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CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF THE ALCSÍK BASIN, ROMANIA

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Abstract: A recent investigation on the bryophyte flora of the Alcsík Basin resulted in recording 70 bryophyte taxa (5 liverworts and 65 mosses). Although declining in some aspects, the area still preserves very valuable bryophyte vegetation rich in elements characteristic for fens and mires. *Hamatocaulis vernicosus* is the most valuable species recorded, a bryophyte included in the Bern Convention, in the European Union Habitats and Species Directive, and in the Red data book of European bryophytes. Several other rarities in SE Europe occur in the investigated area, including *Breidleria pratensis*, *Dicranum bonjeanii*, *Drepanocladus polygamus*, *Philonotis marchica*, *P. caespitosa*, *Plagiomnium ellipticum*, *Polytrichum strictum*, *Scorpidium cossonii*, *Sphagnum* spp., and *Tomentypnum nitens*. Some of these, such as *Plagiomnium ellipticum* or *Tomentypnum nitens*, are very abundant and represent the largest populations recently recorded in SE Europe.

Key words: *Hamatocaulis vernicosus*, rare species, *Sphagnum*, wetlands

INTRODUCTION

Romania has 19 Ramsar sites with a total area of 1,156,448 ha designated as Wetlands of International Importance, that is 4.84% of the country's land surface. Not all wetlands of Romania are included in the Ramsar site system, one of these is the Csík Basin. When compared to the neighbouring countries, Hungary has 28 Ramsar sites with 233,927 ha, while Bulgaria has 11 Ramsar sites with 50,000 ha (<http://www.ramsar.org>).

The Csík Basin has been a very important wetland region in Romania, since almost 25% of the total area of fens was concentrated here. Unfortunately, these wetland complexes have been destroyed due to water regulation works started in the 1970s. Currently the small remnants of natural wetlands, hidden among agricultural fields, are legally protected and in 2007 these were declared Natura 2000 sites. However, this act has not been followed up by conservation manage-

ment and the state of these wetlands is continuously declining (KEREKES 2010). Most of the botanical surveys concerning the Csík Basin were carried out before or a few years after the water regulation works begun (NYÁRÁDY 1929, POP 1938, 1960, KRISTÓ 1958, GERGELY and RAȚIU 1973, RAȚIU and GERGELY 1974, 1975*a, b*, 1981, COLDEA and PLĂMADĂ 1977, RAȚIU 1980, MITITELU and SÁNTHA-ELEKES 1984, GERGELY *et al.* 1988), and only a few recent investigations were conducted in the area, mainly dealing with human activities affecting the state of the wetlands (JAKAB *et al.* 2007, KERÉKES 2010).

In spite of a long tradition of bryology in the region – though mostly focusing on the high mountains of the surroundings – only a few reports are available regarding the Alcsík Basin (JAKAB *et al.* 2007). Among these the most interesting result is a record of *Meesia hexasticha* from Borsáros wetland, Sîncrăieni (Csíkszentkirály), identified by Ádám Boros from the material collected by Gyula Nyárady E. (BOROS 1943*b*). The specimen was collected in 1925, but when investigating the same location in 1941 Boros did not find it again. His herbarium, deposited in the Hungarian Natural History Museum, Budapest (BP), on the other hand, contains a few (*ca* 30) other bryophyte specimens from the Alcsík Basin, including samples found around Sîncrăieni (Csíkszentkirály) (BOROS 1941, 1943*a*), Sînsimion (Csíkszentsimon) (BOROS 1941), Tușnadu Nou (Újtusnád) (BOROS 1942).

The present paper provides recent data on the bryophyte vegetation sampled during a field survey in 2013, carried out in the frame of a larger project aiming at the exploration of the flora and fauna occurring in the wetlands of the Alcsík Basin. Based on our findings, bryophyte conservation aspects are also discussed here.

MATERIAL AND METHODS

Study area

With an elevation range of 650–740 m, the Alcsík Basin is the southernmost part of the Csík Basin situated between Miercurea-Ciuc (Csíkszereda) and Băile Tușnad (Tusnádfürdő) at the eastern foothills of the Hargita Mts (Fig. 1). These wetlands are fed by limonite (iron hydrogen carbonate) rich spring waters (the local name is “borvíz”). The river Olt is dividing the *ca* 18 km long and 10 km wide basin from north to south. On the flysch base the sediment layer is made up of andesite and is covered by black meadow-, peat-, and bog soils. The water table is high (0–1.0 m). The climate is montane with significant temperature inversions, strongly affecting the flora of these peatlands, with annual mean temperature of 5.9 °C and average annual precipitation of 567 mm (KERÉKES 2010).

