

CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF THE
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Abstract: A total of 222 bryophyte taxa (37 liverworts and 185 mosses) were recorded during our field trip to the Jablanica Mts. Twenty-six species (8 liverworts and 18 mosses) regionally threatened in the Balkans, or even in Europe, were found in the investigated area. The most important habitat types for nature conservation are the limestone and siliceous grasslands in the alpine zones and bogs and water-source areas, which seem to be severely affected by climate warming, but still maintain a very diverse bryophyte flora with many threatened species including several arctic-alpine, subarctic-subalpine, and boreal, montane taxa. In the beech forest at high elevations some other threatened montane species occur.

Key words: liverworts, mosses, species of conservation interest, the Balkans

INTRODUCTION

The bryophyte flora of North Macedonia, according to the latest checklists of European countries (HODGETTS and LOCKHART 2020), consists of 569 species (one hornwort, 111 liverworts, and 457 mosses). It is far below the number of species known from other Balkan countries, which usually harbour around 700 or more. Only the neighbouring Albania is bryologically less rich, with 532 known species, which is a consequence of low intensity of bryophyte research. Both countries belong to the bryologically under-explored areas. MARTINČIČ (2009) also stated that North Macedonia is one of the areas poorly known especially regarding recent bryophyte data. SABOVLJEVIĆ *et al.*

(2001) and SABOVLJEVIĆ (2004) expected in the future many new bryophyte records for North Macedonia with the intensification of bryological research. Even after the checklist of HODGETTS and LOCKHART (2020), some papers should be considered as well, where 10 taxa (2 liverworts and 8 mosses) have already been reported for the first time from the country based on our collection from the Jablanica Mts, which are the following: *Porella baueri* (SABOVLJEVIĆ *et al.* 2022), *Solenostoma confertissimum* (ELLIS *et al.* 2022), *Brachytheciastrum collinum* (TOMOVIĆ *et al.* 2022), *Brachytheciastrum dieckei*, *Kiaeria starkei*, *Orthotrichum schimperi* (PAPP *et al.* 2024), *Fissidens exilis* (TOMOVIĆ *et al.* 2023a), *Pseudostereodon procerrimus* (SABOVLJEVIĆ *et al.* 2023a), *Streblotrichum convolutum* var. *commutatum* (SABOVLJEVIĆ *et al.* 2023b), *Tortella fasciculata* (TOMOVIĆ *et al.* 2023b), *Tortella pseudofragilis* (SABOVLJEVIĆ *et al.* 2023c).

As data on the bryophyte flora of North Macedonia are very scarce and the knowledge on the distribution of species in the country is far from complete, in this paper we publish the whole list of bryophytes found during our field trip made in 2018 with special attention to the species of conservation interest.

MATERIAL AND METHODS

Description of the area investigated

Jablanica Mts is situated in the western part of North Macedonia at the border with Albania. The part of the massive belonging to North Macedonia is more than 250 km². The direction of the Jablanica Mts is north to south, between the Debar valley and Lake Ohridsko. Its eastern limit is the river Crni Drim. The highest peak is Crn Kamen (2,258 m of altitude) and the mountain range is composed of several peaks higher than 2,000 m a.s.l. Among the peaks there are plateaus with streams and wetlands. A lot of glacial formations are also characteristic in the area, like the four glacial lakes, namely Vevčansko, Podgorsko, Gorno Labuniško, and Dolno Labuniško ezero. The area is geologically very interesting, above Paleozoic schists, there are Triassic limestone rocks. The climate in this area is typical montane with Mediterranean and continental influences.

Methods

Our collecting trip was made in June 2018. Various habitat types, such as wetlands, streams, calcareous and siliceous rock formations, grasslands, and forests were investigated, and bryophytes were collected from different substrates (soil, exposed and shaded rocks, tree bark, and decaying wood). The investigated area can be seen in Figure 1.

The specimens are preserved in the Herbarium of the Hungarian Natural History Museum, Budapest (BP) and in the Herbarium of the University of Belgrade (BEOU-Bryo). Nomenclature of bryophytes follows HODGETTS *et al.* (2020), except for *Fissidens bambergeri*, which follows AHRENS (2000). Where species distributions are indicated for SE Europe, the following abbreviations are used: ALB = Albania, BG = Bulgaria, BIH = Bosnia and Herzegovina, GR = Greece, HR = Croatia, MK = Macedonia, MNE = Montenegro, RO = Romania, SLO = Slovenia, RS = Serbia, TR = European part of Turkey. Abbreviations of red list categories are as follows: CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, DD = data deficient.

European red list threat assessments of the species are based on HODGETTS *et al.* (2019), while country distributions in SE Europe on HODGETTS and LOCKHART (2020), with updates where relevant. In the neighbouring countries of North Macedonia only Serbia has a recent red list of hornworts and liverworts (SABOVLJEVIĆ *et al.* 2024a), and mosses (SABOVLJEVIĆ *et al.* 2024b), which gives a very good overview of the threat status of the species in the region. Therefore, the selection of species of conservation interest was mainly based on these red lists besides the European red list and the Bulgarian Red Data Book (PEEV *et al.* 2015). Additionally, there is a red list of bryophytes of Bulgaria published in 2006 (NATCHEVA *et al.* 2006), and a preliminary red list of bryophytes of Albania (MARKA *et al.* 2012), which were also taken into consideration in some cases.

