

# FOSSIL FERNS OF THE MATONIACEAE FROM NORTH AMERICA

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ABSTRACT—Three species of the Matoniaceae referable to *Phlebopteris* are known from the Mesozoic of central and western North America. These are *P. galleyi* from the Dakota sandstone horizon (early Upper Cretaceous), and *P. smithii* and *P. utensis* from the Chinle formation (late Triassic). *P. galleyi*, known only from a pinnule fragment in a drill core, is distinctive because of its wide pinnule and numerous sporangia composing the wheel-like sorus. *P. smithii* is a fern of the *P. polypodioides* type but *P. utensis* shows venation characteristics that place it close to *P. angustiloba*.

The holotypes of *Phlebopteris galleyi* and *P. utensis* and topotypes of *P. smithii* are in the Museum of Palaeontology of the University of Michigan.

## INTRODUCTION

THE Matoniaceae, a small family of ferns that at present ranges from the eastern end of the island of New Guinea to the southern end of the Malay Peninsula, has a long history that extends throughout most of the Mesozoic era. Although old, the family apparently has never contained more than a few genera. At present it consists of *Matonia* and *Phanerosorus* which are reported as having two species each. *Phlebopteris*, the oldest and probably the largest genus ever to be encompassed within the family, had at least a half dozen species. It first appeared in the middle Keuper (Upper Triassic) and persisted into the Upper Cretaceous. Another genus, *Selenocarpus*, thrived during the early Jurassic, and *Matonidium* followed in the Middle Jurassic and lasted until Wealden time (early Cretaceous). *Matoniella*, a genus of the early Upper Cretaceous, may be the ancestor of the Recent *Matonia*. During the past the family extended far beyond its present restricted range. It is a common Mesozoic fossil in central

and western Europe, and is on record from Australia, Japan, India, North Africa, Greenland, and several places in the United States.

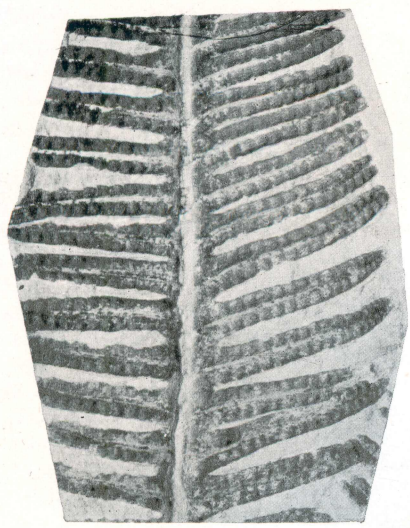
Uptil 1935 all references to matoniaceous ferns in North America (outside of Greenland) are dubious. In 1883 Fontaine described but did not name a fern from the late Triassic of North Carolina that he later (1900) identified as *Lacopteris lanceolata*. None of his figures, however, are more than merely suggestive of ferns having matoniaceous affinity. He also determined some sterile and fertile fragments from the Black Hills as *Matonidium althausii* (1899). The pinnule shape and sorus arrangement render the Matoniaceae possible but not certain. Then in 1905 Ward identified the same species from the Shasts group of California, but the figures likewise fail to do more than merely suggest matoniaceous ferns.

Berry (1911) gave the name *Knowltonella maxoni* to some fern fragments from the Patapsco formation (Potomac group) and later (1933) reported similar material from the Black Hills. The pointed and forwardly

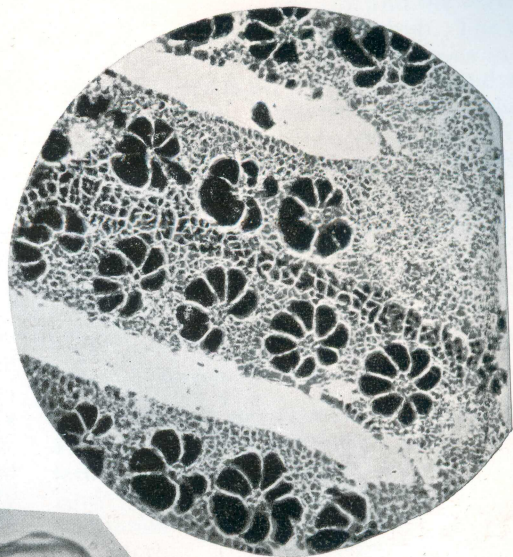
## EXPLANATION OF PLATE 16

### PHLEBOPTERIS UTENSIS Arnold

- FIG. 1—Portion of holotype (Figure 4) showing shape of pinnules and "fields" marked off by venation pattern. ( $\times 2.5$ ).
- 2—Basal portion of fertile pinnule showing form and arrangement of sori. From a cellulose peel transfer. ( $\times 20$ ).
- 3—Spore. ( $\times 750$ ).
- 4—Holotype specimen. Natural size.
- 5—Fertile pinna. Paratype. Natural size.
- 6—Portion of holotype specimen enlarged to show "fields" of the pinnule lamina. ( $\times 5$ ).



