

# CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF SEMI-NATURAL FORESTS OF FOREST STEPPE ZONE IN HUNGARY

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**Abstract:** 57 bryophyte taxa were recorded in semi-natural forests of the Pannonian sandy forest steppe in the northern part of the Great Hungarian Plain. Four species are included (*Eurhynchium striatum*, *Fissidens viridulus*, *Nyholmiella obtusifolia*, *Orthotrichum patens*) in the national red list of bryophytes. 24 taxa (22 epiphytes and two terricolous species) are regarded as forest specialists, among them several species are very rare in the Great Hungarian Plain, like *Dicranum tauricum*, *Hypnum pallescens* var. *reptile*, *Polytrichum formosum*, *Pterygynadrum filiforme*. Two of them (*Plagiothecium laetum*, *P. succulentum*) are reported for the first time from the Great Hungarian Plain.

**Key words:** forest specialist species, Great Hungarian Plain, liverworts, mosses, rare species

## INTRODUCTION

The Pannonian forest steppe is the westernmost exclave of the Eurasian forest steppe zone. The Pannonian sand forest steppe is composed of oak and poplar forests and dry sand grasslands (ERDŐS *et al.* 2018a, 2019, MOLNÁR 2003, ZÓLYOMI 1989). The area of the semi-natural forests has been decreased dramatically in the last centuries (BIRÓ 2008). After clear-cutting, which is even currently used forestry practice in the region, in many places they were replaced by alien tree plantations (e.g. black locust (*Robinia pseudoacacia* L.), black and Scots pine (*Pinus nigra* Arn. and *P. sylvestris* L.), since the afforestation of the earlier oak stands has become very difficult due to the dry climate, the low water retention capacity of the sandy soil, and lowering of the ground water table in the past few decades (BIRÓ 2008, RÉDEI *et al.* 2020).

Nowadays, the semi-natural forests of the Pannonian sand forest steppe region (dominated by oak or white poplar) are critically endangered (BORHIDI and SÁNTA 1999), and their area is still continuously decreasing (BIRÓ *et al.* 2018).

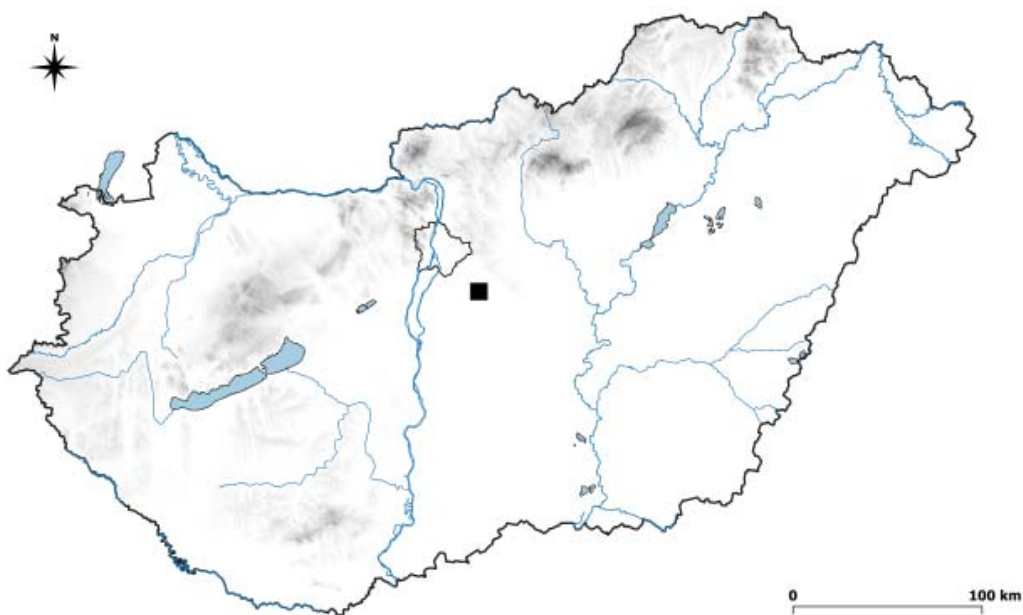
The herb layer of semi-natural forests and plantations was investigated in the region by RÉDEI *et al.* (2020). They found that total species richness was sig-

nificantly higher in semi-natural forests, and semi-natural oak forests were the richest in forest specialist species (*Querco-Fagetea*). It reflects the importance of semi-natural forests and especially oak forests in maintaining the biodiversity of the landscape (ERDŐS *et al.* 2018b, RÉDEI *et al.* 2020).

In this paper the bryophyte vegetation of some semi-natural forests of the northern part of the Great Hungarian Plain in the Danube–Tisza Interfluve is presented with special attention to the forest specialist species.

