GENERAL INFORMATION

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year	2012
English title	The response of forest plant regeneration to temperature variation along a latitudinal gradient
original title	
reference	Annals of Botany 109
pages	1037–1046
type	article (a1)
ecosystem service	supporting - biodiversity
keywords	herb layer – global warming – regeneration
taxa	*Anemone nemorosa*, *Milium effusum*
project	PhD_DeFrenne
supervisor(s)	Verheyen K, Hermy M, Graae BJ
institution	Ghent University, Laboratory of Forestry
document	pdf, hardcopy
data	

ABSTRACT

Background and Aims The response of forest herb regeneration from seed to temperature variations across latitudes was experimentally assessed in order to forecast the likely response of understorey community dynamics to climate warming.

Methods Seeds of two characteristic forest plants (*Anemone nemorosa* and *Milium effusum*) were collected in natural populations along a latitudinal gradient from northern France to northern Sweden and exposed to three temperature regimes in growth chambers (first experiment). To test the importance of local adaptation, reciprocal transplants were also made of adult individuals that originated from the same populations in three common gardens located in southern, central and northern sites along the same gradient, and the resulting seeds were germinated (second experiment). Seedling establishment was quantified by measuring the timing and percentage of seedling emergence, and seedling biomass in both experiments.

Key Results Spring warming increased emergence rates and seedling growth in the early-flowering forb *A. nemorosa*. Seedlings of the summer-flowering grass *M. effusum* originating from northern populations responded more strongly in terms of biomass growth to temperature than southern populations. The aboveground biomass of the seedlings of both species decreased with increasing latitude of origin, irrespective of whether seeds were collected from natural populations or from the common gardens. The emergence percentage decreased with increasing home-away distance in seeds from the transplant experiment, suggesting that the maternal plants were locally adapted.

Conclusions Decreasing seedling emergence and growth were found from the centre to the northern edge of the distribution range for both species. Stronger responses to temperature variation in seedling growth of the grass *M. effusum* in the north may offer a way to cope with environmental change. The results further suggest that climate warming might differentially affect seedling establishment of understorey plants across their distribution range and thus alter future understorey plant dynamics.

MATERIALS & METHODS

study area	5l (seed collection), 5n scientific zone (common garden)
time period	2008–2010
goal	test the hypotheses: - emergence percentages and seedling growth are lower in plants from northern peripheral origin than from southern origin near the core of the distribution range - seedling establishment of understorey plants with contrasting phenology and life form is differentially affected by temperature along a latitudinal transect - seedling establishment is locally adapted, i.e., seedlings perform better when the mother plant has been transplanted closer to the home site
set-up	in situ seed collection: 7 (*Anemone*) or 8 (*Milium*) regions, 1900-2300 km latitudinal gradient from northern France to northern Sweden ex situ seed collection: 3 common gardens (Belgium, southern & northern Sweden) growth chamber germination experiments: autumn (10°C, 8 weeks), winter (2°C, 11 weeks), spring (10°C, 2 weeks) – 8h light, 16h dark - in situ: + 6 weeks spring (10°C, 15°C, 20°C) – 12h light, 12h dark - ex situ: + 6 weeks spring (15°C) – 12h light, 12h dark
data collection	in situ seeds - - 2 populations per region in an area of ca 20 km x 20 km - seeds of 15 randomly chosen individuals per population in 2008 - mean seed mass (random sample of 50 seeds) ex situ seeds - adult individuals collected at the different regions/populations, transplanted in the 3 common gardens (2008) - seeds collected on the transplanted individuals in 2008 - mean seed mass for *Milium* (too few seeds for *Anemone*) growth chamber - weekly number of seedlings - final emergence percentage (March 2009 and 2010) + dry aboveground biomass - belowground + aboveground biomass for 1 *Anemone* in each cell: root-shoot ratio - calculation of Mean Emergence Time
remarks	

RESULTS

In situ experiment The emergence percentage (significant only for *M. effusum*) and above-ground seedling biomass (for both species) decreased with increasing latitude of seed origin, which indicates lower seed quality and seedling performance for individuals of northern origin. Higher spring temperatures consistently increased the above-ground seedling biomass of both species, the belowground biomass and root-shoot ratio of *A. nemorosa*, and decreased the emergence time of *A. nemorosa* and (marginally) increased the emergence time of *M. effusum*. Temperature did not consistently affect emergence percentages in *A. nemorosa*. *Milium effusum*'s response to temperature depended on the latitude of seed origin, i.e., the above-ground seedling biomass increased more with increasing temperature in seedlings from northern than from southern origin. No such pattern could be seen in *A. nemorosa*. Seed mass significantly increased the biomass of *A. nemorosa* seedlings and the emergence time of *M. effusum* seedlings.

Ex situ experiment The biomass of *M. effusum* seedlings decreased significantly with the latitude of seed origin in each of the three common gardens. Above-ground seedling biomass significantly decreased from 52+10 mg in the southern populations to 12+2 mg in the northernmost populations. The common-garden transplant site of the mother plant significantly affected seed quality and seedling performance in terms of emergence and above-ground biomass. Across all provenances, the aboveground biomass in seedlings of which the mother plant was grown in the southern transplant sites was lower than the biomass in seedlings of which the mother plant was grown in the northern sites. The significant interaction between common-garden site and latitude of origin for the emergence percentage and timing again indicates differential behaviour in each transplant site depending on the latitude of origin. The emergence percentage was significantly higher for the seeds produced by the mother plants that were transplanted closer to the home site, which suggests local adaptation. The above-ground seedling biomass increased with increasing latitude difference. Seed mass positively affected the emergence percentage.