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CARBONIFEROUS FOSSILS FROM NEWFOUNDLAND

BY

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above which occur sandstones and shales representing the Millstone grit and coal formation, and holding the workable seams of coal.

In collections from the lower Carboniferous limestone, made by Dr. Robert Bell and Mr. Paterson, I recognized eleven species previously recorded from the lower Carboniferous of Nova Scotia, and two new species, *Serpulites murrayi* and *Macrocheilus terranovicus*. These were described in the report of the Peter Redpath museum for 1883.

The fossil plants are of interest as extending the flora of the Nova Scotia coal fields a little further toward the northeast, and as indicating the vegetation of the parts of the island of Newfoundland then above water, and which constitute the nearest portion of known Carboniferous land in America to the great coal fields of southern Wales and of England.

I shall begin with the description and discussion of certain plants which raise new points, or are new species, and shall then give a list of the better known species with their localities elsewhere.

New or remarkable Fossil Plants.

GYMNOSPERMEÆ.

In the original collection sent by Mr. Murray there was a fragment of calcified wood having its tissues much disintegrated by crystallization, so that in longitudinal sections the woody fibers appeared as irregular tortuous tubes, reminding one of those of the Devonian *Nematoxylon*. On treating fragments with hydrochloric acid, however, it was possible to see that the wood fibers had two to three rows of bordered pores, and that there were simple medullary rays. I therefore considered the wood to be probably that of *Dadoxylon materiarium*, so common in the coal formation of Nova Scotia.

In Mr. Howley's collection there is a large fragment of a trunk in a much better state of preservation, and which is not distinguishable from the species just named. *D. materiarium* is very abundant in Nova Scotia and Cape Breton, and extends from the middle coal formation to the upper coal formation and Permian, where it is associated with leafy branches of *Walchia* in such a manner as to render it probable or certain that it is the wood of that genus.

I may remark here that I prefer the name *Dadoxylon* to the more recent *Araucarioxylon*, as the latter implies a false theory of the affinities of the wood; and that I do not regard the criteria of structures of fossil woods as sufficient to establish good species. They vary much in different states of preservation and in stems of different ages, and the differences of the mere woody structure in fossil woods of different species are too minute to be in-

fallibly ascertained. For this reason it often happens that the same wood in different states receives different names, and that the woods of different species are confounded under one name. As an example of the latter case, while it seems certain that the wood properly called *Dadoxylon* has belonged to *Walchia*, yet there are two or three species of *Walchia* in the upper Carboniferous of Nova Scotia and Prince Edward island, and I have not been able, after examining great numbers of slices, to ascertain a similar specific distinction in the woods showing structure.

Mr. Howley's collection also contains a small stem, about two inches in diameter, showing a very distinct radiating woody structure, with indications of a pith destroyed by decay and compression. The wood of this specimen is more thin-walled than the former, with short and unequal medullary rays and the bordered pores less constant and continuous. These characters ally it with the wood of *Cordaites*, which I believe can always, when well preserved, be distinguished from that of *Dadoxylon*. Leaves of *Cordaites borassifolia* also occur in the collection.

Another remarkable specimen is a quantity of loose and soft fibrous carbonaceous material resembling the mineral charcoal of coal. It contains a small amount of calcareous matter, but not enough to give it coherence, and can be studied only after treatment with nitric acid, when it presents detached carbonaceous fibers. These show two to three rows of bordered pores and traces of the medullary rays, and I imagine it must have been a wood similar to the *Cordaioxylon* mentioned in the last paragraph. Material of this kind, as I have elsewhere shown,* constitutes much of the mineral charcoal of our coals.

Still another specimen, from Codroy river, presented to me some years ago by Dr. Robert Bell, is a black chert, which when sliced proves to be a limpid quartz filled with shreds of vegetable matter. It is, in short, a congeries of fragments of herbaceous plants, appearing as if chopped up finely or disintegrated by maceration, and imbedded in a clear silicious paste. The tissues observed are scalariform vessels, delicate fibers and elongated cells, and parenchymatous cellular tissue, with occasional remains of sporecases or macrospores. The mass may be characterized as a silicified vegetable mould composed of fragments of the more delicate tissues not usually preserved. In this it resembles some of the specimens found by Mr. Grieve under the trappean beds of Burntisland, in Scotland, which have been described by Professor Williamson. I hope to make further examination of this material, and in the meantime would direct attention to it as possibly affording, in some parts of it, more complete organs of plants than those in the specimens in my possession.