## MATERIAL AND METHODS

Investigation of the bryophyte flora was carried out in 2021. The studied area can be seen in Figure 1. Bryophytes were collected from soil, bark of trees, and decaying wood. Specimens are deposited in the Bryophyte Herbarium of the Hungarian Natural History Museum in Budapest (HNHM, BP). Nomenclature of bryophytes follows HODGETTS *et al.* (2020) and ERZBERGER and PAPP (2020). Forest specialist bryophytes were selected on the bases of ORBÁN and VAJDA (1983) and DIERSSEN (2001) indicated as an element of *Querco-Fagetea* or *Fagetalia*. Rarity in the Great Hungarian Plain was given according to ORBÁN and VAJDA (1983) and ERZBERGER *et al.* (unpublished). National nature conservation value was given according to PAPP *et al.* (2010).



**Fig. 1.** Location of the investigated area in Hungary (black square).

### Investigated area

The study area is situated in the northern part of the Great Hungarian Plain, in an inland sand dune region in the centre of the Carpathian Basin, in the Danube–Tisza Interfluvium. The climate of the region is continental with sub-Mediterranean influence. The mean annual temperature is 10.4 °C with monthly means ranging from –1.9 °C in January to 21.1 °C in July. Mean annual precipitation is 500–550 mm, with a peak in June, and a second, minor peak in November. The area is in the forest steppe zone. It is covered by semi-natural oak forests mainly by pedunculate oak (*Quercus robur* L.) dominated stands, semi-natural poplar stands dominated by *Populus alba* or *P. canescens*, and plantations of black locust (*Robinia pseudoacacia*), hybrid poplar (*Populus* × *euramericana* (Dode) Guinier) and black and Scots pine (*Pinus nigra* and *P. sylvestris*) RÉDEI *et al.* (2020).

### Collecting sites

- 1 = Pest County, near Csévharaszt village, *Quercus robur* forest (61D), 47.282583° N, 19.374639° E, 120 m a.s.l., 17.03.2021.
- 2 = Pest County, near Csévharaszt village, old native poplar (*Populus alba-canescens*) forest (99I), 47.262944° N, 19.389833° E, 120 m a.s.l., 10.03.2021. and 18.05.2021.
- 3 = Pest County, near Csévharaszt village, *Quercus robur* forest at Pusztabíróházi resting place (79B), 47.263528° N, 19.385333° E, 120 m a.s.l., 18.05.2021.
- 4 = Pest County, near Csévharaszt village, *Carpinus betulus* L. forest (98E), 47.266361° N, 19.385583° E, 120 m a.s.l., 10.03.2021. and 18.05.2021.
- 5 = Pest County, near Csévharaszt village, *Quercus robur* forest (80K), 47.268444° N, 19.379194° E, 120 m a.s.l., 18.05.2021.
- 6 = Pest County, near Csévharaszt village, *Quercus robur* forest (73B), 47.280472° N, 19.379111° E, 120 m a.s.l., 25.05.2021.
- 7 = Pest County, near Csévharaszt village, *Quercus robur* forest with *Betula pendula* Roth. and *Fraxinus excelsior* L. (63K), 47.28625° N, 19.381333° E, 120 m a.s.l., 25.05.2021.

## RESULTS AND DISCUSSION

Altogether 57 bryophyte taxa (5 liverworts and 52 mosses) were collected. The list of the bryophyte taxa collected can be found in the Appendix.

### Bryophyte vegetation

Some earlier bryophyte data from open sandy oak forests of Csévharaszt were mentioned in the work of SIMON and SZERÉNYI (1975), e. g. *Atrichum undulatum*, *Brachytheciastrum velutinum* (sub. nom. *Brachythecium velutinum*), *Dicranum scoparium*, *Hypnum cupressiforme*, *Plagiomnium cuspidatum* (sub. nom.

*Mnium cuspidatum*), *Ptychostomum moravicum* (sub. nom. *Bryum flaccidum*). All of them were also found during our surveys.

The epiphyte vegetation of the investigated forests was well developed. *Hypnum cupressiforme* and *Platygyrium repens* were the most frequent and abundant species, but on the lower part of the trees *Amblystegium serpens*, *Brachytheciastrum velutinum*, *Brachythecium rutabulum*, *B. salebrosum*, *Leskea polycarpa*, *Plagiomnium cuspidatum*, and *Ptychostomum moravicum* were also frequent. The upper part of trees were colonised by *Frullania dilatata*, *Pylaisia polyantha*, *Radula complanata*, and species of Orthotrichaceae family (*Lewinskya affinis*, *L. speciosa*, *Orthotrichum pallens*, *O. patens*). This bryophyte vegetation, dominated by Orthotrichaceae species, was especially well developed in the *Populus alba-canescens* stand, which provides better light conditions.

