Phylogenetic significance of morphological characters in the tropical Hypotrachyna clade of Parmelioid lichens (Parmeliaceae, Ascomycota)

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Abstract

Lichen-forming ascomycetes exhibit often complex morphologies of the vegetative thallus that are usually not found in non-lichenized fungi. This includes the thallus organization and appendical structures associated with the main thallus, such as cilia and rhizines. Such morphological characters are widely employed in the taxonomy of Parmelioid lichens, especially at generic level. Within Parmelioid lichens, several monophyletic groups can be distinguished, the Hypotrachyna clade being one of them, which includes mostly tropical taxa. In this first molecular study focused specifically on the Hypotrachyna clade, we used maximum parsimony and Bayesian analyses of a combined data set of nuclear ITS and mitochondrial SSU rDNA sequences to (1) test the monophyly of genera presently accepted within the clade and (2) evaluate the phylogenetic value of the morphological characters used to circumscribe genera in Parmelioid lichens. Out of the 89 mtSSU and 88 nuITS sequences included in the present study, 121 sequences were newly obtained. Our results show that the taxa within the clade fall into two major groups and that the genus Hypotrachyna is polyphyletic. Everniastrum and Parmelinopsis are nested within Hypotrachyna sensu stricto, the latter being also polyphyletic. Bulbothrix is paraphyletic with Parmelinella nested within and is basal to the second major Hypotrachyna clade. Monophilies of Bulbothrix and Hypotrachyna are significantly rejected. The phylogenetic analysis demonstrates that morphological characters currently used to circumscribe genera in Parmelioid lichens, such as cortical anatomy, lobe configuration, cilia, and rhizines have been overestimated and have only minor value in identifying monophyletic groups.

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1. Introduction

Lichens are the symbiotic phenotype of lichen-forming fungi and green or brown algae or cyanobacteria. The symbiotic relationship between the fungal and photosynthetically active partner is often so well established that a special lichen thallus is formed. It is quite different in appearance from the morphology of single partners. This includes anatomical and chemical characters that are believed to be adaptive for these symbiotic organisms, such as pores in the cortical layers that facilitate gas exchange through the cortex (Beltman, 1978; Green et al., 1981, 1985; Hale, 1973, 1981; Yoshimura and Hurutani, 1987) or UV absorbent compounds or pigments screening visible light and UV (Begora and Fahselt, 2001; Rikkinen, 1995; Solhaug and Gauslaa, 1996; Solhaug et al., 2003). Previously we have studied the evolution of these characters in the higher-level phylogeny of Parmelioid lichens (Blanco et al., 2006). However, a number of further morphological and chemical characters have been widely employed to circumscribe genera in lichenized fungi, especially in families with numerous foliose taxa, such as Parmeliaceae or Physciaceae (Elix, 1993; Elix and Hale, 1987; Rikkinen et al., 1997; Nordin and Mattsson, 2001; Scheidegger et al., 2001). This includes mainly characters relating to thallus organization and appendical structures associated with the