* Quart. Journ. Geol. Soc., vol. XV, 1859, p. 626.

The gymnospermous remains in the collection are thus of three types only, viz:

1. *Dadoxylon materiarium*, the most common coniferous wood in the coal formation of Nova Scotia;

2. *Cordaioxylon*, sp., the wood probably of the species of *Cordaites* found in the same formation;

3. *Cordaites borassifolia*, leaves of which species occur in the shales, associated with the woods.

LEPIDODENDREÆ.

The genus *Lepidodendron* and its allied genus *Lepidophloios* are at present much involved in that confusion which must necessarily result from the description of mere fragments of large trees. The trunk of a *Lepidodendron* retaining its rotundity, or more or less flattened, showing the outer surface or the inner surface of the epidermal layer, or the surface of the woody zone, or the mere surface of the axis, will under all these different conditions present very different appearances, while leafless or leafy branches or branchlets in like manner are extremely different from one another. Hence the description of fragments of stems without leaves or fruit has encumbered the subject with a load of uncertain synonymy.

My Newfoundland collections contain at least one species which shows the character of the old stem, the branches and the leaves, and which besides belongs to a type of great interest in its relation to other lepidodendra. It may be described as follows:

LEPIDODENDRON MURRAYANUM,* SP. NOV.

(Figures 1, 2 and 3, plate 20.)

The old stem (figures 2 and 3); surface immediately below the thin epidermis has pronounced elongate elliptical leaf-bases, 3 cm. long and 8 mm. broad, running into each other vertically by a narrow isthmus, so as to give from some points of view the appearance of interrupted ribs. The leaf-bases and borders are striate longitudinally, and have on the lower part some transverse wrinkles. The leaf-scar is sub-central but nearer the top of the leaf-base, ovate tending to rhombic, in the natural state inclined strongly inward or prominent at the lower edge. Vascular scars crowded in the center of the leaf-scar; the two outer meet below in a hippocrepian form with the central scar in the middle. This stem has probably been six inches or more in diameter, and has an impression of the axis in the interior. The axis is longitudinally striate and only $\frac{3}{4}$ of an inch in diameter.

* In MS. notes sent to the late Mr. Murray the name *Sigillarioides* was proposed, but this I have found to be preoccupied.

Leafy branches (figures 1* and 3); thickish, with leaf-bases shorter and broader, being about 8 mm. long and 4 mm. broad, but similarly marked. Leaf scars rounded, rhombic, with the vascular scars close together. Leaves about 2 mm. wide and three inches or more in length. Some of these leaves are sufficiently preserved to show under the microscope the scalariform vessels of the midrib in a pyritized state. Loose leaves, probably of the same species, are straight, pointed, and three to four inches in length.

The fruit has not been seen, though there are in the beds certain flattened lepidostrobi which have been long and cylindrical, and also two forms of the genus *Lepidophyllum* of the types of *L. triangulare* and *L. lanceolatum* of authors. Some of these may have belonged to the present species.

In the coal formation of Nova Scotia there is a species which I have described as *L. cliftonense* (figures 4 to 8, plates 21 and 22) from its locality,† and of which I have found very perfect specimens. It is in some respects so near to the above that I have doubted its specific distinctness, though on careful comparison there seem sufficient grounds for a difference of name. I therefore figure this species also, more especially as it has not before been figured and as it shows the fruit and habit of growth.

It will be observed that this species agrees with the last in the forms of the leaf-bases and in the length of the leaves, which are, however, wider and sometimes as much as five inches in length, while the leaf-bases are transversely furrowed above as well as below the scars. The leaf-bases also are somewhat different in shape and more spirally arranged, and the leaves are longer in *L. cliftonense*. Additional specimens might, however, show them to be varieties of one species. The foliage reminds one at first sight of that of *L. longifolium* of Sternberg, but both leaves and scars are altogether different in detail.

