Some Fossil Plants from Eastern Canada.¹

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With Plates XXII and XXIII.

THE geological formations of Eastern Canada, as a whole, have been well understood for a long time, owing mainly to the exhaustive researches of Sir William Dawson. There are, however, a few localities in Prince Edward Island and on the south shore of New Brunswick which have occasioned some uncertainty. Considering first New Brunswick, Dawson² has referred the greater part of the north coast of the Bay of Fundy to the Devonian. The only exceptions are one outcrop of Carboniferous age beginning about ten miles east of St. John, and three of Triassic, situated at Quaco, Salisbury Cove, and Gardiner's Creek. More recently, Mr. Ells³ of the Canadian Government Survey discovered lignitic remains from the sandstones of Martin's Head, identical in anatomical structure with lignite from Quaco and the Trias of Prince Edward Island, described as *Dadoxylon Edvardianum*. Accordingly, it seems advisable to add Martin's Head to the list of Triassic localities.

As regards Prince Edward Island, Dawson⁴ in 1868 considered this whole island to be Triassic, except for certain localities on the south shore, notably at Gallows Point and Des Sables. Here the red sandstones characteristic of the rest of the island are replaced by cliffs of a greyish, more argillaceous composition, which contain abundant fossil plants. The character of these remains, from their similarity to those of the Upper Coal Formation of Nova Scotia, led Dawson to the conclusion that these strata are, if not Permian, at least Upper Carboniferous. In 1871⁵ these beds, together with a similar series on the west coast extending from Cape Wolfe towards the north point, are called 'Permo-Carboniferous'. Later,⁶ this

¹ Contributions from the Phanerogamic Laboratories of Harvard University, No. 60.

² Dawson, J. W.: *Acadian Geology*, 3rd edition, p. 108.

³ *Acadian Geology*, 4th edition, Notes and Addenda, p. 99.

⁴ *Acadian Geology*, 3rd edition, pp. 116 ff.

⁵ Dawson and Harrington: Report on the Geological Structure and Mineral Resources of Prince Edward Island.

⁶ Dawson: *Journal Geological Society*, Aug. 1874.

view is set forth in greater detail with a proposition to divide the strata of the island into two groups, Permo-Carboniferous and Trias, the latter being subdivided into Upper and Lower. Since then, Mr. Francis Bain has discovered a number of fossil plants, including the so-called *Tylodendron Baini*, in the previously designated Lower Trias, which led him to regard it as Permian.¹ Still later, Mr. Ells of the Geological Survey of Canada re-examined the rocks of Prince Edward Island, and stated² that the greater part of the island is Permian, and that the Trias is of very limited extent.

Inasmuch as the beds under discussion, in both New Brunswick and Prince Edward Island, are richly fossiliferous, it seemed desirable to re-investigate them from a palaeobotanical standpoint. The receipt of the Wilby Prize of Radcliffe College enabled the writer to do this in the summer of 1911, and much material was collected from all these localities, which it is the object of this article to describe.

PRINCE EDWARD ISLAND.

Since the outcrops are much more numerous on Prince Edward Island, it will be advisable to describe them first. From Cape Traverse east to the Tryon River, there are occasional pieces of silicified wood to be picked up along the shore; they are, unfortunately, for the most part small and indifferently preserved. From Tryon River to Sable River, on the other hand, such pieces are exceedingly abundant, especially near Victoria. Here it is possible to collect specimens eighteen inches or more in length, and six or seven in diameter, lying partially buried in the mud and sea-weed, uncovered only at low tide. In addition to this petrified wood, many sandstone pith casts of *Tylodendron* may be found. From Sable River to Charlottetown good material is rare, though there is some wood at both Canoe Cove and Holland Cove. For some miles east of Charlottetown this fossiliferous layer is entirely lacking, but at Gallas Point, about twenty miles to the south-east, it reappears. Here tree trunks, sometimes two feet in diameter, may be seen extending into the cliffs. Usually the woody cylinder has been broken up and removed by the action of the tides, which accounts for the abundance of small pieces along the reefs. Pith casts may be found here, but they are comparatively rare. On the east side of Gallas Point, the grey fossiliferous sandstones are replaced by cliffs of a compact reddish sandstone, and in them are many impressions of *Tylodendron* and *Sternbergian* pith casts, *Cordaite*s leaves, &c. On the islands of Hillsborough Bay, a ledge on the north shore of Governor's Island has an abundance of impressions, while at St. Peter's there are also pith casts of both the *Tylodendron* and *Sternbergian* types, together with a small amount of petrified wood.

