Characterizing rooting depth distribution and nitrogen acquisition by dominant tundra plant species

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Rooting depth distributions may be an important factor controlling competition for water and nutrients among plant species in Arctic tundra. Permafrost thaw and degradation resulting from climate warming may increase the thickness of the active soil layer and alter the vertical distribution of plant-available nutrients. Species with root distributions that provide better access to nutrients in an altered soil profile may gain a competitive advantage. However, our ability to predict how tundra plant communities will respond to such changes is hindered by the fact that little is known about the rooting depth distributions and nutrient acquisition strategies of the dominant plant species in tundra ecosystems.

In July 2013, we conducted a ^{15}N isotope tracer experiment to assess the vertical distribution of soil nutrient acquisition among three dominant species representing important plant functional types on the Barrow Environmental Observatory in northern Alaska. We injected a solution of $^{15}NH_4Cl$ into the soil in either the organic horizon (3 cm), the mineral horizon (10 cm), or at the permafrost boundary (~ 30 cm), beneath 9 × 9 cm plots located in homogeneous patches of *Carex aquatilis* (sedge), *Eriophorum angustifolium* (sedge), and *Salix rotundifolia* (deciduous shrub). One week later, soil cores and aboveground vegetation were harvested from the plots. Aboveground leaf and stem biomass and the vertical distribution of root biomass were measured. Soil organic matter and above- and belowground plant tissues were analyzed for ^{15}N content.

Vertical patterns of root distribution and nutrient acquisition varied among the plant species. Both sedge species acquired substantially more ^{15}N from the mineral soil layer than from the organic soil layer, whereas the shrub acquired ^{15}N primarily from the organic soil layer. None of these species acquired much ^{15}N from near the permafrost boundary. The roots of the shrub were located almost exclusively in the organic horizon, which is consistent with the patterns of nutrient acquisition for this species. Contrastingly, the roots of the sedges extended throughout the soil profile, suggesting that root density does not entirely explain the patterns of nutrient acquisition for these species. Minimal plant ^{15}N uptake from near the permafrost boundary may limit the impact of climate warming-induced nutrient release from previously frozen soils. Results from this experiment are being used to improve model representations of tundra root dynamics and plant-soil interactions.