The terricolous bryophyte vegetation was sparse. *Atrichum undulatum* was the most frequent, rarely *Brachytheciastrum velutinum*, *Brachythecium rutabulum*, and *Plagiomnium cuspidatum* also appeared. However, in the *Populus alba-canescens* stand several additional species were found on soil, but in small amount, e.g. *Eurhynchium striatum*, *Fissidens viridulus*, *Homalothecium lutescens*, *Ptychostomum rubens*, *Weissia* species (*W. brachycarpa*, *W. longifolia*).

On decaying wood *Amblystegium serpens*, *Brachythecium rutabulum*, *B. salebrosum*, *Hypnum cupressiforme*, and *Platygyrium repens* were the most important members of the bryophyte assemblage.

### Forest specialist species

In oak forests and in the *Carpinus betulus* stand several species were found which are regarded as *Querco-Fagetea*, *Fagetalia* elements. The richest stand in such species was a mixed forest in the locality No. 7. Thirteen forest specialist bryophytes were found there, among them five species (*Anomodon viticulosus*, *Isothecium alopecuroides*, *Metzgeria furcata*, *Plagiothecium laetum*, *Pseudanomodon attenuatus*) were collected only in this stand in the study area. It was a mosaic of wetter and drier habitats with various tree species. Besides the dominant *Quercus robur*, *Fraxinus excelsior*, *Betula pendula*, *Populus* sp. trees also occurred. The *Carpinus betulus* stand is proved to be also an important bryophyte diversity spot in the landscape providing habitat for eight forest species, among them some unique ones which were found only there in the study area, like *Homalia trichomanoides* and *Pterygynandrum filiforme*.

A list of the forest specialist bryophytes found is given below.

*Anomodon viticulosus* (Hedw.) Hook. et Taylor – It is not frequent in the Great Hungarian Plain. It occurs in humid forest, swamp forest, riverine forests in the region. It had no earlier record from the study area (PAPP and RAJČZY

1999). In this survey it was found only in one forest stand on the bark of *Fraxinus excelsior*.

***Atrichum undulatum*** (Hedw.) P. Beauv. – It is rare in the Great Hungarian Plain. It lives on soil in forests. It has already been recorded from the study area (PAPP and RAJCZY 1999, SIMON and SZERÉNYI 1975). During our survey it was found in five stands.

***Dicranum montanum*** Hedw. – It is rare in the Great Hungarian Plain. The species was not mentioned from the Danube–Tisza Interfluve by PAPP and RAJCZY (1999), but there is a specimen in the Bryophyte Herbarium of HNHM from the Töserdő riverine forest by the Tisza from bark of fallen tree collected by Papp, B. in 2012. In this study it was found on decaying wood and bark of *Betula pendula* trees in three stands.

***Dicranum scoparium*** Hedw. – It is not frequent in the Great Hungarian Plain. It has few records from the Danube–Tisza Interfluve, but it has been mentioned even from plantations of *Pinus* in the southern part of this territory (PAPP and RAJCZY 1999). It has also been reported from the study area, from soil (SIMON and SZERÉNYI 1975). In this survey it was collected from bark of *Quercus robur* and *Betula pendula* in two stands.

***Dicranum tauricum*** Sapjegin – It is very rare in the Great Hungarian Plain. It has no earlier records from the Danube–Tisza Interfluve (PAPP and RAJCZY 1999). In this survey it was found on decaying wood and bark of *Betula pendula* and *Fraxinus excelsior*.

***Homalia trichomanoides*** (Hedw.) Brid. – It is rare in the Great Hungarian Plain. It has few records from humid forest, swamp forest, riverine forests in the Danube–Tisza Interfluve (PAPP and RAJCZY 1999). In this survey it was found on bark of *Carpinus betulus* in one stand which was dominated by that tree.

***Hypnum pallescens*** (Hedw.) P. Beauv. var. *reptile* (Michx.) Husn. – It is very rare in the Great Hungarian Plain. It has no earlier records from the Danube–Tisza Interfluve (PAPP and RAJCZY 1999). In this survey it was found on bark of *Quercus robur* in one stand.

***Isothecium alopecuroides*** (Lam. ex Dubois) Isov. – It is rare in the Great Hungarian Plain. It has only one earlier record from a swamp forest in the Danube–Tisza Interfluve (PAPP and RAJCZY 1999), and there is a recent specimen in the Bryophyte Herbarium of HNHM from the Töserdő riverine forest of the Tisza from *Fraxinus* bark collected by Papp, B. in 2012. In this survey it was found on the bark of a *Populus* sp. in one stand.