Common wetland types that can be found in the area are peaty reedbed, transitional fen, tall herb community, grey willow scrub; while non-tussock tall

sedge community, peat moss transition mire, rich fen, *Molinia* meadow, and alder swamp are rare (KEREKES 2010).

Methods

The investigation was carried out in August 2013. Romanian botanist colleagues, involved in researching the higher plant flora and vegetation, have previously surveyed the territory and provided us very detailed descriptions and GPS coordinates of the important wetland sites making our work more efficient. Our work plan mainly focused on wetlands and source areas, but in some cases specimens were collected from artificial rock walls or volcanic rocks found around the wet places.

The voucher specimens are preserved in the Herbarium of the Hungarian Natural History Museum, Budapest (BP). The nomenclature for liverworts follows GROLLE and LONG (2000), and for mosses HILL *et al.* (2006).

To evaluate the results from nature conservation aspect, the following literature sources were used: the Red data book of European bryophytes (ECCB 1995), the Checklist and the red list of the bryophytes of Romania (ȘTEFĂNUȚ and GOIA 2012), the Bryophyte red list of Serbia and Montenegro (SABOVLJEVIĆ *et al.* 2004), the Red list of the bryophytes of Bulgaria (NATCHEVA *et al.* 2006),

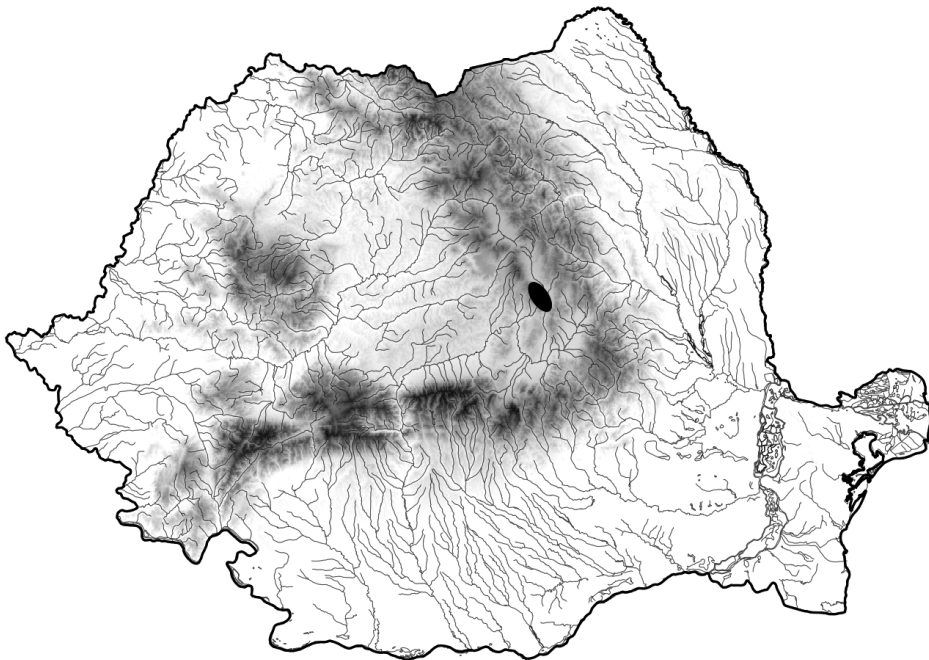


Fig. 1. Location of the investigated area.

the checklist and the red list of the bryophytes of Hungary (PAPP *et al.* 2010) and Ukraine (IGNATOV *et al.* 2006). The symbols of the threat categories used are as follows. In the red list of the bryophytes of Romania (ȘTEFĂNUȚ and GOIA 2012), Bulgaria (NATCHEVA *et al.* 2006) and Hungary (PAPP *et al.* 2010): CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, DD = insufficiently known and NE = not evaluated; in the bryophyte red list of Serbia and Montenegro (SABOVLJEVIĆ *et al.* 2004): EX = extinct, CR = critically endangered, EN = endangered, VU = vulnerable, LR = lower risk or near threatened and DD = data deficient.

