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FLORA OF THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION OF UTAH AND COLORADO, PART II. MESEMBRIOXYLON STOKESI

G. F. Thayn¹ and W. D. Tidwell¹

ABSTRACT.—Mesembrioxylon stokesi, sp. nov., from the Lower Cretaceous Cedar Mountain Formation of Utah is described and compared with other species of Mesembrioxylon. *Mesembrioxylon stokesi* is similar to Aptian members of this genus in having a combination of wood parenchyma and septate tracheids. This lends some support to the Cedar Mountain Formation being partially Aptian in age.

The Lower Cretaceous Cedar Mountain Formation is exposed throughout much of eastern Utah, western Colorado, and north central New Mexico (Young 1960). This formation is fossiliferous at several localities. Fisher et al. (1960) listed the formation as Aptian. It is still uncertain, however, whether it is Aptian, Albian, or both. Fossil plants reported from the Cedar Mountain Formation include *Tempskya* (Katich 1951, Stokes 1952, Tidwell and Hebbert 1972, Tidwell et al. 1976), cycadeoids (Furniss and Tidwell 1972), and dicotyledonous wood (Thayn et al. 1983). This paper is the first detailed report on coniferous woods from this formation.

The specimens of fossil woods constituting this report were collected from Molen Ridge, Emery County, Utah (Thayn et al. 1983). The Cedar Mountain Formation at this locality consists of a cap of coarse-grained, white sandstone that is underlain by channel fills of alternating yellow conglomeritic sandstone and grey-green shales. These beds are underlain by a dark green, nodular, weathering shale. The petrified logs at this site are highly

Fig. 1. Illustration of the transverse section showing distribution of axial parenchyma and general shape and arrangement of tracheids of *Mesembrioxylon stokesi* (Holotype).

Fig. 2. Radial section showing the size and arrangement of radial tracheary pitting, presence of axial parenchyma, septations in the tracheids and the crossfields of *Mesembrioxylon stokesi* (Holotype).

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fragmented and lie on the surface of the yellow channel fills. Other coniferous woods, dicotyledonous woods, and *Tempskya* have also been collected at this site.

*Mesembriorylon stoksei*, sp. nov.

**Description and Diagnosis.**—Growth rings indistinct with only a few layers of late wood cells; ring width varies 1.3–9.2 mm; transition from early to late wood gradual. Tracheids square, rectangular or oval in outline, with walls 7–10 µm; tracheid size ranges from 18 µm and isodiametric to 55 µm radial diameter by 18 µm tangential diameter; intercellular space common in late wood. Tracheids septate; radial tracheary pitting uniseriate, generally separate but occasionally vertically contiguous, circular bordered pits 10–19 µm in diameter. Pit apertures either circular or elliptic and small (3 µm) in relation to the size of the pit; crassulae lacking. Tangential pitting not apparent. Axial parenchyma abundant, 12–60 cells/mm². Parenchyma resinous, filled with dark cell contents. Axial parenchyma cells 40–210 µm high and up to 35 µm in diameter with 2–3 µm thick walls. Rays abundant, 9–14/tangential mm; 1–8 (ave. 4) rows of tracheids between the rays. Rays entirely parenchymatous; marginal cells wavy in outline. Rays uniseriate to partially biseriate, 1–50 (generally 8–16) cells (870 µm) high. Horizontal and tangential walls of ray cells smooth to slightly nodular and 2–3 µm thick (common wall). Ray cells square to rectangular; 35–125 µm radial diameter, 8–35 µm both tangential and vertical diameter. Crossfield pitting of two types; generally one podocarpoid pit per crossfield or very rarely 1–3 small bordered pits with slitlike apertures. Pits up to 18 µm in diameter, generally with broad border and with elliptic to square-oblong apertures, rarely thin borders with diagonally or vertically oriented elliptic apertures that range 3–9 µm at the widest point. Small crossfield pits approximately 4–8 µm in diameter with slitlike apertures.

