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Botanical and Nature Conservation Studies Supporting Habitat Protection Interventions in *Molinia* meadows

Theses of Doctoral (PhD) Dissertation

Bence Fülöp
Keszthely
2025

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1. Antecedents and objectives of the work

Natural and semi-natural grasslands play an important role in maintaining biodiversity on the global level (VALKÓ et al. 2016). In Europe these grasslands are mostly man-made habitats, yet they are among the most diverse communities (POSCHLOD et al. 2009, WILSON et al. 2012, DAHLSTRÖM et al. 2013). In European countries, agricultural intensification caused a reduction in the area of traditionally managed grasslands to a fraction of their former extent (MATĚJKOVÁ et al. 2003, VALKÓ et al. 2018). Intensification has been accompanied by a significant increase in the cultivation of fodder crops, which has greatly reduced the economic value of hay, consequently, extensive livestock production has declined significantly (VALKÓ et al. 2018). In parallel with the expansion of intensive agriculture, urbanisation and industrialisation have also led to a decline in the ecological value of semi-natural habitats (BEKKER et al. 1997, WALLIS DE VRIES et al. 2002). The above-mentioned processes are still prevalent today, with many more areas at risk of abandonment of traditional landscape use (VALKÓ et al. 2012).

The vast majority of *Molinia* meadows are of anthropogenic origin, were mostly created by clearing of moist forests and draining of wetlands. Meadows dominated by *Molinia* spp. are grassland habitats of Community importance (Council Directive 92/43/EEC), which are classified as habitat type 6410 "Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)", providing basis for the designation of Natura 2000 sites. This habitat type is typical for the whole of Europe, although they have specific vegetation patterns in different geographical regions (KOVÁCS 1962, ELLENMAUER and MUCINA 1993, BOTTA-DUKÁT et al. 2005, HAVLOVÁ 2006, KĄCKI and MICHALSKA-HEJDUK 2010; KĄCKI 2007, ŘEZNÍČKOVÁ 2007, ZELNIK and ČARNI 2008).

Nowadays, changes in landscape use (primarily abandonment) are also strongly affecting *Molinia* meadows. Abandoned grasslands are characterised by a strong overgrowth of giant goldenrod (*Solidago gigantea*) and frequently by scrub encroachment, which is leading to a decline of specialist rare and protected species. Accordingly, the issue of degradation of wet and moist grasslands is of concern to many conservationists in Hungary (CZÚCZ et al. 2009, BIRÓ 2011, VALKÓ et al. 2012, KISS et al. 2018), but possible responses and widely applicable methods aimed to conserve these habitats are yet to be developed. The conservation status of *Molinia*

meadows in Hungary (BIRÓ et al. 2018) and across Europe (OSTERMANN 1998) is threatened, as illustrated by the fact that the results of the 2019 national reports (INTERNET 1) on the status of species and habitats of Community importance show that the conservation status of the habitat is unsatisfactory or poor in almost all EU Member States.

Similar difficulties are faced by *Molinia* grasslands in Hungary, where climate change and land-use changes have triggered negative processes. The impact of management methods must always be assessed on a site-specific basis, in order to make scientifically sound recommendations for improving the conservation status of habitats of high ecological value, which can demonstrably improve the living conditions of threatened plant species and halt the global loss of the high biodiversity that characterises *Molinia* meadows.

For the experts of the Balaton-felvidéki National Park Directorate, maintaining or improving the conservation status of emblematic habitats with outstanding natural values, including a large number of *Molinia* meadows, is also a major challenge. Similar habitats cover large areas at the Nyirádi Sár-álló and Batyk fen meadow, where the conservation of natural values is under significant threat from degradation, mainly from the accumulation of plant litter, the encroachment of shrubs and woody plants and the spread of species with good competitive ability. In both areas, the key question is therefore how to ensure the maintenance of vegetation of high ecological value in a cost-effective way.

The primary aim of my research is to show, through two partial studies, that semi-natural grasslands, established in areas with sufficient water supply, still have significant natural values today. However, their long-term survival and conservation is endangered by a number of threats. As these habitats occur over large areas across Europe, almost all of which face similar problems (lack of active management and its consequences), research of potential appropriate management protocols is urgently needed for practical conservation.

Partial study I. Inventory of protected species of Batyk fen-meadow

Targets:

- To assess the current status of the sample area and the recent occurrence data of protected and rare vascular plant species.

