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Nutrient stoichiometry as a driver of community composition of wetland plant communities

Jerry van Dijk[1], Ineke Roeling[1], Wim Ozinga[2,3], Maarten Eppinga[1], Martin Wassen[1]

[1] Environmental Sciences | Copernicus Institute of Sustainable Development | Faculty of Geosciences | Utrecht University | The Netherlands
[2] Team Vegetation | Forest and Landscape Ecology | Wageningen Environmental Research | Wageningen | The Netherlands
[3] The Netherlands Institute for Water and Wetland Research | Radboud University | Nijmegen | The Netherlands

@ j.vandijk2@uu.nl

Research questions

- Are nutrient ratios important for species composition of the vegetation?
- Do species occupy distinct niches along nutrient gradients?
- Is there a trade-off between niche position and niche width along nutrient gradients?

Methods

- Analysis of species composition (p/a), aboveground biomass, N, P and K contents (and ratios), and community averaged Ellenberg values of 644 plots in Eurasian terrestrial freshwater wetlands
- Analysis of the distribution of all plant species along the N:P gradient represented by these plots

Results

Contribution of N:P ratios to species composition

- N:P ratio was among the most important variables explaining species composition (Fig. 1; Table 1)
- N:P ratio explained a larger part of the variance in species composition than N, P or K availability alone (Table 1)