Site details

1. Sincräieni (Csíkszentkirály), Borsáros wetland along river Olt, 46.31113° N, 25.83130° E, 650 m, 31.07.2013.
2. Sincräieni (Csíkszentkirály), *Alnetum* and *Salicetum cinereae* at Borsáros, 46.31061° N, 25.83986° E, 660 m, 31.07.2013.
3. Sinsimion (Csíkszentsimon), Honcsok wetland, 46.25369° N, 25.86644° E, 650 m, 31.07.2013.
4. Sinsimion (Csíkszentsimon), Felső Honcsok wetland, 46.25736° N, 25.85469° E, 660 m, 31.07.2013.
5. Sinsimion (Csíkszentsimon), Felső Honcsok wetland, 46.25616° N, 25.85697° E, 660 m, 31.07.2013.
6. Sinsimion (Csíkszentsimon), *Phragmitetum*, 46.24438° N, 25.85458° E, 670 m, 01.08.2013.
7. Sinsimion (Csíkszentsimon), limonite spring cone, 46.24536° N, 25.85413° E, 670 m, 01.08.2013.
8. Sinsimion (Csíkszentsimon), 46.24727° N, 25.85436° E, 660 m, 01.08.2013.
9. Sinsimion (Csíkszentsimon), wetland at river Olt, 46.25205° N, 25.85277° E, 655 m, 01.08.2013.
10. Tușnadu Nou (Újtusnád), Varsavész, wetland between the railway and river Olt, 46.19808° N, 25.89091° E, 650 m, 01.08.2013.
11. Tușnadu Nou (Újtusnád), Varsavész, wetland between the railway and river Olt, 46.19950° N, 25.89002° E, 650 m, 01.08.2013.
12. Tușnadu Nou (Újtusnád), Nádasfürdő wetland, 46.17677° N, 25.90747° E, 740 m, 01.08.2013.
13. Sîntimbru (Csíkszentimre), ditches on the right side of river Olt, 46.28725° N, 25.86152° E, 660 m, 02.08.2013.
14. Sîntimbru (Csíkszentimre), ditches on the left side of river Olt, 46.28208° N, 25.86177° E, 660 m, 02.08.2013.
15. Sîntimbru (Csíkszentimre), wetland near Henter mansion, 46.27711° N, 25.86500° E, 660 m, 02.08.2013.
16. Sîntimbru (Csíkszentimre), wetland near Henter mansion, 46.27652° N, 25.86541° E, 660 m, 02.08.2013.
17. Sîntimbru (Csíkszentimre), wetland near a chapel, 46.27005° N, 25.85288° E, 660 m, 02.08.2013.
18. Sîntimbru (Csíkszentimre), 46.26413° N, 25.84980° E, 670 m, 02.08.2013.
19. Cetățuia (Csatószeg), limonite spring cone near river Olt, 46.22463° N, 25.87736° E, 660 m, 02.08.2013.
20. Vrabia (Csíkverebes), Kiscsemő wetland, 46.21380° N, 25.88711° E, 655 m, 03.08.2013.
21. Tușnad (Tusnád), 46.20722° N, 25.88797° E, 655 m, 03.08.2013.
22. Tușnadu Nou (Újtusnád), wetland opposite to Közép-stream, 46.18500° N, 25.88194° E, 650 m, 03.08.2013.

RESULTS AND DISCUSSION

During our fieldwork 70 bryophyte taxa (5 liverworts and 65 mosses) were collected. The complete list of bryophyte records can be found in Appendix 1.

18 species are included in the Red list of the bryophytes of Romania (ȘTEFĂNUȚ and GOIA 2012). Among them one species, *Hamatocaulis vernicosus* is included in the Bern Convention and the European Habitat Directives, and in the Red data book of European bryophytes (ECCB 1995).