***Lewinskya striata*** (Hedw.) F. Lara, Garilleti et Goffinet – Although this species is regarded as a Querco-Fagetea element according to ORBÁN and VAJDA (1983), it is not rare in the region. It has several records for example from *Populus*

bark. It has also been recorded from the study area (PAPP and RAJCZY 1999). In this survey it was collected from bark of *Populus* sp. and *Quercus robur*.

*Lophocolea heterophylla* (Schrad.) Dumort. – It is not a frequent liverwort in the Great Hungarian Plain. It occurs in humid forest, swamp forest, and riverine forests in the Danube–Tisza Interfluve (PAPP and RAJCZY 1999), and there is a recent specimen in the Bryophyte Herbarium of HNHM from the Töserdő riverine forest of the Tisza from decaying wood collected by Papp, B. in 2012. In this survey it was collected from decaying wood in one stand.

*Metzgeria furcata* (L.) Corda – It is a rare liverwort in the Great Hungarian Plain. It has only two earlier records from the Danube–Tisza Interfluve (PAPP and RAJCZY 1999), and there are two recent specimens in the Bryophyte Herbarium of HNHM from the Töserdő riverine forest of the Tisza from *Quercus* barks collected by Papp, B. in 2012. In this survey it was found on bark of *Quercus robur* in one stand.

*Plagiomnium cuspidatum* (Hedw.) T. J. Kop. – It has several records from the region, from various forests ranging from dry oak forest to swamp forest. It has earlier records from the study area as well (PAPP and RAJCZY 1999). In this survey it was found in four stands on soil and on the bark of various trees (*Betula pendula*, *Populus* sp., *Quercus robur*).

*Plagiothecium laetum* Schimp. – It is the first record of the species from the Great Hungarian Plain (ERZBERGER *et al.* unpublished). It was found on bark of *Quercus robur* in one stand.

*Plagiothecium succulentum* (Wilson) Lindb. – It is the first record of the species from the Great Hungarian Plain (ERZBERGER *et al.* unpublished). It was found on bark of *Quercus robur* in one stand.

*Platygyrium repens* (Brid.) Schimp. – Although this species is regarded as a Querco-Fagetea element according to ORBÁN and VAJDA (1983), it is not rare in the Great Hungarian Plain. It is widespread all over the country and it occurs in various forest types. It has five specimens in the Bryophyte Herbarium of HNHM from the Danube–Tisza Interfluve, from the Töserdő riverine forest of the Tisza from bark of *Quercus*, *Acer* and fallen trees collected by Papp, B. in 2012, and a specimen from a riverine forest by the Danube in the Gemenc area, from *Quercus* bark collected by Papp, B. in 1999. Besides these it has also several records from the neighbouring counties belonging to the Great Hungarian Plain. It was also quite frequent in the study area. It was collected in all stands except the *Populus alba-canescens* forest. It was found on decaying wood and on the bark of various tree species (*Betula pendula*, *Fraxinus excelsior*, *Quercus robur*).

*Polytrichum formosum* Hedw. – It is very rare in the Great Hungarian Plain. It lives on soil in forests. It has only two earlier records from the Danube–Tisza

Interfluve (PAPP and RAJCZY 1999). One is from our study area (SIMON and SZERÉNYI 1975). In this survey it was found only in one oak stand.

*Porella platyphylla* (L.) Pfeiff. – Although this species is regarded as a Fagetalia element according to DIERSSEN (2001), it is not rare in the region. It has several records from various forests. It has also an earlier record from the study area (PAPP and RAJCZY 1999). In this survey it was collected from the bark of *Fraxinus excelsior* and *Quercus robur* in two stands.

*Pseudanomodon attenuatus* (Hedw.) Ignatov et Fedosov – It is rare in the Great Hungarian Plain. It has only two earlier records from the Danube–Tisza Interfluve (PAPP and RAJCZY 1999). There is a recent specimen in the Bryophyte Herbarium of HNHN from the Töserdő riverine forest of the Tisza from *Quercus* bark collected by Papp, B. in 2012. In this survey it was found on the bark of *Quercus robur* in one stand.

*Pterygynandrum filiforme* Hedw. – It is very rare in the Great Hungarian Plain. It has only two earlier records from the Danube–Tisza Interfluve, one of them is from our study area (PAPP and RAJCZY 1999). In this survey it was found on the bark of *Carpinus betulus* in one stand which was dominated by that tree.

