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Research Article

The effect of grassland management on diversity of spider assemblages in the Mátra mountain

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Abstract
Our investigation targeted the diversity of spider communities of meadows under nature conservation management and the relationship between mowing and the spider diversity. The study sites represented by six grasslands on three localities of Mátra mountain of Hungary. All three localities were contained a hay meadow and a not mowed meadow. Hay meadows had the richest spider communities. In the control habitats, the equitability and the Shannon-Wiener diversity were lower than in the mowed grasslands. According to the Bray-Curtis similarity index significant differences were observed between spider assemblages of mowed and control habitats. The prevention of succession effects so rich structure of the vegetation where diverse spider communities can live. Our results suggest that mowing is a suitable management for maintaining a high biodiversity in mountain grasslands.

Key words: Mowing, meadows, Hungary.

Introduction

The spiders are sensitive indicator organisms (Horváth et al. 2009). The most important factors, which influence the structure of spider species assemblages are the shading and the humidity of the soil (Entling et al. 2007). Spiders are sensitive management such as mowing (Cattin et al. 2003). Therefore the examinations of the spider assemblages are necessary for the suitable coordination of the grassland managements. The Mátra mountain is part of the northern medium mountains of Hungary. The grasslands of Mátra were developed under traditional management including meadows mowing and grazing. The regional species pool can be preserved by means of the habitat protection and habitat resturation. Several researches proved that grasslands and woody pasture are the most species richness habitats of Middle Europe (Steffan-Dewenter 2002; Ilmarinen 2009). Because of diverse flora and fauna great attention was devoted to natural grassland habitats from an ecological point of view. Grassland management has been going on the Landscape Protection Area since 2000, of which role is the maintenance of the diverse grassland.

Materials and methods

Sampling areas and methods

The study area included 6 mountain grasslands of 3 localities (Sár Hill, Bátonyterenye, Fallóskút). A not mowed (control) and a mowed (hay) meadows were sampled at each location. All sampling sites are valuable mountain meadows which include many high of nature conservation value plant species such as *Lilium martagon* or the *Gladiolus palustris*. Treatments were made on those habitats where the ecological succession is at an advanced stage. The first phase of the treatment is bushwhacking, followed by steam-mashing and finally mowing. The treatments were coordinated and made by Bükk National Park. We performed sampling for three years (2010-2012) as a part of soil zoological monitoring of the treatments. Relatively large number (twelve) double glass pitfall traps were established on each sampling sites because these located in protected area, therefore we used only live traps. In all four sides of meadows were three live traps two meters from each other (Figure 1). We used 10 cm diameter plastic glasses covered fiberboard. The traps were outside for 3 times (April-May, July-August, September-October) 3 weeks periods in a year. During every sampling, we used a sweep net (100 net strokes / sample).

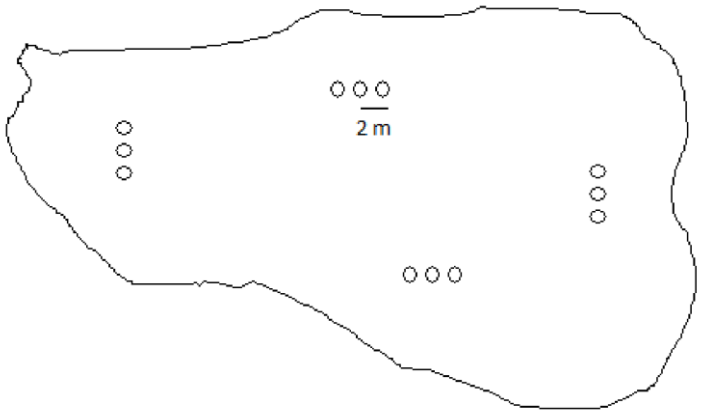

Figure 1. Distribution of the traps on the sampling sites.

