

PEAT MOSSES OF NORTH HUNGARY

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Altogether 17 peat moss species of 18 habitats of North Hungary were floristically investigated. Earlier and recently gained knowledge of species occurrences were compared and the conservation and threat status of species determined. The distribution of all species has changed, they have disappeared from locations and established in others. *Sphagnum riparium* is new for the studied area (and also for Hungary) while *S. teres* has disappeared. *S. angustifolium*, *S. fallax*, *S. fimbriatum* and *S. palustre* still have stable populations and presumably they will live in this area in the foreseeable future, in similar quantities. *S. compactum*, *S. contortum*, *S. cuspidatum*, *S. quinquefarium*, *S. riparium* and *S. subsecundum* have only few small populations and their survival is doubtful. The condition of mires is a very important factor for survival of local peat moss populations in the region.

Key words: bryophytes, distribution, mire, North Hungary, *Sphagnum*

INTRODUCTION

Peat mosses and their habitats are very rare in Hungary and since the 19th century they have attracted special attention. The genus *Sphagnum* is protected by law in Hungary since 1986 and most of their habitats are located in protected areas (national parks, landscape conservation areas, nature reserves or nature conservation areas). Since 1996 all mires (bogs, intermediate mires, fens, swamps, swamp-forests) in Hungary are nation-wide protected by virtue of the law (*ex lege*).

Of the 48 European *Sphagnum* species, recent records in Hungary include 24 peat mosses (DANIELS and EDDY 1985, ORBÁN and VAJDA 1983, LÁJER 1998a, SZURDOKI *et al.* 2000).

Peat mosses and their localities were relatively well explored from early times of botany until the 1970s in Hungary (*e.g.* BORBÁS 1886, BOROS 1924, 1926, 1964, 1968, ZÓLYOMI 1931, 1939, SIMON 1953, MÁTHÉ and KOVÁCS 1958, 1959, PÓCS 1958, BOROS and VAJDA 1960, PÓCS *et al.* 1962, BARBALICS 1976). This is especially true for the mires of the Northern Mountain Range where numerous scientists investigated the mires and peat mosses from different points of view (*e.g.* BORBÁS 1886, ZÓLYOMI 1931, 1939, SIMON 1953, MÁTHÉ and KOVÁCS 1958, 1959, BOROS and VAJDA 1960, BOROS 1964, 1968).

In the 1990s numerous studies were published about the distribution of *Sphagnum* from different parts of the country (NAGY 1996, 2002, ÓDOR *et al.* 1996, 2002, SZURDOKI 1996, LÁJER 1998a, b, NAGY *et al.* 1998, SZURDOKI *et al.* 2000, 2001,

in press). Some of these contain new data and information about North Hungarian *Sphagnum* occurrences (NAGY 1996, 2002, LÁJER 1998a, b, NAGY *et al.* 1998, SZURDOKI *et al.* 2000, in press). A recent study by SZURDOKI and NAGY (2002) summarised the recent knowledge about *Sphagnum* dominated mires and other peat moss occurrences of North Hungary.

The aims of the present study are the following: (1) to compare the recent distribution of different *Sphagnum* species with these based on earlier data in North Hungary, (2) to describe their population sizes and (3) their populational changes during the last decades and (4) to establish their conservation status in the region.

STUDY AREA

The investigated area has mainly mountainous-hilly and partly plain relief (from 150 to 1,015 m), containing the whole Northern Mountain Range, the Gödöllő Hills and the Northern Hungarian Plain (Bereg and Nyírség). Geologically, this area is very diverse, the bedrock is also variable, partly calcareous, partly volcanic or alluvial. For the mountains and the proximity of the Carpathians, the mean annual temperature is lower (8–10 °C) and the mean annual precipitation is higher (600–800 mm) than the average values of the whole country. The wintertime precipitation is also higher in this region, which is a very important factor in securing positive water balance of the mires. The colder and more humid microclimate helps the establishment and survival of *Sphagnum*. The montane region is dominated by deciduous forests and the plains by open forest-steppe woodlands. There are numerous small and isolated peat moss dominated mires and peat moss occurrences in North Hungary. These small mires are about 1–2 hectares in size, developed mostly in depressions or in oxbow lakes. The peat moss occurrences are small, covering only square metres or square decimetres. The *Sphagnum* patches are developed on wet soil of forests or in open areas, among streamlets and springs or in tall sedge vegetation. SZURDOKI and NAGY (2002) summarised the present knowledge of these habitats.

In this paper the following sites were investigated: Csömöri-tó, Nádas-tó, Nyírjes-tó, Kis-tó, Nagy-tó, Futyó-völgy, Csipkés-kút, Kis-Mohos, Nagy-Mohos, Lókosár, Zemplén Mts, Nyíres-tó, Báb-tava, Bence-tó, Zsid-tó, Navat, Bátorliget Nature Reserves, Júlia-major. Figure 1 shows the distribution of the investigated sites.

Csömöri-tó is situated in the Gödöllő Hills, at about 150 m a. s. l. Peat mosses were described from the floating island situated in the centre of a small lake dominated by *Salix cinerea* and *Thelypteris palustris*. There was a fire in the 1980s and the *Sphagnum* have disappeared (STOLLMA-YER-BONCZ 1982, 1999).

Nádas-tó totalling about 2,000 m², is found near Nagybárkány in the Cserhát Mts at about 360 m a. s. l. The shallow depression is covered mainly with willow swamps and partly with *Phragmites*. Peat mosses live under the willow shrubs (MÁTHÉ and KOVÁCS 1959).

Nyírjes-tó is situated in the Mátra Mts, near Sirok village at about 250 m a. s. l. This bog has developed in a basin of about 9,000 m². The central part is more or less open (with *Carici lasiocarpae-Sphagnetum*), mainly surrounded by *Salici cinereae-Sphagnetum* and the outer part is a lag zone (MÁTHÉ and KOVÁCS 1958). In the 1990s the water table was very low and the lag zone was dry, but at the end of the decade the basin has filled up; the high water table is high from the central part to the lag zone (SZURDOKI and NAGY 2002).

Kis-tó and Nagy-tó are in the Bükk Mts, near Egerbakta village at about 280 m a. s. l. Kis-tó was a *Sphagnum* dominated willow swamp in the first part of 20th century. At that time the water table was high, the open communities of the central part were surrounded by willow swamp. In the end of 20th century it has dried out and most *Sphagna* have disappeared (ZÓLYOMI 1931, DULAI and VOJTKÓ 1991, SZURDOKI and NAGY 2002). Nagy-tó is a real pond, surrounded by *Salix cinerea* and sedges, and is noted for its Lemnetaea communities in the open water. Peat mosses live under the willow shrubs (DULAI and VOJTKÓ 1991).