*Ptychostomum moravicum* (Podp.) Ros et Mazimpaka – Although this species is regarded as a Fagion element according to ORBÁN and VAJDA (1983), it is frequent in the Great Hungarian Plain. It is widespread all over the country and it occurs as epiphyte on any kind of trees in various forest types. It is also not rare on other substrates (soil, rocks, rotting materials), even in man-made habitats. It has a lot of earlier records from the Danube–Tisza Interfluve, and also from the study area (PAPP and RAJCZY 1999). It was frequent in the studied stands occurring in all stands on soil, and on the bark of various tree species (*Carpinus betulus*, *Quercus robur*, *Populus* sp.).

*Pulvigeria lyellii* (Hook. et Taylor) Plášek, Sawicki et Ochrya – It is not frequent in the Great Hungarian Plain. It has only one earlier record from the southern part of the Danube–Tisza Interfluve (PAPP and RAJCZY 1999). Some recent specimens in the Bryophyte Herbarium of HNHN from the Töserdő riverine forest of the Tisza from fallen trees collected by Papp, B. in 2012, and from a riverine forest by the Danube in the Gemenc area from *Populus* bark collected by Papp, B. in 1999. In this survey it was found in two stands on the bark of *Populus* sp. and *Quercus robur*.

*Sciuro-hypnum populeum* (Hedw.) Ignatov et Huttunen – It is rare in the Great Hungarian Plain. It has few records from the Danube–Tisza Interfluve mainly from the southern part of this territory (PAPP and RAJCZY 1999). It has a recent specimen in the Bryophyte Herbarium of HNHN from the Töserdő riverine forest of the Tisza from decaying wood collected by Papp, B. in 2012, and another specimen from a riverine forest by the Danube in the Gemenc area

from *Fraxinus* bark collected by Papp, B. in 1999. In this survey it was found in three stands on the bark of various tree species (*Betula pendula*, *Carpinus betulus*, *Quercus robur*).

### Grassland specialists

Grassland specialist species were found mainly in the *Populus alba-canescens* forest. It coincides with the results of RÉDEI *et al.* (2020) that richness of higher plant species of grasslands was highest in poplar stands, which are more open forests compared with the other stands. *Homalothecium lutescens*, *Syntrichia ruralis*, *Weissia brachycarpa* and *W. longifolia* were found on soil there. The latter two species occur mainly in the grasslands of hilly regions of Hungary. It seems that they are rare in the Great Hungarian Plain or they might have been overlooked. *W. brachycarpa* was regarded as a Quercetea pubescentis-petraeae element by ORBÁN and VAJDA (1983), but it was treated as Festuco-Brometea element by DIERSSEN (2001). This species is considered here according to the latter publication as a grassland element. *W. brachycarpa* has no earlier record from the Danube–Tisza Interfluvium, while *W. longifolia* has only one record from a saline area (PAPP and RAJCZY 1999). In an opening of the *Quercus robur* forest in the locality No. 6, *Abietinella abietina* and *Syntrichia subpapillosissima* occurred. The latter taxon has been recognised on the species level by GALLEGO *et al.* (2002). But still there is some doubt about its ranking, e.g. according to HEDENÄS *et al.* (2019) it may represent a special phenotype within *Syntrichia ruraliformis* or *S. ruralis* but more study is required. We have recently started to pay more attention to this species, hence any new data can improve our knowledge on the distribution, ecology, and habitat requirements of this species.

### Species of conservation interest

*Eurhynchium striatum* (Hedw.) Schimp. – This species is red listed in Hungary as near threatened (NT). It is regarded as a Fagion element according to ORBÁN and VAJDA (1983). It is very rare in the Great Hungarian Plain. It has one earlier record from the southern part of the Danube–Tisza Interfluvium from a plantation of *Pinus* (PAPP and RAJCZY 1999). In this survey it was collected from soil in the *Populus alba-canescens* forest.

*Fissidens viridulus* (Sw.) Wahlenb. – This species is near threatened (NT) according to the national red list. It is regarded as a Querco-Fagetea element according to ORBÁN and VAJDA (1983). It is rare in the Great Hungarian Plain. It has no earlier record from the Danube–Tisza Interfluvium (PAPP and RAJCZY 1999). In this survey it was collected from soil in the *Populus alba-canescens* forest.

*Nyholmiella obtusifolia* (Brid.) Holmen et E. Warncke – Although this species is red listed in Hungary as near threatened (NT), it has turned out in the last decade that it is not rare. It is an epiphyte of forests rich in light. It has also several earlier records from the region mainly from *Populus* bark (PAPP and RAJCZY 1999). In the study area it was collected from bark in the *Populus alba-canescens* forest.