I would remark here that the leafy branches in figure 8 (plate 22) are not a "restoration," but taken from a sketch in my note-book of a specimen exposed on a large slab of sandstone. It is the more necessary to remark this as several European paleobotanists have borrowed similar figures from my papers without acknowledgemnt, and have printed them as "restorations." It may also be remarked that though the leaf-bases of *L. cliftonense* are smaller in the older part of the stem than those of *L. murrayanum*, this difference may be more apparent than real, since the specimen of the latter may be from the main trunk, and that of the former from one of the larger branches only.

These plants raise several interesting points in regard to the lepidodendra. As I have elsewhere pointed out,‡ the growth in diameter of stems of lepido-

* Figure 1 is unfortunately inverted in the plate.
† Geological History of Plants, 1888, p. 164.
‡ Ibid, p. 162; also Acadian Geology, 1878, p. 452.

dendra took place in three different ways: In some, as in *L. Sternbergi*, the bark retains its vitality in such a manner that the leaf-bases increase in size and do not become separated from each other. In others, as in *L. veltheimianum* and *L. pictoense*, the leaf-bases remain small and the intervening bark becomes torn in strips, leaving wide gashes without any scars. An intermediate type is that which we have in *L. rimosum* and *L. corrugatum*, in which the scars increase only slightly in size and then become separated by rims of slightly wrinkled bark. It would appear, from the observations of Williamson and others, that the first condition appertains to those Lepidodendra that possess only a very slight development of the woody axis, while the second occurs in those species in which the woody zone becomes thick and strong.

The two species above referred to evidently belong to the first category; and, as the stems found are not large, still older stems would probably show larger leaf-bases. Such species of lepidodendra approach nearer than others to the genus *Lepidophloios* in the expansion of the old leaf-bases and the small development of the woody axis; and it is interesting to notice that they also resemble them in the great length of the leaves and the thickness of the branches. The lepidodendra whose branches end in slender sprays are usually, if not always, those in which the woody axis is large and the bark of the old stems torn and wrinkled.

I may add that these differences are most important in the discrimination of species of the genus *Lepidodendron* by the markings on the stems, though they have been too often overlooked.

Another noteworthy point is the manner in which the fruit of *L. cliftonense* is borne on slender branchlets with few and short leaves, extending from the thick branches. Such branchlets might, if alone, be readily mistaken for branches of other species. They also help to explain the scars of fructification often found on lepidodendra, as well as on the so-called ulodendra, some of which, however, are not generically distinct from the lepidodendra, and on *Lepidophloios*. In some species, especially of the latter genus, these scars are seen from their form to represent sessile cones, usually of large size; but in other cases they are merely round marks, as if indicating the insertion of branches or buds. The little fertile branchlets of *L. cliftonense*, which would probably die after the maturity of the fruit, would leave such scars, and may probably account for some of the less intelligible of them.

If now we compare our two species above described with others found in America and Europe, and most of which are characterized merely by the forms of the leaf-bases and scars, we may exclude from consideration all those in which the leaf-bases do not expand in growth, and confine ourselves to those having living and expanding leaf-bases. At first sight we might imagine that these would be the oldest, as being simpler than the others in

structure; but though some of the Erian or Devonian species are probably of this type, in the lower Carboniferous, where the lepidodendra first became important, the species with leaf-bases separated by wrinkled bark or by expansion of the cortical tissues between the leaf-bases are apparently predominant, though others also exist, and the type which we are now considering perhaps culminates in the coal formation.

We may first refer to *L. costatum* of Lesquereux, with vertical rows of corrugated leaf-bases, but separated by distinct longitudinal spaces of wrinkled bark. This is a lower Carboniferous species, and is compared by Lesquereux with his *L. brittzi* and with *L. volkmannianum*, Sternberg, of the European Carboniferous, both of which have strong points of resemblance in the characters of the leaf-bases, though differing in the scars and in the leaves, so far as known. The *L. wortheni* of Lesquereux is based on fragments closely allied in general form to our species. So also is *S. diplotegioides*, a species found in the lower coals as far west as Arkansas. None of these species are, I think, sufficiently near to be identified with our Newfoundland and Nova Scotia species, though as most of them are known only by the bark of old stems, this may admit of doubt. In any case, lepidodendra of this general type and aspect were widely distributed, both in Europe and America, in the Carboniferous, and especially in the lower portions of the coal formation, to which in all probability the Newfoundland specimens belong.

