

Correlation between the diversity and mowing in cleared grassland areas in the Börzsöny mountains

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Areas of natural grasslands have considerably decreased in Europe in the past decades (Luick, 1998; Dullinger et al., 2003; Sebastià et al., 2008; Penksza et al., 2013; Kiss and Penksza, 2018; Házi et al., 2011, 2012; Szentés et al., 2011; Zimmermann et al., 2011; Horváth and Komarek, 2016).

Due to changing land use, traditionally managed grasslands are rarely seen (Kaligarič et al., 2006; Komarek, 2007a, 7b). This is an unfortunate fact as regular mowing and foraging are the primary tools of maintaining these areas. These methods are of high importance in terms of nature conservation management, by affecting the successive processes (Penksza et al., 2008; Komarek, 2008; Török et al., 2011, 2018; Pápay et al., 2019a, b, c; Valkó et al., 2012; Kelemen et al., 2014).

Natural disturbances are part of the ecological systems, and the majority of meadows and hayfields of high nature conservation value can only be preserved through management. By means of nature conservation treatments, the number of grasslands species can be increased and various accompanying species can be introduced (Besnyői et al., 2012; Stroh et al., 2002; Szabó et al., 2011, 2017).

One of the most important danger threatening mountain grasslands is the increasing cover of shrubs (Pápay and Uj, 2012; Penksza et al., 2015; Pápay, 2016), which is a problem that exists also on a global scale (Pápay et al., 2020). This situation calls for management, such as extensive grazing, pasturing (Járdi et al., 2017; Zimmermann et al., 2018) and shrubcutting (Pápay et al., 2017). However, in some cases, ungulate browsing can provide help in this task by setting back the growth of new sprouts (Katona et al., 2016; Penksza et al., 2016; Pápay et al., 2019b, 2020).

The surveyed area is situated in the Carpathian basin, in the Northern region of Hungary, within the countryside Mount Cserhát in the small region of Kosd hills. The meadow Gyadai is situated at the Northern end of Mount Naszály forming a part of the Kosd hills in the valley of the stream Lósi, this is where our surveys were carried out. The sampling points were assigned based on a rectangular grid projected on the area, which were slightly altered by on-site corrections to avoid the quadrats falling on roads, bushes, wild boar diggings, or mud flows. Due to the random samplings it may have occurred that a quadrat had been assigned on slightly disturbed patches. We assigned a total of 40 quadrats of 2×2 m for the coenological sampling so that 10 quadrats were assigned to each portion of the area. Quadrats

21-30 are located in the grassland near to the village Katalinpuszta, which is a popular tourist destination. At weekends thousands of people visit the area. In 2-3 weeks, during the main plant reproduction and growth period programs are organized where 50-100 people take part, or school children play games. The area located at the beginning of the grassland is strongly separated within the mowed grasslands. By comparing the results with the sampling cover values, it is evident that *Potentilla alba* is primary and highly dominant in the above mentioned portion of the grassland. Besides, the covers of *Bromus erectus*, *Festuca rupicola* and *Trisetum flavescens* are considerable. The sampling quadrats represent a well isolated group of species with connections to each other at low levels whose locations are often visited by tourists. In this portion of the grassland, the primary dominant plant species is *Bromus erectus* whose cover is very extensive, and the secondary-dominant species are *Festuca rupicola* and *Filipendula vulgaris*. We deemed dominant plant species to be the one whose cover exceeded 8% estimated by an on-site assessment.

The quadrats of the two mowed grasslands next to Ósagárd are connected to each other at a higher level, and these areas are not completely isolated from each other. Each of the two portions of grassland are diverse, and the number of the plant species found in these two portions of grassland is much higher than in the two other portions of mowed grassland. It is worth mentioning that there are 5 dominant species: *Bromus erectus*, *Gallium verum*, *Festuca valesiaca*, *Festuca rupicola*, *Alopecurus pratensis*. 5a and 6a quadrats are different from the others. These quadrats are highly covered by *Calamagrostis epigeios*.

On the mowed grassland, the area was also isolated in the second year. The portion of grassland is highly covered by *Potentilla alba* and *Bromus erectus*. The presence of *Trisetum flavescens* is also considerable. In this portion of grassland, cover of the primary species of *Bromus erectus* and *Festuca rupicola* was considerably high in 2014. There is a higher level connection between the quadrats of the two mowed grasslands next to Ósagárd, and based on the dendrogram these portions of area are not clearly isolated from each other. These two portions of grassland are heterogeneous compared to the two other mowed portions of grassland. Similarities between the individual quadrats occur only at high connection levels. Similar to the previous year, quadrats are different from the other sampling

quadrats, and the quadrats are highly covered by *Calamagrostis epigeios*.

On the grassland effected by tourism, there are more extensive cover of *Agrostis stolonifera*, *Plantago lanceolata*, *Thesium linophyllum*, *Centaurea jacea* subsp. *angustifolia*. In the mowed grassland located at the beginning of the meadow, the following species occur at higher rates: *Potentilla alba*, *Trifolium montanum*, *Saxifraga bulbifera*, *Rhinanthus minor*, *Plantago media*, *Luzula campestris*, *Festuca pratensis*.

From a nature conservation point of view, it is favourable that the number of species of *Potentilla alba* occurring in the area is high. It is a special plant species with low stress resistance (Pavlů et al., 2011). However, due to tourism, it occurs even less in the area and instead, *Bromus erectus* becomes dominant. It might be also due to tourism that *Bromus erectus* not only displaces previous species, but also achieves a less dominant cover of species. The plant species whose covers are more extensive in areas not effected by tourism – for example *Alopecurus pratensis*, *Galium verum*, *Carex praecox*, *Trisetum flavescens* – occur less frequently in areas effected by tourism. The species reacts first to the changed conditions not with disappearance but with a the change in relation to dominance, as has been already supported by other survey (Podani, 1997).

The ordination analysis shows that the species composition considerably differs with the portions of land cultivated in different ways. In the portion of grassland effected by tourism, the number of species characterising the individual area is low, which is more characteristic in years with less rain, when the diversity of species is reduced. The change of the cover values affects not only the occurrence of the dominant species but of the species with less cover. The decrease of diversity, the change of plantcover,

the decrease of number of sensitive species as a result of tourism are registered all over the world (Le et al., 2014; Grabherr, 1982).

The Shannon diversity records show that due to human presence and trampling the diversity of the species is reduced. The diversity of species is considerably low in years with less rain. In years with more rain the diversity of species is considerably higher, however, the difference in diversity between the surveyed areas is much increased. All these examples draw attention to the important role of environmental factors alongside the human factors (Catorci et al., 2017). The water reserve also influences the productivity of grasslands and water has primary importance in the structure of plant communities (Barcsák, 1989; Pápay et al., 2019a, b; Bajor et al., 2016; Baráth et al., 2012).

According to the survey, on the two areas not effected by tourism, in the rainier year the difference between the humidity preference of the plant species occurred on the dry areas and on the less dry areas became similar. In the rainier year, the differences increased between two portions of grassland with similar humidity preferences but different land use. On areas not effected by tourism, there were more species with higher humidity preferences occurred in rainier year, however, this tendency could not be observed in the rainier year on areas effected by tourism. The areas effected by tourism may react less flexibly to the change in rain conditions.

It can be said based on our analysis, that the surveyed semi-dry grasslands in the Pannon mountains are extremely rich in species and therefore proper grassland management plans should be drawn up.

Keywords: mowing, tourism, forest, diversity

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