*Orthotrichum patens* Bruch ex Brid. – This species is vulnerable (VU) according to the national red list. In the last decade several data of this species have arisen in our country, hence its national threat status is surely overestimated. It has no earlier record from the Danube–Tisza Interfluvium (PAPP and RAJCZY 1999). In our study area it was found in four stands on the bark of various tree species (*Carpinus betulus*, *Populus* sp., *Quercus robur*).

#### Other interesting occurrences

*Dicranoweisia cirrata* (Hedw.) Lindb. – It was regarded as a very rare species in Hungary according to ORBÁN and VAJDA (1983). However, in the last decade many data have arisen. It is supposed to be expanding (PAPP *et al.* 2010). It has no earlier record from the Danube–Tisza Interfluvium (PAPP and RAJCZY 1999), and still it may be rare in the Great Hungarian Plain. In the study area it was collected from decaying wood in one stand.

*Dicranum polysetum* Sw. ex anon. – It was regarded as a Pino-Quercetalia element in Hungary according to ORBÁN and VAJDA (1983). In spite of the many *Pinus* plantations on the lowland regions of Hungary, it is rare in the Great Hungarian Plain and has no earlier record from the Danube–Tisza Interfluvium (PAPP and RAJCZY 1999). It was found at the border of the *Populus alba-canescens* forest with *Pinus nigra* plantation together with *Pseudoscleropodium purum*, which also a characteristic species of conifer forests in our country.

*Orthotrichum cupulatum* Brid. – It is a saxicolous species and as rocky substrates are rare in the Great Hungarian Plain, this species is rare in this region. It has only one record from the Danube–Tisza Interfluvium from stones of a dike (PAPP and RAJCZY 1999). In this survey it was collected together with another saxicolous species, *O. anomalum*, from the bark of *Populus*. This is not their usual habitat, but *O. anomalum* has also an earlier record from *Populus* bark in the region.

*Orthotrichum schimperi* Hammar – This epiphyte species was previously treated as a synonym of *Orthotrichum pumilum* Sw. in many flora works (FREY *et al.* 1995, SCHÄFER-VERWIMP 2001), and it has not received adequate attention in our country. In the European checklist of 2006 (HILL *et al.* 2006), however, it already appeared on species rank. In the study area it was found on the bark of *Quercus robur* in one stand.

## CONCLUSIONS

57 bryophyte taxa were recorded in the studied semi-natural forests. 42% (22 epiphytes and two terricolous species) of them are regarded as forest specialists, among them several species are very rare in the Great Hungarian Plain, like *Dicranum tauricum*, *Hypnum pallescens* var. *reptile*, *Polytrichum formosum*, *Pterygynandrum filiforme*. Two of them (*Plagiothecium laetum*, *P. succulentum*) are reported for the first time from the Great Hungarian Plain. The stand richest in forest specialists is a mixed forest dominated by *Quercus robur*, but many other tree species occur there, e.g. *Fraxinus excelsior*, *Betula pendula*, *Populus* sp. A *Carpinus betulus* stand is also rich in forest specialists with some species rare in the Great Hungarian Plain, which were found only there in the study area, like *Homalia trichomanoides* and *Pterygynandrum filiforme*. The old *Populus alba-canescens* stand is rich in grassland species and light demanding epiphytes, like species of Orthotrichaceae family. As interesting data, two saxicolous species (*Orthotrichum anomalum*, *O. cupulatum*) also appear on bark in this forest. Besides these, two nationally near-threatened (NT) terricolous species (*Eurhynchium striatulum*, *Fissidens viridulus*), rare in the Great Hungarian Plain, also occur there. Some grassland specialist species, rare in the Great Hungarian Plain, were also collected, like *Weissia brachycarpa* and *W. longifolia*. Hence old, native poplar stands are also important in the formation of bryophyte diversity of the region.

The remnants of semi-natural forests of lowland areas are important in maintaining bryophyte diversity of the landscape. Especially stands with various tree species can support high diversity and are hotspots of forest specialist bryophytes which are rare in low elevations.

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**Összefoglalás** – 57 moha taxont mutattunk ki természetközeli erdőkből az Alföld északi részén található Csepvaraszt környéki homokvidékről. A fajok 42% (22 epifita és 2 talajlakó) erdő specialista, köztük az Alföldön nagyon ritka fajokkal, mint *Dicranum tauricum*, *Hypnum pallescens* var. *reptile*, *Polytrichum formosum*. Két fajnak (*Plagiothecium laetum*, *P. succulentum*) első adatát sikerült kimutatnunk az Alföldről. Az erdő specialista fajokban leggazdagabb állomány egy kevert faállományú kocsányos tölgyes volt, amelyben kőris, nyír és nyár egyedek is nagy számban előfordultak. Egy Alföldön unikális gyertyános állomány szintén néhány alacsony tengerszint feletti magasságon nagyon ritkán előforduló fajnak (*Homalia trichomanoides*, *Pterygynandrum filiforme*) adott otthont. Egy idős nyaras (*Populus alba-canescens*) állomány talaján szintén több ritka mohát találtunk, mint az *Eurhynchium striatulum*-t és a *Fissidens viridulus*-t. A nyaras rendkívül gaz-

