

BRYOFLORESTIC RESEARCHES WITH NEW RECORDS IN SELECTED PEATLANDS OF THE APUSENI MOUNTAINS (WESTERN ROMANIAN CARPATHIANS)

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Abstract

*The aim of this study is to explore the bryophyte diversity and distribution patterns of bryoflora of certain peatlands in the Apuseni Mountains. From our twenty-six collection sites, all being representative peat bogs and fens for this mountain unit, hitherto 64 bryophyte taxa (6 liverworts and 58 mosses) were identified. The most frequent and abundant species are *Sphagnum capillifolium*, *S. centrale*, *S. cuspidatum*, *S. flexuosum*, *Polytrichum commune* and *P. juniperoideum*. Besides these, some other species could be considered rare, having a great biogeographical and nature conservation importance. Among them, the endangered (EN) *Sphagnum tenellum*, the vulnerable (VU) *Hamatocaulis vernicosus*, *Helodium blandowii*, *Hygrohypnella ochracea*, *Odontoschisma fluitans* and the not evaluated (NE) *Sphagnum affine* are worth mentioning. Several species are reported with new localities of occurrence in the Apuseni Mts. and others are confirmed in their previously known localities. Thus, the results of this study significantly contribute to the knowledge on the bryoflora of Romania.*

Key words: bryophyte conservation, distribution, Natura 2000, oligotrophic raised bog, poor fen.

INTRODUCTION

Peatlands (peat bogs and fens) are intrazonal wetland habitats, with a pronounced biogeographical, paleoenvironmental, ecological and hydrogeological importance, as well as with special demands of the environmental factors (e.g. water balance, microclimate) and particularly sensitive to their changes, even on a fine scale (Frink et al., 2014; Jakab et al., 2021a; 2021b). Also, they are important in terms of biodiversity and nature conservation, being increasingly endangered across Europe (Janssen et al., 2016), especially due to drainage, habitat loss and fragmentation. The drying out of wetland habitats associated with climate change poses a particularly great threat to vascular plant species and bryophytes (Gignac & Vitt, 1994).

Among terrestrial ecosystems, peatlands sequester carbon over long millennial time scales more efficiently than any other. Northern peatland ecosystems cover approximately 4.23 million km² or 2.84% of global land area (Xu et al., 2018), but store about 30% of the global terrestrial carbon (Yu et al., 2010; 2014) and 10% of the global soil nitrogen stock (Loisel et al., 2014; Vitt & House, 2021). Over the past 11,700 years (during the Holocene), these peatland ecosystems have played a significant role in the global carbon budget, functioning as sinks for atmospheric carbon and sources of methane to the atmosphere. Carbon and nitrogen are stored in organic matter that accumulates when net primary production exceeds organic matter decomposition, leading to deposits of incompletely decomposed organic matter, or peat (Vitt & House, 2021).

One of the characteristic features of northern hemisphere peatlands is the pronounced abundance of bryophytes that occupy the ground and form their basic architecture, in which vascular plants establish and grow (Vitt, 2006; Vitt & House, 2021). Peatland habitats, whether sedge-dominated, shrub-dominated, or wooded with an open tree canopy, all have ground layers composed of 80-100% bryophyte cover (Hartsock et al., 2021). This bryophyte-dominated ground layer differentiates them from non-peat forming wetlands such as marshes (no trees) and swamps (with shrubs or trees) (Vitt et al., 2023). Also, *Sphagnum* mosses, dominant in bogs and poor fens, and brown mosses, dominant in rich fens, make up a large percentage of the organic matter that is stored as deep deposits of peat (Vitt et al., 2023). Thus, bryophytes play fundamental roles in the structure and functioning of peatland ecosystems. For instance, they are of decisive importance in peatland habitat types and in plant community identification and classification. At the same time, many bryophytes are rare, circumboreal relicts, so their accurate identification at species level and the mapping of their distribution are scientific demands with a practical importance from the nature conservation perspective.

The total area of Romanian peatlands is estimated to 7,100 hectares, which represent about 0.03% of the country's territory (Pop, 1960; Minayeva et al., 2009). These peatland sites are generally small in extent (from a few to tens of hectares) and scarcely distributed in hilly and mountainous areas. Fifteen fen districts have been distinguished on the basis of site size and altitude, most of them being located in Carpathian intra-mountain depressions (Minayeva et al., 2009). Also, there are eleven districts with ombrotrophic raised bogs, confined to the main Carpathian ridge (Minayeva et al., 2009), reaching here the southern boundary of their European distribution area (Stoica et al., 2022). The largest ombrotrophic mires in the country are located in the Eastern Carpathians (Dorna river basin and the Harghita Mountains), but the Apuseni Mts. (Figure 1) also have a wide diversity of peatlands. All of them host many glacial relicts and circumboreal species,

vascular plants and bryophytes, too. Most of the peat bogs and fens in Romania are included in natural protected areas of national interest and in the European Natura 2000 network (Sârbu et al., 2007; Mountford et al., 2008; Brînzan, 2013; Frink et al., 2014).

The present paper provides floristic and distribution data on the bryophytes collected in the selected peatlands of the Apuseni Mts. The research was carried out within a larger project aiming to evaluate the conservation status of Natura 2000 habitats of peat bogs and fens in Romania. Also, the article aims to explore the conservation prospects of the bryophytes documented during the field survey.

MATERIALS AND METHODS

Study area

Located between the Transylvanian Basin and the Pannonian Plain, the Apuseni Mts. (Figure 1) appear like an island in the middle of the Carpathian Basin, separated from the rest of the Carpathian ridgeline, from which greatly differ orographically and geologically, having its unique authenticity (Frink & Petrean, 2005). From a geographical point of view, this mountain unit belongs to the Western Romanian Carpathians. It has a total surface of approx. 20,000 km² and offers a big variety of landscapes on a relatively small surface (Ficheux, 1996). Its main landscape characteristics are the moderate altitudes, the wide plateaus cut by deep valleys and the steep slopes (Cocean, 2000; Pop, 2000). The average height ranges between 1000 and 1400 m a.s.l. The highest peak (Biharia - Figure 1) has 1849 m altitude.

Due to the great variety of relief forms, the big number of caves and gorges, as well as to the unique flora and vegetation, the Apuseni Mts. have the biggest number and the highest density of protected areas in Romania (Frink & Petrean, 2005). Also, they host most of Romania's peatlands (Pop, 1960) which are located mainly north of the Arieș river (Figure 1), where they were formed due to orographic conditions (large mountain plateaus), geological conditions (predominance of crystalline shales and volcanic bedrocks, as