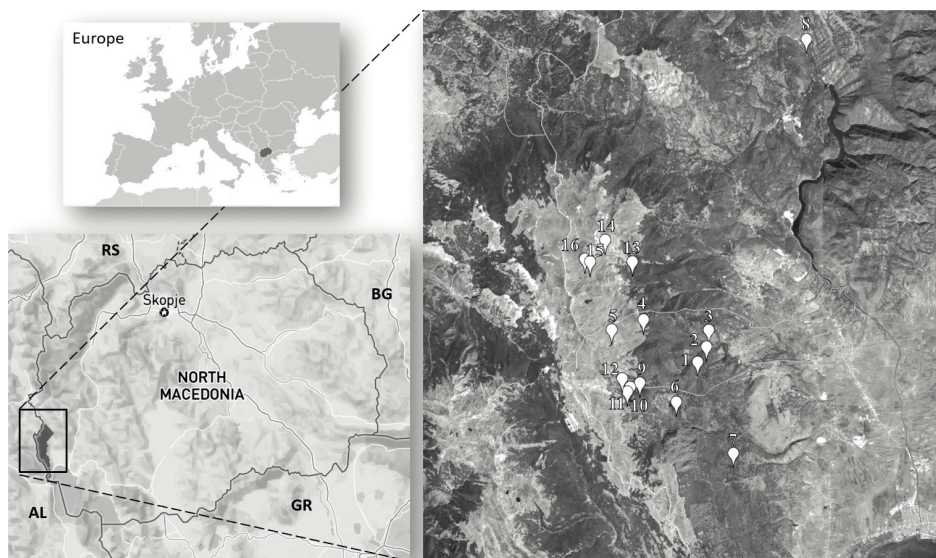


Fig. 1. Location of the area investigated. Abbreviations: AL = Albania, BG = Bulgaria, GR = Greece, RS = Serbia. Numerals refer to the collection sites described below.

Site details

1. Jablanica Mts, between Gorna Belica and Vevčani villages, towards Jankov kamen, in *Fagetum*, 41° 14' 13.8" N, 20° 34' 34.5" E, 1,198 m, 21.06.2018.
2. Jablanica Mts, between Gorna Belica and Vevčani villages, at Jankov kamen around a lake, 41° 13' 54.3" N, 20° 34' 19.7" E, 1,198 m, 21.06.2018.
3. Jablanica Mts, Vevčani springs in Vevčani village, 41° 14' 35.3" N, 20° 34' 38.3" E, 979 m, 21.06.2018.
4. Jablanica Mts, towards Lake Vevčansko ezero, alpine zone with siliceous rocks, 41° 14' 49.3" N, 20° 32' 51.1" E, 1,684 m, 22.06.2018.
5. Jablanica Mts, at Lake Vevčansko ezero, alpine zone with limestone and siliceous rocks, 41° 14' 37.0" N, 20° 31' 59.8" E, 1,965 m, 22.06.2018.
6. Jablanica Mts, downwards from Gorna Belica, limestone cliff along the road, 41° 13' 03.2" N, 20° 33' 43.4" E, 1,223 m, 23.06.2018.
7. Jablanica Mts, downwards from Gorna Belica, before Višni, *Quercetum*, 41° 11' 56.3" N, 20° 35' 20.3" E, 1,100 m, 23.06.2018.
8. Drim valley towards Debar, riverbank, 41° 20' 54.7" N, 20° 37' 26.3" E, 620 m, 23.06.2018.
9. Jablanica Mts, from Gorna Belica towards Čumin vrv, in *Fagetum*, 41° 13' 28.7" N, 20° 32' 43.6" E, 1,485 m, 24.06.2018.
10. Jablanica Mts, from Gorna Belica towards Čumin vrv, acidic grassland, 41° 13' 23.6" N, 20° 32' 27.8" E, 1,623 m, 24.06.2018.
11. Jablanica Mts, from Gorna Belica towards Čumin vrv, alpine zone with limestone rocks, 41° 13' 18.1" N, 20° 32' 23.6" E, 1,723 m, 24.06.2018.
12. Jablanica Mts, from Gorna Belica towards Crni kamen, wetland with *Eriophorum*, 41° 13' 34.7" N, 20° 32' 14.8" E, 1,624 m, 24.06.2018.
13. Jablanica Mts, at Podgorečki Bačila settlement, in *Fagetum*, 41° 16' 02.8" N, 20° 32' 32.1" E, 1,718 m, 25.06.2018.
14. Jablanica Mts, from Podgorečki Bačila towards Lake Labuniško ezero, alpine zone with siliceous and limestone rocks, 41° 16' 30.1" N, 20° 31' 46.9" E, 1,738 m, 25.06.2018.
15. Jablanica Mts, around Labuniško ezero lake, 41° 16' 02.7" N, 20° 31' 23.2" E, 1,918 m, 25.06.2018.
16. Jablanica Mts, at a source area under Lake Labuniško ezero, 41° 16' 06.0" N, 20° 31' 14.4" E, 1,908 m, 25.06.2018.

RESULTS AND DISCUSSION

A total of 222 bryophyte taxa (37 liverworts and 185 mosses) were recorded during our field trip. The complete list of species can be seen in the Appendix.

Twenty-six species (8 liverworts and 18 mosses) threatened in the Balkans, or even in Europe, were found in the investigated area.

Species of conservation importance

Liverworts

Lophozia wenzelii is a boreal, montane species (DÜLL 1983). It is vulnerable (VU) in Serbia due to its restricted area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024a). In North Macedonia it still does not seem to be rare, having recent data from the alpine zones with siliceous rocks of Nidže (Voras) Mts (PAPP *et al.* 2011), Pelister Mts (PAPP and ERZBERGER 2012), and Mavrovo National Park (PAPP *et al.* 2016), but nowadays these habitat types are severely threatened by climate change. In the Jablanica Mts it was found in acidic grassland towards Čumin vrv at ca 1,620 m a.s.l.

Marchantia paleacea is red-listed in Europe as vulnerable (VU) due to continuing decline in its area of extent and habitat quality (SABOVLJEVIĆ *et al.* 2019). It is a Mediterranean species DÜLL (1983), known from Azores, Balearic Islands, Canary Islands (EN), France, Italy (NT), Madeira (VU), Spain, Switzerland (VU), and the Caucasus. In SE Europe it has records from ALB, HR, GR, MNE, MK, RS (HODGETTS and LOCKHART 2020). It is vulnerable (VU) in Serbia due to its restricted area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024a), and it is on the preliminary red list of bryophytes of Albania (MARKA *et al.* 2012). In the Jablanica Mts it was found in a wetland towards Crni kamen at ca 1,625 m a.s.l.

Marsipella funckii is a montane species of western temperate zone of Europe (DÜLL 1983). It is vulnerable (VU) in Serbia (SABOVLJEVIĆ *et al.* 2024a) and in Bulgaria (NATCHEVA *et al.* 2006) due to its restricted area of occupancy and number of locations. In North Macedonia it still has several extant populations in the alpine zones with siliceous rocks of Nidže (Voras) Mts (PAPP *et al.* 2011), Pelister Mts (PAPP and ERZBERGER 2012), and Mavrovo National Park (PAPP *et al.* 2016), but the alpine habitats are very threatened by climate change. In the Jablanica Mts it was found in acidic grassland towards Čumin vrv and on soil among siliceous rocks in the alpine zone towards Lake Labuniško ezero.

