

Phylogenetic relationships of cyphelloid and aquatic homobasidiomycetes.

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PROJECT SUMMARY

Homobasidiomycetes include about 13,500 described species of mushroom-forming fungi and related taxa. This ecologically important group includes gilled mushrooms, polypores, puffballs, and other conspicuous macrofungi. Homobasidiomycetes do not have flagellated cells at any stage of their life cycle, and almost all occur in terrestrial habitats.

The proposed research concerns the phylogenetic relationships of cyphelloid and aquatic homobasidiomycetes. Cyphelloid homobasidiomycetes include roughly 300 species that have minute cup-shaped or tubular fruiting bodies. These fungi have been grouped in the family Cyphellaceae (or Porotheleaceae), but it is widely accepted that they are polyphyletic. Aquatic homobasidiomycetes include about 20 marine and freshwater species (including sexual and asexual taxa), some of which have modified spores with elongate appendages that presumably function in dispersal in aquatic habitats. A few aquatic homobasidiomycetes can be tentatively linked to certain terrestrial groups based on morphology, but many are taxonomically enigmatic.

Recently, we discovered that the marine homobasidiomycete, *Nia vibrissa* (which has appendaged spores and a puffball-like enclosed fruiting body), is closely related to the terrestrial cyphelloid fungus, *Henningsomyces candidus* (Binder et al., 2001). The sister group of the *Nia-Henningsomyces* clade includes *Schizophyllum commune* and *Fistulina hepatica*, which have unusual gill-like and pore-like spore-bearing structures, respectively. Preliminary analyses combining published sequences and unpublished sequences from our laboratory suggest that there may be many other cyphelloid forms in these groups, as well as certain resupinate (crust-like) forms, poroid forms, and at least two additional marine taxa. If this is correct, then the *Nia-Henningsomyces* clade plus the *Schizophyllum-Fistulina* clade provide dramatic examples of morphological and ecological diversification in homobasidiomycetes. However, preliminary analyses also suggest that many other cyphelloid and aquatic fungi occur outside of these groups.

The central goal of the proposed research is to delimit the major clades of cyphelloid and aquatic homobasidiomycetes and identify their closest relatives. Special emphasis will be placed on taxa that may be related to the *Nia-Henningsomyces* clade and the *Schizophyllum-Fistulina* clade. Much of the material required for this study is available in herbaria and culture collections, but we will also undertake several collecting trips in the neotropics (Puerto Rico and Panama) and the temperate zone (New England).

Phylogenetic analyses will occur in two phases. In the first phase, nuclear large subunit ribosomal DNA (nuc-lsu rDNA) sequences will be obtained from all individuals studied. These data will be added to reference datasets drawn from the emerging nuc-lsu rDNA database of homobasidiomycetes, which derives largely from the work of Moncalvo and Vilgalys and Langer, as well as our own work. Analyses of the nuc-lsu rDNA data will permit resolution of terminal clades of cyphelloid and aquatic homobasidiomycetes, but this region probably will not provide robust resolution of higher-level relationships of homobasidiomycetes. In the second phase of phylogenetic analyses, exemplars of major groups of cyphelloid and aquatic homobasidiomycetes will be selected (based on results of nuc-lsu rDNA analyses) for inclusion in a four-region dataset, which will contain nuclear and mitochondrial large and small subunit rDNAs. Based on results of a recent study (Binder and Hibbett, in review), the four-region dataset is expected to resolve deeper nodes in the homobasidiomycetes, which will make it possible to place the major groups of cyphelloid and aquatic homobasidiomycetes in a broad phylogenetic context. Ancestral state reconstruction (using both parsimony and maximum likelihood approaches) will be performed to infer the historical pattern of transformations between cyphelloid and other fruiting body forms, as well as transitions between aquatic and terrestrial habitats.

Training and outreach are important aspects of the proposed research. This project will continue the collaboration of DSH and MB, and will also support a Ph.D. student (Mr. Zheng Wang) and several Clark University undergraduates (who we hope to support via REU supplements, as we have done in the past). This project will also involve local high school students and high school biology teachers, who will take part in six-week summer research experiences. The high school teachers will receive professional development points, which are required for certification by the Massachusetts Department of Education. Lastly, this project will provide funds to support a two-month research visit by a German Ph.D. student, Ms Philomena Bodensteiner, who is studying taxonomy of cyphelloid fungi under the direction of Prof. Dr. Reinhard Agerer (University of München).