

BIODIVERSITY AND SPATIAL HETEROGENEITY IN SEMI-NATURAL GRASSLANDS IN A MOUNTAIN AREA IN SLOVAKIA

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Abstract

The spatial pattern of vegetation in the following 3 semi-natural grasslands in Banska Bystrica, Slovakia, was observed in August, 1998: (1) a grassland sown with improved herbage plants after plowing in 1991, (2) a grassland oversown with improved herbage plants in 1991, and (3) a natural grassland without any treatment at the time of establishment. A new method of measuring vegetation was adopted: in each grassland, 50 quadrats 50 cm × 50 cm, composed of 4 smaller cells 25 cm × 25 cm, were set up, and all the species in each cell were recorded. The sown grassland displayed the highest species richness and diversity though its spatial heterogeneity was very high while in the natural grassland these characteristics were least pronounced. The highest species richness and diversity could be maintained on the average in the sown grasslands although their plot-to-plot variations were very large.

Keywords: Central Europe, Grassland community, Spatial pattern, Species diversity, Sustainability

Introduction

The spatial heterogeneity of a plant community in grasslands is one of the important characteristics for the evaluation of grassland quality. The following four aspects can be at least evaluated: the spatial pattern of each species, the botanical composition, the species diversity, and biomass (Shiyomi et al., 1998, 2000). We focused on the species diversity in grasslands due to its importance in grassland sustainability.

The objectives of this study were to determine (1) the frequency of occurrence of all the species which appeared in the Slovakian semi-natural grasslands, and (2) the spatial heterogeneity of species diversity.

Material and Methods

Three grasslands differing in establishment, located at the Grassland and Mountain Agriculture Research Institute, Banska Bystrica, Slovakia (48°44'N, 19°09'E, 460 m above sea-level), were surveyed, August in 1998. The 3 grasslands were established in 1991 as follows: (1) "Sown grassland" established by sowing of improved herbage plants after plowing the old semi-natural grassland, (2) "Oversown grassland" established by oversowing of improved herbage plants after scratching the soil surface with a rake-dozer, and (3) "Natural grassland" not subjected to any artificial treatment. Each grassland had been cut 3 times a year. Plant species sown at the time of establishment of the sown and oversown grasslands were *Dactylis glomerata*, *Lolium perenne*, *Festolium*, tetraploid *Trifolium repens* and *Trifolium pratense*.

At the sites surveyed, the precipitation was 441 mm yr⁻¹ and the mean air-temperature during the growing season was 13.6 °C. The orientation of the sites was north-east to north-west with a gentle slope, and the soil pH was around 4. No fertilizer was applied at any site. The productivity for the sown, oversown and natural grasslands was 4.0, 4.5 and 3.8 ton ha⁻¹ yr⁻¹ on the average, respectively.

In each of the 3 grasslands, 50 quadrats 50 cm × 50 cm (referred to as L-quadrats) were set on a 5 m × 5 m square like a checkerboard. Each L-quadrat was divided into 4 small quadrats 25 cm × 25 cm (S-quadrats). All the species that occurred in each S-quadrat were recorded.

The overall proportion of S-quadrats for a given species i , p_i , was calculated for all the species that occurred:

$$p_i = (\text{Number of S-quadrats with species } i) / (\text{Total number of S-quadrats}).$$

Shannon-Winner's index, H' , was adopted as the measure of species diversity, and the value was calculated for each L-quadrat.

Results and Discussion

The total numbers of species that occurred in the sown, oversown and natural grasslands were 37, 37, and 31, respectively. Figure 1 shows the whole species names occurred and a comparison of occurrence, p , for each species in the 3 grasslands. Among the 51 species occurring in the whole survey, *Taraxacum officinale*, *Trifolium repens* (diploid, native), *D. glomerata* and *Poa pratensis* were commonly dominant at grasslands with different origins. On the other hand, some species, such as *L. perenne*, *Festolium*, *Glechoma hederacea*,

Daucus carota, and *Achillea millefolium*, had an advantage in the sown grassland. *Cerastium holosteoides*, *Trisetum flavescens*, *T. pratense*, *Agrimonia eupatoria* and *Arrhenatherum elatius* occurred more frequently in the natural grassland than in the oversown and sown grasslands.