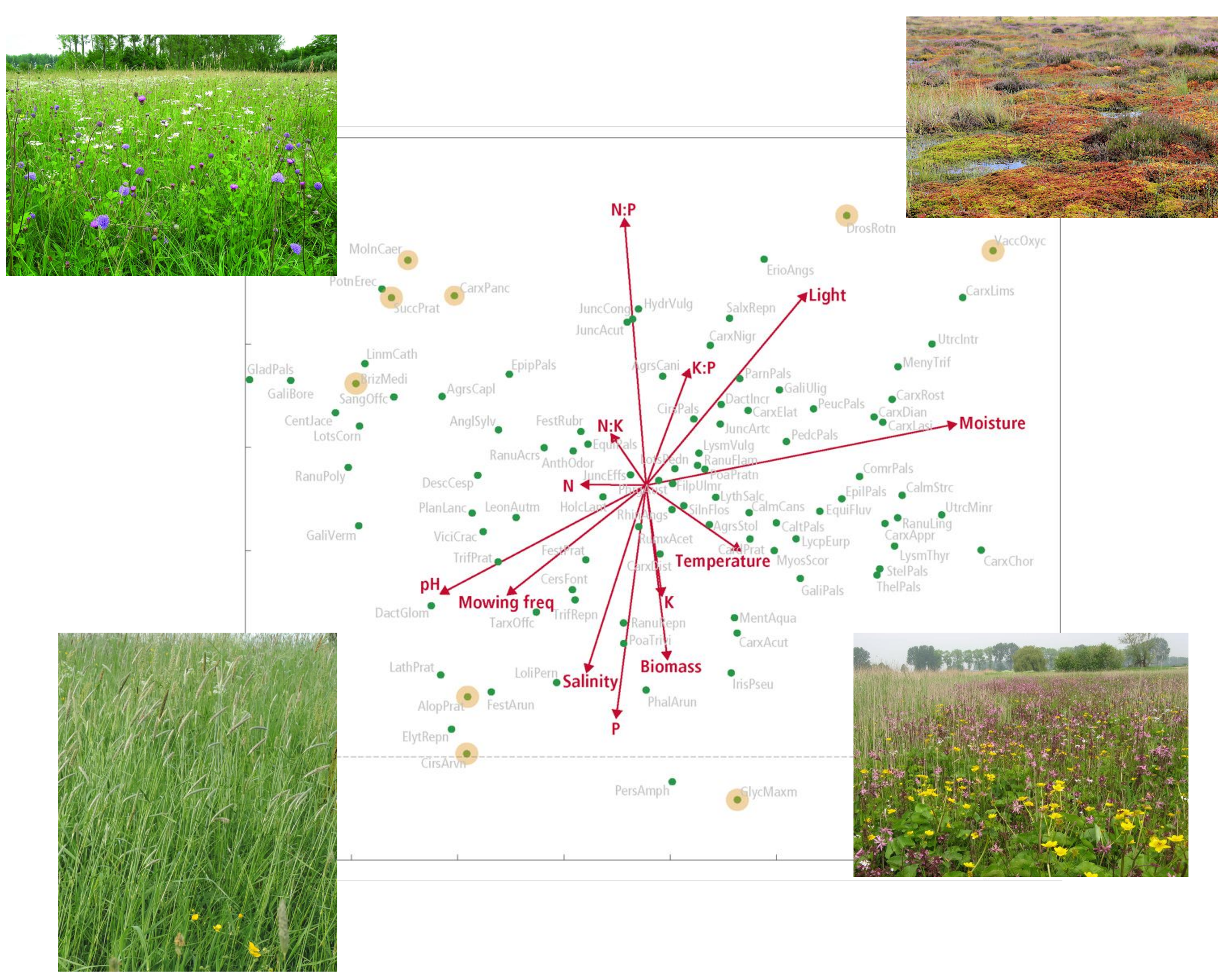

Fig. 1 DCA biplot of the 100 most abundant species (green) and environmental variables (red arrows). The length of the arrow is proportional to the contribution to the variance in species composition. Pictures show vegetation types corresponding to the combination of species in the quadrants of the graphs.

Table 1 Variance in species composition explained by the environmental variables in a CCA, based on marginal (simple) effects. All variables contributed significantly to the variation in species composition

Environmental variable	Variance explained (%)	pseudo-F
Moisture Ellenberg	5.7	38.9***
pH Ellenberg	4.1	27.2***
N:P ratio plants	3.7	24.9***
Light Ellenberg	3.7	24.4***
Salinity Ellenberg	3.6	24.0***
mowing frequency	3.0	19.9***
plant P	2.9	19.1***
K:P ratio plants	2.3	14.9***
Temperature Ellenberg	2.3	14.8***
biomass production	1.6	10.7***
plant K	1.1	7.0***
plant N	1.0	6.7***
N:K ratio plants	1.0	6.4***

Species distribution along the N:P gradient

- Species distribution along the N:P gradient deviated strongly from a null model with random species distribution (Fig. 2),
- Species distribution showed a bimodal distribution along the N:P gradient

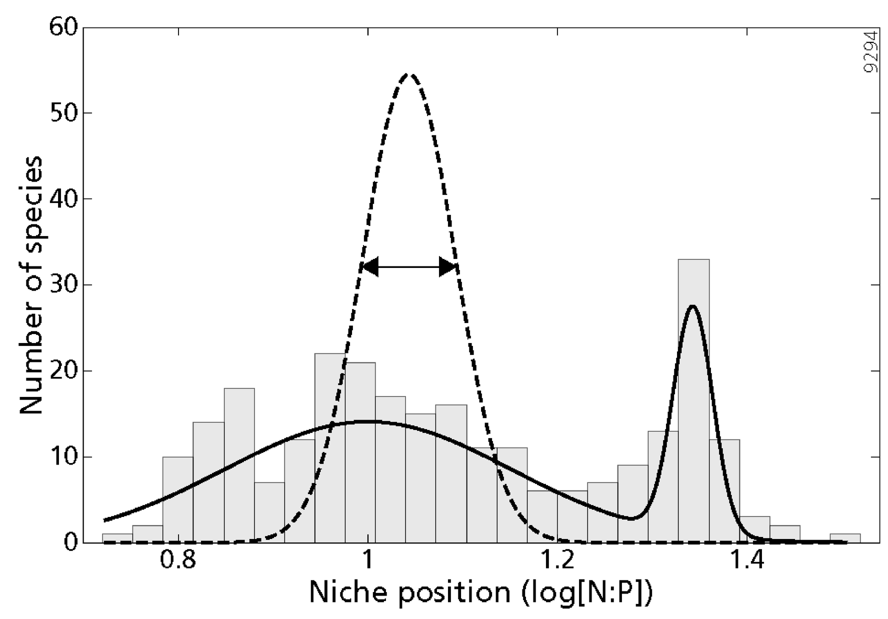

Fig. 2 Distribution of species along the N:P gradient (grey bars and smoothed solid line) compared to a null model of 1000 bootstrapped dataset replicates with random species draws

Niche widths along the N:P gradient

- Species at the extremely P-limited end of the N:P gradient had smaller niche widths than would be expected from a random null model (Fig. 3)