Statistical analysis

For the data analysis, we used the PAST Paleontological Statistic suite (Hammer et al. 2001). The diversity, species richness and equitability were evaluated for communities in each habitat type. For the calculation of the diversity, we applied the Simpson's and the Shannon-Wiener indices. The most abundant species influences the value of Simpson's index, while the Shannon-Wiener index is more sensitive to the frequency of rare species (Magurran 2004). We assessed the differences between habitats by means of cluster analysis and Non-metric MDS for the better demonstration. We used the Bray-Curtis similarity index because this index calculated the similarity based on dominance relations of species (Schmera & Erős 2008). The value of species turnover between habitat types was assessed with Wilson & Shmida's Beta diversity indexes ($ß_T$) (Magurran 2004). We research the guild composition which is an important agent of the structure of a community. With examination of the guilds, construction can be found the community relations (Terborgh & Robinson 1986). The usage of guilds gives more information of composition of assemblages, than the number of individuals or the diversity (Székely & Moskát 1991).

Results

γ and α diversity

In total, we collected 1850 individuals of 63 species, included 4 vulnerable species. The total Shannon-Wiener diversity was relatively high (2, 652). The highest species richness was observed in the mowed habitats and the abundance of spiders almost in all mowed habitats was significantly high compared to control habitats (Table 1). The number of individuals and the species richness correlate with each other

between the control and mowed habitats (Figure 2). In the case of all locations, the values of both diversity indices were higher in the mowed meadows than the control ones (Figure 3).

Table 1. Number of species (S), number of individuals (N), Margalef's richness index (D_{Mg}) and the equitability (J) in the different habitat types

	Location 1		Location 2		Location 3	
	Mowed	Control	Mowed	Control	Mowed	Control
	736	540	133	58	218	173
S	41	27	26	20	17	17
D_{Mg}	6,059	4,133	5,112	4,641	2,971	3,105
J	0,591	0,5662	0,8322	0,873	0,7052	0,6653

