

STRUCTURE OF SOME CARBONIFEROUS PLANTS FROM ILLINOIS.

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In the few years since the discovery in America of those petrifications known as coal balls by Doctor Noé, of the University of Chicago, his students and others have described a number of American Coal Measure Plants based on structure from this type of material.

This paper deals in a preliminary way with some additional forms, not heretofore described from American material.

The petrifications which formed the material basis of this paper were collected, either by Doctor Noé or by the writer from the McLeansboro formation of the Coal Measures of Illinois.

The specimens described fall into three orders of vascular spore-bearing plants, the Lycopodiales, Equisetales and Filicales.

I. Lycopodiales: One of the common Coal Measure representatives of this order is *Lepidodendron*. Anatomically, two general types of steles are recognized, those in which a continuous ring of primary xylem encloses a central pith, and is in turn immediately enclosed by the cortex, and those in which the primary wood may or may not enclose a pith, but is surrounded by a definite zone of secondary wood, which often is of considerable thickness. Of the dozen or more British species known from structure, about half belong in each group. Our specimen of the first type has a relatively large and well preserved pith. The primary xylem forms a fairly narrow but continuous zone, with the protoxylem occurring as small groups of tracheids on the periphery of the woody zone. The tissue outside the xylem is not well preserved, and little is known of the structure of the cortex. The stem has a diameter of about 20 mm.

A decorticated stem approximately four inches long and an inch in diameter illustrates the second type of stem, in which the primary wood is surrounded by a zone of secondary wood. In this case the secondary wood formed a relatively thick zone, and the indications are that an unknown amount of wood was removed before petrification occurred.

The pith, while probably occurring in a branch of this size, is not preserved. The primary wood is continuous and of uniform character throughout part of the cylinder only, as part of the circumference is broken into units which give the appearance of individual bundles. The tracheids of the primary wood have the usual scalariform markings on all walls, and the protoxylem is easily recognized on the outer circumference of the primary wood.

The radially arranged cells of the secondary wood are slightly smaller than those of the primary. The pith rays are narrow and fre-

quently contain spiral elements. Occasionally a leaf trace is encountered passing out through the secondary wood.

Nothing can be told of the phloem and cortex of this particular specimen.

A common fossil in these petrifications is *Stigmaria*, the underground part of *Lepidodendron*, and also the underground part of *Sigillaria* and *Bothrodendron*, other coal measure members of the arborescent Lycopodiales. In transverse section it may be seen that there is a very small development of primary wood, which grades promptly into the secondary wood. The smallest tracheids, those with spiral markings constituting the protoxylem, contrary to the situation found in the stem of *Lepidodendron* and contrary to the situation most generally found in the living members of the Lycopodiales, are found next the pith, and consequently the entire development of the primary wood of *Stigmaria* was centrifugal.

Primary rays divide the woody stem into bundles. Traces to the so-called "rootlets" are frequently found traversing these primary rays, and in tangential section appear as tongues of wood, with the apex free in a cavity formed by the breaking down of the parenchyma tissue of the ray. The point of the rootlet trace, consisting of the spirally marked protoxylem cells, is directed toward the growing point of the *Stigmaria*.

The "rootlet" in transverse section consists of a small centrally placed stele and a wide cortex. The cortex has three distinct zones of tissue; the inner cortex, which is a narrow zone of parenchyma immediately surrounding the vascular elements; the middle cortex, generally not preserved, made up of very thin-walled cells, and the outer cortex, composed of compact heavy-walled cells.

The vascular strand as a rule has only the wood preserved, but occasionally all the tissues of the rootlet remain. The xylem in transverse section is somewhat triangular, with the protoxylem at one apex which is generally somewhat elongated. The phloem, when it can be identified, is more abundant on the side of the triangle opposite the protoxylem point, and while it may extend somewhat around the xylem, never encloses it. The phloem is difficult to identify as distinct from a possible pericycle and other parenchyma tissue.

Secondary xylem sometimes occurs in the form of a few radially arranged rows of tracheids on the side of the primary xylem opposite the protoxylem.