The Futyó-völgy is situated in the Tarna-vidék, a hilly area lying between the Mátra Mts and the town of Ózd. The valley is covered by beech forest developed on acidic soil (*Luzulo-Fagetum*) with relatively wet and cool microclimate. Numerous peat moss patches have found (BAKALÁR *et al.* 1975, SZURDOKI and NAGY 2002).

The Csipkés-kút area is part of the Bükk Mts at about 800 m a. s. l., with forest cover, mainly with beech; the peat mosses could live on the acidic, wet forest soil (SIROKI 1961).

The well-known Mohos lakes (Kis-Mohos and Nagy-Mohos) are situated in the Putnok Hills, near Kelemér village at 296 m a. s. l. The oval-shaped bogs are surrounded by closed oak-forests dominated by *Quercus cerris* and *Q. petraea*, which turn into a shrubby marginal zone of *Salix cinerea*. The bogs are belted by a lag zone and different willow communities, and in the inner part *Betulo pubescenti-Sphagnetum* community has developed. In the innermost part open associations (*e.g.* *Carici lasiocarpae-Sphagnetum*, *Eriophoro angustifolii-Sphagnetum*, *Eriophoro vaginati-Sphagnetum*) can also be found (MATUS *et al.* 2000, SZURDOKI and NAGY 2002).



Fig. 1. The geographical position of mires and peat moss occurrences in North Hungary. Abbreviations: CSOM = Csömöri-tó, NADT = Nádas-tó, NYIS = Nyírjes-tó, KIST = Kis-tó, NAGY = Nagy-tó, FUTY = Futyó-völgy, CSIP = Csipkés-kút, KMOH = Kis-Mohos, NMOH = Nagy-Mohos, LOKO = Lókosár, ZEMP = Zemplén Mts, NYTB = Nyíres-tó, BAPT = Báb-tava, BENC = Bence-tó, ZSID = Zsid-tó, NAVA = Navat, BATO = Bátorliget Nature Reserves, JULI = Júlia-major.

The place Lókosár is situated near Aggtelek village. The bedrock is calcareous, thus the *Sphagnum* patches could establish only in sites of special local conditions (SOMLYAY and Lőkös 1999).

The Zemplén Mts is the easternmost part of the Northern Mountain Range. The subsequent zonal associations, from lower to higher elevations, are usually dominated by oaks, hornbeam and beech and there are also extensive planted spruce forests. Peat moss occurrences are in the northern part of the range, dominated by acidophilous oak and beech forests (*Luzulo-Genisto tinctoriae-Quercetum*, *Luzulo-Deschampsio-Fagetum*) with numerous Carpathian and acidofrequent floristical elements. In the degraded parts of the forests birch stands appear mixed with heath patches (*Betulo-Callunetum*). On open slopes, extensive presence of *Nardetum* is observed. The Komlóska and Kemence valley system contains numerous *Sphagnum* occurrences in montane alder forests, fens and even on the dryer parts of meadows (VAJDA 1969, SIMON 1970, 1977, VOJTKÓ and MARSCHALL 1995, SZURDOKI *et al.* 2000).

In the Bereg Plain five mires were investigated: Nyíres-tó, Báb-tava, Bence-tó, Zsid-tó and Navad. The Bereg Plain, in the northeastern part of the Great Hungarian Plain, is somewhat colder and more humid than the rest of the Plain. Its mires are developed in oxbow lakes. Nyíres-tó and Báb-tava are bogs with various plant communities; the oligotrophic ones (*e.g.* *Eriophoro vaginati-Sphagnetum*, *Carici lasiocarpae-Sphagnetum recurvi*, *Betulo pubescenti-Sphagnetum*) are in the centre of the mires while marsh and swamp communities are adjacent to these. Both mires have been supplied by artificial water replenishment since 1986. Navad mire was similar to the above ones but a fire has damaged it in 1967. Only a few *Sphagnum* patches have survived the fire, and after the artificial water replenishment they have totally disappeared (FINTHA 1994). Recently, small alder swamps and large patches of *Salix cinerea*, *Typha latifolia* or *Glyceria maxima* dominate this pond. Lake Zsid-tó is covered by alder and willow swamps with numerous floating islands. Bence-tó has open-water surface in the centre, but its size and deepness has changed several times in the past. The open water is surrounded by different associations of *Salix cinerea* and other marsh and tall-sedge communities. In 1998 the mire received natural water replenishment, the water table became much higher and all *Sphagna* have disappeared. The peat mosses lived under willow shrubs in the outer part of the mire (SIMON 1992, NAGY 2002, SZURDOKI and NAGY 2002).

The Bátorliget Nature Reserves and Júlia-major are situated in the Nyírség, in NE Hungary, which is also part of the Great Hungarian Plain. The relief of the Nyírség is determined by different sand formations. Mean annual temperature (10 °C) is lower here than in other parts of the Plain. The annual precipitation is about 550 mm, with a maximum in July (BORSY 1961). The Bátorliget Nature Reserves is a complex of different vegetation types including mires, marshes, fens, flooded forests and oak-forest. The reserve is surrounded by agricultural land and large parts of the reserve bear some signs of earlier human impact (*e.g.* drainage). In the last half century the potential distribution of different wetland communities has decreased dramatically (SOÓ 1953, STANDOVÁR *et al.* 1991). Together with his colleagues Standovár found one small patch of peat moss, which has disappeared in the last decade.

The Júlia-liget is situated near Piricse village in the vicinity of the Bátorliget Nature Reserves. This is a complex of meadows, fens and swamp communities. There are several peat moss patches on the floor of a *Salici pentandrae-Betuletum pubescentis* stand (JAKAB and LESKU 1995, 1996, LESKU and JAKAB 1997, JAKAB 1997).

METHODS

The nomenclature of bryophytes follows CORLEY *et al.* (1981), CORLEY and CRUNDWELL (1991) and GROLLE (1983), for the vascular plants SIMON (2000) and for the associations BORHIDI and SÁNTA (1999).

The author has been investigating peat mosses since 1994, hitherto all known *Sphagnum* localities had been visited at least twice and among others their *Sphagnum* flora was investigated. Numerous specimens were collected and they were identified also by microscopic way. These collections are now part of the Bryophyte Herbarium of BP.

The earlier collections (specimens of the Bryophyte Herbaria of BP and EGR) have mostly been revised. The following sources were consulted during this study: publications, floristical notes of BOROS (1915–1971) and VAJDA (1933–1978) (preserved at BP), the bryological collections of BP and those of Botanical Department of EKF (EGR) and the Bryophyte Herbarium of Zoltán Tóth (Dept. of Plant Taxonomy and Ecology, L. Eötvös University).

RESULTS

Section *Sphagnum*

This section is easily recognisable, because the species are normally large and robust, with distinct capitula and tumid branches. In Hungary, it can be confused only with *S. squarrosum*, but the branch leaves of the latter are mostly squarrose. In Hungary, 3 species of this section may be found and all of them occur in the investigated area.

