XIII.—On the Carboniferous Flora of Berwickshire. Part I. *Stenomyelon Tuedianum* Kidston. By R. Kidston, LL.D., F.R.S., and D. T. Gwynne-Vaughan, M.A., Professor of Botany, Queen's University, Belfast. (Plates I.–IV.)

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INTRODUCTION. By R. KIDSTON.

My first knowledge of *Stenomyelon Tuedianum* was derived from a microscopical preparation in the collection of the late Mr C. W. PEACH, A.L.S., which, through the kindness of his son, Dr B. N. PEACH, F.R.S., subsequently came into my possession.* The specimen was labelled as having been found "near Berwick."

During the investigation of the fossil flora of Berwickshire, in company with Mr A. MACCONOCHIE of the Scottish Geological Survey, a special effort was made to secure additional specimens of this plant, as the original material, as far as known to me, was quite inadequate for a satisfactory description of the species. It was ascertained that the specimen in Mr PEACH's collection had been received from the late Mr ADAM MATHESON, Jedburgh, a geologist who took much interest in the fossils of his neighbourhood, and whom I believed to be the author of an anonymous pamphlet—apparently a reprint from a local newspaper—describing some fossil stems found at Norham Bridge. A perusal of this paper led me to infer that his specimen of the fossil, here described as *Stenomyelon Tuedianum*, had also come from the same locality, an opinion which subsequent events showed to be correct.

The matrix containing Mr MATHESON's fossil was an impure fine clay, apparently with a fair proportion of iron, and one showing features which were possible of recognition in the field; but though a careful search for a similar bed was made in the neighbourhood of Norham Bridge, no trace of such could be found *in situ*. Subsequently, in 1901, we discovered some small blocks of the desired rock lying on the side of the road near the north end of Norham Bridge. It was ascertained that the material came from a cutting made in the road while putting in a drain some time before; the surface of the road in the neighbourhood of the drain was therefore carefully examined, and in a small block which had been used for refilling the cutting the specimen was discovered which has enabled us to give a detailed description of the species.

We are also indebted to the original material for additional points of interest.

Subsequently, in 1903, Dr D. H. SCOTT, F.R.S., informed me that some sections of *Stenomyelon* had been presented in 1859 to the Botanical Museum, Royal Botanic Gardens, Edinburgh, by Mr ADAM MATHESON; and from a copy of a letter referring to these specimens which has been kindly forwarded to me by Dr SCOTT, who had received

* Slide No. 2105.

it from Professor I. BAYLEY BALFOUR, F.R.S., it would appear that Mr MATHESON only found one specimen of *Stenomyelon*, and that this had been got at Norham Bridge, which the study of the anonymous paper already mentioned had led me to infer.

In addition to the parts of the original specimen received from Mr MATHESON by Professor BALFOUR and Mr C. W. PEACH, in 1900 I received a few fragments attached to glass slips from Miss MATHESON, daughter of the original discoverer of *Stenomyelon Tuedianum*. Some additional specimens, also mounted for microscopical examination, were given me by Mr JAMES VEITCH, Jedburgh, to both of whom I take this opportunity of recording my sincere thanks.

DESCRIPTION OF *STENOMYELON TUEDIANUM*, KIDSTON. By R. KIDSTON and
D. T. GWYNNE-VAUGHAN.

Owing to the imperfect preservation of the softer tissues of the specimen it is not possible to determine the true outline of the stem, for in all cases the thin-walled tissues of the cortex are completely disintegrated and destroyed. As a result, the stem has become flattened, and those tissues of the cortex that remain form wing-like projections on two opposite sides of the stele. One of these extensions is seen in its entirety, but of the other only a part is preserved. In some of the sections it is quite narrow, having a regular and very wing-like appearance (figs. 1-2), while in others it is much wider, and is irregularly crushed in at its margin (fig. 3). The xylem of the stele has not suffered any damage, and is almost circular in section. We are of the opinion that the present appearance of the fossil does not imply that the stem of the living plant actually possessed wings, but it will be shown that the leaves were arranged in three rows, and it is therefore quite possible that the stem possessed three more or less prominent decurrent ridges.