Mesoptychia bantriensis is a boreal, montane species (DÜLL 1983). It is near threatened (NT) in Serbia due to its restricted area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024a). In SE Europe besides Serbia, it is known from BG, GR, MNE, MK, RO, and SLO. In Slovenia it is considered vulnerable (VU) (MARTINČIČ 2024b). In North Macedonia it has recent records only from the Jablanica Mts, where it was found in three localities: from Gorna Belica towards Čumin vrv in a source area in a beech forest at ca 1,485 m a.s.l. and in a

wetland at *ca* 1,625 m a.s.l., and at a source area under Lake Labuniškozero at *ca* 1,910 m a.s.l.

Mesoptychia heterocolpos is a subarctic, dealpine species (DÜLL 1983). It is vulnerable (VU) in Serbia due to its restricted area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024a). In North Macedonia it has recently been recorded in Mavrovo National Park (PAPP *et al.* 2016) and in Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was found in the alpine zone at Lake Vevčanskozero.

Obtusifolium obtusum is a boreal, montane species (DÜLL 1983). It is vulnerable (VU) in Serbia due to its restricted area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024a). In North Macedonia it has recently been recorded in the Pelister Mts (PAPP and ERZBERGER 2012) and in Mavrovo National Park (PAPP *et al.* 2016). In the Jablanica Mts it was collected in the alpine zones under Čumin vrv and around Lake Labuniškozero.

Scapania aequiloba is a boreal, montane species (DÜLL 1983). It is vulnerable (VU) in Serbia due to its restricted and declining area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024a). In North Macedonia it has recently been recorded in Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was collected on limestone rocks in the alpine zones under Čumin vrv and at Vevčanskozero and Labuniškozero lakes.

Solenostoma confertissimum is an arctic, alpine species (DÜLL 1983). In SE Europe it is known only from BG, MNE, RO, and SLO. It is vulnerable (VU) in Bulgaria due to its restricted area of occupancy and number of locations (PEEV *et al.* 2015, NATCHEVA *et al.* 2006). It has been reported as new to the bryophyte flora of North Macedonia based on the collection from the Jablanica Mts, where it was found in three localities: in a wetland along a rivulet in the alpine zone towards Lake Vevčanskozero at *ca* 1,685 m a.s.l, from Gorna Belica towards Čumin vrv in a beech forest at *ca* 1,485 m a.s.l., and in an acidic grassland at *ca* 1,625 m a.s.l.

Mosses

Brachytheciastrum collinum is an arctic-alpine species (DÜLL 1985). It has a sporadic distribution in Europe, mainly in Northern Europe and in high mountain areas of Europe. In SE Europe it is known only from BG, GR, MNE, and SLO. In Slovenia, it is red-listed as vulnerable (VU) (MARTINČIČ 2024). It has been reported as new to the bryophyte flora of North Macedonia based on this collection. It was found in acidic grassland under Čumin vrv at *ca* 1,620 m a.s.l.

Brachytheciastrum olympicum is red-listed in Europe as vulnerable (VU). It is known from France, Italy, Hungary (PAPP *et al.* 2020a), Portugal, Cyprus and

in SE Europe ALB, BIH, HR, GR, MK, RO, RS (DD; SABOVLJEVIĆ *et al.* 2024b), SLO, and TR. Although it is not frequent, several existing populations are known from the high mountain areas of GR and MK (e.g., Voras Mts/Nidže Mts (PAPP *et al.* 2011), in the Pelister Mts (PAPP and ERZBERGER 2012), in Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was found on soil, limestone rock, and on *Fagus* bark in beech forests at ca 1,200 m a.s.l.

Brachythecium geheebii is red-listed in Europe as vulnerable (VU) and endangered (EN) in Serbia (SABOVLJEVIĆ *et al.* 2024b) and in Bulgaria (PEEV *et al.* 2015, NATCHEVA *et al.* 2006) due to few locations, declining area of occupancy, and small population size. It is also on the preliminary red list of bryophytes of Albania (MARKA *et al.* 2012). Being a subcontinental, montane, dealpine species (DÜLL 1985) climate change highly influences its distribution. It is known from all SE European countries except the European part of Turkey. In North Macedonia it has recent data from the border region with Greece in the Nidže (Voras) Mts (PAPP *et al.* 2011). In the Jablanica Mts it was found on acidic rock in a beech forest under Čumin vrh at ca 1,485 m a.s.l.

Encalypta alpina is a subarctic, subalpine species (DÜLL 1984). It has a sporadic distribution in Europe, mainly in Northern Europe and in high mountain areas of Europe. In SE Europe it is known from almost all countries except BIH, HR, and TR. According to the latest red list of Serbia it is data-deficient (DD) (SABOVLJEVIĆ *et al.* 2024b). It is also on the preliminary red list of bryophytes of Albania (MARKA *et al.* 2012). In the Jablanica Mts a small population was found on limestone rocks in the alpine zone at Lake Vevčansko ezero.

Grimmia anomala is a subarctic, subalpine species (DÜLL 1984) red-listed in Serbia as vulnerable (VU) due to its restricted area of occupancy (SABOVLJEVIĆ *et al.* 2024b). In the mountainous areas of North Macedonia, it still does not seem to be rare, having several large populations in the alpine zones of the Pelister Mts (PAPP and ERZBERGER 2012) and Mavrovo National Park (PAPP *et al.* 2016), but nowadays these habitat types are threatened by climate change.

Kiaeria starkei is a subarctic, subalpine species (DÜLL 1984) having a sporadic distribution in Europe, mainly in Northern Europe and in the high mountainous areas of Europe. In SE Europe it is known from ALB, BIH, BG, MNE, RO, and SLO. It is endangered (EN) in Slovenia (MARTINČIČ 2024). It has been reported as new to the bryophyte flora of North Macedonia based on this collection. It was found on siliceous rock in the alpine zone near Lake Labuniško ezero, at ca 1,740 m a.s.l.