General aspects of the bryophyte vegetation

In the wetlands of the Alcsík Basin the most characteristic, abundant species are the following: *Aulacomnium palustre*, *Brachythecium mildeanum*, *B. rutabulum*, *Bryum pseudotriquetrum*, *Calliergonella cuspidata*, *Climacium dendroides*, *Drepanocladus aduncus*, *Marchantia polymorpha*, *Plagiomnium elatum*, *P. ellipticum*, *Tomentypnum nitens*. *Aneura pinguis*, *Campylium stellatum*, *Dicranum bonjeanii*, *Fissidens adianthoides*, *Philonotis caespitosa* are also important elements in some wetlands or at source areas. Most of these are indicators of wetlands of conservation importance, which means that these species by their mere presence refer to a greater level of conservation merit of the habitat. At two sites small populations of *Sphagnum* species (*S. angustifolium*, *S. capillifolium*, *S. palustre*, *S. subsecundum*) were also discovered. *Breidleria pratensis*, *Drepanocladus polygamus*, *Polytrichum strictum*, *Scorpidium cossonii* occur in small quantities in a few places. All of them are rare in SE Europe and have great importance for nature conservation. At source areas *Lophocolea bidentata*, *Pellia endiviifolia*, *Cratoneuron filicinum*, *Dicranella varia*, *Didymodon tophaceus*, *Palustriella falcata*, *Philonotis marchica*, *Pohlia wahlenbergii* appear. The latter four mosses are also indicator species of source areas of great conservation value.

As a comparison of the bryophyte vegetation in the past and recent, it may be mentioned that Ádám Boros collected 15 species in the area in the 1940s (BOROS 1941, 1942, 1943a) (Table 1). All of his findings were also collected during our research, and most of them are characteristic species of the wetlands of the Alcsík Basin even nowadays. The only difference is *Sphagnum recurvum* from Borsáros wetland at Sîncrăieni (Csíkszentkirály) (documented by Á. Boros), which probably is the same that we collected in the same place and identified as *S. angustifolium*. The *Sphagnum recurvum* group is a complex of closely related bryophytes that were only later separated (ISOVIITA 1966, SMITH 2004).

Nature conservation value of the species recorded

The most valuable species found is *Hamatocaulis vernicosus*. It is a boreal moss (DÜLL 1985) occurring in oligotrophic wet grasslands, and is included in

Table 1. Species collected by Ádám Boros in the Alcsík Basin between 1941 and 1943.

	Sîncrăieni	Sînsimion	Tușnadu Nou
<i>Abietinella abietina</i>	+		
<i>Aulacomnium palustre</i>	+	+	+
<i>Brachythecium mildeanum</i>	+		
<i>Bryum pseudotriquetrum</i>	+		
<i>Calliergonella cuspidata</i>		+	+
<i>Climacium dendroides</i>	+		+
<i>Drepanocladus aduncus</i>	+		
<i>Hamatocaulis vernicosus</i>		+	+
<i>Hygroamblystegium humile</i>	+		
<i>Marchantia polymorpha</i>		+	+
<i>Philonotis caespitosa</i>		+	
<i>Polytrichum strictum</i>	+		
<i>Sphagnum capillifolium</i>	+		
<i>Sphagnum recurvum</i>	+		
<i>Tomentypnum nitens</i>	+	+	+

the Bern Convention, the European Union Habitats and Species Directive, and in the Red data book of European bryophytes (ECCB 1995). In addition, it is a priority species of Natura 2000 wetlands. It is categorised as VU in Romania and Bulgaria, DD in Hungary without any currently existing population. In Serbia it has only two recently discovered localities, both of them in the southern part of the country. The population at Vlasina Lake is very small (PAPP *et al.* 2012), while in 2012 a larger population was found on the Pešter plateau (PAPP *et al.* 2014).

In Romania the following earlier localities are known (pers. comm. Irina Goia, Cluj-Napoca): Bistrita Nasaud County: Munții Țibleșului – Valea Mestecănișului, Valea Țibleșului; Brasov County: mlaștina Hărman; Cluj County: Valea Someșului Cald- Bălcești – Călățele, Masivul Vlădeasa – Vârfuraș, Micău, Rogojel; Covasna County: Comandău; Dimbovita County: Munții Leaota – Valea Vaca; Gorj County: Munții Parâng, Lacul Câlcescu; Harghita County: Depresiunea Giurgeu, Bazinul Ciucului, Mlaștina Pietroasa de la Joseni, Bazinul Gheorghieni; Hunedoara County: Munții Retezat – Tăul Judele; Sibiu County: Munții Făgăraș – Ucea Mare, Corabia; Suceava County: Codrul Secular Slătioara, Plaiul Todirescu, Pârâul Chiril, Valea Sâlhoasa Grădinița, Turbăria Coșna, Lucina; Muntele Rarău, Munții Călimani, Mlaștina eutrofică Drăgoioasa, Tinovul Găina – Lucina, Valea Stâniei, Mlaștina Criștișor.

Monitoring of *Hamatocaulis vernicosus* has been started in many localities, but information about the existing populations and results of the population monitoring are still not available.

