Proceedings of the Iowa Academy of Science

Volume 21 | Annual Issue Article 11

1914

Notes on a Fossil Tree-Fern of Iowa

Clifford H. Farr
State University of Iowa

NOTES ON A FOSSIL TREE-FERN OF IOWA.

BY CLIFFORD H. FARR.

The members of the *Psaroneae* comprise a family of ferns which lived during later Paleozoic times and often developed to treelike dimensions. Some believe that they were closely related to the *Cyatheaceae,* to which modern tropical tree-ferns belong. Most botanists, however, consider the *Psaroneae* a family of the order *Marattiales.* Members of this order still live, but, though tropical, are, for the most part, low forms with stumplike stems and enormous leaves. The *Marratiales* have been sometimes thought of as ancestors of the *Pteridospermae,* and it is possible that the *Psaroneae* may yet be associated with this latter group. Specimens of the fossil *Psaronius* have in rare instances been found in organic contact with the impressions of the frond of *Pecopteris sterlzeli.* This last-named species closely resembles the leaves of *Pecopteris pluceneti,* which according to Grand 'Eury is one of the seed-bearing forms.

The *Psaroneae* proper are all treelike in habit, and have been found only in the Upper Carboniferous and the Lower Permian strata. Their geographical distribution includes Saxony, Central France, Bohemia, Brazil, and North America. Some writers believe that at times the tree reached a height of at least sixty feet.

A peculiarity of *Psaronius* lies in the fact that after the lower leaves had fallen off, adventitious roots grew out among the leaf scars and thence downward to the ground. Though these are individually very small, they are produced in such numbers that the leaf scars were completely obscured from view, and a sort of false cortex enveloped the stem in its lower region.

The genus is composed of three general types of stems distinguished by the arrangement of leaves and hence of leaf scars. Each of these types is represented by a number of species. One kind has the leaves in two longitudinal rows, *distichi;* in another there are four longitudinal rows, *tetrastichi;* and the remaining species have them disposed more or less in spirals, *polystichi.*

Several years ago some fragments of *Psaronius* were found in the Upper Carboniferous of Hardin county, Iowa. They consisted for the most part of petrifactions of adventitious roots, while one showed a small portion of the periphery of the stem. Dr. T. H. Macbride re-

ferred these to a new species, *Psaronius borealis,* and described them in the Proceedings of the Davenport Academy of Science for 1907. That description has been appended to this paper.

During the summer of 1913 Mr. Ralph Gray found another specimen of *Psaronius* in that same region. It had been eroded from the bank of a nearby stream, so that its geological position unfortunately cannot be exactly determined. Its composition is sandstone infiltrated with a large amount of iron. Since it bears no marks of glaciation there is no evidence that it grew and was fossilized in any other locality than that in which it was found. The country rock at that place is Upper Carboniferous, and this also lends strength to this interpretation, that it grew near the place of finding.

The fossil is cylindrical, about fourteen inches in length, and three inches in diameter. Judging from the thickness of the false cortex of roots the portion fossilized is that part of the stem some distance above the ground. The vascular system at the upper end indicates that the living stem must have extended upward at least twenty inches farther, so that this tree-fern was doubtless several feet in height.

The leaf scars are arranged in eight longitudinal rows, those of adjacent rows alternating. They thus appear to be spirally disposed, and hence this specimen should be classed with the *polystichi.* The distance between successive leaf scars of the same longitudinal row varies from twenty-five to thirty-two millimeters. Each leaf scar is oval in form, and its abscess surface has a vertical diameter of thirty-eight millimeters and a horizontal diameter of nineteen millimeters. On this surface there is a V shaped elevation somewhat below the center, doubtless marking the leaf trace. A very prominent groove extends downward from the lateral margin of each leaf scar, defining the boundary of the leaf base as it enters the stem proper. This groove varies from eight to thirteen millimeters in length. The leaf scars are not all well preserved, about half of them being hollow cavities which were packed with friable sand when the specimen was found. These poorly preserved leaf bases are for the most part on one side of the stem, which indicates that the latter lay on the surface of the ground for some time before it was petrified. In this way decomposition took place on the lower, more moist, side.

Between adjacent rows there appears a ridge, one centimeter in diameter, and perpendicular in direction. It is bounded on either side by the leaf scars and the grooves which are associated with them. The degree of convexity of the ridge is rather variable. It may be almost

flat, or be uniformly rounded, or a sharp edge may be found on either side or along the center.

Among the leaf bases are the attachments of the rootlets which grew out after the leaves had fallen off. These are very minute, being not more than one millimeter in diameter. They are especially prominent along the grooves, but may occur in any part of the inter-abscissal area. The roots themselves were probably torn off in some way before petrifaction took place, for no evidence of abrasion is seen on the fossil remains. At the lower end of the stem an area of about twenty-eight square centimeters is covered with a mass of these rootlets about eight millimeters in thickness. These present a very fibrous appearance due to the parallel arrangement of the rootlets. It cannot be absolutely determined whether this represents the entire thickness of the false cortex at this place or not; but the general appearance favors such an interpretation. A few of the absciss surfaces of the leaf scars appear fibrous; it is probable that this indicates the overlying of rootlets, most of which had in some way been removed.

