Patterns and drivers of fine-scale beta-diversity in Palaearctic grasslands

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GRASSPLOT

eDGG Grassland research and conservation

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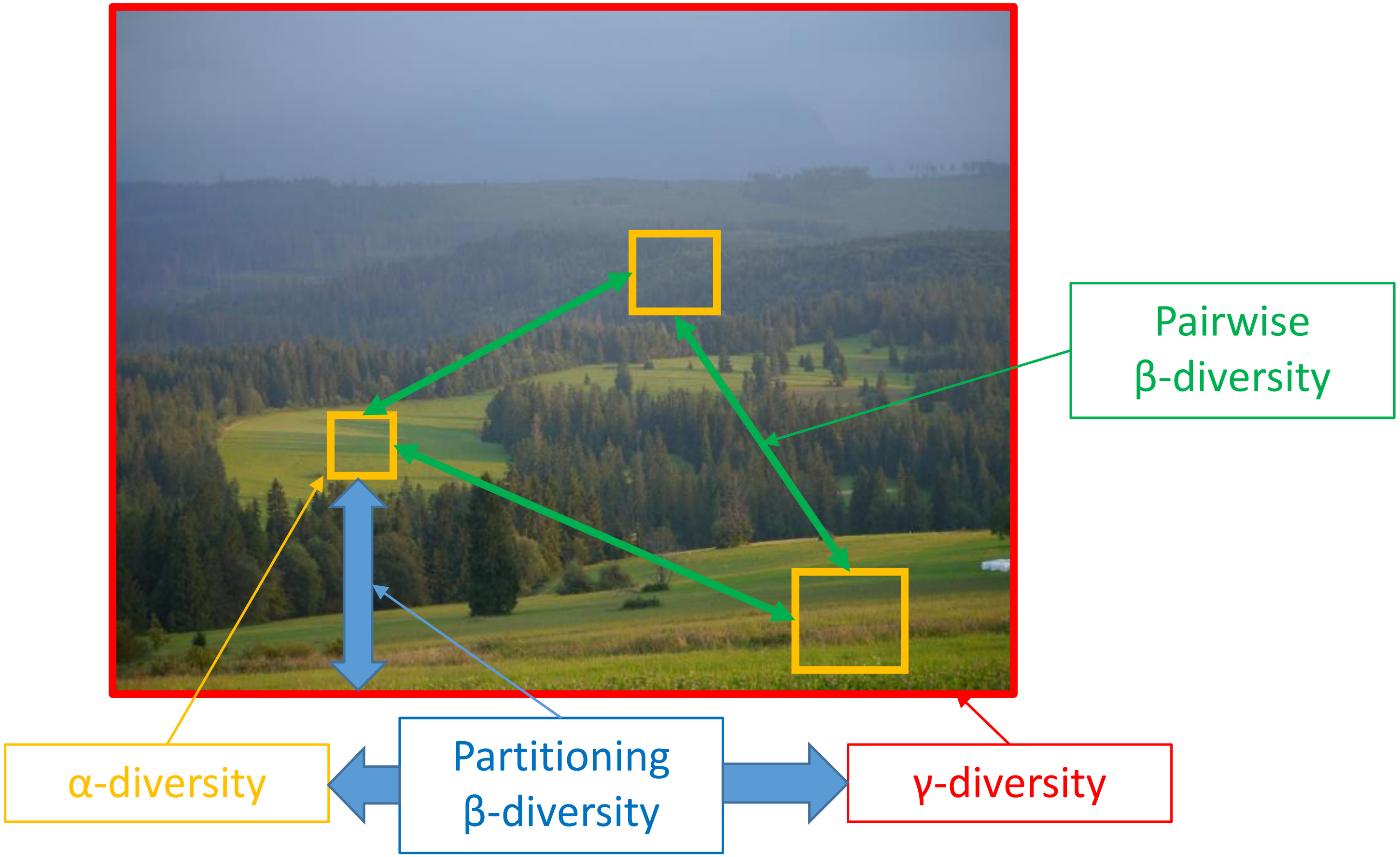
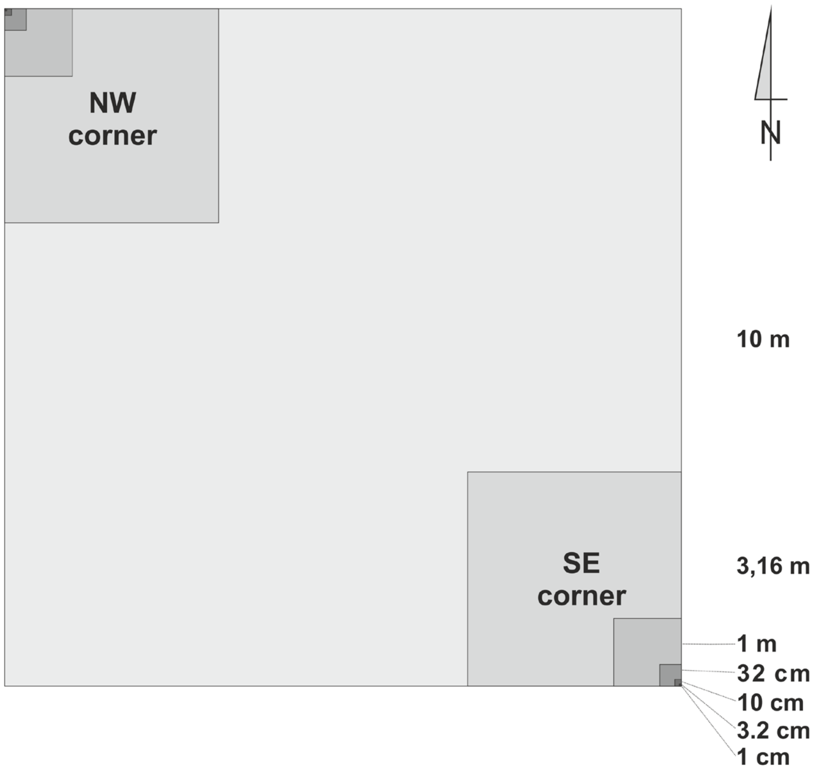
Alpha, beta and gamma diversity

- α – diversity: diversity of single habitat, of single plot
- β – diversity: variability among the basic units in space
- γ – diversity: total diversity of an area, landscape



Fine-grain β-diversity

- rarely studied compared to other scales of β-diversity
- useful in comparing the rate of spatial species turnover between different ecological situations
- can be assessed using nested-plot series