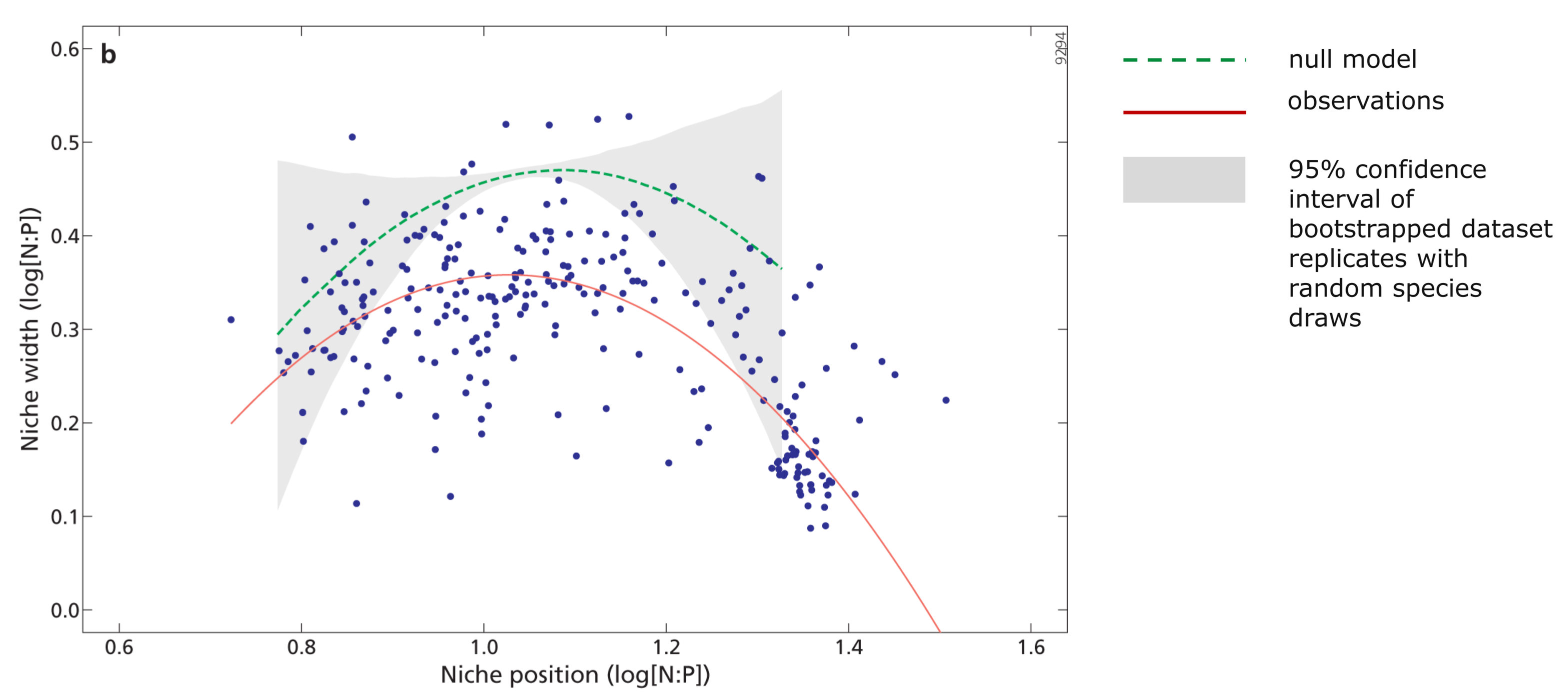

Fig. 3 Median quantile regression (τ=0.50) for observed species niche position and niche width (red line) compared to a null model of 1000 bootstrapped dataset replicates with random species draws (green dotted line)

Conclusions

- Nutrient stoichiometry (esp. N:P ratio) is an important factor that structures wetland plant communities
- Plant species occupy distinct niches along N:P gradients
- There is a trade-off between niche position and niche width at high N:P ratios, indicating that plants adapted to extreme P-limitation are more restricted in their occurrence along N:P gradients than other species

Roeling et al. (in press). Plant species occurrence patterns in Eurasian grasslands reflect adaptation to nutrient ratios. Oecologia