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Emissions of biogenic volatile organic compounds from litter are coupled with changes in the microbial community composition

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Emissions of biogenic volatile organic compounds (BVOCs) from natural ecosystems have significant impact on atmospheric chemistry and belowground chemical processes. Most attention has been given to emissions from plants. However, several studies have found that soil, and especially the decomposing leaf and needle litter, emits substantial amounts of BVOCs. The contribution of litter to ecosystem BVOC emissions may be increasingly significant in the Arctic, where the living plant biomass is low, and the amount of litter increasing due to the expansion of deciduous vegetation in response to climate change. It is known that the types and amounts of BVOCs emitted from the soil are highly dependent on the microbial community composition and the type of substrate. In this study we measured emissions of BVOCs from the leaf litter of common arctic plant species at different temperatures. The BVOC measurements were coupled with an analysis of the relative abundance of dominating bacterial species (determined as operational taxonomic units, OTUs).

Leaf litter from evergreen Cassiope tetragona and two species of deciduous Salix were collected from two arctic locations; one in the High Arctic and one in the Low Arctic. The litter was incubated in dark at 5 ˚C. Over an eight week period the temperature was increased 7 ˚C every two weeks, giving temperature incubations at 5 ˚C, 12 ˚C, 19 ˚C and 26 ˚C. Emissions of BVOCs from the litter were sampled in adsorbent cartridges weekly and analyzed using gas chromatography-mass spectrometry. The relative abundance of bacteria was determined at the end of the incubation at each temperature using DNA sequencing.

Results showed that emissions of BVOCs belonging to different chemical functional groups responded differently to increasing temperatures and were highly dependent on the type of substrate. For instance, terpenoid emissions from the Cassiope litter increased with increasing temperature, whereas the emissions from the Salix litter decreased. Likewise, the relative abundance of bacteria depended on temperature and the type of substrate. Especially the actinobacteria showed strong increasing trends with increasing temperature in the Salix litter. Acidobacteria had much higher relative abundance in the Cassiope litter than in the Salix litter. Multivariate analyses were used to assess potential links between the BVOC and bacterial abundance datasets.

Similar patterns in the BVOC emissions and bacterial community composition at different temperatures and for different substrates suggest that the differences in BVOC emissions, at least to some extent, are driven by changes in the microbial community composition.