Species-area relationships (SARs) and β-diversity

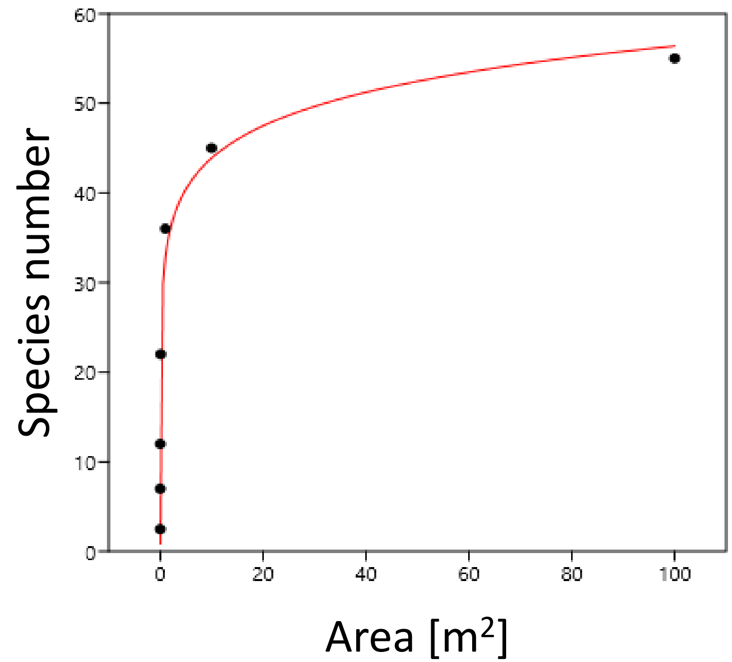
- small scale SARs follow **power law** (Dengler et al. 2019)
- the slope of power law (**z**) measures how fast species richness increases with increasing area
- it is a measure of **multiplicative β-diversity** (Jurasinski et al. 2009) standardised by the relative increase in area

$$z = \log_{10}\left(\frac{S_\gamma}{S_\alpha}\right) / \log_{10}\left(\frac{A_\gamma}{A_\alpha}\right)$$

S – species number in α- and γ-level
A – area of the α- and γ-level

Species number **Area** **z-value**

$$S = cA^z$$

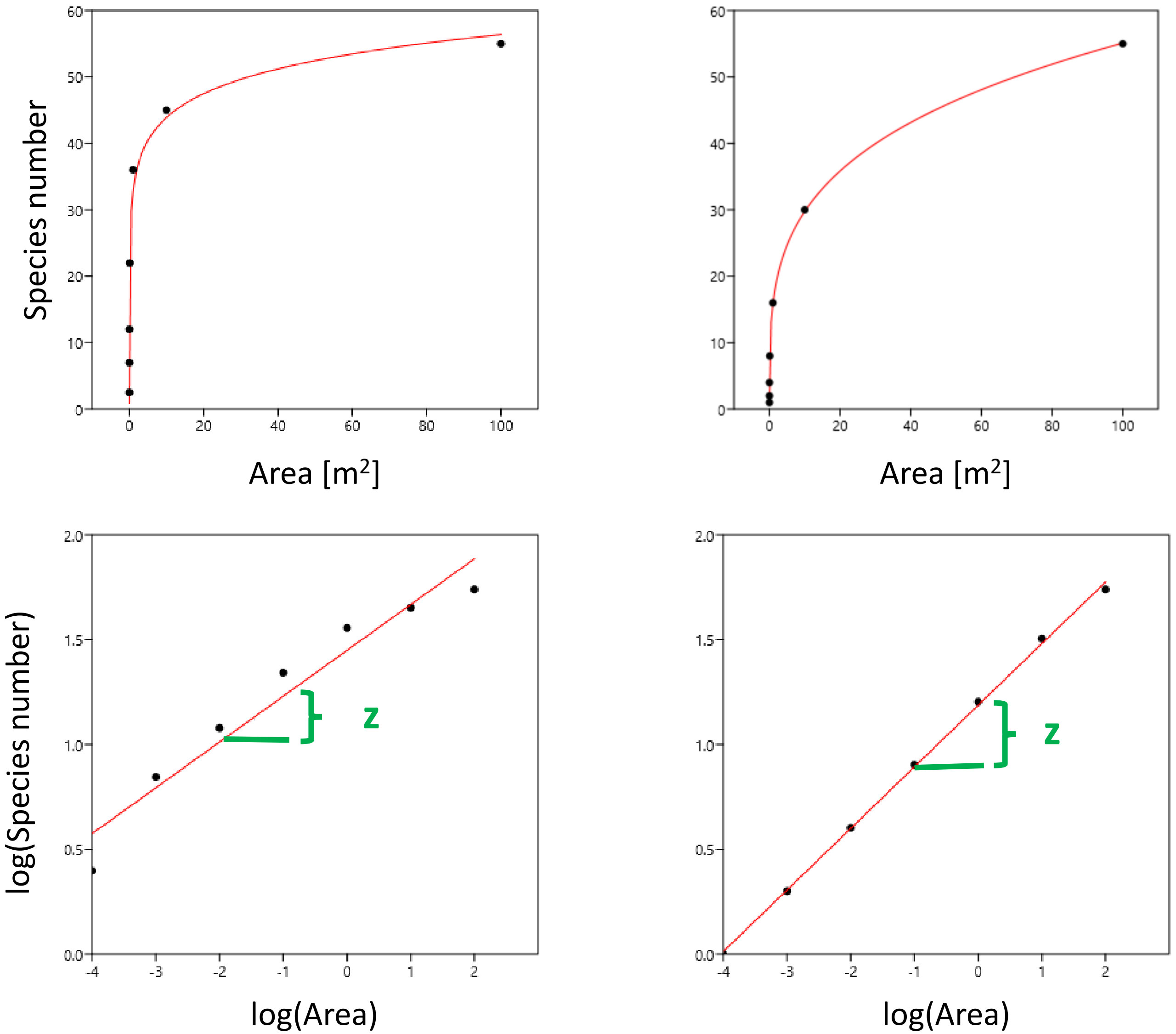


lower z-value

higher z-value

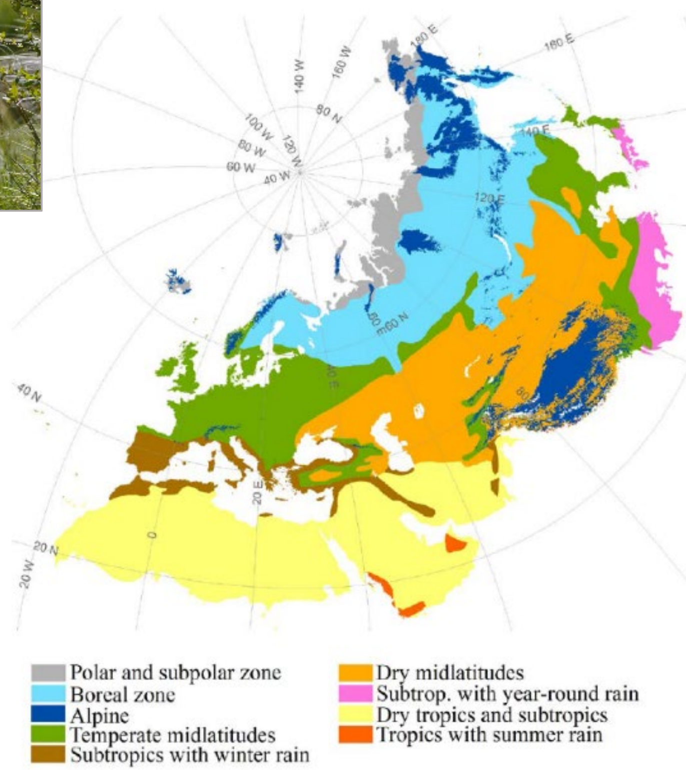
S-space

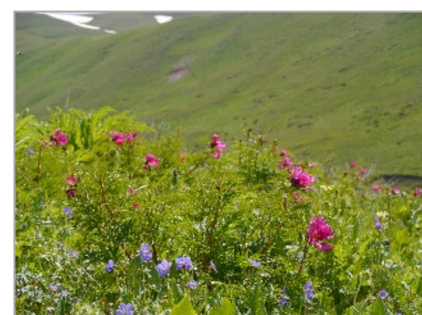
log(S) and log(A)-space



Aim of the study

we asked which biotic and abiotic characteristics influence fine-scale beta diversity of grassland communities across a broad biogeographic gradient