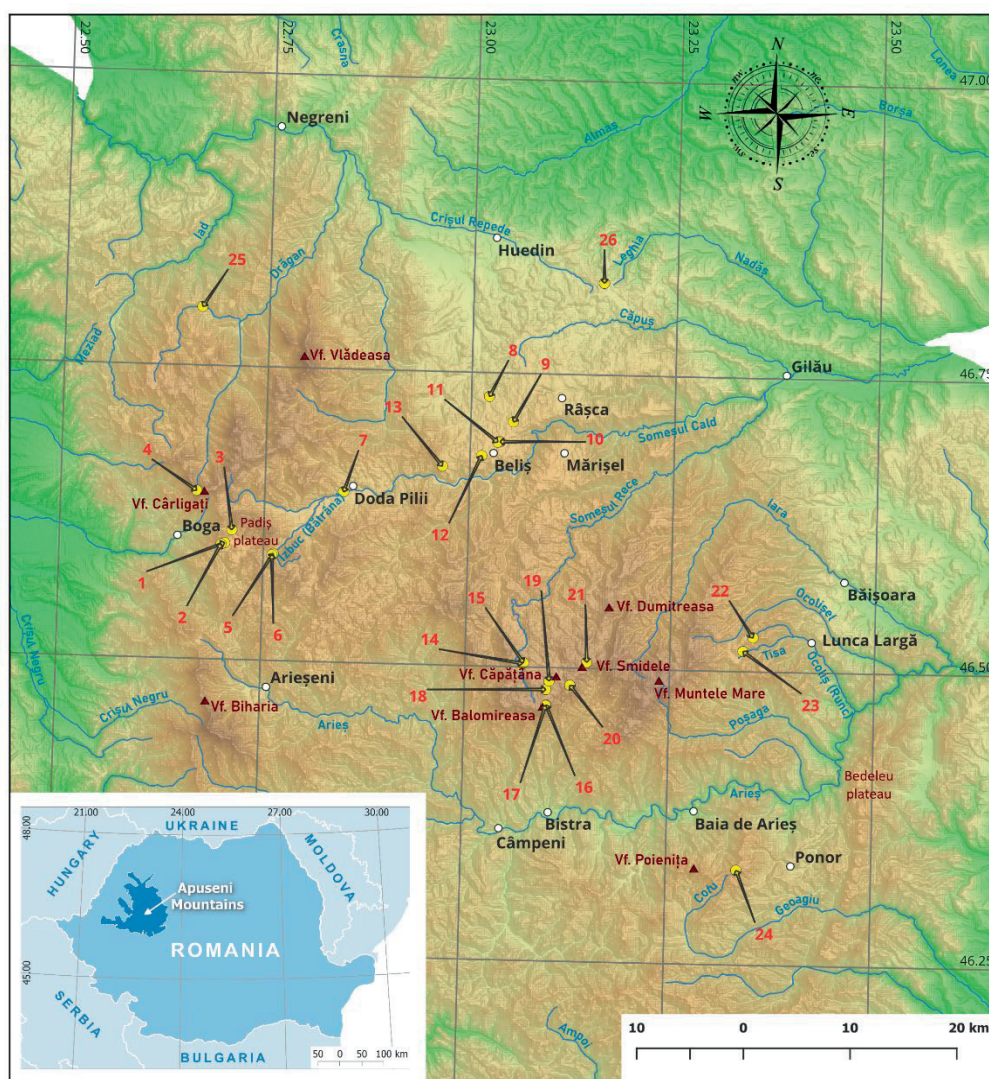


Figure 1. Geographical position of the Apuseni Mountains and of the collection sites:

1. Padiș-molidiș; 2. Padiș-Bălăleasa; 3. Mlaștina din Poiana Vărășoia; 4. Mlaștina de la Fântâna Rece; 5. Molhașul cel Mare de la Izbu; 6. Molhașul dintre Izbu; 7. La Doda; 8. Molhașul de la Călățele; 9. Molhașul de la Rîșca ("Lágyas"); 10-11. Dîmbu Negru-La Pod; 12. Târșă Vălenilor (Bălceștilor); 13. Mlaștina deasupra lacului Fântânele; 14-15. Cotel Someșului; 16-17. Molhașurile Căpățînii, northeast of Balomireasa peak; 18. Molhașurile Căpățînii, La Zăpodie; 19. Molhașurile Căpățînii, Mocirle-Tăul Sărat; 20. Molhașurile Căpățînii, Vîrful Băii-Tăul Căpățînii; 21. Calul de Piatră; 22. Mlaștina din fundul văii Jghebuoasa; 23. Mlaștina de la izvoarele Tisei; 24. Mluha ("Tău Mluhi"); 25. Mlaștina Poienița; 26. Mlaștina de pe Dealul Leșului

well as Permian and Eocene sandstones in the western and northern parts) and a particular climate (abundant precipitations in the 900-1800 m a.s.l. altitudinal range). These peatlands are relatively small in size, their surface generally does not exceed 10 hectares, but most of them are typical ombrotrophic raised bogs with characteristic vascular plant species and bryophytes. There are also many transition mires (poor fens) in the vicinity of these raised bogs or in spring areas (soft-water spring mires). Pop (1960) delimits two large regions of peatlands in the Apuseni Mts: the first one in the spring area and on the upper course of *Someșul*

Cald river and the second one in the spring area and on the upper course of *Someșul Rece* river, including "Muntele Mare" and "Dobrinu" areas.

Previous bryological investigations

Rich and detailed bryofloristical literature is available for the Apuseni Mts. One of the earliest floristic studies on the peat bogs of this mountain unit refers to the "Mluha" peat bog, describing its vascular plant species, and containing data on its bryoflora, too (Csató, 1885). Furthermore, the first detailed floristic work on mosses belongs to M. Péterfi (1908), in which he reports a total of 400 moss species from the Bihor Mountains. Later on, I. Győrfy

& M. Péterfi (1919) published notes and observations only on peat mosses as additional data on the moss flora of the high Tatras and Transylvania. The most complete literature on peat mosses, which comprises detailed descriptions of peatlands in the area, is represented by the series of papers of E. Pop (1932; 1937; 1939; 1947; 1954; 1956), including his monograph (Pop, 1960). Ș. Páll (1963) reports eight species of *Sphagnum* and the rare *Hamatocaulis vernicosus* from the *Padiș* plateau and the “*Izbucul Ponorului*” area. I. Ciobanu (1967) reports two new bogs in the Apuseni Mts. and gives a detailed palynological analysis of the peatlands in the upper course of *Someșul Cald* river (Ciobanu, 1965), of “*Mluha*” peat bog (Ciobanu, 1958) and of “*Călățele*” peat bog (Ciobanu, 1968). A comprehensive and reference work on the ecology and chorology of *Sphagnum* species in Romania was published by T. Ștefureac (1978). Further on, in the following decades, the research on peatlands in Romania continued intensively, including in the Apuseni Mts. (Coldea & Plămadă, 1970, 1989; Pop et al., 1987). G. Jakab (2000) provides detailed bryofloristic lists from various locations in the *Padiș* area. Bodnariuc et al. (2002) compared palynological data in the Apuseni Mts. with other peatland areas of the Romanian Carpathians and of the surrounding countries. A detailed study on plant associations of the peat bogs in the Bihor Mts. was published by P. Burescu and G. Togor (2010). Păcurar et al. (2011) draws attention on the preservation and sustainable management measures concerning peat bogs in Romania. On the basis of floristic and phytocoenotic data from field studies and from the literature, Coldea et al. (2018) published the detailed vegetation map of *Molhașul Mare de la Izbuc* peat bog. Recently, two genuine active raised bogs in the Apuseni Mts., namely *Calul de Piatră* and *Izvorul văii Șoimului* were proposed to be included in the ROSCI0116 *Molhașurile Căpățînii* site of community interest (Stoica et al., 2022).

Field survey

Bryophyte samples were collected in July 2013 and 2014, along several transects carried out in twenty-six peatland sites (Figure 1; Supplementary material), all being representative for the Apuseni Mts.

Nevertheless, most of them were not systematically studied from a bryological point of view in the last two-three decades. On each collection site, GPS coordinates were recorded using a Garmin Montana 650 device, site/habitat descriptions were made, especially the microhabitats for bryophytes, and vascular plant species were also recorded for Natura 2000 habitat identification (Frink, unpublished).

All collection sites with their general geographic attributes are listed in the Suppl. material and a short description of them is given below. The Romanian toponymy for these sites has been used according to Pop (1960).

The voucher specimens are deposited in the Cryptogamic Herbarium of Eszterházy Károly Catholic University in Eger (EGR) and some of them also in the Herbarium of Babeș-Bolyai University in Cluj-Napoca (CL - inventory numbers: 672676-672678; 672680-672682; 672685; 672687-672691; 672695; 672697, 672698; 672701-672703; 672705; 672707-672714; 672716-672719; 672722; 672723; 672725-672733; 672735, 672736; 672739-672742; 672744; 672746; 672761-672763).

The nomenclature of taxa follows Hodgetts et al. (2020). In the checklist, for each taxa, the following features are indicated: number of the collection site (corresponding to the site toponymy coding used in Figure 1 and in Suppl. material) and peatland habitat type in which the species was found.

Also, for the discussed species, their conservation and indicator status follows the Checklist and country status of European bryophytes (Hodgetts & Lockhart, 2020). The symbols of the threatened categories are as follows: CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, DD = insufficiently known and NE = not evaluated.

Description of the collection sites

For this research, representative peatland sites in the Apuseni Mts. were selected (Figure 1), based on relevant bibliographic sources. During the literature review process, we identified inconsistencies in the toponymy and location of some peatland sites, E. Pop's monograph (1960) serving as a basis for comparison. Our goal was the accurate identification of the selected

peatland sites, based on Pop's descriptions and on the local toponymy used in his monograph. Below, we give a detailed description of our collection peatland sites, using their toponymy and initial spelling, exactly as it was used by Pop (1960). These descriptions, together with the geographical coordinates included in the Suppl. material, could be helpful for future studies because they eliminated the previously found inconsistencies.

