxites Logani*. I made a careful examination of specimens which I owed to the kindness of Dr. Dawson, and published the results of this examination in the Monthly Microscopical Journal, giving the reasons for placing it among cellular plants and naming it *Nematophycus Logani*. The specimens show very distinctly the larger tubes of *Nematophycus*, running generally in a subparallel direction, but passing in and out amongst each other. The walls are not in juxtaposition, leaving free space all around them, which was occupied, as is shown in the better-preserved specimens from Gaspé, with a dense tissue of more delicate tubes of smaller dimensions. That your specimens belong to the plant called *Nematophycus* I have no doubt. The conditions under which they are found are very different from those described by Dr. Dawson. His specimens were large trunks, sometimes perfectly silicified and preserving their most minute structures. Your specimens, consisting of small fragments, consequently supply no help to the further knowledge of this remarkable plant, unless the occurrence on the same slab, in tolerable abundance, of small round bodies having the same form and structure as those found in the Ludlow bone-bed, which were figured and described by Sir J. D. Hooker under the name *Pachythecca*, indicate some possible relationship. The specimens found by you are perhaps smaller than those from Ludlow. They present no indication of attachment, and no evidence of their relation to *Nematophycus*, except their being found together, which is not always a good basis for structural re-

* 'American Naturalist,' vol. v. p. 245.

lations in fossil plants. The minute bodies, aggregated together, which you have also shown me are, I believe, spores; and as they are united in threes, they agree with the forms of the microspores of Lycopodiaceæ, both recent and fossil, and testify to the existence of a dry-land flora. Perhaps some of the anthracite fragments may belong to the stems of the plants of which these are the reproductive organs. The ribbon-like carbonaceous impressions, with a slender axis, must have been also dry-land plants; they remind me of the plants discovered and described by Principal Dawson, C.M.G., as *Psilophyton*.

“W. CARRUTHERS.”

The specimens found, hitherto, of *Nematophycus* are all in a fragmentary condition, the largest pieces being generally under 2 inches in length, and a little over half an inch in thickness. The natural outline, however, is frequently preserved; and if the majority of the fragments are any guide to the natural size of the mature plant, it is evident it must have been small as compared with the Devonian one of Sir W. Logan, which attained to over a foot in diameter. That the plant must have been plentiful at this early period is clear from the very great abundance of the fragments in some of the beds; sometimes so closely compressed together are they, that they form an actual carbonaceous seam from one to two inches in thickness.

The microscopical characters of this plant, which are peculiarly interesting, will be fully referred to in the Appendix by Mr. Etheridge*.

The discovery of *Pachythea* and other spore-like bodies in considerable abundance in association with *Nematophycus* is curious, but, as remarked by Mr. Carruthers, is no direct evidence of their relationship. We know, moreover, from geological evidence, that the shoreline at the time could not have been very far distant, and therefore that it is quite possible there may be here a mixture of marine and dry-land plants. The broken condition of the specimens also tends to show that none of them lived in the actual positions in which they are now found, but that they were brought here by some accidental cause, possibly along with a great amount of sediment, and as the result of river-floods, or of depression followed by rapid marine denudation.

The almost abrupt appearance at this horizon of massive beds of grits upon fine muddy deposits of considerable thickness, such as the slates immediately below, evidently tends to show that a physical change was then taking place in some neighbouring area; but besides this there is nothing to indicate a physical break at this point.

* Dr. Dawson, in his reply to Mr. Carruthers, ‘Monthly Microscopical Journal,’ 1873, still insists on his former diagnoses; and in a letter addressed to me, dated June 16th, 1881, in reference to the published abstract of this paper, says:—“I have perfect confidence in my genera *Prototaxites*, *Nematoxylon*, and *Celluloxylon*, as representing primitive types of land plants; and I maintain my judgment as to these genera, and I believe it will be vindicated by future discoveries.”

In addition to the above-mentioned tolerably well-preserved plant-remains from the shales associated with the grits, there are undoubted evidences of a still earlier and probably equally important flora in beds of slate at the base of the quarry. Instead, however, of the remains being preserved chiefly in the condition of mineral charcoal, as in the upper beds, they occur here mainly in the state of a very pure anthracite. At the same horizon some large nodules are seen; and in the centre of these anthracite is also occasionally found, evidently forming the nucleus. From some of the specimens examined, I conclude there can be no doubt that these plants must have been of considerable size; and the amount of carbon left on some of the surfaces, apparently from a single fragment only, would tend to show, as suggested by Mr. Carruthers, that it must have been derived from vascular plants. There can be little doubt, therefore, that there is in the slates and nodules, even in the so-called Taranon slates, very clear evidence of a terrestrial flora of considerable importance*. The anthracite, as now found, is usually broken into innumerable small fragments; but it is perfectly clear that this must be due to changes to which it has been subjected since it was deposited—changes which also produced induration, cleavage, and fractures in the argillaceous sediments. The fissures in the anthracite, and in the charcoal in the other beds, are generally filled by a fibrous mineral, which occurs here in some places in considerable abundance. Mr. T. Davis has kindly examined this, and says that it is a “fibrous form of a hydrated magnesian silicate.” In other cases the fissures are filled with calcite.