¹ Canadian Record of Science, July, 1885.

² Report of 1883.

A considerable number of *Tylodendron* pith casts and specimens of petrified wood were collected. All the wood from Gallas Point, St. Peter's, Holland Cove, and most of that from the vicinity of the Sable River, proved to be of different species of *Cordaite*s. Certain specimens from Sable River, however, presented slightly different features, and will be referred to later.

Some of the pith casts presenting the characteristics of *Tylodendron*, Weiss, and *Tylodendron Baini*, Dawson, are shown in Pl. XXII, Figs. 1-9. Figs. 1-4 represent a particularly good specimen. It shows one of the swellings which recur at regular intervals, probably marking the nodes, and also the rhomboidal scars which completely cover the surface. These scars are of variable length, being considerably longer in the internodes than at the nodes. In the more highly magnified views (Figs. 3 and 4), it may be seen that the lower half of each rhombic area is characterized by a slit. This cast was found near Cannoe Cove, almost entirely buried in the mud. Figs. 5 and 6 represent a similar specimen from the same locality. Here, too, the cleft ridges are well marked, but there is less of a nodal swelling. The upper part of Fig. 6 shows the pith to be crossed by transverse diaphragms similar to those of *Sternbergia*. Figs. 7-9 are different magnifications of another specimen. This specimen includes the region of the branch whorls, and also demonstrates the presence of diaphragms. Fig. 10 shows a petrified stem. This piece is of especial value, since it contains the pith, and also has a wound cap.

The nature of such stems was for a long time misunderstood. Weiss,¹ who originally defined the genus, considered them branches denuded of leaves. The rhombic areolae he took for the scars left by leaf-bases, and the split he believed to be caused by a resin canal. Potonié,² however, showed them to be pith casts, bearing the same relation to *Tylodendron* as *Sternbergia* to *Cordaite*s. The surface configuration he showed to be caused by the course of the protoxylem strands. The material from Prince Edward Island confirms these statements in detail. Pl. XXIII, Fig. 13, a transverse section of the stem shown in Fig. 10, shows the instanding protoxylems, causing the ridges and furrows on the stem. The manner of exit of the leaf-trace is elucidated by Figs. 15 and 16, cut from the same stem. When a protoxylem strand is going to the supply of a leaf, it starts from the furrow at the base of one of the rhombic scars. At first, it pursues a course which is chiefly upward and only slightly outward. Accordingly, it splits the scar, which does not become entire until about half-way up, when the trace turns and passes directly out. Fig. 15 shows one of these strands during its upward journey in the act of splitting the ridge; Fig. 16 shows it at the point where it begins to pass out. That its path is almost exactly

¹ Weiss: Die fossile Flora der jüngsten Steinkohlenformation u. des Rothliegenden im Saar-Rheingebiete, p. 182.

² Potonié, H.: Ueber die fossile Pflanzen-Gattung *Tylodendron*. Jahrb. der Königl. Preuss. Geol. Landesanstalt, 1887, p. 311.

horizontal after it leaves the pith is demonstrated by the fact that a given transverse section of a stem sometimes includes a trace almost from pith to cortex. This 'hump' of the foliar strand is a perfectly constant phenomenon, each scar being characterized by the resulting slit.

The nature of the pith escaped the notice of Weiss, but, as recorded by Potonié, it is marked by anastomosing diaphragms. This feature has been referred to in connexion with Figs. 6 and 9; Fig. 14, a longitudinal section of the specimen represented in Fig. 10, also demonstrates their presence.

The ligneous structure of this interesting fossil was ascertained both from sections cut from undoubted *Tylodendron*, and from pieces of petrified wood from the Sable River. It agrees exactly with that described by Dawson from Mr. Bain's specimen as *Tylodendron Baini*,¹ and with that described by Potonié as *Araucarioxylon rhodeanum*,² Goepp. As represented by Figs. 17 and 18, the tracheides are pitted throughout their entire length, usually by one (Fig. 18), rarely by two (Fig. 17) rows of closely approximated pits. Further, the mouth of each pit is circular. As shown in Fig. 19 the rays are abundant, low, and normally uniseriate, though rarely diseriata.

