Fungi in a Warmer World: Middle Miocene Fungal Assemblages and Diversity from Alum Bluff, Florida

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Introduction

Fungi play a key role in the terrestrial carbon cycle, soil formation, and overall plant growth as terrestrial decomposers (1, 2). Thus, the study of fungi, especially in the fossil record, is critical to understanding how fungal assemblages will react to future warming events. Fossil fungi provide a large-scale, long-term dataset unavailable from modern records, allowing for the generation of viable paleoclimate reconstructions and predictions (3, 4). Despite their importance and advantages in forming ecological and climatological interpretations, deep-time fungi have been underutilized (3).

The Fungi in a Warmer World (FiaWW) project aims to deliver the first global view of fungal biodiversity, ecology, and biogeography for the Miocene Climate Optimum (MCO): the warmest interval of the last 23 MY. The MCO is a good proxy for near-future climate change scenarios because atmospheric CO_2 concentrations ranged between current concentrations of ~400ppm and future projected concentrations for the end of this century (5, 6).

The Alum Bluff locality of Florida, which has yielded significant plant remains from the Fort Preston Formation, contains sedimentary records that include the MCO (7, 8). Jarzen et al. (7) reported the recovery of abundant fungal remains, but identified very few. To generate climatic and ecological information from the taxa reported, we must re-study and correlate them with extant lineages through techniques developed by O'Keefe (9), Nuñez Otaño et al. (10), Pound et al. (11), and Ferrer et al. (12). This information will be used to generate paleoclimate reconstructions and future predictions for the region.

Here we present preliminary results of the fungal diversity as found in existing Alum Bluff material from the Florida Museum of Natural History. When complete, this study will be the first detailed record of microfungal assemblages for this locality.

Study Area

The Alum Bluff site is a world-famous paleontological locality that exposes the Lower-Middle Miocene Fort Preston Formation on a cutbank of the Apalachicola River in Florida (Fig. 1; 5, 8). Its lithostratigraphy is characterized by 6m of yellow and white clay- and silt-rich sands (Fig. 2; 13, 7). The area has been dated to 16.3–13.6 Ma by mammalian stratigraphy (Fig. 3; 7, 8).

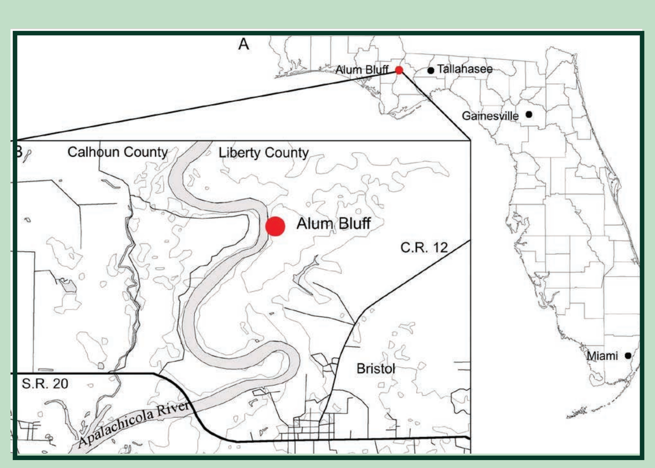

Fig. 1: Location of Alum Bluff site, Florida. Red point indicates the Alum Bluff outcrop (Modified from Lott et al., 2019).


Fig. 2: Outcrop showing that samples were stratigraphically-controlled when collected.

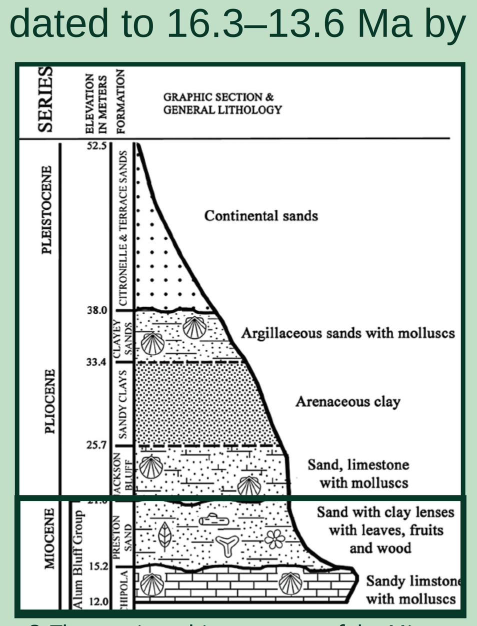

Fig. 3: The stratigraphic sequence of the Miocene outcrop section and its composition is found within the green box (Modified from Jarzen. 2010).

Methods

For this preliminary study, we evaluated existing palynological material from the Florida Museum of Natural History. This initial pass permits us to develop a synopsis of fungi present in the area. Stratigraphically-controlled samples have been collected by our team, but have yet to be processed and analyzed.

