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Long-term mountain tundra composition's responses to grazing pressure in the context of environmental changes

Patrick Saccone, Tuija Pyykkonen, Anu Eskelinen, and Risto Virtanen
Departement of Biology, University of Oulu,Oulu, Finland (patrick.saccone@gmail.com)

Strong changes in northern tundra in response to climate changes are expected and in particular an increasing shrubiness. However, global changes contain not only warming or shifts in snow-cover but also changes in land-use, e.g. for arctic low productive ecosystems changes in grazing pressure. Grazing could also represent an important driver of future Arctic tundra communities. However, the relative importance of biotic and abiotic drivers of plant communities' composition remains largely unknown, in particular because short-term experiments provided to conflicting evidences. Here, we present the results from a long-term (23 years) experiment set up in 1989 at Kilpisjärvi in the north-western Finnish Lapland. The experiment consisted in the transplantation of twenty 40x50 cm blocks of Vaccinium myrtillus heath including 5-10 cm thick soil layer from a 660 m.a.s.l. dry slope to a snowbed 150m higher in elevation containing dry and wet sites. We considered the transplantation at higher altitude in snowbed conditions an increase in harsher conditions (shorter growing season, lower productivity). Half of the transplanted blocks were protected from herbivores and the percentage cover of each plant species was estimated in mid-august 2012 from a central 12.5 x12.5 cm area in each block.
Our results showed that the dominance of the shrub V. myrtillus was strongly reduced as response to transplantation to snowbed. Consequently the competitive pressure also decreased and allowed an increase of the species richness. Soil moisture differences between installation locations induced divergence in plant communities' composition allowing the increase in abundance of subordinate species as bryophytes and graminoids in wet and dry sites respectively. Excluding herbivory, some species assumed high dominance reducing the community diversity. In the wet exclosures, quarter of the surface was covered by a moss and V. myrtillus co-dominated. The strongest changes occurred in dry exclosure, where the absence of grazing pressure in non-disadvantageous conditions allowed the dominance of V. myrtillus which also led to a low diversity level largely composed by vascular plants.
Our long-term exclosure study shows that grazing is a driver of Arctic tundra plant composition, as, at least equally strong, as environmental conditions (snow duration, soil moisture). Our results highlighted that the interaction of these two major drivers could lead, depending on local conditions, to alternative plant community states. These states could be diverse in terms of plant morphology, functional traits and chemistry. Finally such changes in plant communities could induce changes in interaction and feedback between biotic and abiotic compartments of the ecosystem.

Key-words: Alternative stable states; Competitive dominated communities; Habitat filtering; Niche differentiation; Species Abundance Distribution