The difference in the conditions of fossilization in which the remains are now found at the two chief horizons may doubtless be to a great extent explained by taking into consideration the manner in which they were imbedded in the deposits. The thick grit-beds were evidently thrown down rapidly, and covered over the fragments before decomposition had taken place in them to any great extent. The fine muddy deposits which compose the slates were evidently thrown down much more slowly, and in a tolerably quiet sea; therefore vegetable material resting on the bottom would have time to decompose almost completely before it would be sufficiently covered over by the deposits. To a certain extent the same cause has allowed remains of vascular plants only to be preserved, as cellular ones would be too readily and too completely destroyed to show indications of their presence in such deposits. This is, I believe, the reason why remains of Algæ are not more frequently found in these older rocks, and why impressions only are seen in most cases.

The Pen-y-Glog quarry, where the specimens were obtained, has

* Since this paper was read I have received from Mr. Phillips, the manager of Pen-y-Glog quarry, to whom I am indebted for much assistance, specimens which show clearly that plant-remains occur in the pale shales below the Denbigh-grit series in the same state of preservation as in the beds at the top of the quarry. These shales also contain numerous calcareous nodules.

been already referred to in several papers read before this Society; and its geological position is therefore well known. In the Survey maps and sections its horizon is given as immediately at the base of the Denbigh-grit and Flag series. It is shown to be separated from the Bala or Caradoc beds by only a very thin band of shales, which also contain plant-remains. In the published sections across this neighbourhood approximate thicknesses of between 4000 and 5000 feet of beds belonging to the Denbighshire-grit and Wenlock series are shown to occur in direct superposition to the beds in which the plants are found. None of the beds belonging to the Ludlow series are mentioned as occurring in these sections, the highest given being Wenlock; hence, if the former were deposited in this area, they have all been since removed by denudation.

The geological horizon of the plant-yielding beds in relation to typical sections in other areas is rather difficult to define, since hitherto the Denbighshire-grit series has not been satisfactorily correlated with any other group. In the Survey sections the true Wenlock beds are made to come in at an horizon somewhere about 2000 feet above these beds, and to occupy the remainder of the sections. The only beds below the plant-beds which have been actually correlated by their fossil contents with those in other areas are the Bala and Lower Llandovery beds; hence, at present, the evidence goes to prove that they must be older than the Wenlock, and newer than the Lower Llandovery. In Mr. Ruddy's paper* the Lower Llandovery beds are said to be represented in this area by the Corwen-grit series of Prof. Hughes; and the latter, in summing up the evidence as to the succession in this section, says it goes to prove:— "that the Corwen grits are distinct from the Pen-y-Glog grits; that there is more evidence of a discordancy at their base than at the base of the pale slates or the Pen-y-Glog grits; that there are generally some beds of conglomerate, sandstone, or limestone with sandstone on the horizon of the Corwen grits; that the general facies of the few fossils obtained from these beds in the district examined is that of May-Hill rocks"†.

He states, further, that these Corwen grits are succeeded by beds which "pass up into the 'pale slates' of the Survey, which in turn pass up into the striped flaggy beds of Pen-y-Glog, on the top of which come grits, to be referred to the true Denbigh Flag and Grit series." As the latter are the higher beds mentioned where plants were obtained, we have ample evidence of their position in regard to the succession exhibited here, both from beds below and from those which rest upon them. In other areas the position occupied here by the Denbighshire flag and grit series, the pale slates, and the Corwen grits seems to be chiefly filled up by the Llandovery or May-Hill group and the Tarannon slates: the latter, I think, with the late Mr. Salter, however, should always be included in the May-Hill

* *Quart. Journ. Geol. Soc.* vol. **xxxv.** p. 200.

† *Ibid.* vol. **xxiii.** p. 207.

Diagram Section from Nant Llachos, near Corwen, to Moel Morfydd. (Horizontal scale 1 inch to a mile. Vertical scale about 3000 feet to 1 inch.)