Lewinskya shawii is a southern sub-oceanic epiphyte species previously treated as synonymous with *O. striatum*. It was elevated to species rank by MAZIMPAKA *et al.* (2000). In SE Europe it is known from ALB, BIH, GR, MNE, and MK. However, its distribution is still insufficiently known. In North Mace-

donia it has recently been reported from Mavrovo National Park (PAPP *et al.* 2016) and from Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was found on bark of *Castanea sativa* Mill. at Vevčani springs at ca 980 m a.s.l.

Mnium spinulosum is a subcontinental, montane species (DÜLL 1984) red-listed in Serbia as vulnerable (VU) due to its small population size in the country (SABOVLJEVIĆ *et al.* 2024b). In SE Europe it is known from BIH, HR, MNE, MK, RO, RS, and SLO. In the Jablanica Mts it was collected in the alpine zone of Čumin vrv.

Myurella julacea is a subarctic, dealpine species (DÜLL 1985) red-listed in Serbia as vulnerable (VU) due to its restricted area of occupancy (SABOVLJEVIĆ *et al.* 2024b). In SE Europe it is known from all countries except TR. It has sporadic distribution in the calcareous high mountain areas of the Balkans. In North Macedonia it has a recent record from Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts its small populations were discovered in the alpine zones at Lake Vevčansko ezero and under Čumin vrv.

Philonotis calcarea is red-listed in Europe as near threatened (NT). It is vulnerable (VU) in Serbia due to restricted and declining area of occupancy, number of locations and number of mature individuals (SABOVLJEVIĆ *et al.* 2024b). It is a subboreal species (DÜLL 1984) of calcareous wetlands. In North Macedonia extant populations have been reported from Mavrovo National Park (PAPP *et al.* 2016). In the Jablanica Mts six populations were found in source areas at various elevations between ca 980–1,900 m a.s.l.

Plagiomnium ellipticum is endangered (EN) in Serbia due to restricted and declining area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024b). It is also a boreal species (DÜLL 1984) of calcareous wetlands. In North Macedonia it has recent records from Mavrovo National Park (PAPP *et al.* 2016) and from Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was collected at Vevčani springs at ca 980 m a.s.l.

Pseudostereodon procerrimus is a Northern sub-atlantic, alpine species (DÜLL 1985). It is endangered (EN) in Serbia due to restricted extent of occurrence and area of occupancy, and decline in number of locations (SABOVLJEVIĆ *et al.* 2024b), and critically endangered (CR) in Bulgaria due to few localities and continuous decline in habitat quality (PEEV *et al.* 2015, NATCHEVA *et al.* 2006). It has a sporadic distribution in the mountainous areas of Europe being also red-listed in Great Britain (EN), Spain (VU), and Switzerland (EN) (HODGETTS and LOCKHART 2020). In SE Europe it is known from almost all countries except ALB, GR, and TR. It has been reported as new to the bryophyte flora of North Macedonia based on this collection. It was found on limestone rock in the alpine zone under Čumin vrv at ca 1,720 m a.s.l.

Ptychostomum turbinatum is red-listed in Europe as vulnerable (VU) and endangered (EN) in Serbia due to restricted extent of occurrence and area of occupancy, small population size, and decline in the number of locations (SABOVLJEVIĆ *et al.* 2024b). It is a species of the temperate zone of Europe (DÜLL 1984) occurring in source areas, by streams, at waterfalls, and on wet cliffs. In North Macedonia it has been reported in the Pelister Mts (PAPP and ERZBERGER 2012) and in Mavrovo National Park (PAPP *et al.* 2016). In the Jablanica Mts it was found in three localities: at Jankov kamen around a lake, on limestone rocks under Čumin vrv, and near Lake Labuniškozero.

Sciuro-hypnum reflexum is a boreal, montane species (DÜLL 1985) red-listed in Serbia as vulnerable (VU) due its restricted area of occupancy (SABOVLJEVIĆ *et al.* 2024b). In SE Europe it is known from all countries except TR. In North Macedonia it has a recent record from the Pelister Mts (PAPP and ERZBERGER 2012). In the Jablanica Mts it was found on limestone rock in a beech forest from Gorna Belica towards Čumin vrv.

Syntrichia handelii is on the European red list as data-deficient (DD). It is an Eastern Mediterranean, continental species (DÜLL 1984). It is known from the Balearic Islands, Cyprus, France, Sicily, Spain (EN) and in SE Europe from ALB, HR, GR, MNE, and MK. In North Macedonia it has recently been reported in Mavrovo National Park (PAPP *et al.* 2016) and Galičica National Park (PAPP *et al.* 2020b). It has also recent records from the neighbouring Albania, where it was found in two mountainous areas (PAPP *et al.* 2010). In the Jablanica Mts it was found on limestone cliff downwards from Gorna Belica at ca 1,220 m a.s.l. and on limestone rocks in the alpine zone under Čumin vrv at ca 1,720 m a.s.l.

Syntrichia subpapillosissima is on the European red list as data-deficient (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. In North Macedonia it has recently been recorded in the Mavrovo National Park (PAPP *et al.* 2016). It seems not to be rare in the Jablanica Mts being collected in six localities. These data contribute to the better knowledge on the distribution and habitat preference of this species.

Timmia austriaca is a subarctic, subalpine species (DÜLL 1984). It is vulnerable (VU) in Serbia due to restricted extent of occurrence and declining area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024b). In North Macedonia it has recent data from the Nidže (Voras) Mts (PAPP *et al.* 2011), from the Pelister Mts (PAPP and ERZBERGER 2012), and from Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was found on a limestone cliff downwards from Gorna Belica and in the alpine zones at Lake Vevčanskozero and under Čumin vrv.

Timmia bavarica is a Northern subcontinental, dealpine species (DÜLL 1984). It is vulnerable (VU) in Serbia due to its restricted area of occupancy and number of locations (SABOVLJEVIĆ *et al.* 2024b). It is also on the preliminary red list of bryophytes of Albania (MARKA *et al.* 2012). In North Macedonia it has recently been recorded in Mavrovo National Park (PAPP *et al.* 2016) and in Galičica National Park (PAPP *et al.* 2020b). In the Jablanica Mts it was found on a limestone cliff downwards from Gorna Belica and in the alpine zone under Čumin vrh.