By polishing the upper end of the specimen it was possible to define the general system of vascular supply. From the marked radial symmetry of the leaf arrangement it seemed probable that the vascular system would also be symmetrically disposed. On this account the

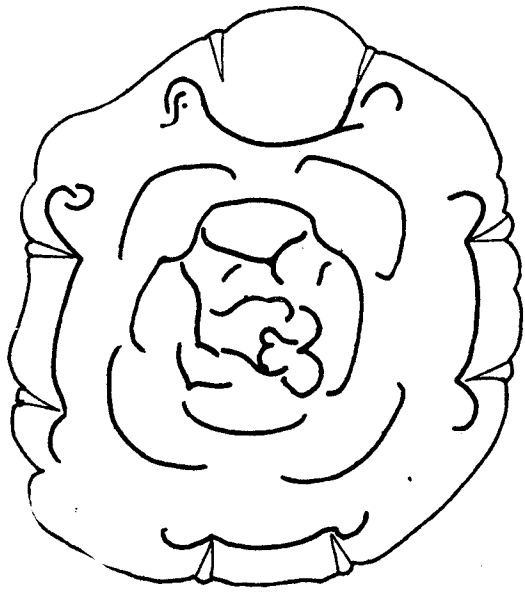

Fig. 3.—Diagram of the slightly oblique polished surface of the upper end of the specimen, showing the arrangement of vascular bundles.

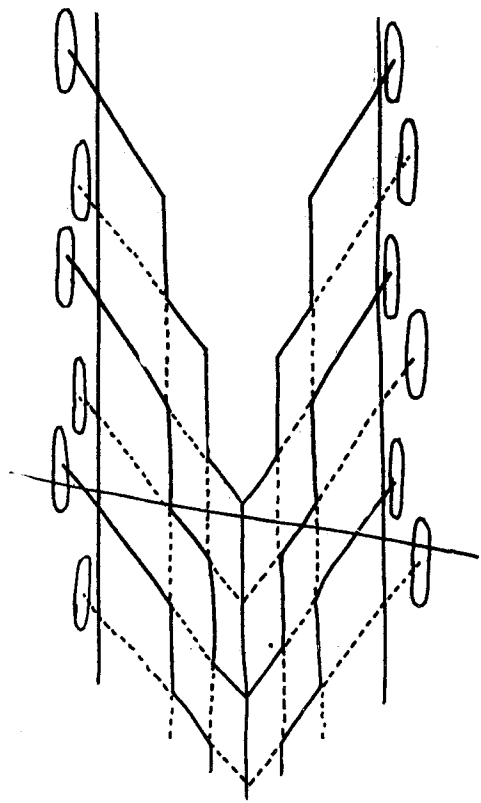

Fig. 4.—Schematic drawing of vascular system in longitudinal aspect.

polished surface was made slightly oblique, making possible the determination of the form and general course of the strands from a single section (Fig. 3). Figure 4 is a schematic drawing of the bundle arrangement in longitudinal aspect, constructed from a study of the polished section and the leaf scars. The leaf traces of only four rows of leaves are indicated in this scheme, those of the other four being omitted for the sake of simplicity. In order to distinquish between the leaf traces of successive nodes they have been represented alternately by broken and entire lines.

Beneath each ridge, which runs longitudinally between two rows of leaf scars, a horseshoe-shaped vascular strand extends from the base to the apex of the stem. This strand is convex outward and measures about eight millimeters from edge to edge. Small accessory bundles may sometimes be seen along these edges; they probably arise from the horseshoe-shaped strand and proceed to the rootlets. Other root bundles arise from the junction of the strand with the leaf trace itself.

For each leaf base there is a single leaf trace. As it enters the leaf base it is broad, and slightly convex outward. As it passes in its outward course between two of the horseshoe-shaped peripheral strands it connects with them along either edge. It will thus be seen that the peripheral strand in its upward course unites with a leaf trace first on one side and then on the other, but at no one level do peripheral strands and leaf traces constitute a complete ring.

The four leaf traces of the leaves of the next node above may be found alternate with those just described and on their inner side. They are similarly convex outward and in addition their edges are slightly recurved. They are at least two centimeters in width and are separated laterally by a distance of not more than one centimeter.

The leaf traces of the second node above the polished surface form a similar cycle within the one last mentioned. They are, however, less convex; and their edges are in no instance recurved. Within this cycle the system is somewhat more complicated. Each leaf trace of the third node above is broken into three vascular strands arranged side by side in the form of a curve. The middle strand is fused along its edges with the two adjacent traces of the next outer, or second, cycle. Since in this way each leaf trace of the second node unites on either side with the middle strand of the leaf trace of the third node there is formed a complete vascular ring. Each of the lateral strands of the leaf trace of the third node is joined to the middle strand of the leaf trace of the fourth node; while the lateral strand of the fourth sometimes remains independent or may connect with both the middle strand of the fourth and the lateral of the third node, forming a triradiate figure. This anastomosis of the leaf traces into three strands is only a local modification and does not disturb the individuality of the leaf trace as it is followed downward. It seems that these three strands unite again at a lower level to constitute the original leaf trace once more.