Partial study II. Carrying out a study to justify the choice of conservation management

Targets:

- To provide a scientific basis for conservation management of the *Molinia* meadows of Nyirádi Sár-álló and Batyk fen meadow.
- Examining the generalisability of the observations in the sample plots.

2. Material and methodology

The **Batyk fen meadow** is one of the most ecologically valuable members of the grasslands situated in the Zala valley. It is a part of the Alsó-Zala-völgy Natura 2000 site (HUBF20037). The area is part of the National Ecological Network, most of it is „core area", a smaller part of it falls into the „ecological corridor" category.
The meadow is in a borderline position from a phytogeographical point of view. According to recent analyses the study area is located at the meeting point of the Eupannonicum, Praenoricum and Praeillyricum floristic zones (FEKETE et al. 2017). The meeting of Pannonian, Alpine and Illyrian influences in this region has been the subject of long-standing studies (JÁVORKA 1940, KÁROLYI and PÓCS 1954, KIRÁLY et al. 2007 Directly next to the Zala River, south of the railway which divides the area into a northern and a southern part, there are fen and *Molinia* meadows that have undergone varying degrees of cultivation and shrub encroachment. Meanwhile, north of the railway, the area is characterized by reed-cover, shrub-encroached and waterlogged sections that are difficult to traverse.

The **Nyirádi Sár-álló** is protected by individual legislation (Decree 17/2005 (VII. 14.) KvVM), a Nature Reserve of national importance. In addition, it is a Special Conservation Area of Community Importance (Felső-Nyirádi erdő and Meggyes erdő [HUBF20011]), part of the Bakony-Balaton Geopark and, as a core area, part of the National Ecological Network. Today, the vast majority of the Sár-álló is covered by lowland oak forests, with an additional approximately 100 ha of grassland habitats. The alternation of woodland, grassland and wetland habitats

results in a high degree of habitat heterogeneity, creating a species-rich habitat complex where many rare and protected species find suitable habitats.

Partial study I. Inventory of protected species of Batyk fen-meadow

The survey of protected species of the Batyk fen meadow was carried out using a combination of several methods. The field visits were timed to coincide with the flowering period of the protected species, with a total of 15 visits between June 2019 and September 2021.

For the areas south of the railway, we conducted a systematic survey, following virtually pre-designated transects running in an east-west direction, spaced 10 meters apart.

The area north of the railway, due to its better water supply and the lack of habitat management interventions, represents the most difficult-to-access part of the study site. The extensive reed expansion and shrub encroachment, along with water coverage exceeding one meter depth in some locations, made systematic field surveying impossible. Therefore, we aimed to traverse the area multiple times using free navigation, adapting to the terrain conditions to conduct the most thorough assessment possible.

The surveys were carried out in a north-south direction, while the number of plant shoots was estimated using a grid with 20 m x 10 m cells, in which the number of shoots was counted at every intersection in a radius of 1.5 m for protected species with large populations. Based on the values counted at each point of the grid, a model was constructed to estimate the overall number of shoots for the whole area. Specimens of protected plant species that are rare or occur in smaller numbers were recorded individually at flowering time. During the field surveys, data collection was carried out using the LocusMap application.

We searched the literature for references to the Batyk fen meadow and organised the records in this literature that relate to the occurrence of currently protected or highly protected plant species into a database. This allowed us to compile a list of protected plant occurrences for four different time periods: 1938−1955, 1990−2019 and 2019−2021 (with our own survey results).

The changes in the assemblage of protected species of the fen meadow are assessed using ecological indicator values. Plant species can be classified according to their role in natural systems and their ecological requirements, the first such scoring system was developed by ELLENBERG in 1950, several Hungarian adaptations of which have been published, and in our study we used the relative moisture requirement, relative heat requirement and the social behaviour types from the classification of BORHIDI (1993, 1995).

Contingency tables of plant species of currently protected status recorded in the three study periods (1938−1955, 1990−2019 and 2019−2021), compiled according to the values of each ecological indicator, were subjected to a Chi-square test to determine their fit, whether the data actually observed in later periods differed from the theoretically expected value compared to the first survey period, thus verifying whether there was a significant shift or change in the distribution in the values of the ecological indicators of the currently protected plant species recorded in the area during the period. If the test indicated a significant change, Freeman-Tukey residuals were calculated to determine which categories had changed and in which direction.