In the Alcsík Basin we found the species at two sites. In Felső Honcsok wetland at Sînsimion (Csíkszentsimon) it has a population of *ca* 2–3 m², while in Varsavész wetland at Tuşnadu Nou (Újtusnád) only a few individuals were found mixed in a patch of *Tomentypnum nitens* and *Aulacomnium palustre*. Both sites were known previously. In the Herbarium of the Hungarian Natural History Museum there are specimens collected by Ádám Boros on 20.07.1941 at Sînsimion (Csíkszentsimon) (BOROS 1941). In the “Field diaries” he made a note on the species, stating that it is “abundant, nice”. At Tuşnadu on the bank of river Olt he also collected a specimen on 04.08.1942 (BOROS 1942).

Bryophyte rarities

To our knowledge of the bryoflora of SE Europe, the following species are rare or redlisted in Romania (ŞTEFĂNUŢ and GOIA 2012). Their threat status is commented on the basis of their red list status in the neighbouring countries and on our experiences.

Breidleria pratensis is a northern subcontinental (DÜLL 1985) wetland species. It is not known from Hungary, and is CR in Bulgaria. Although it is not redlisted in Romania, it can be regarded as threatened, rare species in SE Europe. In the Alcsík Basin we collected it mixed with other species in the wetland near river Olt at Cetăţuia (Csatószeg) and Kiscsemő wetland at Vrabia (Csíkverebes). Apparently, the populations are very small.

Bryum klinggraeffii is EN in Romania. Not redlisted in the neighbouring countries. This tiny *Bryum* species is overlooked, undercollected. Its high threat status in Romania is probably due to the limited research on the rhizoid gemmae bearing *Bryum erythrocarpum* complex, where this species belongs to.

Bryum radiculosum is EN in Romania. Not redlisted in the neighbouring countries. Being also a member of *Bryum erythrocarpum* complex, the same comments can be made as for the former *Bryum* species.

Campylium protensum is EN in Romania, VU in Bulgaria. The known records of this species resulted in a false picture about its distribution, as in the past (and even now), in many floristical works it is not separated from its close relative *C. stellatum*. Taking into account that *C. stellatum* is a frequent species and not redlisted in Romania, the high red list category of *C. protensum* should be re-evaluated after a careful taxonomic revision of herbarium specimens and future fieldworks, which would provide a clearer view about its distribution.

Dicranella rufescens is VU in Romania. Not redlisted in the neighbouring countries. This tiny species of wet muddy soils is also overlooked, undercollected.

Drepanocladus polygamus is a boreal wetland species (DÜLL 1985), VU in Romania and Bulgaria, and NT in Hungary. It is a threatened wetland species in SE Europe. In the Alcsík Basin we collected it in a spring cone at Sînsimion (Csíkszentsimon) and in the Nádasfürdő source area at Tuşnadu Nou (Újtusnád).

Grimmia laevigata is VU in Romania. Not redlisted in the neighbouring countries. This is a frequent *Grimmia* species of siliceous rocks. Its high-rank red list status reflects the limited knowledge on the genus *Grimmia* in Romania.

Grimmia muehlenbeckii is VU in Romania and Bulgaria. This is also a frequent species of siliceous rocks. Its high-rank red list status can be also attributed to the limited knowledge on genus *Grimmia* in Romania.

Philonotis marchica is a sub-Mediterranean species (DÜLL 1985), NT in Romania, EN in Bulgaria. According to PAPP *et al.* (2010) it is DD in Hungary without any recent record, but not long ago it was also found in two localities. In Serbia, three recently located populations were found (PAPP and ERZBERGER 2005, 2007, 2009). In the Alcsík Basin we collected it at a source area at Tuşnad (Tusnád) from a small population.

Philonotis caespitosa is a boreal element (DÜLL 1985), EN in Hungary, and VU in Bulgaria. In Serbia there are two recently known populations (PAPP and ERZBERGER 2005, PAPP *et al.* 2004). Although this species is not redlisted in Romania, it is considered a rare wetland species in SE Europe. We found it in several wetlands in the Alcsík Basin; Borsáros at Sîncrăieni (Csíkszentkirály), Sînsimion (Csíkszentsimon), Tuşnadu Nou (Újtusnád), and Sîntimbru (Csíkszentimre). It usually occurs along rivulets, and at sources in the wetlands.

