

**PD 124548**  
**Final report**  
**Tamás Miglécz**

Exploring the effects shaping species coexistence and plant-plant interactions is essential to plan effective grassland management strategies. Moreover, the exploration of fine-scale plant coexistence patterns of natural vegetation is crucial for identifying the target state of grassland restoration. In our studies our aim is to explore the effects of recent (grazing) and past (cultivation as cropland) disturbances on fine scale plant-plant interactions in grasslands. On one hand, we focus on the effects of facilitation achieved by unpalatable plants as they physically protect palatable ones from herbivores. On the other hand, we planned to reveal the fine-scale species coexistences and their regeneration during old-field succession.

Overall, the research outlined in the work plan has been carried out successfully. During the three years of the fund, 10 impacted journal papers (planned: 5), 2 papers in English peer reviewed journals and 2 papers in Hungarian journals (planned 2) were published. Our results were presented at 4 international and 3 Hungarian conferences and workshops.

**Main results of the fund:**

(i) We studied the direct effects of grazing on species-rich meadow steppes and the underlying mechanisms of dietary choice of cattle using trait-based approaches. According to our results, cattle showed significant preference to species characterized by high specific leaf area and high nitrogen content. Our study underline that it is important to consider the productivity and plant traits during the planning of a sustainable grazing regime (Balogh et al. 2018, Természetvédelmi Közlemények).

(ii) In this paper we assessed the seed bank development during the spontaneous secondary succession of sandy old-fields. The development of vegetation and seed banks in old fields progressed toward that of target grasslands and the proportion of weedy species (e.g. indigenous weeds and invasive species) also decreased with time. However, our results indicated that the role of persistent seed banks in the regeneration of calcareous sand grasslands from old fields is rather limited and promising vegetation changes are mostly driven by spatial dispersal. (Török et al. 2018, Restoration Ecology)

(iii) Regulation of plant biomass accumulation is a key issue in effective grassland conservation in Europe. 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. 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 biomass 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, *Science of the Total Environment*)

(iv) We tested the effectiveness of seed sowing, transplanting greenhouse-grown plants and individuals from threatened populations on burial mounds in Hortobágy National Park, Hungary. According to our results, a combination of seed sowing and transplanting greenhouse-grown plants is advisable. Sowing was found as a cost-effective method for introducing large-seeded species, whilst introduction of greenhouse-grown transplants warranted higher establishment rates for a larger set of species. Intensive management, like mowing with heavy machinery and intensive grazing, should be avoided in the first few years after introduction. Introducing characteristic grassland species on cultural monuments offers a great opportunity to link issues of landscape and biodiversity conservation. (Valkó et al. 2018, *Nature Conservaton*)

(v) Despite the importance of plant generative reproduction, little is known about the germination capacity of the seeds of the Pannonian flora, particularly under field conditions. In this paper we provided original data on the germination capacity of 75 herbaceous species. The data regarding the germination capacity of target species, as well as weeds and invasive species, can be informative for nature conservation and restoration projects. Our findings support the composition of proper seed mixtures for ecological restoration and also highlight the importance of testing seed germination capacity before sowing. (Kiss et al. 2018, *Acta Botanica Hungarica*)

(vi) Plant species performance in rangelands highly depends on the effect of grazing and also on the occurrence of unpalatable benefactor species that can act as biotic refuges protecting neighbouring plants from herbivores. The balance between facilitation and competition may

change with the benefactor density. We analysed the density dependent effects of unpalatable herbaceous plants on the performance of other species. We detected a humped-back pattern of facilitation along the density gradient of an herbaceous benefactor in pastures. 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 them is advantageous from a conservation point of view (Kelemen et al. 2019, *Frontiers in Plant Science*).

(vii) Linking the conservation of cultural heritage and natural values provides a unique opportunity for preserving traditional landscapes and receives an increased awareness from stakeholders and society. Ancient burial mounds are proper objects of such projects as they are iconic landscape elements of the Eurasian steppes and often act as refugia for grassland specialist species. The aim of this project was to reintroduce grassland plant species to burial mounds for representing them as cultural monuments with the associated biodiversity for the public. The effectiveness of seed sowing, transplanting greenhouse-grown plants and individuals from threatened populations on burial mounds in Hortobágy National Park, Hungary was tested. A combination of seed sowing and transplanting greenhouse-grown plants was found to be advisable. Sowing was found as a cost-effective method for introducing large-seeded species, whilst introduction of greenhouse-grown transplants warranted higher establishment rates for a larger set of species. Intensive management, like mowing with heavy machinery and intensive grazing, should be avoided in the first few years after introduction. Our results suggest that introducing characteristic grassland species on cultural monuments offers a great opportunity to link issues of landscape and biodiversity conservation (Valkó et al. 2018, *Nature Conservation*).

