

DESCRIPTIONS OF FOSSIL PLANTS FROM THE MESOZOIC AND CENOZOIC OF NORTH AMERICA. I.

By F. H. KNOWLTON

WITH TWO PLATES

I. TWO NEW FOSSIL, CHAIN-FERNS (WOODWARDIA) FROM OREGON AND WYOMING

**WOODWARDIA MAXONI, sp. nov.**

PLATE LXIII, FIGURE 3; PLATE LXIV, FIGURES 1, 2

Outline of whole frond unknown; pinnæ lanceolate, broadest at base, narrowly acuminate at apex, cut  $\frac{3}{4}$  or more of distance to the rachis into numerous, approximate, oblong, obtuse, often slightly falcate lobes which are finely serrate-toothed at apex, the basal lobes with small oblong or triangular auricles on the lower side; rachis very strong; midvein relatively strong, with a single series of elongate, or elliptic—oblong, slightly oblique, areoles on each side, the veins thence free to the margin; sori, as in the living species, linear or oblong, one to each areole, becoming confluent with age; indusium attached by its outer margin to the fruit-bearing veinlet.

*Type*: U. S. N. M., 33992 [pl. LXIV, fig. 1]; co-types 33993 [pl. LXIV, fig. 2]; 33994 [pl. LXIII, fig. 3].

*Locality*: Southeast of Rock Springs, Wyoming.

*Geological horizon*: Fort Union (Eocene).

This splendid species is represented by a large number of well-preserved specimens, but as all are in the form of detached pinnæ we are still in ignorance of the outline of the whole frond, though it must have been of imposing size and appearance. The pinnæ, as stated in the diagnosis, are lanceolate in shape, and, so far as observed, are always broadest at the base and narrowly acuminate at the apex. The largest, evidently nearly perfect, pinna observed is 10.5 cm. in length and its width 2.75 cm. Other pinnæ, especially the fruiting ones, are slightly smaller, though the difference is not great. In only one specimen is the extreme base of a pinna preserved, namely, that shown in figure 2. In this the basal lobes are provided on the lower side with small oblong or triangular auricles, and the pinna was apparently closely sessile.

The living species to which this fossil form appears to be most closely related is *Woodwardia virginica* (L.) Smith, the common chain-fern so widely distributed over eastern North America, from Nova Scotia to Ontario and Michigan, and south to Florida, Louisiana, and Arkansas. There are, however, a number of slight, though apparently constant, differences. In nervation and in the size and disposition of the sori, both young and mature, the two forms are practically identical. The differences are as follows: In *Woodwardia virginica* the pinnæ are almost always broadest in the middle and narrowed at base, usually very markedly so; in *Woodwardia Maxoni* they are always broadest at the base. In the living species the segments of the pinnæ are rather open or spreading and have the margins entire, while in the fossil species the segments are very close and have the ends finely serrate. In no case have auricles been observed on the basal segments of the pinnæ in the living species; as above stated, they are present in the fossil species.

Among the several fossil species previously described from this country, the one under discussion appears to approach closest to *Woodwardia latiloba* Lesquereux<sup>1</sup> of the Denver beds of Colorado, but from this it differs essentially in size, shape, and nervation. The other American fossil species, as set forth in the discussion under the succeeding species, all belong to other sections of the genus as gauged by the living species.

The material upon which *Woodwardia Maxoni* is based was obtained from two localities, though practically at the same horizon. The first locality is on the Brown's Park stage road about 35 miles southeast of Rock Springs, Wyoming (4 miles east of Mud Springs), in section 35, township 15 N., range 102 W. Collectors, C. A. Fisher and T. W. Stanton, July 25, 1908. This material is mostly sterile, there being only a single fragment in fruit. (See figure 3, plate LXIII.) The other locality is also on the Brown's Park stage road on the head of Vermilion Creek, about 47 miles southeast of Rock Springs, Wyoming, in section 31, township 15 N., range 101 W. Collectors, A. C. Veatch and A. R. Schultz, July 27, 1908. Nearly all these specimens are in fruit. (See figure 1, plate LXIV.) Both localities are very near the base of the Fort Union formation, here resting unconformably on the Lewis shale.

