

CONTRIBUTION TO THE BRYOPHYTE FLORA OF THE METALLIFEROUS AREAS OF THE EASTERN RHODOPI MTS, BULGARIA

Beáta PAPP¹, Galin GOSPODINOV² and Rayna NATCHEVA²

¹Hungarian National Museum Public Collection Centre, Hungarian Natural History Museum,
Department of Botany, H–1431 Budapest, PO Box 137, Hungary; papp.beata@nhmus.hu

²Institute of Biodiversity and Ecosystem Research, BAS, 2 Gagarin Street, 1113 Sofia, Bulgaria

Papp, B., Gospodinov, G. & Natcheva, R. (2026): Contribution to the bryophyte flora of the metal-
liferous areas of the Eastern Rhodopi Mts, Bulgaria. – *Studia bot. hung.* 56(2): 5–30. (2025).

Abstract: During investigation of the bryophyte flora formed on igneous rocks enriched in metals, we identified a total of 183 bryophyte taxa (one hornwort, 33 liverworts, and 149 mosses). Nine taxa (two liverworts and 7 mosses) have been reported for the first time from Bulgaria, namely *Riccia michelii*, *Targionia lorbeeriana*, *Didymodon nicholsonii*, *D. tophaceus* subsp. *erosus*, *Epipterygium tozeri*, *Orthotrichum schimperi*, *Lewinskya acuminata*, *Schistidium dupretii*, and *Scorpiurium sendtneri*. Two species (*Philonotis calcarea* and *Syntrichia subpappillosissima*) are included in the European bryophyte red list in the NT and DD category, respectively. Twenty-seven species (6 liverworts and 21 mosses) have conservation importance based on recent knowledge on their distribution and threats affecting them in Bulgaria and neighbouring countries.

Key words: liverworts, mosses, new national records, species of conservation interest, southeastern Europe

INTRODUCTION

The bryophyte flora of Bulgaria has intensively been studied during the recent years (GOSPODINOV and NATCHEVA 2022, NATCHEVA and GOSPODINOV 2024). Nevertheless, there are still areas that have received less attention. The Eastern Rhodopi Mts is among these poorly known regions in Bulgaria. Only 7 species of liverworts and 65 species of mosses have been published from the area up to date (GOSPODINOV and NATCHEVA 2022, NATCHEVA and GANEVA 2005). A much larger diversity is expected considering the location of the region at the border of the temperate and Mediterranean climatic regions, the extremely diverse geological structure, and the presence of a large variation of habitats.

The aim of this study was to contribute to the knowledge of the bryophyte diversity of the Eastern Rhodopi Mts with a special emphasis on igneous rocks enriched in metals.

MATERIAL AND METHODS

Description of the area investigated

The Eastern Rhodopi Mts is the easternmost part of the Rilo-Rhodopean massif, Southeast Bulgaria (Fig. 1). Geologically, it is the most diverse region in Bulgaria with a complex geological history and lithology. The landscape was formed by several rounds of volcanic activity, starting during the Palaeocene and ending in the late Oligocene. During this period, the territory of the Eastern Rhodopi Mts has been a complex island-arc system, consisting of depressions filled with shallow warm sea and the volcanoes formed islands and archipelagos. The volcanic activity gave rise to several metallogenic ore fields enriched with various heavy metals: Pb, Zn, Cu, Au, Sb, etc. Thus, the present geological structure is composed of various igneous acid to ultrabasic rock formations (rhyolite, andesite, latite, basalt, etc.) and sedimentary (mostly organogenic carbonates and limestone) rocks formed over the Precambrian to Mesozoic metamorphic basement (gneiss, schist, migmatite, and serpentinized ultrabasites) (GEORGIEV 2012). The metallogenic occurrences in the Eastern Rhodopi Mts have intensively been exploited since prehistoric times up to the present.

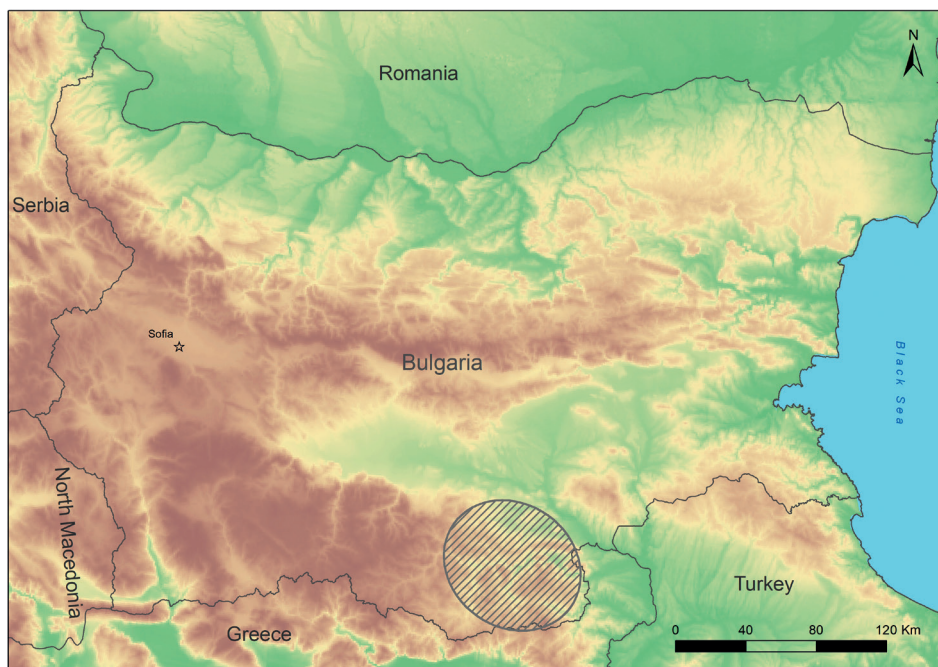


Fig. 1. Location of the area investigated.

The study area belongs to the Continental-Mediterranean climatic region (VELEV 2002). The mean January temperature is -3°C – $+4^{\circ}\text{C}$ and the mean July temperature is 16 – 24°C . The annual precipitation is 500 – 900 mm, which is among the largest ones in the country for the lowland and the middle mountain belt, with a winter (November–January) maximum and summer-autumn (July–September) minimum (YORDANOVA *et al.* 2002). The altitude is 200 – 1000 m (mostly 200 – 600 m). From a phytogeographical point of view, the Eastern Rhodopi Mts belong to the Illyric (Balkan) province of the European deciduous forest region with the predominance of xerothermic oak forests and scrublands (BONDEV 2002). The study area has been inhabited by humans at least since the Neolithic and the landscape and vegetation are strongly affected by human activities.

Sampling sites

Sampling sites were selected in areas of metallogenic ore fields. Within each site, we attempted to cover the diversity of microhabitats and substrates as much as possible. Most of the study sites (with the exception of sites 12 and 13) belong to the Natura 2000 SCI site BG0001032 Rodopi – Iztochni (Rhodopi – Eastern).

1. W of Spahievo village, on the E slopes of peak Aida, andesite outcrop with heavy metals at rivulet Erikdere, $41^{\circ} 53' 55.3''$ N, $25^{\circ} 18' 41.0''$ E, 510 m, 12.06.2019.

2. W of the town of Madzharovo, by River Arda, andesite bedrock, by an old lead mine, $41^{\circ} 38' 16.3''$ N, $25^{\circ} 51' 02.1''$ E, 162 m, 13.06.2019.

3. W of the town of Madzharovo, by River Arda, andesite bedrock, by old lead mines, $41^{\circ} 38' 26.8''$ N, $25^{\circ} 50' 46.1''$ E, 143 m, 13.06.2019.

4. E of village Studen Kladenets, andesitobasaltic bedrock, $41^{\circ} 36' 33.5''$ N, $25^{\circ} 39' 14.9''$ E, 183 m, 13.06.2019.

5. S of Golyamo Kamenyane village, abandoned mine area, metaserpentine bedrock, $41^{\circ} 24' 10.4''$ N, $25^{\circ} 42' 22.4''$ E, 440 m, 14.06.2019.

5x. S of Golyamo Kamenyane village, abandoned mine area, metaserpentine bedrock, rocky dry grassland, rivulet, $41^{\circ} 24' 10.4''$ N, $25^{\circ} 42' 22.4''$ E, 440 m, 15.06.2019.

6. By River Avrenska between Arven and Devesilovo villages, metaserpentine bedrock, $41^{\circ} 20' 33.5''$ N, $25^{\circ} 41' 14.9''$ E, 380 m, 14.06.2019.

7. E of Kazak village, in serpentine grassland, $41^{\circ} 24' 43.4''$ N, $25^{\circ} 53' 03.7''$ E, 405 m, 15.06.2019.

8. Along the road from Kazak to Chernichevo, E of Chernichevo village, metaserpentine bedrock, $41^{\circ} 21' 29.1''$ N, $25^{\circ} 48' 34.2''$ E, 635 m, 15.06.2019.

8x. Along the road from Kazak to Chernichevo, E of Chernichevo village, metaserpentine bedrock, $41^{\circ} 21' 29.1''$ N, $25^{\circ} 48' 34.2''$ E, 635 m, 18.06.2019.

9. N of Sentse village, below old lead mines, stream with shaded basaltic and andesite rocks, $41^{\circ} 27' 24.1''$ N, $25^{\circ} 28' 21.7''$ E, 565 m, 16.06.2019.

10. N of Sentse village, basaltic and andesite bedrock, 41° 27' 36.3" N, 25° 28' 09.9" E, 535 m, 16.06.2019.

11. At mine Zvezdel, N slopes of peak Kalabak, acidic tufa bedrock, along a stream valley, 41° 27' 17.2" N, 25° 30' 25.4" E, 485 m, 16.06.2019.

12. SW of Gorna Yakovica village, dry grassland by a lead mine, on metaserpentine bedrock, 41° 18' 35.3" N, 25° 15' 30.4" E, 765 m, 17.06.2019.

13. E of Dzherovo village, along River Arabadzhiiska, sandstone bedrock, 41° 18' 52.1" N, 25° 18' 55.4" E, 375 m, 17.06.2019.

14. At Studen Kladenets village, just below the wall of Studen Kladenets Dam, loc. Sheitan dere, andesitobasaltic rocks at the river, 41° 36' 47.0" N, 25° 38' 23.9" E, 162 m, 19.06.2019.