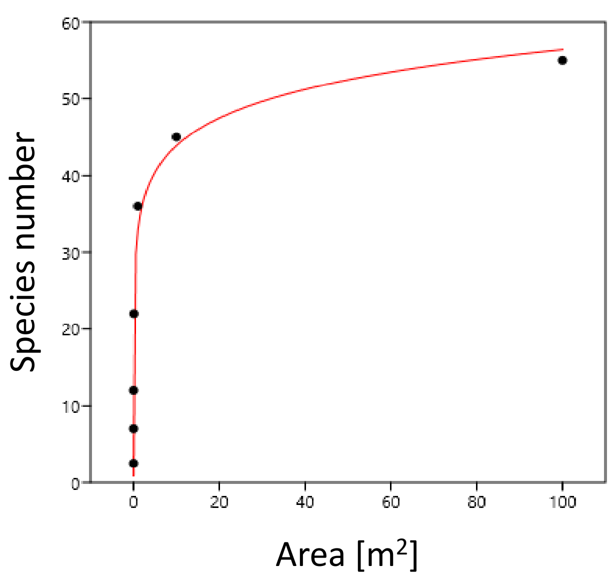


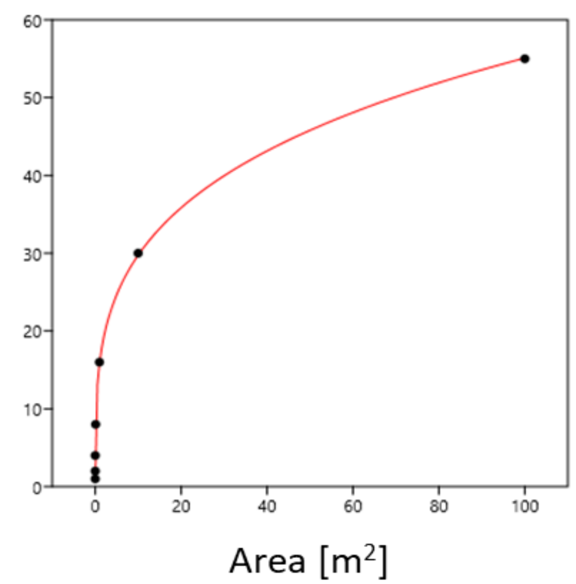
Research questions

(1) How do z-values differ among taxonomic groups?

(2) How do *z*-values differ among biomes, and vegetation types?

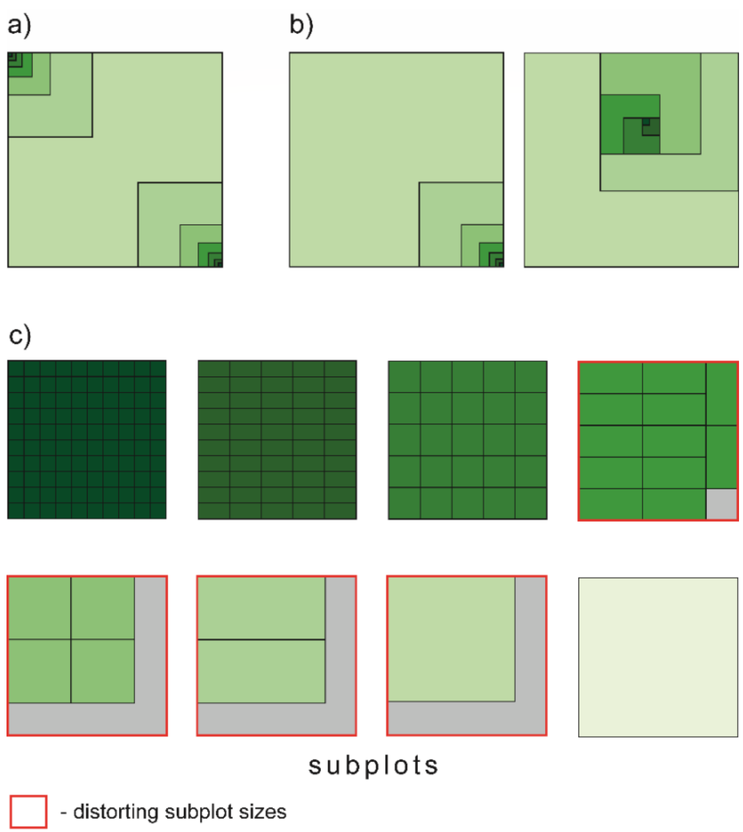
(3) How are *z*-values related to small-scale heterogeneity (microrelief, shrub cover) and disturbance (land use, slope)?



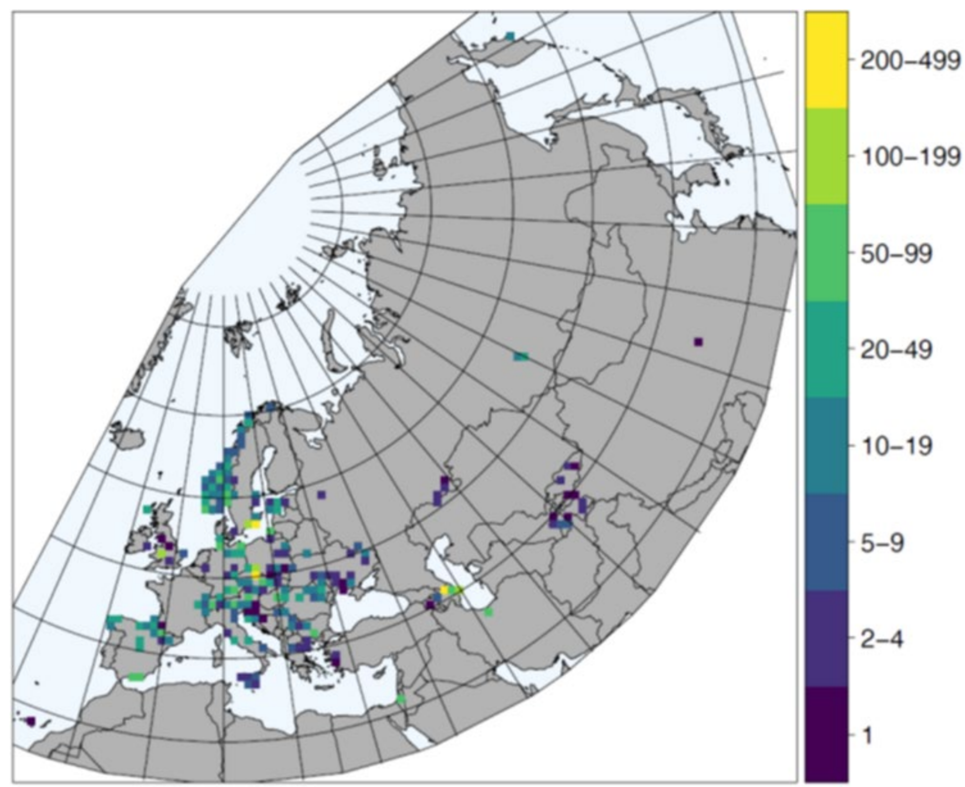


Materials and Methods

- 4546 nested-plot series with at least four different plot sizes from GrassPlot database (any type of grassland s.l. from the Palaearctic realm)
- species richness data + environmental variables



