

Annals of the Missouri Botanical Garden

Vol. 29

APRIL, 1942

No. 2

CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS

III. STIPITOPTERIS

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The fossil described in this paper, a fern petiole fragment referable to the form genus *Stipitopteris*, was discovered in a coal-ball collected at the Pyramid Mine of the Binkley Coal Company, located three miles south of Pinckneyville in Perry County, Illinois. The coal in this mine is described as belonging to the lower McLeansboro series and is known as coal number 6. A more detailed discussion of the occurrence of coal-balls at this locality has been given in the first of this group of contributions (Andrews, '42).

Materials and Procedure.—The single specimen of this fern consists of a fragment of a petiole approximately 4 cm. long. The coal-ball containing it, numbered WBC170 in the collections of the Henry Shaw School of Botany of Washington University, was cut into six sections, each being approximately 13 mm. in thickness. The fern petiole was well preserved in the two center sections, but rather badly crushed and distorted in the two adjoining ones. Of the center sections, one was used to prepare a series of transverse peels while the other was used for longitudinal sections. It was possible in this way to observe the nature of the tracheid pitting as well as the distinctive transitional anatomy of the trace as a whole.

The nitrocellulose peel method was used in obtaining preparations. This method produced much more satisfactory preparations for study and photographic purposes than ground sections, chiefly

because the dark contents in the parenchyma cells of the latter made it very difficult to grind sections sufficiently thin.

Description.—The petiole is more or less oval in outline and measures approximately 10 by 13 mm. in diameter. The most distinctive feature is the transitional organization of the xylem of the leaf trace. At one end of the specimen (pl. 9, fig. 1) the trace is in the form of an elongated "horseshoe" with the free ends involuted, while at the opposite end (fig. 4) it forms a continuous band enclosing an isolated W-shaped segment. A selection from the peel preparations shows these extremities as well as two intermediate stages (figs. 3, 4) in the isolation of the W-shaped strand. Text-figures 1 and 2 show the organization of the xylem tissue of the leaf trace as reconstructed from the series of peel preparations. The actual distance through which the illustrated transition takes place is approximately 10 mm. The longitudinal dimension has been exaggerated somewhat in the text-figures in order to show the transition clearly.

The xylem of the trace, which is shown as the rather prominent white band in figs. 1-4, consists of primary metaxylem 2-4 cells wide with scattered groups of protoxylem located on the inner side. The metaxylem cells are uniformly scalariform (pl. 10, fig. 7) and vary from 15 to 91 μ in transverse section, the average being about 47 μ .

The protoxylem groups are endarch and numerous, being arranged around the entire inner periphery of the metaxylem, although they are more numerous in the involuted portion of the trace (fig. 1). It is difficult to ascertain the exact number of protoxylem groups, partly because of faulty preservation in spots and partly because the size distinction is not always great between metaxylem and supposed protoxylem. The number is approximately 25-30 and the average size of a clearly defined protoxylem cell is 21 μ . In the isolated W-shaped strand they are found on the upper side, as the petiole is illustrated in fig. 3. This corresponds to the inner side of the surrounding cylinder.

Scott ('09), in describing the protoxylem of *Caulopteris*, does not mention the number of protoxylem groups present but only says that they occur, "as a number of small groups of cells on the inner edge of the xylem, which is thus endarch" [page 302]. This agrees with the specimen described here which has been shown to have centrally located protoxylem groups.

Phloem, pericycle and endodermis are not preserved. In all our

preparations the inner cortex is rather closely appressed to the xylem although there is some evidence that a tissue (or tissues) was formerly present between them. If such were the case it must have been a very narrow layer.

The cortex presents a number of distinctive features. Taken as a whole, it is composed of two sharply defined zones. The outer one reaches a thickness of a little more than 1 mm. and consists of cells which are large, thin-walled and rather badly crushed due to their apparently delicate nature in life. The inner zone averages about 1.5 mm. thick and consists of somewhat smaller cells partially filled with an opaque substance which may represent metamorphosed tannin or gum deposits. These two zones are separated by a narrow band of dark brown, closely compacted cells suggestive of meristematic activity. The pith or central parenchymatous mass consists of isodiametric cells with some dark contents but these are not so abundant as in the inner cortex.