Methods

The materials were collected in June 2019. Herbarium materials are deposited in the Herbarium of the Hungarian Natural History Museum, Budapest (BP) and in the Herbarium of the Institute of Biodiversity and Ecosystem Research, Sofia (SOM).

The nomenclature follows HODGETTS *et al.* (2020). The selection of species of conservation interest is based on the European red list (HODGETTS *et al.* 2019), the Bulgarian red list (NATCHEVA *et al.* 2006), and the Serbian red lists of hornworts and liverworts (SABOVLJEVIĆ *et al.* 2024a), and mosses (SABOVLJEVIĆ *et al.* 2024b). The recent red lists of Serbia, which is a neighbouring country of Bulgaria, give a very good overview of the threat status of the species in the region. Therefore, it was very useful to consider them. In some cases the red list of the neighbouring Romania was also considered (ȘTEFĂNUȚ 2012). Abbreviations of red list categories are as follows: CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, DD = data deficient. The European distribution (floristical element categorisation) of species is given according to DÜLL (1983) for liverworts and DÜLL (1984, 1985) for mosses, while country distributions in Europe and red list status in countries according to HODGETTS and LOCKHART (2020), with updates where relevant.

RESULTS AND DISCUSSION

During this study, we identified a total of 183 bryophyte taxa, i.e. one hornwort (Anthocerotophyta), 33 liverworts (Marchantiophyta), and 149 mosses (Bryophyta). The list of species is presented in Appendix. Nine taxa (two liverworts and 7 mosses) are reported for the first time from Bulgaria, and 130 species are new to the Eastern Rhodopi Mts. Two species are included in the European

bryophyte red list in the NT and DD category, respectively (HODGETTS *et al.* 2019). Twenty-seven species (6 liverworts and 21 mosses) have conservation importance based on the recent knowledge on their distribution and threats affecting them in Bulgaria (NATCHEVA *et al.* 2006) and the neighbouring countries (SABOVLJEVIĆ *et al.* 2024a, b, ȘTEFĂNUȚ 2012).

New additions to the Bulgarian bryophyte flora

Liverworts

Riccia michelii – It is a Mediterranean, sub-Atlantic liverwort. In the Western Mediterranean it is known from Portugal, Spain, France, and Italy, where it is red listed in the NT category. It also occurs in Switzerland, where it is VU. It is regionally extinct (RE) in Germany. In SE Europe it has records from Albania, Bosnia-Herzegovina, Croatia, Greece, and Montenegro. In the Eastern Rhodopi Mts it was collected in several dry grasslands near Studen Kladenets, Golyamo Kamenyane, Kazak, and Sentse villages.

Targionia lorbeeriana – It is a Mediterranean, sub-Atlantic liverwort. It is widely distributed in the Western Mediterranean, but CR in Italy. In SE Europe it is known from Croatia, Greece, and Montenegro. Considering the distribution of the species, the Bulgarian populations are at the northern edge of its range. In the Eastern Rhodopi Mts it was collected in a dry grassland near Kazak village.

Mosses

Didymodon nicholsonii – It is an Atlantic, sub-Mediterranean species living on rocks in streams and rivers, often below flood level (SMITH 2004). It has a sporadic distribution from the Atlantic coast to Eastern Europe; known from Great Britain, Ireland, Balearic Islands, Canary Islands, Portugal, Spain, France, Italy, Belgium, the Netherlands, Germany, and Luxembourg, where it is red listed as VU. In SE Europe it has records from Albania, Greece, Montenegro, Serbia, and Slovenia. It is included in the recent red list of Serbia as VU due to its restricted area of occupancy and number of locations. In the Eastern Rhodopi Mts it was found in two sites by River Avrenska and at Studen Kladenets Dam.

Didymodon tophaceus subsp. *erosus* – This taxon has recently been described as *Didymodon erosus* from northwestern Spain by JIMÉNEZ *et al.* (2004). Later on, studies on the *Didymodon tophaceus* complex by KUČERA *et al.* (2018) reduced *Didymodon erosus* to the subspecies level. The taxon is known from the following countries so far: France, Portugal, Spain, Austria, Germany, Luxembourg, and Hungary. From SE Europe it has been reported from Albania. It does not seem to be rare in the Eastern Rhodopi Mts evidenced by collections from four localities.

Epipterygium tozeri – It is a sub-Atlantic, Mediterranean species widely distributed in the Western Mediterranean. It also has records from Great Britain and Ireland. It is also known from Switzerland, where it is red listed as VU. In SE Europe it has records from Greece, Montenegro, and the European part of Turkey. In the Eastern Rhodopi Mts it was found on soil at a streambank near Chernichevo village.

Lewinskya acuminata – It is a sub-Mediterranean, montane epiphyte. It is widely distributed in the Western Mediterranean region, and it is known from Great Britain, where it is red listed as VU. It has records from Belgium, the Netherlands, Switzerland, and Germany, where it is extremely rare. In SE Europe it occurs in Albania, Bosnia-Herzegovina, Croatia, Greece, Montenegro, and Slovenia. In the Eastern Rhodopi Mts it was found on the bark of a *Quercus pubescens* tree at mine Zvezdel.

Orthotrichum schimperi – It is an epiphyte species which was previously treated as a synonym of *Orthotrichum pumilum* Sw. in many flora works (FREY *et al.* 1995, SCHÄFER-VERWIMP 2001), therefore it has not received adequate attention in many regions. It has a wide distribution in Europe; however, it is red listed in Portugal as CR, in Great Britain as VU, and in Sicily as NT. In Finland and Switzerland, it is in the DD category. In SE Europe it was known from almost all SE European countries except Bulgaria, the European part of Turkey, and North Macedonia. Later on, it has also been reported from the latter country (PAPP *et al.* 2024a). In the Eastern Rhodopi Mts it was collected at two sites from *Salix* and *Quercus* barks.

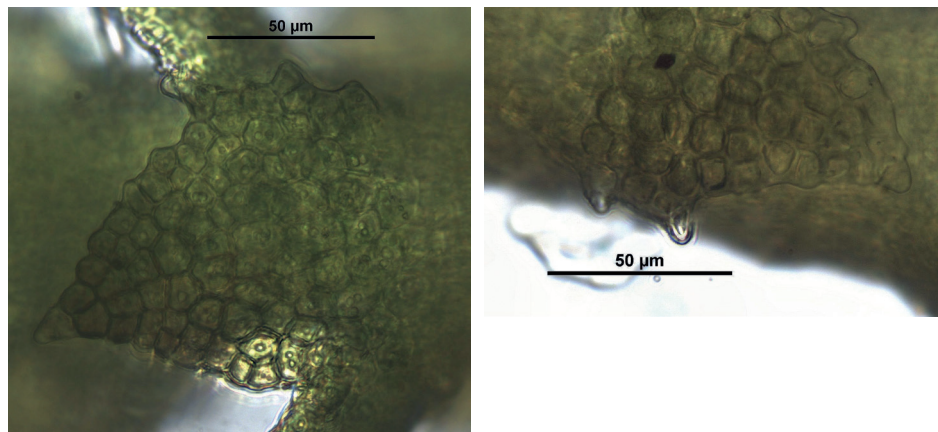
Schistidium dupretii – It has a wide, but sporadic distribution in Europe, but probably it is still under-recorded. In SE Europe it is known from almost all countries except Bosnia-Herzegovina, Bulgaria, and the European part of Turkey. It is included in the recent red list of Serbia as VU due to its restricted area of occupancy and number of locations. In the Eastern Rhodopi Mts several patches were collected at Spahievo village on an andesite outcrop.

Scorpiurium sendtneri – It is a sub-Mediterranean species. It has a sporadic distribution. In the Western Mediterranean it is known from Portugal, France, Italy, and Spain, where it is in the DD category. In SE Europe it occurs in Albania, Croatia, Greece, Montenegro, and Slovenia, where it is red listed as EN. In the Eastern Rhodopi Mts it was found on andesite rocks by River Arda near Madzharovo.

Taxonomically noteworthy records

Cephaloziella divaricata var. *scabra* – It is a sub-Atlantic taxon. It is distinguished from var. *divaricata* by having strongly dentate leaves, verruculose cuticle, and frequently large conical outgrowths on the back part of the leaves below the

sinus (DAMSHOLT 2002). It lives on exposed, dry acidic cliffs, ledges, and sandy heaths in Scandinavia (DAMSHOLT 2002). In Great Britain and Austria it intergrades with more typical forms and according to SMITH (1990) and KÖCKINGER (2017) it cannot be maintained even at varietal rank. The specimens collected in many localities in the Eastern Rhodopi Mts contain a lot of shoots matching with the description of this taxon.



Figs 2–3. Leaf lobe of *Cephaloziella divaricata* var. *scabra* (loc. 2).

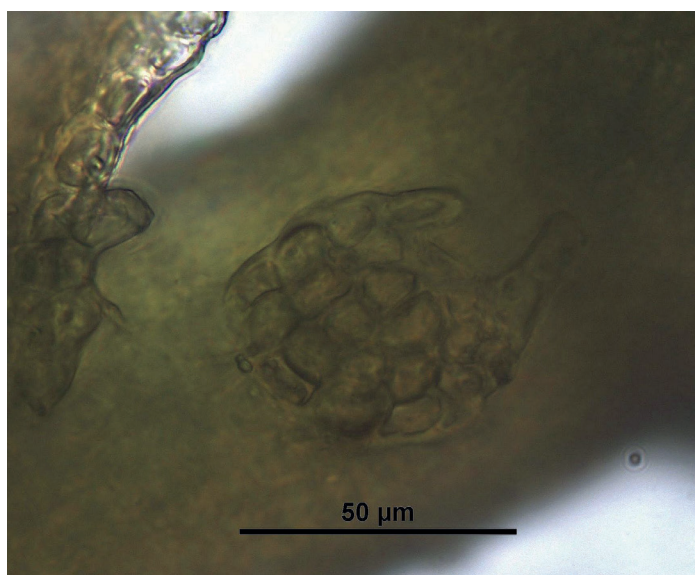


Fig. 4. An underleaf of *Cephaloziella divaricata* var. *scabra* (loc. 2).