I take pleasure in naming this species in honor of Mr. William R. Maxon, of the U. S. National Museum, who has rendered valued assistance in the study of this and other fossil ferns.

---

<sup>1</sup> Rept. U. S. Geol. Surv. Terr., vol. 7 (Tert. Fl.), 1878, p. 54, pl. iii, figs. 1, 1a.

## WOODWARDIA COLUMBIANA, sp. nov.

PLATE LXIII, FIGURES 1, 2

Outline of whole frond unknown, though presumably the frond was pinnate; pinnæ lanceolate, apparently broadest at base, cut nearly to the rachis into numerous, linear or lanceolate, acute-pointed segments which are entire or rarely undulate-margined, and separated by deep rounded sinuses; rachis strong; midvein or midrib of segments relatively slender; veinlets forming a single row of large, oblong, sorus-bearing areolæ on either side of, and parallel to the midrib, outside of which is a single series of smaller areolæ oblique to the midrib, the veinlets thence free to the margin; sori linear or oblong, in a chain-like row on either side of the midrib and attached to the outer margin of the fruit-bearing areolæ.

*Type:* U. S. N. M. 7529 [pl. LXIII, fig. 1]; co-type, 7528 [pl. LXIII, fig. 2].

*Locality:* Cascades of Columbia River, Oregon.

*Geological horizon:* Pleistocene.

This species is represented by a large number of specimens, two of the best of which are here figured. Unfortunately all are in the form of detached pinnæ, so we are left in ignorance of the form of the whole frond, though, following its analogy to what are obviously its nearest relations among the living species, it was without much doubt pinnate, and must have presented an imposing appearance when living. The most perfect pinna observed in the collection is 14 cm. in length, but as this lacks both base and apex, considerable being apparently missing at both points, it seems probable that the length when perfect could hardly have been less than 18 or 20 cm. The width of the pinnæ is from 5 to 8 cm. As may be seen from the figures, especially figure 1, the pinnæ are cut nearly to the rachis into numerous linear or lanceolate, rather remote segments which are separated by deep, broad, rounded sinuses. The margin of the segments are entire or exceptionally undulate. The nervation, which is fully described above and well shown in the figures, is characteristically that of the section *Eurwoodwardia* of the living species, which, to quote from Underwood,<sup>2</sup> has the "fronds uniform, the veins forming at least one series of areolæ between the sori and margins." The sori, as beautifully shown in figure 1, are oblong or linear, and in a chain-like row on either side of the midrib, the

<sup>2</sup> Our Native Ferns and their Allies, 6th Ed., 1900, p. 102.

indusia being attached to the outer margin of the fruit-bearing veinlets.

The only living North American species belonging to the section *Eurwoodwardia* is *Woodwardia spinulosa* Martens and Galeotti, described originally from Mexico, which is found also in Guatemala, Arizona, California, and Washington. This species was formerly included under the Old World *W. radicans* (L.) Smith, but recently pteridologists have quite generally separated it, principally on the ground that the segments are shorter and less pointed, the row of sterile areoles outside the fruiting row is usually confined to the basal portion instead of being distinctly double throughout, and finally that the segments are separated by rather broad and round, instead of by deep, sharp sinuses; the margins of the segments in both species are usually spinulose.

The fossil species under consideration appears to combine to some extent the characters of both of the above mentioned living species. Thus it has a complete row of areolæ outside of the large fruiting row, as in *W. radicans*, but it agrees with *W. spinulosa* in having relatively short segments separated by rounded sinuses; it differs from both in having the margins of the segments entire, or at most slightly undulate.

The material upon which this species is based was collected by Mr. G. K. Gilbert, of the U. S. Geological Survey, at the Cascades of the Columbia River, Oregon.