We examined the 12 museum samples using brightfield microscopy at 1000x magnification on Leica DM 750P microscopes with integral ICC50W cameras and Leica Application Suite® software.

Fungal Assemblages

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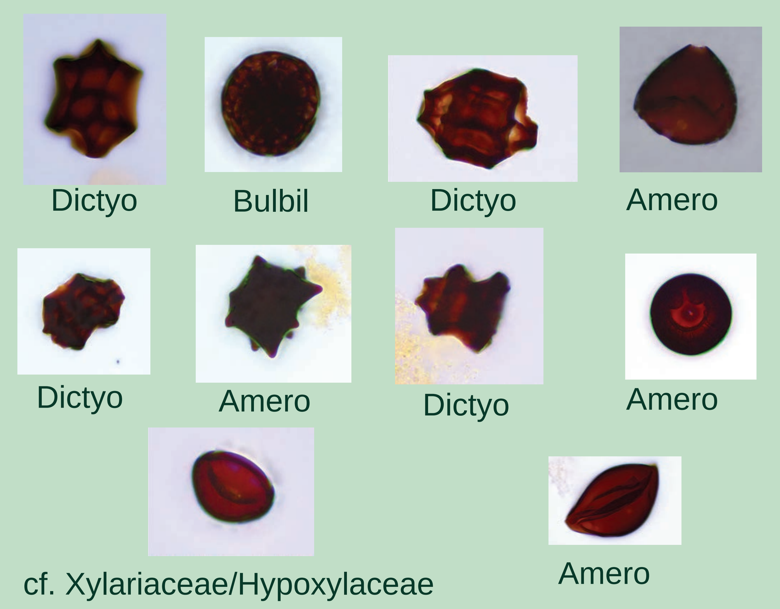

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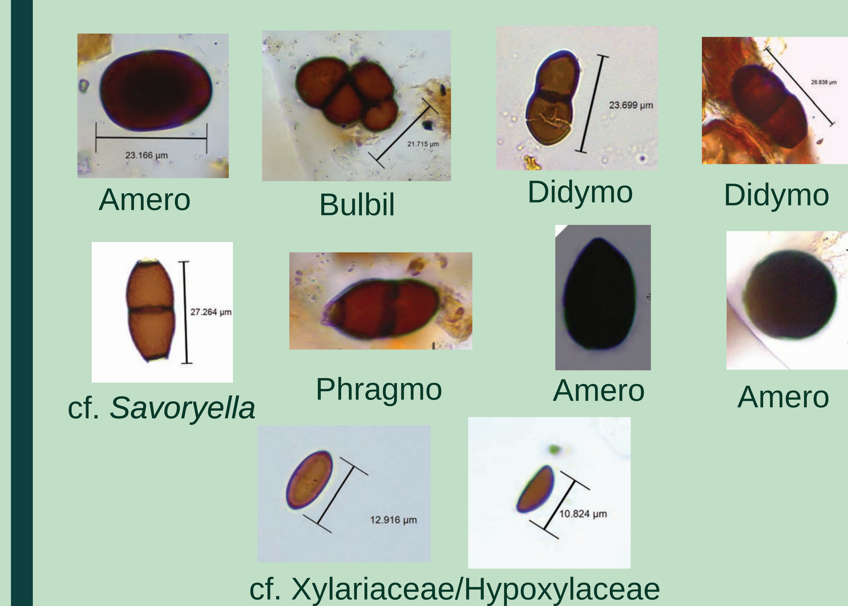

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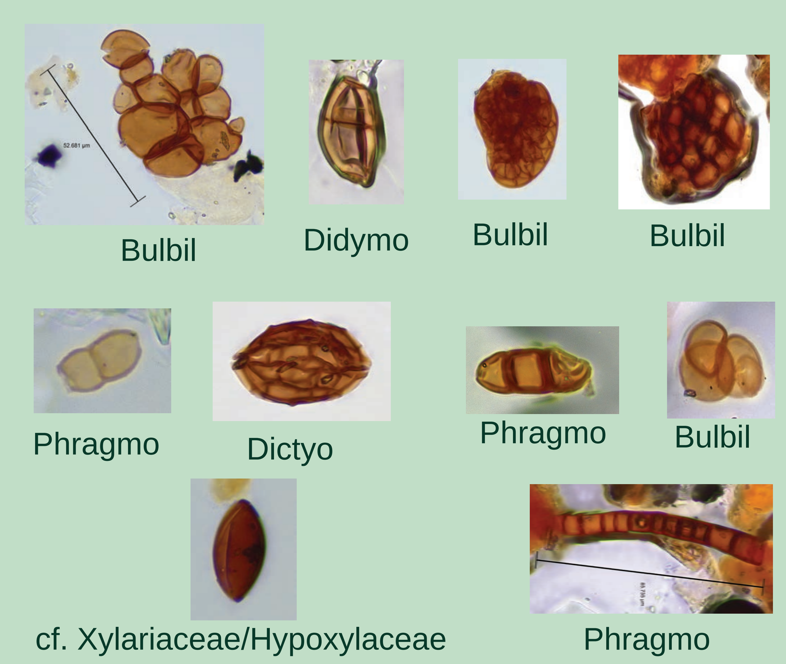