Partial study II. Carrying out a study to justify the choice of conservation management

The aim of our study was to investigate the effects of three selected active habitat maintenance treatments on vegetation composition, with a particular focus on species that cause conservation problems in many grassland areas across Europe, such as giant goldenrod (*Solidago gigantea*), alder buckthorn (*Frangula alnus*) and wood small-reed (*Calamagrostis epigejos*).

A total of three sample plots have been designated at the Nyirádi Sár-álló and four at the Batyk fen meadow. The experimental design employed the BACI (before-after-control-impact) design. The sample plots were selected by surveying the area, looking for grassland areas with similar vegetation patterns and apparently the same conservation problems (shrub encroachment, presence of *Solidago gigantea*). Our sample plots in *Molinia* meadows were installed in such a way that the areas were as far apart as possible. Within a sample plot, 4 quadrats of 10x10 m were designated for the four treatments, with a minimum buffer zone of 5 m between each quadrat.

Four types of treatment were applied: 1) control - no treatment; 2) mowing - after cut (with handheld brushcutters), hay was collected and removed; 3) imitation of

topping – after mowing with brushcutters, the hay was not collected; 4) burning - we burned the selected quadrats in the first treatment year (winter after the baseline survey) and then used topping in the second and third years in these areas, as burning consecutively is not advisable due to its well-documented adverse effects (MILBERG et al. 2018).

A baseline survey was carried out on the Nyirádi Sár-álló before the first treatments were carried out, at the peak of the growing season (June 2019). In the Batyk fen meadow the baseline survey was carried out in 2020 and treatments started afterwards.

To characterise the composition of the biomass, four characteristics were analysed: dead monocotyledonous biomass, dead dicotyledonous biomass, live monocotyledonous biomass and live dicotyledonous biomass. Biomass samples were collected in 20x20 cm plots in each treatment area at the same time as the the vegetation relevés were recorded. Sampling sites were selected along the diagonals of the treatment areas, leaving a 1 m buffer zone. Care was taken to ensure that destructive samples were not collected from the same location in each year. At the time of sample collection, living and dead biomass above the entire soil surface was collected in the 20x20 cm squares and dried afterwards at room temperature. The dry samples were sorted into the four categories mentioned above and weighed with an analytical balance (Ohaus Adventurer Pro Av412) with the accuracy of 0.01 grams.

In each 10x10 m quadrat of each plot, 3 different 2 x 2 m vegetation relevés were recorded in every year. The relevés located 2 m from the corners of the 10x10 m quadrats along the diagonals. In addition to the cover of individual species, we also estimated the summed cover of bare soil, graminoids, forbs and shrubs. Each of these data was recorded as a percentage.

The hay was raked from the "mown" areas and then collected, while in the "topped" areas, the shredded hay was left in place, simulating the effect of topping. The topping has a similar effect to slashing, although the size of the cut material is not as small as in a typical mechanical slashing operation and the time of our treatment is much earlier than in common practice. We mowed and removed the vegetation around the 10x10 m quadrats designated for burning, and then burned the area from one side in calm weather. The first mowing and "topping" took place after the baseline survey in the same year. Thus, all treated plots were treated once during the second survey.

Based on the baseline survey data, we examined whether significant relationships were found between a wide range of threatening factors (litter cover, shrub cover, cover of aggressive competitor species) and different diversity indexes (Shannon's diversity, Simpson's diversity, herbaceous species richness) for *Molinia* meadows. The relationship between threats and diversity indexes was examined using Kendall's rank correlation.

Changes in vegetation composition as a function of different treatments were investigated using several methods. The relative effects of the four treatment types and the trajectories of changes in vegetation composition of each quadrat were investigated by redundancy analysis (RDA) using the R software (version 4.3.1) and the 'vegan' package (version 2.6-6.1) (OKSANEN et al. 2015). Percentage of cover values for each species were used as dependent variables in the models, the interaction of treatments and time (years) was chosen as independent variables, and sample plots were used as covariates.

The effects of the four treatment types on each species were investigated using generalised linear mixed models (GLMM), where the dependent variable was the cover value (in %) for each species, the independent variables were time (in years) and its interactions with the treatment types, and the sampling quadrat identifiers were used as random factors. The adequacy of the models used was checked by examining diagnostic plots generated from residuals (using the DHARMa package, version 0.4.6).

The masses of biomass (total biomass, live biomass, dead biomass, monocot biomass, dicot biomass) from destructive samples collected during each treatment were analysed by one-factor analysis of variance (ANOVA) and compared using Tukey-tests. The results are detailed by treatment type, focusing on parameters showing significant variation.