2. A NEW NAME FOR *DAVALLIA TENUIFOLIA* SWARTZ, AS IDENTIFIED BY DAWSON, AND *ASPLENIUM TENERUM* LESQUEREUX

**DENNSTÆDTIA AMERICANA**, nom. nov.

PLATE LXIII, FIGURE 4; PLATE LXIV, FIGURES 3-5

*Davallia* (*Stenoloma*) *tenuifolia* Swartz. Dawson, Brit. N. A. Boundary Commission (Rept. Geol. and Resourc. Vicinity 49th Parallel) 1875, Appen. A, p. 329, pl. xvi, figs. 1, 1a, 2, 2a; Roy. Soc. Canada, Trans., vol. 4, 1886 [1787], p. 21, pl. i, figs. 1, 1a, 1b; Penhallow, Rept. Tert. Pl. Brit. Columbia, 1908, p. 52.

*Asplenium tenerum* Lesquereux. Rept. U. S. Geol. Surv. Terr., vol. 8 (Cret. and Tert. Fl.), 1883, p. 221, pl. xlvia, figs. 1, 2. [Not *Asplenium tenerum* Forster, *Florulæ Insularum australicum Prodrromus*, 1786, p. 80.]

Frond apparently lanceolate in outline, bipinnate, the rachis relatively strong, grooved; pinnæ alternate, oblique, lanceolate or sometimes linear, pointed; pinnules deltoid or oblong, oblique, unequal-

sided, closely sessile or slightly decurrent, cut more or less deeply into oblong, obtuse lobes—usually five on each side—which are entire or occasionally with a few low teeth; nervation delicate, consisting of a slender, slightly flexuose pinnately dichotomous midvein, with lateral nerves at an acute angle of divergence and once or twice forked; sori small, globular, on the apex of a free vein, and marginal on the tips of the lobes of the pinnules, mostly on the upper side.

This species is represented by a large number of specimens from a number of widely separated localities, though so far as known all are from the same geological horizon. They are mostly in the form of portions of detached pinnæ, of greater or less size, although occasionally a pinna is found nearly perfect, and in a few instances a considerable portion of the whole frond has been found, such, for instance, as that shown in plate LXIV, figure 5. From this it appears that it was a delicate fern of rather strict habit and apparently lanceolate in general outline. It is impossible to give the exact size, but it was at least 15 or 20 cm. in length and 8 cm. or more in width. It is not rare to find pinnæ that are 8-10 cm. in length, though the majority are apparently somewhat less than this. They are alternately and very obliquely placed on the rachis, and have a relatively rather strong secondary rachis. The pinnules are also obliquely attached, and are either sessile or sometimes slightly decurrent. In shape they are deltoid or oblong, largest on the upper side, and cut often rather deeply into oblong, obtuse usually entire lobes, on the apices of which, usually on the upper side, the sori are borne. The largest pinnules observed are about 18 mm. in length and 10 mm. in width, but the average size is much less.

This fern is referred without hesitation to the genus *Dennstædtia*, since it is closely congeneric in habit, nervation, and fructification with the numerous species now segregated under this designation. It is not particularly close to *Dennstædtia punctilobula*, the only living North American species, but appears to find its closest relationship in *D. scabra* (Wall.) Moore, a species widely spread over China and tropical Asia. From this it differs in being bipinnate instead of tripinnate, as well as in its narrower fronds, more slender pinnæ, and much smaller pinnules; its general appearance, however, is much the same.

The fern here renamed *Dennstædtia americana* has had a rather complicated nomenclatorial history. It appears to have been first found in 1875 near Porcupine Creek, Saskatchewan, by the British North American Boundary Commission, and was referred by Daw-

son to *Davallia* (*Stenoloma*) *tenuifolia* Swartz (now called *Odontosoria chinensis* (L.) J. Smith), a living species widely spread over Japan, China, tropical Asia, Polynesia, and Madagascar. A careful comparison of the sori, which are often in an admirable state of preservation, shows, however, that it is not congeneric with the forms now placed in *Odontosoria*, but is distinctly so with the species of *Dennstædtia*.