The leaf trace of the fifth node above is seen to anastomose in a similar manner, but the strands are in this case much narrower, being only about five millimeters in width. The four leaf traces of the fifth node, when followed downward, are seen to unite together to form the central strand of the stem. It thus appears that all leaf traces originate from this central strand and after more or less anastomosis proceed individually to their respective leaf bases. It will be remembered that in their course they fuse laterally with the leaf traces of the whorl immediately above and that immediately below. In this way two con-

centric vascular rings are seen to be formed enveloping the central strand. Each of these rings is, however, slightly perforate, due to the anastomosis of the individual leaf traces into three strands at different levels.

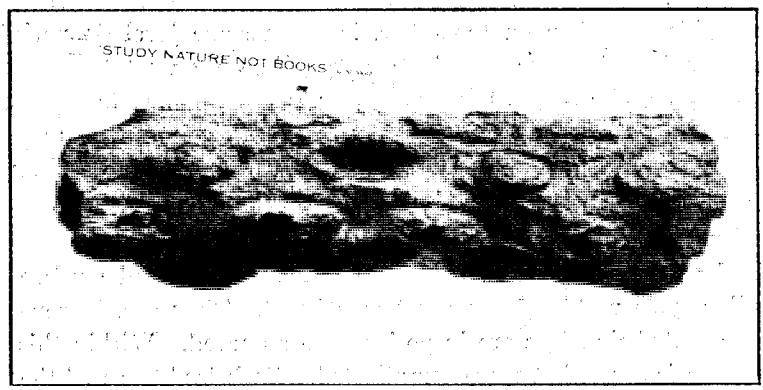

Fig. 5.—Photograph of the specimen of Psaronius.

It seems probable, therefore, that this stem arose from one with a single solid central vascular core, from which the leaf traces proceeded independently to the leaf bases. Such an arrangement would resemble the primitive protostele. The system, as here found, may thus have arisen by a lateral fusion of the leaf traces at different points. It is easy to see, that, should this tendency toward fusion continue a little farther, two imperforate hollow cylinders would be developed about the central strand. This might be thought of as a double siphonostele. It would furnish direct vascular connection between the roots and the leaves, irrespective of the vascular strand in the center; and, since it would be more peripheral, might, in a large stem, constitute a considerably shorter route, and hence transmit a larger amount of water than the central strand. According to the generally accepted theory of use and disuse the central strand would tend to abort under these circumstances. The same factor might operate to obliterate the inner of the two hollow cylinders, so that finally but one hollow cylinder or, in other words, an ordinary siphonostele would supplant the present more complex form. It is not here contended that this is the only way in which a siphonostele may have evolved from the protostele, but the specimen here described suggests the above as a possible course in this group of plants.

ADDENDA.

The following description of *Psaronius borealis,* Macbr. is taken from the Proceedings of the Davenport Academy of Science, vol. X, p. 158:

> The fossil here described is represented by several fragments of a pteridophytous stem about ten centimeters in length and six in width. The whole specimen is strongly impregnated with iron, probably haematite. The iron deposits are so extensive as to have replaced almost entirely the vascular parts of the associated structures. The central mass of the stem seems to have been composed of two elements, a parenchymatous, as we infer from the homologies of the case, now wholly lost and replaced by sand, and a vascular element preserved only in part, but showing the bandlike form characteristic of the stems of larger ferns, as for instance, some Cyatheas, where the section of each bundle is arcuate with the tips of the arc more or less reversed or flexed. This feature of the fossil is indicated in Plate V, Fig. 1. The entire stem, when perfect, must have been fifteen or eighteen centimeters in diameter.
>
> The outer part of the stem, Plate V, Fig. 2, much better preserved than the central axis, shows a vast multitude of vascular strands more or less parallel to each other and to the principal axis; not straight, however, but interwoven, grown through each other apparently in a most intricate mass. Between the strands a crude, rather thick-walled parenchyma is seen. Each strand has for its center a fibro-vascular bundle of the concentric type, showing scalariform ducts of unequal diameter; but the bundle is itself surrounded by a strongly developed sheath or moss of sclerenchymatous cells everywhere well preserved. Plate VI, Figs. 1 and 2.
>
> The generic reference of this fossil would seem sufficiently clear. Specific distinctions here, as elsewhere, are purely tentative, but for convenience of reference the specimen may be called by a specific name. The distribution of the principal vascular strands may possibly here suggest specific characters, although in existing forms such arrangement is generally significant of a much larger group.

BOTANICAL LABORATORY,
STATE UNIVERSITY OF IOWA, IOWA CITY.