Bryophyte surveys were carried out in twenty-six peatland sites (Figure 1), which, according to Pop's (1960) geographical division of peatlands in the Apuseni Mts., are distributed as follows: thirteen investigated sites in the spring area and on the upper course of *Someșul Cald* river; eight sites in the spring area of *Someșul Rece* river, to which are added a few isolated peatlands (two sites on the eastern border of *Muntele Mare* Mts., one site south to *Arieș* river, one on *Drăganului* valley and one on *Dealul Leș*, in a bordering hilly area of the Apuseni Mts).

It should be mentioned that all the collection sites are included into, or are located in the close vicinity of natural protected areas like natural parks, scientific reserves or community interest Natura 2000 sites (Suppl. material).

1. The region of peatlands at the springs and along the upper course of *Someșul Cald* river

Pop (1960), in a wider context, also places here the bogs from the *Șesul Padiș* area, which have the special characteristic of having been formed on the Mesozoic limestones with karst elements, which are interspersed between the very heterogeneous siliceous rocks of a larger area in the Apuseni Mts. Here, fens and later peat bogs were formed over time in sinkholes (dolines), during a long term filling process. This was possible due to the insulating layer represented by the dust deposited by winds on the bottom of these sinkholes, which isolated, at the beginning, the vegetation of a primary eutrophic mire from the bedrock. Over this eutrophic peat, the oligotrophic facies with a thick deposit of peat developed in time (Pop, 1960; Kovács et al., 1962). This process was favoured by the rich precipitations characteristic of this high mountain plateau of approx. 1200 m altitude.

One such investigated sinkhole is ***Padiș-molidiș* (1¹)**, mentioned by Pop (1960) as hosting an oligotrophic peat bog with a group of spruce-trees. According to Kovács et al. (1962), it seems to correspond to "*Dolina nr. 11*" (Sinkhole no. 11). Indeed, this sinkhole located to south and opposite to the Apuseni Nature Park visitor center and to the former house of the forester (landmark used by Pop, 1960) is the only peatbog-transformed sinkhole with a well developed Norway spruce stand in the whole *Șesul Padiș* area.

In *Șesul Padiș*, another peat bog called ***Padiș-Bălăleasa* (2)** was also surveyed on its southwestern extremity. This is an oligotrophic bog of ca. 1-1.5 hectares developed on a slightly inclined slope, at the edge of a spruce forest.

***Mlaștina din Poiana Vărășoaia* (3)** is a small poor fen of ca. 0.1 hectares, located around a spring, on a slope with an inclination of 5-8 degrees and of south-southwest exposure, situated opposite to the *Vărășoaia* camping (*Cabana Vărășoaia*). Jakab (2000) published 13 bryophyte taxa from here.

***Mlaștina de la Fântâna Rece* (4)** is a small sized high mountain spring fen of a few square meters in the spring area of *Drăganului* river. It is formed on a slightly inclined terrain (1-3 degrees) with eastern exposure, on the mountain saddle located between *Fântâna Rece*, *Cornu Muntelui* and *Cârligați* peaks, at approx. 1620 m altitude. The geological substrate is of volcanic origin.

The spring area of *Izbucul* valley or "*Groapa*" (Pop, 1960) shelters a complex of 7 oligotrophic peat bogs (Pop et al., 1987), of which the two largest and best preserved are ***Molhașul cel Mare de la Izbuc* (5)** (of approx. 8 hectares) and ***Molhașul dintre Izbuțe* (6)** (of ca 3 hectares). Both were surveyed bryofloristically within the present study. These peat bogs are among the most representative and authentic raised bogs of the Apuseni Mts., situated at ca 1200 m a.s.l in the spring area of the *Izbuc* rivulet, which flows into the *Someșul Cald* river. They are typically lens shaped in their central parts, the first and the bigger one having 8 small bog-pools (*Blânten* – Figure 2a) and 13 small water filled hollows (*Schlenken*) (Coldea et al., 2018).

¹The number corresponds to site coding from Figure 1, Figure 2 and Supplementary material

The area was designated as a scientific reserve of botanical interest in 1982 (Coldea et al. 2018) under the name *Molhașurile din Valea Izbuclor* (RONPA0164). Later, in 2000, a national protected area corresponding to the IUCN category IV was declared here (Law no. 5/2000). Its scientific reserve status was reinforced in 2005 (RONPA0357 Molhașul Mare de la Izbuce) with the CMN² document no. 1598/21.12.2005. Today it is also part of the Apuseni Nature Park (RONPA0004) and the Natura 2000 site ROSCI0002 Apuseni.

La Doda (7) is located on the left terrace of *Someșul Cald* river (Pop, 1960) and also on the left side of the *Ic Ponor - Doda Pili* road. The entrance to *Doda Pili* mountain village is very close to the site (the first houses are at ca. 450 m) and the Apuseni Nature Park visitor center is on the same road, at approx. 1 km distance. This is a poor fen with 70-80% moss cover, very wet, as Pop (1960) also mentions, but which contains oligotrophic flora elements like *Drosera rotundifolia*, *Eriophorum vaginatum*, *Vaccinium microcarpum* on small surfaces (Frink, unpublished).

1.1. Group of peatlands in Bălcești-Călățele area

Within the above described peatland region, a distinct group is represented by bogs and fens located around *Bălcești* and *Călățele* settlements, of which, in the past, the most representative was the *Molhașul de la Călățele* (8), with a surface of ca 12 hectares and a peat deposit of approx. 360,000 m³ (Pop, 1960; Ciobanu 1968). Pop (1960) mentions rare bryophyte species growing here, like *Sphagnum balticum* (at that time with the only known locality of occurrence in the country), or the cormophytes *Rhynchospora alba* and *Heleocharis carniolica*. The last two species have not been found in the last decades and are most probably extinct today. Unfortunately, over the course of time, this peatland was severely disturbed by human activities. Pop (1960) and Ciobanu (1968) mentioned that in 1951 a massive exploitation of peat began in its eastern part and continued throughout the communist era. Today, the *molhaș* is strongly degraded, with very deficient water regime,

almost dried up, with peat extraction holes full of water (Figure 2b). It has been transformed into a degraded bog, which still retains fragments of the characteristic peat bog vegetation in certain patches.

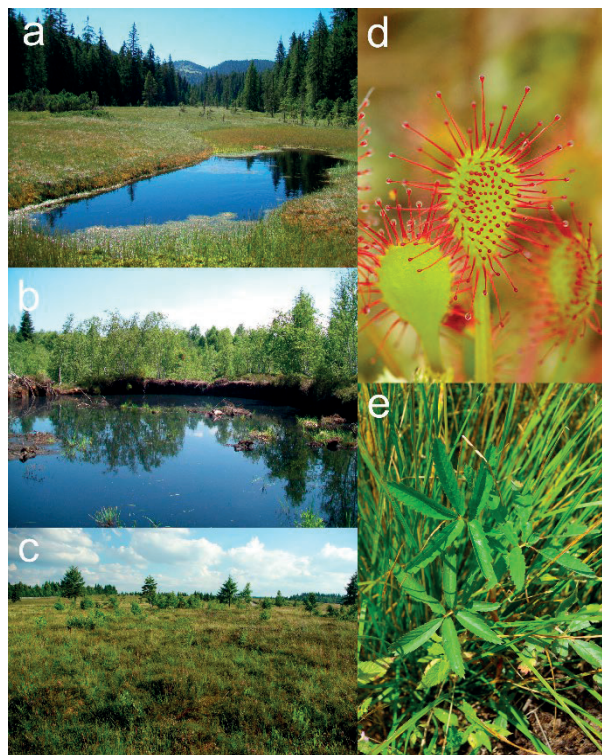


Figure 2. a) Peat bog pool in *Molhașul cel Mare de la Izbuclor*; b) Peat extraction pond in *Molhașul de la Călățele*; c) *Molhașul de la Râșca* blanket bog; d) *Drosera intermedia*; e) *Comarum palustre* (photos by Frink J.P. [a-b] and Jakab G. [c-e])

Molhașul de la Râșca (*Molhașul de la Dealul Negru - "Lágyas"* – Figure 2c) (9) is located on a large plateau called *Dealul Negru*, at approx. 1070 m altitude, which represents the watershed between the *Călata* valley and the *Râșca* valley. As a landmark, nearby is situated *Râșca Transilvană* Orthodox monastery, respectively *Dealul Negru* locality (in continuous development and expansion), administratively belonging to *Râșca* commune. According to Pop (1960), here the peat was formed mainly in the sub-Atlantic and it is approx. 2.2 m thick, with an estimated volume of ca 120,000 m³. It was exploited during the communist times, beginning with 1952. Today, it has a flat bog physiognomy (Figure 2c). Although its water regime is deficient, it is densely covered by mosses (80% coverage, mainly of *Sphagnum*

²Comisia Monumentelor Naturii (Natural Monuments Commission)

species) and nano-phanerophytes from the *Ericaceae* family, such as *Calluna vulgaris* (the most abundant), *Empetrum nigrum*, *Vaccinium myrtillus*, *V. vitis-idaea* (Frink et al., 2017). It is very similar to the Atlantic bogs, known also as blanket bogs (ladder fens – included in Natura 2000 habitat 7130-Blanket bog). Moreover, its Atlantic features are also reflected in the presence of some Atlantic species (Frink et al., 2017), such as the recently discovered *Juncus squarrosus* (with its only, so far known locality of occurrence in Romania) and *Sphagnum compactum*, reported from here by Györfi & Péterfi (1919) under *S. compactum* var. *squarrosa*. Unfortunately, in the last half century this peat bog has been under continuous degradation. Pop (1947; 1960) mentions strong anthropogenic influences due to the nearby settlements. Even today, in some parts, it is heavily grazed by cattle and horses.