3. Results and Discussion

Between 2019 and 2021, we recorded the occurrence of 40 protected plant species (including 2 strictly protected species) in the area, of which 8 species were recorded for the first time. A further 10 protected species were reported in the literature to have been lost in the past, and significant number of the newly observed species are not associated with marshes but with drier grasslands or woodlands, including *Anacamptis morio*, *Cephalanthera damasonium*, *Cephalanthera longifolia*,

Ornithogalum sphaerocarpum and *Potentilla rupestris*. The recorded number of individuals in the case of typical moorland species were alarmingly low as in the case of *Carex appropinquata*, *Carex davalliana* and *Parnassia palustris*.

Several species did not have observations in the Batyk fen meadow since 1955, but our survey has recorded the presence of *Carex appropinquata*, *Carex davalliana*, *Juncus alpinoarticulatus* and *Thelypteris palustris*.

Despite the systematic survey, the following marsh specialist species were not found in the sample area: *Eriophorum angustifolium*, *Eriophorum latifolium*, *Menyanthes trifoliata*, *Pedicularis palustris*, *Ranunculus lingua*. These species have not been recorded for several decades, and habitat changes likely lead to their extinction.

A significant proportion of the protected species associated with wetter habitats have disappeared from the area, while drought-tolerant species became present in significantly higher proportions. Although the changes in relative heat requirements are not as marked, the proportion of more heat-tolerant species has still doubled, while the proportion of montane species has halved. The area previously was not rich in unique fen specialist species, but nowadays generalists have become predominant, while disturbance tolerant species have also appeared.

Although several previously unmentioned protected plant species have recently appeared, such as *Dianthus superbus*, *Dryopteris carthusiana*, *Fritillaria meleagris* and *Leucojum vernum*, these are not specifically related to the *Molinia* meadows, and are much less linked to the fen conditions.

Our results confirm the outstanding botanical and conservation importance of the Batyk fen meadow, but also shed light to a trend of vegetation conversion and drying of the area, making it an urgent task to improve water supply and to develop appropriate conservation management to preserve its botanical values.

Partial study II. Carrying out a study to justify the choice of conservation management

In order to identify conservation problems that are specific to the study areas, the first step in the analysis of the survey results of our management experiment was to investigate the relationship between the threats that are considered as common threats for *Molinia* meadows in the literature and the observed diversity values and species abundance recorded during the baseline survey.

We found factors that could be considered as general threats for both sampling sites. Both at the Nyirádi Sár-álló and Batyk fen meadow the diversity values were negatively affected by shrub cover and *Molinia* cover. Higher *Molinia* cover values also affected species abundance, but a correlation between lower species abundance and *Molinia* cover was also found at both sites.

In addition to what can be considered general problems, site-specific threats have been also identified. While the higher proportion of *Calamagrostis epigejos* in the Nyirádi Sár-álló, while elevated cover values of *Solidago gigantea* caused lower species diversity at the Batyk fen meadow.

An important objective of our research was to investigate how different management types influence the impact of these threats on the vegetation and possibly contribute to mitigating their effects. For the study areas, topping was found to be the best tool to reduce the common threats.

In general, in all cases, the first treatment was the one that had the greatest effect on the variables tested. This is true for the vegetation as a whole, for the cover values of the individual species and for the changes in biomass composition as well.

In 2023, exceptionally high numbers of species were observed in almost all sampling units. However, this increase was more subdued in the control sites at the Nyirád Sár-álló and was not observed at all in the Batyk fen meadow control sites. This suggests that, in the absence of treatments, ecological niches are not forming that would provide space for the introduction of new species when external conditions become more favourable. This also demonstrates the importance of active management interventions.

The vegetation of the control areas was more or less stable during the survey period in both sampling sites, especially in the case of the Nyirádi Sár-Álló, while in Batyk it was more characterised by a slow, but gradual loss of diversity with the dominance of *Frangula alnus*.

Our results clearly show that each treatment type had a significant effect on the vegetation composition, despite the high heterogeneity observed in the relevés, regardless of the treatment. The applied treatments induced different responses to the observed species cover values, but the effects caused directly by treatments seem to be at least equivalent to external differences, known collectively as the seasonal effect, typically due to weather, which markedly influence the actual observed

vegetation composition in a given year. One of the most dominant of these is most likely precipitation and its temporal distribution within the growing season, as confirmed by the substantial differences between the survey data for 2022 and 2023, when the precipitation patterns were practically opposite during the vegetation periods in the two years.