Spatial distribution of the species richness and diversity per L-quadrat is illustrated in Figure 2. There were differences in the means (M) and variances (V) between the 3 grasslands. The sown grassland showed the highest species richness/diversity, the natural grassland the lowest and the oversown grassland showed intermediate characteristics. In the semi-natural grasslands of central Europe, the original type of the presently improved herbage plants, for example, *L. perenne*, *D. glomerata*, *P. pratensis* and *T. repens*, is often found. Native species including these plants invade into sown grasslands from the surrounding areas. The sown grassland contains some other native species, too, which are not frequently observed in oversown and natural grasslands, such as *G. hederacea*, *Lotus corniculatus*, *Veronica chamaedrys*, *Vicia cracca* and *Agrostis tenuis*, some of which are common annual weeds in crop fields. Furthermore, in the sown grassland, improved herbage plants such as *Festolium*, *T. repens* (tetraploid) and *L. perenne* were abundant compared with those in the natural grassland. These facts suggest that niches which were vacant when only natural species grew were occupied by seeded herbage plants and their accompanying native weed species.

A high H' -value indicates a spatially intricate mixture of many species. The sown grassland with the highest H' -value was composed of a higher mixture of species than the natural grassland on the average. The oversown grassland was intermediate between the two. Variances shown in Fig. 2B indicate that the sown grassland exhibited the largest spatial heterogeneity in species diversity, that is, the spatial pattern of the sown grassland tended to consist of patches with a very low to very high species diversity, compared with the natural grassland. A high species diversity, in spite of a large site-to-site variation in a grassland, could be maintained in artificial sown grasslands in this area.