There have been numerous theories as to the affinities of *Tylodendron*. Its closely compressed and alternating pits clearly affiliate it with *Araucarioxylon*, Krauss. The question then arises whether it be related to the Cordaitales or to the Araucarineae. There are several criteria on which it has been proposed to differentiate the woods of these groups. Felix³ attempted to do so on the number of pits on the radial wall of the tracheides: in *Cordaioxylon* there are generally three or four rows, while in *Araucarioxylon* there are normally but one or two. Gothan⁴ enumerates several differences: in *Cordaioxylon* the mouth of the pit is elliptical, while in other Conifers, at least in the spring wood, it is usually circular. Further, the medullary rays of the Cordaitales are usually thirty to fifty cells high and two cells in width, as opposed to the Araucarineae, where they are rarely over ten cells in height or a single cell in width. On all these criteria, *Tylodendron* is an Araucarian Conifer. Further, as pointed out by Potonié, the nodal swellings and instanding protoxylem strands causing the ridges and furrows of the pith casts are identical with similar structures in *Araucaria* and *Agathis*. Moreover, such characteristically Cordaitan features as the double leaf-trace, and the broad transitional region between primary and secondary xylem, are replaced by the Araucarian single trace and small amount of primary wood. Impressions present more evidence for merging

¹ Dawson: New Plants of Erian and Carboniferous, and Character and Affinities of Palaeozoic Gym., p. 13.

² Potonié, loc. cit.

³ Felix: Ueb. d. verst. Hölzer von Frankenberg, 1883.

⁴ Gothan, W.: Zur Anat. lebender u. foss. Gymn-Hölzer, 1905, p. 12.

Tylodendron with the Araucarians. Several varieties of leafy branches, known as *Walchia*, and definitely associated with *Tylodendron* pith casts, have been described, all bearing a close resemblance to different species of *Araucaria*. Of their fructifications little is known, further than that, as shown by Zeiller,¹ the scales of the female cone bear single seeds, another Araucarian feature. If all these criteria are reliable, the presence of *Tylodendron* in Permian strata bears out the orthodox view that the Araucarineae are the oldest living family of the Coniferales.

When this evidence is weighed more carefully it is not so convincing. The worthlessness of Felix's distinction, based on whether or not the radial wall is covered with pits, Gothan has already detected. He points out² that *Dadoxylon stephanense* and *D. subrhodeanum* are described by Grand'Eury³ as encircling Artisian pith casts; and yet the pitting of the radial walls of the tracheides is usually uniseriate. As regards the shape of the mouth of the pit, Gothan may be correct in stating that the pits of *Cordaites* always have elliptical openings, yet in the Conifers there seems to be no invariable rule. For example, *Agathis* has sometimes elliptical and sometimes circular openings, and such is the case throughout the Abietineae and Cupressineae. The other lines of evidence adduced above demonstrate that the relationship between *Tylodendron* and the Cordaitales cannot be close, but do not prove a closer between *Tylodendron* and the Araucarians. All living Conifers have low, uniseriate rays, instanding protoxylem strands, and no extensive development of primary wood. Though the character of the pitting of the tracheides suggests the Araucarian Conifers, recent investigations of Mesozoic woods have shown that closely compressed and alternating pitting is not the primitive condition for the Araucarineae.⁴ Further, there are woods of the *Tylodendron* type extending as far back as the Culm, yet no advocate of the antiquity of the Araucarian line would suggest that it extends as far as that. We can do no better than agree with Gothan⁵ when he writes that '*Walchia* has not been proved to belong to the Araucarineae, and that the opposite is much more probable'.

SUMMARY.

1. There are abundant remains of *Tylodendron* in the strata of the south shore of Prince Edward Island.

2. Since *Tylodendron* is characteristic of the Permian, there can be no question that these strata are of that age.

¹ Zeiller: Études sur la flore fossile des dépôts houillers et permien des environs de Brive. Paris, 1892.

² Gothan: loc. cit., p. 15.

³ Grand'Eury: Flore carbonifère du Dép. de la Loire, p. 257.

⁴ Jeffrey, E. C.: The Araucarioxylon Type. Proceedings Am. Academy of Arts and Sciences, vol. xlviii, No. 13, Nov., 1912.

⁵ Gothan, Walter: loc. cit., p. 13.

3. The affinities of *Tylodendron* are uncertain; it is not closely related to the Cordaitales, and there appear to be no sufficient grounds for relating it to any one living group rather than to another.

