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Diversity of aquatic hyphomycetes in streambed sediments of temporary streamlets of Southwest India

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ABSTRACT

Assemblages of aquatic hyphomycetes in streambed sediments of nine temporary streamlets in Southwest India were monitored during the wet and dry seasons. Sediments were baited with sterile banyan (*Ficus benghalensis*) leaf disks followed by conidial induction in bubble chambers. Species richness as well as conidial output were higher during the wet than dry season, while it was opposite for diversity. *Anguillospora longissima*, *Cylindrocarpon* sp. and *Flagellospora curvula* were common among the top five spore producers in both seasons. During the wet season, species richness was higher in sandy clay loam sediments than in loam and sandy loam sediments, while species similarity showed a decreasing trend from loam > sandy clay loam > sandy loam sediments. This corresponds to greater dispersal ability of filiform conidia than branched conidia in sediments. The conidial output positively correlated with organic carbon in sediments during the wet season.

Introduction

Lotic habitats with intermittent water flow in their channels are common around the world (Tooth, 2000; Larned et al., 2010; Acuña et al., 2014). These buffer zones between aquatic and terrestrial ecosystems, ranging from small drainage basins to large river reaches, constitute a significant part of ecologically valuable but infrequently studied lotic ecosystems (Storey et al., 1999; Tooth, 2000; Larned et al., 2010; McDonough et al., 2011). Temporary streams serve as ecological niches for fauna, flora and microorganisms, zones of nutrient processing, and links between watersheds and perennial river networks (Williams and Hynes, 1977; Williams, 1993; Romani et al., 1998; Storey et al., 1999; Lake et al., 2000; Hose et al., 2005; McDonough et al., 2011). These ecosystems are highly influenced by climate change, especially by higher temperatures and lower precipitation (Lake et al., 2000; Palmer et al., 2008; Brooks, 2009).

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Hyporheic zones are spatially fluctuating ecosystems driven by organic matter mineralization, elemental cycling and metabolism. They connect stream surfaces with ground water and are influenced by physicochemical characteristics, water movement, soil porosity, soil particle size and soil biota (Brunke and Gonser, 1997; Cleven and Meyer, 2003; Boulton, 2007). A wide range of hyporheic zones are available to study the fundamental processes and biological activities (e.g. freshwaters, marshes, estuarine, mangrove and hydrothermal vents). These zones are the major source of energy and contain 25–82 % of total stored organic matter in aquatic ecosystems (Cummins et al., 1983; Jones et al., 1997; Storey et al., 1999). Interest in the importance of fungi in hyporheic zones (on surfaces of inert substrata, buried leaf litter and the impact of raised temperature) is relatively recent (e.g. Bärlocher and Murdoch, 1989; Bärlocher et al., 2006, 2008; Sridhar et al., 2008; Cornut et al., 2010; Navel et al., 2011). Although aquatic hyphomycetes (major fungal colonizers and processers of leaf litter in lotic habitats) are known to occur in stream sediments and ground waters, their diversity, biomass and conidial output are substantially lower than on non-buried leaf litter (Krauss et al., 2003, 2005; Sridhar et al., 2008; Sudheep and Sridhar, 2012). Cornut et al. (2010) reported leaf litter breakdown in hyphoreic zones of up to 12 %, while Marmonier et al. (2010) positively correlated leaf mass loss with quantity of coarse particulate organic matter as well as richness of macroinvertebrates and negatively correlated with depletion of oxygen. Recently, Cornut et al. (2014) conducted field and micorcosm studies to evaluate dispersal efficiency of filiform vs. branched conidia of aquatic hyphomycetes in the hyporheic zone in streams of Southwestern France.

Aquatic hyphomycetes have several survival strategies under stress such as low temperature, desiccation and organic matter depletion. Aquatic hyphomycetes may survive as endophytes in roots exposed to water, leaf litter on stream banks and riparian tree canopies (treeholes, stemflow and throughfall) (e.g. Sridhar and Bärlocher, 1992, 1993; Sati and Belwal, 2005; Bärlocher, 2006; Selosse et al., 2008; Sridhar, 2009). However, there has been no comprehensive study of aquatic hyphomycete communities in streambed sediments during wet (monsoon) and dry (summer) regimes of temporary streams. Hence, the goal of this study was to compare the occurrence of aquatic hyphomycetes in sediments of nine temporary streamlets of Southwestern India during the wet and dry seasons. The specific objectives were: (i) comparison of conidial output, diversity and similarity of aquatic hyphomycetes in streambed sediments in wet and dry seasons; (ii) correlation of species richness, conidial output and diversity of aquatic hyphomycetes with physicochemical characteristics of the streambed sediments.

Materials and methods

Streamlets

Nine temporary streamlets (S1–S9) were selected for study in three regions of Southwest India (Uppinangadi: S1–S3; Puttur: S4–S6; Mangalore: S7–S9) (Fig 1). Details of each streamlet (coordinates, altitude, streamlet order, dates of sampling, sediment texture and vegetation) are given in Table 1. The study sites completely dry up during summer season (January–May), and are covered with water during monsoon (June–September) and post-monsoon (October–December) seasons.

Sediments

To compare aquatic hyphomycetes during wet and dry seasons, sediment samples were collected in September/October 2013 and April 2014. Samples were harvested at three sites in each streamlet (distance: ∼50 m) with a Peterson's Grab (Partex Products, Mumbai, India; capacity, 2 kg), by scooping sediment down to 30 cm. Sediment temperature in undisturbed sections was measured at 10 cm depth using a thermometer (N.S. Dimple Thermometers, New Delhi, India; Model, # 17 876; accuracy, ±0.2 °C). Sediment samples collected during the wet season were spread on blotting paper in the laboratory for 2–3 d, and texture was determined gravimetrically (USDA, 1975). Sediments collected during the dry season were directly used for texture determination as moisture content was low. Sediments were diluted with distilled water (1:2.5 v/v) to determine pH and conductivity (Water Analysis Kit, Systronics, India; Model #, 304). The organic carbon of sediments was estimated by

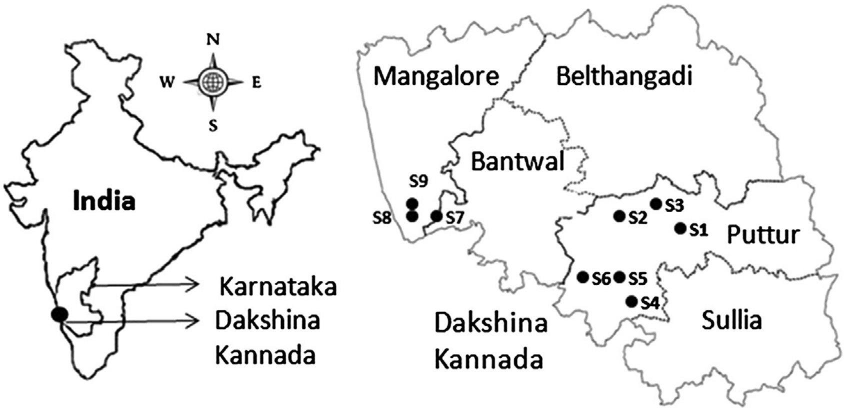

Fig 1 – Locations of temporary streamlets studied: Uppinangadi region (S1–S3), Puttur region (S4–S6) and Mangalore region (S7–S9).