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Morphotype Catalog of a Zone I (Aptian–Earliest Albian) Flora from Fairlington, Virginia, USA

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ABSTRACT
Plant fossil collections from Lower Cretaceous floodplain deposits sometimes provide snapshots of local communities that included early herbaceous angiosperms. Here I describe the plant megafossils in a collection made from the lower part of the Potomac Group near Fairlington, Virginia, USA. The collection includes 123 identifiable plant fossils on 42 hand specimens, comprising nine plant morphotypes: three ferns, five gymnosperms and one angiosperm. All but one of the described morphotypes also occur in other collections from the lower Potomac Group. There is one moderately abundant angiosperm species in this collection that has been found at other Potomac Group sites but was incorrectly identified as a fern. Well-preserved specimens of this morphotype clearly show axillary branching, complex leaves and glandular teeth at the apices of lobes on the leaves; together, these characteristics suggest it was an herbaceous eudicot angiosperm. The one new morphotype in this collection is an enigmatic plant of intermediate abundance and unknown affinity. On the basis of the simple, pinnate stenophyllous leaves with two vein orders, reticulate secondary veins and the attachment of one leaf to a carbonized axis roughly 1 cm across with long internodes, I hypothesize that it was a shrubby riparian gymnosperm. This work represents the first step toward a complete morphotype catalog for the flora of the lower Potomac Group.

KEYWORDS
Paleobotany, morphotype, Early Cretaceous, Potomac Group, angiosperm, Virginia

Introduction
Plant fossil collections from the Potomac Group record part of the rapid diversification of flowering plants during the late Early Cretaceous (Fontaine 1889; Berry 1911; Brenner 1963; Doyle and Hickey 1976; Hickey and Doyle 1977). The oldest collections of plant megafossils from the Potomac Group come from Aptian–earliest Albian assemblages (Brenner 1963; Doyle and Robbins 1977; Hochuli et al. 2006), and the leaves of flowering plants in these assemblages are rare and mostly small. In younger assemblages from the middle of the Potomac Group, the leaves of flowering plants show greater diversity of form, are more widely distributed among facies, and angiosperm leaves dominate some collections from crevasse-splay and channel-fill deposits. These observations led to the hypothesis that early flowering plants were primarily herbs and shrubs that colonized bright, disturbance-prone habitats in mesic environments; in other words, they were riparian weeds. From those initial bright, disturbance-prone, near-channel habitats, angiosperm diversity was hypothesized to have spread to a wider variety of habitats such as forest understories and freshwater ponds (Doyle and Hickey 1976; Hickey and Doyle 1977). By contrast, phylogenetic trees in which the extant Amborella is the sister group to the rest of angiosperms have been used more recently to infer that the ancestral habitat of crown-group angiosperms may have been wet and shady tropical understories (Feild et al. 2004; Feild et al. 2009) rather than bright and...
arid “uplands” or bright, mesic riparian corridors on coastal plains (Stebbins 1965; Hickey and Doyle 1977).

Most hypotheses of seed plant phylogeny imply the angiosperm stem lineage had a long Mesozoic history (Mathews et al. 2010), but unequivocal angiosperm fossils are Cretaceous or younger. The oldest fossils that document the appearance of crown-group angiosperms are very rare pollen grains found in Hauterivian–Barremian deposits that would have been at low and middle latitudes at that time (Hughes et al. 1991; Brenner 1996; Doyle 2012). The age of the node that unites crown-group angiosperms is uncertain, but distribution of fossil pollen indicates that the three major clades of angiosperms, the magnoliids, monocots and eudicots (collectively the mesangiosperms), were distinct by the latest Barremian and probably not much earlier (Doyle 1992, 2012; Magallón and Castillo 2009; Doyle and Endress 2010). Morphologically disparate angiosperm pollen and megafossils occur in Aptian deposits worldwide, indicating that the diversification of crown-group angiosperms, including mesangiosperms, was finally underway (Doyle et al. 2008; Mohr et al. 2008; Sun et al. 2011; Barral et al. 2013; Coiffard et al. 2013a, 2013b; Jud and Hickey 2013).

