

Macroneuropteris scheuchzeri, a Pennsylvanian seed fern confined to wetland habitats

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Background

- The medullosan seed fern *Macroneuropteris scheuchzeri* is an abundant component of Middle-Late Pennsylvanian floras of Euramerica. Its fossil record consists almost entirely of isolated pinnules (parts of a large compound leaf), which are highly diagnostic of this species.
- Though the stratigraphic range of this species is well documented (Europe: 311 to 307 Ma; North America: 311 to 299 Ma), its specific ecological preferences are not firmly understood.
- Many have suggested that this species tended to occupy drier habitats, on the basis of certain pinnule features that have been interpreted as adaptations for water retention (e.g., thick cuticles, sunken stomata, leaf hairs). Others, however, have documented this species in deposits from swampy habitats, suggesting a wetter environmental preference.
- To determine the specific habitat preferences of this species, we surveyed its ecological distribution across its entire stratigraphic range in North America.
- We show that this species is significantly associated with wetter, more nutrient-rich habitats. This finding offers insight to the ecological functions of its anatomical features and provides a strong framework for interpreting its overall abundance patterns through time.

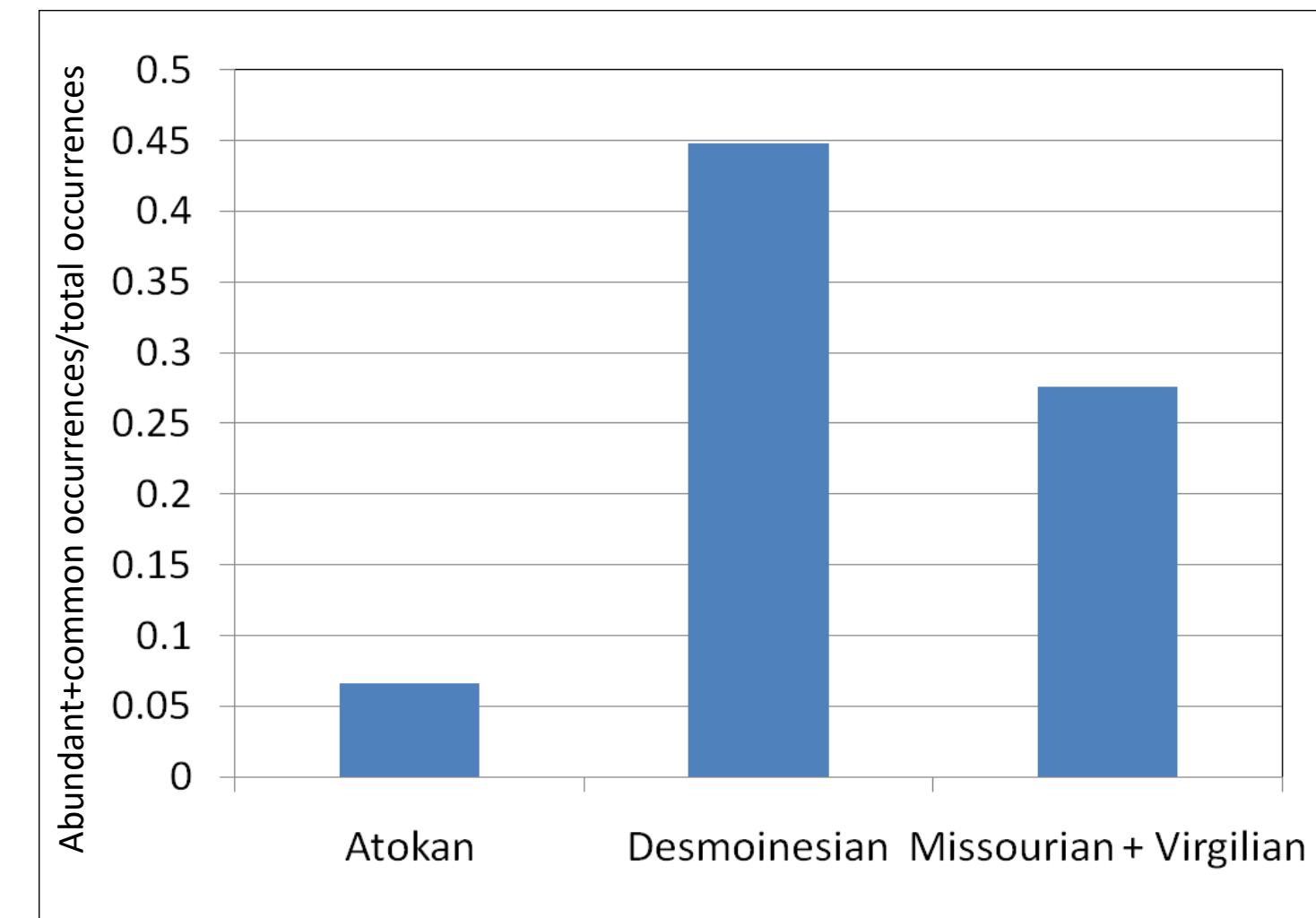


Materials and Methods

- We surveyed the abundance of *M. scheuchzeri* in approx. 300 collections obtained from the Illinois Basin, North Central Texas, and West Virginia.
- These collections span the entire stratigraphic range of this species and represent three major ecological divisions:
 - I. *Above coal*: seasonally dry swamp or wet floodplain
 - II. *Below/coal*: clastic and coal swamps, consistently wet
 - III. *Not associated with coal*: driest habitats sampled
- For each collection, *M. scheuchzeri* was ranked as either absent, rare (<10%), common (10-50%), or abundant (>50%) based on its abundance in relation to the other species in the collection.
- The data was then assembled ecologically and stratigraphically and analyzed using chi-square tests to determine if this species was differentially distributed among different habitats.