Nested-plot sampling schemes in GrassPlot



Available series per 10,000-km² grid cell

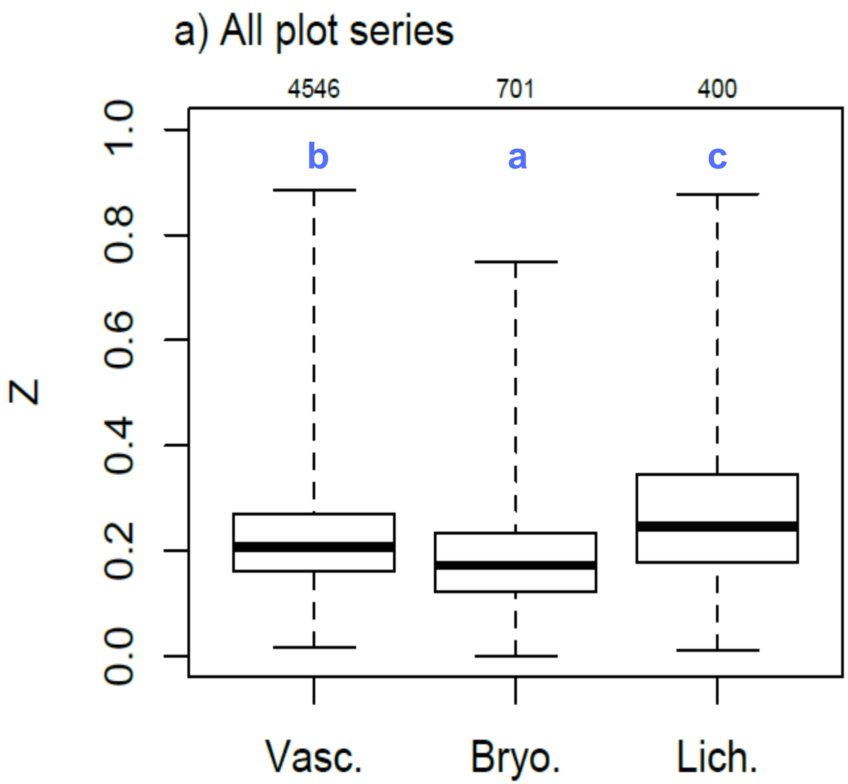
Data analysis

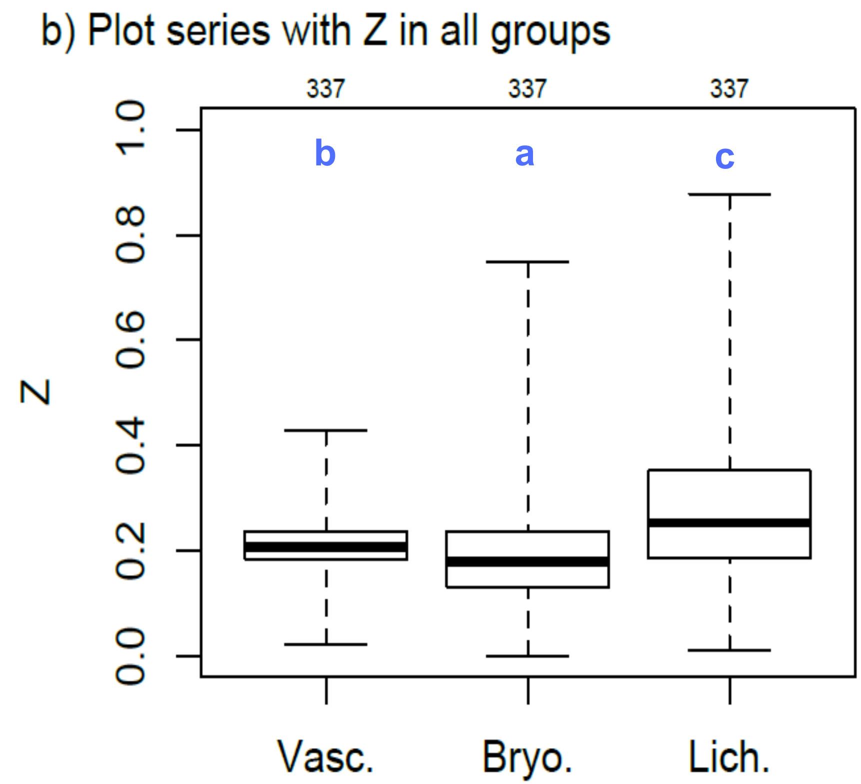
1. Fitting of the power function for species richness in a "linear space" (S-space) using non-linear regression
2. Modelled **z-values** of the power function subjected to:

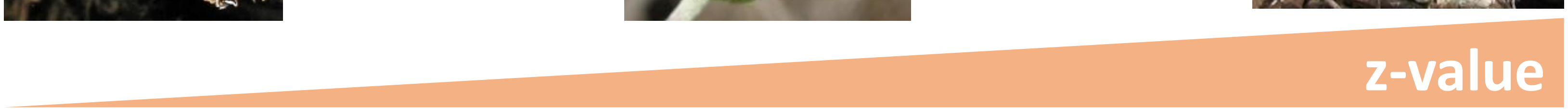
- **ANOVA** to test for differences in z-values between:
  (a) taxonomic groups [vascular plants, bryophytes, lichens]
  (b) biomes [Bruelheide et al. 2019, based on Schultz 2005]
  (c) main vegetation types
  (d) land-use types

- **linear regression** to test the potential influence of the following variables on *z*-values:
  (l) slope inclination
  (m) microrelief [measure of habitat heterogeneity]
  (e) shrub cover

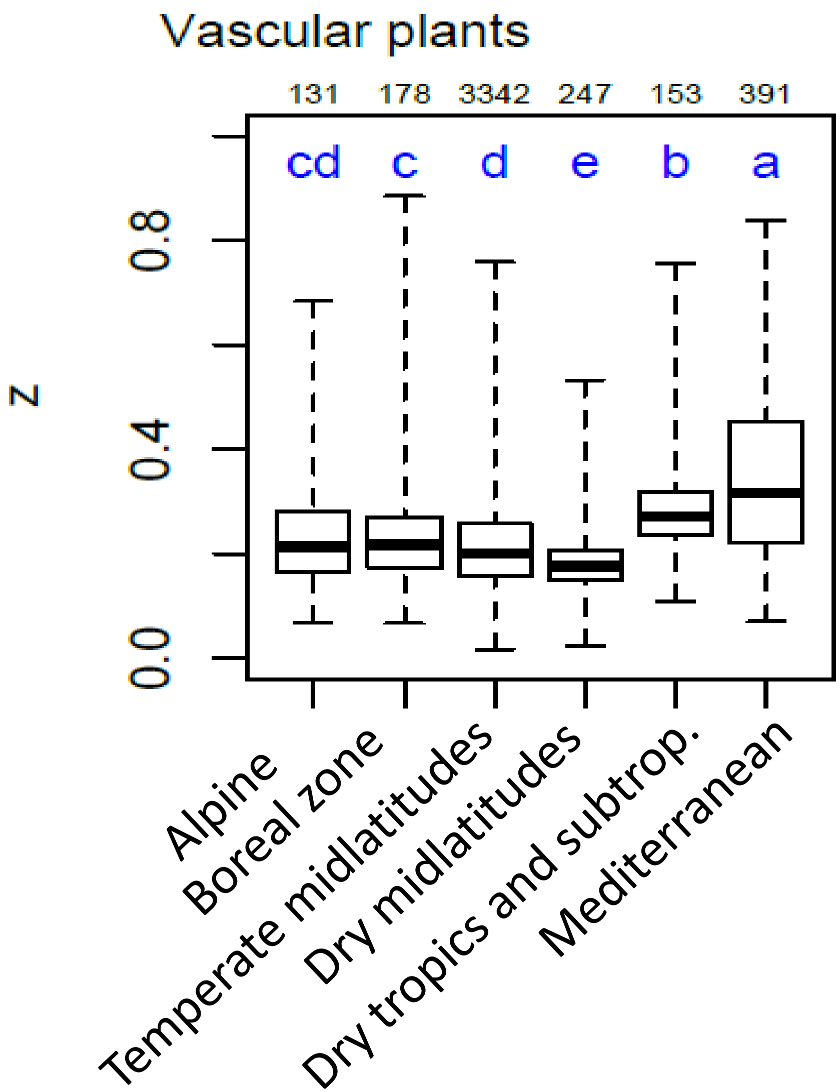
Differences in z-values between the taxonomic groups