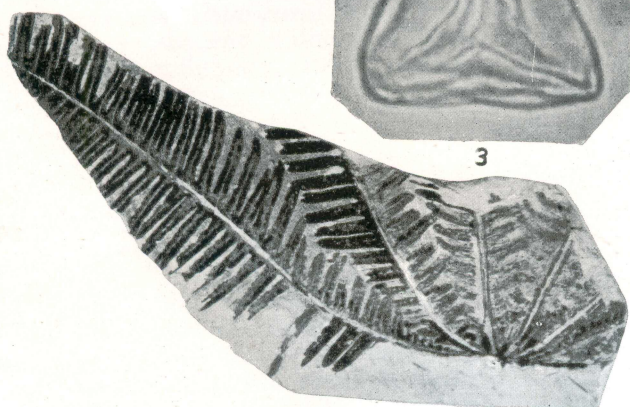
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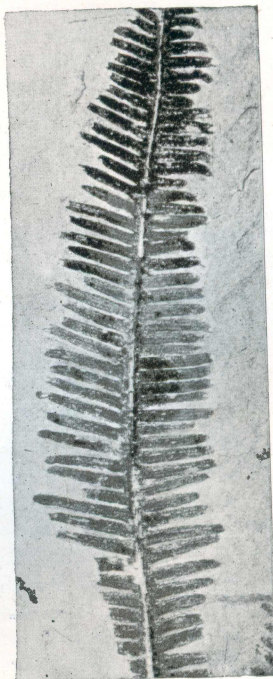
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ARNOLD: FOSSIL FERNS OF THE MATONIACEAE, FROM N. AMERICA.

directed pinnules of this fern are basally joined as in the Matoniaceae, but family affinities of any kind are not strongly expressed.

Aside from those that were reported by Seward (1926) and Harris (1931, 1946) from Greenland, the only North American ferns so far described that are unquestioned members of the Matoniaceae are *Phlebopteris galleyi* (Miner, 1935) from the Dakota sandstone horizon of Kansas, and *P. smithii* (Daugherty, 1941) from the Chinle formation of Arizona. The former is merely a pinnule fragment. The other, however, shows frond characters. Both were placed in Presl's genus *Laccopteris* by their authors, a name which Hirmer and Hoerhammer (1936) have shown to be invalid and which must be replaced by Brongniart's *Phlebopteris*. Hirmer and Hoerhammer examined the type specimen of *Laccopteris* and found that it was not only poorly preserved, but had basally rounded, shortly stalked pinnules along with a venation pattern more indicative of the Marattiaceae than the Matoniaceae. As a consequence of their observations *Phlebopteris* has been adopted by subsequent authors (Harris, 1946); Sahni and Sitholey, (1945); Arnold, (1947); and Mägdefrau (1953).

## SYSTEMATIC DESCRIPTION

PHLEBOPTERIS GALLEYI (Miner) comb. nov.  
*Laccopteris galleyi* Miner

The material upon which Miner (1935) based his description of this species consists merely of a pinnule fragment 2 cm. long that was revealed in a drill core. It shows two rows of circular sori with a midrib between, but no trace of lateral veins. Each sorus contains 11-16 sporangia. Because no frond or venation characters are present, reference to *Phlebopteris* must remain provisional. In some respects it is unlike other species. The pinnule fragment, which is 7.5 mm. wide, is large for *Phlebopteris*, and although the sori are of normal size, the free lamina between the sori and the margin is unusually wide. Moreover, the number of sporangia per sorus is larger than usual. Each one is rather narrowly wedge-shaped and attached at its inner end. The

annulus seems to be confined to the outer edge of the sporangium. The whole sorus resembles a wheel with 11 to 16 spokes; the annuli representing the rim and the region of attachment at the centre, the hub. The thin-walled spores measure 25-33 microns in diameter. There is no evidence of an indusium although dark substance of unexplained origin covers portions of some of the sori. If this fern is correctly placed in *Phlebopteris* it is the latest known species of the genus.

*Horizon*.—Dakota sandstone, Upper Cretaceous.

*Locality*.—Mankato, Kansas.

PHLEBOPTERIS SMITHII (Daugherty) Arnold  
*Laccopteris smithii* Daugherty

Daugherty's description of this species in 1941 was the first account of a matoniaceous fern from North America outside of Greenland to include frond characters. Some additional material was secured by the present author from the type locality in the Petrified Forest National Monument in 1941 which has been used in this study. The species was transferred to *Phlebopteris* in 1947. Daugherty compared it with *P. polypodioides* and there is little to be added concerning its affinity with other species, except to stress the marked differences between it and the other Chinle species to be described.

*Horizon*.—Chinle formation, Upper Triassic.

*Locality*.—Petrified Forest National Monument, Arizona.

