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Scale-dependent patterns of plant diversity and species-area relationships in Palaearctic grasslands: first results based on GrassPlot

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Introduction

Fine-grain biodiversity data sampled over broad biogeographic regions is essential for understanding the drivers of macroecological patterns. These patterns and their drivers depend on spatial grain and extent, but the exact effect of these two components of scale on biodiversity is not well understood and limited by the lack of fine-grain biodiversity data sampled at different spatial grains and extent. In addition, drivers and patterns of biodiversity could vary between major taxa, which has frequently been shown for terrestrial vertebrate classes. The lack of such data for terrestrial vegetation has hampered comparisons among–vascular plants, bryophytes and lichens. To fill this gap, we compiled **GrassPlot, a unique database of high-quality vegetation-plot observations** at eight grain sizes (0.0001, 0.001 … 1000 m²) and with extensive environmental data from any type of grassland and related vegetation types throughout the Palaearctic biogeographic realm. Here we present examples of preliminary analyses that exemplify the potential of GrassPlot.

(1) Benchmarking grassland diversity

Answering what is the **normal (average), minimum and maximum richness** of different grassland types in different regions and at different spatial scales was hardly possible before. We now can present a first approximation to these questions:

Table 1. Average vascular plant species richness for 11 well-represented vegetation classes and 7 different grain sizes. The two classes with lowest and highest means are always highlighted.

		Area [m²]						
Type	Class	0.0001	0.001	0.01	0.1	1	10	100
Temperate	Cleistogenetea squarrosae	1.8	3.4	7.0	15.7	27.5	41.1	33.9
Temperate	Festuco-Brometea	2.3	3.5	8.0	16.0	21.3	36.4	49.1
Temperate	Koelerio-Corynephoretea canescentis	1.4	2.1	3.4	6.0	10.3	15.6	25.8
Temperate	Molinio-Arrhenatheretea	3.1	4.7	6.5	10.5	17.9	29.7	38.2
Temperate	Sedo-Scleranthetea	0.9	2.2	4.6	8.8	15.7	26.7	45.1
Mediterranean	Lygeo sparti-Stipetea tenacissimae	1.7	2.9	5.4	12.8	21.8	36.6	59.4
Coastal	Ammophiletea	0.6	0.9	1.4	2.6	5.6	7.1	10.4
Coastal	Helichryso-Crucianelletea maritimae	0.7	1.1	2.1	4.2	7.8	12.0	17.4
Coastal	Juncetea maritimi	1.7	2.3	2.8	2.9	4.8	7.1	11.4
Alpine	Elyno-Seslerietea	3.3	5.0	6.8	13.3	20.5	43.4	57.5
Alpine	Juncetea trifidi	3.0	5.4	9.1	16.3	23.1	39.2	50.8

(2) Alpha-diversity patterns

GrassPlot has high-quality data to analyse grassland diversity patterns, largely unaffected by methodological artifacts and allows comparing these patterns across grain sizes.

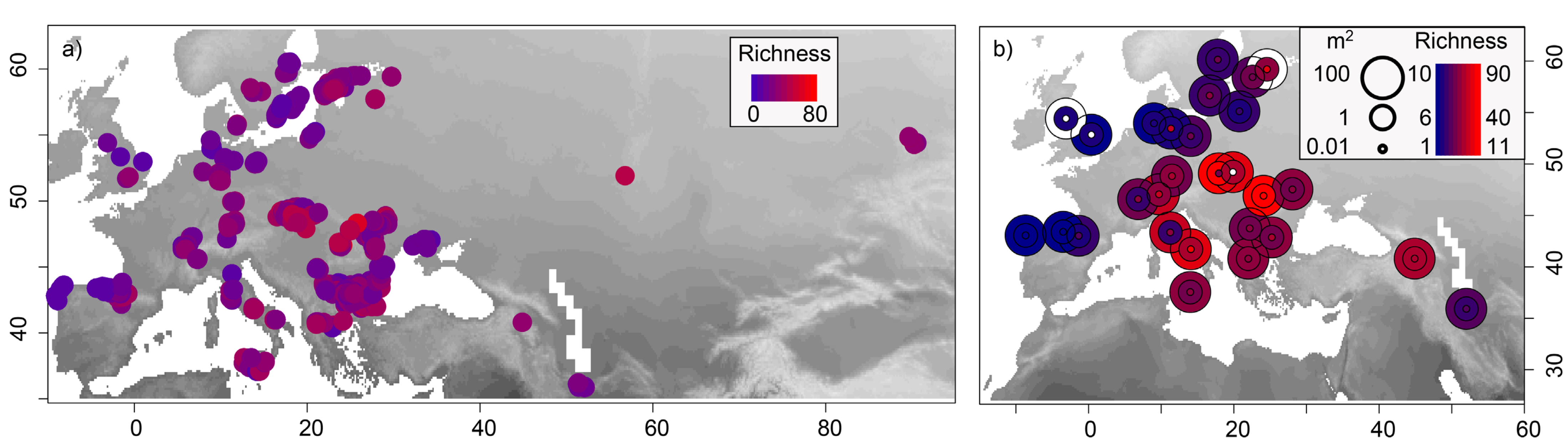

Fig. 2. (a) Example of alpha diversity of vascular plants for plots of one grain size (1 m²). (b) Illustration how ranking of richness changes across scales for vascular plants, richness values aggregated by regions (regional mean; inner circle: 0.01 m², middle circle: 1 m², outer circle: 100 m²). Some regions are extraordinarily rich or extraordinarily poor at all scales, while others are outstanding at only one grain size.