Sphagnum palustre L.

It is a robust, normally pale green plant with brown or red-brown stem. It can be undoubtedly distinguished from *S. centrale* and from the green form of *S. magellanicum* with microscopic investigation. The stem leaf is large, spatulate and usually fibrillose. The cross section of branch leaf is typical for the species: the green cells are triangle to trapezoid shape and highly inflated on the abaxial (dorsal) and slightly on the adaxial (ventral) leaf surface (DANIELS and EDDY 1985).

In Hungary, *S. palustre* is relatively widespread, it lives in bogs, fens, willow or alder swamps, on forest soil and on moist roadside embankments.

In North Hungary it is also widespread (Table 1). Nowadays it can be found in Nyírjes-tó, Nagy-Mohos, Kis-Mohos, Báb-tava and Nyíres-tó and in the Zemplén Mts. It was found in Lókosár in 1999 (SOMLYAY and LŐKÖS 1999). In the last decades it has disappeared from Navát and Futyó-völgy, and became less frequent in Nyírjes-tó (SZURDOKI and NAGY 2002). In 1994 it was reported from Kis-tó (KRÖEL-DULAY 1995), but later has disappeared. The largest population lives in

Báb-tava in various associations (e.g. *Carici lasiocarpae-Sphagnetum*, *Eriophoro angustifolii-Sphagnetum*, *Salici cinereae-Sphagnetum*). It also has large populations in the Mohos lakes both in open and closed associations (SZURDOKI *et al.* in press). Earlier *S. palustre* were published also from the Komlóska and Kemence valley (Zemplén Mts), but the recent revision had proven that besides that, some *S. centrale* specimens were also found among those labelled as *S. palustre* (SZURDOKI *et al.* 2000). In the past few years nobody has collected *S. palustre* from these valleys, but it has new record from the meadow called Tó-oldal (Zemplén Mts) at the foot of Nagy-Bekecs hill (SZURDOKI *et al.* 2000).

Although decreases and some populations have disappeared, *S. palustre* is still relatively frequent in North Hungary.

Sphagnum centrale C. Jens.

The macroscopic characteristics of this species are similar to those of *S. palustre*, but in the field (by magnifier) they are not easily distinguishable. The main microscopic difference is that the green cells of the branch leaf in cross section are oval shaped and strongly thickened in the adaxial walls (DANIELS and EDDY 1985).

S. centrale is rare in Hungary, there are some populations in North and West Hungary. In the western part it lives in the intermediate mire of Alsó-erdő near Kőszeg (BOROS 1964, SZÖVÉNYI 1998) and from the year 1955 it has one old herbarium specimen from the Őrség region, but it has disappeared since then (ÓDOR *et al.* 2002).

It is also rare in North Hungary (Table 1), occurring in bogs and fens. Earlier it has lived in Kis-tó (BOROS 1964, DULAI and VOJTKÓ 1991), Kis-Mohos and Nagy-Mohos (ZÓLYOMI 1931, BOROS 1964) and in the Zemplén Mts (SZURDOKI *et al.* 2000). Though in 1994 it existed there (KRÖEL-DULAY 1995), it has probably disappeared from Kis-tó, because no subsequent search could record it. Earlier, *S. centrale* was collected from *Salix* dominated parts of Mohos lakes (ZÓLYOMI 1931, CZENTHE 1985), but according to recent investigations it occurs only in the *Betulo pubescentis-Sphagnetum* community of Nagy-Mohos and in the *Eriophoro angustifolii-Sphagnetum* community of Kis-Mohos (SZURDOKI *et al.* in press). In the Zemplén Mts it dwells in fens of the Komlóska and Kemence valleys. Earlier collections have been identified as *S. palustre* (SZURDOKI *et al.* 2000).

The populations of *S. centrale* appear to be stable in the Zemplén Mts, however, their size has decreased. To estimate its frequency in Mohos lakes is very difficult because of its great similarity to *S. palustre* in the field. It cannot be excluded

Table 1. The presence of the peat moss species of *Section Sphagnum* by locations of North Hungary. Key: O = old data, which were not confirmed in 1990's, C = confirmed earlier data, N = only new data (from 1990's), N* = new data, which were published in 1990's, but they disappeared in 1990's. Abbreviations: 1 = Csömöri-tó, 2 = Nádas-tó, 3 = Nyírjes-tó, 4 = Kis-tó, 5 = Nagy-tó, 6 = Futyó-völgy, 7 = Csipkés-kút, 8 = Kis-Mohos, 9 = Nagy-Mohos, 10 = Kis-Mohos and Nagy-Mohos, 11 = Lókosár, 12 = Zemplén Mts, 13 = Nyíres-tó, 14 = Báb-tava, 15 = Bence-tó, 16 = Zsid-tó, 17 = Navat, 18 = Bátorliget Nature Reserves, 19 = Júlia-major.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Section Sphagnum																			
<i>S. palustre</i>			C	O				C	C		N	C	C	C					O
<i>S. centrale</i>				O				C	C			C							
<i>S. magellanicum</i>			C					C	O			N	C		N*				O
Section Acutifolia																			
<i>S. quinquefarium</i>												C							
<i>S. capillifolium</i>				O		O	O	N	C			N							
<i>S. fimbriatum</i>	O	N	C	O				C	C		N	N		N	N*	N			N
Section Squarrosa																			
<i>S. squarrosum</i>	O	C	O	O	N			C	C			N	N	N	N*	N			N
<i>S. teres</i>				O				O	O			O				O			
Section Subsecunda																			
<i>S. subsecundum</i>			O							O		N					N		
<i>S. contortum</i>									O			C					N		
Section Cuspidata																			
<i>S. riparium</i>												N							
<i>S. cuspidatum</i>				N					C										
<i>S. obtusum</i>				C	C							N	N						
<i>S. fallax</i>	O	N	C					N	C			N	C	N					
<i>S. angustifolium</i>		N	C	O				C	C			N	N	C					O
<i>S. flexuosum</i>			O					N	C			N	C	C					
<i>S. recurvum s. lato</i>					N														N*
Section Rigida																			
<i>S. compactum</i>						O						N							

that, it still lives in *Salix* dominated areas. *S. centrale* populations of North Hungary are the most important ones in whole Hungary.

Sphagnum magellanicum Brid.

It is a robust plant and from anthocyan, in light is red coloured. It is easily recognisable in the field based on its colour and size, but the shade forms, which are green, can be undoubtedly determined only by microscopic examination. The cross sections of spreading branch leaves are typical, the small and oval-shaped green cells are enclosed into the large hyaline cells (DANIELS and EDDY 1985).

It is rare in all parts of Hungary, with most of the occurrences in North Hungary; in West Hungary it is extremely rare (ÓDOR *et al.* 2002).