dag volt az Orthotrichaceae család fajaiban is, amelyek tagjai többnyire fényigényes fajok. A nyarasban ezen kívül néhány gyepekben előforduló, Alföldön ritka, faj is előkerült, mint a *Weissia brachycarpa* és *W. longifolia*. Úgy tűnik, hogy az idős nyaras állományok is nagy szerepet játszanak a moha diverzitás alakításában.

Összességében elmondható, hogy az alföldi természetközeli erdő állományok rendkívül fontosak a térség moha diverzitásának fenntartásában. Főleg a kevert fafajú állományok kulcs fontosságúak az erdő specialista fajokban gazdag mohaközösség számára.

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**Appendix.** Enumeration of the bryophyte taxa collected. After the name the number of collecting sites and substrates are given.

### Liverworts

- Frullania dilatata* (L.) Dumort. – 2: bark of *Populus*; 3: *Fraxinus* and *Quercus* bark; 5: *Quercus* bark; 7: *Fraxinus* bark
- Lophocolea heterophylla* (Schr.) Dumort. – 1: decaying wood
- Metzgeria furcata* (L.) Corda – 7: *Quercus* bark
- Porella platyphylla* (L.) Pfeiff. – 3: *Quercus* bark; 7: *Fraxinus* bark
- Radula complanata* (L.) Dumort. – 1: bark of *Sambucus nigra*; 2: bark of *Populus*; 3: *Fraxinus* and *Quercus* bark; 4: bark of *Carpinus betulus*; 5, 6: *Quercus* bark; 7: *Betula* and *Fraxinus* bark

## Mosses

- Abietinella abietina* (Hedw.) M. Fleisch. – 6: on soil
- Amblystegium serpens* (Hedw.) Schimp. – 1, 5: *Quercus* bark; 2: on soil and bark of *Populus*; 3: *Quercus* bark; 4: bark of *Carpinus betulus*; 6: decaying wood and *Quercus* bark; 7: *Fraxinus* and *Quercus* bark
- Anomodon viticulosus* (Hedw.) Hook. et Taylor – 7: *Fraxinus* bark
- Atrichum undulatum* (Hedw.) P. Beauv. – 1, 2, 3, 4, 5: on soil
- Brachytheciastrum velutinum* (Hedw.) Ignatov et Huttunen – 1, 5: *Quercus* bark; 2: on soil and bark of *Populus*; 3: on soil and *Quercus* bark; 4: bark of *Carpinus betulus*; 6: on soil, *Pyrus* and *Quercus* bark
- Brachythecium rutabulum* (Hedw.) Schimp. – 1, 3, 5: *Quercus* bark; 2: on soil and decaying wood; 4: bark of *Carpinus betulus*; 6: decaying wood, *Pyrus* bark; 7: *Betula* and *Fraxinus* bark
- Brachythecium salebrosum* (Hoffm. ex F. Weber et D. Mohr) Schimp. – 1, 5: *Quercus* bark; 3: *Fraxinus* and *Quercus* bark; 4: bark of *Carpinus betulus*; 6: decaying wood and *Quercus* bark; 7: *Betula*, *Fraxinus* and *Quercus* bark
- Ceratodon purpureus* (Hedw.) Brid. – 4: decaying wood; 6: on soil
- Dicranoweisia cirrata* (Hedw.) Lindb. – 6: decaying wood
- Dicranum montanum* Hedw. – 1, 4: decaying wood; 7: *Betula* bark
- Dicranum polysetum* Sw. ex anon. – 2: on soil
- Dicranum scoparium* Hedw. – 1: *Quercus* bark; 7: *Betula* bark
- Dicranum tauricum* Sapp. – 4, 6: decaying wood; 7: *Betula* and *Fraxinus* bark
- Eurhynchium striatum* (Hedw.) Schimp. – 2: on soil
- Fissidens taxifolius* Hedw. – 2: on soil
- Fissidens viridulus* (Sw.) Wahlenb. – 2: on soil
- Homalia trichomanoides* (Hedw.) Brid. – 4: *Carpinus* bark
- Homalothecium lutescens* (Hedw.) H. Rob. – 2: on soil
- Homalothecium sericeum* (Hedw.) Schimp. – 3: *Quercus* bark
- Hypnum cupressiforme* Hedw. – 1, 6: decaying wood and *Quercus* bark; 2: decaying wood and bark of *Populus*; 3: *Fraxinus* bark; 4: decaying wood and bark of *Carpinus betulus*; 5: *Quercus* bark; 7: *Betula* and *Fraxinus* bark
- Hypnum pallescens* (Hedw.) P. Beauv. var. *reptile* (Michx.) Husn. – 3: *Quercus* bark
- Isoetecium alopecuroides* (Lam. ex Dubois) Isov. – 7: bark of *Populus*
- Leskea polycarpa* Hedw. – 2: bark of *Populus*; 3: tree bark; 4: bark of *Carpinus betulus*; 7: *Betula* and *Fraxinus* bark
- Lewinskya affinis* (Schr. ex Brid.) F. Lara, Garilleti et Goffinet – 2: bark of *Populus*; 3: *Quercus* bark *Fraxinus* bark; 5, 6: *Quercus* bark
- Lewinskya speciosa* (Nees) F. Lara, Garilleti et Goffinet – 2: bark of *Populus*; 6: *Quercus* bark
- Lewinskya striata* (Hedw.) F. Lara, Garilleti et Goffinet – 2: bark of *Populus*; 6: *Quercus* bark
- Nyholmiella obtusifolia* (Brid.) Holmen et E. Warncke – 2: bark of *Populus*
- Orthotrichum anomalum* Hedw. – 2: bark of *Populus*
- Orthotrichum cupulatum* Brid. – 2: bark of *Populus*
- Orthotrichum diaphanum* Brid. – 1: bark of *Sambucus nigra*; 2: bark of *Populus*
- Orthotrichum pallens* Bruch ex Brid. – 2: bark of *Populus*; 3, 6: *Quercus* bark; 4: bark of *Carpinus betulus*
- Orthotrichum patens* Bruch ex Brid. – 2: bark of *Populus*; 4: bark of *Carpinus betulus*; 5, 6: *Quercus* bark
- Orthotrichum schimperi* Hammar – 6: *Quercus* bark
- Oxyrrhynchium hians* (Hedw.) Loeske – 2: bark of *Populus*