Taxonomy.—There is little doubt that this petiole belongs to a stem of one of the Carboniferous tree ferns known from structurally preserved remains as *Psaronius* and it evinces leaf scars of the *Caulopteris*¹ type. This is evident from a comparison of the Illinois specimen as shown in figs. 1-4 with *Caulopteris varians* Renault and Zeiller ('88) (pl. 10, fig. 5). The portion of the stem of *C. varians* in Renault and Zeiller's figure shows leaf scars at slightly different levels, and since the transition of the leaf trace takes place rapidly the comparison is possible. One of the bundle scars shown in their figure presents the elongated horseshoe type of trace similar to that in the Illinois specimen shown in pl. 9, fig. 1. Another bundle scar on the same portion of the stem shows the trace as a continuous band with the isolated W-shaped segment within the outer band (c.f. pl. 9, fig. 4).

Since the petiole described here was not found attached to the stem of *Caulopteris*, though there is little doubt that it was originally, it becomes necessary to describe it under the name *Stipitopteris*. That genus was introduced by Grand'Eury in 1877 for petioles of ferns whose structure in cross-sections corresponds to the marks on the leaf scars of *Caulopteris*, but which were not known in organic connection with the latter.

The leaf scars of certain species of *Stemmatopteris* Corda, de-

¹ The name *Caulopteris* was first used by Lindley and Hutton ('32) for supposed stems of the tree fern *Psaronius* which had been preserved as casts showing only surface features.

scribed by Lesquereux ('80) from the Carboniferous formation of Pennsylvania, show a similarity to a cross-section of the petiole described in this paper. *Stemmatopteris* and *Caulopteris* are undoubtedly closely related or even congeneric, and Lesquereux himself wrote that "the whole number of our species could have been described without inconvenience under the name of *Caulopteris*." Hirmer ('27) considers the two congeneric.

There is also a striking similarity between the petiole described here and species of the genus *Anachoropteris* Corda. Darrah ('41), in his recent account of the Coenopterid ferns of the American coal-balls, points out that the taxonomic limits of *Anachoropteris* are in considerable doubt and that some of the forms included in the genus are now known to be portions of plants really belonging to other genera. He states, however, that the involute stele of most of the species seems to constitute a generic character. Corsin ('37), in his treatment of *Anachoropteris*, speaks of the protoxylem as occurring on the outside of the metaxylem rather than on the inside as in *Stipitopteris*. This apparent difference, in conjunction with the similarities between both of the aforementioned genera, brings up the question of the taxonomic value of the location of the protoxylem. Tansley and Lulham ('05) considered that in many cases it is of considerable significance, and they point out the universal exarchy of the steles of the Sphenophyllales and Lycopodiales and the endarchy of the Angiosperms. However, they conclude that the Filicales are rather different in that the exact position of the spiral protoxylem in relation to the metaxylem of the vascular strands of the stem is decidedly variable. They found exarchy, endarchy and mesarchy all within comparatively small groups, and concluded that the actual course of evolution seems to affect the position of the protoxylem much more freely and rapidly than in the other great groups of vascular plants. From this evidence it would seem that the use of the location of the protoxylem to separate genera in this group of ferns might be questioned. It is, however, evident that the stability of this character varies in different groups.

It is probable that an extensive taxonomic revision of the genera *Anachoropteris*, *Caulopteris*, *Stipitopteris* and *Psaronius* will be necessary in the future. This paper is intended as a further contribution to the apparent relationship between petioles described as *Anachoropteris* and *Stipitopteris* and fern stems described as *Psaronius* and *Caulopteris*.

STIPITOPTERIS

Grand'Eury ('77) described four species of *Stipitopteris* from the Carboniferous of France. His descriptions are very brief, and his only illustration is the cross-section of a petiole which is merely labeled *Stipitopteris*. It is interesting to note, however, that the isolated strand of xylem in his specimen is turned in the exact opposite direction from the Illinois specimen. Since the Illinois specimen is quite distinct from any described species of *Stipitopteris* it is described here as a new species.