Plagiomnium elatum is a boreal moss (DÜLL 1985), NT in Romania. Not redlisted in the neighbouring countries. It is a characteristic *Plagiomnium* species of wetlands, source areas. Its near threatened status in Romania seems to be an overestimation.

Plagiomnium ellipticum is a boreal species, VU in Romania, NT in Hungary. It is a rare wetland species, although in the Alcsík Basin it is a characteristic element of wet grasslands. Its populations are quite extensive.

Pohlia melanodon is NE in Romania. This species of wet muddy soils is also among the overlooked, undercollected bryophytes in the country.

Scorpidium cossonii is CR in Romania. It has been recently separated from its close relative *S. revolvens* (HEDENÄS 2003). Its distribution should be clarified on the basis of taxonomic revision of herbarium specimens and future fieldworks. In the Alcsík Basin we found it in two wetland areas at Sînsimion (Csíkszentsimon) and Tuşnadu Nou (Újtusnád).

Sphagnum subsecundum is NT in Romania, VU in Hungary and Serbia. It seems to be a rare species of its genus in SE Europe. In the Alcsík Basin we collected it in a small quantity in a wetland near Sîntimbru (Csíkszentimre).

Tomentypnum nitens is a boreal element (DÜLL 1985), EN in Hungary, in Bulgaria and in Serbia. This is a rare wetland species in the neighbouring countries with only a few known existing populations (e.g. in Serbia only at Vlasina Lake (PAPP *et al.* 2012)). In Romania it is not redlisted. In the wetlands of the Alcsík Basin this is a characteristic and abundant species, which also reflects the high nature conservation value of this area.

Trichodon cylindricus is VU in Romania. Not redlisted in the neighbouring countries. This tiny plant of wet muddy soils is also overlooked, undercollected.

CONCLUSIONS

In spite of the small extension and reduced water supply of the wetland fragments found in the Alcsík Basin, the area still preserves very valuable bryophyte vegetation rich in elements characteristic for fens and mires. Such species are *Breidleria pratensis*, *Dicranum bonjeanii*, *Drepanocladus polygamus*, *Philonotis marchica*, *P. caespitosa*, *Plagiomnium ellipticum*, *Polytrichum strictum*, *Scorpidium cossonii*, *Sphagnum* spp., and *Tomentypnum nitens*. Some of these, such as *Plagiomnium ellipticum*, or *Tomentypnum nitens*, are very abundant and represent the largest populations currently known in SE Europe. The maintenance and assisted increase of the population sizes of these rare bryophytes would be a major goal of conservation efforts.

Based on our knowledge on the state of wetlands in SE Europe and our field experience, it may be stated that the main threat is the reduced water supply and recurring dry summers. Also, due to the changes in land use, large tracts of these areas became abandoned; without mowing the wetlands are often invaded by reed and pioneer shrubs (mainly *Salix*) or transformed into tall herb community, and their structure is getting denser. Under such circumstances the bryophytes cannot receive sufficient amounts of light and space to grow. It is fearful that especially the most valuable rarities will soon disappear, which are (or should be) in the focus of nature conservation. These rare species are adapted to oligotrophic conditions and low-growing vegetation with good water supply.

Another threatening factor is the wetland burning, which is a widely used management form in the basin. It physically destroys the bryophyte vegetation and may alter the oligotrophic condition towards mesotrophic.

To protect the bryophyte assemblages it is suggested that a June mowing is adequate, but mowing later in the summer can be harmful as it can lead to water loss and intensified drainage of the area.

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Összefoglaló: 2013 nyarán egy a Natura 2000-es területek állapotát, biológiai sokféleségét felmérő projekt keretében az Alcsíki-medence mohászati vizsgálatát végeztük el. Egykor a mai Románia vizes területeinek, lápjainak 25%-a ebben a 650–740 m tengerszint feletti magasságon fekvő medencében koncentrálódott. Mára csak töredéke maradt fenn e lápoknak, többségük mezőgazdasági területek közé ékelődött kis kiterjedésű maradvány, amelyek 2007 óta védettséget élveznek, mint Natura 2000-es területek. Az Alcsíki-medence mohafldrájáról az 1940-es évekből származnak korábbi adatok, az utóbbi időben felmérés nem történt.