Lewinskya fastigiata – It is an epiphyte species of the temperate zones of Europe. Its previous name, *Orthotrichum fastigiatum* Bruch ex Brid., was treated as a synonym of *Orthotrichum affine* Schrad. ex Brid. in many widely used checklists (HILL *et al.* 2006, ROS *et al.* 2013). *Lewinskya fastigiata* was reinstated by VIGALONDO *et al.* (2019), on the basis of integrative taxonomic analyses on the *Lewinskya affinis* complex. Therefore, the distribution of this taxon should be re-investigated. In Bulgaria it was known from the Central Rhodopi Mts (GANEVA and DÜLL 1999). In the Eastern Rhodopi Mts it does not seem to be rare, several patches were collected at four localities.

Species of conservation interest

Liverworts

Cephaloziella hampeana – This is a northern sub-Atlantic liverwort, which is known in Bulgaria from Rila (STEFANOFF and PETROV 1962) and the Vitosha Mts (DIMITROV *et al.* 2015). It is included in the Bulgarian red list as CR.

Clevea hyalina – So far, it is known from the Pirin (PETROV 1962, MEINUNGER 1975), Rila, and the Western Rhodopi Mts (ŠMARDÁ 1970). Despite being a subarctic-subalpine species according to DÜLL (1983), in Bulgaria it has been found at fairly low elevation under sub-Mediterranean climates, e.g. 400 m in this study and 850 m in the Southern Pirin Mts, as well as at 2,500 m in the central part of the Pirin Mts. It has a wide, but scattered distribution in Europe. It is red listed in many countries where it occurs. It is known from Finland (EN), Norway, Svalbard, Sweden, Great Britain (CR), Andorra, Balearic Islands, France, Italy (CR), Spain, Austria (VU), Hungary, (EN), Germany (EN), Poland (VU), Slovakia (VU), and Switzerland (VU). In SE Europe it occurs in almost all countries except Bosnia-Herzegovina, Serbia, and the European part of Turkey. It is also red listed in Montenegro as CR and in Slovenia as VU. Towards east it is known from the Caucasus, Crimea, Ukraine, and NE and NW Russia. It is red listed as VU in Bulgaria.

Corsinia coriandrina – This species is known from the Black Sea coast (PETKOFF 1908), the Strandzha Mts (PETROV 1963), and the Valley of River Struma (NATCHEVA 2024). Despite the fact that this sub-Atlantic, Mediterranean species is red listed as EN in Bulgaria, recent data suggest that it is more widespread in areas with sub-Mediterranean climate.

Scapania compacta – This is the second report and the first recent record of this species in Bulgaria. It has been found only at two localities in the Strandzha Mts (PETROV 1963). It is a sub-Atlantic, sub-Mediterranean element. It is EN according to the Bulgarian bryophyte red list. It is also included in the bryophyte red list of Romania, in the DD category.

Mannia androgyna – It has only one published record in Bulgaria, from the Southern Pirin Mts (PETROV 1962). It is a Mediterranean liverwort; hence these populations are at the northern edge of its distribution range. It is red listed as CR in Bulgaria.

Riccia crozalsii – This Atlantic, Mediterranean liverwort has recently been reported as new for the Bulgarian bryophyte flora partly based on the collections in 2019 in the Eastern Rhodopi (ELLIS *et al.* 2024). Beside the Eastern Rhodopi Mts, it is known from the Struma valley (Western Bulgaria).

Mosses

Atrichum angustatum – In Bulgaria it is known from Eastern Stara Planina (STEFANOFF and PETROV 1962), Strandzha (PAPP *et al.* 2011), and the Forebalkan Mts (NATCHEVA and GYOSHEVA 2016). It is a sub-Mediterranean species being in DD category according to the Bulgarian red list. It is NT in Serbia due to its restricted area of occupancy and number of locations.

Bartramia aprica – It has only one locality in Bulgaria in the Valley of River Struma (LÜTH 2007). This sub-Atlantic, Mediterranean species is in the DD category in Serbia.

Bryum gemmiparum – It is the first recent record of the species in Bulgaria. Until now, it has been reported only from the Vitosha Mts (PODPÉRA 1911). This sub-Atlantic, sub-Mediterranean species is red listed as VU in Bulgaria. It is also VU in Serbia due to restricted and declining area of occupancy and number of locations and CR in Romania for similar reasons.

Cheilothela chloropus – It is the first documented report of this species in Bulgaria. It has been mentioned by VELENOVSKY (1902), however the voucher specimen in Velenovsky's collection at PR was revised to *Ditrichum flexicaule*. Therefore, the species was excluded from the bryophyte flora of Bulgaria (NATCHEVA and GANEVA 2018). This Atlantic, Mediterranean species is included in the Bulgarian red list as VU. In the Serbian red list it is placed in the DD category.

Coscinodon cribrosus – It is known from the western and central part of the Stara Planina Mts (GANEVA 2002, NATCHEVA 2003). This is a boreal-temperate species living on acidic rocks (SMITH 2004). It is red listed as VU in Bulgaria. Its sporadic distribution in the region is the consequence of the predominance of calcareous bedrocks in the Balkans. It is NT in Romania.

Dicranella cerviculata – It is the first recent and documented report of the species in Bulgaria. It is known only from the Vitosha Mts (STEFANOFF and PETROV 1962). It is a boreal species living on damp acidic or gravelly soil (SMITH 2004). It has a pioneer character (SAUER 2000). In Hungary, it occurs in a single known location, on the aluminium-containing soil of an abandoned mining area (ERZBERGER and PAPP 2004). It is in the DD category in Bulgaria.

Dicranella howei – This species has recently been added to the bryophyte flora of Bulgaria from the Strandzha Mts (PAPP *et al.* 2011), and this is the second report for the country. This Atlantic, Mediterranean species is red listed as NT in Serbia due to restricted and declining area of occupancy and number of locations. In spite of its Mediterranean character, it is also present in many Central European countries, e.g. Austria, Hungary, Germany, Luxemburg, and Switzerland, where it is VU. In Hungary it occurs in arid habitats like saline grassland and loess cliffs.

Fissidens viridulus – In Bulgaria it is known from the Central Rhodopi Mts, North Black Sea coast, and the Forebalkan (BP and SOM herbarium data). This sub-Mediterranean species is probably under-recorded due to its minute size. It is red listed as VU in Serbia due to restricted and declining area of occupancy and number of locations. It is NT in Romania.

Grimmia longirostris – This is the second known locality of the species in Bulgaria, the first being in the Rila Mts (GANEVA and DÜLL 1999). It is a boreal, montane species and red listed as VU in Bulgaria.

Grimmia muehlenbeckii – This species is known so far only from Rila (LÜTH 2007), Western Stara planina (GANEVA *et al.* 2008), and the Central Rhodopi Mts (BLOCKEEL 1994). This is a species of the temperate zones of Europe living on exposed acidic rocks (SMITH 2004) and red listed as VU in Bulgaria. It is also VU in Romania due to restricted and declining area of occupancy and number of locations. Its sporadic distribution in the region is the consequence of the predominance of calcareous bedrocks in the Balkans.

Gyroweisia tenuis – The specimen collected in the Eastern Rhodopi is the first valid record of this species in Bulgaria. It had been reported for the first time from Bulgaria from the Strandzha Mts (PAPP *et al.* 2011), then later it had a record from the northern Black Sea coast (PAPP *et al.* 2018), however these specimens deposited in the BP herbarium have been revised to *Gymnostomum calcareum*. Both turned out to be small forms of *G. calcareum*. It is a sub-Mediterranean and sub-Atlantic montane element. It is widely distributed in Europe, but red listed in many countries, e. g. Finland (CR), Ireland (VU), Norway (NT), Sweden (VU), Portugal (CR), Spain (DD), Austria (Risk assumed), Czech Republic (VU), Germany (NT), Slovakia (VU), Hungary (NT), Latvia (Rare), and Lithuania (VU). In SE Europe it is known from all countries except Bosnia-Herzegovina, however red listed as VU in Romania and EN in Slovenia. There are many reports from the Balkan countries, but these should be carefully checked because many specimens are misidentified (PAPP *et al.* 2023, 2024b). GUERRA *et al.* (2006) also mention that this species is rarer in the Iberian Peninsula than it seems on the basis of literature data, because it is frequently mistaken for *Gymnostomum* species. In the Eastern Rhodopi Mts it was found in a cave entrance on metaserpentine rock near Gorna Yakovica village and on sandstone rock by River Arabadzhiiska near Dzherovo village.

Philonotis calcarea – This subboreal element of wetlands is NT in Europe, because its habitat extent and quality are continuously decreasing in Europe (SABOVLJEVIĆ *et al.* 2019). It is also VU in Serbia due to restricted and declining area of occupancy, number of locations, and number of mature individuals. It is in the group of medium conservation priority in Europe according to the Priority Scores for conservation (BISANG *et al.* 2025). In Bulgaria it is relatively widespread but until now it has not been reported from the Eastern Rhodopi Mts (NATCHEVA and GANEVA 2005).

Philonotis capillaris – Until now, it has been reported from two localities (PETROV 1963, PAPP *et al.* 2011). This northern sub-Atlantic species is vulnerable (VU) in Bulgaria. It is also red listed in Serbia as EN due to restricted and declining area of occupancy and number of locations, and also EN in Romania for similar reasons.

Philonotis marchica – Known from four floristic regions in Bulgaria (NATCHEVA and GANEVA 2005) This sub-Mediterranean species is endangered (EN) in Bulgaria. It is also red listed in Serbia as VU due to restricted and declining area of occupancy, number of locations, and number of mature individuals. It is NT in Romania.

Rhynchostegiella curviseta – This species is a relatively new addition to the bryophyte flora of Bulgaria and it is known from the Western Stara Planina (PAPP *et al.* 2006), the Strandzha Mts (PAPP *et al.* 2011), and the Northern Black Sea coast (PAPP *et al.* 2018). This sub-Mediterranean, sub-Atlantic element is in DD category in Serbia and in Romania.

Rhynchostegium confertum – In Bulgaria it is known from three localities (PETROV 1962, MICKIEWICZ *et al.* 1966, NATCHEVA and GANEVA 2022). This sub-Mediterranean, Atlantic element is red listed as NT in Bulgaria. However, this species is widespread in the Balkans, which is evidenced by several recent collections even from the neighbouring countries, like Serbia (PAPP *et al.* 2016, 2019), Northern Macedonia (PAPP *et al.* 2020), and Greece (PAPP and TSAKIRI 2011).