It still lives in Nyírjes-tó, Kis-Mohos, Nyíres-tó and there is a new occurrence from the Zemplén Mts. It has disappeared from two mires of the Bereg Plain (Table 1).

From Mohos lakes, only Kis-Mohos has recent records of this species. It lives in the central part of the mire in the following associations: *Betulo pubescens-Sphagnetum*, *Eriophoro vaginati-Sphagnetum* and *Sphagno flexuosi-Eriophoretum angustifolii* (LÁJER 1998a, SZURDOKI *et al.* in press). Earlier it was also published from the central part of Nagy-Mohos (ZÓLYOMI 1931, BOROS 1964, and CZENTHE 1985). The new and old distribution data show that *S. magellanicum* prefers the central, open and most nutrient poor sites.

In the Bereg Plain, a small population of *S. magellanicum* still lives in Nyíres-tó. It forms small patches on the side of small hummocks in *Eriophoro vaginati-Sphagnetum*. Its amount has increased in the past few years (LÁJER 1998a, SZURDOKI and NAGY 2002). Earlier it had much higher abundance (SIMON 1960, FINTHA 1994, LÁJER 1998a) but in the mid-1990s, when this bog became much drier, *S. magellanicum* has almost disappeared. It lived in Navat (SIMON 1960), but after the fire in 1967 it has disappeared (FINTHA 1994). FINTHA (1994) also published *S. magellanicum* from Bence-tó as being abundant, but neither earlier nor later this species was found there.

S. magellanicum lived in Nyírjes-tó in the past decades (MÁTHÉ and KOVÁCS 1958, BOROS 1964). It was collected from the central, open part (MÁTHÉ and KOVÁCS 1958). In the 1990s the author found only a few amount of *S. magellanicum* on the top of a small hummock in *Carici lasiocarpae-Sphagnetum* community.

A new, interesting occurrence of the species was discovered in the Zemplén Mts in the valley of Suta-patak, where it lives on wet soil (SZURDOKI *et al.* 2000).

Presumably this is only a temporary establishment, like the one in the Órség region (ÓDOR *et al.* 2002).

The populations of *S. magellanicum* mainly live in nutrient poor parts of bogs. In European mires it can be found on the lower part of hummocks, relatively far from the water table. In Hungarian mires, the hummock-hollow system is not really visible, but small hummocks have developed around trees and herbs and sometimes *S. magellanicum* lives on these hummocks. Both the number and size of the populations of *S. magellanicum* has decreased in the past decades in North Hungary. It was a rare species earlier also, but recently it became endangered.

Section *Acutifolia*

The species of this section have an interesting pattern of distribution in Hungary. Except for *S. fimbriatum*, they can be found on wet and acidic forest soil, wet road embankments and ditches but they rarely occur in mires. Members of this section are medium-sized, rarely robust, usually with well-developed capitulum and often with red or brown pigmentation (except for *S. fimbriatum* and *S. girgensohnii*). They have well-developed cortex, and their stem leaves are rarely smaller than 1.2 mm. The shape of the stem leaves is variable among species; they are of great help in field identification. The cross section of branch leaves is typical for the section: the hyaline cells are triangular or trapezoid and widely exposed on the adaxial (ventral) leaf surface (DANIELS and EDDY 1985).

Eight species of this section are found in Hungary (*S. fimbriatum*, *S. girgensohnii*, *S. capillifolium*, *S. rubellum*, *S. quinquefarium*, *S. russowii*, *S. warnstorffii*, *S. subnitens*, ORBÁN and VAJDA 1983, ÓDOR *et al.* 1996, SZURDOKI 1996, LÁJER 1998*a, b*, SZURDOKI *et al.* 2000, 2001, in press), in Europe 13 (DANIELS and EDDY 1985) and in North Hungary only three of them (Table 1).

Sphagnum quinquefarium (Braithw.) Warnst.

It is medium-sized, normally pale green coloured plant with red or pink flack; in Hungary it is rare. Characteristic features are the 3 spreading branches per fasciculum, strictly 5-ranked branch leaves and the porose stem cortex. This species is absent from mires, lives under shrubs and in woodlands (DANIELS and EDDY 1985).

It is not frequent in Hungary occurring mainly in the western part of the country, on acidic forest soils.

In North Hungary it lives only in the Zemplén Mts (Table 1). On the northern slope of Lackó-hegy, near Kishuta, very small, only a few dm²-sized patch of *S. quinquefarium* grows on the humus-covered rock, in the shade of old beech trees (SZURDOKI *et al.* 2000). This occurrence was reported earlier as a fairly large, of several m²-sized patch of *S. capillifolium*, but later revised as *S. quinquefarium* (VAJDA 1933–78, SOÓ 1938, BOROS 1953, 1964, 1968, 1969, SIMON 1977a, b).

This isolated small patch of the species is very sensitive and endangered. The species abundance has decreased in the past decades, and there is a real danger of becoming extinct from this region.

Sphagnum capillifolium (Ehrh.) Hedw.

Normally the patches of *S. capillifolium* in Hungary are compact, but sometimes lax and variable in height. It is pale green coloured with red flacks or sometimes the upper part is overall red. Characteristic features are the more or less hemispherical capitula, the two spreading branches per fasciculum, the non 5-ranked branch leaves, the fibrils in the upper part of the stem leaf and the relatively large (10–15 µm) abaxial pores of the branch leaves (DANIELS and EDDY 1985).

In Hungary, similarly to *S. quinquefarium*, it lives mainly on wet, acidic forest soils, and appear only rarely in mires (*e.g.* in the intermediate mire near Kőszeg called Alsó-erdő, SZÖVÉNYI 1998).

S. capillifolium was also reported from North Hungary (Table 1). On the basis of publications and herbarium material it lived in Kis-tó (JUHÁSZ 1963, DULAI and VOJTKÓ 1991), in Nagy-Mohos (BOROS 1924, 1926, ZÓLYOMI 1931), in the Futó-völgy (BAKALÁR *et al.* 1975) and in Csipkés-kút (SIROKI 1961). Nowadays it lives in Nagy-Mohos and Kis-Mohos and it has a recently discovered local population in the Zemplén Mts. In Kis-tó it was not found in the past decade.

In Nagy-Mohos and Kis-Mohos, *S. capillifolium* mainly lives in the central part of the bogs, but relatively far from the water table and sometimes it forms small hummocks. The small patches of the species can be found in *Carici lasiocarpae-Sphagnetum*, *Eriophoro vaginati-Sphagnetum recurvi* and in *Salici cineruae-Sphagnetum recurvi* (ÓDOR *et al.* 2000, SZURDOKI *et al.* in press).

In the Zemplén Mts it has a relatively small, 0.5 m²-sized patch on the floor of *Vaccinium-Betula* heath near Füzér. This occurrence is similar to the habitat of *Sphagnum* patches of the forests of Vendvidék and Őrség (SZURDOKI *et al.* 2000).

