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Beyond the water column: aquatic hyphomycetes outside their preferred habitat

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ABSTRACT

Aquatic hyphomycetes have adapted to running waters by their uncommon conidial shape, which facilitates dispersal as well as adherence to plant substrata. However, they have been early and regularly reported to occur in a variety of environments other than their preferred habitat (e.g., in lentic freshwaters, brackish and marine environments, in terrestrial niches such as stream banks, dew, canopy waters and tree holes). In addition, several aquatic hyphomycetes have adapted to a mutualistic lifestyle which may involve plant defence, as endophytes in leaves, gymnosperm needles, orchids and terrestrial roots. There are several lines of evidence suggesting that aquatic hyphomycetes survive under terrestrial conditions due to their sexual states. Although exhibiting higher diversity in pristine streams, aquatic hyphomycetes can survive environmental stress, e.g., pollution or river intermittency. They also inhabit ground and hyporheic waters, where they appear to be subjected to both physical and physiological selection. Appropriate methods including molecular ones should provide a more comprehensive view of the occurrence and ecological roles of aquatic hyphomycetes outside their preferred habitat.

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Introduction

Ingold's discovery of aquatic hyphomycetes, a diverse fungal community with predominantly tetraradiate (multiradiate) or sigmoid conidia, growing abundantly on deciduous leaves decaying in streams, shifted fungal research efforts toward running waters (Ingold, 1975; Bärlocher, 1992a). However, several, maybe a majority of, aquatic hyphomycetes occur in both aquatic and terrestrial habitats. Webster (1977), therefore, began referring to them as "aquatic" hyphomycetes, and Michaelides and Kendrick (1978) suggested that the more appropriate term for this group is "amphibious hyphomycetes". The most straightforward connection seems to be the occurrence of sexual reproduction when the still moist substratum (generally wood) is exposed to air. To our knowledge, nothing is known about the impact of sexually produced spores on the activity and composition of fungal populations in streams. In some circumstances, the presence of aquatic hyphomycetes in terrestrial habitats may be accidental, e.g., leaves fall into a stream and are colonized. Due to variable water flow, some leaves are subsequently deposited on the banks, on bare ground within the floodplain, even trapped on branches of riparian trees and bushes, or buried in the streambed sediment, and may eventually be returned to the actual stream. In these cases, survival of the dry period will be essential. Finally, it seems that terrestrial existence is a requisite or common occurrence for some fungi with stauro- or scoleco-sporous conidia. These taxa may or may not be properly classified as aquatic hyphomycetes. They are found in (moist) leaf litter layers on the ground or in tree holes, and may be connected to species found in throughfall and stemflow. Potential sources for these species are phylloplane and endophytic fungi. In line with this variety of niches and physiological traits, Descals and Moralejo (2010) discussed possible terminologies for fungal groups with connections to aquatic habitats. The present review provides an insight into the various environments occupied by aquatic hyphomycetes apart from their main habitat, i.e., running waters (as illustrated in Fig 1), together with mechanisms involved in dispersal and colonization.

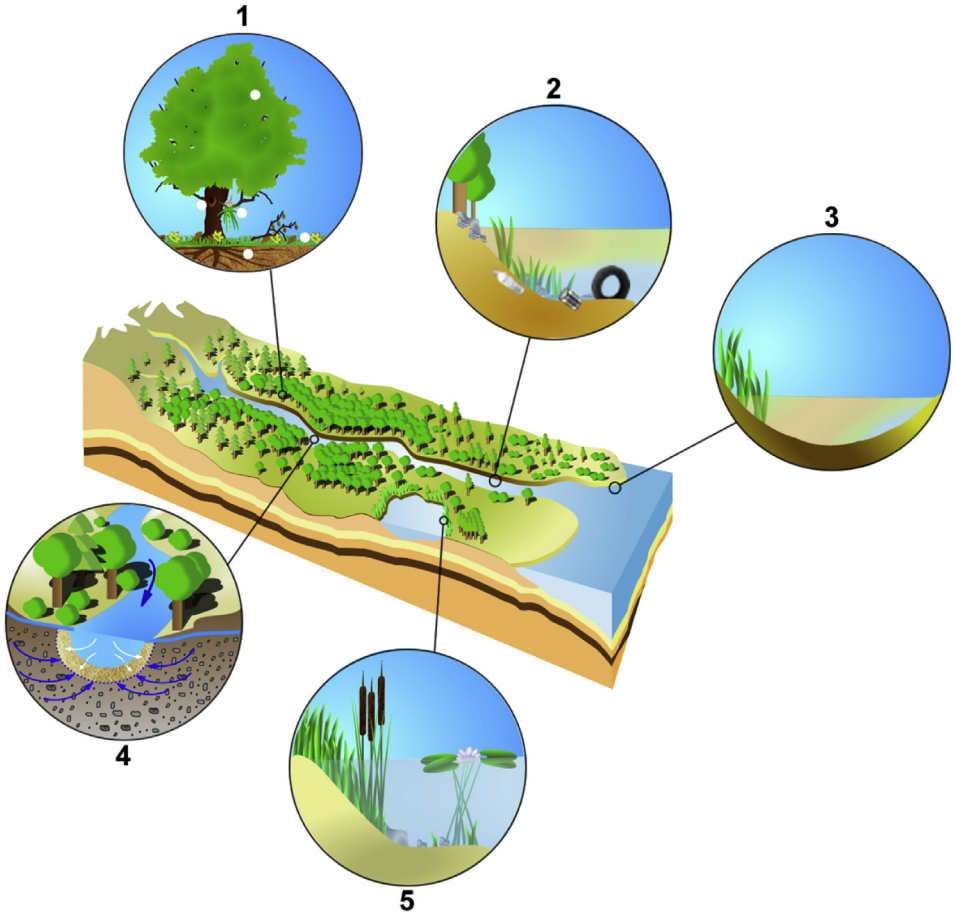

Fig 1 – Aquatic hyphomycetes have been reported from a wide variety of environments and niches, outside their preferred habitat (i.e., running waters): 1. Trees, including canopy, orchids, tree holes, roots, and forest floor, as illustrated by white dots (some occurring as endophytes in roots or needles, cf. Fig 2); 2. Stressed freshwaters; 3. Estuarine environments; 4. Hyporheic habitat and groundwaters; 5. Lentic waters.