To the west of the monastery, on the right side of the main road *Călățele-Beliș*, we studied a ca 1.5 hectares large peat bog, called ***Dîmbu Negru-La Pod (10-11)***, which stretches out along the *Valea Neagră* stream, according to Pop's descriptions (1960). Two collection points were settled here, one on each side of the rivulet. The next studied peatland in the area is located at the exit from *Beliș* to *Bălcești* locality, on the right side of the road. The collection site belongs, according to Pop (1960), to ***Târsa Vălenilor (12)*** peat bog, also called *Târsa Bălceștilor* in newer references (Groza & Turtureanu, 2008). The last studied peatland of the area is ***Mlaștina deasupra Lacului Fântânele (13)***, located above *Fântânele* Lake, at an elevation of ca 1180 m. The road from *Bălcești* to *Dealul Botii* mountain settlement and *Răchițele* commune passes a few hundred meters above the collection site.

2. The region of peatlands at the springs of *Someșul Rece* river

It is the highest region with typical ombrotrophic raised bogs in the Apuseni Mts. and in whole Romania, many of them being at the upper limit of the boreal forest belt, at 1600-1700 m altitude. Most of these bogs shelter *Drosera intermedia* (Figure 2d), a rare glacial relict (Pop, 1960; Jakab et al., 2021b; Stoica et al., 2022).

The first bog investigated in this area is located on the upper course of the *Someșul Rece* river, upstream of *Cabana Blăjoaia*, on the left terrace of the stream, in a turning area. According to Pop (1960), it appears under the name of ***Cotul Someșului (14-15)***, representing a peatland complex of 3 bogs of totally 20 hectares with a peat deposit of more than 60,000 m³. In its oligotrophic part, peat exploitations were carried out during the communist time. Today, the hydrological regime of the bog is deficient, due to past drainages and peat excavations. Two collection points were registered here, with one survey in its oligotrophic part and the other in its transitional *lagg* area.

The most authentic raised bogs in the Apuseni Mts. are strung at a short distance from each other, in the area of *Balomireasa* and *Căpățâna* peaks. This entire complex of peat bogs is generically called ***Molhașurile Căpățînii (16-20)*** and is located at an altitude of ca 1600 m a.s.l. They are variable-sized oligotrophic raised bogs, from 0.5 to 8 hectares, with a classic lens shape physiognomy and some of them with a few, small-sized polyhumic and acidic bog pools. In this peatland complex five collection points were established. All these are included in Natura 2000 site ROSCI0116 *Molhașurile Căpățînii*, which has a total area of 816 hectares (Stoica et al., 2022).

Below *Smidele* and *Creasta Dobrinului* peaks, there is a peat bog of approx. 3.5 hectares, completely surrounded by forest, very well protected and preserved. It is called ***Calul de Piatră (21)*** and is probably the most authentic, active raised bog of the Romanian Carpathians, still intact, unaltered by human activities, with a central depth of 5.6 m (Jakab et al., 2021a; 2021b). However, it is not currently protected, not being part of any natural protected area, but it was recently proposed to be included in Natura 2000 site ROSCI0116 *Molhașurile Căpățînii* (Stoica et al., 2022).

3. Other peatlands isolated from the previous regions/groups

At ca 15 km east of the last mentioned peat bog (*Calul de Piatră*) and approx. 3 km east of *Muntele Băișorii* ski resort, we studied two base-rich fens, formed on sedimentary and metamorphic rocks, at ca 1100-1200 m a.s.l.: ***Mlaștina din fundul văii Jgheburoasa (22)***

located in the spring area of *Jgheburoasa* rivulet and ***Mlaştina de la izvoarele Tisei* (23)** in the spring area of *Tisa* rivulet (also called *Apa Rătăcită*), both situated above *Lunca Largă* locality.

***Mluha* (“Tău Mluhii”) (24)** is an oligotrophic peat bog of ca 10 hectares (Ciobanu, 1958; Pop, 1960), isolated from the other peatland regions of the Apuseni Mts. It is located south of the Arieş river valley, on a broad plateau of Miocene erosion, called “*Dealul Ponorului – La Mluhă*” (Ciobanu 1958), at ca 1300 m altitude. It is one of the oldest known and studied peat bogs in the Apuseni Mts., the first investigations dating back to 1880-1883 (Csató, 1885; Ciobanu, 1958; Pop, 1960). Pop (1960) estimates that in its central part it has a depth of 7.3 m and a peat deposit of approx. 450,000 m³. Csató (1885), cited later by Ciobanu (1958) and Pop (1960), mentions that, before 1870, the bog was exploited and the peat was used as fuel at the ore smelters in *Baia de Arieş* (*Aranyosbánya* at that time in Hungarian). Currently, it is characterized by a water deficit and, according to our field observations, it is invaded by *Calluna vulgaris*, *Empetrum nigrum* and *Betula pendula* (from the edge to the interior), but it still presents a strong oligotrophic part with different species of *Sphagnum* sp., *Carex limosa*, *Drosera rotundifolia*, *Eriophorum vaginatum* and *Vaccinium microcarpum* (Frink, unpublished).

***Mlaştina Poienița* (25)** is located in the *Sebişelului* valley (Raţiu & Gergely, 1976), a tributary of the *Drăganului* valley. It is an eumesotrophic transition mire of less than 0.1 ha, formed around a spring and located at an altitude of 890 m a.s.l.

***Mlaştina de pe Dealul Leşului* (26)** is located in a small depression without leakage on the crest of *Leşului* Hill, close to *Crişul Repede* river spring area, at about 730 m altitude. It is the remains of a former mesotrophic transition mire identified in 1965 (Nyárády et al. 1966). At that time, it contained characteristic moss species like *Sphagnum centrale* (mentioned as *Sphagnum subbicolor*) and *Aulacomnium palustre*, as well as the rare vascular species *Comarum palustre*, *Menyanthes trifoliata* and *Carex buxbaumii* (Nyárády et al., 1966). The authors mention the small surface of the mire (3,100-3,200 m²) and estimate its mesotrophic peat deposit to 3,000 m³, which, based on their

own palynological analyses, was deposited during the beech period, corresponding to the sub-Atlantic. Till nowadays, the surface of this mire has been reduced continuously and considerably, being transformed into a degraded site on the way to extinction, surrounded by agricultural crops. It is strongly eutrophied, periodically burned and in a drying process. However, during our visit, ca 20 non-flowering aerial stems with their leaves of the relict species *Comarum palustre* (Figure 2e) were found (Frink, unpublished).

RESULTS AND DISCUSSIONS

A total of 64 bryophyte taxa (6 liverworts and 58 mosses) were identified. The complete list of bryophyte records is given below. The numbers following the species names refer to the collection sites from Figure 1.

