Available online at www.sciencedirect.com

SciVerse ScienceDirect

Polar Science 6 (2012) 200−208

http://ees.elsevier.com/polar/

Effects of neighboring vascular plants on the abundance of bryophytes in different vegetation types

Annika K. Jägerbrand [a,*], Gaku Kudo [a], Juha M. Alatalo [b], Ulf Molau [c]

[a] Graduate School of Environmental Earth Science, Hokkaido University, Sapporo 060-0810, Japan
[b] Gotland University, School of Culture, Energy and Environment, SE 621 67 Visby, Sweden
[c] Department of Plant and Environmental Sciences, Göteborg University, P.O. Box 461, SE 405 30 Göteborg, Sweden

Received 21 November 2010; revised 19 September 2011; accepted 21 February 2012
Available online 3 March 2012

Abstract

Due to the climate change, vegetation of tundra ecosystems is predicted to shift toward shrub and tree dominance, and this change may influence bryophytes. To estimate how changes in growing environment and the dominance of vascular plants influence bryophyte abundance, we compared the relationship of occurrence of bryophytes among other plant types in a five-year experiment of warming (T), fertilization (F) and T + F in two vegetation types, heath and meadow, in a subarctic−alpine ecosystem. We compared individual leaf area among shrub species to confirm that deciduous shrubs might cause severe shading effect. Effects of neighboring functional types on the performance of *Hylocomium splendens* was also analyzed.

Results show that F and T + F treatments significantly influenced bryophyte abundance negatively. Under natural conditions, bryophytes in the heath site were negatively related to the abundance of shrubs and lichens and the relationship between lichens and bryophytes strengthened after the experimental period. After five years of experimental treatments in the meadow, a positive abundance relationship emerged between bryophytes and deciduous shrubs, evergreen shrubs and forbs. This relationship was not found in the heath site. Our study therefore shows that the abundance relationships between bryophytes and plants in two vegetation types within the same area can be different. Deciduous shrubs had larger leaf area than evergreen shrubs but did not show any shading effect on *H. splendens*.

Keywords: Fertilization; Moss; Shrub; Arctic; Chlorophyll a/b; OTC; Warming effect

1. Introduction

The structure of plant communities is the outcome of complex coexisting plant-to-plant interactions in an ecosystem. Despite the fact that vascular plants and bryophytes often coexist in terrestrial ecosystems, interactions between these plant groups have not been investigated thoroughly (van der Wal et al., 2004). Knowledge of the interactions among plants is crucial to predict vegetation changes caused by global climate change. In fact, there is currently an urgent need to study not only climate change effects but also to include the interactions taking place between species (Walther, 2010).

* Corresponding author. Current address: VTI, Swedish National Road and Transport Research Institute, Lindstedtsvägen 24 KTH Campus Valhallavägen, Box 55685, SE 102 15 Stockholm, Sweden. Tel.: +46 13 204000; fax: +46 8 285043.

E-mail address: annika.jagerbrand@vti.se (A.K. Jägerbrand).

1873-9652/$ - see front matter
doi:10.1016/j.polar.2012.02.002

Bryophytes play a significant role in many terrestrial ecosystems (Longton, 1984) and exhibit an increase in relative abundance in ecosystems at higher altitudes and latitudes (Wielgolaski et al., 1981; Vitt and Pakarinen, 1977). Bryophytes are important components of the ecosystem functioning, especially in colder biomes (Cornelissen et al., 2007).

The impact of climate change is increasing particularly in ecosystems in cold biomes compared to others (EEA, 2004). In fact, over the past few decades the Arctic has experienced rapid climatic change: average mean temperature has increased twice that of the rest of the world (ACIA, 2004). The observed temperature increase can manifest to form enhanced plant growth at northern high latitudes and mid-latitudes (Myneni et al., 1997; Nemani et al., 2003), while altering the distribution and abundances of species (EEA, 2004; McCarthy et al., 2001). Temperature increases at high altitudes has caused the tree-line to continually move northwards and upwards (ACIA, 2004; Kullman, 2001, 2002; McCarthy et al., 2001; Parmesan and Yohe, 2003), concurrently with wide shifts in species ranges (Parmesan and Yohe, 2003; Root et al., 2003) and increased abundances of more thermophilic organisms (EEA, 2004).

Consequently, global climate change is predicted to cause major biome shifts, for example, large parts of tundra vegetation could be converted into boreal or temperate forests (ACIA, 2004; EEA, 2004). Both alpine and arctic ecosystems are identified as most sensitive with high risks of irreversible damage at the species level (McCarthy et al., 2001). Previous studies demonstrated that plant communities in subarctic and arctic ecosystems shifted in an increase of native deciduous shrubs to climate change (Chapin et al., 1995; Jägerbrand, 2005; Jägerbrand et al., 2009; Sturm et al., 2001). A previous study in an alpine region in Japan revealed that deciduous shrubs highly increased the height growth and canopy expansion due to the frequent incremental branching under warming treatment resulting in the suppression of other plants (Kudo and Suzuki, 2003).

Experimental manipulations simulating climatic change usually have negative and detrimental effects on abundance, growth or cover of bryophytes (Graglia et al., 2001; Jägerbrand, 1996; Jägerbrand et al., 2003; Potter et al., 1995; Press et al., 1998; van Wijk et al., 2003), while some other studies show positive trends in growth or patterns of species distributions (Gordon et al., 2001; Jägerbrand, 2007; Sandvik and Heegaard, 2003). Negative effects on bryophytes can be interpreted as an indirect response to increased dominance of vascular plants caused by increases in canopy layer, shading, and overloaded litter fall on ground vegetation (van Wijk et al., 2003). A previous study conducted in Alaska and northern Sweden revealed negatively correlated responses of bryophytes against deciduous shrubs and grasses under simulated environmental change (van Wijk et al., 2003). However, experimental field trials showed increased shading in tundra ecosystems with very weak or non-significant responses in abundance or biomass of bryophytes (Graglia et al., 2001; van Wijk et al., 2003). Studies performed in different ecosystems suggest that light might be a limiting factor for growth or biomass accumulation of bryophytes (Bergamini and Peintinger, 2002; van der Wal et al., 2004). Consequently, there are large uncertainties in our understanding on how vascular plants in high alpine, subarctic, and arctic ecosystems may influence bryophytes.

Shading effects from structure and growth of vascular plants on bryophytes need to be investigated with reference to the growth dynamics of shrubs in tundra vegetation. New approaches to analyze the possible shade responses of bryophytes are required because *in situ* shade experiments may not reproduce the actual shade responses of those observed in simulated climatic change in the field. In this study, we therefore focussed on investigating the underpinning of abundance of vascular plants on bryophytes under natural conditions and after a five-year experimental perturbation, at a subarctic–alpine site. We compare the results between two different vegetation types, a meadow and a heath ecosystem, because it has been shown previously that the response to simulated climate change might be different or even dissimilar between these two vegetation types within the same study area (Jägerbrand et al., 2009). Furthermore, effects of simulated climate change in heath sites have been abundantly studied, but there is a lack of studies showing responses in meadow sites (see references in Jägerbrand et al., 2009). Thus, in order to reveal the variation of responses to experimental manipulations simulating climate change it is crucial to include ecosystems that have the potential for different responses. Results from the climate change experiment (i.e. warming and fertilization) have been described in previous publications (Jägerbrand et al., 2003, 2009; Molau and Alatalo, 1998).

First, we investigated if bryophyte abundance was negatively affected by the proximity of deciduous or evergreen shrubs in different vegetation under natural conditions. Then, we assessed if the simulated climate