NEW BRUNSWICK.

Just west of Martin's Head, on the south shore of the Bay of Fundy, the grey sandstone characteristic of the Devonian gives way to cliffs of brown arenaceous rock, embedded in which there is a confusion of lignitic remains. Among them were found a number of tree trunks with woody cylinders much broken, but with the pith still present as a sandstone cast. Such casts were usually not more than 1 or 2 cm. in diameter, while others, from which all trace of organic material had disappeared, had sometimes a diameter of 5 or 6 cm. One, represented natural size in Fig. 11, was traced at least 100 cm. along the cliff without coming to any swellings such as are characteristic of the *Tylodendron* type of pith cast. In addition to these trunks there were some decorticated twigs, considerably flattened, but otherwise in a fair state of preservation. A few hundred feet further west this fossiliferous layer crops out again, containing bits of wood, but no twigs.

During the past winter this lignite has been subjected to a microscopic examination. To prepare it for sectioning, it was first softened by a sojourn of several days on a paraffin bath, in a mixture of equal parts of 70 per cent. alcohol and 5 per cent. caustic soda. The alkali was then thoroughly washed out with alcohol, and the lignite transferred to a mixture of glycerine and 30 per cent. alcohol. In this condition a preliminary examination may be made, the useless bits rejected, and those desired for further study treated with hydrofluoric acid, and then embedded in celloidin. Most of the wood was of no value from a structural standpoint, but occasionally well-preserved pieces were found. From these the ligneous structure could be ascertained without difficulty.

Fig. 11 shows one of the casts. As may be seen, the entire surface is covered with rhombic scars. These scars are of variable length, but always lack the slit characteristic of similar structures in *Tylodendron*. It may be suggested that imperfect preservation might have obliterated this feature, but examination of a large number of such casts, most of which were beautifully preserved, proves such not to be the case.

Thin sections of the small lignitic twigs referred to above show that the furrows of the pith cast represent instanding protoxylem strands. As would be inferred from the absence of a slit, the foliar trace passes out directly from the medulla, without the 'hump' characteristic of *Tylodendron*. The leaf-strand is single when it leaves the pith, but forks during its passage through the wood. A similar condition may be seen in the living *Agathis*. Fig. 24 shows in transverse section one of these traces in the process of splitting; Fig. 23 shows the double trace immediately after the split. In

these illustrations the division is approximately in a horizontal direction, but more frequently it is oblique, so that in a given transverse section the trace appears single all the way out. That the foliar traces are not persistent, as in both the living members of the Araucarineae, may be inferred from their abundance in the twigs and complete absence in the mature wood. The pith itself never contains diaphragms like those of *Cordaite*s, *Tylodendron*, and certain members of the living Abietineae. On the contrary, it is homogeneously parenchymatous, as shown in Fig. 20, a longitudinal section of one of the small lignitic twigs.

The wood itself is composed of tracheides and rays. The former are isodiametric, with no trace of annual rings; they are usually empty, though sometimes filled with a dark, pitch-like substance. The entire length of the radial wall is covered with bordered pits, which are always uniseriate and usually scattered. Fig. 22 represents a typical condition, though frequently they are further apart than is shown here, and rarely they are so closely compressed as to be flattened and angular. While they are as distant as the pits of the Abietineae and Taxodineae, they are never, as is the rule in these groups,¹ separated by the so-called bars of Sanio (cellulose thickenings embedded in the substance of the cell-wall). In this respect they resemble the wood of such types as *Brachyoxylon*² and *Paracedroxylon*.³ As opposed to the latter, however, the mouths of the pits are sometimes circular and sometimes elliptical.

There is no vertical wood parenchyma, but ray parenchyma is extremely abundant. As is shown in Fig. 21, the rays are highly resinous and invariably uniseriate; their tangential and horizontal walls are thin and unpitted, but the radial walls have from 2 to 4 small piciform pits to each cross-field. The characteristics of the rays are thus seen to be exactly like those of the living Araucarineae.

Having described the salient points in the anatomy of our fossil, we may now consider its affinities. It seems probable that this wood represents the *Dadoxylon Edvardianum* described by Dawson⁴ as characteristic of the Trias of Prince Edward Island, Quaco, and Martin's Head, for although his specimens differ in having the radial walls of the tracheides covered with 1-2 rows of contiguous, hexagonal pits, they agree with ours in such characters as simple rays, and absence of either annual rings or transverse lamellae in the pith. The discrepancy in the matter of pitting is probably due to imperfect preservation of the tissue in question in the case of the material investigated by Sir William Dawson.

