

Collaborative Research: Toward a Global Phylogeny of the Boletales

The Boletales is a monophyletic order of homobasidiomycetes (Fungi) that includes approximately 1025 described species that are distributed worldwide. The Boletales are diverse in both morphology and ecology. Fruiting bodies in the group include stipitate-pileate forms (those with a stalk and cap), crust-like resupinate forms, earthballs, and false truffles. Members of the Boletales obtain carbon nutrition by entering into ectomycorrhizal symbioses or decaying wood—and a few are suspected to be mycoparasites. Some are highly prized edibles; others are important food sources for mammals, and many are rearing sites for insects.

The Boletales have been widely studied by fungal systematists, chemists, ecologists, and mycorrhizal biologists. However, investigations in all these areas have been hampered by the lack of a comprehensive phylogenetic classification for the group. For example, poor resolution of the basal clades of Boletales makes it difficult to infer the ancestral form of the group; lack of understanding of generic boundaries makes it difficult to assess relationships of newly discovered species, especially from the tropics; and ambiguous species limits within many clades are a barrier to ecology and biodiversity studies.

We propose a collaborative project that will contribute to a comprehensive phylogenetic classification of the Boletales. The proposed research involves a nested set of three sub-projects:

1. Multi-gene phylogeny using exemplars of all major groups of Boletales and representatives of potential outgroups. The goals of these studies are to 1) provide a “backbone” phylogeny of the Boletales; 2) resolve the order of early branching events in the group; and 3) identify the sister group of the Boletales. This work will use many of the same loci as the NSF-supported “Assembling the Fungal Tree of Life” (AFTOL) project.

2. Survey of diverse Boletales, using nuclear large-subunit rDNA and ITS sequences. The goals of these studies are to 1) develop a phylogenetic framework within which generic-level diversity of Boletales can be addressed; 2) provide resources for species-level taxonomy and molecular ecology; and 3) understand the evolution of morphological and ecological characters in the Boletales.

3. Monographic studies on selected genera and species-complexes in Boletaceae. These studies will use morphological and molecular characters to refine taxonomic limits and clarify biogeographic patterns in selected problematical groups. Results of these studies will provide tools for taxon identification, and may provide insight into the total number of species of Boletales worldwide. This part of the project will capitalize on hypotheses about higher-level relationships obtained in parts 1 and 2 of the project.

Intellectual merit of the proposed activity: The proposed research will build on prior work in systematics of Boletales, including important contributions by Halling and Binder, and will contribute to a phylogenetic classification of this ecologically important clade. Well-sampled phylogenetic trees will permit analyses of the evolution of fruiting body forms and other taxonomically important characters, as well as transitions between symbiotic and free-living lifestyles. The PIs and Co-PI bring complementary skills and considerable material resources to the project, including DNA samples from the work of Binder and personally documented specimens collected by Halling from around the globe.

Broader impacts resulting from the proposed activity: The proposed research will provide resources for fungal molecular ecologists (specifically ITS sequences in GenBank) and will promote the discovery and detection of new species of Boletales, for example in the tropics. This project will support two graduate students and two post-doctoral fellows (one each at Clark University and the New York Botanical Garden) as well as undergraduates, for whom we will seek REU supplements. In addition to technical publications, a Boletales web site will be developed that will provide a synthesis of the phylogeny, biodiversity, and ecology of the group, as well as images, literature guides, and other resources for researchers and educators. Finally, this project will promote collaboration between Clark University, a small liberal-arts institution, and the New York Botanical Garden, which is one of the world’s major herbaria (largest in the Western Hemisphere) and has an active biodiversity research program.