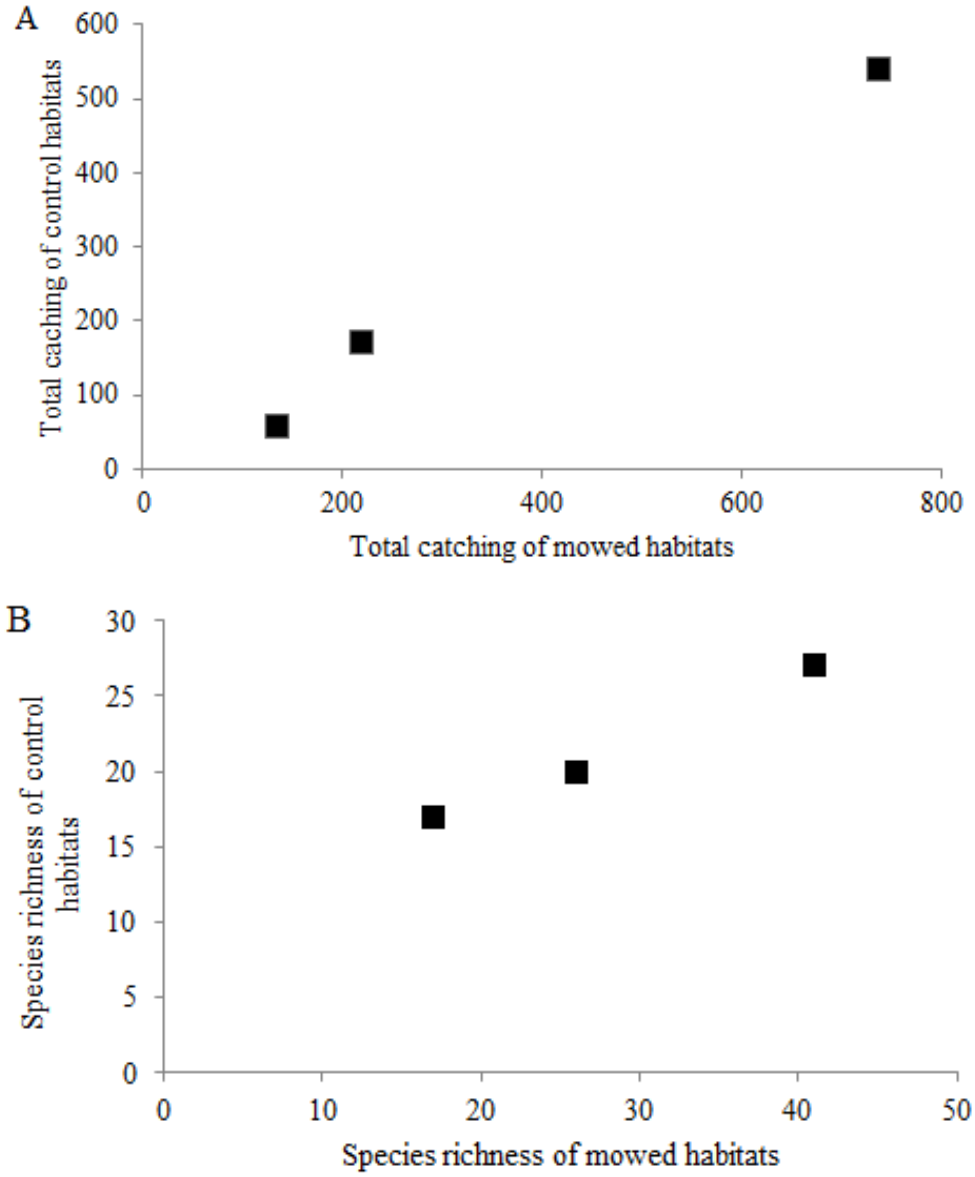

Figure 2. Correlation of (A) number of individuals and (B) species richness between control and mowed habitats

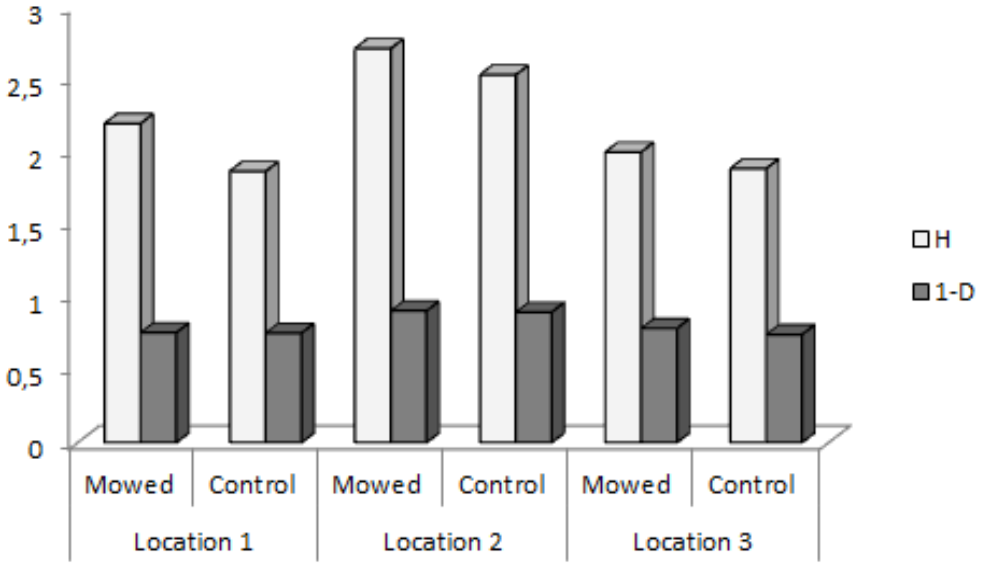

Figure 3. The values of Shannon-Wiener diversity (H) and Simpson's index (1-D) in the different habitat types.