S. capillifolium is still rare in this region, but more abundant in the western part of the country. All North Hungarian populations are very small. *S. capilli-*

folium will presumably thrive in Mohos lakes in the future, but the survival of the small patch in the Zemplén Mts is very doubtful.

Sphagnum fimbriatum Wils.

Variable in size, but the capitula are always small with a conspicuous, projecting stem bud. It is pale green coloured and never has red flacks. The stem leaves are characteristic; large, shortly spatulate, the apex very widely rounded and distinctly fimbriate (DANIELS and EDDY 1985).

20–30 years ago it was relatively rare in Hungary, in the 1970s we have known only 10 occurrences, in the 1980s 3 new locations were found and in the 1990s 22 new *S. fimbriatum* occurrences had been described. Four earlier known occurrences extinct in the meanwhile. In the past decades *S. fimbriatum* were found in most areas where *Sphagna* live. Nowadays it lives in bogs, intermediate mires, fens and willow or alder swamps, on moist roadside embankments and in temporarily wet places with occasional runoff and also in forests (SZURDOKI and ÓDOR in press).

Recently, *S. fimbriatum* is not rare in North Hungary, and in comparison with earlier known data it has a broad, though scattered, distribution (Table 1). The earlier known occurrences of *S. fimbriatum* were published from Kis-tó in the 1880s (BORBÁS 1886), from Nagy-Mohos in 1960 (BOROS 1915–71, VAJDA 1933–78, BOROS 1964), and from Csömöri-tó in 1976 (STOLLMAYER-BONCZ 1982). In the 1980s this species was found in the Nyírjes-tó (BAKALÁR 1981) and in Kis-Mohos (CZENTHE 1985). In the past decade (1990s) it was found in Nádas-tó (LÁJER 1998a, b), in Lókosár (SOMLYAY and LÓKÖS 1999), in three places in the Zemplén Mts (SZURDOKI *et al.* 2000), in Bence-tó, Báb-tava and Zsid-tó in the Bereg Plain (NAGY and FIGECZKY 1998, SZURDOKI and NAGY 2002), and in Júlia-liget near Piricse in the Nyírség (JAKAB and LESKU 1995). From three earlier colonised mires (Kis-tó, Csömöri-tó and Bence-tó) *S. fimbriatum* is extinct.

S. fimbriatum lives in different types of mires, but occurs mainly under willow shrubs. In the Zemplén Mts it grows on open wet soil and in Lókosár on dead wood and soil in broad-leaved forest. This species is distributed not only in the investigated area, but in all peat moss-occupied areas. This is one of the most frequent peat mosses in North Hungary. The populations appear to be viable with good dispersal possibilities (frequent sporophyton and good vegetative reproduction), therefore these populations presumably will thrive in the future. SZURDOKI and ÓDOR (in press) studied its expansion in past decades and its habitat preferences in detail.

Section Squarrosa

These plants are small to robust, usually medium-sized with green or yellowish colour. They have a prominent, projecting stem bud on large capitulum. Stem leaves are large and lingulate with thin border. There are two species in this section in the Northern Hemisphere with circumboreal distribution. Both have records from Hungary including North Hungary. They grow in mesotrophic to rather eutrophic habitats.

Sphagnum squarrosus Crome

This is a robust moss with large capitula with conspicuous stem bud and characteristic, spreading branch leaves. It has pale green colour and large ovate stem leaf. The typical plants are easy to recognise because of their robust and dishevelled appearance (DANIELS and EDDY 1985).

S. squarrosus occurs in different parts of Hungary, but is relatively rare, and the habitats of several old occurrences are damaged. It lives mainly in alder and willow swamps (ORBÁN and VAJDA 1983).

S. squarrosus has numerous old and new records from North Hungary, too (Table 1). Earlier it was reported from Csömöri-tó (STOLLMAYER-BONCZ 1982), from Nádas-tó (MÁTHÉ and KOVÁCS 1959), from Nyírjes-tó (BOROS 1964), from Kis-tó (DULAI and VOJTKÓ 1991), from Kis-Mohos and Nagy-Mohos (ZÓLYOMI 1931, BOROS 1964, CZENTHE 1985). Nowadays, this species is present in Nádas-tó, in Kis-Mohos and Nagy-Mohos from earlier reported locations and new populations were found in the Zemplén Mts, Nagy-tó, Báb-tava, Nyíres-tó, Zsid-tó and Júlia-liget.

In Mohos lakes it lives not only in *Salix* dominated communities, but also occurs in open areas and birch dominated parts (SZURDOKI *et al.* in press). In the Zemplén Mts it is found along springs and streams (Tegda-völgy and Suta-patak, SZURDOKI *et al.* 2000) and in Nagy-tó under *Salix* shrubs (DULAI and VOJTKÓ 1991). In Báb-tava and Nyíres-tó it mainly lives in alder dominated parts, but in Nyíres-tó has only a small population, being a remnant of the dry period over a decade ago (NAGY 2002). *S. squarrosus* could have lived in the willow or alder swamps of Nyíres-tó and Báb-tava earlier, but the first data come only from the 1990s (LÁJER 1998a, b, NAGY 2002). It had a relatively large population in the *Salix* swamp of Bence-tó, but it (as all *Sphagna*) has disappeared when the basin was filled by water in 1998 (NAGY *et al.* 1998, NAGY 2002). It was found on floating mats of Zsid-tó in 1999 (by Szurdoki and Zoltán Tóth). There is a small patch

of *S. squarrosum* in Júlia-liget (JAKAB and LESKU 1995, 1996, JAKAB 1997) on the soil of a *Salici pentandrae-Betuletum pubescentis* forest.

Some populations have disappeared, while there are numerous new *S. squarrosum* populations in this region. These are of great importance, because this species has become very rare in other parts of Hungary. It still has relatively large populations in Nádas-tó and in the Zemplén Mts, but the others are small. The largest population has disappeared from Bence-tó by natural water replenishment, and this process also pointed out the sensitivity of this species. In the western part of Hungary, the recent process of desiccation of swamps decreases its potential habitats (ÓDOR *et al.* 2002).

Sphagnum teres (Schimp.) Ångstr.

Small to medium-sized plant with conspicuous stem bud. It has green or sometimes brown colour. Stem is normally pale to dark brown and the stem leaves are large, mostly lingulate with eroded apex. Branch leaves are large, closely overlapping and only apices divergent slightly (DANIELS and EDDY 1985).

S. teres is a rare peat moss in Hungary, and most of its earlier known populations have disappeared.

In North Hungary it is also very rare (Table 1); earlier it lived in Kis-tó (DULAI and VOJTKÓ 1991), Kis-Mohos (CZENTHE 1985), Nagy-Mohos (SZURDOKI *et al.* in press), in the Zemplén Mts (VAJDA 1969) and in Zsid-tó (FINTHA 1994) (Table 1). All five populations have disappeared by the end of the 1990s. No new data of this species have been recorded neither from North Hungary nor from the other parts of the country. Presumably, most of the earlier populations are damaged.