Schistidium papillosum – Until now, this species has been known only from the Pirin Mts (LÜTH 2007). It is a boreo-arctic, montane species (SMITH 2004). It does not seem to be rare in the Balkans, where acidic bedrocks occur. It has several records from the neighbouring Serbia (PAPP and ERZBERGER 2007, PAPP *et al.* 2012, 2016), Northern Macedonia (PAPP and ERZBERGER 2012, PAPP *et al.* 2024c), and Greece (PAPP and TSAKIRI 2017).

Scorpiurium circinatum – This Atlantic, Mediterranean species is red listed as EN in Bulgaria and it is in DD category in the Serbian red list. In Bulgaria it is known from several localities in the eastern part of the country (NATCHEVA and GANEVA 2005, PAPP *et al.* 2011, 2018). Considering the distribution of the species, the Bulgarian populations are at the northern edge of its range.

Syntrichia latifolia – This is a species of the temperate zones of Europe living on tree barks near larger watercourses (AHRENS and NEBEL 2000). There is only one old report of this species in Bulgaria (STEFANOFF and PETROV 1962). Therefore, it is red listed as CR in Bulgaria. It is VU in Romania due to restricted and declining area of occupancy and number of locations.

Syntrichia princeps – This Atlantic, sub-Mediterranean species is red listed in Bulgaria as VU and it is known from only one floristical region – Pirin (SIMON and VAJDA 1959). It is in DD category in Serbia, and CR in Romania.

Syntrichia subpapillosissima – It is on the European red list as DD. It is treated as an Atlantic, Mediterranean species by DÜLL (1984). Being similar in the field to the common *Syntrichia ruralis* it is under-recorded, and its distribution is still not well known. There is only one location in Bulgaria (PAPP *et al.* 2018). It is VU in Serbia due to restricted and declining area of occupancy and number of locations.

Some other red-listed species in Bulgaria collected in the Eastern Rhodopi like *Fissidens crassipes* (VU), *Marsupella funckii* (VU), *Microeurhynchium pumilum* (EN), *Oxyrrhynchium schleicheri* (CR), *Scleropodium touretii* (EN), *Syntrichia papillosa* (EN), *Trichodon cylindricus* (VU), and *Trichostomum brachydontium* (VU) turned out to be not rare or threatened in the country based on investigations after the publication of the Bulgarian red list (NATCHEVA *et al.* 2006).

Bryophyte vegetation

The region is rich in dry grasslands and dry rocky places (Figs 5, 6, 7), which maintain high bryophyte diversity; 51.6% of the species collected live in these habitats. In the bryophyte assemblages of these dry habitat types sub-Atlantic-sub-Mediterranean and Atlantic-Mediterranean species have the highest proportion (47.8%). The species of the temperate zones of Europe are also important constituents (32.6%). The proportion of boreal, subboreal species is 19.6%. They occupy and are sporadically found mostly in more shaded, humid microhabitats, like rocks crevices. Among the most frequent species of Mediterranean character several thalloid liverworts can be mentioned, like *Mannia androgyna*, *Oxymitra incrassata*, *Riccia ciliata*, *R. ciliifera*, *R. crozalsii*, *R. nigrella*, *R. michelii*, *Reboulia hemisphaerica*, and *Targionia hypophylla*. The most frequent sub-Atlantic-sub-Mediterranean, and Atlantic-Mediterranean species are the following: *Cynodontium bruntonii*, *Encalypta vulgaris*, *Dialytrichia mucronata*, *Didymodon luridus*, *Didymodon insulanus*, *Grimmia laevigata*, *G. tergestina*, *Pleuridium subulatum*, *Scleropodium touretii*, *Syntrichia princeps*, *S. subpapillosissima*, *Tortella squarrosa*, *Trichostomum brachydontium*, *Barbula unguiculata*, *Brachytheciastrum*



Fig. 5. Dry andesite rocky outcrop by River Arda near Madzharovo (loc. 3).



Fig. 6. Dry serpentine grassland near Kazak (loc. 7).



Fig. 7. Acidic tufa rocky slopes at mine Zvezdel (loc. 11).

velutinum, *Cephaloziella divaricata*, *Ceratodon purpureus*, *Grimmia muehlenbeckii*, *G. pulvinata*, *Homalothecium lutescens*, *Hypnum cupressiforme* var. *lacunosum*, *Orthotrichum anomalum*, *Polytrichum juniperinum*, *P. piliferum*, *Ptychostomum capillare*, *P. imbricatum*, *Riccia sorocarpa*, *Syntrichia ruralis*, *Tortula muralis*, *Trichostomum crispulum*, *Weissia controversa* are the most frequently found species of the temperate zones of Europe. Only two boreal (*Coscinodon cribrosus*, *Racomitrium canescens*) and a subboreal species (*Grimmia ovalis*) can be mentioned as common in these habitats.

On the shaded rocks and on acidic soil in forests, among the frequent, characteristic species we can find species of the temperate zones of Europe and sub-Atlantic, sub-Mediterranean species almost in the same number. *Dicranella heteromalla*, *Fissidens bryoides*, *Fissidens dubius*, *F. taxifolius*, *Plagiomnium affine*, *P. undulatum*, and *Pseudoscleropodium purum* are the most frequent temperate species, while *Cirriphyllum crassinervium*, *Lejeunea cavifolia*, *Microeurhynchium pumilum*, *Oxyrrhynchium schleicheri*, *Rhynchostegium confertum*, and *Tortula schimperi* are frequently found sub-Atlantic, sub-Mediterranean elements. In these habitat types a few boreal (e.g. *Mnium stellare* and *Plagiothecium cavifolium*) and subboreal (*Dicranum scoparium*, *Plagiochila porelloides*, and *Tortula subulata*) species are also characteristic.

In the species composition of the aquatic-riparian bryophyte vegetation formed at rivers, streams, and rivulets (Figs 8, 9) species of the temperate zones of Europe and sub-Atlantic, sub-Mediterranean, and Mediterranean elements also take part almost in the same proportion. *Apopellia endiviifolia*, *Cratoneuron filicinum*, *Hygroamblystegium tenax*, *Pohlia melanodon*, *Ptychostomum pseudotriquetrum*, and *Rhynchostegium riparioides* are the most frequent temperate species, while *Bryum gemmiparum*, *Cinclidotus fontinaloides*, *Didymodon nicholsonii*, *D. sinuosus*, *Imbribrum alpinum*, *Lunularia cruciata*, and *Orthotrichum cupulatum* var. *riparium* can be mentioned as frequent sub-Mediterranean, Mediterranean species. Only two species of northern distribution are common in the region in this habitat; the boreal, montane *Philonotis tomentella* and the subboreal *Brachythecium rivulare*.

The epiphyte flora mainly consists of species of the temperate zones of Europe, like *Frullania dilatata*, *Radula complanata*, *Homalothecium sericeum*, *Hypnum cupressiforme*, *Leucodon sciuroides*, *Lewinskya affinis*, *L. fastigiata*, *Orthotrichum pumilum*, *O. schimperi*, *Syntrichia latifolia*, and *S. papillosa*, but species with sub-Atlantic, sub-Mediterranean character also frequently appear in this habitat, too, e.g. *Lewinskya acuminata*, *L. striata*, *Orthotrichum stramineum*, *O. tenellum*, *Pulvigeria lyellii*, and *Zygodon rupestris*.



Fig. 8. River Avrenska between Arven and Devesilovo villages (loc. 6).

CONCLUSIONS



Fig. 9. Below the wall of the Studen Kladenets Dam, loc. Sheitan dere, andesitobasaltic rocks by the river (loc. 14).

A bryological investigation in special habitats formed on metal-rich igneous bedrock in the Eastern Rhodope Mountains has revealed several new national records and data on species of conservation interest. Most of the new additions to the Bulgarian bryophyte flora are species with sub-Mediterranean, Mediterranean, and sub-Atlantic distribution. Similar conclusions can be drawn about the species of conservation interest. The results suggest that the study area maintains high bryophyte diversity and species of Mediterranean character play an important role in the species composition of each habitat type. This very valuable bryophyte flora has developed in many cases in areas under high anthropogenic influence and pressure (e.g. at or nearby mining areas). Finally, we have to highlight the necessity of further research and adequate protection of these diverse bryophyte assemblages.

* * *

Acknowledgement – The study was financed by the Hungarian and Bulgarian Academies of Science within the framework of a bilateral research project between 2019–2021, entitled „Metallophilic cryptogams – a poorly known group with high conservation value”.

Összefoglaló: „A Fémkötő kriptogámok – egy alig ismert csoport nagy természetvédelmi értéke” című 2019–2021 között folyó kétoldalú akadémiai kutatási projekt keretében, 2019-ben a Kelet-Rodope hegység ércben gazdag lelőhelyein, felhagyott bányák és meddőhányók térségében, valamint szerpentin és homokkő alapkőzetű területeken vizsgáltuk a mohafldrát. Összesen 183 taxont (egy becsmohát, 33 májmohát és 149 lombosmohát) gyjtöttünk. Kilenc mohát (két májmohát és 7 lombosmohát) elször mutattunk ki Bulgária területéről, amelyek a következők: *Riccia michelii*, *Targionia lorbeeriana*, *Didymodon nicholsonii*, *D. tophaceus* subsp. *erosus*, *Epipterygium tozeri*, *Orthotrichum schimperi*, *Lewinskya acuminata*, *Schistidium dupretii* és *Scorpiurium sendtneri*. Két faj (*Philonotis calcarea* és *Syntrichia subpapillosissima*) szerepelnek a 2019-ben publikált IUCN Európai Moha Vörös Listán a veszélyeztetettséghez közeli (NT), illetve az adathiányos (DD) kategóriában. Természetvédelmi szempontból 27 faj (6 májmoha és 21 lombosmoha) rendkívül fontosnak tekinthető, elsősorban bulgáriai és balkáni szórványos elterjedésük, illetve az őket veszélyeztető tényezők alapján.

