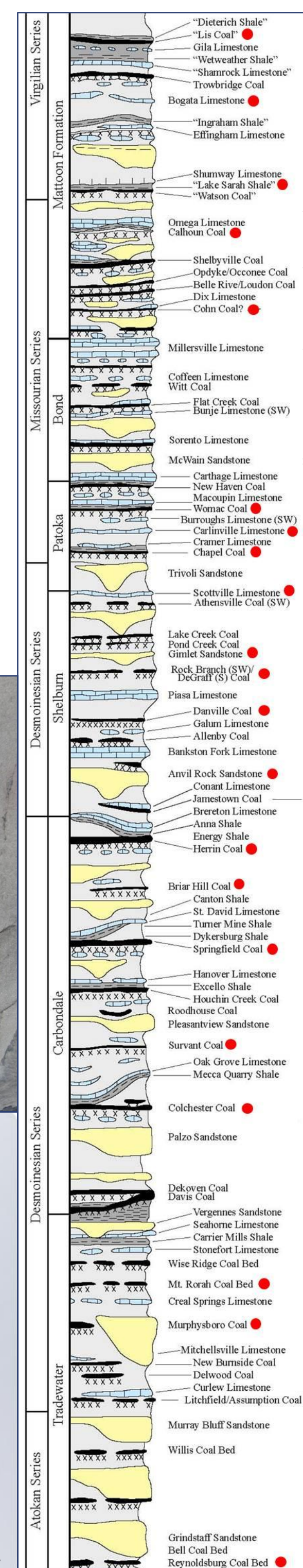


Background

- Throughout the Pennsylvanian of North America and Europe, peat-forming tropical wetland plant communities were temporally variable
- Plant communities of the Early and Middle Pennsylvanian were lycopod-dominated, while plant communities of the Late Pennsylvanian were tree-fern-dominated
- Previous studies using coal ball and palynological abundance data have indicated that tree-ferns gradually increase from low abundances in the mid-Desmoinesian, to moderate levels in the later Desmoinesian, to a sudden and rapid increase to dominance in the Missourian
- To better understand the dynamics of this abrupt change to tree-fern dominance at the Desmoinesian-Missourian boundary, we quantitatively examined the abundance of the marattialean tree-fern genus, *Pecopteris*, throughout the Pennsylvanian Period in a single geographic area, the Illinois Basin
- The Illinois Basin is a sedimentary depositional basin consisting of primarily marine Pennsylvanian rocks. Tree-ferns, which are the ancestors of modern ferns, grew in the swampy wetland plant communities that are now preserved as layers of coal in the Basin
- Such a study using compression fossils has never been undertaken for tree-ferns in the Illinois Basin



Research Questions

- How does tree fern abundance in plant communities from the Illinois Basin change over the Pennsylvanian?
- How do patterns of tree fern abundance determined from plant compression fossils compare to patterns determined from coal balls and palynological studies?