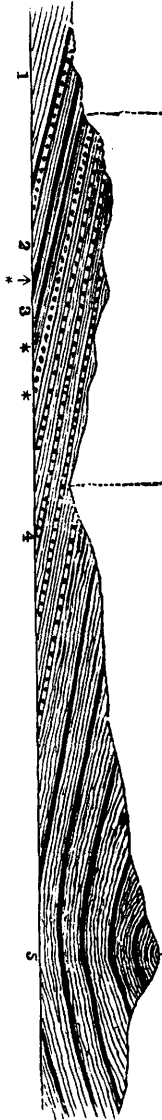
S.W.

Position of slates
of Pen-y-flog
slate-quarry.

Dee river.

Moel Morfydd.

N.E.



- 1. Bala beds.
- 2. Corwen Grits and Shales (Lower Llandovery).
- 3. Pale slates.
- 4. Denbigh Grit and Flag series.

- 5. Wenlock series.
- * Chief positions of plant-remains.
- † Base of Upper Silurian of Surrey.

group. The accompanying section (p. 487) will explain more fully the succession in this area and the actual position of the chief beds containing the plant-remains.

The evidence of the geological horizon, derived from the fossils, is at present imperfect; for the animal remains found in the slates, in association with the plant-remains, are chiefly Graptolites, though fragments of *Encrinurites*, species of *Orthoceras*, and some Brachiopods are occasionally found. The following species of Graptolites were recognized by Mr. Hopkinson, in a collection made by him and myself at different horizons in this quarry in 1875, viz. *Cyrtograptus Murchisoni*, *Monograptus priodon*, *M. Sedgwickii*, *M. spiralis*, *M. vomerinus*, *M. Halli*, and *Retiolites Geinitzianus**.

These forms, he considered, were "characteristic of beds at the summit of the Coniston Mudstones, or base of the Coniston Flags" in the Lake district. The abundance of Graptolites found in these beds would tend to show that the deposits, for the most part, were thrown down in a tolerably quiet sea.

It seems, therefore, so far as the evidence can be read at present, that this immediate area was not greatly affected by the physical changes which occurred in the neighbouring areas at the close of the Bala epoch—that if uplifted above sea-level, it must have been previous to the deposition of the Corwen Grits, as shown by Prof. Hughes. The physical break, therefore, if it exists here at all, must be placed at that point, and not, as formerly supposed, at the base of the so-called Tarannon Shales. There is, however, no visible unconformity between the Lower and Upper Silurians anywhere in the sections in this neighbourhood; and it is quite possible that the area may have remained under water during the whole of the Mid-Silurian epoch †. The parts raised above sea-level were chiefly to the south-east, south, and north-west of this area. I am inclined to think that there was not a very extensive land area, but numerous islands, some of them of volcanic origin. They reached undoubtedly as far as Shropshire to the S.E., and to Caernarvonshire (and probably beyond it) to the N.W. There is no satisfactory evidence to show that they extended much further to the S.W. than the neighbourhood of Builth, as the deposits apparently accumulated uninterruptedly during this time in part at least of Caermarthenshire, in Pembrokeshire, and in Cardiganshire. This is the only way in which we can account for the presence in those areas of some thousands of feet of beds between the topmost Bala and the Wenlock series, and

* Mr. C. Lapworth has also kindly examined a small collection made by me recently in the same quarry, and mentions the following forms as recognizable. They were chiefly collected from the middle bands of slate and above the beds with nodules and anthracite:—*Retiolites Geinitzianus*, *Cyrtograptus Murchisoni*, *Monograptus vomerinus*, *M. personatus*, *M. priodon* (and vars. *riccantensis*, *Lapw.*, and *Flemingii*, Salt.). He states, as to the correlation of these beds with those in other areas, that, so far as the evidence derived from the above Graptolites can be made out, they would occupy a position equivalent to the "lower zones of the Wenlock shale of Shropshire and the west of England."

† See paper by author, Brit. Assoc. Report, 1875.

their almost entire absence in the Longmynd and other districts. For the same reason also it must be expected that a great diversity will be shown in the sediments belonging to this period in different areas, and particularly so in proportion as they approached to or were distant from any of the raised parts. The fauna would also in consequence vary considerably. For these reasons it becomes difficult to correlate with any satisfaction all the beds which are found between the Hirnant limestone of the Bala epoch and the base of the Wenlock, which are known in different places chiefly under the name of Llandovery or May-Hill, or Tarannon, and in the area under consideration as the Denbigh Grit and Flag series. The conclusions, therefore, arrived at in regard to the plant-remains and the geological horizon in which they are found are:—that the age of the beds must be somewhere between the base of the Wenlock and the Lower Llandovery, probably not far from the horizon of the May-Hill beds (Mid Silurian); that the plants did not live on the surfaces on which they are now found; that their position here is an accidental one; that they were not brought from a great distance, as they occur at several horizons; that the shore-line from which they were derived was towards the south or west; and that the land areas were chiefly formed towards the close of the Bala epoch.