Bryofloristic checklist

Hepaticae

1. *Calypogeia sphagnicola* (Arnell et J. Perss.) Warnst. et Loeske – 5: in raised bog
2. *Chiloscyphus pallescens* (Ehrh. & Hoffm.) Dum. – 8: in degraded raised bog; 13: in poor fen
3. *Odontoschisma fluitans* (Nees) L.Söderstr. & Váňa – 14, 18, 20, 21, 24: in raised bog
4. *Pellia endiviifolia* (Dicks.) Dum. – 3: in poor fen; 4: in high mountain spring fen; 8: in degraded raised bog
5. *Preissia quadrata* (Scop.) Nees – 4: in high mountain spring fen
6. *Scapania undulata* (L.) Dum. – 3: in poor fen

Musci

7. *Amblystegium serpens* Hedw. – 7: in poor fen; 8: in degraded raised bog
8. *Atrichum undulatum* (Hedw.) P. Beauv. – 13: in poor fen
9. *Aulacomnium palustre* (Hedw.) Schwaegr. – 4: in high mountain spring fen; 6, 13, 25: in poor fen; 8: in degraded raised bog; 24: in raised bog; 22, 23: in base-rich fen
10. *Bryum pseudotriquetrum* (Hedw.) Gaertn. et al. – 3, 6, 10, 25: in poor fen; 22, 23: in base-rich fen
11. *Calliergon giganteum* (Schimp.) Kindb. – 6, 7: in poor fen

12. *Calliergonella cuspidata* (Hedw.) Loeske – 10: in poor fen; 11: in raised bog; 23: in base-rich fen
13. *Campylophyllopsis calcarea* (Crundw. & Nyholm) Ochyra – 23: in base-rich fen
14. *Ceratodon purpureus* (Hedw.) Brid. – 26: in degraded fen
15. *Climacium dendroides* (Hedw.) Web. & Mohr – 8: in degraded raised bog; 22, 23: in base-rich fen
16. *Dicranella palustris* (Dicks.) Crundw. – 1: in raised bog; 3, 13, 25: in poor fen; 4: in high mountain spring fen
17. *Drepanocladus aduncus* (Hedw.) Warnst. – 6: in poor fen
18. *Fissidens dubius* P. Beauv. – 23: in base-rich fen
19. *Hamatocaulis vernicosus* Hedenas – 13: in poor fen
20. *Helodium blandowii* (Web. et Mohr.) Warnst. – 23: in base-rich fen
21. *Hygrohypnella ochracea* (Turn. ex Wils.) Ignatov & Ignatova – 4: in high mountain spring fen
22. *Hypnum cupressiforme* Hedw. – 26: in degraded fen
23. *Leucobryum juniperoideum* (Brid.) C. Muell – 9: in blanket bog
24. *Meesia triquetra* (Hook. & Tayl.) Ångstr. – 10: in poor fen
25. *Palustriella commutata* (Hedw.) Ochyra – 4: in high mountain spring fen
26. *Palustriella falcata* (Brid.) Hedenäs – 22, 23: in base-rich fen
27. *Philonotis calcarea* (Bruch & Schimp.) Schimp. – 4: in high mountain spring fen; 6: in poor fen
28. *Philonotis marchica* (Hedw.) Brid. – 8: in degraded raised bog
29. *Philonotis seriata* Mitt. – 4: in high mountain spring fen; 22, 23: in base-rich fen
30. *Plagiomnium undulatum* (Hedw.) Kop. – 22: in base-rich fen
31. *Pleurozium schreberi* (Brid.) Mitt. – 6, 13: in poor fen; 8: in degraded raised bog
32. *Polytrichum commune* Hedw. – 2, 20, 21: in raised bog; 3, 6, 15, 17, 25: in poor fen
33. *Polytrichum juniperoideum* (Brid.) C. Müll. – 18, 19, 20, 24: in raised bog; 23: in base-rich fen
34. *Polytrichum strictum* Brid. – 4: in high mountain spring fen; 5: in raised bog; 15: in poor fen
35. *Sanionia uncinata* (Hedw.) Loeske – 22: in base-rich fen
36. *Scorpidium revolvens* (Sw. ex anon.) Rubers – 10: in poor fen; 11, 16: in raised bog; 22: in base-rich fen
37. *Sphagnum affine* Renauld et Cardot – 9: in blanket bog
38. *Sphagnum angustifolium* (Russ.) C. Jensen – 5, 14: in raised bog; 10, 13, 15, 25: in poor fen
39. *Sphagnum capillifolium* (Ehrh.) Hedw. – 8: in degraded raised bog; 9: in blanket bog; 13, 15, 25: in poor fen; 18, 19, 20, 21, 24: in raised bog; 22: in base-rich fen
40. *Sphagnum centrale* C. Jens. – 2, 11, 12, 18: in raised bog; 6, 10, 13: in poor fen; 8: in degraded raised bog
41. *Sphagnum compactum* DC. – 9: in blanket bog; 19, 20: in raised bog
42. *Sphagnum contortum* Schultz. – 13: in poor fen; 16: in raised bog
43. *Sphagnum cuspidatum* Hoffm. – 2, 5, 14, 20, 21, 24: in raised bog; 7, 10: in poor fen
44. *Sphagnum divinum* Flatberg et Hassel – 1, 5, 24: in raised bog; 8: in degraded raised bog
45. *Sphagnum fallax* (Klinggr.) Klinggr. – 1, 2, 12, 19: in raised bog; 7, 13: in poor fen; 8: in degraded raised bog
46. *Sphagnum flexuosum* Dozy & Molk. – 2, 16, 20, 24: in raised bog; 6, 17: in poor fen; 8: in degraded raised bog; 9: in blanket bog
47. *Sphagnum fuscum* (Schimp.) Klinggr. – 5, 14, 18, 21: in raised bog; 15, 17: in poor fen
48. *Sphagnum girgensohnii* Russ. – 4: in high mountain spring fen
49. *Sphagnum majus* (Russow) CEO Jensen – 19: in raised bog
50. *Sphagnum medium* Limpr. – 16, 18, 19, 20, 24: in raised bog
51. *Sphagnum palustre* L. – 7, 15, 17: in poor fen; 8: in degraded raised bog; 9: in blanket bog; 16: in raised bog
52. *Sphagnum platyphyllum* (Braithw.) Warnst. – 9: in blanket bog
53. *Sphagnum riparium* Angstr. – 16: in raised bog
54. *Sphagnum rubellum* Wils. – 5, 11, 18, 20, 21: in raised bog; 8: in degraded raised bog; 9: in blanket bog; 10, 13, 17, 25: in poor fen; 23: in base-rich fen

55. *Sphagnum russowii* Warnst. – 5: in raised bog
 56. *Sphagnum squarrosum* Crome – 8: in degraded raised bog
 57. *Sphagnum subsecundum* Nees – 3: in poor fen; 16: in raised bog
 58. *Sphagnum tenellum* Brid. – 8: in degraded raised bog
 59. *Sphagnum warnstorffii* Russ. – 2: in raised bog
 60. *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs – 15: in poor fen; 16: in raised bog
 61. *Thuidium abietinum* (Hedw.) Schimp. – 22: in base-rich fen
 62. *Tomenthypnum nitens* (Hedw.) Loeske – 23: in base-rich fen
 63. *Warnstorfia exannulata* (Schimp.) Loeske – 4: in high mountain spring fen; 6, 13: in poor fen
 64. *Warnstorfia fluitans* (Hedw.) Loeske – 16, 20: in raised bog

Most of the above listed bryophytes are characteristic of peatlands generally, and specifically of the peat bogs and fens of the Apuseni Mts. The most frequent and abundant species are the following: *Sphagnum capillifolium*, *S. centrale*, *S. cuspidatum*, *S. flexuosum*, *Polytrichum commune* and *P. juniperoideum*. Besides these, some other species could be considered rare (Figure 3), having great biogeographical and nature conservation importance. These species are presented and discussed below in considerable detail.

Also, contrary to our efforts, we were not able to find *Sphagnum balticum* (Russ) C. Jens., a very rare species mentioned for the first time in *Molhașul de la Călățele* peat bog by Györfy & Péterfi (1919).

***Calypogeia sphagnicola* (Arnell et J. Perss.) Warnst. et Loeske**

It is a LC species in Romania according to Hodgetts & Lockhart (2020). It is known from *Molhașul de la Rîșca*, *Molhașul de la Călățele*, from the peat bogs and fens on the upper course of *Someșul Cald* river and from *Bălcești-Călățele* area (Ștefănuț, 2008). We hereby report this species as a new occurrence in *Molhașul cel Mare de la Izbuc*.

***Odontoschisma fluitans* (Nees) L.Söderstr. & Văna**

It is a VU species in Romania according to Hodgetts & Lockhart (2020). Previously, it was known from *Molhașul cel Mare de la Izbuc* and *Molhașul de la Călățele* (Ștefănuț, 2008). In the present study, we report new occurrences of this species in the following raised bogs: *Cotul Someșului*, *Molhașurile Căpățînii (La Zăpodie, Vîrful Băii-Tăul Căpățînii* - Figure 3a), *Calul de Piatră* and *Mluha*.