Section *Subsecunda*

The species of this section are variable in size, colour and ecology. Their stem always has cortex (1–3 layers of hyaline cells) and the internal cylinder is occasionally brown. Branches are usually short, blunt-ended and curved, especially the spreading ones (DANIELS and EDDY 1985). In Hungary, most of their populations live in habitats of relatively high pH and in areas of considerably changing water table.

Of this group 5 species (*S. subsecundum*, *S. inundatum*, *S. auriculatum*, *S. platyphyllum* and *S. contortum*) live in Europe and all of them were described from Hungary (DANIELS and EDDY 1985, ORBÁN and VAJDA 1983), but *S. inundatum*

and *S. denticulatum* were not found in the past decades. Only 2 species live in North Hungary: *S. subsecundum* and *S. contortum* (Table 1).

Sphagnum subsecundum Nees in Sturm

It is a small to medium-sized, never robust plant, its colour is varied from green to orange. Stem is always deep brown coloured with 1 layer of hyaline cells. Triangular-lingulate stem leaves are small with few fibrils around the apex. Generally it prefers mesotrophic mires but sometimes lives under oligotrophic conditions (DANIELS and EDDY 1985).

In Hungary it lives in intermediate mires, spring mires, fens and sometimes in willow swamps. It is relatively common in Hungary, occurring mainly in the western part of the country. Like in other parts of Europe, it prefers mesotrophic conditions.

S. subsecundum has only a few records from North Hungary (Table 1). Earlier it was known from Nyírjes-tó (MÁTHÉ and KOVÁCS 1958, BOROS 1964, BAKALÁR 1981) and from Mohos lakes (SZURDOKI *et al.* in press). Presently it lives in the Zemplén Mts and in Zsid-tó.

In Nyírjes-tó it lived in different communities from the edge of the bog to the central part (MÁTHÉ and KOVÁCS 1958, BAKALÁR 1981), but in the past decade it has disappeared.

It was also collected from Mohos lakes by Zólyomi, but it is not clear from which bog of the two (see also SZURDOKI *et al.* in press, SZURDOKI and NAGY 2002). It had not been collected from there recently.

In the Zemplén Mts one occurrence was found by SZURDOKI and her colleagues at the end of the 1990s, on a wet, *Calamagrostis canescens* dominated meadow. There are numerous *S. subsecundum* patches and also *S. fallax* and *S. palustre* in the 50 m²-sized place (SZURDOKI *et al.* 2000).

There is a new population from the Bereg Plain, too. In the small floating mire of Zsid-tó, a few patches of *S. subsecundum* were found under willow bushes by E. SZURDOKI and Z. TÓTH in 1999.

This species was already rare in North Hungary in the first part of the 20th century, but all earlier known populations have disappeared and presently only two new, small populations exist there. There is a high probability of having *S. subsecundum* soon to be extinct from this region.

Sphagnum contortum Schultz.

It is a slender plant with yellowish, brown or ochre colour. Stem is pale-coloured (green or brown) with 2–3 well-developed layers of hyaline cells. Stem leaves are small and fibrillose near the apex. It tolerates relatively high nutrient content (DANIELS and EDDY 1985).

It is not rare in Hungary, but it has higher abundance in the westernmost part of the country. It usually lives in fens and sometimes in intermediate mires.

In northern Hungary it only has a few occurrences (Table 1). Earlier it lived in Nagy-Mohos (ZÓLYOMI 1931), but it has not turned up during recent searches (SZURDOKI *et al.* in press). In the fens of the Komlóska and Kemence valley it has a large and relatively stable population, *S. contortum* is the most frequent peat moss there. Earlier it lived in 3 different locations along these streams and now it lives in 4 places (BOROS 1915–71, VAJDA 1933–78, SIMON 1977, SZURDOKI *et al.* 2000). There is a new population of *S. contortum* on one floating island of Zsid-tó (unpublished data of E. Szurdoki and Z. Tóth from 1999).

S. contortum has stable populations in the Zemplén Mts, which survived the drier periods in the end of the 20th century. It will probably thrive there in the foreseeable future.

Section *Cuspidata*

The species of this section usually are medium-sized, sometimes small or robust. Their colour is green or brown, but never red (DANIELS and EDDY 1985). In Europe 13 species can be found, 6 of them live in Hungary, and all of these occur in North Hungary. Some of these are locally frequent, as *S. angustifolium* and *S. fallax*, while others are locally rare like *S. riparium* and *S. cuspidatum* (ORBÁN and VAJDA 1983, DANIELS and EDDY 1985, LÁJER 1998a, b, SZURDOKI *et al.* 2000).

The *S. recurvum* complex was divided into numerous species (*e.g.* ISOVIITA 1966, DANIELS and EDDY 1985, FLATBERG 1991, 1992), and from them *S. flexuosum*, *S. fallax* and *S. angustifolium* live in Hungary. Since most available publications used only the name *S. recurvum* (*e.g.* ZÓLYOMI 1931, SIMON 1960, BOROS 1964, CZENTHE 1985, Dulai and Vojtkó 1991, Standovár *et al.* 1991), the earlier distribution of these species (which would be based on a few collections only) cannot be clearly established, and based only on the herbarium material of BP. Another difficulty is that usually two of them live together in one locality and sometimes not easy to distinguish them.

There are two data of *S. recurvum s. lato*, which were not revised by the author. The first was recorded from Nagy-tó (Dulai and Vojtkó 1991) and it is still

living there. The second was published from the Bátorliget Nature Reserves (Standovár *et al.* 1991) but it has disappeared.

Sphagnum riparium Ångstr.

This is a robust plant with green or brownish colour. The dark stem, conspicuous stem bud and the triangular-lingulate stem leaves with deeply notched tip are characteristic (DANIELS and EDDY 1985).

There is only one small population of this species in Hungary. It lives in a few dm²-sized patches in the upper part of the Köves-patak, in the spruce stand of "Kis-Bohó-rét" in the Zemplén Mts. There is a mixed patch composed of *S. fimbriatum*, *S. obtusum* and *S. riparium* and there are some *S. fimbriatum* patches also. *S. riparium* is a relatively new record for the present territory of Hungary (SZURDOKI *et al.* 2000). It does not appear to be a very stable population, and its survival at the present site is questioned (Table 1).

Sphagnum cuspidatum Hoffm.

This is a weak, long and usually floating plant. The long and narrow branches and large branch leaves are of great help in the identification. The non-typical specimens can be identified with difficulties (DANIELS and EDDY 1985).