- Plagiomnium cuspidatum* (Hedw.) T. J. Kop. – 1: *Quercus* bark; 2: on soil and bark of *Populus*; 6: decaying wood and *Quercus* bark; 7: *Betula* bark
- Plagiothecium laetum* Schimp. – 7: *Betula* bark
- Plagiothecium succulentum* (Wilson) Lindb. – 1: *Quercus* bark
- Platygyrium repens* (Brid.) Schimp. – 1, 6: decaying wood and *Quercus* bark; 3: *Quercus* bark, *Fraxinus* bark; 4: decaying wood; 5: *Quercus* bark; 7: *Betula* and *Fraxinus* bark
- Polytrichum formosum* Hedw. – 1: on soil
- Pseudanomodon attenuatus* (Hedw.) Ignatov et Fedosov – 7: *Fraxinus* bark
- Pseudoscleropodium purum* (Hedw.) M. Fleisch. – 2: on soil
- Pterygynandrum filiforme* Hedw. – 4: bark of *Carpinus betulus*
- Ptychostomum moravicum* (Podp.) Ros et Mazimpaka – 1: on soil and *Quercus* bark; 2: bark of *Populus*; 3, 5, 7: *Quercus* bark; 4: bark of *Carpinus betulus*; 6: on soil, *Pyrus* and *Quercus* bark
- Ptychostomum rubens* (Mitt.) Holyoak et N. Pedersen – 1, 2: on soil
- Pulviger a lyellii* (Hook. et Taylor) Plášek, Sawicki et Ochrya – 2: bark of *Populus*; 6: *Quercus* bark
- Pylaisia polyantha* (Hedw.) Schimp. – 1: bark of *Sambucus nigra*; 2: bark of *Populus*; 3, 7: *Fraxinus* and *Quercus* bark; 5, 6: *Quercus* bark
- Sciuro-hypnum populeum* (Hedw.) Ignatov et Huttunen – 1: *Quercus* bark; 4: bark of *Carpinus betulus*; 7: *Betula* bark
- Syntrichia papillosa* (Wilson) Jur. – 2: bark of *Populus*; 6: *Quercus* bark
- Syntrichia ruralis* (Hedw.) F. Weber et D. Mohr – 2: bark of *Populus*
- Syntrichia subpapillosissima* (Bizot et R. B. Pierrot ex W. A. Kramer) M. T. Gallego et J. Guerra – 6: on soil
- Weissia brachycarpa* (Nees et Hornsch.) Jur. – 2: on soil
- Weissia longifolia* Mitt. – 2: on soil