Patterns of grassland diversity in relation to environmental gradients and management

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Borská nížina Lowland | Biele Karpaty Mts. | Poľana Mts. | Starohorské vrchy Mts.

Introduction

In the most semi-natural grasslands the main environmental gradients responsible for the vegetation variation coincide with moisture, content of nutrients and soil reaction. In our contribution, species richness and β-diversity were studied along these gradients using data sets originating from four distinct regions of Slovakia (the Biele Karpaty Mts., the Poľana Mts., the Starohorské vrchy Mts. and the Borská nížina Lowland) differing in their geographical location, altitudinal range, geological bedrock and variety of semi-natural grassland types (Table 1).

Table 1 Characteristics of the study region.

Region	Location	Range of altitudes (m a.s.l.)	Geology
Borská nížina Lowland	north-western part of the Pannonian Basin	140-250	eolic sands fluvial sediments
Biele Karpaty Mts.	western part of the Western Carpathians	150-800	flysch carbonates
Poľana Mts.	central part of the Western Carpathians	380-1450	andesites cristalline rocks
Starohorské vrchy Mts.	central part of the Western Carpathians	350-1250	carbonates andesites quaternary sediments

Aims

- to identify regional patterns of grassland diversity by answering the following questions:

1. Do the most diverse grassland communities occur at the same position on all moisture, nutrient and soil reaction gradients irrespectively from the region?
2. What management practices support high species diversity in the studied grasslands?
3. Is the relation between species richness and β-diversity the same in all studied regions?

Material and methods

The environmental conditions of individual relevés were expressed by Ellenberg indicator values. In two of the studied regions management practices applied were recorded during the phytosociological sampling. The effects of three environmental factors were studied: moisture, nutrients and soil reaction. The variables were calculated as unweighted averages of Ellenberg indicator values for species in individual relevés (Ellenberg 1991). Only relevés with plot size 16-25 m^2 were used for calculation of species richness and β-diversity. Species richness was calculated as number of vascular plant species in a relevé excluding the woody species. Averages of species richness calculated for ten randomly selected relevés within the given level of environmental factor are shown in the figures. Whittaker index was used to express β-diversity (a measure of the extent to which the diversity of two or more spatial units differ in terms of their species composition, Maguran 2004): $\beta W = S/\alpha$ where S is the total number of species recorded in both sites, and α is the average sample richness. Average values and confidence intervals were obtained from 100 bootstrap samples taken from repeated comparison of 10 randomly selected relevés within the given level of environmental factor. In each regional data set, the diversity parameters were calculated only for intervals (factor levels) documented by at least 10 relevés.

Results and conclusions

- Concerning species richness, the most diverse were semi-dry grasslands on base-rich soils with lower nutrient supply (Fig. 1). The species richness decreased towards wet, nutrient-rich and acidic habitat conditions. The patterns of species richness were similar for all studied regions with only slight shift in position of individual peaks. The Biele Karpaty Mts. had the highest and the Borská nížina Lowland the lowest species richness at any position along all studied gradients. Concerning β-diversity, the differences between the regions were more pronounced, so that only restricted general features could be indicated: grasslands of wet and nutrient-rich habitats showed the highest β-diversity.
- Traditional management regimes including mowing and grazing were in general the most important factors increasing species richness in the studied grasslands (Fig. 2). Even the irregular mowing and grazing can help to maintain the species-rich grasslands. In the Biele Karpaty Mts. the mowed grasslands with grazing of aftermath have the highest species richness. The positive effect of grazing on the species richness was more pronounced in the Poľana Mts. than in the Biele Karpaty Mts. However, intensively utilized grasslands affected by hurdling had lower species richness. Due to the long-term abandonment species richness was strongly impoverished in the Poľana Mts. and also in the Biele Karpaty Mts. Such grasslands gradually diverge in their structure and species composition what results in their high β-diversity (Fig. 2).
- The patterns of β-diversity are much more region-specific than the patterns of species richness. In general, β-diversity seems to be inversely related to species richness: it is the highest in the region with the lowest species richness (the Borská nížina Lowland) and the lowest in the region with most species-rich grasslands (the Biele Karpaty Mts.).

