Winter climate matters! The reaction of tundra plants to snow manipulations

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Introduction

Some of the most pronounced changes in the global climate are occurring a) at high altitudes and latitudes and b) in winter. In many alpine and arctic regions, increased winter temperatures and earlier snowmelt timing have been detected. The "new" climate is generally considered beneficial for plant growth and could lead to drastic changes in vegetation, especially those communities typical for harsh climate.

In our study, we test how snow characteristics affect alpine and arctic tundra communities. We conducted field experiments and surveys near Davos, Switzerland and Fairbanks, Alaska USA. Here, we present results from one of the most frequent species, *Empetrum nigrum* at the subarctic study site.

Hypothesis

The timing of snowmelt is **negatively** correlated with plant phenology, growth and reproduction:

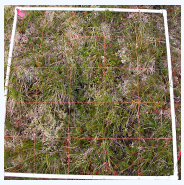
The earlier snow melts => the longer the growing season => the fitter are the plants

Methods

In a tundra ecosystem near Fairbanks, we manipulated the timing of snowmelt by removing or adding snow. Effects on winter and spring temperatures were recorded with miniature temperature loggers (soil surface) and a weather station (air). We then measured the reaction in phenology, growth and reproduction of the most frequent tundra species.

Snowmelt treatments
- Early (~ -4d)
- Control
- Late (~ +9d)

Study design
3 snowmelt treatments x 9 replicates

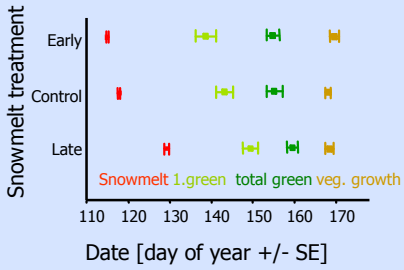


Plant variables
- Phenology 2003
- Shoot growth 2002+2003
- Reproduction density 2002+2003

Study species
Empetrum nigrum ssp. *hermaphroditum* (crowberry), a dwarf shrub with arctic-alpine distribution

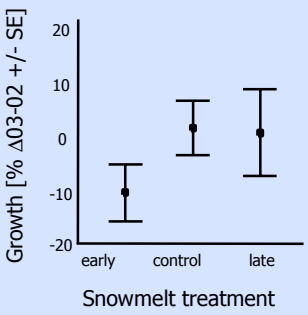
Results

Phenology



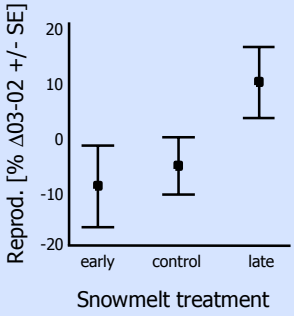
The timing of the earliest phenological stages strongly depended on the timing of snowmelt. However, in plots with late snowmelt the development of plants was faster and had soon caught up.

Shoot Growth



There was no difference in the date when vegetative shoot growth started (see "phenology"). However, growth (compared to previous year) was decreased after early snowmelt.

Reproduction



Plants from late melting plots reproduced more successfully than those from early melting and control plots. Compared to the previous year, reproduction rates in late melting plots were higher.

Discussion and conclusions

! Contrary to our expectations, the timing of snowmelt was **positively** correlated with growth and reproduction of *E. nigrum,* thus early snowmelt reduced its fitness.

! Spring temperatures as experienced by plants just after snowmelt were the lower and frosts the more frequent, the earlier snowmelt was. We therefore conclude that:

The earlier snow melts => the harsher is spring climate => the more reduced is fitness of *E. nigrum*

! Predictions of increase in plant growth due to climate warming might hold true a) for other species and b) if the earlier snowmelt doesn't create a harsher spring climate.

Outlook

In the same experimental setup, we also study the reaction of other tundra species, as well as changes in species interactions, community processes and vegetation composition. Moreover, we study the effects of snow depth and winter soil temperatures on various plant parameters.

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