The control of competitor species is an essential element in maintaining diverse habitats. This seems to be a key issue for both of our study areas. The competitor species that is present at both sites with high cover values is *Molinia caerulea*, for which mowing and topping seemed to be effective solutions for control, based on our experiments. We observed a decrease in its cover values by both treatments, but this change was only significant with topping, which was the case at both sites.

Reduction of the cover of shrub species is also important factor, and all active treatments having eradicated shrub cover. However, the Batyk fen meadow was characterised by the abundance of *Frangula alnus*, which responded to physical impact with an intensive branching, therefore the *F. alnus* cover did not disappear even after three treatments. However, this phenomenon was not as intense in the burnt quadrats, so it is possible that burning significantly reduces the formation of new shoots, and therefore burning may be an effective way of controlling *F. alnus*.

Invasive alien species include *Solidago gigantea*, which occurs at both study sites. It can be said that at the control sites the species shows a gradual increase in cover, but among the treatments, only mowing reduced its presence significantly at the Batyk fen meadow, while at the Nyirádi Sár-álló it significantly decreased by all active treatments.

Protected plant species were typically recorded in low numbers and with low cover values, but significant changes in the cover values of *Iris sibirica* and *Schoenus nigricans* were still observed at the Batyk fen meadow, with all active treatments increasing their cover overall.

No distinct trends in biomass composition were observed, but active treatments typically reduced the proportion of dead biomass. On the whole, mowing and topping seem to be more effective ways of reversing the accumulation of litter, burning less so.

A marked decline in the amount of dead biomass was observed in a few cases after burning. This is presumably due to the fact that burning is effective in removing standing dead biomass during the winter period, but that accumulated hay is often left behind.

4. Conclusions and Recommendations

Active habitat management interventions play an essential role in the long-term preservation of wet grassland communities, particularly of specialist species. Therefore, it is crucial to extend conservation-oriented, regular grassland management interventions over the largest possible area.

With a few exceptions, it is difficult to make general, globally or even nationally applicable conclusions regarding the effects of different management types on vegetation. The first step in maintaining or improving the ecological condition of wet semi-natural grasslands is to identify the actual threats affecting the diversity of the specific area, and then to select the appropriate management method accordingly.

However, the success of management interventions is strongly influenced by numerous external factors and local conditions. This is evidenced by our survey, which found that only a few percent of the variance in vegetation composition could be attributed to the effects of the treatments. Therefore, the impact of treatments should always be evaluated in consideration of these circumstances.

Our results indicate, among other things, that in periods of extreme drought during the growing season, a decline in species numbers is observed. However, this phenomenon is not directly caused by the applied management interventions, as it also occurred in untreated areas.

Mowing and topping are widely used interventions, and in line with the literature, they appear to be effective tools for suppressing invasive species. We demonstrated that with regular management, litter accumulation could be also reduced.

Burning, however, is a highly controversial method, with mixed opinions among conservation managers, and it is not commonly regarded as a conservation management tool in Europe. Our experimental burning trials produced favourable results in areas with significant litter accumulation. Moreover, in the case of alder buckthorn (*Frangula alnus*), burning inhibited the strong resprouting response

typically induced by mowing and mulching while not negatively affecting the coverage of protected species. Another practical advantage for conservation is the relative cost-effectiveness of this method.

Over the past decades, the biodiversity of the Batyk fen meadow has been affected by numerous threats. However, our results confirm that this habitat still holds outstanding conservation value. At the same time, its drying trend is apparent when comparing current conditions with historical maps. This drying process is reflected in changes in species composition, which suggests that only the implementation of conservation-oriented water management strategies can help halt the decline of the marsh characteristics. Such measures would facilitate the preservation of specialist marsh species, thereby safeguarding one of the most endangered groups of our botanical heritage.

The decline in groundwater levels is most evident in the expansion of alder buckthorn (*Frangula alnus*), which is threatening the biodiversity of the Batyk fen meadow. Therefore, measures aimed at its suppression should be given high priority, and instead of sporadic interventions conducted at irregular intervals, continuous management practices should be implemented.

5. New scientific results

New Scientific Findings of the Dissertation:

1. I created a mapped database representing the current conditions of the protected plant species of the Batyk fen meadow, including their distribution and population density.

2. I established that the impact of generally recognized threats on the plant composition of *Molinia* meadows is not uniform. Therefore, even habitats facing seemingly identical conservation challenges may require different management approaches for their long-time maintenance.

