Final Report

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I discontinued my research fund in the end of the first year, therefore in this final report I summarise the research carried out in the first year and the publications that followed from this. There were eight studies published in impacted journals under the support of this fund.

Grasslands harbour a diverse flora and fauna and they provide essential ecosystem services for people. However, grassland biodiversity has decreased worldwide during the last century, thus conservation of grasslands are high-priority tasks of nature conservation actions nowadays. In a lot of cases the sufficient management of grasslands is hampered by the lack of knowledge about the functioning of these habitats. In our studies we aimed to close some of these gaps of knowledge, which is crucial for effective biodiversity conservation and grassland restoration. Here I present brief summaries of the main findings of our researches supported by the Hungarian Scientific Research Fund.

We aimed to reveal the differences between "perennial-crop-mediated succession" (succession of alfalfa fields) and "classical old-field succession" where the initial vegetation is generally dominated by short-lived species. Classical old-field succession studies focused on vegetation changes after the abandonment of annual croplands or on succession after the elimination of cultivated crops. However, there is a little knowledge about the succession where fields are initially covered by perennial crops. In the course of the study of perennial-crop-mediated succession, we found increasing functional richness and functional divergence, but also unchanged or decreasing functional evenness. We detected a shift from resource acquisition to resource conservation strategy of communities during the succession. The role of spatial and temporal seed dispersal was found to be important not only at the initial but also at latter successional stages. We found an increasing stress-tolerance and a decreasing ruderality during succession, while the competitiveness remained unchanged at the community level. Despite the markedly different starting conditions, we found that classical and perennial-crop-mediated old-field successions have some similarities regarding the changes of functional diversity, resource acquisition versus conservation trade-off, and seed dispersal strategies. However, we revealed also the subsequent differences. The competitive character of communities remained stable during the succession; hence, the initial stages of perennial-crop-mediated succession were similar to the middle stages of classical old-field succession from functional ecological viewpoint. Therefore, the recovery of grasslands could be much faster in former alfalfa fields compared with the old-fields initially dominated by short-lived species. Based on this research, we can state, that spontaneous succession in alfalfa fields can be a vital option in recovery of grassland vegetation (Kelemen et al. 2017a).

In another research, we studied the effects of the invasive Asclepias syriaca on the sandy flora. Common milkweed (Asclepias syriaca L.) is an invasive 'super species' that has invaded extensive areas in Europe. However, the effects of common milkweed on native flora are generally unknown. We detected no effect of common milkweed on total species richness, but it had a negative effect on the cover of native grassland species. This negative effect of common milkweed was most pronounced on the cover of species with low specific leaf area, low seed mass and low clonal spreading ability. Because of this negative impact, we suggested that the eradication of milkweed is essential for the conservation of the sandy grassland ecosystems (Kelemen et al. 2015).

We also studied the role of unpalatable shrubs in vegetation dynamics of pastures. Understanding plant-plant interactions is essential in planning and implementing effective grassland management strategies. Positive and negative interactions generally co-occur in plant communities and the net effect of these interactions may depend on the disturbance regime, including grazing. Shrubs can act as biotic refuges by physically protecting neighbouring plants from herbivores. As a result, we would expect that in pastures the diversity and flowering success of plants is higher in the close vicinity of shrubs compared to the open vegetation. Nevertheless, we can also assume a competitive trade-off cost for plants that grow together with shrubs. In this study, we assessed the small-scale effects of dwarf shrubs on species density and flowering success. Specifically, we considered three types of microsites: (i) shrub interior, (ii) edge of shrub, and (iii) open pasture (more than 2 meters away from the shrub). We surveyed these three types of microsites using 10 × 10 cm sized plots both in grazed and ungrazed meadow steppes. The highest species density was found at the edge of shrubs, both in grazed and ungrazed vegetation. Meanwhile, species density did not differ significantly between shrub interiors and the open pasture. However, in grazed vegetation, species flowering success was significantly higher in shrub interiors and edges than in the open pasture; no significant trend was observed for this measure in ungrazed vegetation. In contrast to previous studies, we did not detect a competitive effect of small-sized shrubs on plants in ungrazed vegetation. Our results indicate that small-sized shrubs protect other plants from herbivores and that the edge effect plays an important role for the maintenance of small-scale species diversity in pastures. Overall, our results underline the beneficial effect of biotic refuges in pastures and we suggest that retaining a sparse population of small-sized native shrubs is advantageous from a conservation point of view (Kelemen et al. 2017b).