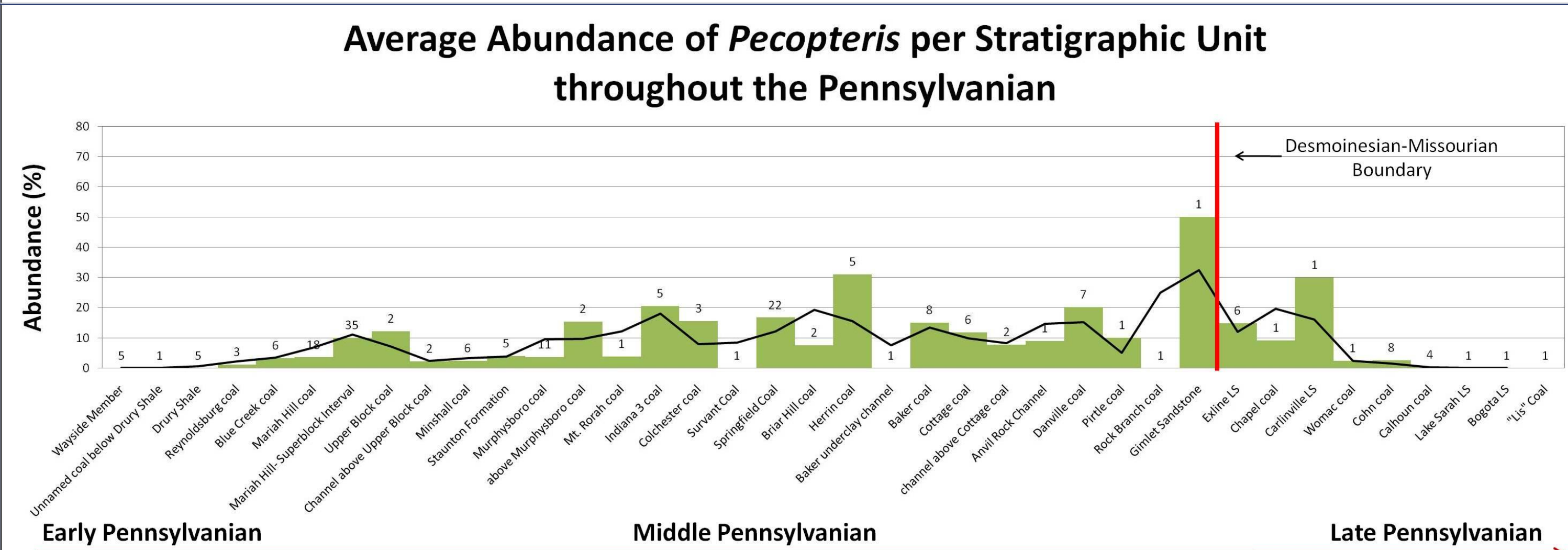
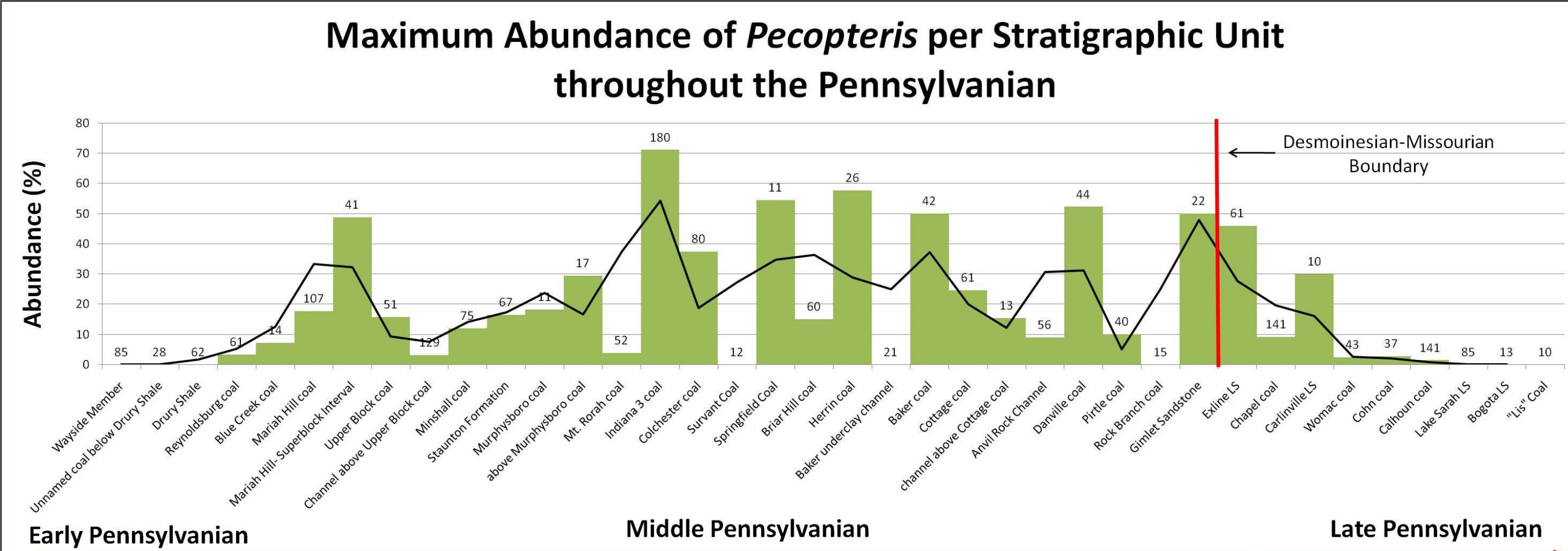
At the top left is an example of a typical tree fern pinnae. On the bottom left is a map showing the extent of the Illinois Basin over the states of Illinois, Indiana, and Kentucky. On the right is a stratigraphic column of the units in the Illinois Basin from the Early to the Late Pennsylvanian. Units sampled for the study are marked with red dots.