Fig. 1
Species richness and β-diversity in semi-natural grasslands along gradients of three studied environmental variables: moisture, nutrients and soil reaction.

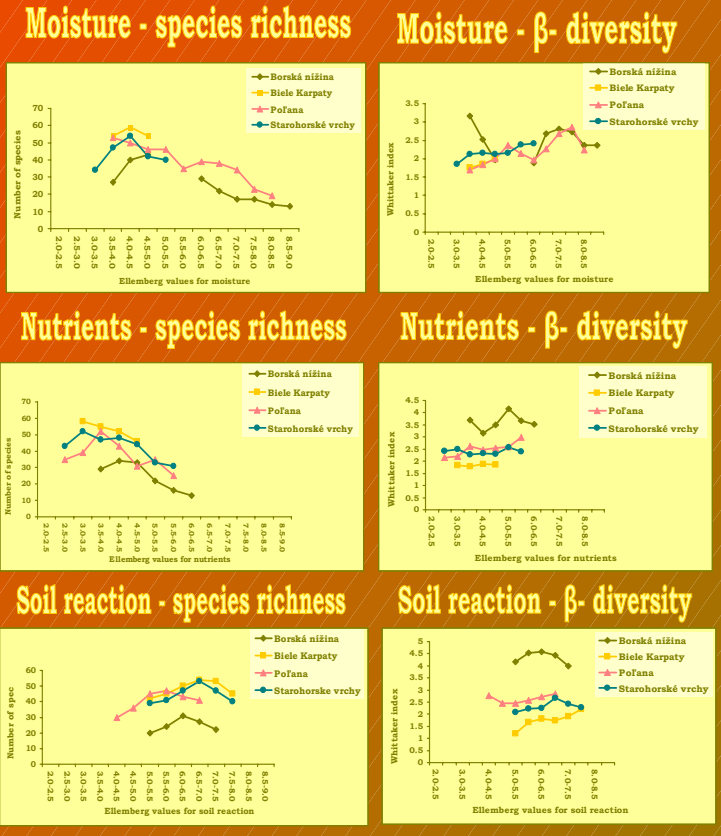
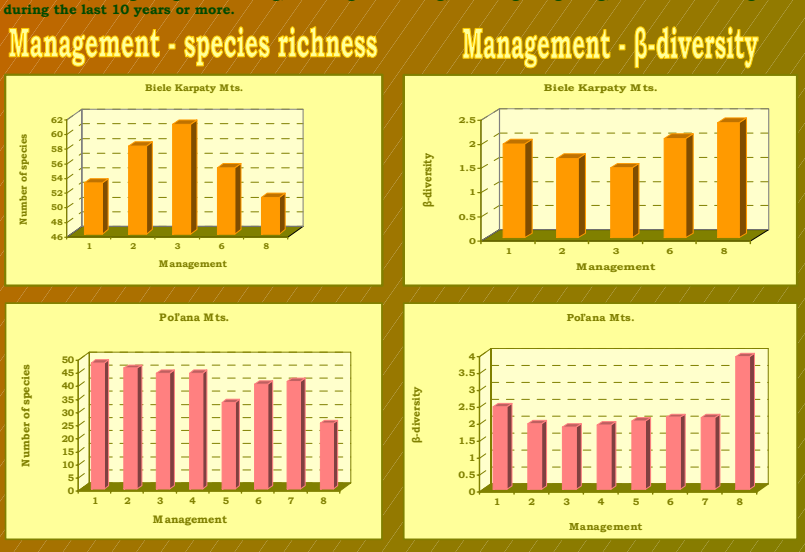


Fig. 2
Species richness and β-diversity of grasslands with different management regimes in the Poľana and the Biele Karpaty Mts.: 1 – regular mowing, 2 – grazing, 3 – combination of mowing and grazing, 4 – grazing and fertilization, 5 – grazing and hurdling, 6 – irregular mowing, 7 – irregular grazing, 8 – without management during the last 10 years or more.



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