¹ Gerry, Eloise: The Distribution of 'Bars of Sanio' in the Coniferales. *Annals of Botany*, xxiv, pp. 119-24, 1910.

² Hollick, A., and Jeffrey, E. C.: Studies of Cretaceous Coniferous Remains from Kreiserville, N.Y. *Mem. N. Y. Bot. Garden*, 3, pp. 1-138, 1909.

³ Sinnott, E. W.: *Paracedroxylon*. *Rhodora*, II, pp. 165-73, 1909.

⁴ Dawson, J. W.: *Acadian Geology*, 4th edition, Notes and Addenda, p. 99.

The pith cast is the most distinctive feature of our fossil. It suggests at once *Tylodendron*, but differs from that characteristically Permian type in that there are no periodic swellings, and that the rhombic areolae are never slit at the lower end. Professor Seward¹ has described specimens of the pith casts of *Voltzia heterophylla*, Brongn., in the Strassburg Museum, which resemble the New Brunswick casts in the absence of nodal swellings, but differ in having the scars always slit like those of *Tylodendron*. His observations are confirmed by those of Blankenhorn,² though it is possible that the latter author is referring to impressions of decorticated, and not delignified, stems. In the description of Weiss,³ there is no doubt that such is the case, since he notes that each rhombic area, in addition to the slit, has in the centre an elliptical scar with a central thickening. Bronn⁴ is also probably referring to surface impressions. Our specimen is, however, identical with a specimen of *Voltzia coburgensis*, Schaur., from the Keuper of Coburg, loaned by Professor Arthur Willey from the Peter Redpath Museum of McGill University, Montreal. Fig. 12 represents this cast, and its detailed resemblance to the New Brunswick specimen of Fig. 11 is evident. That this is *V. coburgensis* is shown beyond question by its similarity to the type figured by Schenk⁵ from the Lettenkohle of Estenfeld. On the other hand, *V. coburgensis*, as figured by Potonié⁶ under the name of *Voltziopsis coburgensis*, has sometimes the slit scars of *V. heterophylla*, though usually there is no slit. Further, the description of *Glyptolepis coburgensis*,⁷ Schimper, which both Schimper himself and Potonié⁸ consider the same as *Voltzia coburgensis*, Schaueroth, contains the following: 'cicatrices in ramis derelictis quadrato-rhombeae.' If by 'ramis derelictis' Schimper means pith casts, there seems to be every reason for calling our specimen *Voltzia coburgensis*. Schimper, however, goes on to say that the wood of *Glyptolepis* is probably *Araucarioxylon keuperianum*, Goepp. *Araucarioxylon keuperianum*⁹ or *Dadoxylon keuperianum*¹⁰ agrees with our specimen in the absence of annual rings, but differs in that the radial pits are sometimes biseriate, and always approximated closely; further, the rays are occasionally two cells in width. Accordingly, if Schimper be correct in referring the wood of *Araucarioxylon keuperianum*

¹ Seward, A. C. ('90): *Tylodendron*, Weiss, and *Voltzia heterophylla*, Brongn. Geol. Mag., p. 218.

² Blankenhorn ('86): Die fossile Flora des Buntsandsteins und des Muschelkalks der Umgegend von Commern. Palaeontograph, vol. xxxii, p. 135, Pl. XXII.

³ Weiss, C. E.: Ueber *Voltzia* und andere Pflanzen des bunten Sandsteins zwischen der unteren Saar und dem Rheine. N. Jahrb. f. Min., 1864, p. 279.

⁴ Bronn: N. Jahrb. f. Min., 1858, p. 139.

⁵ Schenk: Beiträge zur Flora der Vorwelt. Palaeontograph, vol. ii, p. 308, Pl. XLVI, Fig. 2.

⁶ Potonié, H.: Lehrbuch der Pflanzenpalaeontologie, p. 302.

⁷ Schimper: Paléontologie végétale, v. 2.

⁸ Potonié: loc. cit., 303.

⁹ Goeppert, Monog. Conif. foss., p. 234.