I may add here that Zeiller* figures a species as *L. veltheimianum* which can scarcely be that species and may be a branch of *L. murrayanum*, with which it agrees very closely. The same plant is figured by Renault.† The leaf-bases of the Newfoundland species have also some resemblance to those of *L. aculeatum*, Sternberg, but differ in detail.

Another interesting question rises here as to the limits of *Lepidodendron* and *Sigillaria*, as determined by their surface markings. The markings of the latter have usually been considered as characterized by the leaf-scars being placed in vertical rows and often on continuous prominent ribs, and also by the fact that the lateral vascular scars are much larger than the central one; but in such a case as Lesquereux's species, *L. costatum*, the confluent leaf-bases in vertical rows have the effect of ribs, and in a less degree the same remark applies to *L. murrayanum*. I may add that when one happens to find young stems of *Sigillaria* not compressed, the leaf-bases are seen to project in the manner of those of *Lepidodendron*, and that in some non-ribbed Sigillarids, as in *L. elegans*, the very young branches have the scars arranged spirally.‡ In connection with this I may observe that Sauveur§ has described

* Vegetaux fossiles du Terrain Huillier, 1880, pl. XXII.
† Cours de Botanique Fossile, 1881, pl. v, fig. 2.
‡ Acadian Geology, 1878, p. 435.
§ Fossil Flora of Belgium, 1848, pl. LVI and LVIII.

two species of *Sigillaria*, *S. augustata* and *S. undulata*, which are scarcely distinguishable, so far as the old bark is concerned, from *L. murrayanum;* and Goldenberg* has two similar species, *S. aspera* and *S. coarctata*. Goldenberg's two species are by the character of their scars unquestionably *Sigillaria*, but *S. augustata* and *S. undulata* of Sauveur, especially the former, might well have been lepidodendroid trees very near to *L. murrayanum*. This, however, could be certainly ascertained only if more complete specimens could be found. On the whole one might infer that as the spiral and lepidodendroid characters of *Sigillaria* appear most prominently on young branches, the more lepidodendroid and spiral sigillaria are the lowest in type and the ribbed lepidodendra among the highest of that genus. But such a conclusion must be received as liable to many exceptions.

Annotated List of well known Plants.

LEPIDODENDRA.

* *Lepidodendron pictoense*, Dawson†.—Specimens imperfectly preserved, but in general aspect and form of the leaves and cones resembling this species, are not infrequent in the Newfoundland shales. I see that my friend, Mr. Kidston, in the British Museum catalogue of fossil plants, refers this species doubtfully to *Lepidodendron rimosum*. The latter is known to me in Nova Scotia only by the bark of mature stems, but this is entirely distinct from similar portions of *L. pictoense*, in which the leaf-bases remain small but occur in strips closely placed together and separated by deep clefts in the bark. In short it belongs to a type altogether different from that of *L. rimosum*. Its nearest European allies seem to be *L. haidingeri* of Ettingshausen and *L. lycopodioides* of Sternberg; but the latter is now regarded by Kidston ‡ as identical with *L. sternbergi*.

FILICES.

* *Neuropteris rarinervis*, Bunbury.
* *N. auriculata*, Brongt. (or allied species).
* *Altehopteris lonchitica*, Brongt.
* *Pecopteris abbreviata*, Brongt.
* *P. oreopteroides*, Brongt. (or allied species).
* *P. arborescens*, Brongt. This fossil shows rounded impressions of sori on the upper surface of the pinnules.

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* Planzen versteinerungen, 1857, pl. IX.
† Canadian Naturalist, vol. VIII, 1863, p. 431; Acadian Geology, 1878, p. 487, fig. 169.
‡ Brit. Mus. Catalogue, 1886, p. 151.

* *Sphenopteris* (*Cheilanthites*)* *hoeninghausi*, Brongt. This is the most abundant fern in the collection. Several of the specimens show the outer edges of the pinnules strongly reflected in the manner of *Adiantum* when in fructification.