The first unpublished record of *S. cuspidatum* comes from 1951 in Hungary. Later, Lájér published it as new species from Hungary (LÁJÉR 1998a, b).

The above mentioned first record is from North Hungary, Nagy-Mohos by Pirooska Palik (Bryophyte Herbarium at BP) and in 2000 this species was found again during the monitoring of the bryophyte layer of *Eriophoro vaginati-Sphagnetum recurvi* association of Nagy-Mohos (ÓDOR *et al.* 2000, Szurdoki *et al.* in press). Lájér (1998b) published this species from the *Caricetum lasiocarpae-Sphagnetum* community of Nyíres-tó. The author did not find *S. cuspidatum* on Nyíres-tó.

There are the only known occurrences of *S. cuspidatum* in North Hungary (Table 1). It seems to be a stable one, but the size of the populations is not known.

Sphagnum obtusum Warnst.

This plant is medium-sized to robust with green, yellowish or brownish colour. The stem cortex is distinguishable and the triangular-lingulate stem leaves have broadly truncate, eroded apices (0.2–0.3 mm across tip). The branch leaves are relatively large (1.8–2.2 mm). The hyaline cells have few pores (7–10 µm) on

the adaxial surface, but it only after strong staining can be visible. In the lower lateral part of the branch leaves have numerous small ($2\ \mu\text{m}$) pores in the mid-line of hyaline cells. The photosynthetic cells of stem leaves are triangular in cross section, and they are widely exposed on the abaxial and only shallowly on the adaxial surface (DANIELS and EDDY 1985).

In Hungary it is rare. It lives in bogs, intermediate mires and sometimes fens.

S. obtusum is also infrequent in North Hungary (Table 1). Earlier (before the 1990s) it was published from Nyírjes-tó (BAKALÁR 1981) and Kis-tó (BOROS and VAJDA 1960). In 1994 the author collected it from Nyíres-tó and Nyírjes-tó, but could not find it again. VOJTKÓ and MARSCHALL (1991) published the occurrence of *S. obtusum* from Kis-tó in the early 1990s, but subsequent search by the author in 1994 was unsuccessful. *S. obtusum* has another occurrence in the Zemplén Mts, where it lives in a waterlogged place near Köves-patak (SZURDOKI *et al.* 2000).

The survival of *S. obtusum* in North Hungary is very doubtful. The small patch in the Zemplén Mts is threatened. Its presence in Nyíres-tó and Nyírjes-tó is possible, but presumably in very small amounts. Additionally, it has fewer and fewer occurrences in the whole territory of Hungary. On the basis of ORBÁN and VAJDA (1983) it lived in numerous places, but the presence records reflect a strong decrease of the species.

Sphagnum fallax (Klinggr.) Klinggr.

This is a medium-sized plant with pale green colour. The stem cortex is distinguishable. Stem leaves are mostly isosceles triangular shaped with acute apices. Branch leaves are clearly 5-ranked and the hyaline cells of pendent branch leaves have medium-sized pores ($8\text{--}12\ \mu\text{m}$) on the abaxial surface (DANIELS and EDDY 1985).

In Hungary it lives in bogs, intermediate mires and fens, and sometimes in willow or alder swamps. Relatively common peat moss species, which occurs in most regions, where *Sphagna* live in Hungary.

Until the 1990s *S. fallax* was not recorded from Hungary, because most bryologists used the name *Sphagnum recurvum s. l.* The revision of the *S. recurvum s. l.* material of the Bryophyte Herbarium of BP resulted in the recognition of numerous *S. fallax* specimens from North Hungary (and of course from other parts of Hungary, too): Csömöri-tó, Nyírjes-tó, Nagy-Mohos and Nyíres-tó (Table 1). Recent records are from Nádas-tó, Nyírjes-tó, Mohos lakes, Zemplén Mts, Báb-tava and Nyíres-tó (Table 1).

LÁJER (1998a) published the occurrence of *S. fallax* from Nádas-tó. The author has also made collection there (in 1997 with Peter Erzberger), but of the *S.*

recurvum complex only *S. angustifolium* was collected. A possible answer for the difference in the identification is found with the description of *S. angustifolium* (see below).

From Nyírjes-tó it was collected earlier (recent revision of *S. recurvum* specimens of BP). Nowadays it is living in the open area (*Caricetum lasiocarpae-Sphagnetum*) and in a willow dominated part (*Salici cinereae-Sphagnetum*) (KRÖELDULAY 1995, LÁJER 1998a and the collections by the author in 1994, 2000).

S. fallax also present in the Kis-Mohos and Nagy-Mohos. The author has found it in most of the important communities (SZURDOKI *et al.* in press), but LÁJER (1998a) published it only from the open parts of the two bogs (*Carici lasiocarpae-Sphagnetum*) and from the *Betulo pubescentis-Sphagnetum* of Nagy-Mohos.

In the Zemplén Mts, it can be found around springs, in waterstanding places, on moist roadside embankments and on wet forest soils. All of these (in the Zemplén Mts) are relatively new establishments (SZURDOKI *et al.* 2000).

In Nyíres-tó *S. fallax* is frequent, it can be found in *Eriophoro vaginati-Sphagnetum* and *Betulo pubescentis-Sphagnetum* (LÁJER 1998a, b, PAPP *et al.* 2000 and collections by the author in 1994, 1999, 2000). Báb-tava also contains *S. fallax* (LÁJER 1998a), but the author has collected it only in 1994 and later only *S. angustifolium*.

To sum up, *S. fallax* is relatively widespread in North Hungary. It occurs in larger mires with relatively high abundance. It appears that *S. fallax* will thrive in the upcoming decades.

Sphagnum angustifolium (Russ.) C. Jens. in Tolf.

This is a medium-sized or smaller plant with green or sometimes brownish colour. The stem cortex is not distinct and the stem leaves are equilateral triangle shaped with eroded apices. The branches are dimorphic, the pendent ones are thinner and longer, than the spreading ones. The branch leaves are not consistently 5-ranked. The hyaline cells of pendent branch leaves are wider in the apical end than the basal end (best observed in lower-lateral part of the leaf) and there are numerous large pores (12–18 μm) in the apical angles on the abaxial surface (DANIELS and EDDY 1985).

In Hungary, numerous specimens were collected, which show mixed characteristic features of *S. fallax* and *S. angustifolium*. The most frequent combination is the following: more or less equilateral shaped stem leaves with acute apices, large (>15 μm) resorption gaps (or pores) in the apical end of hyaline cells of pendent branch leaves and the stem cortex is not or only very shallowly distinct. These

specimens were identified as *S. angustifolium* by the author (annotated with "cf" on the label of the specimens), on the basis of a remark made by DANIELS and EDDY (1985): "the large resorption gap in apical angles on the abaxial surface of pendent branch leaves are characteristic and stable features of *S. angustifolium*".