Results

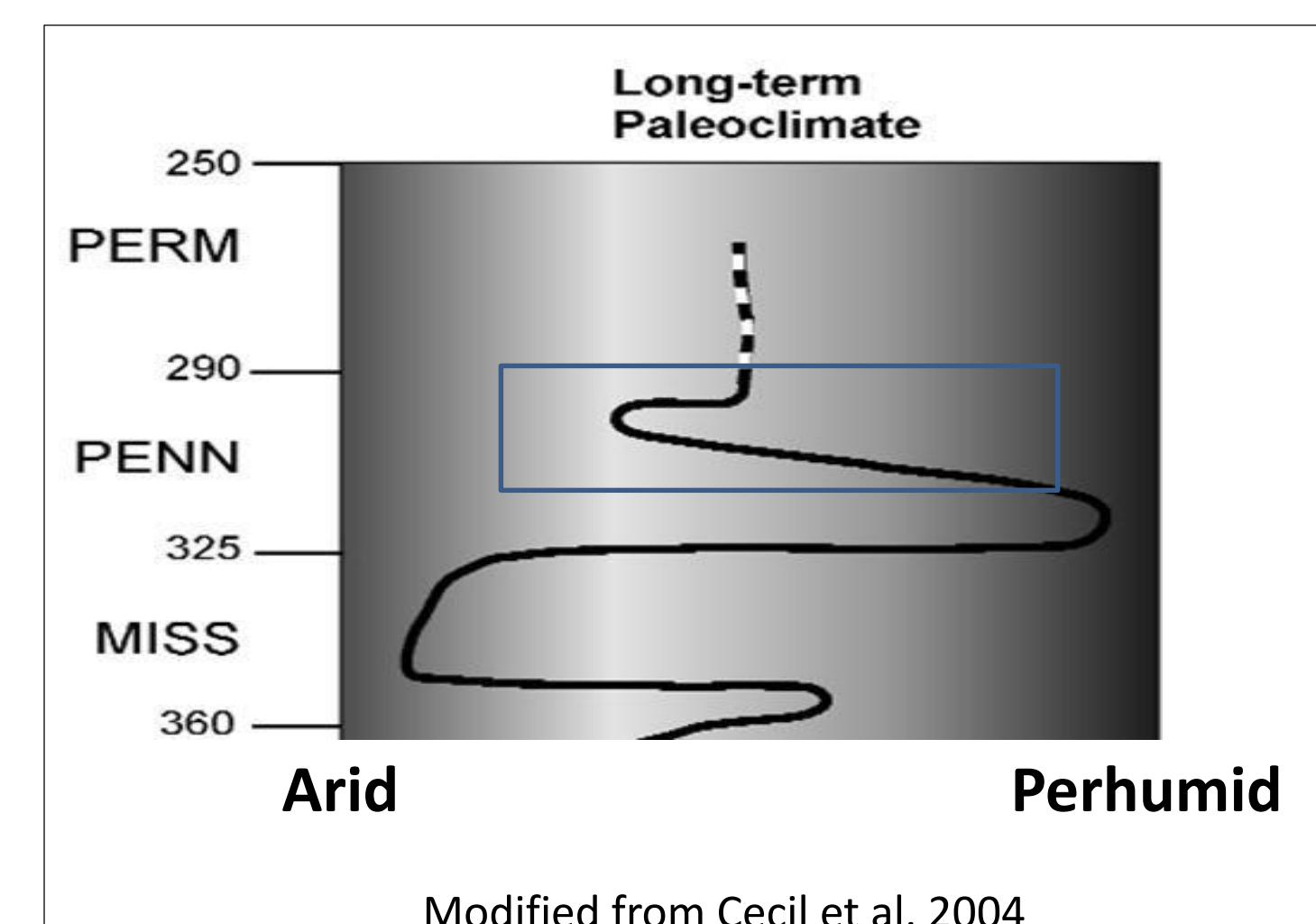