The flora of Zone I of the Potomac Group postdates the origin of eudicots, monocots and magnoliids by several million years. If most of the species in the Zone I flora are, in fact, eudicots and magnoliids,
then the distribution and diversity of angiosperm fossils in the Potomac Group may be primarily a signal of the radiation of mesangiosperms rather than angiosperms as a whole; however, ANA-grade angiosperms (Amborellales, Nymphaeales and Austrobaileyales) do appear to be present in the flora (Upchurch 1984). New studies of these plant communities, as well as the angiosperm species in them, will provide important insights on the ecological context of the angiosperm diversification.

Morphotype catalogs express the variety of plant fossils in a flora, using a classification system unique to a site, flora or geologic unit that is independent of the Linnean system (Peppe et al. 2008). The advantage of the morphotype system is that once operational taxonomic units have been established for a flora, ecological analyses can be applied before the time-consuming process of dealing with taxonomic and systematic descriptions of each entity in a flora is completed. Although morphotypes do not necessarily correspond to Linnean taxa, some morphotypes can be attributed to Linnean taxa either as they are defined or as new information becomes available (Peppe et al. 2008). The fossils described here were collected from U.S. Geological Survey (USGS) locality 9030 in northern Virginia, USA. These fossils have not been published before and were not included in the analyses of Doyle and Hickey (1976) and Hickey and Doyle (1977). The objectives of this work are to present quantitative data on the diversity of a single collection from the lower Potomac Group, to provide descriptions and illustrations of these lower Potomac Group plant fossils, and to extract environmental data since the original outcrop is inaccessible.

Methods

The plant fossils are preserved as adpressions and charcoalified fragments on poorly laminated, light brown mudstone blocks. The fossils were collected by R.W. Brown and Alan Bennison from lower part of the Potomac Group on October 31, 1943, during the construction of Interstate 395 “about 0.5 miles south of Cowden, at base of steep slope on south side of new concrete highway out of Fairlington [VA]; south side of Four-mile Run” (Figure 1). The collection can be attributed to Zone I of the Potomac Group (Aptian–earliest Albian) based on the locality description and taxonomic similarity with other Zone I collections (Figure 2). In Maryland, the blue-gray, iron-bearing clays at the top of the Patuxent Formation are recognized as the Arundel Formation (Kranz 1989) or upper Zone I (Doyle and Robbins 1977), but in Virginia the Arundel Formation is not recognized and the Lower Cretaceous beds are sometimes referred to as the Potomac Formation. All of the specimens are curated in the Department of Paleobiology at the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA.

I numbered all of the blocks in the collection and assigned decimal numbers to specimens of interest on blocks (e.g., block 11 bears fossil specimens 11.1 and 11.2). Then I sorted the plant fossils into three broad taxonomic categories (ferns, gymnosperms and angiosperms) and grouped the shoots and leaves into morphotypes by leaf architecture (Ellis et al. 2009) (Table 1). As formatted in the morphotype descriptions that follow, I assigned each morphotype an informal designa-
tion beginning with the letters PA, referring to the Patuxent and Arundel Formations, which compose the lower part of the Potomac Group in Maryland. I provide photographs and descriptions of each morphotype, along with exemplar data (USGS locality-block number.specimen number), and include some synonymies to aid in comparison with other Potomac Group collections. I photographed the specimens using a Canon EOS digital camera with a 100 mm EF macro lens and processed the images with whole-image manipulations such as the Adjust Levels tool and the Auto Color tool, using Adobe Photoshop (San Jose, California, USA).

Description of Morphotypes

Ferns

Morphotype: PA1

*Sectilopteris* sp. Miller and Hickey, 2008

Systematic affinity. Class Polypodiopsida; Order incertae sedis (cf. Schizaeales); Family incertae sedis; Genus *Sectilopteris* Miller and Hickey, 2008.

Description. Frond fragments sterile and at least bipinnate, anadromous; rachilla course straight. Pinnae alternate, more than 20 mm long, 2 mm wide, costa straight, attachment decurrent, forming an acute angle to rachilla. Pinnules pinnate, becoming somewhat pinnatifid distally, alternate, width less than 1 mm, length 2 to 3 mm, narrowly elliptic to obovate, apex rounded, base broadly attached to rachilla, diverging from rachilla at an acute angle. Pinnule length less than 4 mm, pinnule shape elliptic to obovate, basiscopic pinnule margin decurrent, margin irregularly toothed. Venation dichotomous, without midvein, without reticulation; veins appear to end freely at the margin. Cuticle not visible under fluorescence microscopy.