Materials and Methods

- The tree-fern genus *Pecopteris* was used to quantify tree-ferns due to its widespread geographic range and long stratigraphic range
- 192 collections from 38 stratigraphic units throughout the Pennsylvanian were surveyed, for a total of 10,446 specimens
- The collections were made from bulk samples to capture as much of the floristic diversity as possible without biasing the collection
- Tree fern abundance in each collection was determined using the quadrat method, where each hand sample is counted as a quadrat. The number of quadrats with any amount of recognizable *Pecopteris* was divided by the total number of quadrats in the collection, to obtain a percentage of quadrats bearing *Pecopteris*
- Exceptionally well preserved specimens were photographed using a photostand and digital camera to catalogue how the diversity of tree fern morphotypes changes over the Pennsylvanian

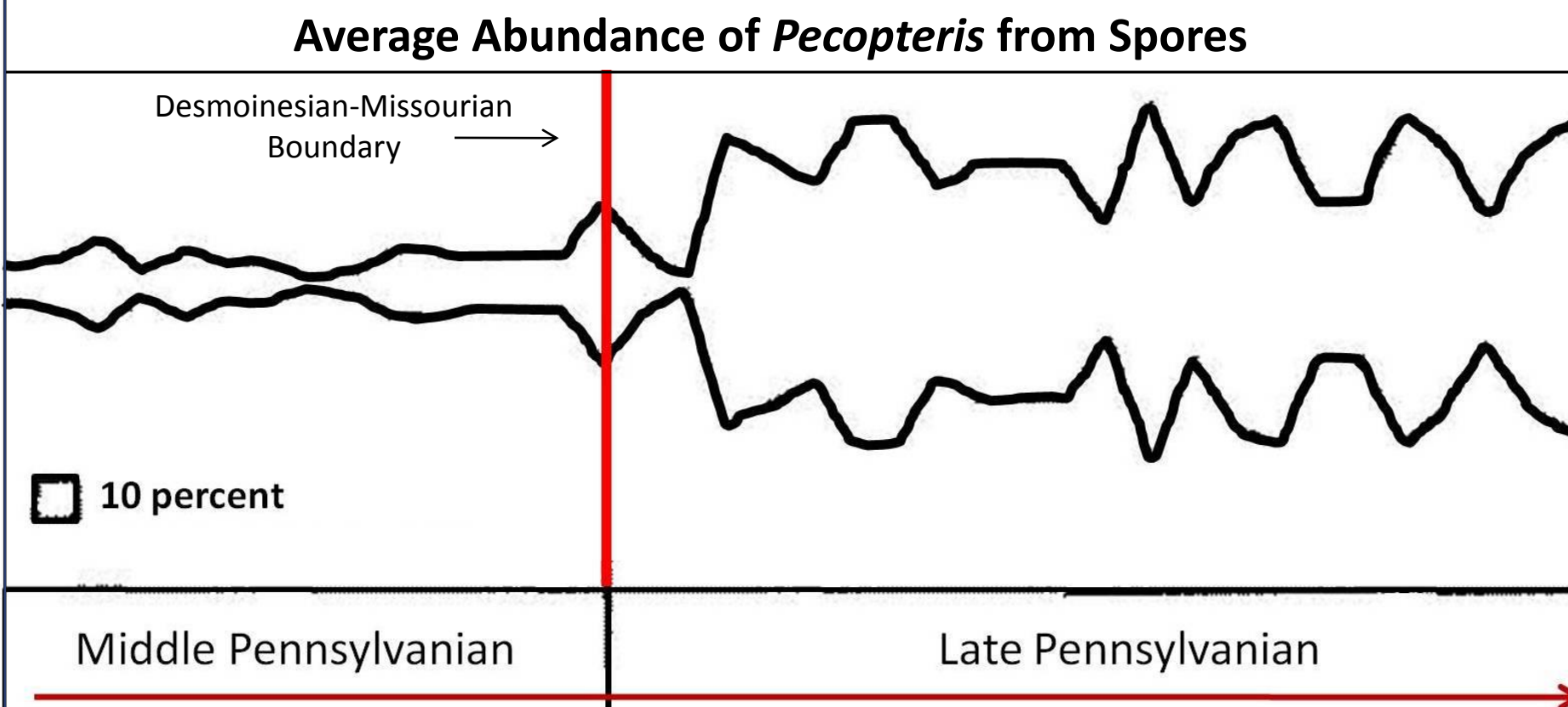
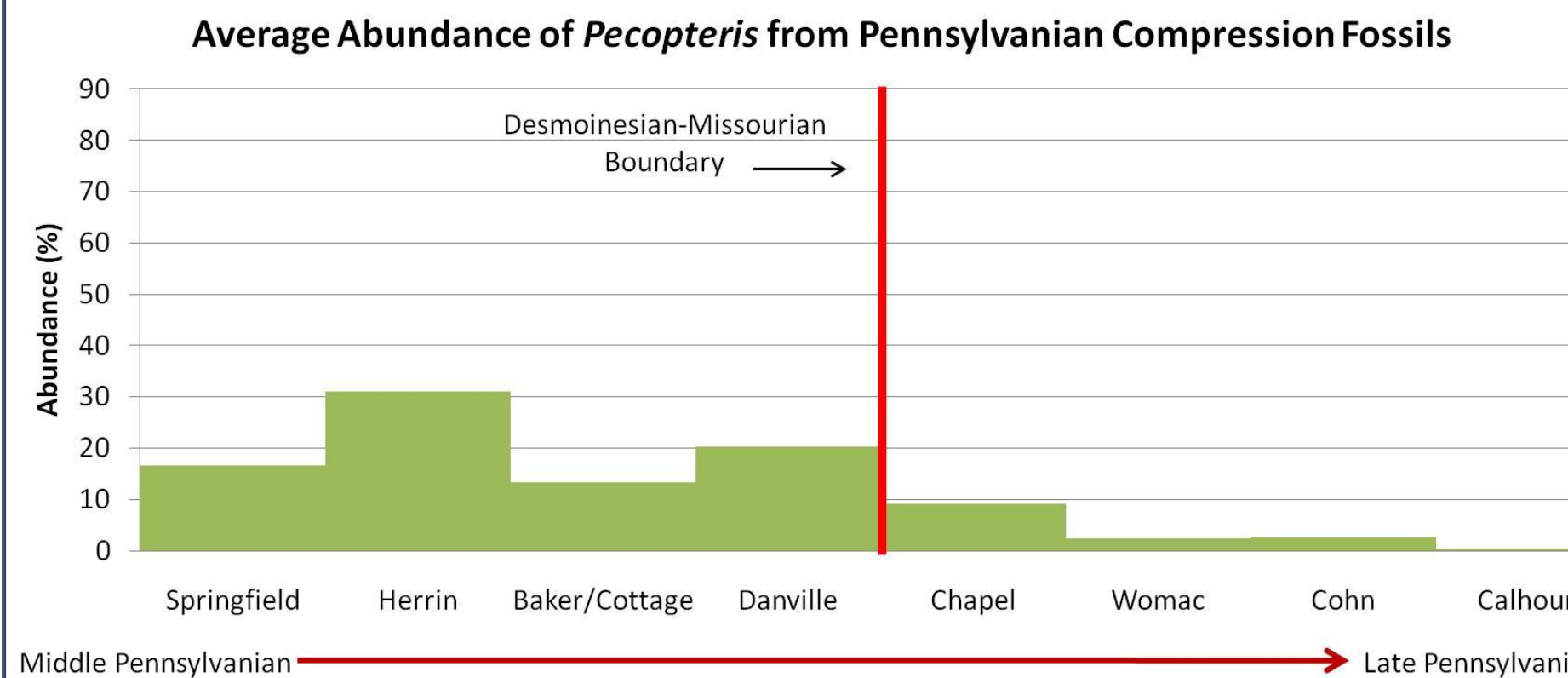
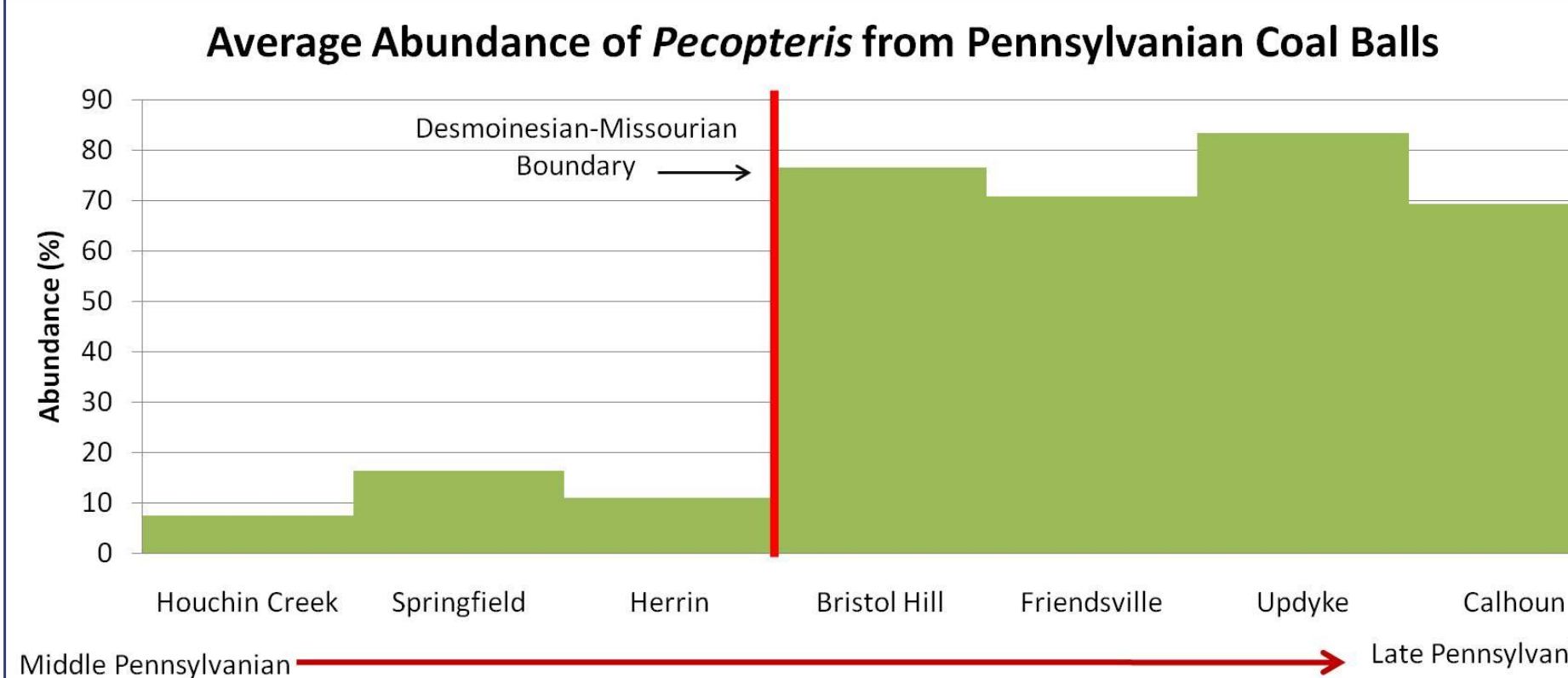