Some other species red-listed in the nearby Serbia seem to be more frequently recorded in North Macedonia, namely *Lescuraea incurvata* (VU), *L. saviana* (VU), and *Neckera menziesii* (EN). Tiny *Fissidens* species like *Fissidens exilis* (VU) and *F. viridulus* (VU), living on bear soil and frequently mixed with other bryophytes are under-collected and overlooked. Distribution data are missing, and the field investigation intensity is low, therefore, it is difficult to assess their threat-status in the region. The sub-Mediterranean *Fissidens viridulus* (DÜLL 1984) becomes more frequent towards south in the more Mediterranean parts of the Balkans evidenced even by our collections from the neighbouring Albania (PAPP *et al.* 2010, 2018) and Greece (PAPP and BABALONAS 1996, PAPP and TSAKIRI 2017). Its spread is expected northwards due to climate warming. However, the water regime changes are also a factor affecting suitable sites. The situation is rather similar in the case of the sub-Mediterranean and sub-Atlantic montane *Neckera menziesii* DÜLL (1985), which has also several records even in North Macedonia from other mountainous regions like in Mavrovo National Park (PAPP *et al.* 2016) and in Galičica National Park (PAPP *et al.* 2020b). *Lescuraea incurvata* and *L. saviana* occur mainly at elevations above 1000 m a.s.l. in the Balkans and they share the same habitat on shaded rocks, but *L. saviana* also frequently appears on the bark of trees. They both seem to be rather frequent in North Macedonia evidenced by several records even in our collections (PAPP *et al.* 2011, 2016, 2020b, PAPP and ERZBERGER 2012).

CONCLUSIONS

In the Jablanica Mts the most important habitat types for nature conservation are the limestone and siliceous grasslands in the alpine zones, which are affected by climate warming and hydric regime changes, but still maintain a very diverse bryophyte flora with many threatened species in the Balkans and even in Europe, like several arctic-alpine, subarctic-subalpine (*Mesoptychia heterocolpos*, *Solenostoma confertissimum*, *Brachytheciastrum collinum*, *Encalypta alpina*, *Grimmia anomala*, *Kiaeria starkei*, *Myurella julacea*, *Pseudostereodon procerrimus*,

Timmia austriaca, *T. bavarica*), and boreal, montane species (*Lophozia wenzelii*, *Marsupella funckii*, *Obtusifolium obtusum*, *Scapania aequiloba*, *Mnium spinulosum*). In beech forests at high elevations some other threatened montane species occur, e. g. *Brachytheciastrum olympicum*, *Brachythecium geheebii*, and *Sciuro-hypnum reflexum*. Bogs and water-source areas are also important habitat types from conservation point of view, because these habitats are also threatened by the climate warming especially in SE Europe. In the Jablanica Mts, these wetlands provide habitats for some species of European conservation interest, like *Marchantia paleacea*, *Philonotis calcarea*, and *Ptychostomum turbinatum*, and for species threatened in the region, like *Mesoptychia bantriensis* and *Plagiomnium ellipticum*. Our data of some species of Mediterranean character (*Syntrichia handelii* and *S. subpapillosissima*) which are on the European red list as data-deficient (DD), contribute to a better knowledge on the distribution and habitat preference of these species.

* * *

Összefoglaló: A Jablanica-hegységben 2018 júniusában tett gyűjtőutunk során összesen 222 mohafajt (37 májmohát és 185 lombosmohát) sikerült kimutatni, köztük 26 olyan fajt (8 májmohát és 18 lombosmohát), amelyek regionálisan veszélyeztetettek a Balkánon vagy akár egész Európában. Természetvédelmi szempontból a legfontosabbak az 1600 m feletti magashegyi zónában található meszes és savanyú sziklagyepek és sziklakibukkanások, amelyek számos veszélyeztetett arktikus-alpin vagy szubarktikus-szubalpin fajnak (*Mesoptychia heterocolpos*, *Solenostoma confertissimum*, *Brachytheciastrum collinum*, *Encalypta alpina*, *Grimmia anomala*, *Kiaeria starkei*, *Myurella julacea*, *Pseudostereodon procerimus*, *Timmia austriaca*, *T. bavarica*), valamint borealis, montán fajnak (*Lophozia wenzelii*, *Marsupella funckii*, *Obtusifolium obtusum*, *Scapania aequiloba*, *Mnium spinulosum*). adnak otthont. A montán bükkösökben, főleg árnyas sziklákon, szintén előfordul néhány veszélyeztetett faj, mint a *Brachytheciastrum olympicum*, *Brachythecium geheebii* és *Sciuro-hypnum reflexum*. A láprétek, forrásfeltörések rendkívül veszélyeztetettek a klímaváltozás miatt Dél-Kelet Európában, kiterjedésük folyamatosan csökken, fragmentálódnak. A Jablanica hegység gazdag az ilyen típusú élőhelyekben és néhány olyan faj is megtalálható rajtuk, amelyek egész Európában veszélyeztetettek, mint a *Marchantia paleacea*, *Philonotis calcarea* és *Ptychostomum turbinatum*, vagy a regionálisan veszélyeztetett *Mesoptychia bantriensis* és *Plagiomnium ellipticum*. Ezen kívül gyűjtéseinkből előkerült néhány olyan faj is, amelyek a legutóbbi Európai Moha Vörös Listán az adathiányos (DD) kategóriában szerepelnek. Ilyen a mediterrán elterjedésű *Syntrichia handelii* és *S. subpapillosissima*, amelyek jablanicai adatai hozzájárulnak elterjedésük és élőhelyi igényeik jobb megismeréséhez.