In Hungary it is a frequent peat moss, living in habitats similar to those of *S. fallax*: bogs, intermediate mires, fens, and sometimes in willow or alder swamps.

S. angustifolium is relatively frequent in North Hungary, too (Table 1). Earlier it was published only from Nyírjes-tó (BAKALÁR 1981), but it was also collected at Kis-Mohos and Nagy-Mohos (SZURDOKI *et al.* 2000), Kis-tó, Báb-tava, Navat (recent revision of the *S. recurvum* s. l. material of the Bryophyte Herbarium of BP by the author). Recently it occurs in Nádas-tó, Nyírjes-tó, Mohos lakes, Báb-tava and Nyíres-tó.

In Nádas-tó they live in a willow swamp. From the *S. recurvum* complex LÁJER (1998a, b) reported only *S. fallax*, while the author found only *S. angustifolium* (in 1997), but all specimens have the above mentioned mixed features. It lives in Nyírjes-tó, but mainly in associations of the middle part. Presently, it lives in all parts (associations) of Kis-Mohos and Nagy-Mohos, and in Kis-Mohos it seems to be more frequent than *S. fallax*. It also lives in the Bereg Plain, most frequently in Báb-tava, basically in all associations. In Nyíres-tó it occurs sporadically, in that locations *S. fallax* is the most frequent peat moss, while *S. flexuosum* is also present in higher amount.

S. angustifolium is also relatively widespread in North Hungary. Similarly to *S. fallax*, it is common in the larger mires. Generally speaking the future status of *S. angustifolium* appears safe and sound.

Sphagnum flexuosum Dos. et Molk.

This is a medium-sized plant, with green to ochre colour. The stem cortex is not distinguishable from the cortex and the triangular stem leaves have obtuse, rounded apices sometimes with a small notch on the tip. The branch leaves are not consistently 5-ranked and they are relatively large (up to 3 mm). The hyaline cells of pendent branch leaves are proportionately wider and have about 12 µm-sized pores on the adaxial surface. It is also an important feature that the photosynthetic cells are trapezoid shaped (in cross section) and exposed on both adaxial and abaxial surface (while *S. fallax* and *S. angustifolium* have triangular shaped photosynthetic cells and are exposed only on the adaxial surface) (DANIELS and EDDY 1985).

S. flexuosum is not frequent in Hungary, this is the rarest species of the *S. recurvum* complex. It lives in bogs, intermediate mires and fens.

Though unpublished, this species was earlier collected from Nagy-Mohos (SZURDOKI *et al.* in press) and Nyírjes-tó, Báb-tava and Nyíres-tó (recent revision of specimens of the Bryophyte Herbarium of BP). Presently it lives in Mohos lakes (LÁJER 1998, SZURDOKI *et al.* in press), in the Zemplén Mts (SZURDOKI *et al.* 2000), Báb-tava and Nyíres-tó (LÁJER 1998, collections of Szurdoki from 1994, 1999, 2000) (Table 1). Except for the small patch in the Zemplén Mts, all habitats of *S. flexuosum* is acidic and relatively poor in nutrients, it lives in various associations of bogs (*Eriophoro angustifolii-Sphagnetum*, *Sphagno flexuosi-Eriophoretum angustifolii*, *Eriophoro vaginati-Sphagnetum recurvi*, *Betulo pubescentis-Sphagnetum*). Except for Nyíres-tó, all occurrences represent relatively small populations. In the field, *S. fallax*, *S. angustifolium* and *S. flexuosum* are hardly distinguished from each other, thus it is very difficult to establish their distribution in mires or even in associations. LÁJER (1988) has published numerous occurrences from the western part of the country from fen communities.

S. flexuosum is still relatively rare in North Hungary, but the populations do not appear threatened or endangered.

Section *Rigida*

This is a relatively small section, represented in Europe by two species (*S. compactum* and *S. strictum*), of which only *S. compactum* occurs in Hungary. These are robust but low growing plants. In some respect they resemble those of section *Sphagnum*, but the species of that section have large stem leaves while members of section *Rigida* have small ones.

Sphagnum compactum DC. in Lamarc and De Candolle

This is a robust and very low growing plant. It forms very dense cushions or compact mats. The colour of plant is whitish-green and sometimes brownish. It has small capitula, which usually concealed by the branches (DANIELS and EDDY 1985). The very small stem leaves distinguish it from *S. palustre*, which also has low growing form in drier places in Hungary.

S. compactum has only a few small populations in Hungary, beside the ones North Hungary it lives in the mire of Kőszeg (Alsó-erdő, SZÖVÉNYI 1998), while it seems to have disappeared from the Vendvidék (SZURDOKI 1996, ÓDOR *et al.* 1996).

In North Hungary, in the Zemplén Mts SZURDOKI *et al.* (2000) reported the occurrence of *S. compactum* from "Borzás-oldal" (in the Komlóska-völgy). The

cushion, covering 1–1.5 m², is the only Hungarian population that has sporophyte. According to earlier data (BAKALÁR *et al.* 1975) it lived in Futyó-völgy on acidic soil, but since that time all *Sphagna* have disappeared from there (SZURDOKI and NAGY 2002) (Table 1).

The population in the Zemplén Mts seems to be stable. In overall, *S. compactum* is very rare, but it will probably thrive in the following decades.

CONCLUSIONS

The *Sphagnum* dominated stands and *Sphagnum* occurrences of North Hungary were thoroughly investigated in the last century. The numerous published data and specimens in herbaria provide good basis for comparison of old and recent distribution of the species. Peat moss occurrences of 18 habitats in North Hungary, which are mostly mires and one is a mountain (Zemplén Mts) have been recently investigated.

Of the 17 investigated peat moss species one is a new record (*S. riparium*) and one (*S. teres*) has disappeared, while the others are apparently still present in North Hungary. The distribution of all species has changed, some species have disappeared from certain mires (or from other habitats) and established in others. In North Hungary *S. fimbriatum* become most frequent in the past decade. This is similar to the trend seen in other parts of Hungary, too.

The condition of mires and other habitats (fens, forests) has changed in the past decades, and these changes have considerably influenced the fine distribution of the peat mosses. The amount of peat moss species has decreased or increased locally and in extreme cases some species have disappeared. The most *Sphagnum* species appeared in new locations (while disappear from others), but these dynamics do not necessarily correspond with the general conditions of the mires.

S. angustifolium, *S. fallax*, *S. fimbriatum* and *S. palustre* seem to have stable populations and it can be safely stated that they will thrive in the foreseeable future. The rest of the species (*S. compactum*, *S. contortum*, *S. cuspidatum*, *S. quinquefarium*, *S. riparium* and *S. subsecundum*) with only few recently existing populations are very sensitive and their long term survival is doubtful.

Although all peat mosses and mires are protected by law in Hungary, their preservation requires more attention and active intervention of conservationists.

* * *

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