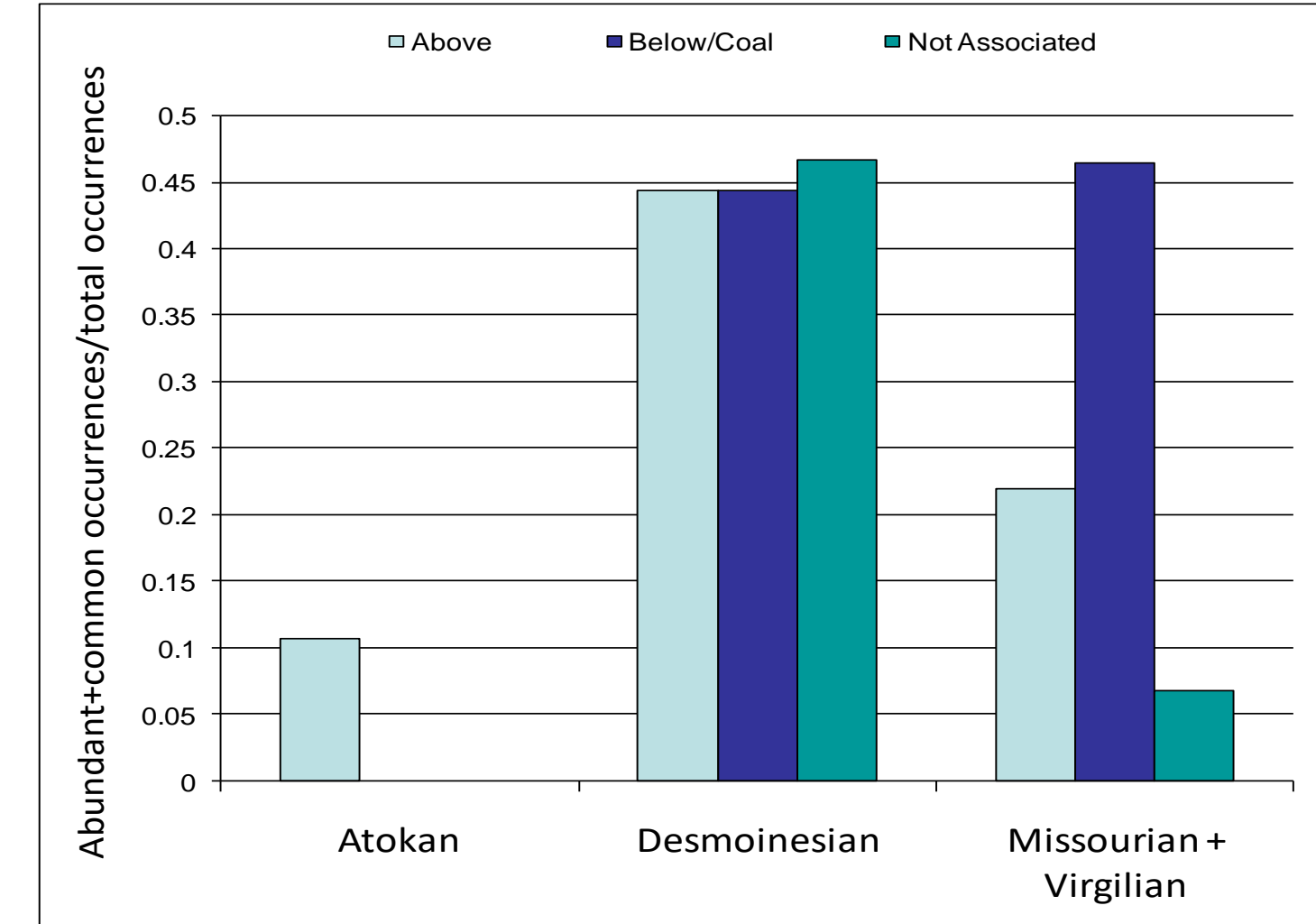
Abundance levels through time