¹⁰ Endlicher: Syn. Conif., p. 289; Unger: Gen. et Spec., p. 379.

to *Voltzia coburgensis*, although he admits that he never found them in actual connexion, our specimen cannot be identified with his. The evidence furnished by the Coburg specimen and by Schenk's figure is, however, sufficient to warrant referring the New Brunswick fossils to *Voltzia coburgensis*, Schaur.

Before discussing further its affinities, it is necessary at this point to refer briefly to its external features. As defined by Brongniart,¹ *Voltzia* closely resembles *Araucaria excelsa* in general habit, even in heterophylly. The cones, however, are stated to have nothing in common with *Araucaria*, but simulate closely those of the Taxodineae, notably *Cryptomeria*. Each scale is double, consisting of a so-called 'Samen-' or 'Fruchtschuppe' which bears the seeds (two in *V. coburgensis*), and a 'Deckschuppe'. The 'Samenschuppe', or ovuliferous scale, is more or less deeply lobed. There are a number of minor differences between *V. heterophylla* and *V. coburgensis*, in the foliage, and especially in the structure of the cone. In the former, the cones are solitary, not more than three times as long as broad, and the cone scale is deeply two or three lobed, as contrasted with the latter, where the cones are grouped, ten times as long as broad, and the cone scale only crenulate. Further, *V. heterophylla* does not occur after the Muschelkalk, where it is replaced by *V. coburgensis*, which extends well into the Jura. Schimper recognized these differences and proposed to change the name *V. coburgensis* to *Glyptolepis coburgensis*; ² while Potonié³ used the name *Voltziopsis coburgensis* to include the cones of *Glyptolepis*, the pith casts of *Voltzia coburgensis*, and certain impressions known as *Cheirolepis*. Zittel,⁴ however, does not consider these differences as of sufficient importance to warrant a generic distinction. The difference in configuration of the pith cast seems considerable, but until the wood structure of *Voltzia heterophylla* is known the best evidence is unavailable.

As regards systematic position, *Voltzia* is usually placed under the Taxodineae, as by Zittel,⁵ Gothan,⁶ Potonié,⁷ Zeiller,⁸ &c. Although the resemblance of the leaves to those of *Araucaria* is recognized, and the bract on the back of the ovuliferous scale homologized by Potonié with the ligule of *Araucaria*, the double nature of the cone scale is generally considered enough to justify including it with the Taxodineae. On the other hand, Endlicher, Unger, and Goeppert put it with the Cupressineae, while Schimper places it with the Abietineae. Recent investigations have shown the futility of attempting to classify on the basis of external appearances. For example, Dr. Jeffrey has shown that the genera *Geinitzia*,

¹ Brongniart, Ad.: Ann. Sci. Nat., Sér. l. t. 15, 1828.

² Schimper: Paléontologie végétale.

⁴ Zittel, Karl: Palaeontologie, p. 288.

⁶ Gothan: Ueber die Coniferen und ihre Verwandten in ihrer Vorgeschichte. Naturwissenschaftliche Wochenschrift, June, 1911.

⁷ Potonié: loc. cit., p. 300.

³ Potonié: Lehrbuch, p. 303.

⁵ Zittel: loc. cit., p. 287.

⁸ Zeiller: Éléments de Paléobotanique, p. 267.

Brachyphyllum, *Widdringtonites*, *Thuyites*, &c., all previously referred to the Taxodineae or Cupressineae, are really, judged by anatomical structure, Araucarian Conifers.¹ A similar fate seems destined for *Voltzia coburgensis*. As regards external features, the size and general appearance of the leaves are Araucarian, while the double cone scale and two seeds are distinctly Abietineous. As regards internal structure, the nature of the medullary rays, absence of wood parenchyma, and large pith are Araucarian; while the scattered position of the pits is Abietineous. By far the most reliable criterion for diagnosing coniferous woods is the occurrence of 'bars of Sanio', since, as shown by Miss Gerry (op. cit.), they are present invariably in all coniferous tribes except the Araucarineae. *Voltzia* accordingly appears to be beyond question Araucarian. Within the last few years a number of fossil woods have been described by Gothan, Seward, Jeffrey, Sinnott, and others, which possess different combinations of structures which to-day are confined exclusively to either the Abietineae or Araucarineae. That these are transitional forms between the two great groups of Conifers seems evident, the question being whether they represent Araucarians on the way to becoming Abietineae, or vice versa. Dr. Jeffrey,² by a study of comparative anatomical, experimental, and palaeobotanical evidence, appears to have demonstrated that the Abietineae are older, and that it is the Araucarineae which become progressively more and more like the Abietineae in successively older geological formations. *Voltzia* is probably one of the earliest of these intermediate types; *Woodworthia*, which presents other combinations of Abietineous and Araucarian characters, is also Triassic. The antiquity of these genera does not in any way discount Dr. Jeffrey's phylogeny, for the distinguished and experienced palaeobotanist Nathorst, as a result of his extensive studies of the Mesozoic coniferous flora of northern Europe, has reached the conclusion that the Abietineae were abundant in circumpolar regions in the Trias.³

