Global distribution and dispersal pattern of snow algae

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Red snows are a worldwide springtime phenomenon caused by blooms of red-pigmented green algae in thawing snow and historically have been recorded in the daily logs of polar and alpine explores such as Captain John Ross and Charles Darwin. The red pigments are carotenoids that serve as antioxidants, as an energy sink, and as a light shield for algal cells exposed to the intense ultraviolet radiation on the snow surface. The algae photosynthetically produce organic matter, which can reduce the snow-surface albedo and accelerate the melt rate of snow, and thus algae have an impact on cryospheric environments. A current hot topic is whether the biogeographical distribution of microorganisms is global or local. The microbial cosmopolitan dispersion hypothesis of Baas Becking ("Everything is everywhere, but the environment selects") is often invoked to explain the observed patterns of global algae distribution driven by the capacity for widespread dispersal. In this study, we describe the biogeographical distribution of snow algae on red snows collected from the Arctic and Antarctica using the sequences of the nuclear rDNA internal transcribed spacer 2 (ITS2) region, which has a high evolutionary rate and is thus suitable for revealing fine-scale genetic structures. We addressed the issue of whether snow algal species on red snows have a bipolar distribution or are distributed in limited areas of the world. We found that limited numbers of the phylotypes exist in both polar regions and that most of them are present only in the Arctic or Antarctic. The bipolar phylotypes account for the majority (37%) of the entire sequences, suggesting that red-algal blooms observed worldwide are caused by only a few phylotypes of algae that are globally dispersed via the atmosphere across both polar regions. Thus, it seems unlikely that the Baas Becking hypothesis holds for snow algae. Our findings underscore the importance of understanding the ecology of snow algae as well as improving the population analyses and taxonomic classification methods that utilize environmental samples. In addition, to understand the mechanism by which snow algae form geographically specific population structures and how they migrate across the global cryosphere, here we study samples from glaciers and snowpacks in mid-latitude mountain ranges, where red-snow algae also commonly bloom. We discuss what our results suggest about the global distribution and dispersal pattern of red snow algae from both polar and mid-latitude regions.

References

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