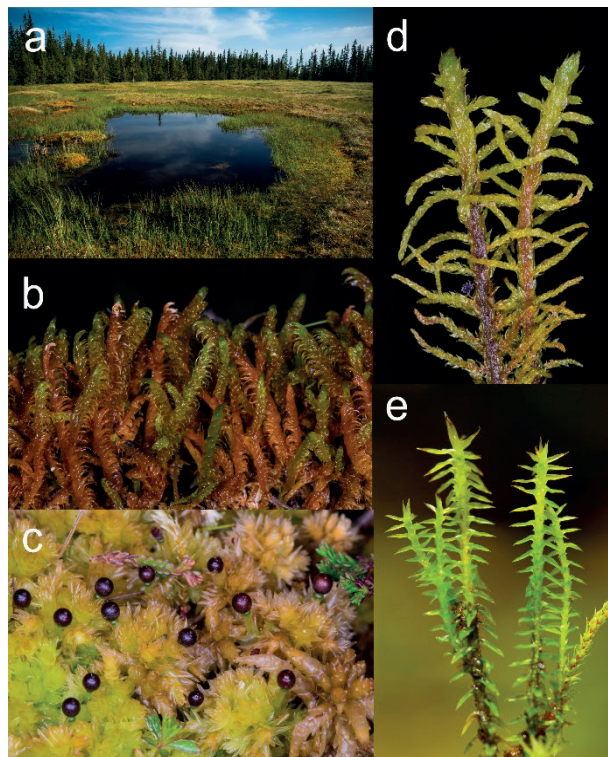


Figure 3. Rare bryophytes and their habitats: a) peat bog pond at *Molhașurile Căpățînii*, habitat of *Odontoschisma fluitans*; b) *Hamatocaulis vernicosus*; c) *Sphagnum compactum*; d) *Helodium blandowii*; e) *Meesia triquetra* (photos by Jakab G.)

***Hamatocaulis vernicosus* Hedenäs**

It is a boreal moss occurring in oligotrophic wet grasslands (Düll, 1985). Its great importance from biodiversity and nature conservation perspectives resides in its rarity. Therefore it is included in the Bern Convention (1982), in the European Union Habitats and Species Directive (1992) and in the Red data book of European bryophytes (ECCB, 1995). Also, it is a Natura 2000 priority species of community interest. In Romania, it is categorised as VU (Hodgetts et al., 2020), appearing also VU on the European checklist (Hodgetts & Lockhart, 2020). Earlier studies mentioned its presence in some sites of the Apuseni Mts. such as in the peatlands of *Bălcești-Călățele* area, in *Someșul Cald* river

valley, on Vlădeasa Mts. (*Vârfuraș, Micău, Rogojel*) (Mohan, 1998). We hereby report it from *Mlaștina deasupra Lacului Fântânele* (*Bălcești* area) (Figure 3b; Figure 4), this being a new locality of the species in the Apuseni Mts. ***Helodium blandowii*** (Web. et Mohr.) Warnst.

It is a NT species in Europe and VU in Romania, according to Hodgetts & Lockhart (2020). It is a circumpolar, boreal-montane moss, being found in boreal and subarctic areas of Europe, including Iceland, but absent from the high Arctic, and with scattered occurrences southwards to the Alps, in the Carpathians and in Bulgaria. This species is threatened across Europe by habitat destruction and degradation (Širka et al., 2018; Düll & Düll-Wunder, 2023). It is considered a rare glacial relict in Romania, being known only from a few localities (Ștefureac, 1985; Mohan, 1998), peat bogs and mires distributed mainly in the northern part of the Romanian Carpathians (Maramureș and Bukovina regions): the peat bogs *Poiana Brazilor, Tăul Morărenilor* (eutrophic mire), *La Tăcinoasa, Coșna, Lucina* (also along *Hortineț* and *Camionca* rivulets), *Răchitișu Mare, Grădinița, Valea Stâinii, Drăgoioasa* (eutrophic mire) and *Cristișor*. Further to south, in the Eastern Carpathians, it is reported from the peat bog “*Răbufnitoarea*” (“*Buffogó*” - Ștefureac, 1985; Gergely et al., 1989) and from the site *Săcărîmb-Haitău* (*Certeju de Sus* commune in *Hunedoara* County) at the south-eastern limit of the Apuseni Mts, where it was found by M. Péterfi in 1899 (Ștefureac, 1985). Further on, Ștefureac (1985) reported that the species could not be found in the latter site, but its typical habitat with some characteristic species was conserved. We report here specimens found in *Mlaștina de la izvoarele Tisei* (Figure 3d; Figure 4), site which represents the only certain locality of occurrence of this species in the Apuseni Mts. ***Hygrohypnella ochracea*** (Turner. ex Wils.) Ignatov & Ignatova

It is a VU species in Romania according to Hodgetts & Lockhart (2020). It is known only from a few scattered localities: in *Argeș* county: *Iezer-Păpușa* Mts.; in *Bihor* County: *Apuseni* Mts. (*Drăganului* valley); in *Prahova* County: *Ciucaș* Mts. (*Gropșoarele* valley, *Bratocea* peak); in *Suceava* county: *Codrul Secular Slătioara*; in *Vâlcea* county: *Lotrului* Mts. (*Latorița* valley) (Mohan, 1998). We hereby

report it from *Fântâna Rece, Drăganului* river spring area.

Leucobryum juniperoideum (Brid.) Müll. Hal. It is considered NT in Romania (Hodgetts & Lockhart, 2020), known previously from *Drăganului* valley, *Piatra Capra* and *Someșul Rece* river valley (Boros & Vajda, 1967; Mohan, 1998). We found it on *Molhașul de la Rîșca* blanket bog (Figure 4), a site the species was also mentioned from in one of our previous studies (Frink et al., 2017). This locality is a new one for the Apuseni Mts.

Meesia triquetra (Hook. & Tayl.) Ångstr.

It is a boreal and arctic moss with circumpolar distribution, growing in nutrient rich wetlands and especially in calcareous mires (Favreau & Brassard, 2011). Its range spans across the Holarctic temperate-alpine zones of Europe and North America. Also, it has a disjunct distribution area in North Africa and South-East Australia (Odgaard, 1988). The species is treated as a glacial relict (Šoltés, 1997, 2000), however according to Odgaard (1988) it is not a glacial relict in Central and Western Europe, while in Eastern Europe it is not a relict at all in the strict sense of the term. It is considered NT at European level and LC in Romania (Hodgetts & Lockhart, 2020). It is known from several localities in Romania, but until now it has had just one single occurrence in the Apuseni Mts., at *Scărișoara* (Mohan, 1998). We report a second, new locality of this species at *Dîmbu Negru - La Pod*, in a poor fen habitat (Figure 3e; Figure 4).

Philonotis marchica (Hedw.) Brid.

It is considered NT in Romania (Hodgetts & Lockhart, 2020), being known previously from *Pădurea Vâlcele* (a forest, south of *Cluj-Napoca*) and from the *Someșul* river valley in the Apuseni Mts. (Plămadă, 1967; Mohan, 1998). Therefore, *Molhașul de la Călățele* is a new, second locality of occurrence of this species for the above mentioned mountain unit (Figure 4).

Sphagnum affine Renauld et Cardot

It is a very rare species in Romania, reported earlier from *Bălcești-Călățele* area (Mohan, 1998 *apud* Pop, 1960), from *Molhașul de la Rîșca* (under the toponymy “*Lágyas-Văleni*”) as *S. imbricatum* var. *cristata* fo. *fuscescens* (Györfy & Péterfi, 1919: 68 - *Comit. Kolozs: in pratis turfosis ad margines silvae Csicsera juxta pagum Magyarvalkó, cca 940 m.s.m.*). In the

present study, we confirm its occurrence in this peat bog (Figure 4). Its conservation status is NE in Romania (Hodgetts & Lockhart, 2020), because of its rarity and lack of chorological information. Therefore, this species needs special attention in the future.