Exemplar. 9030-37.1.

Discussion. Fossils of ferns such as *Sectilopteris* are found throughout Cretaceous deposits worldwide (Miller and Hickey 2008). *Sectilopteris* is a genus for ferns (Polypodiopsida) of indeterminate affinity but likely includes many members of Schizaeaceae and Cyatheaceae. The characteristic features of *Sectilopteris* are fronds at least bipinnate with narrow, acutely attached pinnules that have dichotomizing venation and without midveins (Miller and Hickey 2008). The acute, narrow pinnules distinguish this morphotype from others in this collection.

Morphotype: PA2

*Furcillopteris* sp. Miller and Hickey, 2008

Figure 4

Systematic affinity. Class Polypodiopsida; Order and Family incertae sedis; Genus *Furcillopteris* Miller and Hickey, 2008.

Description. Single fragment of a sterile fern pinnule. Pinnule attachment to rachilla unknown but likely pinnate. Pinnule length unknown, pinnule width 3 mm; margin smooth, base appears truncate, apex unknown. Venation open, no reticulation; midvein distinct with pinnately arranged lateral veins; lateral veins depart at angle of 50°, fork once near the midvein and terminate at edge of the pinnule. Seven lateral veins terminate along 2.5 mm of pinnule margin. Cuticle not visible under fluorescence microscopy.

Exemplar. 9030-11.1.

Discussion. This genus is used for vegetative fern foliage similar to *Cladophlebus*, but for which the mode of attachment to the rachis or rachilla is unknown. Only a single specimen assignable to this genus occurs in the collection. It is clearly not a fragment of another better-known morphotype in the collection because the pinnate venation with forked lateral veins is distinct.

<table>
<thead>
<tr>
<th>Morphotype code</th>
<th>Species</th>
<th>Fragments</th>
<th>Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA5</td>
<td><em>Pagiphyllum</em> sp.</td>
<td>77</td>
<td>24</td>
</tr>
<tr>
<td>PA8</td>
<td></td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>PA9</td>
<td>“<em>Sphenopteris</em> thrysopteroides”</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>PA1</td>
<td><em>Sectilopteris</em> sp.</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>PA2</td>
<td><em>Furcillopteris</em> sp.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PA3</td>
<td><em>Acrostichopteris densifolia</em></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PA4</td>
<td><em>Dioonites buchianus</em></td>
<td>1*</td>
<td>1</td>
</tr>
<tr>
<td>PA6</td>
<td><em>Pityocladus</em> sp.</td>
<td>1*</td>
<td>1</td>
</tr>
<tr>
<td>PA7</td>
<td><em>Podozamites angustifolia</em></td>
<td>1*</td>
<td>1</td>
</tr>
</tbody>
</table>

*These morphotypes are likely underrepresented in the collection, and therefore their rank abundance is underestimated.

Table 1. Rank abundance of each morphotype in the collection. Note that the rank abundance is slightly different if measured by identifiable fragment in contrast to by occurrence on blocks.
Morphotype: PA3

*Acrostichopteris densifolia* Fontaine, 1889

**Systematic affinity.** Class Polypodiopsida; Order and Family *incertae sedis*; Genus *Acrostichopteris* Fontaine, 1889.

**Description.** Single fragment of a sterile, at least once-pinnate frond. Rachilla winged. Pinnules small, alternate, flabellate, lobed and toothed; each pinnule is divided once into two major lobes, and each of those once into two secondary lobes and each of those is divided once into two tertiary lobes. Tertiary lobes terminate in one or two simple acute teeth. Pinnule sinuses acute; pinnule base acute; basipodic margin decurrent on the rachilla; course of the basipodic margins basally recurved until roughly perpendicular to the rachilla. A single vein departs the rachilla and enters each pinnule at an angle of about 30° and dichotomizes at angles of 20°–25° up to four times. Pinnule...
venation open, dichotomizing, no reticulation. Veins terminate in simple marginal teeth. Cuticle not visible under fluorescence microscopy.

Exemplar. 9030-24.2.

