Increasing tree abundance may prime a loss of soil organic matter through carbon allocation to ectomycorrhizal fungi in the subarctic-alpine forest-heath ecotone

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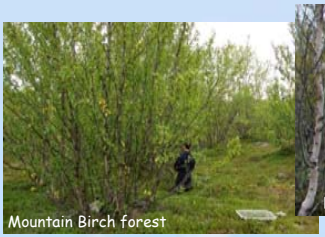
Background & Results

- The warming climate is shifting forest northwards into arctic tundras currently storing a large proportion of the global soil C stock. The biotic feed-backs from these ecosystems to future climatic changes are highly uncertain.
- In this study we hypothesized that increasing abundance of shrubs and trees along the heath-to-forest ecotone would be linked to increasing abundance of symbiotic ectomycorrhizal fungi and consequently decreasing stocks of soil carbon, due to more efficient organic matter turnover.
- Our results point to a strong negative coupling between tree abundance and soil C stock → *Pointing to higher turnover rate of soil organic matter in the forest where litter production is highest*
- Ectomycorrhizal mycelial growth was ten-fold higher in forest than in heath soil → *Pointing to larger ectomycorrhizal fungal contribution to organic matter turnover in the forest*
- C/N ratios of humus and the dissolved organic pools increased with depth in the forest → *Suggesting more efficient mobilization of N, probably an effect of higher mycorrhizal activity*
- Fungal communities changed down soil profiles and along the vegetation gradient, particularly in humus → *Supporting that a forest-humus-specific fungal community is important for fast organic matter turnover in the forest. Whether ectomycorrhizal fungi are the main actors, however, is still not clear, mainly due to the unknown ecology of many of the found species*

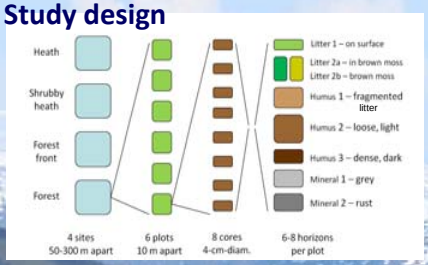

Mountain Birch forest


Forest front/ transition

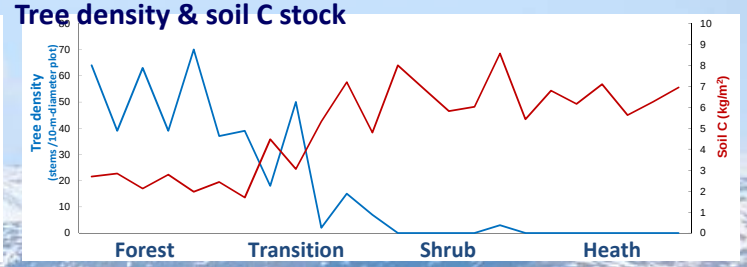

Dwarf Birch shrub


Cassiope heath

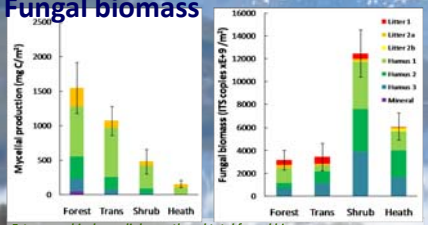
Study design



Tree density & soil C stock

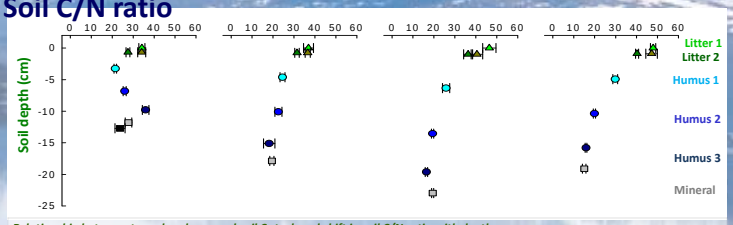


Fungal biomass



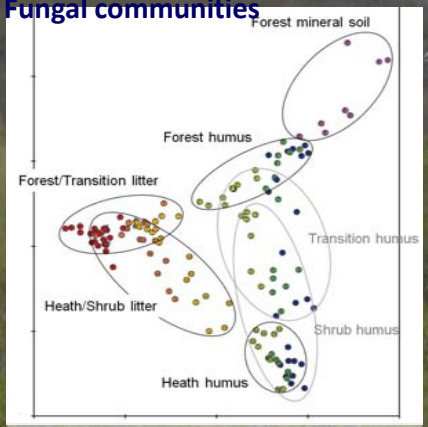
Ectomycorrhizal mycelial growth and total fungal biomass.
Left - sand-filled ingrowth bags were incubated in each plot and ectomycorrhizal mycelial biomass estimated by C analysis of extracted mycelia. Right - fungal biomass estimated by qPCR of the fungal rDNA ITS region. N=6, means ±SE

Soil C/N ratio



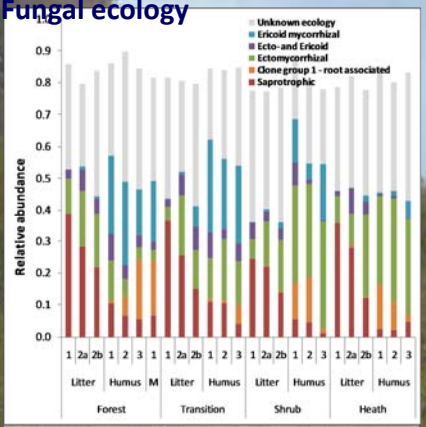
Relationship between tree abundance and soil C stock and shift in soil C/N ratio with depth.
We studied a subarctic-alpine forest-heath ecotone from mountain birch forest to heathland dominated by ericaceous species, near Abisko in Northern Sweden. The coverage of ericaceous species was constant over the gradient, however dominance shifted from Vaccinium myrtillus in the forest to Cassiope tetragona at the heath. Ectomycorrhizal shrubs were most abundant in the transition and shrub. Bottom – N=6, means ±SE

Fungal communities



Correspondence analysis of fungal ITS communities in soil profiles.
Using 454-sequencing we obtained 66392 high quality sequences in total, on average 500 per sample. These were clustered into 1604 clusters at 1.5% maximum distance using the SCATA pipeline (www.scata.mykopat.slu.se)

Fungal ecology



Relative abundance of functional groups of fungi in soil profiles.
Fungal clusters were assigned to functional groups based on phylogenetic analyses together with identified reference sequences. The 360 most common clusters were analysed. N=6. Preliminary data!

Conclusion

In conclusion, our study clearly suggests that birch forest expansion into the Scandinavian arctic would shift the main C storage from soil to tree stems. This may increase the vulnerability of the C store towards fire and human exploitation and demand altered natural resource management.

Our results also suggest that a shift in activity and composition of the fungal community in the humus layer rather than in the litter layer is responsible for increased organic matter turnover with increasing tree abundance – mycorrhizal fungi could be the main actors.

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