Jelen vizsgálat során összesen 70 mohafajt (5 májmoha, 65 lombosmoha) sikerült kimutatni. Annak ellenére, hogy a vizes területek kis kiterjedésűek és vízellátottságuk sem kielégítő, még számos olyan lápi, lápréti mohafajnak adnak otthont, amelyek Délkelet-Európában ritkák, pl. *Breidleria pratensis*, *Dicranum bonjeanii*, *Drepanocladus polygamus*, *Philonotis marchica*, *P. caespitosa*, *Plagiomnium ellipticum*, *Polytrichum strictum*, *Scorpidium cossonii*, *Sphagnum* spp., *Tomentypnum nitens*. Ezek közül néhány (pl. *Plagiomnium ellipticum*, *Tomentypnum nitens*) gyakori, és igen nagy populációkat alkot a vizsgált területen. A legértékesebb megtalált mohafaj a *Hamatocaulis vernicosus*, amely szerepel a Berni Konvencióban, az Európai Unió Élőhelyvédelmi Irányelv listáján, valamint az Európai Moha Vörös Könyvben.

A ritka fajok számára az egyik fő veszélyeztető tényező a vízellátottság csökkenése, amely klimatikus okokra vezethető vissza (pl. száraz nyarak gyakoriságának növekedése). Veszélyeztető tényező a hagyományos földhasználat megváltozása is. A kaszálás elmaradása a lápréteken a nád és cserjék (pl. füzek) térhódítását idézi elő, ami a fényigényes, alacsony fűvű láprétekhez alkalmazkodott mohák visszaszorulásával jár. A ritka, lápréti fajok megőrzése érdekében a területek kaszálása fontos lenne.

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Appendix 1. Complete list of bryophyte records.

The numerals following the species names refer to the collection sites described in Material and Methods under site details.

Liverworts

- Aneura pinguis* (L.) Dumort. – 1, 12, 20: in wetland
Lophocolea bidentata (L.) Dumort. – 12: at a source
Lophocolea heterophylla (Schrad.) Dumort. – 2: soil
Marchantia polymorpha L. subsp. *polymorpha* – 1, 3, 4, 5, 12, 20: in wetland; 19: soil; 21: at a source
Pellia endiviifolia (Dicks.) Dumort. – 12: in wetland; 21: at a source

Mosses

- Abietinella abietina* (Hedw.) M. Fleisch. – 18: soil
Amblystegium serpens (Hedw.) Schimp. – 1: in wetland and on bark of *Salix*; 2: bark of *Betula*; 3, 17: in wetland; 14: wall of a bridge
Atrichum undulatum (Hedw.) P. Beauv. – 1: in wetland
Aulacomnium palustre (Hedw.) Schwägr. – 1, 3, 4, 5, 8, 9, 10, 11, 12, 17, 20, 22: in wetland; 19: soil
Barbula convoluta Hedw. – 14: soil
Brachytheciastrum velutinum (Hedw.) Ignatov et Huttunen – 18: on volcanic rock
Brachythecium mildeanum (Schimp.) Schimp. – 1: in wetland and on bark of *Salix*; 5, 9, 11, 12, 15, 17, 20: in wetland; 7, 19: soil
Brachythecium rivulare Schimp. – 12: in wetland and at a source
Brachythecium rutabulum (Hedw.) Schimp. – 1, 3, 5, 8, 17, 20: in wetland; 2: bark of tree; 21: at a source
Brachythecium salebrosum (Hoffm. ex F. Weber et D. Mohr) Schimp. – 21: on decaying wood
Breidleria pratensis (W. D. J. Koch ex Spruce) Loeske – 19: on soil; 20: in wetland

