

genera *Lyginodendron* and *Heterangium* approach most nearly to the Osmundaceae and Gleicheniaceae respectively; in *Megaloxyton*, on the other hand, the structure of the primary xylem affords evidence that the *Lygodium* type of stem was also represented in the Cycad-fern alliance, which played so prominent a part in Palaeozoic vegetation.

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ON THE PRIMARY WOOD OF CERTAIN ARAUCARIOXYLONS.—The genus *Araucarioxylon* of Kraus (*Araucarites*, Goepp., *Dadoxylon*, Endl.) is used to include those fossil Gymnospermous woods which have approximately the structure of the recent *Araucaria* or *Dammara*. The characters of the genus as given by Kraus are as follows: 'Lignum stratis concentricis distinctis vel obsoletis; cellulis prosenchymatosis porosis; poris magnis rotundis, rarius uniseriatis contiguis, creberrime pluriseriatis spiraliter dispositis compressione mutua hexagonis; cellulis ductibusque resiniferis nullis; radiis medullaribus uni-rarius pluriseriatis¹.'

The genus is admittedly an artificial and provisional one. From the investigations of Grand'Eury and Renault we know that many, though not necessarily all of the Palaeozoic Araucarioxylons were identical with the wood of the Cordaiteae, that remarkable extinct Order of Gymnosperms which those observers have revealed to us. Other specimens, and especially those of Mesozoic age, no doubt belonged to true Coniferae; in fact the secondary wood, by itself, is of little value as a guide to affinities. Where other tissues, such as the pith and primary xylem, are also preserved, the case is a good deal more favourable, for we then have the anatomical ground-plan of the organ before us. The study of the primary tissues will no doubt lead in the future, as it has done in the past, to the gradual breaking up of these artificial genera into more natural groups.

In the Cordaiteae and in the more typical Araucarioxylons generally, the primary wood of the stem, where it has been investigated, has proved to be purely *centrifugal* in development, the first-formed spiral tracheides lying at the inner edge of the wood, adjacent to the pith².

¹ In Schimper, *Paléontologie Végétale*, vol. ii, p. 380, 1870.

² I leave out of account, for the moment, such stems as those of *Protopitys* or *Lyginodendron*, which were at one time included under *Araucarioxylon*, but have long since been separated.

In fact the primary structure is *endarch*, just as in the stems of recent Coniferae and Cycadaceae¹.

In March of this year my friend Mr. R. Kidston, F.G.S., called my attention to certain sections of *Araucarioxylon* in his possession, which showed distinct strands of primary wood in the pith of the stem. Mr. Kidston, with his accustomed generosity, lent me his sections and specimens for further investigation. Only the chief results can be given here; a full illustrated description will, I hope, appear later on.

The specimens in question are of two very distinct types. The one, which we will first consider, will be named provisionally *Araucarioxylon fasciculare*. Mr. Kidston's specimen came from the Loch Humphrey Burn in the Kilpatrick Hills, Dumbartonshire, where it was found by Mr. John Renwick in 1898. Its horizon is given as that of the Calciferous Sandstone series, and it is thus of about the same antiquity as the well-known Lower Carboniferous fossils of Burntisland and of Arran. I find in the Williamson collection, sections (C. N. 1378-80; 1391-93) of a stem showing a perfectly similar structure; this specimen was derived from the Carboniferous Limestone, near Haltwhistle in Northumberland.

The pith of *A. fasciculare* is small, having a maximum diameter of about 2 millim. in the Kidston specimen, and about 3 millim. in that from the Williamson collection. The pith itself consists of short-celled parenchyma, and presents nothing remarkable, but around its periphery is a ring of eight or nine distinct strands of primary wood. These strands show a gradation in size; the smaller are imbedded in the outer layers of the pith; the larger are beginning to enter the surrounding zone of secondary wood, through which they can be traced for some distance in the different sections. These strands, which are thus on the point of exit, are most conspicuous objects in the transverse sections, attaining a diameter of from .8 millim. to 1 millim., with an approximately circular contour. The smallest elements lie almost in the middle of the strand, or slightly nearer its outer surface; in one case their spiral markings were clear. The structure of these primary strands is thus *mesarch*, as in those of *Lyginodendron Oldhamium*. The large primary tracheides surrounding the protoxylem are spiral, reticulate or pitted.

¹ *Exceptis exceptandis*; cf. Scott, On Peduncle of Cycadaceae, Annals of Botany, vol. xi, 1897.

The smaller circum-medullary strands, which clearly represent leaf-traces at a greater distance below their point of exit, also show mesarch structure, but in the smallest of them the protoxylem-group approaches the inner edge of the strand. It is evident that the outgoing leaf-trace became much enlarged on approaching its point of exit. The same thing is seen in *Poroxyton*, and in *Lyginodendron Oldhamium*, though less conspicuously. The arrangement of the larger outgoing traces agrees with a $2/5$ phyllotaxis. The internodes were presumably short, for in the Williamson specimen three bundles are seen passing out in one transverse section. The bundles soon assumed a nearly horizontal course, for they are sometimes cut almost transversely in tangential sections of the wood.

The structure of the secondary wood is in all respects that of a typical *Araucarioxylon*; the rays are narrow, usually uniseriate, occasionally two cells thick in the middle. In height they vary as a rule from one to about twelve cells, but a few are higher. The pits are limited to the radial walls of the tracheides; they are ranged in three or four alternating rows, and have an hexagonal outline, with the slit-like pore often beautifully preserved. The medullary rays are of typically muriform structure.