In 1883 Lesquereux<sup>3</sup> described and figured sterile portions of this fern from Fort Union beds at Gilmore Station, supposed to be in North Dakota,<sup>4</sup> under the name of *Asplenium tenerum*, apparently not connecting it with the fragments previously referred by Dawson, as set forth above, to *Davallia tenuifolia* Swartz. In transferring this material to the genus *Dennstædtia*, which the fruit characters now enable us to do, Lesquereux's specific name if valid should be the one available for the species, but unfortunately it has never had nomenclatorial standing, being antedated nearly a hundred years by *Asplenium tenerum* Forster,<sup>5</sup> a living species, and moreover this combination has been twice employed for different living forms between its use by Forster and Lesquereux, namely, Raddi, 1819, and Gaudichaud-Beaupré, 1827. It becomes necessary, therefore, to rename it, and I have called it *Dennstædtia americana*.

Although Lesquereux did not possess fruiting material of this fern, he evidently had a pretty clear idea as to its relationship, for he says: "Its nearest affinity is with living species of *Asplenium* of the section of the *Dicksonia*, like *Dicksonia tenera*, etc." Modern study of the ferns has resulted in drawing sharper generic lines, and not only has *Asplenium*, but what was long accepted as *Dicksonia*, been segregated into a number of smaller genera, such as *Dennstædtia*, *Odontosoria*, etc.

So far as I know there are no fossil ferns described in this country that are likely to be confused with the one under consideration, though, as both Dawson and Lesquereux pointed out, it is probable

<sup>3</sup> Rept. U. S. Geol. Surv. Terr., vol. 8 (Cret. & Tert. Fl.), 1883, p. 221, pl. xlviA, figs. 1, 2.

<sup>4</sup> The full locality is given as "Bad Lands near Gilmore Station of the U. P. R. R. Collected by Professor Wm. Denton." I have not been able to identify exactly this locality, but it is reasonably certain that "U. P. R. R." is an error for N. P. R. R., since Professor Denton is known to have collected in the Bad Lands of North Dakota, and possibly adjacent Montana, through which runs the Northern Pacific railroad. Moreover, this species has since been collected at a number of places in North Dakota.

<sup>5</sup> Flor. Ins. austral. Prod., 1786, p. 80.

that *Sphenopteris Blomstrandi* Heer,<sup>6</sup> from the Miocene or upper Eocene of Greenland, is at least con-generic with it.

*Dennstaedtia americana* is characteristic of the Fort Union formation, never having been, so far as I know, found outside of it. Following is a list of localities and collectors:

Porcupine Creek, Saskatchewan; British North American Boundary Commission, 1875.

Gilmore Station, North Dakota (?); Wm. Denton, about 1882.

Black Butte, 45-50 miles south of Medora, North Dakota; Earl Douglass, 1905.

Custer Trail Ranch, 5 miles south of Medora, North Dakota; F. H. Knowlton, 1907.

Sentinel Butte, North Dakota; F. H. Knowlton and A. C. Peale, 1907.

Thirty-five miles southeast of Rock Springs, Wyoming, about 100 feet above base of formation; C. A. Fisher, T. W. Stanton, and F. H. Knowlton, July, 1908.