**Repository:** Brigham Young University 2192 (Holotype).

**Locality:** Molen Ridge (Ferron Site) 9 miles east of Ferron, Utah (U.S. Geol. Surv.: Desert Lake Quadrangle NE, SW, Sec. 23, T20S, R8E).

**Horizon:** Lower Cretaceous Cedar Mountain Formation.

**Affinities.**—The most characteristic feature of *Mesembriorylon stoksei* is the large...
open pits seen in the crossfields. Among extant woods this type of pitting occurs in several members of the Podocarpaceae and in the genera Juniperus (Cupressaceae), Pinus (Pinaceae), and Sciadopitys (Taxodiaceae). In 1905 Gothan proposed the name Phyllocladoxylon for petrified conifer wood that lacks resin canals and wood parenchyma but has one simple ray pit (phyllocladoid) per crossfield and separate circular bordered pits on the tracheids. The name Podocarpoxyylon was also established by Gothan (1905) for fossil conifer wood with wood parenchyma and bordered crossfield pits with large elliptic apertures (podocarpoid pits). Stopes (1915) combined Gothan’s genera into Podocarpoxyylon pointing out that the two could not be distinguished on the basis of the crossfield pitting since both types of pits occur in the various species of both Podocarpus and Phyllocladius. Seward (1919) established the genus Mesembrioxylon because he thought, when there is no evidence of affinity with any particular living genus, a name free from implication should be used.

Krausel (1949) maintained a distinction between Phyllocladoxylon and Podocarpoxyylon also on the basis of the crossfield pitting. He defined Podocarpoxyylon as having small crossfield pits with vertical to steeply inclined apertures, whereas Phyllocladoxylon was to have large crossfield pits with oblique-elliptic apertures. Nevertheless, Bhardwaj (1953), Ramanujam (1953), Jain (1964), and Nishida (1966) all retained Seward’s Mesembrioxylon.

About 30 species have been described as Mesembrioxylon, Phyllocladoxylon, or Podocarpoxyylon. All but four of these species differ from M. stokesi by having different combinations of ray height, size and number of crossfield pits, axial parenchyma, configuration of tracheary pitting, and lack of septations in the tracheids (Table 1).

Mesembrioxylon woburnense (Stopes) Seward (1919) resembles M. stokesi in having rays varying from 1 to over 40 cells high and are occasionally partially biseriate. It differs in lacking septations in the tracheids and by having 1 or 2 pits in the crossfield that are in one horizontal row. It also has crassulae that are lacking in M. stokesi and radial tracheary pitting that is occasionally in two opposite rows rather than exclusively uniseriate.

Of the described species of Mesembrioxylon only M. nihei-takagi Nichida (1966) and M. gothani (Stopes) Seward (1919) have a combination of septate tracheids and wood parenchyma similar to M. stokesi. Mesembrioxylon nihei-takagi has rays up to 10 cells high that are uniseriate or partially biseriate and parenchyma in tangential bands. M. stokesi has rays up to 50 cells high that are uniseriate or partially biseriate and diffuse wood parenchyma. Mesembrioxylon gothani, as originally described by Stopes (1915), has
rays of 1–8 cells high that are exclusively uniseriate and scattered wood parenchyma. Shimakura (1937) reported a specimen of this species that had rays up to 18 cells high. Mesembrioxylon stokesi, however, has higher rays that are partially biseriate. Mesembrioxylon stokesi has a ray structure similar to M. woburnense and septate tracheids and crossfield pitting like M. gothani. Thus, M. stokesi appears to be a new species intermediate between the two.

