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ORIGINAL PAPER

Metagenomic insights into the fungal assemblages of the northwest Himalayan cold desert

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Abstract

Psychrophilic fungi are a critical biotic component in cold deserts that serves a central role in nutrient recycling and biogeochemical cycles. Despite their ecological significance, culture-independent studies on psychrophilic mycobiome are limited. In the present study, the fungal diversity patterns across the Drass, an Indian cold desert in the Himalaya, were indexed by targeted amplicon pyrosequencing (ITS). In the Drass dataset, Ascomycota was represented by 92 genera, while 22 genera represented Basidiomycota. The most abundant genus was Conocybe (20.46%). Most of the identified genera were reported in the literature to be prolific extracellular hydrolytic enzyme producers. To identify whether the Drass fungal assemblages share similarities to other cold deserts, these were further compared to Antarctic and Arctic cold deserts. Comparative analysis across the three cold deserts indicated the dominance of Dikarya (Ascomycota and Basidiomycota). The observed alpha diversity, Shannon index as well as Pielou's evenness was highest in the Antarctic followed by Drass and Arctic datasets. The genera Malassezia, Preussia, Pseudogymnoascus, Cadophora, Geopora, Monodictys, Tetracladium, Titaea, Mortierella, and Cladosporium were common to all the cold deserts. Furthermore, Conocybe was represented predominantly in Drass. Interestingly, the genus Conocybe has not been previously reported from any other studies on Antarctic or Arctic biomes. To the best of our knowledge, this is the first fungal metagenome study in Drass soil. Our analysis shows that despite the similarities of low temperature among the cold deserts, a significant differential abundance of fungal communities prevails in the global cold deserts.

Keywords Fungal diversity · Cold desert · Pyrosequencing · Conocybe · Ecotype

Introduction

The mycobiome represents the fungal community within a biome (Schnecker et al. 2014) and these biotic communities participate in crucial ecological processes operating in the ecosystems. The literature holds ample reports on the fungal community structure of contrasting ecosystems (Zimmerman and Vitousek 2012; Moll et al. 2016; Durán et al. 2019). However, psychrophilic and psychrotolerant microbes, inhabiting ice-covered regions of the cold desert have gained much attention in recent decades as they play a significant role in decomposing organic matters, nutrient recycling, and biogeochemical cycles in intensely cold environments (Margesin and Miteva 2011; Gesheva and Vasileva-Tonkova 2012). Besides, they are a significant producer of cold-tolerant enzymes and secondary metabolites with industrial and pharmaceutical applications such as cold-adapted lipase in detergent Lipoclean® (Duncan et al. 2008; Krishnan et al. 2011; Wang et al. 2013; Sarmiento et al. 2015; Duarte et al.

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