Voltzia is of especial interest in view of the different theories which have been advanced to explain the organization of the female cone of the Conifers. The generally accepted interpretation is that the Abietineous ovuliferous scale and sterile bract have, in the Taxodineae and Cupressineae, become more and more fused, though their double nature is still evident in some genera, e. g. *Cryptomeria*. It has been suggested by Seward⁴ and Thomson⁵ that the cone scale of the Araucarineae is entirely different morphologically from that of the remaining Conifers. It seems more probable, however, that in

¹ Hollick, A., and Jeffrey, E. C.: loc. cit.

² Jeffrey, E. C.: The Araucarioxylon Type. Proc. Am. Acad. Arts and Sciences, vol. xlviii, No. 13, Nov., 1912.

³ Nathorst: Beiträge zur fossilen Flora Schwedens. 4^o, Stuttgart, 1878.

⁴ Seward, A. C., and Ford, Sibille O.: The Araucarineae, recent and extinct. Phil. Trans. Royal Soc., series B, vol. cxcviii, pp. 305-411, Pls. XXIII and XXIV.

⁵ Thomson, R. B.: The Megasporophyll of *Saxegothea* and *Microcachrys*. Bot. Gazette, 47, 345-54, Pls. XXI-XXV, 1909.

them the process of adhesion has become more and more complete, until in *Agathis* there is no external evidence of the primitively double nature of the cone scale, while in *Araucaria* the sterile bract is now represented by the ligule. That this is the true explanation is indicated by the double series of vascular bundles in the cone scale of some species of *Araucaria*. That *Voltzia*, whose Araucarian affinities are proved by the absence of 'bars of Sanio', should have a double scale similar to that of *Cryptomeria*, is additional evidence that the condition now obtaining in the living Araucarians is, as in the Cupressineae and Taxodineae, the result of a coalescence of parts originally separate. As an intermediate stage between that of living Araucarineae and that of the Triassic *Voltzia* may be mentioned the Cretaceous *Protodammara*, which has a single scale and three seeds. It is interesting to note that the *Voltzia* type of cone scale, consisting of two segments, persisted into the Cretaceous. Hollick and Jeffrey (op. cit.) described this form under the name of *Dactylolepis cryptomerioides*, diagnosing it as Araucarian, with the suggestion that if there should prove to be any close affinity between this specimen and *Voltzia*, the latter would have to be removed from the Taxodineae, and placed in the Araucarineae. That this suggestion was justified is now evident from the wood structure of *Voltzia coburgensis*.

The occurrence of plant remains at Martin's Head is of importance in correlating the Trias of New Brunswick with that of the eastern United States. Newberry¹ figures, from the Newark of New Jersey, a pith cast which strongly resembles those from Martin's Head. He calls his specimen *Palissya*, though stating that the resemblance to *Voltzia coburgensis* is so great, that he is deterred from diagnosing it as such only by the absence of foliage referable to that genus. Both he and Fontaine² mention the occurrence of *Cheirolepis*, which Potonié (loc. cit., p. 303) considers to be sufficiently near to *V. coburgensis* to justify its inclusion in his new genus *Voltziopsis*. Accordingly, it seems probable that *V. coburgensis* is common to both localities. Another bit of evidence that these beds are coeval is afforded by the presence at Martin's Head of an *Equisetum*, which seems identical with that figured by Fontaine as *Equisetum Rogersii*, Schimper. Different authorities have correlated the Trias of the eastern United States with every horizon from the Permian to the Jura. Fontaine (loc. cit.), from a comparison of the plants, concluded that it is Rhaetic, but more recently Stur³ showed that it is nearer the German Lettenkohlen or Lower Keuper. This conclusion is borne out by the plant remains from Martin's Head; for

¹ Newberry, J. S.: Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and Connecticut Valley. Monographs of U.S. Geol. Survey, 14, 1888.

