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# Sorting out non-sorted circles: Effects of winter climate change on the Collembola community of cryoturbated subarctic tundra

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Non-sorted circles (NSC) are a common type of cryoturbated (frost-disturbed) soil in the arctic and store large amounts of soil organic carbon (SOC) by the burial of organic matter. They appear as sparsely vegetated areas surrounded by denser tundra vegetation, creating patterned ground. Snowfall in the arctic is expected to increase, which will modify freezing intensity and freeze-thaw cycles in soils, thereby impacting on SOC dynamics. Vegetation, soil fauna and microorganisms, important drivers of carbon turnover, may benefit directly from the altered winter conditions and the resulting reduction in cryoturbation, but may also impact each other through trophic cascading.

We investigated how Collembola, important decomposer soil fauna in high latitude ecosystems, are affected by increased winter insulation and vegetation cover. We subjected NSC in North-Swedish subarctic alpine tundra to two years of increased thermal insulation (snow fences or fiber cloth) in winter and spring, increasing soil temperatures and strongly reducing freeze-thaw frequency. From these NSC we sampled the Collembola community in: (i) the non-vegetated center, (ii) sparsely vegetated parts in the center and (iii) the vegetated domain surrounding NSC. To link changes in Collembola density and community composition to SOC dynamics, we included measurements of decomposer activity, dissolved organic carbon (DOC) and total extractable nitrogen (TN).

We observed differences in Collembola density, community composition and soil fauna activity between the sampling points in the NSC. Specifically Collembola diversity increased with the presence of vegetation and density was higher in the vegetated outer domains. Increased winter insulation did not affect diversity but seemed to negatively affect density and decomposer activity in the vegetated outer domains. Interestingly, SOM distribution over NSC changed with snow addition (also to a lesser extent with fleece insulation) towards less SOM in the vegetated outer domains. This corresponded to a general decrease in Collembola density and activity and to alterations in carbon mobilization (a decrease in extractable DOC).

Changing SOM distribution in shallower soil layers might be an important mechanism by which increased snowfall in winter will affect subarctic patterned soils and its carbon dynamics. Our results indicate that the bottom-up effects of altered SOM availability and the establishment of vegetation are more likely to drive the decomposer community and its activity than direct winter-warming effects. Eventually, the extent to which SOM will redistribute and vegetation will expand into the non-vegetated parts of NSC will determine the magnitude of effects on decomposers and their activity. The new balance between plant productivity, SOC burial and carbon released by decomposers, will determine the fate of the large amounts of carbon stored in cryoturbated soils.