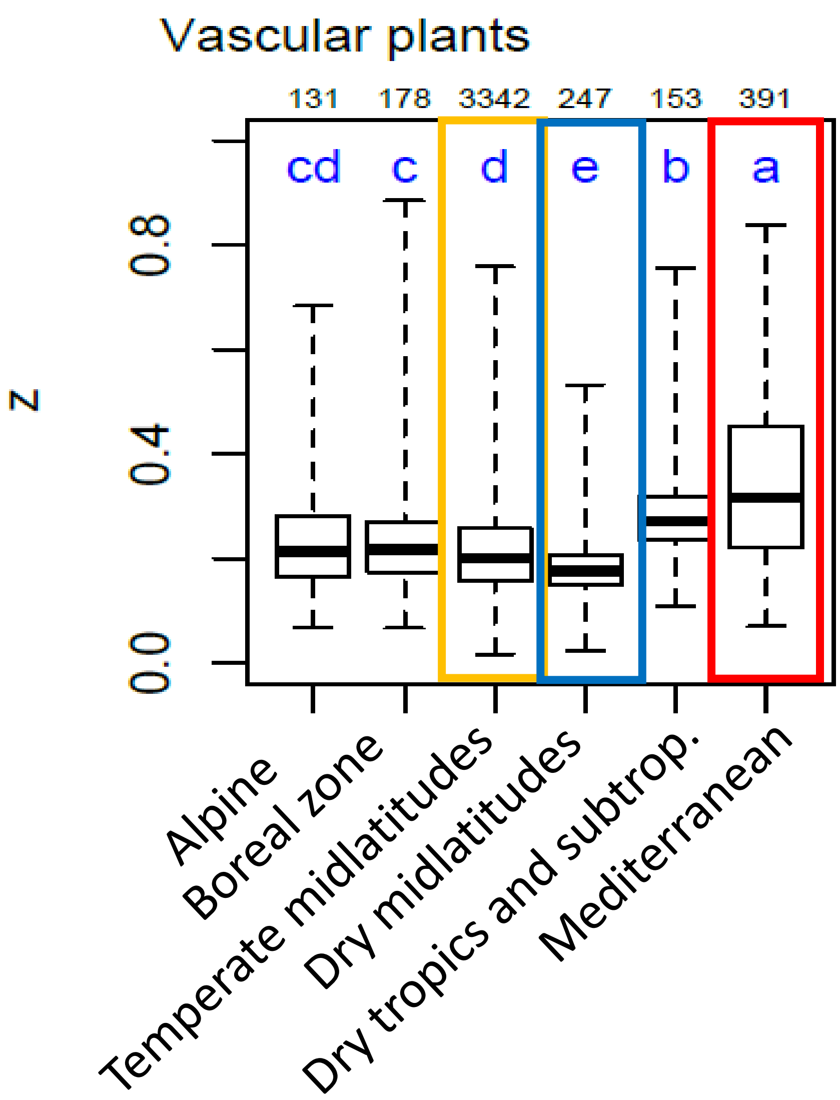




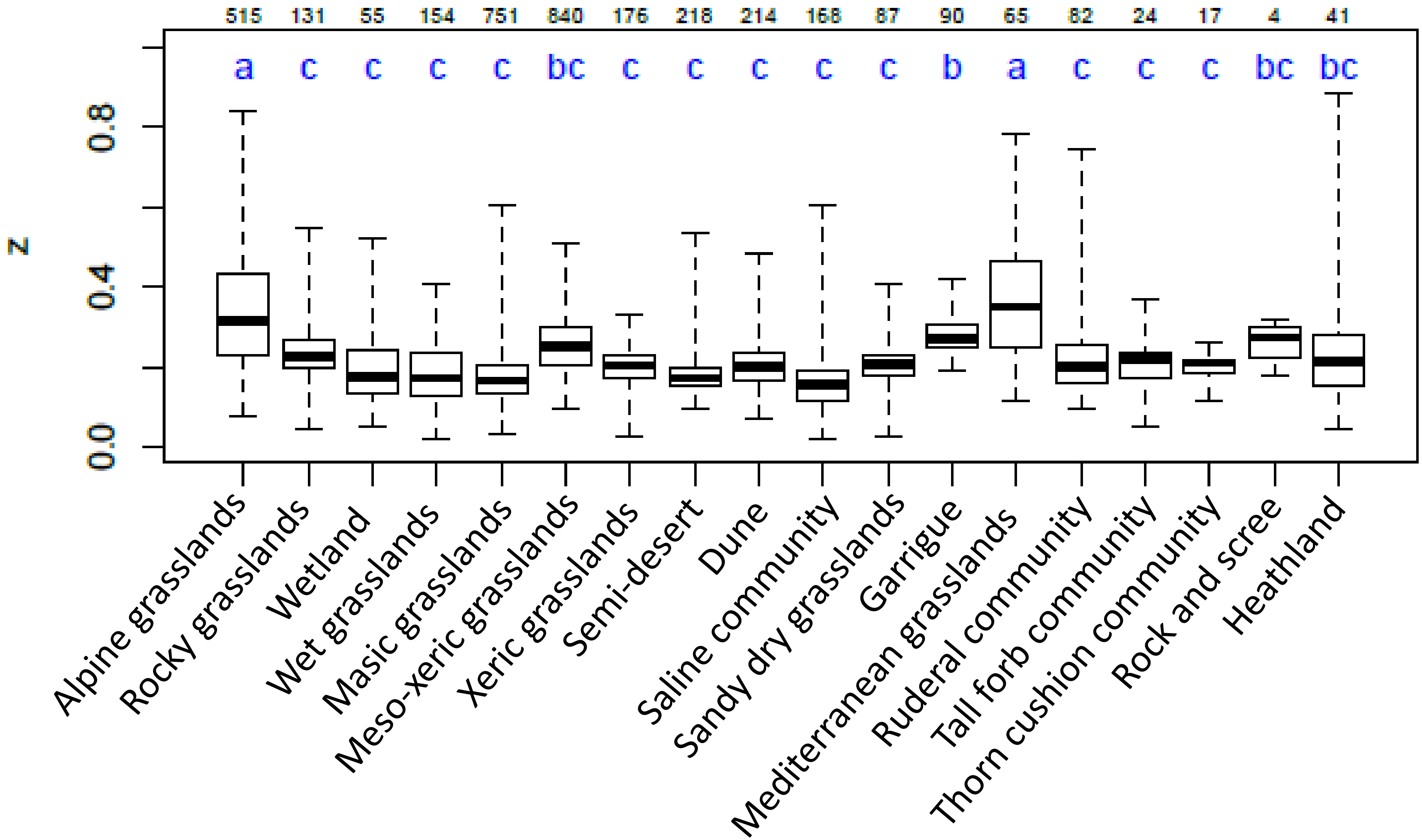
Differences in z-values among the biomes



