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Deciphering interfungal relationships in the 410-million-yr-old Rhynie chert: Morphology and development of vesicle-colonizing microfungi ✡

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Abstract

The intraradical portion of arbuscular mycorrhizal (AM) fungi comprises mycelium, vesicles, and special physiological interfaces termed arbuscules; sometimes mycorrhizal fungi also produce spores within their hosts. Arbuscules are ephemeral structures that collapse after a few days, while the hyphae and vesicles appear to remain intact for some time after arbuscule senescence (post-arbuscule stage). However, little is known about the fate of mycorrhizal fungi in the post-arbuscule state. The Lower Devonian Rhynie chert yields the oldest fossil evidence of arbuscular mycorrhizas, including multiple specimens of mycorrhizal axes in the post-arbuscule stage. These fossils indicate that many older vesicles of Rhynie chert mycorrhizal fungi are colonized by other microfungi. Three types of fungal remains in vesicles are distinguished based on morphology and development: (1) spheroidal propagules up to 55 μm in diameter extending from short, distal branches of a hypha; (2) spheroidal propagules up to 23 μm in diameter produced within a tenuous mycelium; and (3) thin-walled propagules up to 10 μm in diameter within a hyphal inflation. The abundance of microfungal propagules in vesicles of Rhynie chert mycorrhizal fungi suggests that the mycorrhizal