REFERENCES

- AHRENS, M. and NEBEL, M. (2000): *Pottiaceae, Pottmoose*. – In: NEBEL, M. and PHILIPPI, G. (eds): Die Moose Baden-Württembergs. Band 1. Ulmer, Stuttgart, pp. 230–369.
- BISANG, I., SCHYDER, N., SCHRÖCK, C., HODGETTS, N., LOCKHART, N. and BERGAMINI, A. (2025): Priority ranking for conservation of all European bryophytes. – *Biol. Conserv.* **309**: 111297. <https://doi.org/10.2139/ssrn.5166317>
- BLOCKEEL, T. (1994): Some bryophytes new to Bulgaria. – *J. Bryol.* **18**: 199–200. <https://doi.org/10.1179/jbr.1994.18.1.199>
- BONDEV, I. (2002): *Geographsko raionirane*. [Geobotanic regioning]. – In: KOPRALEV, I. (ed.): Geography of Bulgaria, physical geography, socio-economic geography. Publishing House ForCom., Sofia (Bulgaria), pp. 336–352.
- DAMSHOLT, K. (2002): *Illustrated flora of Nordic liverworts and hornworts*. – Nord. Bryol. Soc., Lund, 837 pp.
- DIMITROV, M., NATCHEVA, R., GANEVA, A. and GYUROVA, D. (2015): Plant biodiversity of Sphagnum-dominated mires in Vitosha Nature Park. – *Forest review*, Skopje **46**: 15–29.
- DÜLL, R. (1983): Distribution of the European and Macaronesian liverworts (Hepaticophytina). – *Bryol. Beiträge* **2**: 1–115.
- DÜLL, R. (1984): Distribution of the European and Macaronesian mosses (Bryophytina) I. – *Bryol. Beiträge* **4**: 1–109.
- DÜLL, R. (1985): Distribution of the European and Macaronesian mosses (Bryophytina) II. – *Bryol. Beiträge* **5**: 110–232.
- ELLIS, L. T., ADJIE, B., ALVAREZ, D. J., ARDILES, V., ASTHANA, A. K., ATWOOD, J. J., BAKALIN, V. A., BEDNAREK-UCHYRA, H., BOIKO, M., BUDKE, J. M., CEDRÉS-PERDOMO, R. D., CERRATO, M. D., CSIKY, J., ESPINOZA-PRieto, B., GABRIEL, R., GEY, S., GIL, L., GRAULICH, A., HYLANDER, K., KIEBACHER, T., KONSTANTINOVA, N. A., KUČERA, J., KUNEV, G., LARRAÍN, J., LÖNNELL, N., MACIEL-SILVA, A. S., MAMONTOV, YU. S., MATTOS, G. H. R., MIR-ROSSELLÓ, P. M., NADHIFAH, A., NATCHEVA, R., O’LEARY, S. V., OLIVEIRA, M. F., OPISSE, J., PAPP, B., PEÑALOZA-BOJACÁ, G. F., POLAINO-MARTÍN, C., RAWAT, K. K., RIBAS-SERRA, A., ROSADZIŃSKI, S., SAHU, V., SIPOS, A., STANIASZEK-KIK, M., STARZOMSKI, B. M., SUÁREZ, G. M., TUCKER, D. B. L., VERMA, A. and ZAGORODNIUK, N. (2024): New national and regional bryophyte records, 77. – *J. Bryol.* **46**(2): 139–155. <https://doi.org/10.1080/03736687.2024.2388418>
- ERZBERGER, P. and PAPP, B. (2004): Annotated checklist of Hungarian bryophytes. – *Studia bot. hung.* **35**: 91–150.

- FREY, W., FRAHM, J.-P., FISCHER, E. and LOBIN, W. (1995): *Die Moos- und Farnpflanzen Europas. Kleine Kryptogamenflora Bd. IV.* – G. Fischer, Stuttgart, Jena, New York, 426 pp.
- GANEVA, A. (2002): New data on the distribution of bryophytes in Bulgaria. – *Phytol. Balcan.* 8(2): 191–195.
- GANEVA, A. and DÜLL, R. (1999): *A contribution to the Bulgarian bryoflora. Checklist of Bulgarian bryophytes.* – In: DÜLL, R., GANEVA, A., MARTINČIČ, A. and PAVLETIĆ, Z. (eds): Contributions to the bryoflora of former Yugoslavia and Bulgaria. 1 Auflage. IDH-Verlag, Bad Münstereifel, pp. 111–199.
- GANEVA, A., PAPP, B. and NATCHEVA, R. (2008): Contribution to the bryophyte flora of the NW Bulgaria. – *Phytol. Balcan.* 14(3): 327–333.
- GEORGIEV, V. (2012): *Metallogeny of the Eastern Rhodope.* – Prof. Marin Drinov Academic Publishing House, Sofia.
- GOSPODINOV, G. and NATCHEVA, R. (2022): An updated checklist of liverworts and hornworts of Bulgaria. – *Herzogia* 35(1): 138–154. <https://doi.org/10.13158/heia.35.1.2022.138>
- GUERRA, J., CANO, M. J. and ROS, R. M. (2006): *Flora Briofítica Ibérica.* Vol. III. – Universidad de Murcia, Sociedad Española de Briología, 42 pp.
- HILL, M. O., BELL, N., BRUGGEMAN-NANNENGA, M. A., BRUGUÉS, M., CANO, M. J., ENROTH, J., FLATBERG, K. I., FRAHM, J.-P., GALLEGU, M. T., GARILLETI, R., GUERRA, J., HEDENÄS, L., HOLYOAK, D. T., HYVÖNEN, J., IGNATOV, M. S., LARA, F., MAZIMPAKA, V., MUÑOZ, J. and SÖDERSTRÖM, L. (2006): An annotated checklist of the mosses of Europe and Macaronesia. – *J. Bryol.* 28(3): 198–267. <https://doi.org/10.1179/174328206X119998>
- HODGETTS, N. and LOCKHART, N. (2020): *Checklist and country status of European bryophytes – update 2020.* – Irish Wildlife Manuals, No. 123. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.
- HODGETTS, N. G., SÖDERSTRÖM, L., BLOCKEEL, T. L., CASPARI, S., IGNATOV, M. S., KONSTANTINOVA, N. A., LOCKHART, N., PAPP, B., SCHRÖCK, C., SIM-SIM, M., BELL, D., BELL, N. E., BLOM, H. H., BRUGGEMAN-NANNENGA, M. A., BRUGUÉS, M., ENROTH, J., FLATBERG, K. I., GARILLETI, R., HEDENÄS, L., HOLYOAK, D. T., HUGONNOT, V., KARIYAWASAM, I., KÖCKINGER, H., KUČERA, J., LARA, F. and PORLEY, R. D. (2020): An annotated checklist of bryophytes of Europe, Macaronesia and Cyprus. – *J. Bryol.* 42(1): 1–116. <https://doi.org/10.1080/03736687.2019.1694329>
- HODGETTS, N., CÁLIX, M., ENGLEFIELD, E., FETTES, N., GARCÍA CRIADO, M., PATIN, L., NIETO, A., BERGAMINI, A., BISANG, I., BAISHEVA, E., CAMPISI, P., COGONI, A., HALLINGBÄCK, T., KONSTANTINOVA, N., LOCKHART, N., SABOVLEVIĆ, M., SCHNYDER, N., SCHRÖCK, C., SÉRGIO, C., SIM-SIM, M., VRBA, J., FERREIRA, C. C., AFONINA, O., BLOCKEEL, T., BLOM, H., CASPARI, S., GABRIEL, R., GARCIA, C., GARILLETI, R., GONZÁLEZ MANCEBO, J., GOLDBERG, I., HEDENÄS, L., HOLYOAK, D., HUGONNOT, V., HUTTUNEN, S., IGNATOV, M., IGNATOVA, E., INFANTE, M., JUUTINEN, R., KIEBACHER, T., KÖCKINGER, H., KUČERA, J., LÖNNELL, N., LÜTH, M., MARTINS, A., MASLOVSKY, O., PAPP, B., PORLEY, R., ROTHERO, G., SÖDERSTRÖM, L., ȘTEFĂNUȚ, S., SYRJÄNEN, K., UNTEREINER, A., VÁNA, J. †, VANDERPOORTEN, A., VELLAK, K., ALEFFI, M., BATES, J., BELL, N., BRUGUÉS, M., CRONBERG, N., DENYER, J., DUCKETT, J., DURING, H. J., ENROTH, J., FEDOSOV, V., FLATBERG, K.-I., GANEVA, A., GORSKI, P., GUNNARSSON, U., HASSEL, K., HESPAHOL, H., HILL, M., HODD, R., HYLANDER, K., INGERPUU, N., LAAGA-LINDBERG, S., LARA, F., MAZIMPAKA, V., MEŽAKA, A., MÜLLER, F., ORGAZ, J. D., PATIÑO, J., PILKINGTON, S., PUCHE, F., ROS, R. M., RUMSEY, F., SEGARRA-MORAGUES, J. G., SENECA, A., STEBEL, A., VIRTANEN, R., WEIBULL, H., WILBRAHAM, J. and ŽARNOWIEC, J. (2019): *A miniature world in decline: European red list of mosses, liverworts and hornworts.* – IUCN, Brussels, Belgium.