- Bryum argenteum* Hedw. – 18: on volcanic rock
Bryum klinggraeffii Schimp. – 1: bank of river Olt
Bryum pseudotriquetrum (Hedw.) P. Gaertn. et al. – 1, 3, 4, 5, 10, 11, 15, 17, 20, 22: in wetland; 7, 19: soil; 12: in wetland and at a source
Bryum radiculosum Brid. – 18: on soil
Calliergonella cuspidata (Hedw.) Loeske – 1, 3, 4, 5, 8, 9, 11, 12, 15, 17, 20: in wetland; 13, 14, 19: soil; 21: at a source
Campylium protensum (Brid.) Kindb. – 12: in wetland
Campylium stellatum (Hedw.) Lange et C. E. O. Jensen – 4, 5, 20: in wetland
Ceratodon purpureus (Hedw.) Brid. – 5: in wetland; 18: on volcanic rock
Cirriphyllum piliferum (Hedw.) Grout – 22: in wetland
Climacium dendroides (Hedw.) F. Weber et D. Mohr – 1, 4, 5, 9, 10, 11, 16, 17, 20, 22: in wetland
Cratoneuron filicinum (Hedw.) Spruce – 7: soil; 12: in wetland and at a source; 15: in wetland
Dicranella rufescens (Dicks.) Schimp. – 14: on soil
Dicranella varia (Hedw.) Schimp. – 12: at a source
Dicranum bonjeanii De Not. – 17: in wetland; 19: on soil
Didymodon rigidulus Hedw. – 14: on wall of a bridge support
Didymodon tophaceus (Brid.) Lisa – 12: at a source
Drepanocladus aduncus (Hedw.) Warnst. – 1, 3, 4, 5, 8, 12, 15, 17, 20: in wetland; 6, 7, 13, 14, 19: soil; 21: at a source
Drepanocladus polygamus (Schimp.) Hedenäs – 7: soil; 12: in wetland
Fissidens adianthoides Hedw. – 11, 12, 20, 22: in wetland; 19: on soil
Funaria hygrometrica Hedw. – 18: on soil
Grimmia laevigata (Brid.) Brid. – 18: on volcanic rock
Grimmia muehlenbeckii Schimp. – 18: on volcanic rock
Grimmia ovalis (Hedw.) Lindb. – 18: on volcanic rock
Hamatocaulis vernicosus (Mitt.) Hedenäs – 4, 11: in wetland
Hedwigia ciliata (Hedw.) P. Beauv. – 18: on volcanic rock
Homomallium incurvatum (Schrad. ex Brid.) Loeske – 18: on volcanic rock
Hygroamblystegium humile (P. Beauv.) Vanderp., Goffinet et Hedenäs – 2: on artificial stonewall of the source
Hypnum cupressiforme Hedw. – 18: on volcanic rock
Leptobryum pyriforme (Hedw.) Wilson – 2: on soil and on artificial stonewall of the source; 3: in wetland
Leptodictyum riparium (Hedw.) Warnst. – 9, 15, 20: in wetland; 13: on soil; 21: at a source
Orthotrichum pumilum Sw. ex anon. – 2: bark of *Betula*
Palustriella falcata (Brid.) Hedenäs – 12: in wetland and at a source
Paraleucobryum longifolium (Hedw.) Loeske – 18: on volcanic rock
Phascum cuspidatum Hedw. – 18: on soil
Philonotis caespitosa Jur. – 1, 8, 11, 17: in wetland
Philonotis marchica (Hedw.) Brid. – 21: at a source
Plagiomnium cuspidatum (Hedw.) T. J. Kop. – 2: on soil; 8, 17: in wetland; 18: on volcanic rock
Plagiomnium elatum (Bruch et Schimp.) T. J. Kop. – 5, 10, 11, 15, 17, 20, 22: in wetland; 19: on soil
Plagiomnium ellipticum (Brid.) T. J. Kop. – 1, 3, 4, 5, 17, 20: in wetland; 21: at a source
Plagiomnium undulatum (Hedw.) T. J. Kop. – 2: on soil
Platygyrium repens (Brid.) Schimp. – 18: on volcanic rock
Pohlia melanodon (Brid.) A. J. Shaw – 1: bank of river Olt; 14: on soil
Pohlia wahlenbergii (F. Weber et D. Mohr) A. L. Andrews – 21: at a source
Polytrichum strictum Menzies ex Brid. – 1: in wetland

- Pterigynandrum filiforme* Hedw. – 18: on volcanic rock
Sciuro-hypnum populeum (Hedw.) Ignatov et Huttunen – 2: bark of tree; 18: on volcanic rock
Scorpidium cossonii (Schimp.) Hedenäs – 5, 12: in wetland
Sphagnum angustifolium (C. E. O. Jensen ex Russow) C. E. O. Jensen – 1: in wetland
Sphagnum capillifolium (Ehrh.) Hedw. – 1: in wetland
Sphagnum palustre L. – 17: in wetland
Sphagnum subsecundum Nees – 17: in wetland
Thuidium assimile (Mitt.) A. Jaeger – 11, 16, 17: in wetland; 19: on soil
Tomentypnum nitens (Hedw.) Loeske – 1, 3, 4, 5, 8, 9, 11, 12, 17, 20, 22: in wetland; 19: on soil
Trichodon cylindricus (Hedw.) Schimp. – 12: at a source