Stipitopteris americana Lenz, sp. nov.—Petioles somewhat oval, 10 by 13 mm. in diameter; cortex consisting of two distinct zones, the outer approximately 1 mm. in thickness and formed of cells which are large, thin-walled and rather badly crushed, the inner about 1.5 mm. in thickness and consisting of somewhat smaller cells partially filled with an opaque substance; zones separated by a narrow band of dark closely compacted cells; leaf trace in the form of an elongated horseshoe with the ends involuted and fusing to form an isolated W within a continuous xylem cylinder; protoxylems endarch, of spirally thickened tracheids in small scattered groups; metaxylem 2–4 cells thick, consisting of scalariform-pitted tracheids, 15–91 μ in diameter.

Locality: Pyramid Mine of the Binkley Coal Company, Perry County, Illinois.

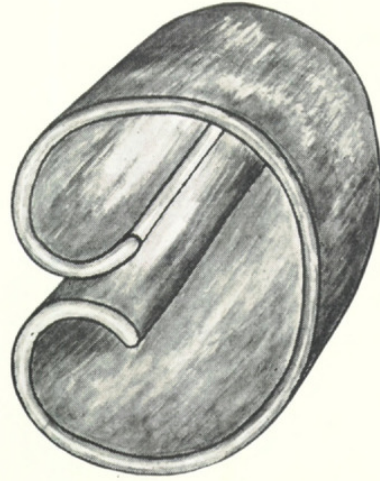
Type: Coal-ball WCB170 in the collections of the Henry Shaw School of Botany of Washington University.

Acknowledgment.—The author wishes to express his appreciation to Dr. H. N. Andrews who suggested the problem and under whose direction the work was carried out; to Dr. A. H. Blikle, for helpful suggestions relative to the natural affinities of the fossil described; and also to the Binkley Coal Co., for its continued kindness and cooperation in extending the privilege of collecting coal-balls from the mine.

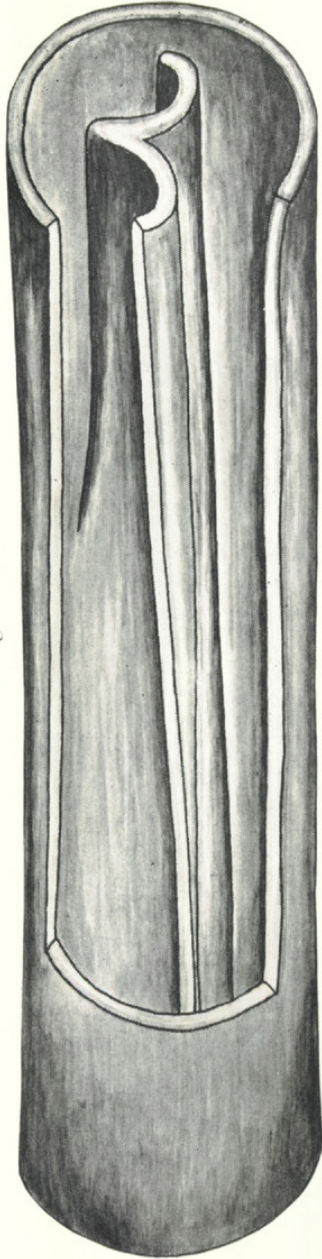
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1