- JIMÉNEZ, J. A., GUERRA, J., CANO, M. J. and ROS, R. M. (2004): *Didymodon erosus* sp. nov. (Musci, Pottiaceae) from the Iberian Peninsula. – *Nova Hedwigia* **78**: 501–506.
- KÖCKINGER, H. (2017): *Die Horn- und Lebermoose Österreichs (Anthocerotophyta und Marchantiophyta)*. – *Catalogus Florae Austriae*. II(2), pp. 1–382.
- KUČERA, J., BLOCKEEL, T. L., ERZBERGER, P., PAPP, B., SOLDÁN, Z., VELLAK, K., WERNER, O. and ROS, R. M. (2018): *Didymodon tophaceus* complex (Pottiaceae, Bryophyta) revisited: new data support the subspecific rank of currently recognized species – *Cryptogamie, Bryol.* **39**(2): 241–257. <https://doi.org/10.7872/cryb/v39.iss2.2018.241>
- LÜTH, M. (2007): Additions to the bryophyte flora of Bulgaria. – *Cryptogamie, Bryol.* **28**(3): 237–241.
- MEINUNGER, L. (1975): Kleiner Beitrag zur Moosflora Bulgariens. – *Herzogia* **3**: 209–212.
- MICKIEWICZ, J., REJMENT-GROCHOWSKA, I. and SOBOTKA, D. (1966): Résultats des recherches bryologiques en Bulgarie. – *Acta Soc. Bot. Poloniae* **35**(1): 111–127.
- NATCHEVA, R. (2003): The bryophyte flora of Mt. Golema Planina, Western Balkan Range. – *Phytol. Balcan.* **9**(1): 9–18.
- NATCHEVA, R. (2024): New localities of some rare bryophyte species in Bulgaria. – *Phytol. Balcan.* **30**(1): 9–14. <https://doi.org/10.7546/PhB.30.1.2024.2>
- NATCHEVA, R. and GANEVA, A. (2005): Check-list of the bryophytes of Bulgaria II. Musci. – *Cryptogamie, Bryol.* **26**(2): 209–232.
- NATCHEVA, R. and GANEVA, A. (2018): On the identity and distribution of some elusive bryophyte species in the Bulgarian flora. – *Phytol. Balcan.* **24**(2): 201–204.
- NATCHEVA, R. and GANEVA, A. (2022): New data on the bryophyte flora of the Bulgarka Nature Park. – *Phytol. Balcan.* **28**(3): 305–310. <https://doi.org/10.7546/PhB.28.3.2022.2>
- NATCHEVA, R. and GOSPODINOV, G. (2024): A supplement to the checklist of the liverwort flora of Bulgaria. – *Phytol. Balcan.* **30**(3): 283–288. <https://doi.org/10.7546/PhB.30.3.2024.2>
- NATCHEVA, R. and GYOSHEVA M. (2016): Contribution to the bryophyte flora and mycota of Bulgaria: I. Bryophytes and larger fungi from Uchilishtna Gora Managed Reserve. – *Phytol. Balcan.* **22**(3): 323–330.
- NATCHEVA, R., GANEVA, A. and SPIRIDONOV, G. (2006): Red list of the bryophytes in Bulgaria. – *Phytol. Balcan.* **12**(1): 55–62.
- PAPP, B. and ERZBERGER, P. (2007): Contribution to the bryophyte flora of Western Stara Planina Mts (E. Serbia). – *Studia bot. hung.* **38**: 95–123.
- PAPP, B. and ERZBERGER, P. (2012): Contribution to the bryophyte flora of the Former Yugoslav Republic of Macedonia (FYROM). – *Polish Bot. J.* **57**(1): 205–221.
- PAPP, B. and TSAKIRI, E. (2011): Contribution to the bryophyte flora of the Skra-Koupa waterfalls area (Mt Paiko, Central Macedonia, North Greece). – *Studia bot. hung.* **42**: 41–50.
- PAPP, B. and TSAKIRI, E. (2017): Contribution to the bryophyte flora of the Paiko, Tzena and Pinovo Mts in Greece. – *Studia bot. hung.* **48**(1): 33–49. <https://doi.org/10.17110/StudBot.2017.48.1.33>
- PAPP, B., ERZBERGER, P. and DRAGIČEVIĆ, S. (2023): Revision of bryophyte specimens from Montenegro. – *Acta Biol. Plant. Agriensis* **11**: 283–301. <https://doi.org/10.21406/abpa.2023.11.1.283>
- PAPP, B., GANEVA, A. and NATCHEVA, R. (2006): Bryophyte vegetation of Iskur River and its main tributaries. – *Phytol. Balcan.* **12**(2): 181–189.
- PAPP, B., NATCHEVA, R. and GANEVA, A. (2011): The bryophyte flora of Northern Mt Strandzha. – *Phytol. Balcan.* **17**(1): 21–32.
- PAPP, B., NATCHEVA, R. and GANEVA, A. (2018): Bryophyte diversity along the Northern Black Sea Coast in Bulgaria. – *Phytol. Balcan.* **24**(1): 25–33.

- PAPP, B., PANTOVIĆ, J., NIKOLIĆ, N. and SABOVLJEVIĆ, M. S. (2019): Contribution to the bryophyte flora of Serbia: Ovčar, Kablar and Vujan Mts. – *Studia bot. hung.* **50**(2): 333–348. <https://doi.org/10.17110/StudBot.2019.50.2.331>
- PAPP, B., PANTOVIĆ, J. P., SZURDOKI, E. and SABOVLJEVIĆ, M. S. (2024a): Three moss novelties in the flora of North Macedonia. – *Hacquetia* **23**(2): 199–202. <https://doi.org/10.2478/hacq-2023-0012>
- PAPP, B., PANTOVIĆ, J. P. and SABOVLJEVIĆ, M. S. (2024b): Revision of bryophyte specimens from Serbia deposited in the Bryophyte Collection of the Hungarian Natural History Museum, Budapest. – *Studia bot. hung.* **55**(2): 223–243. <https://doi.org/10.17110/StudBot.2024.55.2.223>
- PAPP, B., PANTOVIĆ, J. P., SZURDOKI, E. and SABOVLJEVIĆ, M. S. (2024c): Contribution to the bryophyte flora of Jablanica Mts, North Macedonia. – *Studia bot. hung.* **55**(2): 245–265. <https://doi.org/10.17110/StudBot.2024.55.2.245>
- PAPP, B., SABOVLJEVIĆ, M. S. and PANTOVIĆ, J. (2020): A contribution to the exploration of the bryophyte flora of Galičica National Park (the Republic of North Macedonia) with special attention to the species of conservation interest. – *Nova Hedwigia, Beih.* **150**: 117–132. <https://doi.org/10.1127/nova-suppl/2020/117>
- PAPP, B., SZURDOKI, E. and SABOVLJEVIĆ, M. (2012): Bryophyte flora of the Vlasina lake and its surrounding (SE Serbia). – *Studia bot. hung.* **43**: 27–45.
- PAPP, B., SZURDOKI, E., PANTOVIĆ, J. and SABOVLJEVIĆ, M. (2016): An insight into the bryophyte flora of the Ibar gorge and its surroundings (Central and SW Serbia). – *Acta Bot. Hung.* **58**(3–4): 411–423. <https://doi.org/10.1556/ABot.58.2016.3-4.10>
- PETKOFF, S. (1908): Contribution à l'étude des Hépatiques de Bulgarie. – *Period. Spis. Bulg. Knizh. Druzh.* **68**: 115–123.
- PETROV, S. (1962): Contribution à la flore bryologique de la Bulgarie. Bryophytes des montagnes du Pirin et de Slavianka. – *Izv. Bot. Inst.* **10**: 131–144.
- PETROV, S. (1963): Neue Beitrage zur Kenntnis der Moosflora Bulgariens. – *Izv. Bot. Inst. (Sofia)* **11**: 167–187.
- PODPÉRA, J. (1911): Ein Beitrag zu der Kryptogamenflora der bulgarischen Hochgebirge. – *Beih. Bot. Centralbl.* **28**(2): 173–224.
- ROS, R. M., MAZIMPAKA, V., ABOU-SALAMA, U., ALEFFI, M., BLOCKEEL, T. L., BRUGUÉS, M., CROS, R. M., DIA, M. G., DIRKSE, G. M., DRAPER, I., EL SAADAWI, W., ERDAĞ, A., GANEVA, A., GABRIEL, R., GONZÁLEZ-MANCEBO, J. M., GRANGER, C., HERRNSTADT, I., HUGONNOT, V., KHALIL, K., KÜRSCHNER, H., LOSADA-LIMA, A., LUÍS, L., MIFSUD, S., PRIVITERA, M., PUGLISI, M., SABOVLJEVIĆ, M., SÉRGIO, C., SHABBARA, H. M., SIM-SIM, M., SOTIAUX, A., TACCHI, R., VANDERPOORTEN, A. and WERNER, O. (2013): Mosses of the Mediterranean, an annotated checklist. – *Cryptogamie, Bryol.* **34**(2): 99–283. <https://doi.org/10.782/cryb.v34.iss2.2013.99>
- SABOVLJEVIĆ, M. S., PANTOVIĆ, J. P., ŠIRKA, P., VUJIČIĆ, M. M., SABOVLJEVIĆ, A. D. and PAPP, B. (2024a): Red-list of liverwort and hornwort species of Serbia: 2024 assessment. – *Bot. Serbica* **48**(1): 1–6. <https://doi.org/10.2298/BOTSERB2401001S>
- SABOVLJEVIĆ, M. S., PANTOVIĆ, J. P., ŠIRKA, P., VUJIČIĆ, M. M., SABOVLJEVIĆ, A. D. and PAPP, B. (2024b): Red-list of moss species of Serbia: 2024 assessment. – *Bot. Serbica* **48**(2): 207–222. <https://doi.org/10.2298/BOTSERB2402207S>
- SABOVLJEVIĆ, M., PAPP, B., BLOCKEEL, T., IGNATOV, M., HALLINGBÄCK, T. and SÖDERSTRÖM, L. (2019): *Philonotis calcarea* (Europe assessment). – The IUCN Red List of Threatened Species 2019: e.T83659958A87777565 (accessed on 06 October 2025)
- SAUER, M. (2000): *Dicranaceae, Gabelzahnmoose*. – In: NEBEL, M. and PHILIPPI, G. (eds): Die Moose Baden-Württembergs. Band 1. Ulmer, Stuttgart, pp. 129–219.

- SCHÄFER-VERWIMP, A. (2001): *Orthotrichum*. – In: NEBEL, M. and PHILIPPI, G. (eds): Die Moose Baden-Württembergs. Band 2. Ulmer, Stuttgart, pp. 170–197.
- SIMON, T. and VAJDA, L. (1959): Beiträge zur Moosflora Bulgariens. – *Ann. Univ. Sci. Budapest. Rolando Eötvös, Sect. Biol.* 2: 259–272.
- ŠMARDA, J. (1970): Compléments à la flore muscinale de la Bulgarie. – *Rev. Bryol. Lichénol.* 37(1): 33–46.
- SMITH, A. J. E. (1990): *The liverworts of Britain and Ireland*. – Cambridge University Press, Cambridge.
- SMITH, A. J. E. (2004): *The moss flora of Britain and Ireland*. (2nd ed.). – Cambridge University Press, Cambridge.
- STEFANOFF, B. and PETROV, S. (1962): Über die Moose und die Moosflora Bulgariens. – *Bull. de l'Inst. des forêts* 11: 5–38.
- ȘTEFĂNUȚ, S. (2012): Checklist and red list of bryophytes of Romania. – *Nova Hedwigia* 95(1–2): 59–104. <https://doi.org/10.1127/0029-5035/2012/0044>
- VELENOVSKY, J. (1902): Neuter Nachtrag zur Flora von Bulgarien. – *Österr. bot. Zeitschr.* 52(3): 115–121.
- VELEV, S. (2002): *Klimatichesko raionirane*. [Climatic regioning]. – In: KOPRALEV, I. (ed.): Geography of Bulgaria, physical geography. socio-economic geography. Publishing House ForCom., Sofia (Bulgaria), pp. 155–157.
- VIGALONDO, B., GARILLETI, R., VANDERPOORTEN, A., PATIÑO, J., DRAPER, I., CALLEJA, J. A., MAZIMPAKA, V. and LARA, F. (2019): Do mosses really exhibit so large distribution ranges? Insights from the integrative taxonomic study of the *Lewinskya affinis* complex (Orthotrichaceae, Bryopsida). – *Mol. Phyl. Evol.* 140: 106598. <https://doi.org/10.1016/j.ympev.2019.106598>
- YORDANOVA, M., VELEV, S. and DRENOVSKI, I. (2002): *Charakteristika na fisikogeographskite oblasti*. [Characteristic features of the physical geographical regions]. – In: KOPRALEV, I. (ed.): Geography of Bulgaria, physical geography, socio-economic geography. Publishing House ForCom., Sofia (Bulgaria), pp. 391–409.