Description of the Stem.

The xylem mass of the stem contains both primary and secondary xylem, and as a whole measures 8-9 mm. in diameter. The primary xylem forms a bluntly triangular or three-lobed central mass, which measures 3-4 mm. from the extremity of one lobe to that of another (figs. 6-10). It consists of tracheæ alone, except for a few occasional cells of parenchyma near its periphery. There are also three bands of parenchymatous tissue in the primary xylem which extend from the middle of the sides of the triangle so as to separate the three lobes more or less completely from one another. These parenchymatous stripes, although always quite narrow, vary somewhat in breadth, and they also form a few small irregular bays projecting into the tracheal masses of the lobes. Sometimes, but rarely, the three stripes are continuous to the centre, and then the lobes of the xylem are completely separate from one another. More often one or the other of them is interrupted by a wider or narrower bridge of tracheæ, so that two of the lobes are con-

nected. In spite of these occasional fusions, the three lobes of the primary xylem very clearly retain their individuality throughout all the sections, as may be seen by comparing the above-mentioned figures,—so much so indeed that they may be regarded as practically independent of one another.

These three lobes are obviously in relation to the leaf-traces, one of which, as will be shown later, departs from the extremity of each lobe in turn. It is clear, therefore, that the divergence must have been $\frac{1}{3}$. The sequence in which fusion occurs between any two of the lobes is possibly also related to the order of the leaf-trace departure, but our series of sections was not sufficiently extensive to settle this point.

The elements of the primary xylem are fairly large, attaining a diameter of 160μ . In longitudinal section they are seen to be typical elongated tracheæ with finely pointed ends, and beautiful porose pitting on all their vertical walls (fig. 12). Towards the extremities of the lobes the tracheæ become somewhat smaller, and their pitting becomes typical scalariform (fig. 13). There appear to be no protoxylem strands proper to the stem itself, but in the neighbourhood of the departing leaf-traces a pair of definite exarch protoxylem strands are usually to be seen (fig. 11, *prx.*). These are evidently decurrent from the leaf-trace, and lower down in the stem they fuse to a single strand (fig. 10, *prx.*).

The secondary xylem evidently appears first opposite the side bays of the triangle of the primary xylem, and when the bays are filled up it crosses over in front of the angles, so that the outline of the whole xylem mass, which was at first triangular, eventually becomes circular. The earlier elements of the secondary xylem are narrower than those formed later (fig. 11 and figs. 6–10), and its tracheæ are usually separated from those of the primary xylem by a few cells of parenchyma. Often, however, primary and secondary tracheæ are found to be in direct contact. The tracheæ of the secondary xylem are arranged in very regular radial rows, which are separated by the medullary rays into wedges of from 2–5 elements in width (fig. 11). The medullary rays widen out considerably towards the periphery, and in this region secondary medullary rays also make their appearance. The rays are all very long vertically, and are from 1–6 cells broad (fig. 14). A few specially wide medullary rays occur on the inside of the departing leaf-trace (fig. 10, *M.R.*). In radial section the cells of the rays have the ordinary brick-like appearance, with the long axis radial (fig. 15). All the tracheæ of the secondary wood exhibit porose pitting, but the pits are confined to the radial walls; the tangential walls are quite smooth, being entirely without pits (fig. 14).

No trace was found of any tissue resembling phloem, neither around the stele of the stem nor in relation to the leaf-traces in the cortex. However, patches of a very curious tissue have been preserved in the immediate neighbourhood of the stele, which are clearly parts of a zone that in life completely and closely surrounded it. The inner portion of this tissue consists of small cells with very dark contents. They are rectangular in form, and are arranged in very regular radial series. In longitudinal section they have exactly the same appearance as in transverse, only their long axes are vertical instead of being tangential (fig. 16, *i.z.*). There can be no doubt that the cells arose from the

activity of a cambium of some kind, and the general appearance and structure of the tissue indicates it is best regarded provisionally as a deep-seated and probably thick-walled periderm. A certain amount of phloem and other soft tissues may have existed between this zone and the xylem, but if so they have entirely disappeared. In any case such tissues could not have been very extensive, for, after making every allowance for crushing and imperfect preservation, the dark-celled zone fits very closely into the xylem,—so much so indeed at some points as almost to suggest that it might have arisen from the same cambium.

