



INSTITUTIONEN FÖR BIOLOGI OCH MILJÖVETENSKAP

# **The influence of herbivory on shrub expansion in the Scandes forest-tundra ecotone**

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# Abstract

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Arctic and alpine ecosystems are experiencing fundamental changes in vegetation composition due to increasing temperatures. One of the most palpable of these changes is the expansion of shrubs on the treeless tundra, which has been reported from many sites throughout the Arctic. An increase in tall deciduous shrub cover has been hypothesized to have profound implications for ecosystem processes, e.g. through increasing snow trapping in winter, which can raise soil temperatures and accelerate nutrient turnover rates. In spring, taller shrub canopies can lower albedo and speed up spring thaw, thus prolonging the growing season. An increase in low evergreen shrubs, on the other hand, may decrease turnover rates through the production of more recalcitrant litter. The effect of herbivory on different shrub species may therefore be of major importance. The aim of this thesis was to investigate how vegetation has changed in the Scandes forest-tundra ecotone over the past two decades and how large herbivores have influenced these changes. 16-year old reindeer exclosures, in several different vegetation types in the Scandes mountain range, were used to study how plant community composition, mycelia production and nutrient allocation patterns within plants were affected by grazing. The comparative effects of reindeer and hare browsing on tall shrubs were also examined.

Low evergreen shrubs, such as mountain crowberry and heather, had increased dramatically at both shrub heath and mountain birch forest sites, and were not influenced by large herbivores. Deciduous shrub cover, mainly consisting of dwarf birch, had increased to a far lesser extent but was significantly greater and taller inside exclosures. Tall shrub cover was, in turn, negatively correlated with summer soil temperatures, while winter soil temperatures tended to be higher in exclosures. Despite this, no effects of grazing on diversity were found. At a grass heath site, a similar expansion of ericoid shrubs was seen, whereas at a more productive low herb meadow, grazer exclusion had triggered an advancement of willow species, which had grown tall inside the exclosures. Outside the exclosures, low evergreen shrubs had increased, suggesting that, in the absence of herbivores, this group was outcompeted by tall deciduous shrubs. Furthermore, not only reindeer but also mountain hares were found to substantially affect tall shrubs. Apart from plant community composition, herbivory also affected carbon content and isotopic composition of a perennial herb, as well as the overall production of ectomycorrhizal mycelia. Surprisingly, contrasting effects on mycelia production were found in the mountain birch forest, where mycelia biomass was larger inside exclosures, and in the shrub heath, where mycelia biomass was larger outside exclosures.

By holding back the expansion of deciduous shrubs, herbivores can decelerate turnover rates. Furthermore the increase in more recalcitrant litter and ericoid mycelia associated with evergreen shrubs may slow down nutrient cycling further. Hence, the unexpected finding that the major vegetation shift was an increase in ericoid shrubs, rather than tall deciduous shrubs as many other studies have reported, may have far-reaching consequences for ecosystem functioning and soil carbon stocks.