Composition of assemblages

The members of *Lycosidae* family were dominant, followed by *Thomisidae* and *Gnaphosidae* families. With regard to frequency, the most frequent species was *Alopecosa cuneata* (Clerck, 1758), followed by *Trochosa terricola* Thorell 1856. There are many singleton species in meadows e. g. *Arctosa figurata* (Simon, 1876), *Xysticus robostus* (Hahn, 1832). With regard to the guild composition in the mowed habitats the diurnal runnings and crab spiders were dominant also the number of orb-weaver species was lower in control habitats (Figure 4). The most individuals of 4 collected vulnerable species (*Nemesia pannonica* Herman, 1879, *Atypus piceus* (Sulzer, 1776), *Eresus kollari* Rossi, 1846, *Geolycosa vultuosa* C. L. Koch, 1838) were collected on mowed meadows.

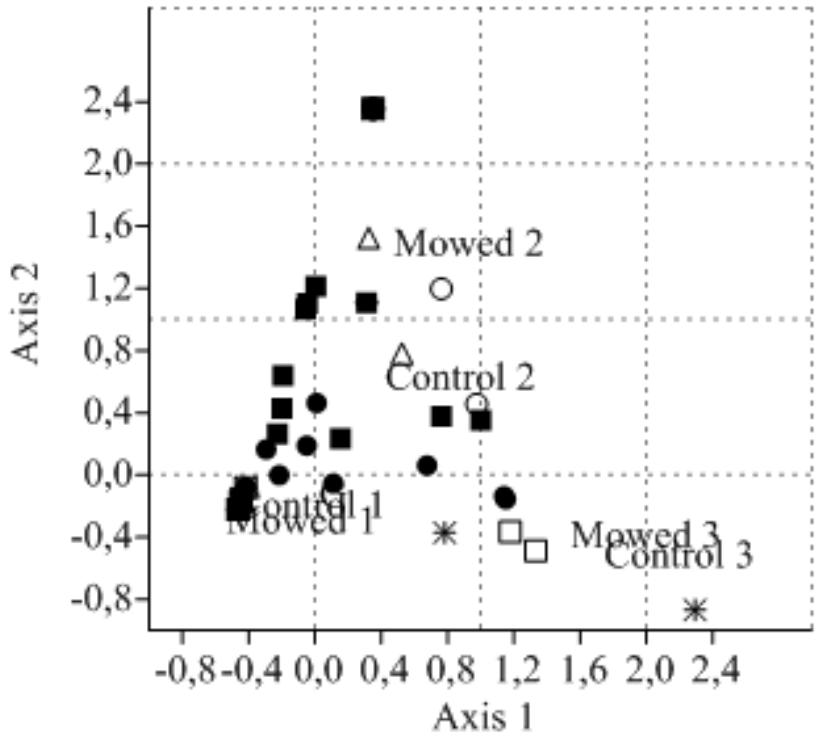

Figure 4. Ordination diagram of a distribution of guilds (hunting strategy) in the habitats. Guild types: +-Shaft diggers, O-Orb weavers, □-Space web spiders, ●-Diurnal runnings, *-Nocturnal runnings, ■-Crab spiders,▲-Jumping spiders.

β diversity and similarity

The highest species turnover was noticed between mowed meadow of locality 1 and control meadow of locality 3. We observed the lowest value of index between habitats of locality 3 (Table 2). According to the Cluster analysis and Non-metric MDS the spider assemblages of hay meadows and control meadows were separated from each other (Figure 5).