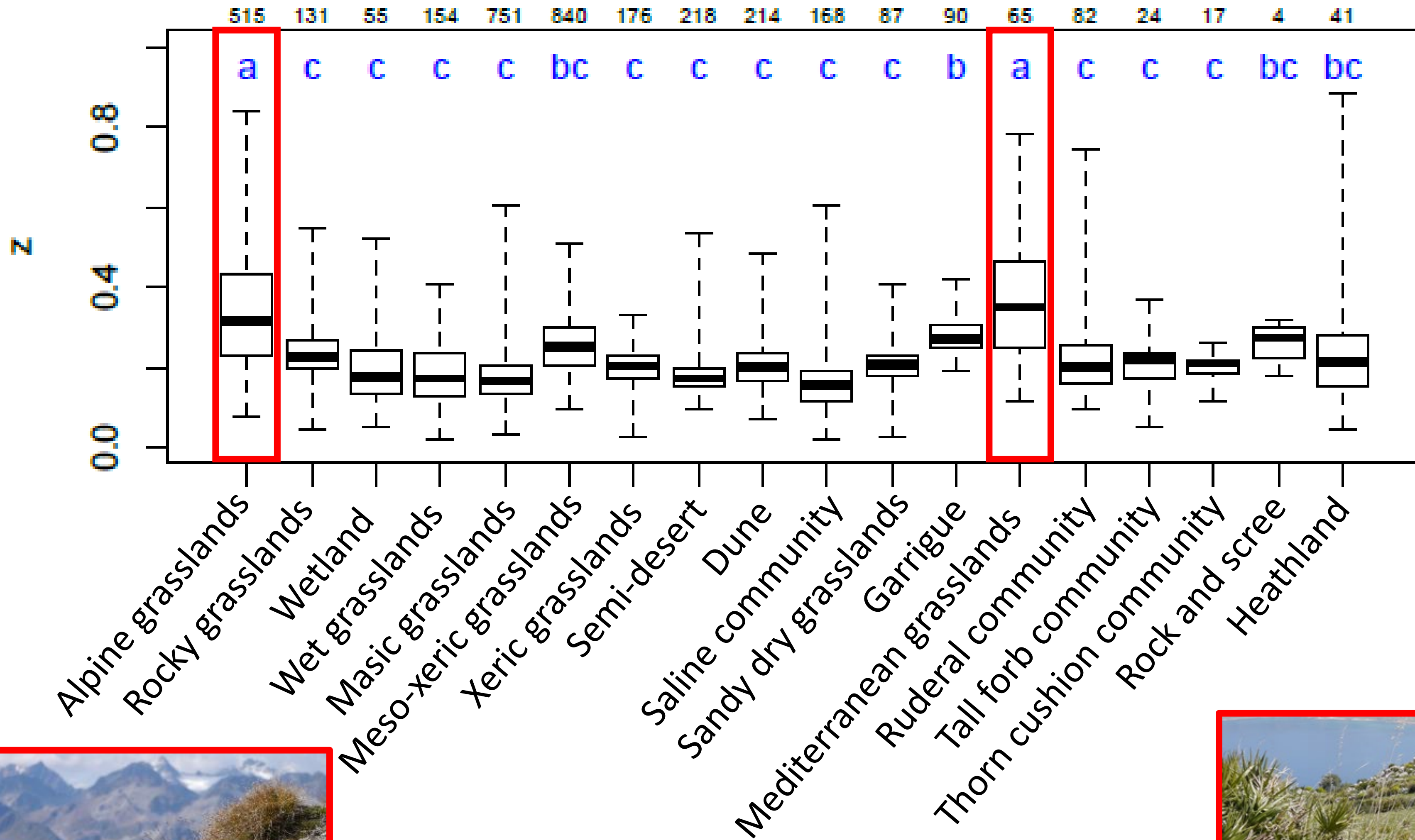
Differences in z-values among the biomes



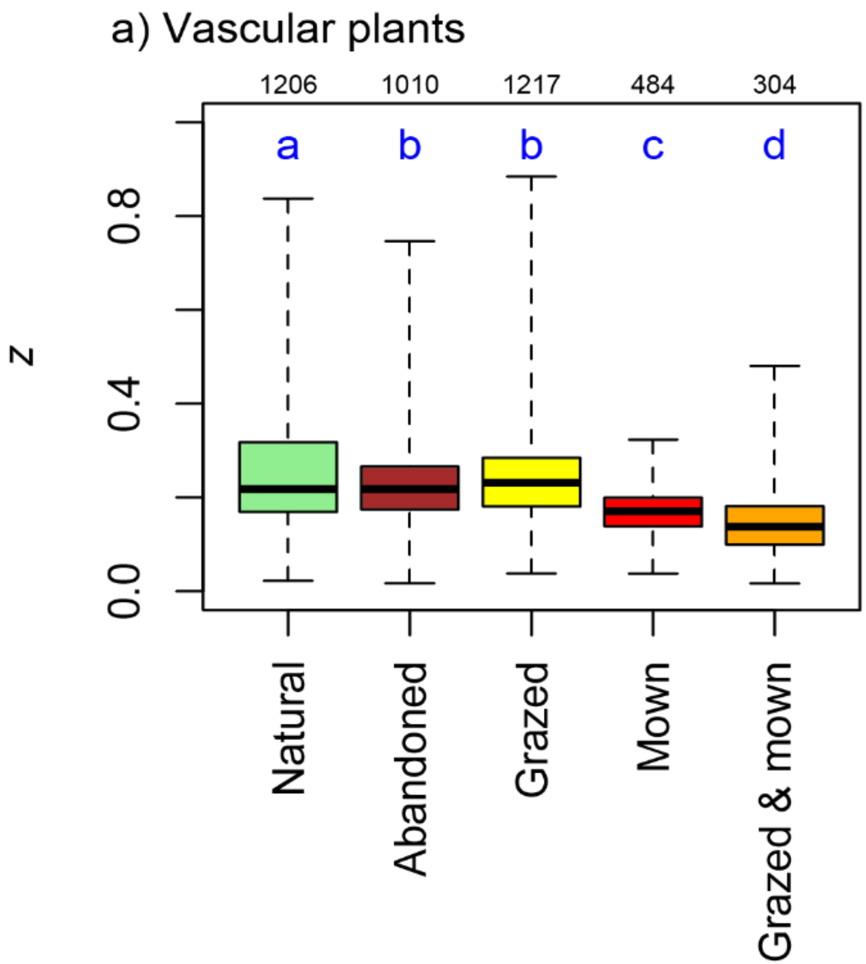
Differences in z-values among the vegetation types