(viii) Regulation of plant biomass accumulation is a key issue in effective grassland conservation in Europe. 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. Our results showed that besides its positive effect on biomass dynamics, high-frequency burning threatens the overall diversity and specialist plant species in semi-natural grasslands (Valkó et al. 2018, *Science of the Total Environment*).

(ix) Spontaneous succession is the most natural and cost-effective solution for grassland restoration. However, little is known about the time required for the recovery of grassland functionality, i.e., for the recovery of reproductive and vegetative processes typical of pristine grasslands. Our aim was to investigate whether reproductive and vegetative processes require different recovery times during spontaneous succession. According to our results, the reproductive trait spectra recovered earlier than the vegetative one, since reproductive attributes first determine plant species sorting at the regional level towards their respective habitats. The recovery of the vegetative trait spectrum needs more time as vegetative-based interactions operate on a smaller spatial scale. Thus, vegetative traits might be more effective in the long-term assessment of restoration success than the reproductive ones (Fantinato et al. 2019, *Applied Vegetation Science*).

(x) We published supplements for the plant distribution maps of *Atlas Florae Hungariae*. Altogether 475 new records of 330 species are published from 54 quadrants of the basic grid mapping cells (Matus et al. 2019, *Botanikai Közlemények*).

(xi) Sowing of grass seed mixtures is a feasible and cost-effective method for landscape-scale grassland restoration. However, sowing only grasses usually leads to species-poor and dense swards, where the establishment of target forbs is hampered by microsite and propagule limitation. To increase the diversity of species-poor sown grasslands, we created “establishment gaps.” and sowed high-diversity seed mixtures of 35 native species into these gaps. We analyzed vegetation development and colonization dynamics of the sown species. Most of the sown species were able to establish permanently in the gaps. The sown target species started to colonize the species-poor grasslands surrounding the gaps within 5 years (Kiss et al. 2020, *Restoration Ecology*).

(xii) In a grazing experiment, we investigated the effect of traditional and crossbred cattle breeds on the vegetation to test the effects on nature conservation value and agricultural production value. We found a habitat type dependent effect of the cattle breed on the habitat conservation values and forage quality. The traditional breed maintained a significantly higher species number and Shannon diversity in marshes than the crossbred beef cattle. Grazing of crossbred cattle led to decreasing moisture indicator values in marsh habitats. Our findings revealed that traditional breeds should be prioritized in the management of wet alkaline grasslands and marshes. Crossbred beef cattle might be a substitute but only in case traditional

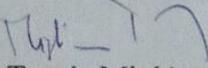
breeds are not available for the management of alkaline wet grasslands. In marshes, however, we recommend prioritizing the traditional breeds as they maintain higher diversity compared to crossbred beef cattle (Koncz et al. 2020, Applied Vegetation Science).

(xiii) Plant invasions are considered among the biggest threats to biodiversity worldwide. In a greenhouse experiment we analysed the effect of soil burial depth and litter cover on the germination of invasive plants. Our findings confirmed that seed size is a major driver of species' response to litter cover and to the combined effects of litter cover and soil burial, but there is no general trend regarding the response to soil burial depth. When planning management or restoration in areas threatened by plant invasions, it is crucial to have specific information on species' response to burial depth and litter accumulation (Sonkoly et al. 2020, Journal of Vegetation Science).

(xiv) We studied a potentially important component of human-mediated seed dispersal by assessing the effects of laundry washing on the dispersed propagules. We studied the germination of species, which have morphological adaptations for epizoochory and are commonly dispersed by people. According to our results, people are not purely transporting propagules from one location to another, but via the laundry cycle. These results have new implications for understanding the early stages of biological invasions and call for improved biosecurity measures in nature reserves subjected to a growing pressure of tourism (Valkó et al. 2020, Neobiota).

I kindly ask the committee to accept the final report of my postdoctoral fund (PD 124548).

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