If we compare these plant-remains with those discovered in lower Palæozoic rocks in other areas in this country, we do not find so important an assemblage anywhere so low in position, certainly not at a lower horizon than the Upper Ludlow rocks, and probably not below the Devonian. It is probable also that an equal number of important plants have not been found together at so low a geological horizon in any other part of the world. Those found in the Silurian rocks elsewhere are:—the branch of a fern, described by Count Saporta under the name of *Eopteris Morieri*, discovered by Professor Morière in the Middle Silurian at Angers, France; the *Glyptodendron* of Prof. Claypole, from the Clinton group of Ohio, America; and the species of *Psilophytum*, *Annularia*, and *Sphenophyllum* described by Prof. Lesquereux, also from the Silurian rocks of Ohio. It is a curious fact that in each of these areas, in Britain, France, and America, the land plants are in a greatly broken condition, and occur in association with a marine fauna.

Their geological position in each country seems to bear out the view that physical changes were taking place almost contemporaneously in Britain, in parts of the continent of Europe, and in America at this time. These changes, which took place towards and at the close of the Lower-Silurian (Ordovician) epoch, caused land to be formed in each of these areas of greater extent than could have existed since the earliest Cambrian times; therefore it is probable that unless we find land plants in the lowest Cambrian deposits, we are not likely to meet with them in the intermediate groups, which appear to have been deposited upon each other uninterruptedly. That there were periods of shallow water, when deposits were thrown down nearly at an equal rate with the depression,

is certain ; and marine plants probably lived in abundance. The cellular structure of the marine plants, however, rendered them so readily liable to decomposition, that it is not much to be wondered at that their remains are seldom found. The various markings which have been attributed to land and marine plants in the earlier rocks may in some cases have been produced by them ; but others, as shown by Salter, must have been tracks produced by worms. Of the most important of those about which doubt still remains may be mentioned *Eophyton* of Torell, from the Lower Cambrian rocks of Scandinavia, but which I have also found at St. David's. *Cruziana*, from the Lingula-flags of North Wales, supposed by Salter to be a worm-track, I believe, from evidence I have been collecting for some time, will prove to be an Alga. *Buthotrephis*, found in the Lingula-flags and in the Arenig rocks in Wales, and by Prof. Nicholson in the Skiddaw Slates of Cumberland*, but first discovered and described by Prof. Hall in America, appears also to be allied to the Algae. Of *Eophyton*? *explanatum*, which I found in the Tremadoc rocks of St. David's, I fear the evidence is scarcely sufficient to ally it with land plants. Its strong tubular structure renders it unlike any known land plant; and the only other fossil found yet to which it can be compared is the *Pyritonema* of Prof. M'Coy, placed by him amongst the Zoophytes, though its true nature is still a matter of much doubt.

Appendix. By R. ETHERIDGE, Esq., F.R.S.. Pres. Geol. Soc.

EARLY in the present month Dr. Hicks brought for my inspection several slabs of micaceous sandstone, having upon their surfaces numerous fragments of carbonaceous matter, which possessed no definite shape or apparent structure. Their general appearance, in some cases, was that of decomposed coniferous wood, in others, resembling bundles of finely striated black or dark-brown carbon, brittle or tough, the black portions being by far the most brittle ; the lighter and darker remains, however, undoubtedly belong to the same plant, but differently mineralized. Hitherto, in Britain, no true plant-remains are known to occur below the Upper Ludlow, and the only recognized species in that formation is *Pachytheca*, or *Pachysporangium*. Between the Upper Ludlow and the base of the Denbighshire Grits no traces whatever of plant-remains have yet occurred in British Silurian strata.

Dr. Dawson, as far back as 1859, in his paper upon the "Fossil Plants from the Devonian Rocks of Canada"†, described, amongst

* The fossils formerly placed by Prof. Nicholson in the genus *Buthotrephis*, from the Skiddaw Slates, have been since redescribed by him and Dr. Dawson under the generic name of *Protannularia*.

† Quart. Journ. Geol. Soc. vol. xv. p. 484.