Submitted Abstract

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Abstract

Elevational diversity gradients of plants and animals are a well-established ecological phenomenon. However, despite some attempts to describe microbial diversity along altitudinal transects, it remains unclear if and to what extent microbes mirror the changes seen in plants and animals. In addition, most studies focused on mountains in temperate regions where temperature decrease with elevation is the primary abiotic gradient affecting biodiversity. We studied the bacterial diversity and population size of various microbial groups along an extreme-high elevation gradient ranging from 4700 to 6450 m.a.s.l in the western Himalayas, where a precipitation gradient exists inversely to the temperature gradient. This leads to the formation of three different vegetation belts: arid, alpine grassland and subnival.

Population densities of bacteria, archaea, fungi and cyanobacteria (determined using qPCR) and alpha diversity estimates for bacteria (determined using Illumina sequencing) all displayed a humped-shape trend peaking at around 5800 m.a.s.l, just below the subnival zone, coinciding with maximum plant diversity. Below this altitude, microorganisms were likely water-limited; they were about ten times less abundant, and the bacterial community was about 30—50% less diverse. Above this altitude, the temperature was likely the critical limiting factor. Population sizes were up to 100 times lower, and the bacteria were up to 70% less diverse. Members of the orders Sphingomonadales, Sphingobacteriales and Solirubrobacterales were abundant throughout the gradient and with Burkholderiales prevailed in the subnival soils, similarly to soils from soils hot and cold deserts. In contrast, lower elevations were dominated by Rhizobiales, Rhodospirillales, Micrococcales and Cytophagales. However, distinct communities dominated the different vegetation belts.

Taxa-elevation relationship and phylogenetic relatedness analyses showed only a little turnover of species along the gradient within each belt, especially within the alpine and subnival ones, and a strong deterministic selection, but a reasonably large one between the belts.

Our results show that soil microbes react to contrasting gradients of precipitation and temperate similarly to plants and demonstrate clear and predictable changes in dominant taxonomic groups with increasing altitude. In addition, we demarcate the importance of Sphingomonadales, Sphingobacteriales, and Solirubrobacterales as pioneer species dominating deglaciated soils.