The endarch collateral bundle of *Stigmaria*, and the vascular arrangement of the "rootlet" in which the primary xylem and phloem are not radial but are on the same radius, seem to prohibit the consideration of *Stigmaria* and its appendages as true roots. Rather it would seem that *Stigmaria* is an underground stem and the *Stigmaria* "rootlets" are of the nature of modified foliar organs.

II. Equisetales: The foliage of Calamites, an arborescent Coal Measure member of the Equisetales was of two types; a narrow linear form, *Asterophyllites*, the anatomy of some species of which is well known due to several excellent investigations of leaves of this type found attached to Calamitean twigs, and a type of foliage known as

Annularia, which is broader than Asterophyllites, slightly united at the base into a sheath, and often spatulate in form. Annularia is not positively known based on structure.

Certain unattached foliar parts of Calamites have been described, but the possibility is always present that they represent not the foliage, but the sterile bracts of a Calamitean fructification. Numerous sections of such a foliar organ from the Illinois Petrifications show, however, such a close comparison not only as to dimensions of impressions of leaves of the Annularia type, but also as to the anatomical details of leaves of the Asterophyllites type, that it seems probable that the sections are those of a Calamitean leaf of the Annularia type.

III. Filicales: Though the systematic position of Psaronius is not at present determined without the possibility of change, it is generally accepted that it belongs in the Filicales. Free rootlets of Psaronius are common in many coal balls and in some instances have remarkable preservation, and are unusual in the small number of xylem arms in the stele of the rootlet, sometimes having as few as four, although commonly having five or six in this specimen. The cortex consists of a wide inner zone, composed of extremely lacunar tissue, bounded on the outer side by a narrow zone of sclerenchyma tissue, which in turn is again surrounded by parenchyma and the epidermis.

Those rootlets making up the "rootlet" zone, which immediately surrounds the stele of the stem, differ from the free rootlets in the absence of the outer parenchymatous zone, the sclerenchyma apparently being the limiting tissue except where the cells have elongated to form the filamentous interstitial tissue. The stelar anatomy of several species of Psaronius is well known; that of the specimen under discussion is not at present sufficiently investigated to offer at this time.

The Botryopteridaceae, or according to Bower, the Caenopteridaceae, is a group of true ferns which have not thus far proved abundant in American coal measure petrifications. Two genera are herein presented: Botryopteris, of the Botryopterideae, and Anachoropteris, of the Anachoropterideae.

Botryopteris was first made known by Renault, in his description of *B. forensis*. Several British species and at least one Belgian species have since been described. One of the interesting characteristics of Renault's *B. forensis* was the elongation of the three xylem arms of the bundle of the petiole in the form of the Greek letter ω . Our American specimen shows no contradiction to Renault's specimen in the matter of dimensions nor anatomy, with one exception. The hairs which clothe the stems and petioles of Botryopteris generally, had a peculiar arrangement in the case of *B. forensis*, in, that each cell of the hair had a ring of teeth at the distal end, giving the hair the appearance of a miniature equisetum. Excellent views of the hairs of our specimen failed to show any such arrangement. However, it is not considered that this difference is specific, in view of the constant similarity of all the other features.

The Anachoropterideae are known by the only representative, Anachoropteris, based on the description of petiole and fructification. The

stem is not known. The petiole, however, has a characteristic anatomical arrangement which is not easily confused with other genera.

The petiole bundle of *Anachoropteris* is concentric with the margins considerably revolute. Apparently the convex side of the bundle was turned toward the stem. The xylem encloses a mass of sclerenchyma which was continuous with the outer cortex. The inner cortex was not preserved.

The protoxylem is located on the convex side, slightly enclosed in the primary xylem. There appear to be four such groups. The pinnae traces are given off from the convex side and are connected with a protoxylem group.

A comparative study of the petiole of *Anachoropteris* and also the fructification identified by Kubart, would seem to show that there is not a close relationship between the *Anachoropterideae* and the other members of the *Botryopteridaceae*.