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Nitrogen transformation in alpine soils of the Northern Caucasus: effect of nitrogen source and low temperatures

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The alpine landscape supports a variety of plant communities whose distribution corresponds to their topographic position. Topography controls snow accumulation and hence soil winter temperature, length of growing season and soil water availability. The research was conducted at the Teberda Biosphere Reserve (Northern Caucasus, Russia). The study sites were located at Mt. Malaya Khatipara (43º27'N, 41º42'E) between 2700 and 2750 m a.s.l. The investigated toposequence was representative of the soil and plant community associations in the alpine zone of the Teberda Reserve: the wind-exposed ridges and upper slopes are covered by low-productive alpine lichen heaths; intermediate topographic positions are occupied by the most productive grasslands and meadows; the slope bottom is occupied by low-productive snowbed community. Under intensive snow cover accumulation typical for many alpine ecosystems, the temperature of soil within winter makes nearby 0 ºC, while in case of absence or thin snow cover, characteristic for a lichen heath, the temperature can fall to –10 ºC. The influence of nitrogen source, low temperatures and soil drying on processes of nitrogen mineralization, nitrification and plant/microbial immobilization was studied in the field and laboratory incubation experiments. 15N labeled ammonium, nitrate, glycine and aspartic acid were injected in situ before growth of aboveground biomass into the soil of lichen heath to investigate how the different nitrogen sources was subsequently utilized and cycled in the ecosystem. We analyzed the distribution of 15N between plants, soil microorganisms and different soil nitrogen compounds during all growing season in order to reveal differences for separate nitrogen sources. We concluded that the soil microorganisms were more efficient than plants in nitrogen uptake (especially amino acids) under natural conditions. In the laboratory, fresh and dry-rewetted soils of different alpine ecosystems were incubated at different temperatures between +15 ºC and –10 ºC in presence of 15N labeled ammonium and glycine. The results indicated that low temperatures and drying-rewetting effected to N transformation by mobilization of additional element from soil organic matter, which became available for the following microbial immobilization. Results of our experiments can help with understanding of possible changes in a cycle of nitrogen which can occur in alpine ecosystems as a result of climatic changes in high-mountain regions.