Discussion. Ferns of the genus Acrostichopteris are widespread in Lower Cretaceous deposits (Sender et al. 2005; Herman et al. 2012). Preliminary work on some fertile specimens of Acrostichopteris from the Potomac Group suggests a close relationship with Schizaeales (Skog 1995). Ferns in the genus Acrostichopteris are characterized by winged rachillae and decurrent, flabellate pinnules with acute teeth at the tips of the lobes. The species A. densifolia is characterized by small pinnules that are densely crowded to slightly overlapping, length-to-width ratio (L:W) less than 2:1, and pinnules generally dissected into three orders of lobes (Fontaine 1889). In this collection this morphotype can be distinguished by the flabellate pinnules and winged rachilla.
Gymnosperms

Morphotype: PA4
Figure 6
Dioonites buchianus (Ettingshausen)
Bornemann, 1856

Systematic affinity. Class Pinopsida; Order Bennettitales; Family Williamsoniaceae; Genus Dioonites Miquel, 1851.

Description. Single specimen of a small pinnately compound frond. Leaf length approximately 9 cm, width at least 6 cm; rachis 1.5 mm wide. Leaflet arrangement subopposite; shape linear–ovate, length 3 to 4 cm, width 2 mm; leaflet apex acute, straight; leaflet base slightly constricted, broadly attached to rachis, with decurrent basiscoic margin. Venation not reticulate, parallel. Margins entire. Cuticle not visible under fluorescence microscopy.

Exemplar. 9030-33.1.

Discussion. This specimen is smaller than most specimens of Dioonites buchianus from other Zone I collections; however, in all other aspects such as leaflet shape and leaflet attachment to the rachis it conforms to Dioonites. Thus, it may simply be an unusually small leaf from this abundant species rather than a distinct species represented by only one remarkably complete specimen. The absence of larger fragments of Dioonites from this collection may be the result of collector bias in the field.

Morphotype: PA5
Figures 4 and 7
Pagophyllum sp. Heer, 1881

Systematic affinity. Class Pinopsida; Order Pinales; Family incertae sedis; Genus Pagophyllum Heer, 1881.

Description. Isolated conifer shoots. Shoot mostly curvilinear, width up to 0.5 cm; main axis width up to approximately 2.5 mm. Leaves persistent, divergent from stem, helically arranged. Length of the free portion of the leaf longer than the width of the cushion, width approximately 2 mm, length up to 5 mm. Leaf base decurrent and not contracted, clasping the stem; leaf apex acute; leaf margins entire. Venation not visible. Cuticle not visible under fluorescence microscopy.


Discussion. I follow Miller and Hickey (2010) in applying the generic name Pagophyllum to isolated conifer shoots with heli-
cally arranged, persistent, falcate leaves with uncontracted and decurrent bases, acute tips, entire margins and inconspicuous veins. Some of the *Pagiophyllum* shoot fragments in this collection are three-dimensionally preserved charcoalified fragments.

**Morphotype: PA6**

*Pityocladus* sp. Seward, 1919

**Figure 8**

*Pityocladus* sp. Seward, 1919.

**Systematic affinity.** Class Pinopsida; Order Pinales; Family Pinaceae; Genus *Pityocladus* Seward, 1919.

**Description.** Branched conifer shoot with long shoot–short shoot organization. Long shoot straight, bearing five alternately arranged short shoots; short shoots bearing densely packed, helically arranged leaves. Long shoot approximately 6 cm long, approximately 2.2 mm wide; short shoots 4–5 mm long, approximately 2.2 mm wide. Leaves linear, more than 2 cm long, 0.5 mm wide; each with a single vein and entire margin. Cuticle not visible under fluorescence microscopy.

**Exemplar.** 9030-2.1.

**Discussion.** The genus *Pityocladus* is used for vegetative shoots similar to *Cedrus, Larix* and *Schizolepis*. The type material of *Pityocladus* was found in association with *Schizolepis* cones (Seward 1919). There are no pinaceous cones in this collection, so I apply the genus *Pityocladus* to this morphotypes following the recommendation of Seward (1919).
Morphotype: PA7
Figure 9
*Podozamites angustifolia* (Fontaine) Jud, comb. nov.

