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Reinvestigating Carboniferous "Actinomycetes:" Authigenic formation of biomimetic carbonates provides insight into early diagenesis of permineralized plants

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ABSTRACT

Paleoecological interactions among fossil microorganisms have garnered significant interest within the paleobotanical community; however, an understanding of the early diagenesis of associated plant material is of critical importance when assessing putative body fossils of fungi and bacteria. Structures preserved within permineralized petioles of the Carboniferous fern *Botryopteris tridentata* Felix (Scott) have been interpreted as the earliest remains of Actinobacteria found in association with vascular plants, but re-examination of the specimens indicates instead that these biomimetic structures (BMS) are authigenic carbonate minerals. Using spinning disk confocal microscopy, we generated monochromatic luminescence maps of BMS found within the phloem cells *of Botryopteris*. Luminescence was captured at wavelengths of 665 nm, consistent with an interpretation of these structures as disordered dolomites, an inference subsequently corroborated with energy-dispersive X-ray spectrometry (SEM-EDS). The presence of high-magnesium carbonates within *Botryopteris* is suggestive of an early anaerobic stage of plant tissue degradation characterized by metabolic activities of sulfate-reducing bacteria. Anaerobic biodegradation may also have been performed by chytridiomycetes, and we interpret larger (5–8 μm) unicells found within the specimens as fossils of chytrid zoosporangia. Understanding microbial contribution to the early diagenesis of plants preserved within calcium carbonate concretions (coal balls) is dependent upon both characterizing diversity of microbial communities within fossil plants, and elucidating the geomicrobiological parameters of mineralization. As such, this study underscores the

necessity of integrating geomicrobiology with plant taphonomy in investigations of the microbial component of ancient ecosystems.