Sphenopteris, sp. A larger broad-leaved species but imperfectly preserved.

* *Dictyopteris*, sp. A single pinnule not well preserved. It may be *D. obliqua*, Bunbury, which is found at Sydney, Cape Breton.

Psaronius, sp. A stem about four inches thick, consisting outwardly of numerous aërial roots, and probably the base of the stem of a small tree-fern.

CALAMITES, ETC.

* *Calamites suckovii*, Brongt.

* *C. cistii*, Brongt. Some of the specimens, from their cylindrical form, would seem to have been erect.

* *C. cannæformis* (?). Decorticated stem.

* *Annularia sphenophylloides*, Zenkel.

* *A. longifolia* (?), Brongt.

Fragment of stem and branches of *Annularia* or *Asterophyllites*.

* *Stigmaria ficoides*. Specimens of large size occur in the collection, and as no specimens of *Sigillaria* are present, these may possibly be roots of *Lepidodendron*. It would seem likely, however, that sigillarids will be found in this coal field as in others in eastern America, and Murray indeed mentions the occurrence of such trees, though he does not seem to have collected specimens. Perhaps, as often occurs, they were too imperfect to deserve preservation.

ANIMAL REMAINS.

The only animal remains seen in the collections are specimens of *Naiadites carbonarius* and *N. elongatus*, *Spirorbis carbonarius*, and a few ostracoid shells. There are also, in a carbonaceus band, some coprolites containing bony scales.

The species in the above notes marked with an asterisk are all found in the coal fields of Nova Scotia and Cape Breton, and especially in the lower beds nearest to the Millstone grit. The collection is small, and some of the more common forms of the coal formation are absent. This is, however, no doubt, accidental, and dependent on the imperfection of the collections, as Mr. Murray in his report of 1873 mentions *Sigillaria* as seen in the beds.

* *Calymmatotheca* of Zeiller.

Mr. Howley informs me that next season he hopes to collect more extensively.

The species present cannot be said to show any special conditions of climate or locality, other than the fact that, as in northeastern America generally, the assemblage of species is more accordant with that of western Europe than with that in the coal regions west of the Alleghanies.

Remarks on the Coal Formation of Newfoundland.

Such details as are known of the structure and distribution of the Carboniferous system in western Newfoundland will be found in the general report on the geology of Newfoundland by Murray and Howley,* and in Mr. Howley's short report of progress for 1889.† Murray estimates the whole thickness of beds seen by him in 1873 at 6,450 feet, composed as follows in ascending order:

a. Coarse conglomerate, with bowlders and pebbles cemented in a greenish sand; also sandstones and sandy shales (this probably corresponds to the lowest Carboniferous or Horton series of Nova Scotia). . . . . 1,300 feet.

b. Gypsum, dark-colored limestone and black shale, argillaceous and marly shale (this is probably the lower division of the Windsor or Gypsiferous or Carboniferous limestone series of Nova Scotia) . . . . . 150 feet.

c. Gray and black limestones with marine organic remains and veins of galena, included in thick beds of variegated marls and sandstones (this is probably the equivalent of the upper part of the Windsor series in Nova Scotia) . . 2,000 feet.

d. Brown and reddish sandstones and conglomerates, with greenish micaceous and arenaceous shales; carbonized plants (this is the "Millstone grit" series of Nova Scotia) . 2,000 feet.

e. Gray and red sandstones, brown and black shales and clays; abundant remains of plants; beds of coal (this is the lower part of the productive Coal Measures) . . . 1,000 feet.

The sequence corresponds very closely in mineral character with that in some parts of Nova Scotia and Cape Breton, but the development of Coal Measure strata appears comparatively small. Mr. Howley, however, in his later investigations finds that the upper members should be greatly extended, and is now disposed to estimate these upper members at not less than 7,500 feet, which would better accord with the thicker portions of the

* London, 1881, pp. 85 et seq. and 309 et seq.
† St. Johns, Newfoundland.