(submitted: 13.11.2025; accepted: 21.11.2025)

Appendix – Complete list of bryophyte records. The numerals following the species names refer to the collection sites described above.

Liverworts

- Apopellia endiviifolia* (Dicks.) Nebel et D. Quandt – 5, 6, 9 – siliceous rock.
- Barbilophozia barbata* (Schmidel ex Schreb.) Loeske – 1, 4 – siliceous rock.
- Barbilophozia sudetica* (Nees ex Huebener) L. Söderstr., De Roo et Hedd. – 1 – siliceous rock.
- Cephaloziella divaricata* (Sm.) Schiffn. var. *divaricata* – 5, 8x, 10, 12 – siliceous rock.
- Cephaloziella divaricata* (Sm.) Schiffn. var. *scabra* (M. Howe) Haynes – 1, 2, 12 – siliceous rock.
- Cephaloziella hampeana* (Nees) Schiffn. ex Loeske – 8x – soil.
- Clevea hyalina* (Sommerf.) Lindb. – 5 – soil.
- Conocephalum conicum* (L.) Dumort. – 6 – siliceous rock.

- Corsinia coriandrina* (Spreng.) Lindb. – 10 – soil.
- Frullania dilatata* (L.) Dumort. – 1, 3, 6, 7, 8x, 9, 11, 12 – bark of *Alnus*, *Quercus*, *Acer monspessulanum*, rocks.
- Frullania tamarisci* (L.) Dumort. – 2, 5 – siliceous rock.
- Lejeunea cavifolia* (Ehrh.) Lindb. – 3, 9 – siliceous rock.
- Lophocolea heterophylla* (Schrad.) Dumort. – 8, 8x, 9 – soil, rock.
- Lophozia excisa* (Dicks.) Konstant. et Vilnet – 1 – siliceous rock.
- Lunularia cruciata* (L.) Dumort. ex Lindb. – 3, 8x, 14 – siliceous rock, soil.
- Mannia androgyna* (L.) A. Evans – 3, 10 – siliceous rock.
- Marsupella funckii* (F. Weber et D. Mohr) Dumort. – 2 – siliceous rock.
- Marsupella sphacelata* (Giesecke ex Lindenb.) Dumort. – 2 – siliceous rock.
- Oxymitra incrassata* (Brot.) Sérgio et Sim-Sim – 4, 5x, 7 – siliceous rock, soil.
- Phaeoceros carolinianus* (Michx.) Prosk. – 8 – soil.
- Plagiochila porelloides* (Torr. ex Nees) Lindenb. – 1, 9 – siliceous rock.
- Porella cordaeana* (Huebener) Moore – 9 – siliceous rock.
- Radula complanata* (L.) Dumort. – 3, 9 – siliceous rock, *Quercus* bark.
- Reboulia hemisphaerica* (L.) Raddi – 2, 3, 4, 5, 7, 8x, 10, 12 – siliceous rock, soil.
- Riccia ciliata* Hoffm. – 5x, 7, 10 – soil.
- Riccia ciliifera* Link ex Lindenb. – 4, 5x, 7, 10 – siliceous rock, soil.
- Riccia crozalsii* Levier – 7, 10 – soil.
- Riccia michelii* Raddi – 4, 5x, 7, 10 – siliceous rock, soil.
- Riccia nigrella* DC. – 5x, 7 – soil.
- Riccia sorocarpa* Bisch. – 3, 9, 10 – siliceous rock.
- Scapania compacta* (Roth) Dumort. – 1, 2 – siliceous rock.
- Solenostoma hyalinum* (Lyell ex Hook.) Mitt. – 8x – soil.
- Targionia hypophylla* L. – 3, 4 – siliceous rock.
- Targionia lorbeeriana* Müll. Frib. – 7 – soil.

Mosses

- Alleniella complanata* (Hedw.) S. Olsson, Enroth et D. Quandt – 9 – siliceous rock.
- Amblystegium serpens* (Hedw.) Schimp. – 9 – siliceous rock.
- Atrichum angustatum* (Brid.) Bruch et Schimp. – 12 – bank of an artificial lake.
- Atrichum undulatum* (Hedw.) P. Beauv. – 8x – soil.
- Barbula unguiculata* Hedw. – 2, 4, 9, 11, 12 – siliceous rock.
- Bartramia aprica* Müll. Hal. – 10 – soil.
- Bartramia pomiformis* Hedw. – 2 – siliceous rock.
- Brachytheciastrum velutinum* (Hedw.) Ignatov et Huttunen – 2, 3, 9, 12 – siliceous rock.
- Brachythecium albicans* (Hedw.) Schimp. – 1 – siliceous rock.
- Brachythecium rivulare* Schimp. – 8, 9, 13 – rock.

- Brachythecium rutabulum* (Hedw.) Schimp. – 5 – siliceous rock.
Bryum gemmiparum De Not. – 4, 6, 14 – siliceous rock.
Calliergonella cuspidata (Hedw.) Loeske – 8, 8x – rock.
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra – 12 – siliceous rock.
Ceratodon purpureus (Hedw.) Brid. – 1, 2, 5, 7, 8x, 9, 10, 11, 12, 13 – siliceous rock, soil.
Cheilothela chloropus (Brid.) Broth. – 5 – siliceous rock.
Cinclidotus fontinaloides (Hedw.) P. Beauv. – 4, 6 – siliceous rock.
Cinclidotus riparius (Host ex Brid.) Arn. – 4 – siliceous rock.
Cirriphyllum crassinervium (Taylor) Loeske et M. Fleisch. – 3, 4 – siliceous rock.
Coscinodon cribrosus (Hedw.) Spruce – 1, 2, 3, 11 – siliceous rock.
Cratoneuron filicinum (Hedw.) Spruce – 4, 5, 6, 9, 12, 14 – siliceous rock.
Cynodontium bruntonii (Sm.) Bruch et Schimp. – 1, 2, 3 – siliceous rock.
Dialytrichia mucronata (Brid.) Broth. – 4, 5, 14 – siliceous rock.
Dicranella cerviculata (Hedw.) Schimp. – 1 – soil.
Dicranella heteromalla (Hedw.) Schimp. – 1, 2, 8 – soil, siliceous rock.
Dicranella howei Renauld et Cardot – 11 – siliceous rock.
Dicranella schreberiana (Hedw.) Dixon – 12 – bank of an artificial lake.
Dicranella varia (Hedw.) Schimp. – 12 – bank of an artificial lake.
Dicranoweisia cirrata (Hedw.) Lindb. – 1 – siliceous rock.
Dicranum scoparium Hedw. – 1, 2, 8, 8x, 9, 12 – siliceous rock, soil.
Didymodon acutus (Brid.) K. Saito – 7 – soil.
Didymodon insulanus (De Not.) M. O. Hill – 2, 3, 4, 5x, 6, 8, 8x, 9 – siliceous rock, soil.
Didymodon luridus Hornsch. – 6, 12, 13 – siliceous rock.
Didymodon nicholsonii Culm. – 6, 14 – siliceous rock.
Didymodon sinuosus (Mitt.) Delogne – 1, 14 – siliceous rock.
Didymodon spadiceus (Mitt.) Limpr. – 6 – siliceous rock.
Didymodon tophaceus (Brid.) Lisa subsp. *tophaceus* – 5 – siliceous rock.
Didymodon tophaceus subsp. *erosus* (J. A. Jiménez et J. Guerra) Jan Kučera – 5, 6, 12, 14 – siliceous rock.
Didymodon vinealis (Brid.) R. H. Zander – 9 – siliceous rock.
Ditrichum pusillum (Hedw.) Hampe – 2, 8x – soil.
Encalypta vulgaris Hedw. – 5, 11 – siliceous rock, lime containing schistose rock.
Epipterygium tozeri (Grev.) Lindb. – 8x – soil.
Eucladium verticillatum (With.) Bruch et Schimp. – 14 – siliceous rock.
Eurhynchiastrum pulchellum (Hedw.) Ignatov et Huttunen – 3 – siliceous rock.
Fissidens bryoides Hedw. – 3, 8x, 9 – siliceous rock.
Fissidens crassipes Wilson ex Bruch et Schimp. – 14 – siliceous rock.
Fissidens dubius P. Beauv. var. *dubius* – 5, 12 – siliceous rock.