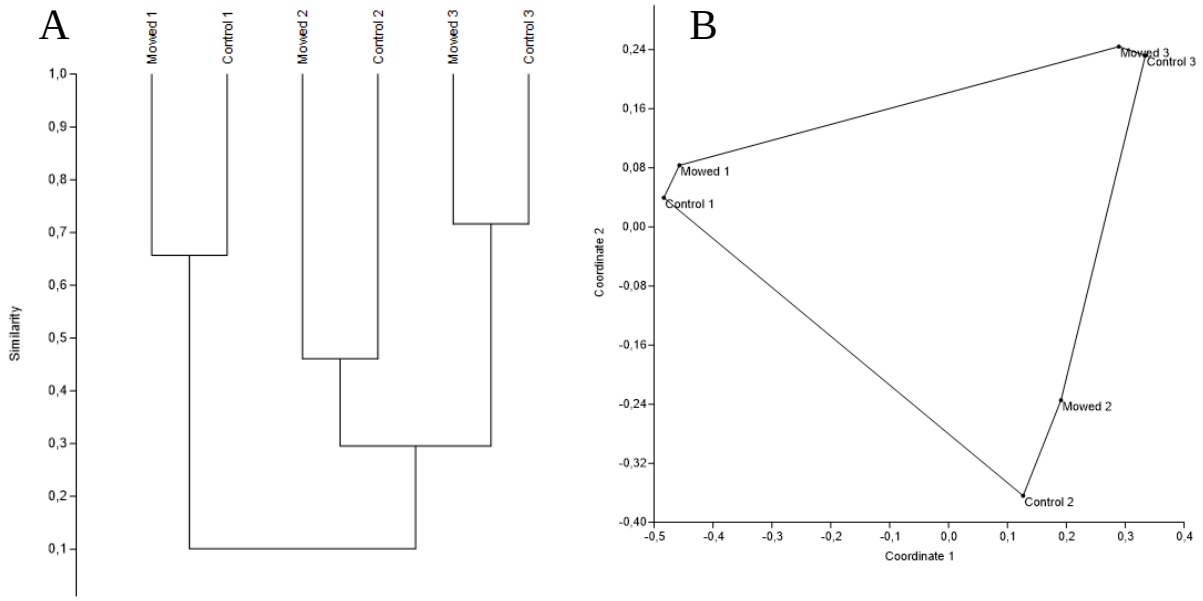

Figure 5. (A) Cluster analysis and (B) Non-metric MDS by Bray-Curtis similarity of spider assemblages between the different habitat types

Table 2. Wilson & Shmida's Beta diversity index (β_T) between habitats.

		Loc. 1		Loc.2		Loc. 3	
		M	C	M	C	M	C
Loc. 1	M	0	0,3823	0,5522	0,6610	0,6551	0,6896
	C		0	0,6603	0,6888	0,6818	0,6818
Loc. 2	M			0	0,4090	0,4418	0,4418
	C				0	0,3142	0,3714
Loc. 3	M					0	0,1764

Discussion

The mowing had a positive effect on the floral diversity (Buttler 1992, Güsewell et al. 1998), the richness of the growing plant species gives diverse habitat structure, therefore the number of spider species increases as well. (Zschokke 1996; Tews et al. 2004; Malumbres-Olarte et al. 2013). These statements are supported by our data because the species richness and the number of individuals were higher in hay meadows. The prevention of succession result the consistency of individual distribution of species and the absence of an eminent number species in these habitats. The treatments results so habitats which have specific spider communities, therefore the control and mowed habitats are separated from each other. In his study of spiders of wet meadows Guitprecht (2001) found that the species richness and the abundance of species were significantly higher in hay meadows than in the not mowed meadows. Thus, similarly to our results he has supported the beneficial effect of the mowing. A study of size of area and the effect of the mowing (Debnár 2012) shows that the height of

herbaceous plant affects the species richness. But the size of the sample sites has not effect on the number of species. Similarly to this study, our result proves that the hay meadows provide more suitable conditions for making the web because of rich structured vegetation therefore besides ground-dwelling spiders space-web species can found, as well. The protected shaft diggers species (*N. pannonica*, *A. piceus*, *E. kollari*) presence on the hay meadows demonstrates the importance of grassland management. These species live mainly area of a nature reserve and national parks sithence these habitats have a high nature conservation value. One way of the protection of the species is the maintenance and the recovery of the habitats. For the interest of the suitable schedule of grassland management, the research of this area is essential. In the Mátra mountain, the semi-natural habitats formed due to a human intervention. The prevention of human impact results the change of habitats and lost the nature conservation value species. Thus, the hay meadows need consecutive grassland management to maintenance the high diversity.

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