Chi-test results

Time periods	P-values
Virgilian	0.018036614
Missourian	0.011743628
Desmoinesian	0.987552195
Atokan	0.192347181
Combined data	0.003880324

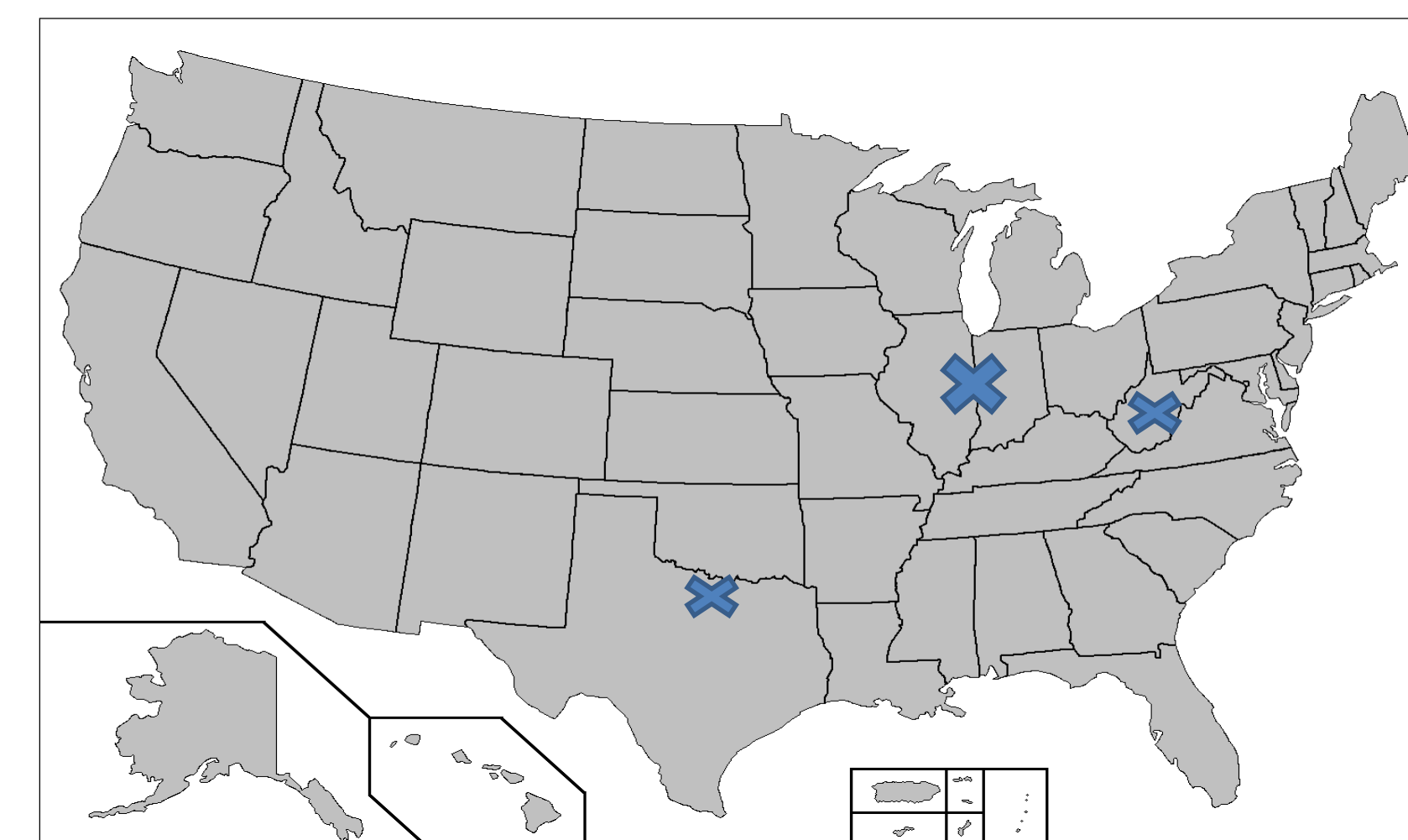
Ecological distribution through time



- We found that, overall, this species was differentially distributed below or within coal beds.
- When examined stratigraphically, however, this species was randomly distributed during the Atokan and the Desmoinesian but differentially distributed below or within coal beds during the Missourian and the Virgilian.
- In terms of abundance, not considering ecological distribution, this species was significantly rare during the Atokan and significantly abundant during the Desmoinesian.

