

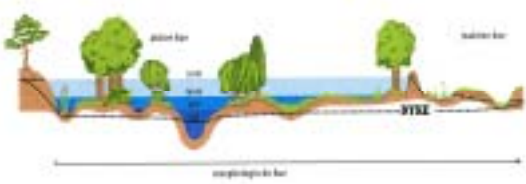
VARIATION IN GROUND BEETLE TRAITS ALONG A GRADIENT OF FLOOD

FLOOD DISTURBANCE ENHANCES SPECIES DIVERSITY BUT REDUCES FUNCTIONAL DIVERSITY OF GROUND BEETLES

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INTRODUCTION



Floodplain species display a large range of life-history and morphological adaptations and strategies to cope with the varying environmental conditions. There is mounting empirical evidence that flood disturbances affect both the spatial and temporal distribution of floodplain species, as well as their life-history strategies, involving ecological, behavioral, and morphological adaptations.



Increasing flood disturbance

Increasing species diversity ?
Increasing functional diversity ?
Increasing flood adaptation ?



AIM

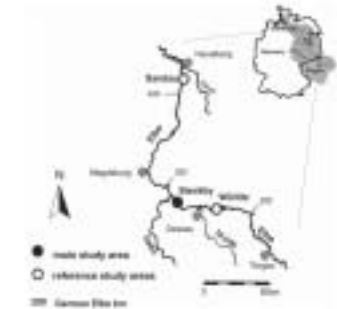
Using single and multiple trait approaches we aim to investigate the distribution of ground beetles along a gradient of flood disturbance in order to understand the mechanistic linkages between environmental disturbances and survival strategies of species in semiterrestrial floodplains:

How do species diversity, key traits for flood adaptation, and functional diversity of floodplain ground beetles change along a gradient of flood disturbance?

STUDY AREA

Seasonally flooded grasslands were selected at three distinct investigation areas within the UNESCO Biosphere Reserve "Elbe River Landscape" in Central Germany as study sites.

All study sites contained higher and lower terrain differently exposed to floods. Altogether 60 sampling plots were established using a stratified randomized design.



METHODS

We used an integrative surrogate index for the assessment of flood disturbance. To obtain the index, a centered principal component analysis (PCA) was conducted based on the hydrological variables of all sampling plots. The high variability explained by the first PCA axis (71.59%) supported its suitability as a proxy for flood disturbance. Maximum flood height, total flood duration, and flood permanency contributed most to the first PCA axis. Consequently we used the ordination scores of the plots along the first axis of the PCA as the **flood disturbance index**.

We compiled biological information of ground beetles in order to set up a **ground beetle life-history trait database**. The database currently consists of 3,801 datasets describing the traits of 172 species.

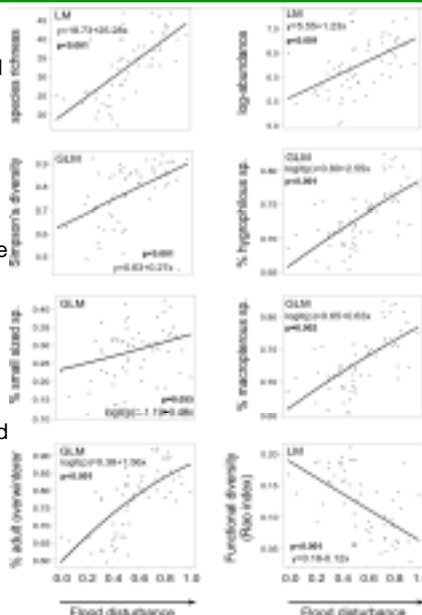
Trait data came from 11 standard references on Central European ground beetles, mostly determination keys and ground beetle compendia. Altogether we included 18 traits with 60 trait categories, ranging from biological and morphological to ecological characteristics.

	Biological information	Response variable
Species traits metrics	Dispersal ability	Proportion of macropterous species
	Body size	Proportion of small sized species (< 10 mm)
	Reproduction season	Proportion of species overwintering as adult
	Humidity tolerance	Proportion of hygrophilous species
Community metrics	Species richness	Number of species
	Species relative abundances	Number of individuals
	Heterogeneity of community in terms of species richness and species evenness	Simpson's diversity
	Heterogeneity of community in terms of life history strategies and functional composition	Functional diversity (FD)

RESULTS

We found strong relationships between flood disturbance and species diversity, functional diversity, and key traits of floodplain ground beetles:

- Species richness and relative abundances showed the strongest relationships to flood disturbance index.
- Flood disturbance also strongly affected the distribution of single ground beetle traits. An increasing percentage of species overwinter as adults on the most disturbed plots. This pattern is also true for species with a strong humidity preference. Although the percentage of fully winged and small-sized species increased with increasing flood disturbance, the relationship is relatively weak and marginally significant for body size.
- Functional diversity of ground beetles decreased continuously with increasing flood disturbance.



LM=linear regression, GLM=generalized linear model

CONCLUSIONS

→ flood disturbance can enhance species diversity and simultaneously reduce the functional diversity of ground beetle assemblages. These results contradict the theory that increasing species richness will also increase the number of biological characteristics held by the species and thus may provide different functional attributes to a community. Disturbance suppressed functional diversity by sorting species according to their life strategies. → trait composition is strongly constrained by environmental factors. → flood disturbance acts as a filter for specific traits limiting the number of life strategies suitable for species survival increasing disturbance leads to heterogeneity of small-scale habitat configuration and environmental parameters and thus to different species compositions

Our study strongly supports the use of life-history traits to reveal species-environment relationships

The question remains, how coexistence can persist in disturbance driven, species rich communities, although most species obviously share similar resources and similar life-history strategies.

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