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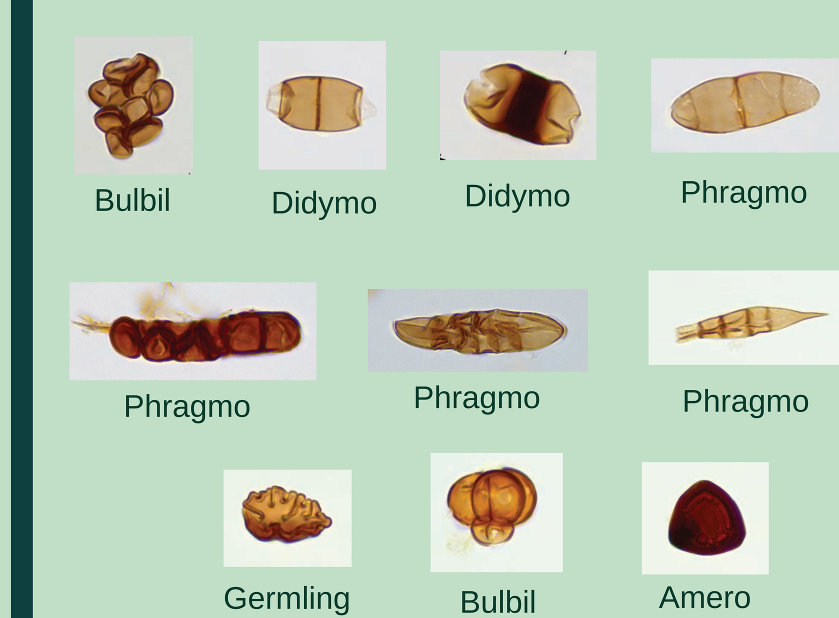

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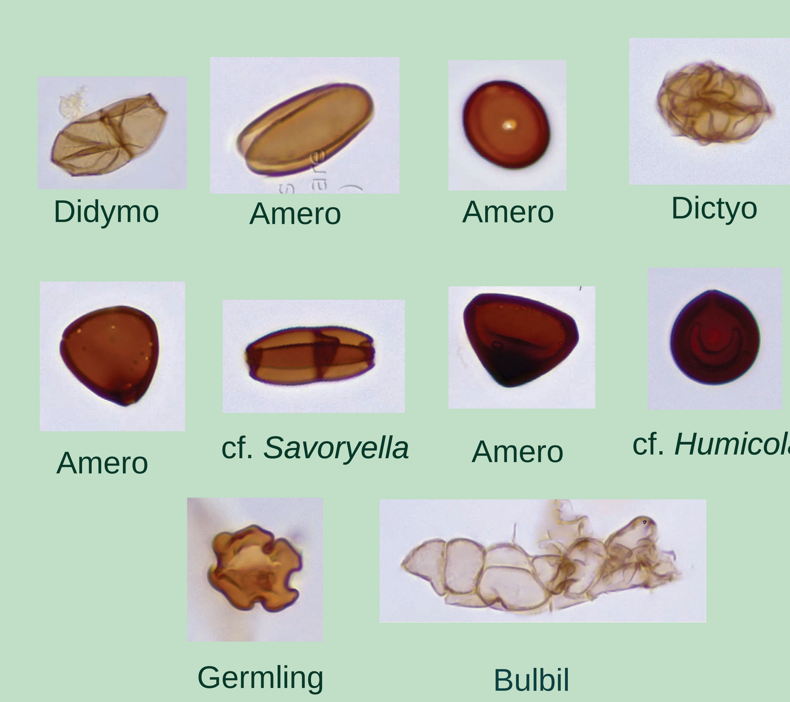

Barren Samples

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UF 18049-043592 PY04

UF 18049-043592 PY03

UF 18049-043592 PY01

UF 18049-043591 PY02

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Conclusions

The diversity of spores varies among samples, with half being barren. This suggests that recovery from the stratigraphically-controlled samples will be highly variable.

From the samples with material, the mycobiota of Alum Bluff are characterized by diverse amerospores and didymospores, with phragmospores and bulbilspores found throughout.

From the museum slides, the appearance of germlings, bulbils, and didymos suggests a humid environment. Preliminary identification data shows the presence of cf. *Savoryella*, cf. *Humicola*, and cf. Xylariaceae/Hypoxylaceae.

As the project continues, we will complete correlation of fossil fungal spores with their extant relatives to make better paleoecological inferences of past environments and possible future predictions.

During summer 2022, the 2021 stratigraphically-controlled samples will be analyzed so that assemblage changes in Alum Bluff can be correlated with existing paleoecological and paleoclimatological proxies.

Acknowledgments

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