Towards the outside of this dark-celled zone its elements become larger and irregularly polygonal in outline, the radial arrangement being in consequence lost (fig. 16, *o.z.*). In addition, large groups of similar cells form rounded bosses, projecting at irregular intervals beyond the general level of the outer surface of the zone (fig. 16, *b.*). The same type of cell also forms a number of scattered spherical masses in the cortex of the stem (fig. 17). The central cells of these masses, and also those of the bosses, are smaller than the others, and form a sort of nucleus from which the larger cells radiate more or less distinctly, appearing as though, during their development, they had been pulled out by the growth of the surrounding tissue. Their cell walls are very imperfectly preserved, but it is very probable that they were of a sclerotic nature. It is clear that the masses they form were during life quite hard and resistant, for whenever they have been pressed against a mass of xylem, it is the latter, and not the former, that has given way and become crushed. The “sclerotic nests,” as they may be called, are scattered without order throughout the inner cortex of the stem, and do not seem to bear any relation to the leaf-traces. In structure and appearance they are quite similar to the sclerotic nests described by Dr SCOTT in the pith of *Calamopitys Beinertianum*.*

The outer cortex of the stem is of the “Sparganum” type (fig. 18). That is to say, it contains a number of rather short radiating bands of fibrous sclerenchyma, running vertically almost without anastomosis (fig. 19, *from the petiole*). The tissue between these sclerotic bands is a rather firm-walled parenchyma. Some of its cells have dark-coloured contents, and may perhaps be regarded as resin sacs.

The Departure of the Leaf-trace.

The leaf-traces depart from the ends of the lobes of the primary xylem in a perfectly protostelic manner. Our series enabled us to follow one such departure from start to finish. First the extremity of one of the xylem lobes is seen to become more and more prominent (figs. 6–7, *l.t.*²). Then the protrusion is gradually nipped off as a fairly large roundish leaf-trace (figs. 8–9, *l.t.*²). As the trace passes out it carries with it some of the secondary xylem on its abaxial side, and at the same time it also obtains a certain amount of secondary xylem of its own on the adaxial side (figs. 9–10). The depar-

* SCOTT, “On the Primary Structure of certain Palæozoic Stems with the Dadoxylon type of Wood,” *Trans. Roy. Soc. Edin.*, vol. xl. p. 342, pl. i. figs. 3–4, 1902.

ture of the trace leaves no gap in the secondary xylem, which closes in immediately behind it.

The leaf-trace continues to possess a certain amount of secondary xylem for some time after it has become free from the xylem of the stem, although that on the adaxial side is very scanty and soon disappears. It was possible also to recognise in our sections the leaf-trace that immediately preceded the one just described (figs. 6-7, *l.t.*,¹ and 18). In this trace the primary xylem had just divided into two approximately equal portions, which are at first still surrounded by a certain amount of secondary xylem common to both. Even after they have become completely separate, the secondary wood on the abaxial side is retained for a considerable time (fig. 7, *l.t.*¹).

