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Interannual vegetation dynamics in forest springs

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Background

Since nearly 20 years at the University of Bayreuth the vegetation of forest springs is investigated for its qualification as bioindicator for the status of its environment. Here reactions of vegetation to short-term changes in hydrological parameters are analysed over a period of four years in series (2003 - 2006), whereas the focus lies on the comparison between bryophytes and vascular plants.

Hypotheses

H1: Interannual variability of environmental parameters causes reactions of spring vegetation.

H2: Mosses and liverworts show a faster and stronger correlated response to short-term changes in environment than vascular plants.

Methods

Vegetation of 27 forest springs in Frankenwald (NE-Bavaria) was recorded by line-transects once a year. Further hydrological data (temperature, pH, discharge, ANC, conductivity) were collected.

Over the entire period of four years (2003 - 2006) species performance was analysed. Therefore three categories, namely „indifferent species" (I), „trend species" (T) and „erratic species" (E) were defined. Using Bray-Curtis dissimilarity, interannual variability of species abundances was investigated.

Linear correlation (Pearson) of changes of species abundances with changes in hydrochemistry (especially pH) is used to specify 3 factors: (1) the direction (positive resp. negative) specifies the type of indicator (neutrality resp. acidity), (2) the slope reflects reaction intensity and (3) the goodness of correlation is an indicator for reaction quality. Multivariate methods (canonical correspondence analysis CCA and non-metric multidimensional scaling NMDS) were used to detect both driving forces of vegetation dynamics and reaction to short-term changes in environment.

Results

All figures: Data set Frankenwald 2003 to 2006, n=27 springs, only species with occurence in > 5 springs (averaged over four years) are shown.

To detect vegetational differences between two consecutive years annual abundances of mosses, liverworts and vascular plants are compared by use of the Bray-Curtis dissimilarity index. The result does not show significant differences between mosses resp. liverworts and vascular plants. Both species groups show a comparable performance within the examination period of four years.

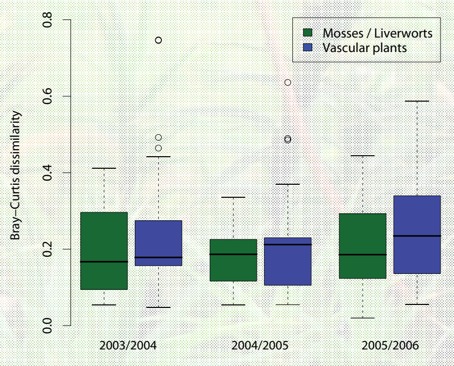

Fig. 1: Interannual dissimilarities of species abundances of bryophytes (mosses and liverworts, n=12) and vascular plants (n=25), calculated by Bray-Curtis distance.

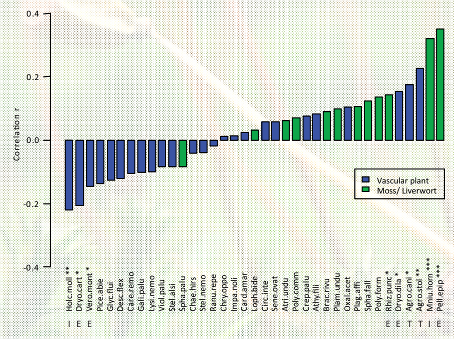

*Fig. 2: Indicator type and reaction quality of bryophyte (n=12) and vascular plant species (n=25) based on Pearson correlation of interannual changes in abundances with those in pH. Species performance is marked by E (erratic species), I (indifferent species) and T (trend species, all three only for significant correlations). Significance levels: $p < 0{,}001$ ***, $p < 0{,}01$ **, $p < 0{,}05$ *.*

The correlation between interannual changes in both species abundances and pH shows differences between species. However mosses and liverworts don't show a stronger correlation than vascular plants. A faster reaction of bryophytes to short term changes in pH can not be detected.

According to CCA, which indicates the environmental variables pH and electrical conductivity as major driving factors of species variance, a NMDS is calculated. As shown in Fig. 3 vascular plants comprise the whole pH spectrum, whereas mosses and liverworts concentrate in regions of lower pH.

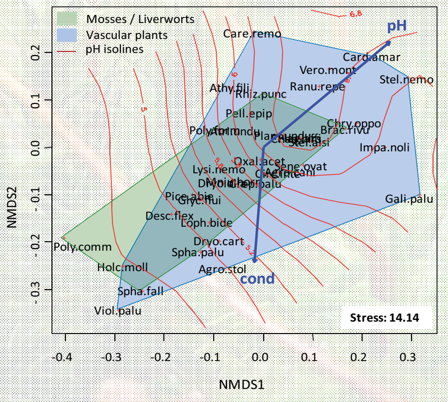

Fig. 3: Ecological spectrum of mosses resp. liverworts and vascular plants. NMDS is based on percental species abundances in line-transects (2003 to 2006). The environmental parameters pH (see also red isolines) and electrical conductivity act as covariables.

Discussion

Interannual variability of vegetation of forest springs was found indeed, but its connection to environmental factors is not univocal. No significant differences of reaction to short-term changes in environment (pH) were found by comparing the performance of the two species groups bryophytes and vascular plants.

Further investigations are needed to detect more reliable driving factors of interannual vegetation dynamics. However, as ordination methods figure out clearly the pH as major influence on species composition, we suggest that changes in abundances are subject to species' inertia and are affected by pH changes in the longer run.

References

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Kapfer, Audorff & Beierkuhnlein (in prep.): Interannual vegetation dynamics in forest springs.

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