This stem thus combines the primary xylem-structure of the *Lyginodendreae* with the secondary wood of a typical *Araucarioxylon*. The name *fasciculare* is proposed for this form of stem on account of the extreme prominence of the primary bundles.

The second species is from the same horizon as the first. Mr. Kidston's sections, on which the following account is entirely based, bear the inscription: '*Araucarioxylon*, Lennel Braes, Berwickshire. Calciferous Sandstone Series, B. N. Peach, 1883.'

This stem differs strikingly from the foregoing in the size of its pith, which is nearly an inch (22 millim.) in diameter. The pith itself is remarkable; it consists of large, very short cells, with abundant 'secretory sacs' among them. There are horizontal lenticular gaps in the tissue, suggesting an approach to the discoid '*Sternbergia*' structure so characteristic of the pith of *Cordaite*s.

The primary xylem-bundles in this case are small, ranging from .15 to .3 millim. in diameter, but are very numerous. Forty-six were counted in a transverse section, but the number no doubt varies. They are ranged in an irregular ring round the periphery of the pith, in which most of them are imbedded, very few being in actual contact

with the secondary wood. At two or more points in the transverse section a pair of these small bundles was observed just entering the zone of secondary wood. At each of these points there was another bundle a little way to the interior, apparently a 'faisceau réparateur' about to replace the outgoing strands. At another place a strand was observed passing out through a large ray of the secondary wood.

The primary xylem-strands show in most cases a very distinct mesarch structure. The smallest elements are near the middle of the strand, and are shown by the longitudinal sections to be spirally thickened, while the surrounding tracheides are reticulate. Anastomosis appears to occur frequently among the primary xylem-strands.

The secondary wood, which is exquisitely preserved, though only present in small quantity, is of the type characterizing the subgenus *Pissadendron*¹ (*Pitus* of Witham, *Palaeoxylon* of Brongniart). The numerous medullary rays attain a great height, and are commonly four cells in thickness, though small uniseriate rays also occur. Towards the pith the rays are much dilated, and the woody wedges correspondingly restricted.

The pitting of the secondary tracheides is preserved with astonishing perfection, and is of the *Araucarian* type; there are usually from three to five rows of the hexagonal pits, each with a narrow, horizontal, or inclined pore, on the radial wall of each tracheide. Tangential pits also occur in places. The innermost secondary tracheides show a spiral thickening, which, however, as in the tracheides of the Yew, appears to co-exist with a pitted structure.

The organization of this stem is, so far as I am aware, quite unique. The numerous small circum-medullary xylem-strands, for the most part independent of the zone of centrifugal wood, appear to be without any near parallel among recent or fossil Gymnosperms as at present investigated.

Yet I believe that the fossil in question is one that has long been known. It will be remembered that Lennel Braes, on the Tweed, from which Mr. Kidston's specimen comes, was one of Witham's localities, whence he obtained specimens of his *Pitus antiqua*². Witham's plant agrees so well with Mr. Kidston's specimen, as shown by a comparison

¹ Kraus, in Schimper, loc. cit., p. 384.

² Witham of Lartington, Internal Structure of Fossil Vegetables, Edinburgh, 1833, pp. 23, 37, 71.

of the sections, that, considering the identical locality, I have no doubt they are one and the same thing, and therefore refer the specimen here described to *Araucarioxylon antiquum* (Witham sp.). The Craigleith Tree (*Araucarioxylon Withami*, Lindl. and Hutt. sp.) is doubtfully distinct¹. No observations appear to have been made hitherto on the primary structure of these fossils.

If we now compare the two species described, it is noticeable that *Araucarioxylon fasciculare* has a distinctly Coniferous or Cordaitean rather than Cycadean type of secondary wood. The rays are narrow, and the elements of moderate size. It is significant that in this stem (as also, in some degree, in *Protopitys Buchiana*) this type of secondary wood co-exists with a Filicinean or Cycadofilicinean primary structure.

In *A. antiquum* the larger elements and broader rays give the wood a more Cycadean character, but the general anatomical habit suggests a Cordaitean stem rather than anything else. The primary bundles, which afford the connecting link with more primitive forms, are here a much less conspicuous feature than in the former species. In fact the primary structure of *A. antiquum* is much less like Cycadofilices than that of *A. fasciculare*, while as regards the secondary wood the reverse is the case. Personally, I put all the weight on the primary structure, and suspect that *A. fasciculare* may still have belonged to the more primitive group, while *A. antiquum* may have been already far on the road towards Cordaiteae.

The facts described in the present note establish a further link between Cordaiteae and Cycadofilices, and so far tend to support the hypothesis of the Filicinean origin of the Gymnosperms generally.

The further discussion of the question of the affinities of these fossils must be reserved for the fuller communication which is to follow. In the mean time I will only add that both *Araucarioxylon fasciculare* and *A. antiquum* will certainly require generic separation, on the basis of their primary characters.

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¹ See Goeppert, Revision meiner Arbeiten über die Stämme der fossilen Coniferen (under *Pitys*). Bot. Centralblatt, vols. v and vi, 1881. In one of Witham's original sections of the Craigleith fossil, kindly lent by Prof. I. Bayley Balfour, I find distinct remains of the primary xylem-strands around the pith, agreeing with those of Mr. Kidston's specimen of *Araucarioxylon antiquum*.



Scott, Dukinfield Henry. 1899. "On the primary wood of certain Araucarioxylons." *Annals of botany* 13, 615–619.

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