**Systematic affinity.** Class: Pinopsida; Order Pinales; Family *incertae sedis*; Genus *Podozamites* Braun, 1843.

**Description.** Unbranched stem with attached leaves. Shoot incomplete; length more than 6.6 cm; width including leaves more than 6 cm; width of stem approximately 0.5 cm. Leaves subopposite to alternately arranged (helical) on the shoot, attached at a 30° to 55° angle to the shoot axis, plagiotropic; leaves lanceolate; leaf margins linear; leaf length more than 3.7 cm, width 0.35 to 0.4 cm; leaf apices not preserved on this specimen; L:W ratio greater than or equal to 10:1; leaf spacing 0.9 to 1.3 cm.
base straight, symmetrical, attached by a short stalk, approximately 1–2 mm long and appearing twisted in some specimens, as a result of the planation of helically arranged leaves; margins entire; resin bodies absent. Venation in one order, parallel, with approximately eight veins in the midsection of the leaf. Cuticle not visible under fluorescence microscopy.

Exemplar. 9030-1.1.

Discussion. I follow Miller and Hickey (2010) in considering Nageiopsis Fontaine, 1889 a junior synonym of Podozamites Braun, 1843 because the slight difference in the arrangement of leaves along the stem in adpression and the convergence of the veins at the apex of the leaves are insufficient to distinguish Nageiopsis from Podozamites. The specimens described here match specimens described as Nageiopsis angustifolia in other Potomac Group collections by Fontaine (1889:202, pl. 86, figs.
8, 9; pl. 87, figs. 2–6; pl. 88, figs. 1, 3, 4, 6–8; pl. 89, fig. 2); these specimens should be transferred to the genus *Podozamites*. Leafy shoots assigned to the genus *Podozamites* are most similar to Araucariaceae and Podocarpaceae. These families compose a monophyletic group with respect to the remaining living extant conifer genera (Rai et al. 2008; Leslie et al. 2012).

**Morphotype: PA8**

**Figures 10–13**

**Systematic affinity**: Class, Order and Family incertae sedis.

**Description**: Axis diameter approximately 7 mm; leaf attachment petiolate; petiole winged, 3 mm wide; petiole attachment marginal. Leaf size notophyll. Leaf simple, unlobed, symmetrical and ovate–elliptic, to possibly linear; leaf more than 5 cm, width 1.6 to 2 cm. Leaf apex acute; base angle acute, base shape decurrent; margins entire; midvein pinnate; second-order veins decurrent to the midvein and forming an irregular reticulum of low-angle anastomoses toward the margin of the leaf; second-order vein spacing constant; angle of origin about 30° and the veins recurve basally so that near the margin of the leaf the angle of the secondary veins to the primary vein is roughly 50° to 60°. Secondary veins terminate at an intramarginal collecting vein. Areoles elongate. Cuticle not visible under fluorescence microscopy. One specimen in the collection was preserved with a petiole attached to an elongate axis approximately 7 mm in diameter with long internodes, but unfortunately this connection was broken during preparation and the fragment of the coalified stem mostly disintegrated (not photographed).

**Exemplars**: 9030–32.1–3.

**Discussion**: The blade of this morphotype is superficially similar to that of *Glossopteris* and *Mexiglossa* leaves and to the leaflets of *Sagenopteris*; however, this morphotype can be distinguished from those genera based on the presence of an intramarginal commissural vein, whereas the former three genera have veins that end freely at the margin (Harris 1964). Furthermore, the simple, petiolate leaves of this morphotype are distinct from the simple, sessile leaves of *Glossopteris* and *Mexiglossa*, and from the palmately compound leaves of *Sagenopteris*, which have an unwinged petiole. The attachment of this simple leaf to a stem with long internodes in this morphotype suggests the herbaceous or shrubby habit of a seed plant rather than a fern because...
Fern stipes are typically crowded along the stem (e.g., ferns usually have short internodes). It is unlikely that this morphotype is an angiosperm because there are only two distinct orders of venation, and the reticulum of minor veins forms elongate areoles. I hypothesize that this morphotype represents an extinct gymnosperm lineage not described from other Potomac Group collections. This is also the only morphotype on which I observed evidence of insect damage (Figure 13). It occurs as small holes surrounded by dark reaction tissue.

**Angiosperms**

**Morphotype: PA9**

*“Sphenopteris” thyrsopteroides* Fontaine (1889):89, pl. 25, fig. 3; pl. 58, fig. 5

**Systematic affinity.** Class Magnoliopsida; Order *incertae sedis* (cf. Ranunculales, Proteales); Family *incertae sedis*.

