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Relationships between plant diversity and microbial properties of mountainous soils in Northwestern Caucasus: intra- and inter-ecosystem context

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Plant and soil microbial community are mutually interrelated ecosystem components providing important ecosystem functions. Numerous studies reveal relationships between plant diversity and microbial properties in experiments under controlled conditions, but the realization of these relationships at intra- and inter-ecosystem levels remains poorly understood. Mountains make a perfect case study to examine these relationships due to variability of environmental factors contributing to high spatial variability of ecosystems at short distance.
Relationships between plant diversity and microbial properties were investigated for the mountainous soils in Northwestern Caucasus, Russia. It is hypothesized: 1) the plant species diversity drives spatial distribution of microbial properties within ecosystem; 2) plant species diversity strongly relates to soil functional diversity (assessing through enzymes) in terms of inter-ecosystem context along altitude gradient. Plant and soil of north-eastern slope of 'Tkachikha' mountain (43°40.47'-43°41.34'N and 40°46.73-40°49.29'E) were studied along the altitude gradient for various ecosystems: mixed (1260 m a.s.l.), fir (1960 m) and deciduous (2060 m) forests, subalpine (2240 m) and alpine (2480 m) meadows. Three plots (10×10 m each, around 70 m between them) within ecosystem were selected. In each plot, four smaller (0.5×0.5 m) sub-plots were randomly chosen. Plant species and plant cover (%) were assessed for plots and sub-plots. Topsoil samples (0-10 cm) were taken from sub-plots in August 2018 (n=60). In the collected samples, microbial biomass carbon (MBC), basal respiration (BR) and enzymes activities (chitinase, β-glucosidase, leucine-aminopeptidase, phosphatase) were measured. Shannon's index was calculated for assessment of plant species diversity (H'p) and microbial functional diversity (H'f) by means of enzyme activities.
No strong relationship between MBC, BR, enzyme activities, H'f and plant species richness, H'p, plant cover within ecosystems was found. Likely, this outcome is explained by low variation in plant species richness. In total 0-4, 4-8, 5-8, 4-9, 8-11 plant species per sub-plots were found for mixed, fir, deciduous forests, subalpine and alpine meadows, respectively. When the ecosystems were grouped into two classes: forests (36 sub-plots) and meadows (24 sub-plots) the significant relationship between leucine-aminopeptidase and H'p was observed (r=0.63 and r=0.71 for forests and meadows, respectively). Variation of chitinase, β-glucosidase and phosphatase for forests and meadows were mainly driven by soil temperature. The variability of MBC along altitude gradient was strongly related to change in plant cover and species richness per plot (n=15). The first hypothesis was partly affirmed when two ecosystems groups (woody and grassy) were considered. The second hypothesis was rejected since MBC was to a larger extent affected by changes in vegetation cover, than microbial functional diversity assessed by enzyme activities.
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