(3) Species-area relationships (SARs)

There has been a long debate which function type describes SARs best. While recent extensive studies for large grain sizes have demonstrated that the power law on average is by far the best model, we can now demonstrate that the same is true in the range of cm² to square meters.

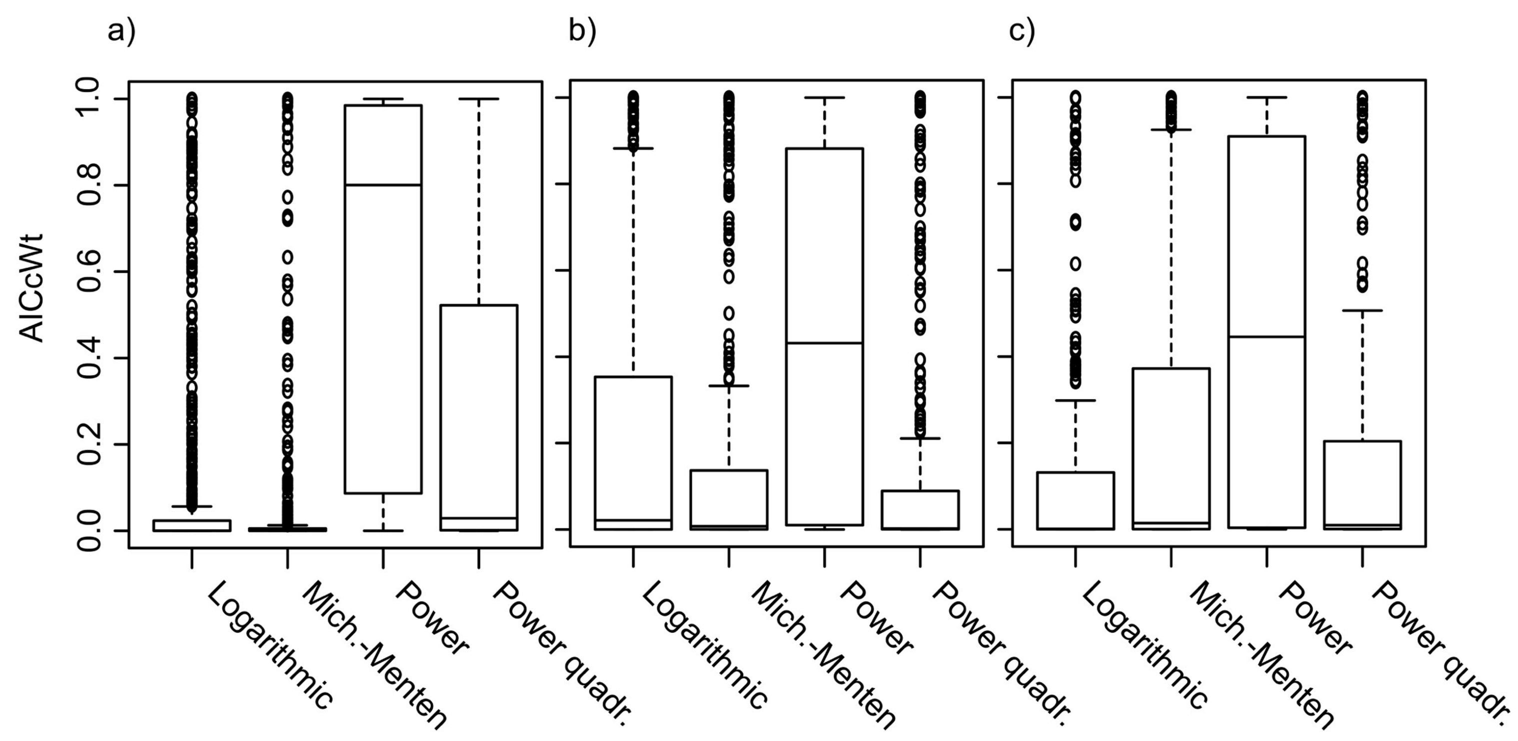

Fig. 2. The power-law model followed by the quadratic power law model performed best, both for a) vascular plant richness, b) bryophyte richness and c) lichen richness. While the logarithmic function ("exponential", often claimed to be best at these scales) and the Michaelis-Menten function (a saturation function) performed poorly.

The *z*-values of the power-law SARs are standardised measures of multiplicative *β*-diversity. We found a mean for total richness of 0.20, while the values for vascular plants were similar (0.21), but much higher for lichens (0.29) and lower for bryophytes (0.19).

Conclusions

GrassPlot can enhance our understanding of community assembly and diversity patterns across a large spatial extent in one of the most extended biomes on Earth. The analyses shown here are only the tip of the iceberg of what is possible.

More information…
https://www.bayceer.uni-bayreuth.de/ecoinformatics/en/grassplot/gru/html.php?id_obj=139267