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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. Quand – 1, 3: limestone rock in the stream; 4: in a wetland along a rivulet; 6: limestone rock; 9: at outflow of a source
- Barbilophozia hatcheri* (A. Evans) Loeske – 4: siliceous rock; 10: in acidic grassland; 11: in limestone grassland; 13: on soil along the road
- Barbilophozia lycopodioides* (Wallr.) Loeske – 4: siliceous rock; 5: in alpine grassland; 11: limestone rock
- Barbilophozia sudetica* (Nees ex Huebener) L. Söderstr., De Roo et Hedd. – 14: on soil among limestone rocks
- Cephaloziella divaricata* (Sm.) Schiffn. – 4: siliceous rock; 10: in acidic grassland; 13: on soil along the road; 14: on soil among limestone rocks
- Chiloscyphus pallescens* (Ehrh.) Dumort. – 4: in a wetland along a rivulet
- Chiloscyphus polyanthos* (L.) Corda – 1: limestone rock along a stream
- Cololejeunea calcarea* (Lib.) Steph. – 6: limestone rock
- Conocephalum conicum* (L.) Dumort. – 1: limestone rock along a stream
- Conocephalum salebrosum* Szweyk., Buczk. et Odrzyk. – 11: limestone rock
- Frullania dilatata* (L.) Dumort. – 1: *Fagus* bark; 7: *Quercus* bark; 8: *Alnus* bark
- Lophocolea minor* Nees – 11: limestone rock; 14: on soil among limestone rocks
- Lophozia wenzelii* (Nees) Steph. – 10: in acidic grassland
- Marchantia paleacea* Bertol. – 12: in wetland
- Marchantia polymorpha* L. subsp. *ruderalis* Bischl. et Boissel.-Dub. – 3: limestone rock in the stream; 5: in alpine grassland
- Marchantia quadrata* Scop. – 5: in alpine grassland; 14: on soil among limestone rocks
- Marsupella funckii* (F. Weber et D. Mohr) Dumort. – 10: in acidic grassland; 14: on soil among siliceous rocks
- Mesoptychia bantriensis* (Hook.) L. Söderstr. et Váňa – 9: at outflow of a source; 12: in wetland; 16: at a source
- Mesoptychia collaris* (Nees) L. Söderstr. et Váňa – 5: in alpine grassland; 6: limestone rock; 14: on soil among limestone rocks
- Mesoptychia heterocolpos* (Thed. ex Hartm.) L. Söderstr. et Váňa – 5: in alpine grassland
- Obtusifolium obtusum* (Lindb.) S. W. Arnell – 10: in acidic grassland; 14: on soil among limestone rocks
- Pellia neesiana* (Gottsche) Limpr. – 12: in wetland
- Plagiochila porelloides* (Torr. ex Nees) Lindenb. – 1: limestone rock along a stream; 4: siliceous rock and in a wetland along a rivulet; 5: in alpine grassland; 6, 11: limestone rock; 9: on soil, limestone rock, and at outflow of a source; 10: in acidic grassland; 13: on soil along the road
- Porella baueri* (Schiffn.) C. E. O. Jensen – 11: limestone rock
- Porella cordaeana* (Huebener) Moore – 1: limestone rock along a stream; 4: siliceous rock and in a wetland along a rivulet; 8: *Ulmus* bark; 11: limestone rock; 13: on soil along the road
- Radula complanata* (L.) Dumort. – 1: *Fagus* bark; 4: siliceous rock; 5: in alpine grassland; 7: *Quercus* bark; 9: acidic rock; 11, 14: limestone rock
- Reboulia hemisphaerica* (L.) Raddi – 2: limestone grassland; 11: limestone rock

- Riccia ciliifera* Link – 2: limestone grassland
Riccia sorocarpa Bisch. – 2: limestone grassland
Scapania aequiloba (Schwägr.) Dumort. – 5: in alpine grassland; 11: limestone rock; 14: on soil among limestone rocks
Scapania aspera M. Bernet et Bernet – 6: limestone rock
Scapania calcicola (Arnell et J. Perss.) Ingham – 2: limestone grassland; 5: in alpine grassland; 14: on soil among limestone rocks
Scapania irrigua Nees – 4: in a wetland along a rivulet; 10: in acidic grassland
Scapania undulata (L.) Dumort. – 12: in wetland
Schistochilopsis incisa (Schrad.) Konstant. – 10: in acidic grassland
Solenostoma confertissimum (Nees) Schljakov – 4: in a wetland along a rivulet; 9: on soil, 10: in acidic grassland
Targionia hypophylla L. – 14: on soil among limestone rocks

Mosses

- Alleniella complanata* (Hedw.) S. Olsson, Enroth et D. Quandt – 6: limestone rock; 8: *Alnus* bark
Amblystegium serpens (Hedw.) Schimp. – 8: *Alnus* bark
Amphidium mougeotii (Schimp.) Schimp. – 5: in alpine grassland
Anomodon viticulosus (Hedw.) Hook. et Taylor – 1, 6: limestone rock; 8: *Ulmus* bark
Atrichum undulatum (Hedw.) P. Beauv. – 1: on soil
Aulacomnium palustre (Hedw.) Schwägr. – 4: in a wetland along a rivulet
Barbula unguiculata Hedw. – 1: on soil and limestone rock; 4: siliceous rock; 6, 11: limestone rock; 8: schistose rock; 9: on soil
Bartramia ithyphylla Brid. – 5: in alpine grassland; 9: on soil; 10: in acidic grassland; 13: on soil along the road
Brachytheciastrum collinum (Schleich. ex Müll. Hal.) Ignatov et Huttunen – 10: in acidic grassland
Brachytheciastrum dieckei (Röll) Ignatov et Huttunen – 6: limestone rock; 9: on soil; 10: in acidic grassland
Brachytheciastrum olympicum (Jur.) Vanderp. et al. – 1: on soil and *Fagus* bark; 6: limestone rock
Brachytheciastrum velutinum (Hedw.) Ignatov et Huttunen – 4, 9: siliceous rock; 11: limestone rock; 13: on soil along the road
Brachythecium albicans (Hedw.) Schimp. – 15: on the bank of lake
Brachythecium geheebii Milde – 9: acidic rock
Brachythecium glareosum (Bruch ex Spruce) Schimp. – 2: limestone grassland; 3: on soil; 4: siliceous rock; 5: in alpine grassland; 6, 11: limestone rock; 10: in acidic grassland; 13: on soil along the road; 14: on soil among limestone rocks
Brachythecium rivulare Schimp. – 1, 3: limestone rock along a stream; 2: at the lakeshore; 4: in a wetland along a rivulet; 9: at outflow of a source; 12: in wetland
Brachythecium rutabulum (Hedw.) Schimp. – 1: on soil; 6: limestone rock; 8: *Alnus* bark; 10: in acidic grassland
Brachythecium tommasinii (Sendtn. ex Boulay) Ignatov et Huttunen – 2: limestone grassland; 6, 9: limestone rock
Bryoerythrophyllum recurvirostrum (Hedw.) P. C. Chen – 1, 6, 11: limestone rock
Bryum argenteum Hedw. – 8: schistose rock
Calliergonella cuspidata (Hedw.) Loeske – 2: at the lakeshore; 4: in a wetland along a rivulet; 9: at outflow of a source; 12: in wetland
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra – 14: on soil among limestone rocks