***Sphagnum compactum* DC**

It is an Atlantic species known in the older literature under *S. compactum* var. *squarrosa* from the peat bogs *Molhașul de la Călățele* and *Molhașul de la Rîșca* (under the toponymy “*Lágyas-Văleni*” - Györffy & Péterfi, 1919: *Lágyas prope pagum Magyarvalkó, alt. 1000 m.s.m.*). Our study confirms its presence in latter site (Figure 3c), and we also report it from new localities in *Molhașurile Căpățînii* (*Mocîrle - Tăul Sărat* and *Vîrful Băii-Tăul Căpățînii* peat bogs) (Figure 4).

***Sphagnum divinum* Flatberg et Hassel**

Until recently, *Sphagnum magellanicum* Brid. was considered to be one of the most widely distributed peat mosses in the world. It is a species complex which includes actually three different species: *S. magellanicum* Brid in *sensu stricto*, *S. medium* Limpr. and *S. divinum* Flatberg & Hassel. The distribution of *S. magellanicum* s. str. is restricted only to the southern part of South America, while the two other species of the complex, *S. medium* and *S. divinum* occur in the Northern Hemisphere (Hassel et al., 2018). We hereby confirm its presence in the following peat bogs: *Padiș-molidiș*, *Molhașul cel Mare de la Izbuc*, *Molhașul de la Călățele* and *Mluha*.

***Sphagnum medium* Limpr.**

In the present study, we report it from the peat bog complex *Molhașurile Căpățînii* and from *Mluha* peat bog. A very recent bryofloristic note

of M-M. Ștefănuț (see Tomović et al., 2024) cites the species from *Sibiu* County: in *Avrig* peat bog; from *Suceava* county: in *Tinovul de lângă drum* peat bog and from *Maramureș* county: in *Tăul la Gutâi* peat bog (Gutâi Mts.). Evaluation and taxonomic reconsideration of this species, as well as of *S. divinum* is still needed in Romania.

***Sphagnum platyphyllum* (Braithw.) Warnst.**

It is categorised as LC at European level (Hodgetts & Lockhart, 2020) and NT in Romania, being known previously from *Molhașul de la Dealul Negru*-“*Lágyas*” (as var. *teretiuscula*, Györffy & Péterfi, 1919: *Lágyas supra pagum Magyarvalkó cca 920 m.s.m.*) and *Dealul Negru, Râșca-Răchitiș* (Plămadă, 1998). We hereby confirm its presence in *Molhașul de la Rîșca* (*Molhașul de la Dealul Negru*-“*Lágyas*”) (Figure 4).

***Sphagnum squarrosum* Crome**

It is categorised as LC in Romania (Hodgetts & Lockhart, 2020). According to Mohan (1998), it is reported from one single locality in the Apuseni Mts., *Stâna de Vale*. Therefore, *Molhașul de la Călățele* peat bog is a new, second locality of occurrence of the species in this mountain area (Figure 4).

***Sphagnum tenellum* Brid.**

It is categorised as EN in Romania (Hodgetts & Lockhart, 2020), being very rare in the Romanian Carpathians and being previously known from the following mountain units: Bodoc Mts. in *Zombor* rivulet valley - *Băile Ceres*; Apuseni Mts. at *Ponor-Sohodol Verde*, *Padiș*, *Izbuc-Călineasa* and in *Molhașul de la Călățele* (Plămadă, 1998). We confirm its presence in the *Molhașul de la Călățele* peat bog (Figure 4).

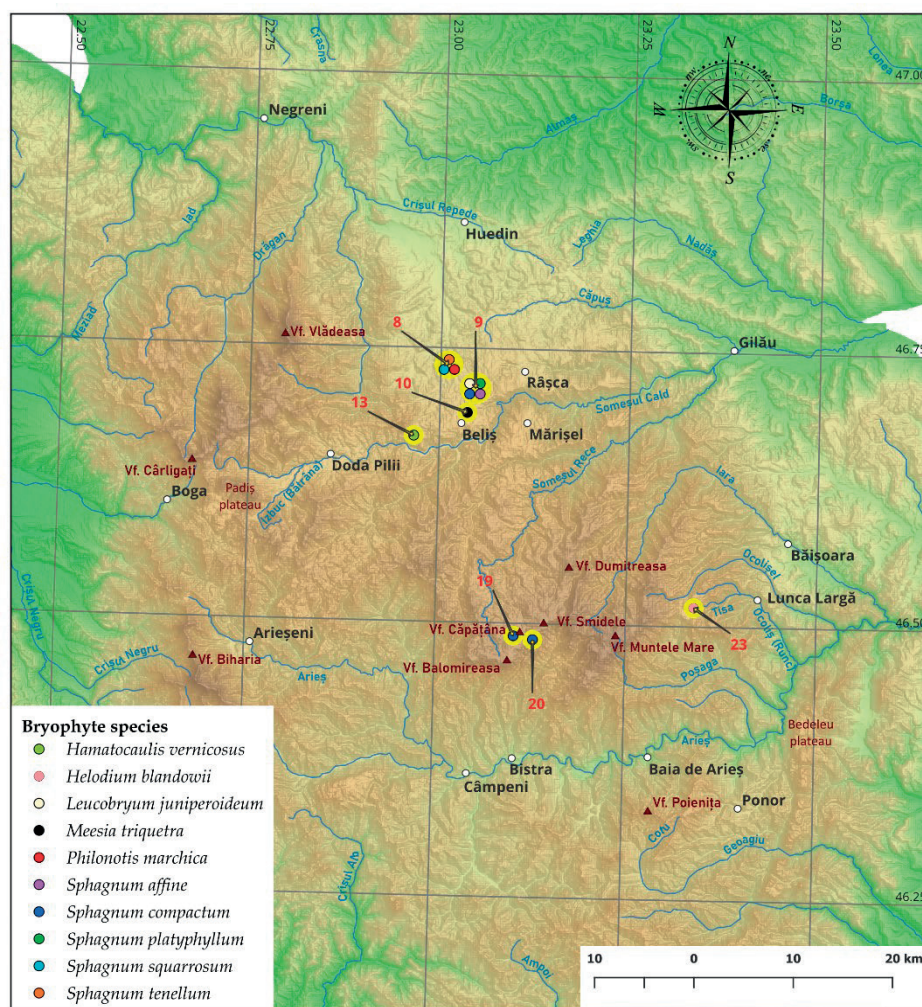


Figure 4. Distribution of some rare bryophytes in peatlands of the Apuseni Mts.:
 8. Molhașul de la Călățele; 9. Molhașul de la Rîșca ("Lágyas"); 10. Dîmbu Negru-La Pod;
 13. Mlaștina deasupra lacului Fântânele; 19. Molhașurile Căpățînii, Mocîrle-Tăul Sărat;
 20. Molhașurile Căpățînii, Vîrful Băii-Tăul Căpățînii; 23. Mlaștina de la izvoarele Tisei

CONCLUSIONS

During our study, in twenty-six collection sites, all being representative peat bogs and fens for the Apuseni Mts., 64 bryophyte taxa (6 liverworts and 58 mosses) were identified. We hereby report ten species with new localities of occurrence, completing their distribution range for this mountain unit and for Romania. These species are: *Calypogeia sphagnicola*, *Odontoschisma fluitans*, *Hamatocaulis vernicosus*, *Helodium blandowii* (first certain locality of occurrence for the Apuseni Mts.), *Hygrohypnella ochracea*, *Leucobryum juniperoideum*, *Meesia triquetra* (second locality), *Philonotis marchica* (second locality), *Sphagnum compactum*, *Sphagnum squarrosum* (second locality). Also, contrary to our efforts, we were not able to find the very rare *Sphagnum*

balticum (Russ) C. Jens., earlier reported from the *Molhașul de la Călățele* peat bog.

It must be noted that most of the above species are on the European Red List of bryophytes (Hodgetts & Lockhart, 2020). Actually, from all the listed bryophyte species of our study, eleven are included into an IUCN category, as follows: (i) EN: *Sphagnum tenellum*; (ii) VU: *Odontoschisma fluitans*, *Hamatocaulis vernicosus*, *Helodium blandowii*, *Hygrohypnella ochracea*; (iii) NT: *Leucobryum juniperoideum*, *Philonotis marchica*, *Sphagnum platyphyllum*; (iv) LC: *Calypogeia sphagnicola*, *Meesia triquetra* and (v) NE: *Sphagnum affine*. Considering the lack or the scarcity of bryofloristic data from the last three decades in the Apuseni Mts. peatlands, as well as the increased vulnerability of these habitats due to nowadays human impacts, the current study is a significant contribution to the knowledge of

bryoflora of this mountain area and to Romania's bryoflora, too. The results obtained, especially the reporting of many species with new localities of occurrence in the Apuseni Mts., as well as the confirmation of some rare species in their previously known localities, enrich our knowledge on the bryological diversity of Romania and underline the necessity and actuality of other similar studies. Furthermore, these new data on the distribution of rare and threatened species can greatly contribute to the protection of their populations and habitats and to their overall long-term conservation.