3. I demonstrated that the vegetation response of *Molinia* meadows to management interventions is primarily site-specific and difficult to generalize. While certain patterns may appear widely applicable, it is challenging to formulate universal guidelines, as management measures are only effective when adapted to local conditions.

4. I verified that mowing is an effective method to control the spread of *Solidago gigantea*, while topping can be an appropriate tool to reduce the excessive dominance of *Molinia caerulea*.

5. I demonstrated that *Frangula alnus* exhibits intense sprouting in response to physical disturbances such as mowing and topping. However, in burned areas, this resprouting ability is significantly reduced, suggesting that burning could be a viable method for its control.

6. I confirmed that without management interventions, the degradation of the studied *Molinia* meadows is inevitable. However, active management can mitigate this process. When monitoring the effectiveness of managements, it is essential to consider inter-annual climatic variability, as it could be a stronger influence than the direct effects of management. Therefore, the success of treatments must always be evaluated in relation to abiotic environmental factors.

7. My findings highlight that one-time interventions are insufficient in *Molinia* meadows. Ensuring the continuity of management treatments is of paramount importance for achieving long-term conservation goals.

6. Publications related to the topic of the dissertation

Publications in peer-reviewed, referenced journals in foreign languages:

BÓDIS, J., **FÜLÖP, B**., LÁBADI, V., MÉSZÁROS, A., PACSAI, B., SVAJDA, P., VALKÓ, O., KELEMEN, A. (2021): One year of conservation management is not sufficient for increasing the conservation value of abandoned fen meadows. *Tuexenia* 41: 381-394. DOI:10.14471/2021.41.015 (Q2)

FÜLÖP, B., PACSAI B., BÓDIS J. (2021): Minor Treatments Can Play a Significant Role in Preserving Natural Habitats and Protected Species on the Shore of a Central European Lake, *Agronomy* 2021, 11(8), 1540; https://doi.org/10.3390/agronomy11081540 (Q1)

Publications in peer-reviewed, journals in foreign languages:

FÜLÖP, B., PACSAI, B., BÓDIS J. (2022): Assessment of interregional generalisability of conservation management experiments on Molinia meadows. *Georgikon for Agriculture*, 26: 31-43.

FÜLÖP, B., PACSAI B., BÓDIS J. (2023): The rearrangement of protected plant species in the Batyk fen meadow warns of drying out. *Georgikon for Agriculture* 27: 26-34.

Publications in peer-reviewed, refered journals in Hungarian:

FÜLÖP, B., KIRÁLY, G., PACSAI, B., BAUER, N., BÓDIS, J. (2022): A Batyki-láprét botanikai értékei. *Botanikai Közlemények* 109: 231-256 (Q3)

Publications in peer-reviewed journals in Hungarian:

FÜLÖP, B., DEÁK, B., PACSAI, B., VALKÓ, O., BÓDIS, J. (2022): Üde gyepekhez köthető védett és ritka növényfajok ex situ csíráztatási kísérlete In: Simon-Gáspár, B.; Simon, Sz. (szerk.) *Ifjúság a tudományért: Tanulmánykötet* Keszthely, Magyarország. Magyar Agrár- és Élettudományi Egyetem Georgikon Campus (2022) 271 p. pp. 207-212., pp. 15–23.

Publications published in full in an edited conference volume in Hungarian:

FÜLÖP, B., DEÁK, B., PACSAI, B., VALKÓ, O., BÓDIS, J. (2021): Üde gyepekhez köthető védett és ritka növényfajok ex situ csíráztatási kísérlete. XXVII. Ifjúsági Tudományos Fórum, Keszthely, 2021. május 20., In: Bene Szabolcs (szerk.): *XXVII. Ifjúsági Tudományos Fórum, 2021. 05.20, Konferenciakötet*, Magyar Agrár- és Élettudományi Egyetem Georgikon Campus, Keszthely, p. 51–56.

Other Conference Participation:

FÜLÖP B., KIRÁLY, G., PACSAI, B., BÓDIS, J. (2021): A Batyki-láprét védett és veszélyeztetett növényei: Protected and endangered plant species of the Batyk fen meadow In: Takács, Attila; Sonkoly, Judit (szerk.) *XIII. Aktuális Flóra- és Vegetációkutatás a Kárpát-medencében nemzetközi konferencia. Program és összefoglalók*. Debrecen, Magyarország. Debreceni Egyetem Természettudományi Kar (2021) pp. 32-32 (előadás).

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