- Campylium protensum* (Brid.) Kindb. – 9: at outflow of a source; 11: limestone rock
Campylium stellatum (Hedw.) Lange et C. E. O. Jensen – 4: in a wetland along a rivulet; 12: in wetland; 16: at a source
Campylophyllopsis calcarea (Crundw. et Nyholm) Ochyra – 1, 3: on soil
Ceratodon purpureus (Hedw.) Brid. – 1, 11: limestone rock; 2: acidic rock and limestone grassland; 4: siliceous rock; 14: on soil among siliceous rocks; 15: on the bank of lake
Cinclidotus aquaticus (Hedw.) Bruch et Schimp. – 3: limestone rock in the water
Cinclidotus riparius (Host ex Brid.) Arn. – 3: limestone rock in the water
Cirriphyllum crassinervium (Taylor) Loeske et M. Fleisch. – 1: limestone rock along a stream; 6: limestone rock
Cratoneuron filicinum (Hedw.) Spruce – 1, 3: limestone rock along a stream; 2: at the lakeshore; 4: in a wetland along a rivulet; 9: at outflow of a source
Ctenidium molluscum (Hedw.) Mitt. – 2, 6, 11, 14: limestone rock; 5: in alpine grassland
Dichodontium pellucidum (Hedw.) Schimp. – 9: at outflow of a source
Dicranella varia (Hedw.) Schimp. – 2: at the lakeshore; 6: limestone rock; 9: at outflow of a source
Dicranum scoparium Hedw. – 1, 3: on soil; 4: siliceous rock; 7: *Quercus* bark; 10: in acidic grassland; 11: limestone rock; 14: on soil among limestone rocks
Didymodon fallax (Hedw.) R. H. Zander – 5: in alpine grassland; 11: limestone rock
Didymodon insulanus (De Not.) M. O. Hill – 2, 6: limestone rock; 8: schistose rock
Didymodon luridus Hornsch. – 1: limestone rock; 3: on soil, 8: schistose rock
Didymodon rigidulus Hedw. – 1, 6, 11: limestone rock; 2: limestone grassland
Didymodon spadiceus (Mitt.) Limpr. – 3: limestone rock in the water
Distichium capillaceum (Hedw.) Bruch et Schimp. – 5: in alpine grassland; 6, 11, 14: limestone rock
Ditrichum heteromallum (Hedw.) E. Britton – 14: on soil among siliceous rocks
Ditrichum pusillum (Hedw.) Hampe – 10: in acidic grassland
Drepanocladus aduncus (Hedw.) Warnst. – 4: in a wetland along a rivulet; 15: on the bank of lake
Encalypta alpina Sm. – 5: in alpine grassland
Encalypta rhaptocarpa Schwägr. – 5: in alpine grassland; 11: limestone rock
Encalypta streptocarpa Hedw. – 1: on soil; 5: in alpine grassland; 6, 11, 14: limestone rock
Encalypta vulgaris Hedw. – 5: in alpine grassland; 11: limestone rock
Eurhynchiastrum diversifolium (Schimp.) J. Guerra – 9: on soil; 11: limestone rock; 13: on soil along the road
Fissidens adianthoides Hedw. – 9: at outflow of a source; 12: in wetland
Fissidens bambergeri Schimp. ex Milde – 6: on soil
Fissidens bryoides Hedw. – 1: on soil
Fissidens dubius P. Beauv. – 2, 11: limestone grassland; 4: siliceous rock; 5: in alpine grassland; 6: limestone rock
Fissidens exilis Hedw. – 1: on soil
Fissidens taxifolius Hedw. – 1: limestone rock along a stream; 3: on soil; 11: limestone rock
Fissidens viridulus (Sw.) Wahlenb. – 9: on soil; 13: on soil along the road
Flexitrichum flexicaule (Schwägr.) Ignatov et Fedosov – 2: limestone grassland; 4: siliceous rock; 5: in alpine grassland; 14: on soil among limestone rocks
Flexitrichum gracile (Mitt.) Ignatov et Fedosov – 2, 6, 11: limestone rock; 5: in alpine grassland; 14: on soil among limestone rocks; 16: at a source
Grimmia alpestris (F. Weber et D. Mohr) Schleich. – 4, 14: siliceous rock
Grimmia anomala Hampe ex Schimp. – 4, 14: siliceous rock
Grimmia caespiticia (Brid.) Jur. – 4: siliceous rock
Grimmia decipiens (Schultz) Lindb. – 4: siliceous rock