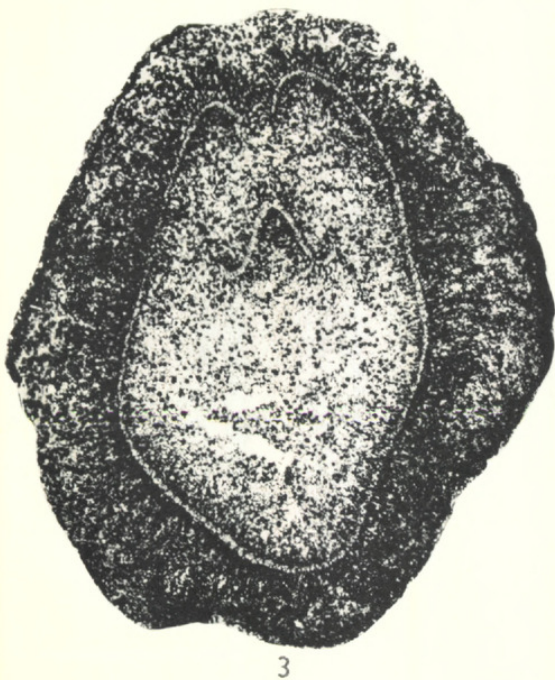
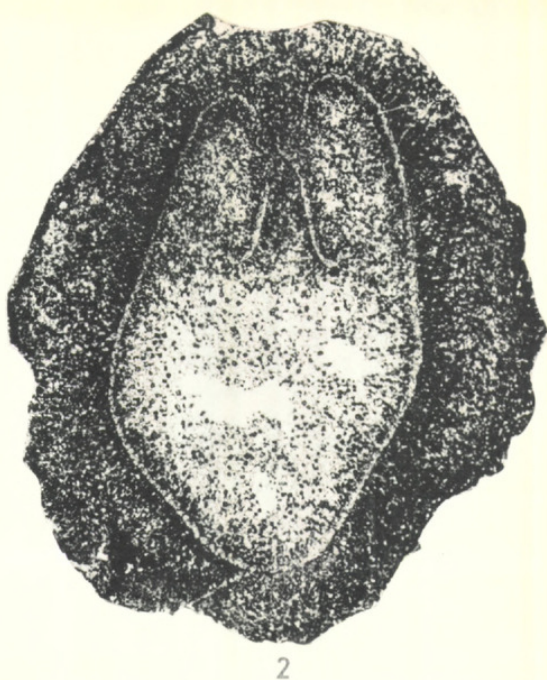
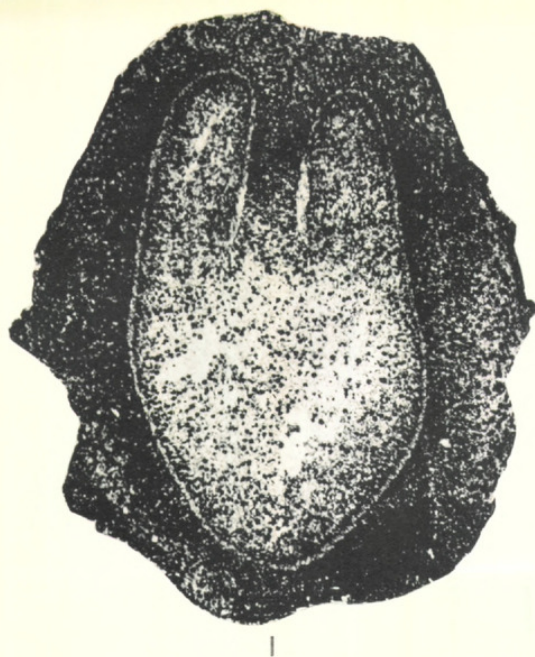
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Text-figs. 1, 2. *Stipitopteris americana*. Reconstruction from a series of peels showing the transition of the xylem tissue from the horseshoe shape, shown in fig. 1, to the cylinder of xylem enclosing the isolated W-shaped segment, shown in fig. 2.

EXPLANATION OF PLATE

PLATE 9

Figs. 1-4. *Stipitopteris americana*. Part of a series of peel preparations showing the transitional anatomy of leaf trace; fig. 1, WCB170D.B9, fig. 2, WCB170D.T40a; fig. 3, WCB170D.T25; fig. 4, WCB170D.T8. All figures $\times 5$.



LENZ—AMERICAN CARBONIFEROUS FLORAS. III



Lenz, L Wayne. 1942. "Contributions to Our Knowledge of American Carboniferous Floras. III. Stipitopteris." *Annals of the Missouri Botanical Garden* 29, 59–68. <https://doi.org/10.2307/2394330>.

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