---

<sup>6</sup> Fl. Foss. Arct., vol. I, 1868, p. 155, pl. xxix, figs. 1, 5, 9

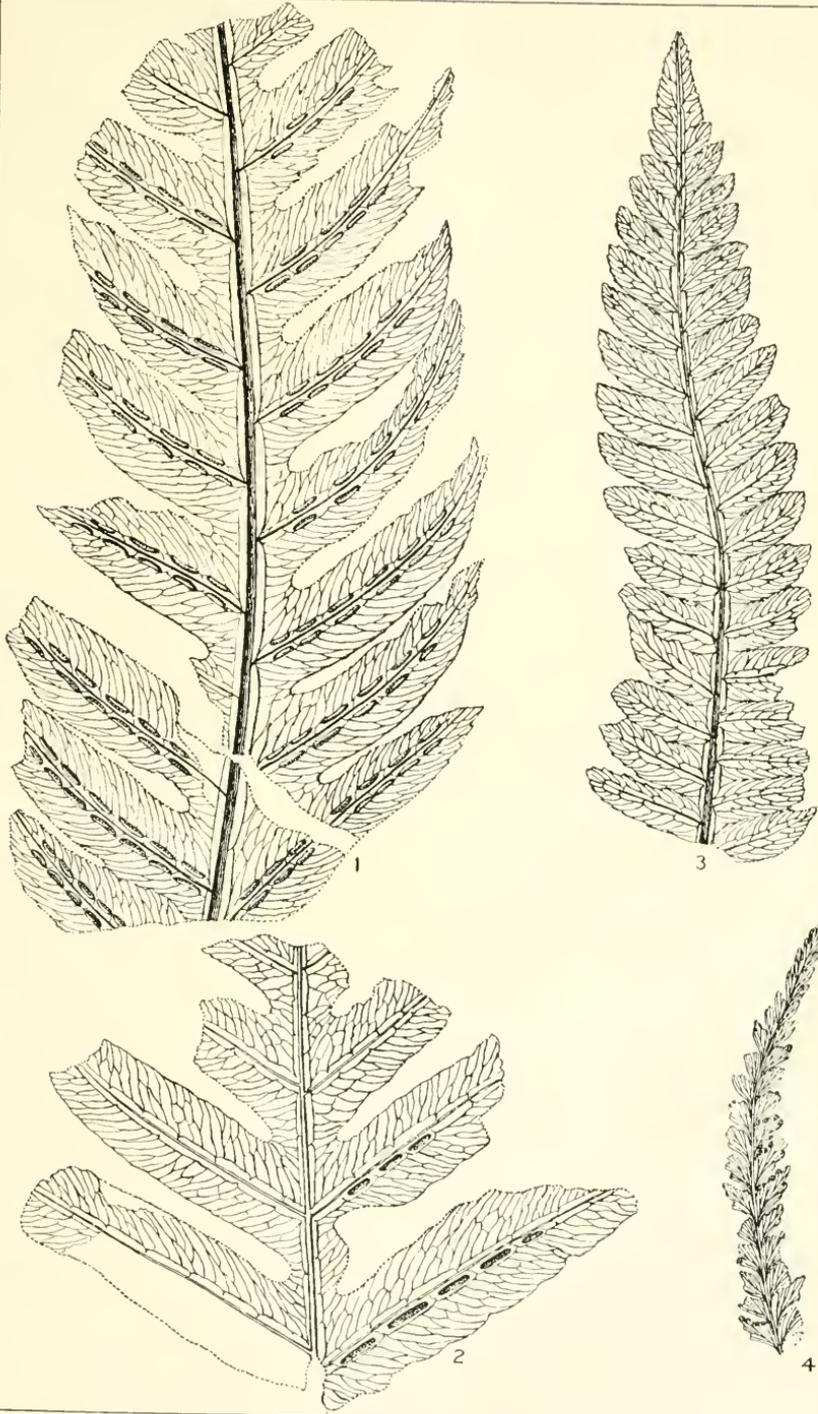
## EXPLANATION OF PLATES

## PLATE LXIII

FIGS. 1, 2.	<i>Woodwardia columbiana</i> , sp. nov.....	491
FIG. 3.	<i>Woodwardia Maxoni</i> , sp. nov.....	489
FIG. 4.	<i>Dennstædtia americana</i> , nom. nov.....	492

## PLATE LXIV

FIGS. 1, 2.	<i>Woodwardia Maxoni</i> , sp. nov.....	489
FIG. 3.	<i>Dennstædtia americana</i> , nom. nov.....	492
FIGS. 3 <i>a</i> , 3 <i>b</i> .	Enlarged pinnules of Fig. 3 x 2.....	492
FIGS. 4, 5.	<i>Dennstædtia americana</i> , nom. nov.....	492



WOODWARDIA AND DENNSTÆDTIA

See explanation, page 496