There is no doubt that all the traces occurring in the space formerly occupied by the cortex were derived by the continued subdivision of primary leaf-traces such as those just described. Several leaf-traces, both large and small, were observed in actual division (fig. 21). It is therefore certain that all the vascular strands given off from the stele are primary leaf-traces, which in their passage through the cortex divide repeatedly to supply the petioles. There is also clearly an entire absence of any meristeles proper to the stem such as those occurring in *Sutcliffia insignis*.*

The xylem of the leaf-traces consists mainly of porose tracheæ without any xylem parenchyma. The tracheæ at the periphery are markedly smaller than those at the centre, and are scalariformly pitted (figs. 20, 21, 22, and 23, *from the petiole*). The scalariform tracheæ are present in greatest number towards the side of the trace on which the protoxylem is situated. The traces usually show a single very distinct and definite protoxylem, except just below a point of division of the trace where there are two (figs. 21-22). In the immediate neighbourhood of the stele the protoxylems appear to be exarch, but at some distance out they are distinctly immersed, and are represented by small cavities situated some little distance within the periphery of the xylem (figs. 20, 21, and 22). Owing to the shifting and displacement of the leaf-traces due to collapse of the cortex, it is impossible to determine their proper orientation with regard to the periphery of the stem. Most probably, however, the protoxylems pointed to the outside. No indication of phloem could be discovered in relation to any of the leaf-traces.

Description of the Leaf.

In the sections of the block which contained the stem there also occurred several other fragments of vegetable tissue. Most of these were portions of leaf lamina, and one of these was found to be in organic connection with an axis which is no doubt the petiole, rachis, or midrib of *Stenomyelon* (fig. 1, L., and text fig. 1). As seen in longitudinal section, the connection between the lamina and the rachis of the petiole extended over a considerable distance, which suggests that the leaf was a simple and not a divided one,

* SCOTT, "On *Sutcliffia insignis*, a new type of *Medulloseæ* from the Lower Coal Measures," *Trans. Linn. Soc.*, vol. vii. p. 49, 1906.

and from the portion of the leaf contained in the block it is evident that it was continued below into a round or oval petiole, which bore the curious emergences described later on (text fig. 1).

The leaf is very large compared with the stem that occurs alongside of it, and it is possible that it belonged to another and perhaps a larger stem (fig. 1, L.). In the section only about one-half of the total circumference of the midrib or rachis was present, and it contained only four vascular strands. These are of exactly the same type as the leaf-traces in the cortex of the stem, but they are on a distinctly larger scale. (Compare fig. 25 with figs 20, 21, and 22, which are all of the same magnification.) The small peripheral elements are more numerous in the strand of the leaf, and in longitudinal section there is a greater proportion of scalariform to porose

FIG. 1.—*Stenomyelon Tuedianum*. Free petiole showing vascular strands, "Sparganum" cortex, and emergences. $\times 8\frac{1}{2}$. (Slide No. 2095.)

elements. Some of the scalariform elements are almost as wide as the porose, but transitional types of pitting are to be observed (fig. 23). The protoxylems are slightly immersed, and in one case two were present, indicating an approaching division (fig. 25). In the three strands that were sufficiently well preserved to show the protoxylems they were on the side of the xylem nearest the periphery of the midrib or rachis. The outer cortex is of the "Sparganum" type (figs. 28 and 19). It attains a greater development than that seen in the stem,—the sclerotic strands being much more numerous and more irregular in form. The dark-coloured resin sacs that occur between the fibrous strands in the stem are present in greater number in the midrib, and they also occur in its more central parenchyma. The "Sparganum" cortex does not reach up to the extreme periphery of the petiole, but there is a narrow zone of homogeneous parenchyma lying to the outside of it (figs. 31 and 4, *par.*). At certain points this tissue is prolonged into a number of curious emergences (figs. 30, 31, and 4). They vary greatly in their form and length, some being quite short and blunt

(fig. 31), while others are narrow, greatly elongated, and somewhat swollen at the end (figs. 30 and 4). They do not seem to be produced by any crushing or folding of the outer tissues. It is possible, however, that they may represent transverse sections of longitudinal ridges. The epidermis of the midrib is well preserved as a definite layer of rather small cells.

Judging from a fragment present in the original block found by Mr MATHESON, the lamina of the leaf must have been of considerable thickness (fig. 24). The epidermis is quite distinct, but no stomata could be distinguished in it. There were indications of a hypodermal zone of sclerotic strands on both sides of the leaf, and resin sacs were very plentiful in the mesophyll. In the fragment in question the vascular bundles lie in single row, but in others less well preserved they appear to be irregularly scattered.