**Description.** Small, much-branched herbaceous shoots with attached leaves and fibrous adventitious roots. Fibrous adventitious roots produced in pairs at nodes. Stems flexuous. Branching axillary, buds occasionally visible in the axils of the leaves. Leaves alternate (helically arranged) along the stem. Leaf attachment petiolate, petioles short (less than or equal to 5 mm), petiole base clasping and without stipules. Petiole attachment marginal. Leaf size leptophyll; blade organization variable, overall laminar shape ovate; roughly twice-pinnately lobed; lobe size and sinus depth decreases smoothly toward the apex; secondary lobes alternate and anadromous. Laminar L:W ratio 1 to 1.25:1; apex obtuse, rounded; base obtuse, concave to decurrent, and base insertion usually slightly asymmetrical. Primary venation pinnate to nearly palmate with three primary veins; major secondary veins craspedodromous; secondary vein spacing decreases distally, secondary vein angle also smoothly decreases proximally; minor secondary veins craspedodromous; tertiary vein network not visible. Teeth vascularized by a medial principal vein that terminates at the apex of the tooth and thickened lateral accessory veins continuous with a faint perimarginal vein.
Figure 11. Morphotype PA8, incompletely preserved apex. Note pinnate secondary vein framework. Scale bar equals 5 mm.
tooth apices papillate. Cuticle not visible under fluorescence microscopy.

Exemplar. 9030-22.1.

Discussion. This species is widespread among Zone I Potomac Group collections. This species is clearly not a fern because the fossils show axillary branching and glandular (papillate) teeth. The herbaceous habit, shape and glandular teeth indicate a relationship to eudicot angiosperms rather than to gymnosperms, ANA-grade angiosperms, or magnoliids (Jud and Hickey 2013). A formal diagnosis and discussion of the significance of this species will follow in another paper.

Discussion

The USGS 9030 collection comprises 42 blocks and 123 identifiable plant fragments that I have attributed to nine species (see Table 1): three ferns, one cycadophyte, three conifers, one broad-leaved gymnosperm of unknown affinity, and one herbaceous angiosperm. Although I have assigned a morphotype code to each entity in the collection, I have opted to use the Linnean name for morphotypes for which I was able to determine the genus or species. The conifer Pagiophyllum sp. is represented by the most specimens in the collection, often occurring on blocks where it was clearly not the specimen of interest. Four morphotypes are represented by a single specimen: one fern, one cycad and two conifers. The relatively complete specimens of Dioonites, Podozamites and Pityocladus in the museum collection suggest that these were chosen from among a larger number of specimens in the field, and thus that the relative abundance of these species was higher. Therefore, this collection probably represents a small fraction of the plant fossils encountered when the collection was made.

The fossils are preserved in a fine-grained bed, or possibly beds, with little or no lamination. Beds like this are typical of overbanks deposits, crevasse-splay deposits, and abandoned channel-fill deposits in the lower Potomac Group (Fontaine 1889; Upchurch and Doyle 1981; Jud and Hickey 2013). The preservation of herbaceous angiosperms with attached stems, leaves and roots in

Figure 12. Morphotype PA8; note rare reticulations between secondary veins at arrowheads. Scale bar equals 2 mm.
the fine-grained matrix suggests minimal transport prior to preservation in topographic lows. An abandoned channel wetland setting appears likely because some of the plants appear to be adapted to bright, channel margin habitats, such as the stenophyllous PA8 and the small-leaved angiosperm herb PA9. The abundance of charcoalified conifer (*Pagiophyllum*) shoots suggests that in addition to overbank floods or channel avulsion events, fire was a common form of disturbance in this community.

The sedimentological context of this collection and the preservation of attached organs indicate that the fossils in this assemblage were not transported far prior to preservation. Together with the sedimentology, the species diversity and relative abundance of plant megafossils in this collection indicate that this assemblage probably represents a snapshot of the plant community that was growing in or near a wetland formed by channel abandonment in a conifer-dominated and disturbance-prone riparian community. Ferns, angiosperms and gymnosperms of small stature formed the understory. In the future, this morphotype catalog can serve as a basis for the development of a larger and more refined morphotype catalog for the Potomac Group Zone 1 flora.

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Figure 14. Morphotype PA9, "Sphenopteris" thyrsopteroides; leafy shoots of the herbaceous angiosperm. Note dissected leaves and arrowheads pointing to axillary buds. Scale bar equals 5 mm.
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MORPHOTYPE Catalog of a Zone I Flora from Virginia • Jud 151


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