Xenoxylon morrisonense Medlyn and Tidwell (1975) from the Upper Jurassic Morrison Formation, which underlies the Cedar Mountain Formation, is anatomically very close to Mesembrioxylon stokesi. They are similar in that both have septate tracheids and large podocarpoid crossfield pits. These species differ in that M. stokesi has broad borders on its podocarpoid pits as compared with the narrow borders in X. morrisonense. M. stokesi has smooth horizontal and end walls in its ray parenchyma and numerous resin cells, and its few contiguous bordered pits are not flattened as in X. morrisonense, a feature characteristic of most Xenoxylon species. Horizontal and end walls of ray parenchyma in X. morrisonense have numerous indentations and it lacks resin in any of its cells.

Protocedroxylon scoticum (Holden) Seward (1919) is also similar to Mesembrioxylon stokesi. However, P. scoticum has araucarian pitting (Holden 1915), which is lacking in M. stokesi.

The specific epithet of Mesembrioxylon stokesi is given in honor of Dr. William Lee Stokes of the University of Utah, who first collected specimens of fossil wood from the Molen Ridge site.

**Stratigraphic relationships.**—It is not presently known whether the Cedar Mountain Formation is Aptian or Albian in age. The presence of dicotyledonous woods in the formation (Thayn et al, 1983) possibly makes

<table>
<thead>
<tr>
<th>Species</th>
<th>Ray height</th>
<th>Tracheid septations</th>
<th>Radial pit size</th>
<th>Crossfield pitting</th>
<th>Axial parenchyma</th>
<th>Crassulaceae</th>
<th>Size and shape of Tracheids (x-section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. stokesi</td>
<td>1–18 to over 50</td>
<td>thick walled</td>
<td>circular 10–19 µm</td>
<td>one large podocarpoid pit with broad borders, having 1–3 small border pits, with lenticular apertures</td>
<td>abundant</td>
<td>lacking</td>
<td>square or radially elongate 18 x 18 to 18 x 55 µm</td>
</tr>
<tr>
<td>M. gothani</td>
<td>1–8, mostly 3 cells high (1–18 in Shimakura, 1937)</td>
<td>thin and horizontal</td>
<td>circular or ovoid, 15–17 µm</td>
<td>one or two 7 µm ovoid, circular or</td>
<td>sparse and diffuse</td>
<td>lacking</td>
<td>various, 20–25 µm</td>
</tr>
<tr>
<td>M. nihir-takagi</td>
<td>1–4, rarely 8 cells high thin and horizontal</td>
<td>circular or three, 5–8 µm</td>
<td>one to two, and diffuse</td>
<td>abundant</td>
<td>lacking</td>
<td>tangentially elongate 15–22 µm</td>
<td></td>
</tr>
<tr>
<td>M. woburnense</td>
<td>4–10, up to 35 cells high (over 40 in Shimakura, 1937)</td>
<td>lacking circular, 9–15 µm</td>
<td>one to two in a horizontal row zonal row 10–15 µm</td>
<td>sparse and</td>
<td>present</td>
<td>rectangular to radially elongate, 30–59 µm</td>
<td></td>
</tr>
</tbody>
</table>
it Albian since reported Aptian dicotyle-
donous woods have been placed in doubt by
Wolfe et al. (1975). Mesembrioxylon ranges
from the Permian to the Pliocene, but the
woods most comparable to M. stokesi were
first collected from sediments reported as
Aptian. Mesembrioxylon gothani and M. wo-
burnense have been collected from the Ap-
tian of England (Stopes 1915) and Japan
(Nishida 1966). However, Shimakura (1937)
reported both species from the Upper Cre-
taceous of Japan and M. woburnense was
reported from the Tertiary of India (Ramanuj-
jam 1953). The only other species of
Mesembrioxylon with septate tracheids and
partially biseriate rays is M. nihei-takagi
which was collected from the Aptian of Ja-
pan (Nishida 1966).

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Fig. 7. Radial section showing two types of crossfield
pits and circular radial tracheary pits (500x) of Mesem-
бриoxylon stokesi (Holotype).

Fig. 8. Closeup of radial section of ray. Note the
broad borders on the crossfield pits (1000x) of Mesem-
бриoxylon stokesi (Holotype).