Nova Scotia coal areas, and would also give a greater probable value to the productive Coal Measures. In so far as these are concerned, the quality and distribution of the coal would seem, as might be expected, to resemble that in the eastern coal fields of Cape Breton. The beds as yet found appear from Mr. Howley's report to be six in number, ranging from 14 inches to 8 feet in thickness, three of them having over four feet of good coal. The coal is apparently a free-burning bituminous variety, resembling that of the Cape Breton mines.

EXPLANATION OF PLATES.*

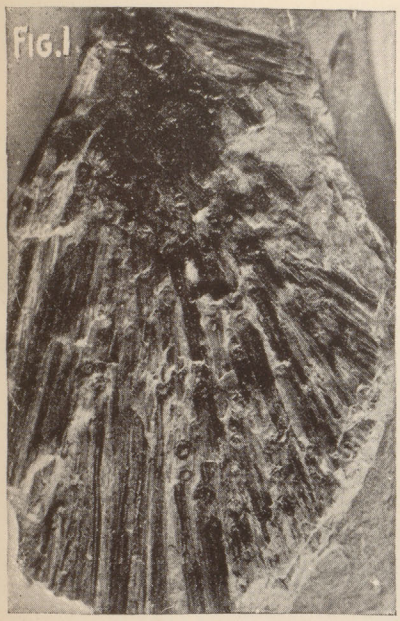
Plate 21—Fossil Plants from Newfoundland and New Brunswick.

Figure 1—*Lepidodendron murrayanum*, Dn. Leafy branch (inverted).
Figure 2— " " Old stem.
Figure 3— " " Leaf scars of stem and branch.
Figure 4—*Lepidodendron cliftonense*, Dn. Leafy branch.

Plate 22—Fossil Plants from New Brunswick.

Figure 5—*Lepidodendron cliftonense.* Old stem.
Figure 6— " " Leaf scars of stem and branch.
Figure 7— " " Strobile borne on slender stem.
Figure 8— " " Branches, as seen on a bed of sandstone; reduced to one-eighteenth natural size.

* The titles printed on plates 21 and 22 are imperfect.



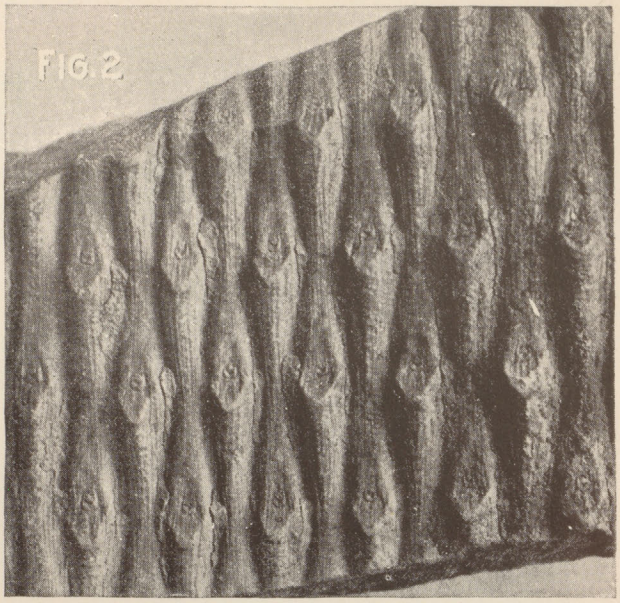


Fig.3.

FOSSIL PLANTS FROM NEW FOUNDLAND.

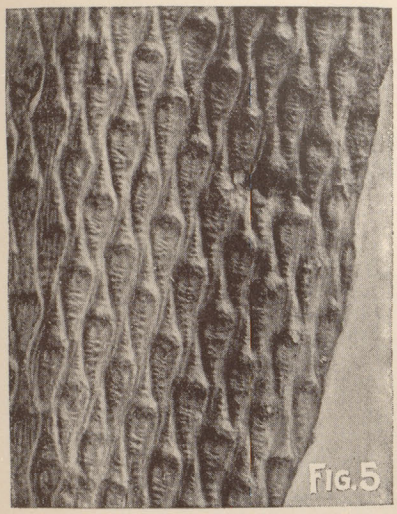


Fig.6.

Fig.8.

FOSSIL PLANTS FROM NEW FOUNDLAND.

MOSS ENG. CO., N. Y.