² Fontaine: The Older Mesozoic Flora of Virginia. Monographs of U.S. Geol. Survey, 6, 1883.

³ Die Lunzer-Lettenkohlen in den 'Older Mesozoic Beds of the Coal-Field of Eastern Virginia'. Verh. KK. Geol. Reichsanst., 1888, pp. 203-17.

Voltzia coburgensis has been described by Schenk (loc. cit.) as abundant in the Lettenkohle, and *Equisetum Rogersii*, Schimper, is probably identical with *E. columnaris* described by Bronn, also from the Lettenkohle. This correlation applies only to Martin's Head and the fossiliferous layers in the Trias of the eastern United States, so that, as pointed out by Wherry,¹ it is entirely possible that the Bunter below and the Rhaetic above may be represented also in the Connecticut Valley, New Jersey, Pennsylvania, and Virginia.

SUMMARY AND CONCLUSIONS.

1. There are present in the Trias of Martin's Head, New Brunswick, specimens of a Conifer which, on the character of the pith cast, may be referred to *Voltzia coburgensis*, Schaur.

2. The foliage of *Voltzia coburgensis* is Araucarian; the organization of the cone, Abietineous; and the anatomical structure intermediate between these two groups.

3. *Voltzia coburgensis* seems to be another transitional form and presents additional evidence for the derivation of the Araucarineae from the Abietineae.

4. Palaeobotanical evidence indicates that the Mesozoic strata of New Brunswick are of the same age as those of the eastern United States, and should be correlated with the Lettenkohle or Lower Keuper of Europe.

In conclusion, I wish to thank Dr. E. C. Jeffrey for helpful advice and assistance in securing the photomicrographs accompanying this article. I wish also to express my thanks to Professor Arthur Willey, of McGill University, for the loan of a specimen of *Voltzia coburgensis*.

EXPLANATION OF PLATES XXII AND XXIII.

Illustrating Miss Holden's paper on Fossil Plants from Eastern Canada.

PLATE XXII.

- Fig. 1. Pith cast of *Tylodendron*. $\times \frac{3}{4}$.
 Fig. 2. Opposite side of same cast. $\times \frac{3}{4}$.
 Fig. 3. Lower part of same cast. $\times 1\frac{1}{2}$.
 Fig. 4. Nodal swelling of same cast. $\times 1\frac{1}{2}$.
 Fig. 5. Another *Tylodendron* pith cast. $\times \frac{3}{4}$.
 Fig. 6. Same cast, opposite side. $\times \frac{3}{4}$.
 Fig. 7. Another cast. $\times 1\frac{1}{2}$.

¹ Wherry, Edgar T.: Age and Correlation of the 'New Red' or Newark Group of Pennsylvania. Proceedings Acad. Nat. Sciences of Philadelphia, July, 1912.

- Fig. 8. Same cast. $\times \frac{3}{4}$.
Fig. 9. Opposite side of same cast. $\times \frac{3}{4}$.
Fig. 10. Specimen of petrified wood. $\times \frac{3}{4}$.
Fig. 11. Pith cast of *Voltzia coburgensis* from New Brunswick. $\times 1$.
Fig. 12. Pith cast of *Voltzia coburgensis* from Coburg. $\times 1$.

PLATE XXIII.

- Fig. 13. Transverse section of *Tylodendron* stem shown in Fig. 10. $\times 1^1$.
Fig. 14. Same stem, radial section. $\times 2$.
Fig. 15. Portion of same stem, transverse section. $\times 60$.
Fig. 16. Another portion of same. $\times 60$.
Fig. 17. Same, radial section. $\times 500$.
Fig. 18. Same, another radial section. $\times 700$.
Fig. 19. Same, tangential section. $\times 500$.
Fig. 20. *Voltzia coburgensis*, radial section. $\times 60$.
Fig. 21. Same, tangential section. $\times 500$.
Fig. 22. Same, radial section. $\times 500$.
Fig. 23. Same, tangential section. $\times 60$.
Fig. 24. Same, transverse section. $\times 60$.

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Holden, Ruth. 1913. "Some fossil plants from eastern Canada." *Annals of botany* 27, 243–255. <https://doi.org/10.1093/oxfordjournals.aob.a089457>.

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