Results

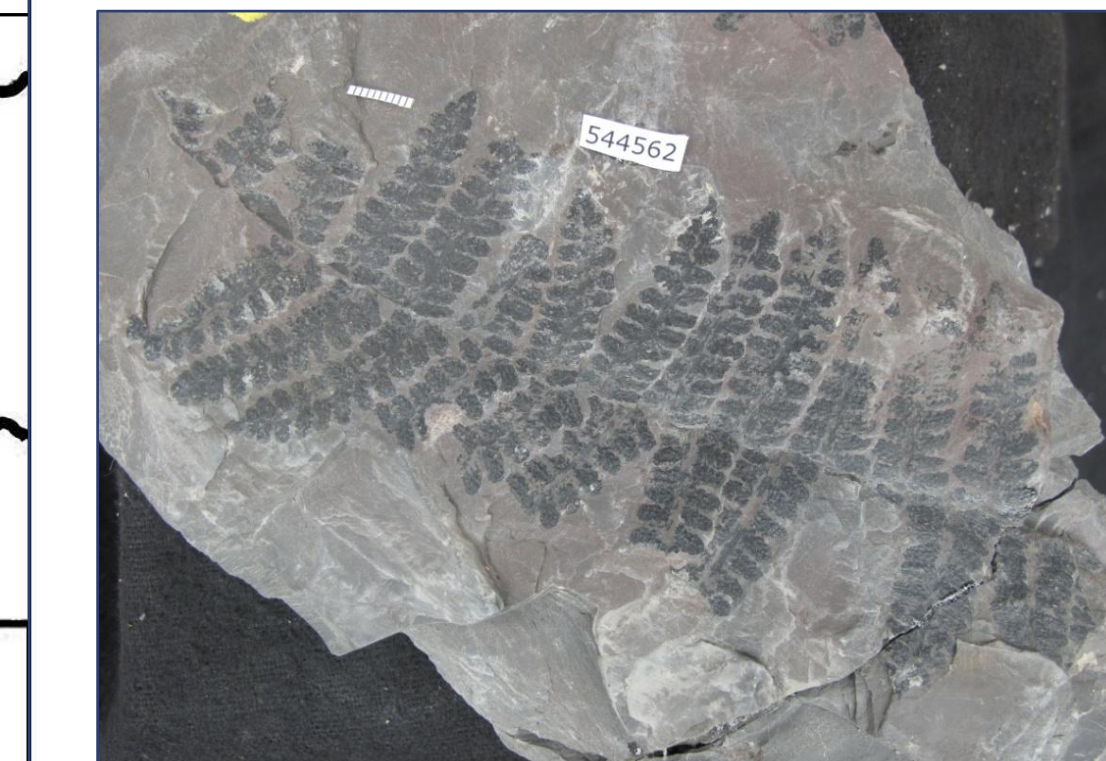


The two histograms above show both the maximum and average percent abundances of *Pecopteris* in each stratigraphic unit throughout the Pennsylvanian. The numbers above the bars represent the total number of quadrats in the collection with the highest abundance for the maximum abundance graph and the total number of collections surveyed per stratigraphic unit for the average abundance graph. The black line is a moving average with a period of two.

- Tree-fern abundance was found to be highly variable throughout the Pennsylvanian
- The highest tree-fern abundance occurred in the late Desmoinesian, with the lowest abundances in both the earliest and latest Pennsylvanian
- Pecopteris* was almost never an overwhelmingly dominant floristic component



- On the left are three histograms showing average *Pecopteris* abundances over the Desmoinesian-Missourian boundary using coal balls, compression fossils, and palynology
- While the abundance of *Pecopteris* increases significantly in both coal balls and spores, the compression fossil data from this study indicate that the abundance of *Pecopteris* actually decreases slightly
- Our results refute the claim from previous studies that tree-ferns rapidly rose to abundance at the Desmoinesian-Missourian boundary



Interpretations

- Abundance patterns inferred from palynology and coal ball studies support the idea that tree-ferns were dominant in the later Pennsylvanian. The variable abundances and low dominance found in our compression fossil data could be due to a sampling bias, where the environments sampled in the Illinois Basin were not representative of the full spectrum of lowland, wetland habitats colonized by tree ferns
- Similarly, a taphonomic bias might have produced such ambiguous results, where tree-ferns were actually abundant in Late Pennsylvanian units, but the absence of widespread Late Pennsylvanian coals significantly decreased areas where preservation is most likely
- If these variable abundance patterns are not the result of sampling or taphonomic biases, they could suggest that tree-ferns prefer environments of low nutrient availability, only to be driven out by competition from pteridosperms during periods of clastic input where nutrients are readily available
- Alternatively, tree-fern abundance may have closely followed glacial-interglacial cycles. While widespread and abundant during interglacials, tree-ferns may have



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