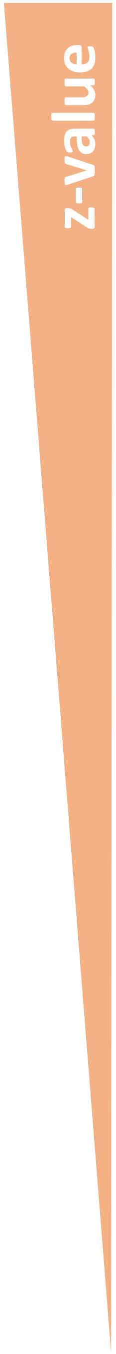


Differences in z-values among the vegetation types

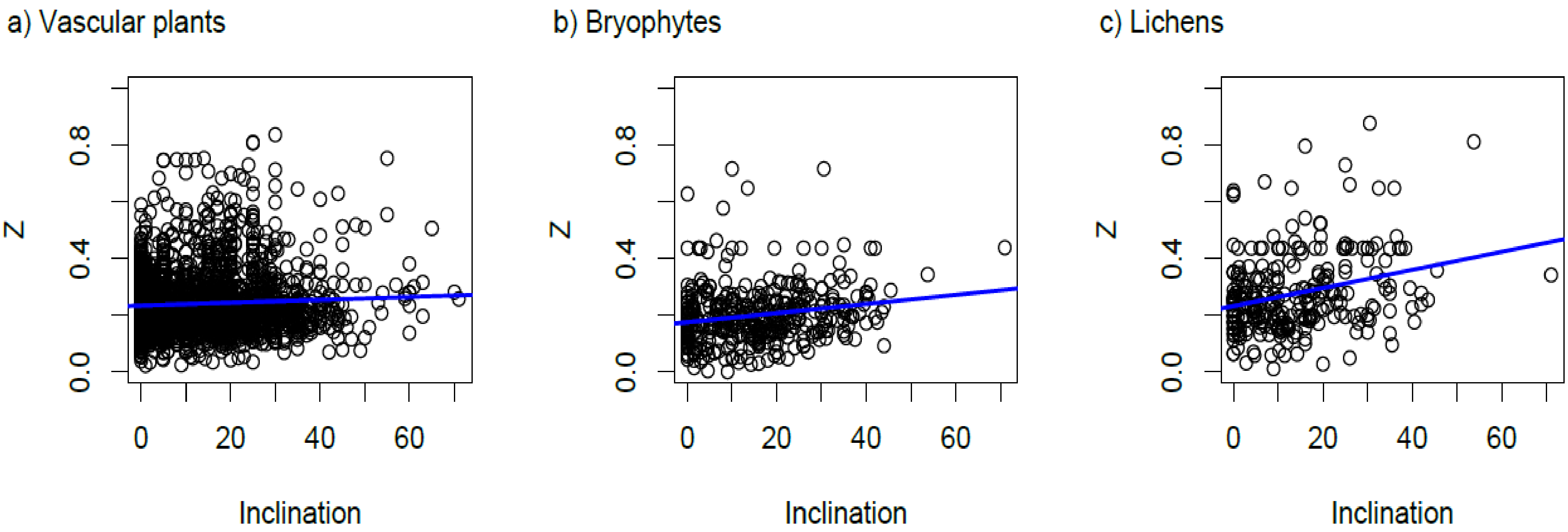


Effect of land use on z-values



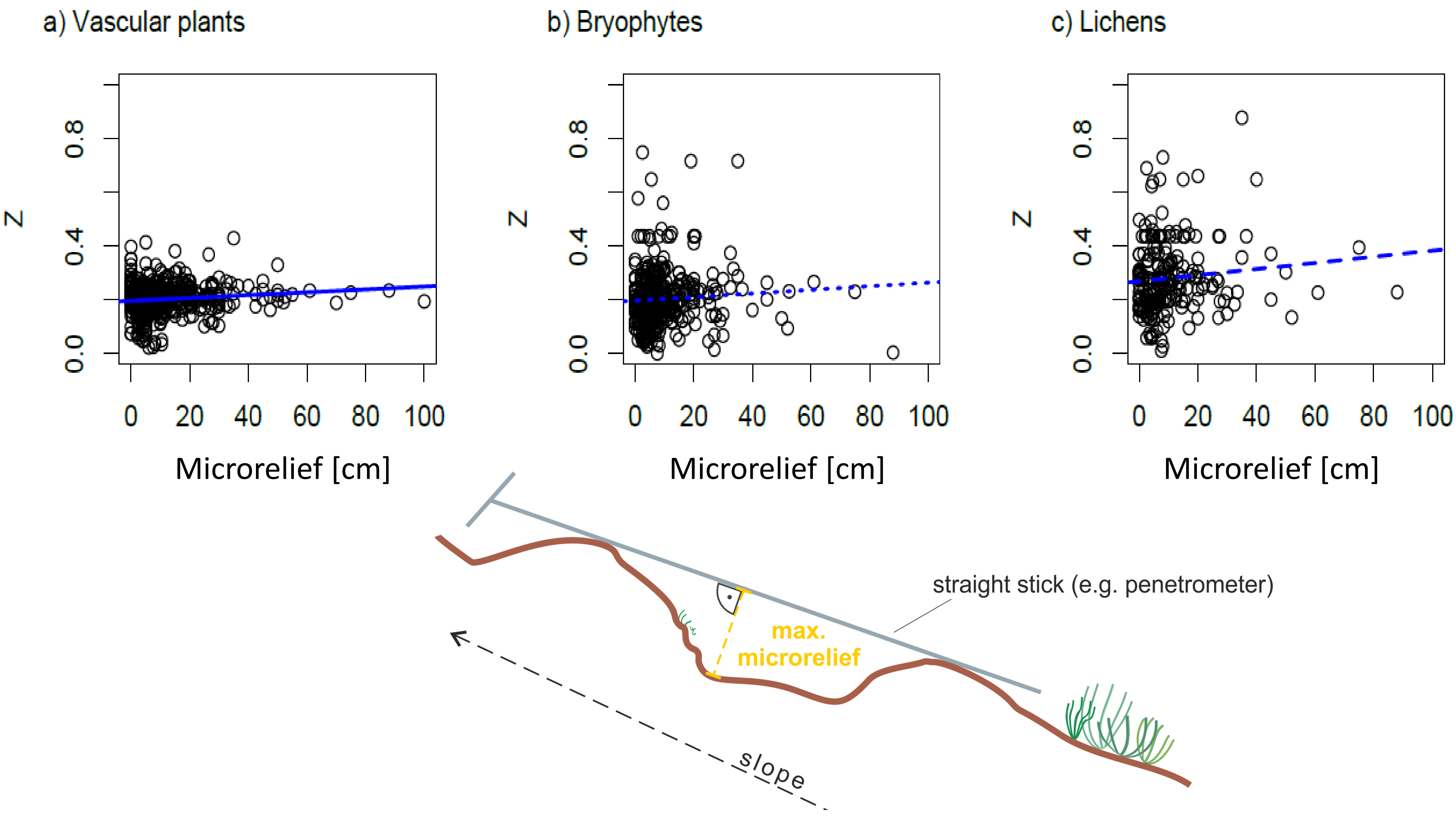


Effect of inclination on z-values



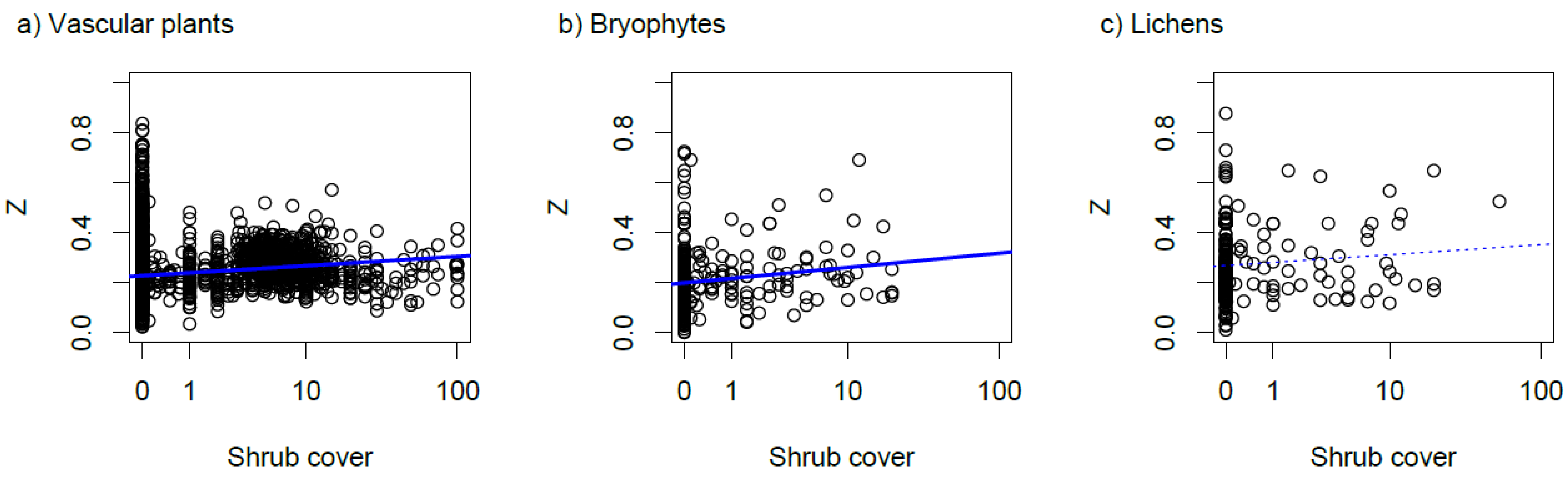
Steeper slope -> higher erosion -> higher disturbance -> higher z-value

Effect of microrelief on z-values



Larger microrelief -> higher within-plot heterogeneity -> higher z-value

Effect of shrub cover on z-values



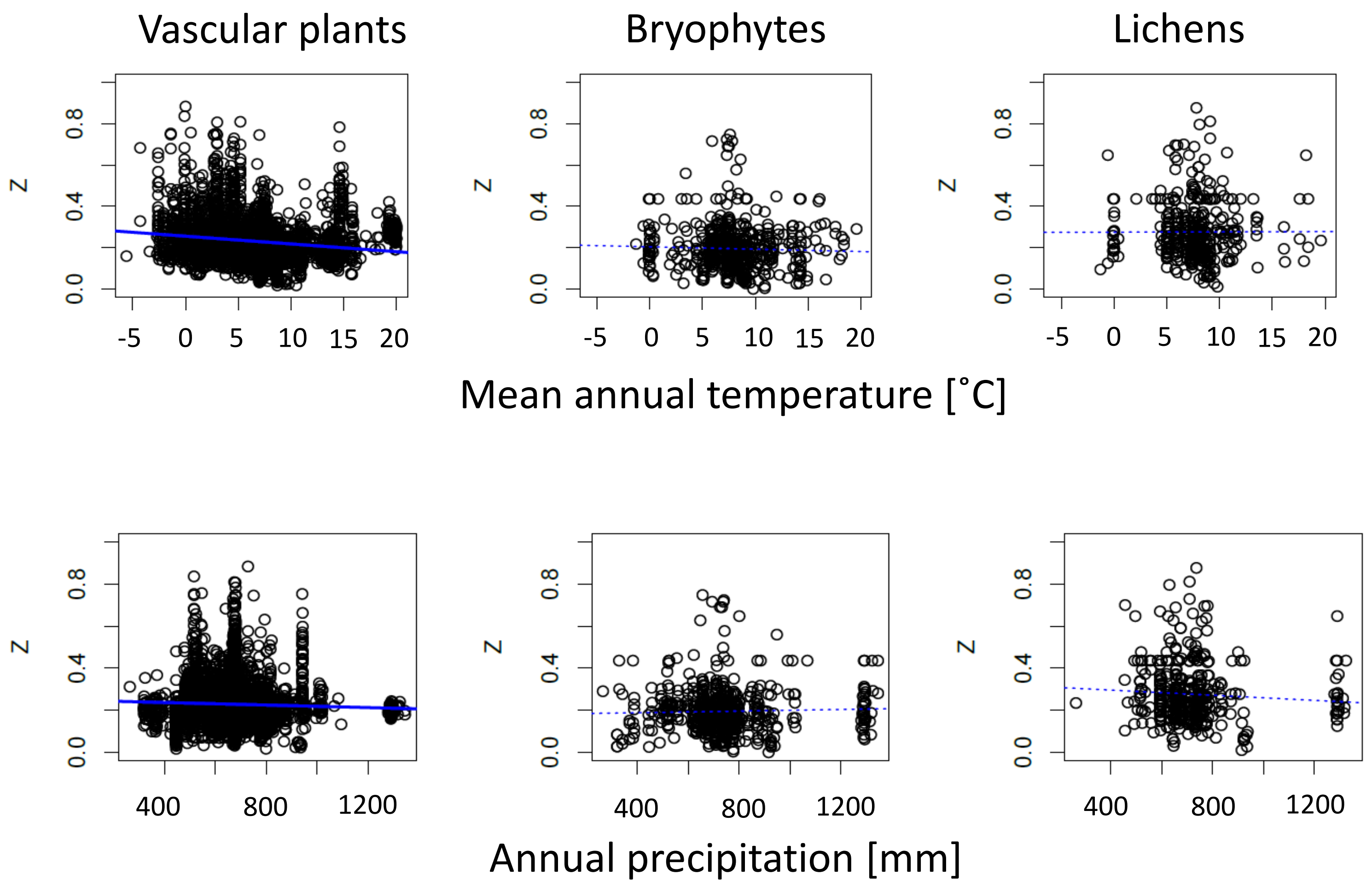
Higher shrub cover -> higher within-plot heterogeneity -> higher z-value

Conclusions

- The **exponent z** of power law SARs is a sensitive measure of fine-grain beta-diversity
- **Taxonomic groups** significantly differ in their beta-diversity similarly to previous findings at much larger grain sizes: bryophytes < vascular plants < lichens
- Limited effect of **biome** and **vegetation type**
- Small-scale **heterogeneity** and **natural disturbance** increase fine-grain beta-diversity, while **man-made disturbance** can have opposite effect


Thank you for your attention!

Relationship between z-values and climate



Differences in z-values of power law SARs depending on climate variables

Some non-linear relationships? – to be checked...