References

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Figure 1

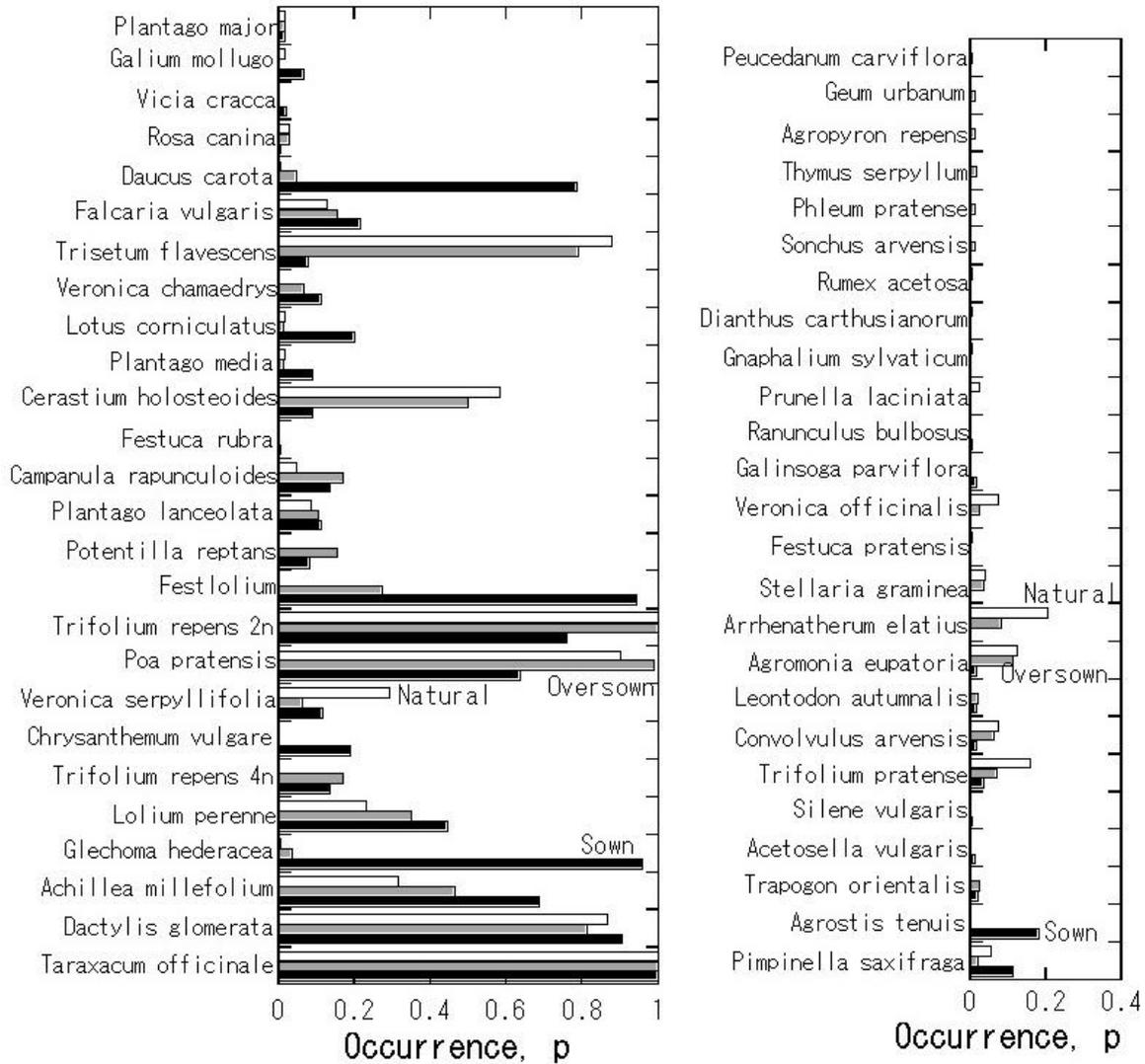


Figure 1 - Occurrence of species in a “sown” grassland () with improved herbage plants, a grassland “oversown” () with improved herbage plants after scratching the soil surface, and “natural” grassland () without any treatment at the time of establishment.

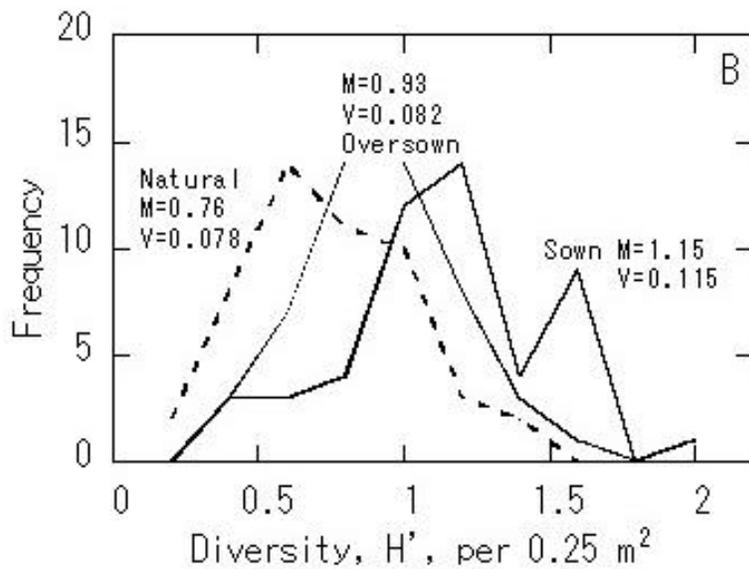
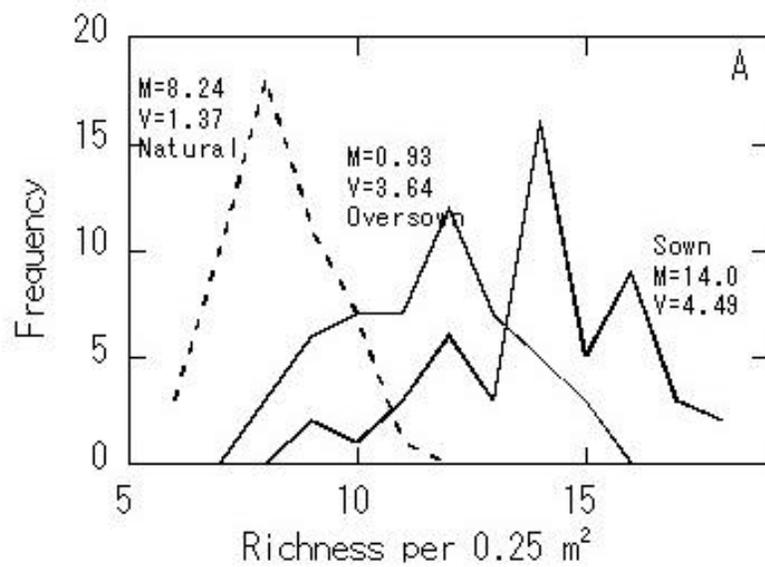


Figure 2 - Distribution of species richness (A) and species diversity (B) in the “sown”, “oversown” and “natural” grasslands. M and V denote the mean and variance, respectively. See Fig. 1 for the meaning of sown, oversown and natural grasslands.