Microbial Ecology (2024) 87:11
https://doi.org/10.1007/s00248-023-02311-w

RESEARCH

Geographical Diversity of Proteomic Responses to Cold Stress in the Fungal Genus *Pseudogymnoascus*

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Received: 12 August 2023 / Accepted: 13 November 2023

Abstract

In understanding stress response mechanisms in fungi, cold stress has received less attention than heat stress. However, cold stress has shown its importance in various research fields. The following study examined the cold stress response of six *Pseudogymnoascus* spp. isolated from various biogeographical regions through a proteomic approach. In total, 2541 proteins were identified with high confidence. Gene Ontology enrichment analysis showed diversity in the cold stress response pathways for all six *Pseudogymnoascus* spp. isolates, with metabolic and translation-related processes being prominent in most isolates. 25.6% of the proteins with an increase in relative abundance were increased by more than 3.0-fold. There was no link between the geographical origin of the isolates and the cold stress response of *Pseudogymnoascus* spp. However, one Antarctic isolate, *sp3*, showed a distinctive cold stress response profile involving increased flavin/riboflavin biosynthesis and methane metabolism. This Antarctic isolate (*sp3*) was also the only one that showed decreased phospholipid metabolism in cold stress conditions. This work will improve our understanding of the mechanisms of cold stress response and adaptation in psychrotolerant soil microfungi, with specific attention to the fungal genus *Pseudogymnoascus*.

Keywords Soil microfungi · Metabolic pathways · Cold adaptation · Lipid metabolism · Fungal adaptation · Methane metabolism

Introduction

Cold environments encompass many of the Earth's biomes, including polar regions and alpine environments. Along with frequent and often long-lasting sub-zero temperatures, these environments are often characterized by frequent freeze–thaw cycles, high salt concentrations, low moisture and nutrient availability, and extreme ultraviolet (UV) and solar radiation. Despite the harshness, they are inhabited

Importance This study contributes to the general understanding of the response of soil microfungi from different geographic regions toward climate change. Through a proteomic perspective, we observed a diversity of cold stress responses and adaptation of soil microfungi in terms of their metabolism and protein regulation. Our findings provide information on the roles and importance of microfungi in the soil environment with broad relevance to the emerging threat of climate change.

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Published online: 07 December 2023