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ANNEX
Supplementary material. Field collection sites

No.	Site toponymy ¹	GPS Coordinates (Lat. N/Long. E)	Elevation (m a.s.l.)	Date of collection	Peatland type	Natura 2000 habitat ²	Natural Protected Area (NPA) ³
1. The region of peatlands at the springs and along the upper course of <i>Someșul Cald</i> river							
1.	<i>Padiș-molidiș</i>	46.59915/22.70254	1240	21.07.2013	raised bog	7110* Active raised bogs	RONPA0004 Parcul Natural Apuseni/ ROSCI0002 Apuseni
2.	<i>Padiș-Bălăleasa</i>	46.59800/22.69820	1237	21.07.2013	raised bog	7110* Active raised bogs	RONPA0004 Parcul Natural Apuseni/ ROSCI0002 Apuseni
3.	<i>Mlaștina din Poiana Vărășoia</i>	46.61030/22.71095	1271	21.07.2013	poor fen	7140 Transition mires and quaking bogs	RONPA0004 Parcul Natural Apuseni/ ROSCI0002 Apuseni
4.	<i>Mlaștina de la Fântâna Rece, Drăganului river spring area</i>	46.64317/22.66655	1619	22.07.2013	high mountain spring fen/ (soft-water spring mire)	7220* Petrifying springs with tufa formation (<i>Cratoneurion</i>)	130 m to RONPA0004 Parcul Natural Apuseni and to ROSCI0002 Apuseni 350 m to RONPA0193 Vârful Cărligați
5.	<i>Molhașul cel Mare de la Izbuc</i>	46.59105/22.76232	1217	21.07.2013/ 22.07.2013	raised bog	7110* Active raised bogs	RONPA0004 Parcul Natural Apuseni/ RONPA0164 Molhașurile din Valea Izbucelor – 1982/ RONPA0357 Molhașul Mare de la Izbuce/ ROSCI0002 Apuseni
6.	<i>Molhașul dintre Izbuce</i>	46.59000/22.76075	1223	21.07.2013	poor fen	7140 Transition mires and quaking bogs	RONPA0004 Parcul Natural Apuseni/ RONPA0164 Molhașurile din Valea Izbucelor/ RONPA0357 Molhașul Mare de la Izbuce/ ROSCI0002 Apuseni
7.	<i>La Doda</i>	46.64526/22.84645	1014	22.07.2013	poor fen	7140 Transition mires and quaking bogs	RONPA0004 Parcul Natural Apuseni/ ROSCI0002 Apuseni
1.1. Group of peatlands in Bălcești-Călățele area							
8.	<i>Molhașul de la Călățele</i>	46.72972/23.02208	920	24.07.2013	degraded raised bog, due to peat extraction in the past	7120 Degraded raised bogs still capable of natural regeneration/	4050 m to RONPA0004 Parcul Natural Apuseni and to ROSCI0002 Apuseni
9.	<i>Molhașul de la Rîșca (Mohușul de la Dealul Negru - "Lăgyas")</i>	46.70849/23.05224	1070	26.07.2013/ 04.07.2014	blanket bog	7130 Blanket bog (ladder fens)	860 m to RONPA0004 Parcul Natural Apuseni and to ROSCI0002 Apuseni
10.	<i>Dîmbu Negru-La Pod</i>	46.69132/23.03632	1080	24.07.2013	poor fen	7140 Transition mires and quaking bogs	RONPA0004 Parcul Natural Apuseni/ ROSCI0002 Apuseni

No.	Site toponymy ¹	GPS Coordinates (Lat. N/Long. E)	Elevation (m a.s.l.)	Date of collection	Peatland type	Natura 2000 habitat ²	Natural Protected Area (NPA) ³
11.	<i>Dîmbu Negru-La Pod</i>	46.69092/23.03355	1088	24.07.2013	raised bog	7110* Active raised bogs	RONPA0004 Parcul Natural Apuseni/ROSCI0002 Apuseni
12.	<i>Târșea Vălenilor (Bălceștilor)</i>	46.67913/23.01421	1143	26.07.2013	raised bog	7110* Active raised bogs	150 m to RONPA0004 Parcul Natural Apuseni and to ROSCI0002 Apuseni
13.	<i>Mlaștina deasupra lacului Fântânele</i>	46.66942/22.96642	1178	26.07.2013	poor fen	7140 Transition mires and quaking bogs	RONPA0004 Parcul Natural Apuseni/ROSCI0002 Apuseni
2. The region of peatlands at the springs of Someșul Rece river							
14.	<i>Cotul Someșului</i>	46.50291/23.07043	1443	27.07.2013	raised bog	7110* Active raised bogs	ROSAC0233 Someșul Rece
15.	<i>Cotul Someșului</i>	46.50361/23.07168	1438	27.07.2013	poor fen	7140 Transition mires and quaking bogs	ROSAC0233 Someșul Rece
16.	<i>Molhașurile Căpățînii</i> , northeast of Balomireasa peak	46.46798/23.10041	1602	27.07.2013	raised bog	7110* Active raised bogs	ROSCI0116 Molhașurile Căpățînii
17.	<i>Molhașurile Căpățînii</i> , northeast of Balomireasa peak	46.46762/23.09982	1606	27.07.2013	poor fen	7140 Transition mires and quaking bogs	ROSCI0116 Molhașurile Căpățînii
18.	<i>Molhașurile Căpățînii, La Zăpodie</i>	46.48125/23.09962	1612	05.07.2014	raised bog	7110* Active raised bogs	ROSCI0116 Molhașurile Căpățînii
19.	<i>Molhașurile Căpățînii, Mocîrle - Tăul Sărat</i>	46.48851/23.10349	1593	05.07.2014	raised bog	7110* Active raised bogs	ROSCI0116 Molhașurile Căpățînii
20.	<i>Molhașurile Căpățînii, Vîrful Băii - Tăul Căpățînii</i>	46.48528/23.12904	1598	05.07.2014	raised bog	7110* Active raised bogs	RONPA0033 Molhașurile Căpățînei/ROSCI0116 Molhașurile Căpățînii
21.	<i>Calul de Piatră</i>	46.50520/23.14893	1629	28.07.2013	raised bog	7110* Active raised bogs	1020 m to ROSAC0233 Someșul Rece/ 1630 m to ROSCI0116 Molhașurile Căpățînii
3. Other peatlands isolated from the previous regions/groups							
22.	<i>Mlaștina din fundul văii Jgheburoasa</i> (Muntele Mare Mts.)	46.52905/23.35125	1217	07.07.2014	base-rich fen	7230 Alkaline fens	ROSAC0253 Trascău

No.	Site toponymy ¹	GPS Coordinates (Lat. N/Long. E)	Elevation (m a.s.l.)	Date of collection	Peatland type	Natura 2000 habitat ²	Natural Protected Area (NPA) ³
23.	<i>Mlaștina de la izvoarele Tisei</i> (Apa Rătăcită, Colibele Zăpodie - Muntele Mare Mts.)	46.51727/23.33949	1109	07.07.2014	base-rich fen	7230 Alkaline fens	100 m to ROSAC0253 Trascău
24.	<i>Mluha</i> ("Tău Mluhii")	46.33066/23.33648	1337	06.07.2014	raised bog	7110* Active raised bogs	5800 m to ROSAC0253 Trascău
25.	<i>Mlaștina Poienița</i>	46.79984/22.66740	889	23.07.2013	poor fen	7140 Transition mires and quaking bogs	550 m to ROSAC0062 Defileul Crișului Repede - Pădurea Craiului
26.	<i>Mlaștina de pe Dealul Leșului</i>	46.82843/23.15981	733	23.07.2013	degraded fen	-	4800 m to RONPA0355 Gipsurile de la Leghia

¹According to Pop (1960), also respecting the original spelling

²Frink, unpublished

³the free GIS database on the limits of Romanian Protected Areas (NPAs) network was used (last update on 11 of March 2024); downloadable from <https://www.mmediu.ro/categorie/date-gis/205>

⁴represents the air distance to the border of the closest NPA, calculated on Google Earth