Submitted Abstract

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Abstract

Soil formation is the result of a complex network of biological, chemical, and physical processes. When ice fronts of glaciers retreat, they expose large expanses of deglaciated forefield, which become colonized by bacteria and fungi. These environments provide unique chronosequences of different soil developmental stages and are ideal for studying the role of keystone microbes, whose interaction promotes mineral soil fertility and pioneer plant growth. Very few studies have investigated the soil microbial community in the winter season and, although estimates suggest that cold-adapted bacteria and fungi are very active under the snow-cover, the quality of their diversity and interactions remains largely unexplored. In this study, we investigated the diversity of both the fungal and bacterial winter communities at the early stages of soil development (0-25 years) in four receding glaciers of the Alps, namely Hallstätter (AU), Marmolada (ITA), Griessen (CH), and Tsanfleuron (CH). These sites are characterized by a calcareous bedrock (i.e., CaCO3). Therefore, they differ from other alpine glaciers already studied mainly by a soil pH close to neutral-basal values and lower water and nutrient retention. Our results show low nutrient concentrations, but increasing with soil maturation. Both soil fungal and bacterial richness increased along the developmental gradient. Most of the microbial taxa detected were unique for the different glacier forefields nevertheless, a shared core community existed. Based on network analysis, the developmental stage of the soil influenced the bacterial-fungal interactions, with fewer interacting nodes in late succession sites. We also speculate a change in trophic interactions among microbes with an increase in competition for nutrients and ecological niche in late succession, compared to more mutualistic relationships in earlier stages. Taken together, our results emphasize the importance of cold-adapted fungal-bacterial interactions to the development of soil in recently deglaciated ecosystems.