In Europe semi-natural grasslands have been created and maintained by natural and anthropogenic disturbances, such as clear-cutting of forests, grazing, mowing and fire, which regularly remove the accumulated biomass and prevent the encroachment of shrubs and trees. Thus, disturbance plays a crucial role in maintaining the open landscape structure in these ecosystems. Regular biomass removal decreases interspecific competition for light, controls litter accumulation and suppresses competitor species; thus, allows the co-existence of several light demanding forbs. Preservation of these grasslands relies on essential disturbance regimes, which control biomass dynamics and woody encroachment and thereby support the maintenance of the characteristic species composition. Burning is an alternative tool to

regulate biomass dynamics in semi-natural grasslands even in the absence of grazing or mowing. We tested the effects of regular spring burning on the biomass fractions and fine-scale plant species composition of species-rich foothill grasslands in North-Hungary. We analysed the main biomass fractions (litter, graminoid and forb biomass), and the species-level biomass scores, and flowering success in the control and burned grasslands. We revealed that fire increased the amount of forb biomass and decreased the amount of litter, which suggested that regular burning might be feasible for regulating biomass dynamics. Plant diversity and the number of flowering shoots decreased significantly in the burned grasslands. In regularly burned sites we found a significant decline of specialist species, as well as of steppic flora elements. Our results showed that besides its positive effect on litter dynamics, high-frequency burning threatens the overall diversity and specialist plant species in semi-natural grasslands. We recommend that proper fire regimes should be first studied experimentally, to provide a scientific basis for the application of prescribed burning management in such habitats (Valkó et al. 2018).

In another study we revealed the high conservation value of the forest edges in Eurasian forest-steppe vegetation (Bátori et al. 2017). Moreover in a further study, we revealed an understudied effect of cyanobacteria on vegetation dynamics of grasslands. Cyanobacteria may have considerable effects on community functioning, mostly because they produce various metabolites that adversely affect other organisms. We aimed to test the chemical effects of a Nostoc (Cyanobacteria) extract on the germination and growth of species of alkali habitats to investigate whether cyanobacteria can alter community structure and diversity via affecting the establishment success of plants. In our germination experiment, Nostoc extract treatment significantly decreased the germination rate of the majority of studied species. Based on our findings, terrestrial cyanobacterium colonies can affect the establishment success of grassland plants, through which they may be important in determining which species can be incorporated into the community. Thus, cyanobacteria might play an important role in shaping diversity, species composition and the structure of natural plant communities (Sonkoly et al. 2017).

We performed two studies focused on the vegetation of burial mounds. During these studies we used the FieldScout TDR 300 soil moisture meter, which was obtained from this fund. Burial mounds (kurgans) of Eurasian steppes are man-made habitat islands that have the potential to harbour rich plant diversity due to micro-habitats associated with their topography. We assessed whether kurgan micro-habitats harboured different species pools and functional groups from those found on the surrounding steppes. In addition, we asked if these mounds were affected by different grazing intensities from those on the surrounding vegetation. We surveyed kurgan micro-habitats (northern and southern slopes, surrounding ditch) and adjacent steppe plains in non-grazed, moderately grazed and heavily grazed sites in northern Kazakhstan. Kurgan micro-habitats had diverse vegetation and supported the co-existence of plant species with different environmental demands. We identified 16 steppe specialists confined to kurgan micro-habitats. Steppe vegetation was well-adapted to grazing, although heavy grazing supported ruderals and a decline in steppe specialists. We highlighted that kurgans play an important role as maintaining high plant diversity locally in extensive

steppe plains in Central-Asia by increasing environmental heterogeneity and supporting specialist species confined to these micro-habitats (Deák et al. 2018).

Due to their hill-like shape, loose soil structure, undisturbed kurgans provide proper habitats for burrowing mammals. Accordingly, grassland vegetation on kurgans is often exposed to bioturbation, which can influence the habitat structure and plant species pool. We studied the effect of fox burrows and landscape context on the habitat properties and vegetation composition of kurgans. We surveyed the vegetation of fox burrows and that of the surrounding grassland on five kurgans situated in cleared landscapes surrounded by arable lands and five kurgans in complex landscapes surrounded by grazed grasslands. We found that foxes considerably transformed habitat conditions and created microhabitats by changing the soil nutrient availability and reducing total vegetation cover and litter. Several grassland specialist grasses established in the newly created microhabitats, although the cover of noxious species was also considerable. We found that landscape context influenced the sort of species which could establish on kurgans by affecting the available species pool and soil moisture. Our results revealed that foxes act as ecosystem engineers on kurgans by transforming abiotic and biotic conditions by burrowing. Their engineering activity maintains disturbance-dependent components of dry grasslands and increases local environmental heterogeneity (Godó et al. 2018).

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