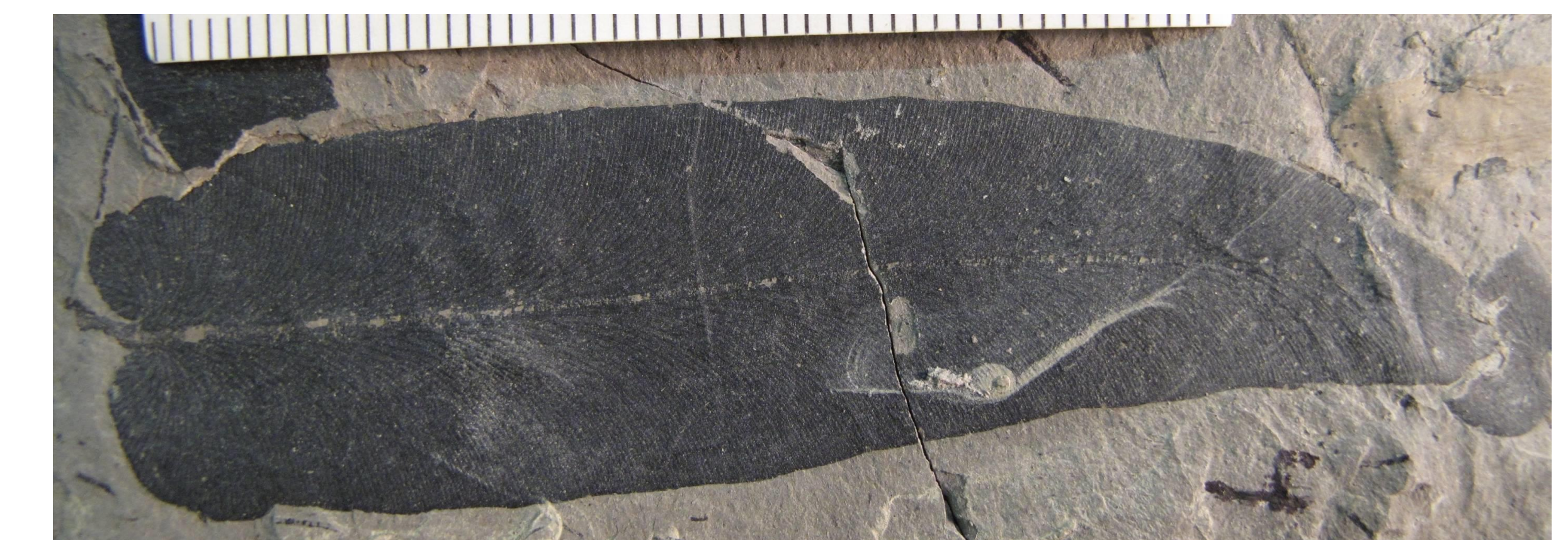
Stratigraphic and geographic locations sampled

Pennsylvanian	Virgilian
	New Castle coal
	Washington coal
	Waynesburg coal
	Missourian
	Calhoun coal
	Cohn coal
	Womac coal
	Chapel coal
	Desmoinesian
	Danville coal
	Jamestown coal
Herrin coal	
Springfield coal	
Murphysboro coal	
Atokan	
Lower Block coal	
Mariah Hill coal	



Interpretation

- M. scheuchzeri* was adapted to wet- and nutrient-rich environments. Its random, and significantly abundant, distribution during the Desmoinesian is explained by the expansion during this period of wet environments, in which this species apparently thrived.
- During the Missourian, and into the Virgilian and lower Permian, the landscape of Euramerica became progressively drier, restricting this species' distribution to the remaining swampy substrate environments.
- The wet conditions conducive to the growth of this species became sufficiently rare in space and time in the Lower Permian to cause it to go extinct.
- The habitat preferences shown by this species indicate that it was anything but drought resistant, suggesting that its supposed "drought-adapted" features were likely adaptations for purposes other than water retention.
- We suggest the pinnules of this species may have been part of a syndrome adapting them for CO₂ conservation. Atmospheric CO₂ was extremely low during this period. Furthermore, studies of biomass allocation indicate seed ferns were the most expensive wetland plants of this time.



References

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