The genus Geosmithia: evolution and taxonomy of long-time overlooked bark beetle symbionts

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ABSTRACT:
Filamentous fungi of the genus *Geosmithia* (Ascomycota: Hypocreales) are a long-time overlooked symbiont of bark beetles. This was due to their strong similarity to the genera *Penicillium* and *Paecilomyces*, which are commonly ignored contaminants of bark beetle galleries. Research over the past twenty years has shown that they are the dominant symbionts of these insects worldwide. During their evolution, a number of lineages have specialized on their insect vector and plant, and some of them have convergently evolved into primary nutritional symbionts of ambrosia beetles. This was followed by significant changes in morphology and metabolic activities. One species, *Geosmithia morbida*, is capable of necrotizing plant tissues and is the causal agent of Thousand Cankers disease of black walnut in the USA and Europe. In reconstructing the evolution of the genus, rDNA has proven to be unsuitable, due to its unequal mutation rate, and GC content, across lineages. This leads to an exemplary incongruence between rDNA and protein-coding gene-based phylogenies. Studies have shown that these fungi, even in well-studied areas of the world, have a large proportion of undescribed diversity. A global survey covering all continents revealed the presence of 60 phylogenetic species. So far, only 31 of them have been described. The taxonomic study is based on knowledge of similar fungi such as the genus *Penicillium* or *Aspergillus* and has shown the insufficient resolution of the ITS rDNA barcode gene and the need to use intron-rich protein-coding genes and different culture conditions. In terms of studying the discriminatory ability of different genes, *Geosmithia* represents a good model for studying integrative approaches in species delimitation because they include species with striking dissimilarities in morphology, ecology and geography, but having identical ITS barcode sequences.

KEYWORDS:
Bark beetles; ambrosia fungi; *Geosmithia*; DNA barcoding; integrative species delimitation; evolution