PHLEBOPTERIS UTENSIS sp. nov.  
Pl. 16, figs. 1-6

The material on which this description is based was collected from the Chinle formation in southeastern Utah in June, 1953. The locality is about 1 mile northwest of Hite, in Garfield County. Hite is on the west bank of the Colorado River across and about one-fourth of a mile downstream from White Canyon. It is also 8 miles slightly north of due east of the summit of Mount Holmes, one of the southernmost peaks of the Henry Mountains. Here, as elsewhere in southern Utah, the Chinle formation underlies the

picturesque and easily recognized Wingate sandstone from which it is separated by an unconformity.

The ferns were found in a light grey undurated siltstone that is apparently made up largely of weathered volcanic ash. The rock disintegrates rapidly when wet and good plant compressions are hard to find in it. In the material collected, very little remains of the plant substance other than thin films of structureless carbon. All attempts to prepare mounts showing epidermal and sporangial characters failed because no cuticle appears to have been preserved. The sporangia along with all leaf tissue, disintegrate completely with chemical treatment. It was possible, however, to make transfer mounts of the carbonaceous layers by coating the surface with thin cellulose cement and placing the specimen in water. The matrix slaked within a few minutes leaving the carbonaceous residue attached to

measure about 40 microns in diameter were recovered (Pl. 16, fig. 3).

Several of the specimens show the characteristic form of the frond (Pl. 16, fig. 4). When first collected, these were all assumed to represent *Phlebopteris smithii*, but closer inspection soon revealed differences indicating another species. Material of *P. smithii* at hand for comparison showed that the new form has a smaller frond and shorter pinnae and pinnules (Table I). A difference of greater significance, however, than that of mere size was noted in the venation pattern. Veinlets that depart at right angles from the midrib of each pinnule divide the lamina into distinct square "fields" (Pl. 16, figs. 1 & 6) like those described by Harris (1931) and Hirmer and Hoerhammer (1936) for *P. angustiloba*. This fern, in fact, is so like *P. angustiloba* that there has been some hesitation in giving it a different name. However, when the two are carefully com-

TABLE I

	<i>P. utensis</i>	<i>P. smithii</i>	<i>p. angustiloba</i>
Length of pinna	20 cm.	30 cm.	20 cm. or more
Width of pinna	25 mm.	40 mm.	50 mm.
Length of pinnule	15 mm.	15—30 mm.	15—30 mm.
Width of pinnule	2 mm	3 mm.	2 mm.
Shape of pinnule apex	tapered	blunt	tapered
No. of pinnules per inch	10	approximately 7	10
Pinnule margins	not touching; slightly crenate	not touching; straight	touching, slightly crenate
Diameter of sorus	0.50—0.65 mm.	1.0 mm.	1.0 mm. (assumed)
No. sporangia per sorus	7—9 (average 8)	7—14	5—7
Length of sporangium	0.25—0.350 mm.	0.40 mm.?	0.40 mm.
Diameter of spores	40—45 microns	..	40 microns

The data given above for *P. utensis* and *P. smithii* is taken from material and from information given by Daugherty (4). That for *P. angustiloba* is from Harris (8) and Hirmer and Hoerhammer (10).

the transparent film. Such preparations show rather well the arrangement of the sporangia in the sori (Pl. 16, fig. 2) but they could not be used for studying the structure of the sporangia except by reflected light. Surface lighting, however, does reveal rather dimly a broad annulus that curves around the outer free margin of the sporangium. The situation thus appears identical with that commonly figured for matoniaceous ferns. A few triangular thin-walled spores that

pared (Table I) differences can be detected which are believed to necessitate naming the Utah plant as new.

*Description.*—Frond pedate, with at least 12 subdivisions; mature pinnae about 20 cm. long, 2.5 cm. wide; fertile and sterile pinnae similar; pinnules up to 15 mm. long and 2 mm. wide with margins parallel or nearly so for three quarters or more of their length, tapered at apex, ordinarily not touching,

and connected basally by narrow continuation of lamina about 1 mm. wide; lamina shallowly crenate and marked out on each side of midrib into square "fields" by means of strong lateral veins at right angles to it; sori circular or slightly concentric, 0.50-0.65 mm. in diameter, nearly touching 7-9 (usually 8) sporangia per sorus; sporangia 0.25-0.35 mm. long with incomplete marginal annulus; spores triangular, thin-walled, smooth, 40-45 microns in diameter.

*Horizon*.—Chinle formation, Upper Triassic.

*Locality*.—Near Hite, Garfield County, Utah.

The most obvious difference between *Phlebopteris utensis* and *P. angustiloba* lies in the slightly separated pinnules of the former. Figures of *P. angustiloba* by Harris and by Hirmer and Hoerhammer show long lancelike pinnules that touch along the greater part of their length. Also, as the accompanying table shows, *P. angustiloba* is the larger of the two species. There is no question, however, but they are close.

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