Remarks on other Stems of STENOMYELON.

A few other stems were present in Mr MATHESON's material which in all essential points resemble the specimen already described, but they exhibit a few features of special interest, to which it is necessary to refer.

In one of these stems the primary xylem at first sight gives the impression of being parenchymatous (figs. 26-27). We were able to satisfy ourselves, however, that this is not the case. The apparent parenchyma cells are really tracheæ that have undergone a certain amount of decay. In this section also the three lobes of primary xylem appear to be quite separate from one another, but this, again, is probably due to decay (fig. 26).

In another stem (fig. 29) the secondary thickening has only just begun. It is present in greatest quantity opposite the sides of the triangle of primary xylem, and has not yet crossed over in front of all the lobes.

Again, an unusually small stem was found in which the primary xylem only measures 2.5 mm. at its greatest width (fig. 5), while the secondary xylem is much more extensive than it is in the stem shown in fig. 29, which is photographed at the same magnification. This indicates that, apart from secondary thickening, the primary axes of *Stenomyelon* were of different sizes, which might perhaps suggest that the plant was branched.

CONCLUSION.

The stem of *Stenomyelon* possesses so many features peculiar to itself that in the present state of our knowledge it is unsafe to enter into any speculation as to its relationship to other members of the *Cycadofilices*. It is perhaps best to let it remain among that nebulous group in which it has been already provisionally placed by Dr SCOTT.* At the same time it should be noted that the absence of independent meristeles in the

* *Studies in Fossil Botany*, 2nd ed., part ii. p. 498, 1909.

cortex of the stem separates it widely from *Sutcliffia insignis*, with which one might be tempted to compare it.

Locality.—Road Cutting at north end of Norham Bridge, Berwickshire.

Horizon.—Calcliferous Sandstone Series.

DIAGNOSIS.

Stenomyelon Tuedianum, Kidston, gen. et spec. nov.

Stem monostelic, primary xylem without xylem parenchyma, divided more or less distinctly into three lobes by as many radiating and interrupted bands of parenchyma. Primary tracheæ porose on all walls. The protoxylems of the leaf-trace decurrent as exarch strands on the extremities of the lobes. Secondary thickening occurs. Secondary tracheæ, with porose pits on radial walls only. Medullary rays numerous. Stele closely invested by a zone of sclerotic periderm. Leaf-traces depart successively from the extremities of the lobes and repeatedly divide in the cortex. Leaf-trace protoxylems become immersed. Outer cortex of the "Sparganum" type.

DESCRIPTION OF PLATES I.-IV.

PLATE I.

Stenomyelon Tuedianum, Kidston.

Fig. 1. General view of the specimen, showing a stem, *st.*, and a portion of a leaf, *L.* $\times 2\frac{1}{2}$. (Slide 2093.)

Fig. 2. Transverse section of the stem, showing the cortex flattened into a thin wing. $\times 2\frac{1}{2}$. (Slide 2089.)

Fig. 3. Transverse section of the stem, showing a thicker and indented cortex. $\times 2\frac{1}{2}$. (Slide 2097.)

Fig. 4. Transverse section of outer cortex of midrib of leaf, showing two long emergences; *par.*, parenchymatous cortex. $\times 13$. (Slide 2094.)

Fig. 5. Transverse section of the small stem in Mr MATHESON's original block. $\times 9$. (Slide 2107.)

Fig. 6. Transverse section of stem, showing the beginning of the departure of a leaf-trace, *lt.*². $\times 9$. (Slide 2088.)

Fig. 7. Do., *lt.*¹, the trace of the proceeding leaf already divided into two. $\times 9$. (Slide 2092.)

PLATE II.

Fig. 8. Transverse section of stem, showing leaf-trace just free from primary xylem. $\times 9$. (Slide 2095.)