- Fissidens dubius* var. *mucronatus* (Limpr.) Kartt., Hedenäs et L. Söderstr. – 7 – soil.
Fissidens taxifolius Hedw. – 8x, 9 – soil.
Fissidens viridulus (Sw. ex anon.) Wahlenb. – 7 – soil.
Fontinalis antipyretica Hedw. – 8 – rock.
Funaria hygrometrica Hedw. – 5 – siliceous rock.
Grimmia laevigata (Brid.) Brid. – 1, 3, 4, 5, 7, 11, 13, 14 – siliceous rock.
Grimmia lisae De Not. – 1, 3, 4, 5, 7, 13, 14 – siliceous rock.
Grimmia longirostris Hook. – 14 – siliceous rock.
Grimmia muehlenbeckii Schimp. – 1, 2, 3, 11, 12 – siliceous rock.
Grimmia ovalis (Hedw.) Lindb. – 1, 3, 5, 7, 11, 12, 13 – siliceous rock.
Grimmia pulvinata (Hedw.) Sm. – 2, 4, 5, 9, 11, 13 – siliceous rock.
Grimmia tergestina Tomm. ex Bruch et Schimp. – 11, 13 – siliceous rock.
Grimmia trichophylla Grev. – 11 – siliceous rock.
Gyroweisia tenuis (Hedw.) Schimp. – 12, 13 – siliceous rock.
Hedwigia ciliata (Hedw.) P. Beauv. – 11 – rock.
Hedwigia emodica Hampe ex Müll. Hal. – 3, 10, 13 – siliceous rock.
Homalothecium aureum (Spruce) H. Rob. – 4 – siliceous rock.
Homalothecium lutescens (Hedw.) H. Rob. – 2, 5, 9, 11 – siliceous rock.
Homalothecium sericeum (Hedw.) Schimp. – 1, 3, 8x, 9, 11 – *Quercus* bark, rock.
Hygroamblystegium tenax (Hedw.) Jenn. – 6, 9 – siliceous rock.
Hygrohypnum luridum (Hedw.) Jenn. – 13 – siliceous rock.
Hypnum cupressiforme Hedw. var. *cupressiforme* – 1, 3, 5, 6, 7, 8, 9, 10, 11, 13, 14 – siliceous rock, bark of *Alnus*, *Quercus*, *Acer monspessulanum*, soil.
Hypnum cupressiforme var. *lacunosum* Brid. – 2, 4, 7, 11, 12 – siliceous rock.
Imbricbryum alpinum (Huds. ex With.) N. Pedersen – 4, 5, 8x, 10, 11, 12, 13 – siliceous rock.
Isothecium alopecuroides (Lam. ex Dubois) Isov. – 9 – siliceous rock.
Kindbergia praelonga (Hedw.) Ochyra – 8x – soil.
Leptodictyum riparium (Hedw.) Warnst. – 14 – siliceous rock.
Leucodon sciuroides (Hedw.) Schwägr. – 1, 3, 7, 8x – bark of *Quercus*, *Acer monspessulanum*.
Lewinskya acuminata (H. Philib.) F. Lara, Garilleti et Goffinet – 11 – *Quercus* bark.
Lewinskya affinis (Schr. ex Brid.) F. Lara, Garilleti et Goffinet – 3, 6 – bark of *Alnus*, *Salix*.
Lewinskya fastigiata (Bruch ex Brid.) Vigalondo, F. Lara et Garilleti – 3, 8x, 11, 12 – *Quercus*, rock.
Lewinskya rupestris (Schleich. ex Schwägr.) F. Lara, Garilleti et Goffinet – 8x, 12 – rock, *Quercus* bark.
Lewinskya striata (Hedw.) F. Lara, Garilleti et Goffinet – 3, 6, 8x, 11 – bark of *Salix*, *Quercus*, *Alnus*.

- Microeurhynchium pumilum* (Wilson) Ignatov et Vanderp. – 3, 8x – siliceous rock, soil.
- Mnium stellare* Hedw. – 8x, 9 – soil, rock.
- Nogopterium gracile* (Hedw.) Crosby et W. R. Buck – 3 – siliceous rock.
- Orthotrichum anomalum* Hedw. – 3, 6, 14 – siliceous rock.
- Orthotrichum cupulatum* Hoffm. ex Brid. var. *cupulatum* – 9 – siliceous rock.
- Orthotrichum cupulatum* Hoffm. ex Brid. var. *riparium* Huebener – 5, 6, 14 – siliceous rock.
- Orthotrichum pumilum* Sw. ex anon. – 7, 8x, 11 – *Quercus* bark.
- Orthotrichum schimperi* Hammar – 3, 11 – *Salix* bark.
- Orthotrichum stramineum* Hornsch. ex Brid. – 6 – *Alnus* bark.
- Orthotrichum tenellum* Bruch ex Brid. – 6, 7 – bark of *Alnus*, *Quercus*.
- Oxyrrhynchium hians* (Hedw.) Loeske – 5, 6, 14 – siliceous rock.
- Oxyrrhynchium schleicheri* (R. Hedw.) Röhl – 8x, 9 – soil.
- Philonotis calcarea* (Bruch et Schimp.) Schimp. – 13 – siliceous rock.
- Philonotis capillaris* Lindb. – 2, 8x, 9 – siliceous rock.
- Philonotis fontana* (Hedw.) Brid. – 4 – siliceous rock.
- Philonotis marchica* (Hedw.) Brid. – 14 – siliceous rock.
- Philonotis tomentella* Molendo – 8, 8x, 9, 10 – rock.
- Plagiomnium affine* (Blandow ex Funck) T. J. Kop. – 3, 8x – siliceous rock.
- Plagiomnium undulatum* (Hedw.) T. J. Kop. – 8x, 9 – soil, rock.
- Plagiothecium cavifolium* (Brid.) Z. Iwats. – 8x, 9 – soil.
- Pleuroidium subulatum* (Hedw.) Rabenh. – 4, 5, 8x, 12 – siliceous rock.
- Pogonatum aloides* (Hedw.) P. Beauv. – 8 – soil.
- Poblia melanodon* (Brid.) A. J. Shaw – 5, 9, 14 – siliceous rock.
- Poblia nutans* (Hedw.) Lindb. – 1 – siliceous rock, soil.
- Polytrichum juniperinum* Hedw. – 1, 4, 7, 10, 12 – siliceous rock.
- Polytrichum piliferum* Hedw. – 1, 2, 8, 8x – siliceous rock, soil.
- Pseudocrossidium hornschi* (Schultz) R. H. Zander – 7 – soil.
- Pseudoscleropodium purum* (Hedw.) M. Fleisch. – 9, 11, 12 – siliceous rock.
- Pterigynandrum filiforme* Hedw. – 9 – siliceous rock.
- Ptychostomum capillare* (Hedw.) Holyoak et N. Pedersen – 1, 2, 3, 5, 9, 11, 12, 13, 14 – siliceous rock.
- Ptychostomum imbricatum* (Müll. Hal.) Holyoak et N. Pedersen – 5, 7, 11, 12 – siliceous rock.
- Ptychostomum pseudotriquetrum* (Hedw.) J. R. Spence et H. P. Ramsay var. *pseudotriquetrum* – 6, 8, 8x, 10 – siliceous rock.
- Ptychostomum pseudotriquetrum* var. *bimum* (Schreb.) Holyoak et N. Pedersen – 6 – siliceous rock.

- Pulviger a lyellii* (Hook. et Taylor) Plášek, Sawicki et Ochrya – 6, 11 – bark of *Alnus*, *Quercus*.
- Racomitrium canescens* (Hedw.) Brid. – 1, 4, 5x, 10, 13 – siliceous rock.
- Racomitrium elongatum* Ehrh. ex Frisvoll – 8x – soil.
- Racomitrium lanuginosum* (Hedw.) Brid. – 3 – siliceous rock.
- Racomitrium sudeticum* (Funk) Bruch et Schimp. – 2 – siliceous rock.
- Rhizomnium punctatum* (Hedw.) T. J. Kop. – 8x, 9 – soil, rock.
- Rhynchostegiella curviseta* (Brid.) Limpr. – 14 – siliceous rock.
- Rhynchostegium confertum* (Dicks.) Schimp. – 1, 9, 14 – siliceous rock.
- Rhynchostegium megapolitanum* (Blandow ex F. Weber et D. Mohr) Schimp. – 12 – siliceous rock.
- Rhynchostegium riparioides* (Hedw.) Cardot – 4, 5, 6, 8, 9, 14 – siliceous rock.
- Schistidium apocarpum* (Hedw.) Bruch et Schimp. – 8x, 9 – rock.
- Schistidium crassipilum* H. H. Blom – 5, 6 – siliceous rock.
- Schistidium dupretii* (Thér.) W. A. Weber – 1 – siliceous rock.
- Schistidium papillosum* Culm. – 1 – siliceous rock.
- Scleropodium touretii* (Brid.) L. F. Koch – 2, 3 – siliceous rock.
- Scorpiurium circinatum* (Bruch) M. Fleisch. et Loeske – 3 – siliceous rock.
- Scorpiurium sendtneri* (Schimp.) M. Fleisch. – 3 – siliceous rock.
- Syntrichia calcicola* J. J. Amann – 11 – lime containing schistose rock.
- Syntrichia latifolia* (Bruch ex Hartm.) Huebener – 3 – *Salix* bark.
- Syntrichia montana* Nees – 11 – siliceous rock.
- Syntrichia papillosa* (Wilson) Jur. – 3 – *Salix* bark.
- Syntrichia princeps* (De Not.) Mitt. – 2, 3, 5, 9 – siliceous rock.
- Syntrichia ruralis* (Hedw.) F. Weber et D. Mohr – 1, 2, 5, 7, 11 – *Quercus* bark.
- Syntrichia subpapillosissima* (Bizot et R. B. Pierrot ex W. A. Kramer) M. T. Gallego et J. Guerra – 5, 11, 13 – siliceous rock.
- Thuidium recognitum* (Hedw.) Lindb. – 9 – siliceous rock.
- Tortella squarrosa* (Brid.) Limpr. – 2, 4, 5, 7, 10, 11, 13 – siliceous rock.
- Tortula inermis* (Brid.) Mont. – 11 – lime containing schistose rock.
- Tortula muralis* Hedw. – 6, 11, 14 – siliceous rock.
- Tortula schimperi* M. J. Cano, O. Werner et J. Guerra – 2, 9 – siliceous rock.
- Tortula subulata* Hedw. – 2, 3, 8x, 9, 11, 12 – siliceous rock, *Quercus* bark.
- Trichodon cylindricus* (Hedw.) Schimp. – 12 – bank of an artificial lake.
- Trichostomum brachydontium* Bruch – 4, 5, 6, 7, 12 – siliceous rock.
- Trichostomum crispulum* Bruch – 6, 11, 12 – siliceous rock.
- Weissia brachycarpa* (Nees et Hornsch.) Jur. – 3, 12 – siliceous rock.
- Weissia controversa* Hedw. – 3, 5, 10, 12 – siliceous rock.
- Zygodon rupestris* Schimp. ex Lorentz – 8x – siliceous rock.