Fig. 9. Do., leaf-trace passing through secondary xylem. $\times 9$. (Slide 2096.)

Fig. 10. Transverse section of stem, showing leaf-trace free from secondary xylem; *m.r.*, specially large medullary rays below the leaf-trace; *prx.*, single protoxylem at summit of lobe. $\times 9$. (Slide 2098.)

Fig. 11. Transverse section of a lobe of the primary xylem with two decurrent leaf-trace protoxylems, *prx.* $\times 35$. (Slide 2091.)

Fig. 12. Longitudinal section of central tracheæ of primary xylem. $\times 110$. (Slide 2101.)

Fig. 13. Longitudinal section of periphery of primary xylem, showing small scalariform elements. $\times 110$. (Slide 2099.)

PLATE III.

Fig. 14. Tangential section of secondary xylem, showing medullary rays and unpitted surface of the tangential tracheal walls. $\times 110$. (Slide 2099.)

Fig. 15. Radial section of secondary xylem, showing porose tracheæ and medullary rays. $\times 110$. (Slide 2100.)

Fig. 16. Radial section at the periphery of the stele, showing its periderm; *i.z.*, inner zone; *o.z.*, outer zone of the same; *b.*, the bosses; *xy.*², secondary xylem. $\times 30$. (Slide 2099.)

Fig. 17. Longitudinal section of the inner cortex, showing the sclerotic nests. $\times 30$. (Slide 2101.)

Fig. 18. Transverse section of the cortex of the stem, showing the "Sparganum" zone; *lt.*,¹ same leaf-trace as in fig. 7. $\times 10$. (Slide 2088.)

Fig. 19. Tangential section through the "Sparganum" zone of the midrib. $\times 17$. (Slide 2102.)

Fig. 20. Transverse section of a leaf-trace in the cortex of the stem, showing a single protoxylem, *prx.* $\times 36$. (Slide 2096.)

Fig. 21. Do. The trace in division. $\times 36$. (Slide 2097.)

Fig. 22. Do. Below the point of division there are two protoxylems. $\times 36$. (Slide 2090.)

Fig. 23. Longitudinal section of the xylem of a leaf-trace in the midrib, showing porose, scalariform, and transitional pitting. $\times 110$. (Slide 2100.)

PLATE IV.

Fig. 24. Transverse section of the lamina of a leaf. $\times 13$. (Slide 678.)

Fig. 25. Transverse section of a vascular bundle in the midrib near a point of division; *prx.*, protoxylem. $\times 36$. (Slide 2094.)

Fig. 26. Transverse section of a stem in Mr MATHESON'S block, with false appearance of parenchyma in the primary xylem. $\times 9$. (Slide 678A.)

Fig. 27. Portion of the same. $\times 30$. (Slide 678A.)

Fig. 28. Transverse section of "Sparganum" cortex of the midrib, *cf.* fig. 19; *scl.*, sclerotic cortex; *par.*, parenchymatous cortex. $\times 15$. (Slide 2094.)

Fig. 29. Transverse section of a stem in Mr MATHESON'S block, showing the beginning of secondary thickening. $\times 9$. (Slide 2105.)

Fig. 30. Transverse section of outer cortex of midrib, showing a long emergence. $\times 13$. (Slide 2093.)

Fig. 31. Transverse section of outer cortex of midrib, showing several short emergences; *scl.*, sclerotic cortex; *par.*, parenchymatous cortex. $\times 13$. (Slide 2095.)

(All the figured specimens are in the collection of Dr R. KIDSTON.)

KIDSTON AND GWYNNE-VAUGHAN.—PLATE I.

KIDSTON AND GWYNNE-VAUGHAN.—PLATE II.

KIDSTON AND GWYNNE-VAUGHAN.— PLATE III.

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R. Kidston, Photo.

STENOMYELON TUEDIANUM, Kidston.

M'Farlane & Brakine, Lith., Edin.,

KIDSTON AND GWYNNE-VAUGHAN.—PLATE IV.

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