- Grimmia laevigata* (Brid.) Brid. – 2: acidic rock
Grimmia muehlenbeckii Schimp. – 2: acidic rock; 4, 14: siliceous rock
Grimmia ovalis (Hedw.) Lindb. – 2: acidic rock; 4, 14: siliceous rock
Grimmia pulvinata (Hedw.) Sm. – 1: limestone rock
Gymnostomum aeruginosum Sm. – 6, 14: limestone rock
Hedwigia emodica Hampe ex Müll. Hal. – 2: acidic rock
Heterocladiella dimorpha (Brid.) Ignatov et Fedosov – 4: siliceous rock; 10: in acidic grassland
Homalothecium lutescens (Hedw.) H. Rob. – 3, 8: on soil
Homalothecium sericeum (Hedw.) Schimp. – 1: on soil and limestone rock along a stream; 4: siliceous rock; 5: in alpine grassland; 6, 11: limestone rock; 7: *Quercus* bark; 8: *Alnus* and *Ulmus* bark
Hygrohypnum luridum (Hedw.) Jenn. – 1, 3: limestone rock in the stream
Hylocomiadelphus triquetrus (Hedw.) Ochyra et Stebel – 10: in acidic grassland; 14: on soil among limestone rocks
Hylocomium splendens (Hedw.) Schimp. – 10: in acidic grassland; 14: on soil among limestone rocks
Hymenoloma crispulum (Hedw.) Ochyra – 4, 14: siliceous rock
Hypnum cupressiforme Hedw. – 1: on soil, decaying wood, *Fagus* bark; 2: acidic rock; 4: siliceous rock; 6, 11: limestone rock; 7: *Quercus* bark; 8: schistose rock
Hypnum cupressiforme Hedw. var. *lacunosum* Brid. – 2: limestone grassland; 10: in acidic grassland
Imbricbryum alpinum (Huds. ex With.) N. Pedersen – 4: in a wetland along a rivulet; 14: at a stream
Isothecium alopecuroides (Lam. ex Dubois) Isov. – 1: on soil
Kiaeria starkei (F. Weber et D. Mohr) I. Hagen – 14: siliceous rock
Lescuraea incurvata (Hedw.) E. Lawton – 5: in alpine grassland; 6, 9: limestone rock
Lescuraea patens Lindb. – 4: siliceous rock
Lescuraea plicata (Schleich. ex F. Weber et D. Mohr) Broth. – 5: in alpine grassland; 11: limestone rock
Lescuraea saviana (De Not.) E. Lawton – 4, 14: siliceous rock; 5: in alpine grassland; 6, 11: limestone rock
Lescurarea saxicola (Schimp.) Molendo – 11: limestone rock
Leucodon sciurioides (Hedw.) Schwägr. – 1: *Fagus* bark; 7: *Quercus* bark
Lewinskya affinis (Schrader ex Brid.) F. Lara, Garilleti et Goffinet – 1: *Fagus* bark; 7: *Juniperus* and *Quercus* bark; 8: *Alnus* bark
Lewinskya rupestris (Schleich. ex Schwägr.) F. Lara, Garilleti et Goffinet – 1: limestone rock; 2: acidic rock; 3: bark of *Castanea sativa*; 4: siliceous rock; 9: acidic rock
Lewinskya shawii (Wilson) F. Lara, Garilleti et Goffinet – 3: bark of *Castanea sativa*
Lewinskya speciosa (Nees) F. Lara, Garilleti et Goffinet – 7: *Quercus* bark; 8: *Alnus* bark
Lewinskya striata (Hedw.) F. Lara, Garilleti et Goffinet – 1: *Fagus* bark; 3: bark of *Castanea sativa*; 7: *Juniperus* and *Quercus* bark; 8: *Alnus* and *Salix* bark
Mnium lycopodioides Schwägr. – 14: on soil among limestone rocks
Mnium marginatum (Dicks.) P. Beauv. – 6, 11: limestone rock
Mnium spinulosum Bruch et Schimp. – 11: limestone rock
Mnium stellare Hedw. – 1: limestone rock along a stream; 6, 9: limestone rock; 13: on soil along the road; 14: on soil among limestone rocks
Mnium thomsonii Schimp. – 5: in alpine grassland; 11: limestone rock
Myurella julacea (Schwägr.) Schimp. – 5: in alpine grassland; 11: limestone rock
Neckera menziesii Drumm. – 1, 6, 11: limestone rock
Orthothecium intricatum (Hartm.) Schimp. – 6: limestone rock
Orthotrichum cupulatum Brid. – 1, 2, 9, 11, 14: limestone rock

- Orthotrichum pallens* Bruch ex Brid. – 3: *Populus* bark; 7: *Juniperus* and *Quercus* bark
Orthotrichum pumilum Sw. ex anon. – 8: *Alnus* bark
Orthotrichum schimperi Hammar – 8: *Salix* bark
Orthotrichum stramineum Hornsch. ex Brid. – 1: *Fagus* bark; 3: bark of *Castanea sativa*; 7: *Quercus* bark
Oxyrrhynchium bians (Hedw.) Loeske – 1: limestone rock along a stream; 3: on soil; 6: limestone rock; 8: on soil; 15: on the bank of lake
Oxyrrhynchium schleicheri (R. Hedw.) Röhl – 6: limestone rock
Palustriella commutata (Hedw.) Ochyra – 1, 3: limestone rock in the stream; 2: at the lakeshore; 4: in a wetland along a rivulet; 9: at outflow of a source; 12: in wetland; 16: at a source
Palustriella decipiens (De Not.) Ochyra – 4: in a wetland along a rivulet
Palustriella falcata (Brid.) Hedenäs – 3: limestone rock in the stream; 4: in a wetland along a rivulet; 12: in wetland; 16: at a source
Philonotis calcarea (Bruch et Schimp.) Schimp. – 2: at the lakeshore; 3: limestone rock in the water; 4: in a wetland along a rivulet; 9: at outflow of a source; 12: in wetland; 16: at a source
Philonotis fontana (Hedw.) Brid. – 12: in wetland; 14: at a stream; 16: at a source
Plagiomnium affine (Blandow ex Funck) T. J. Kop. – 3: on soil; 11: limestone rock
Plagiomnium elatum (Bruch et Schimp.) T. J. Kop. – 9: at outflow of a source; 12: in wetland
Plagiomnium ellipticum (Brid.) T. J. Kop. – 3: limestone rock in the water
Plagiomnium rostratum (Schr.) T. J. Kop. – 1: limestone rock along a stream; 6: limestone rock
Plagiomnium undulatum (Hedw.) T. J. Kop. – 1: limestone rock along a stream; 6: limestone rock
Plagiopus oederianus (Sw.) H. A. Crum et L. E. Anderson – 5: in alpine grassland; 6, 11, 14: limestone rock
Plagiothecium cavifolium (Brid.) Z. Iwats. – 9: limestone rock
Pogonatum aloides (Hedw.) P. Beauv. – 1, 2: on soil; 13: on soil along the road
Pohlia cruda (Hedw.) Lindb. – 5: in alpine grassland; 10: in acidic grassland; 13: on soil along the road; 14: on soil among limestone rocks
Pohlia melanodon (Brid.) A. J. Shaw – 8: schistose rock
Pohlia wahlenbergii (F. Weber et D. Mohr) A. L. Andrews – 3, 9: on soil
Polytrichastrum alpinum (Hedw.) G. L. Sm. – 2: on soil; 10: in acidic grassland; 13: on soil along the road
Polytrichum formosum Hedw. – 4: siliceous rock
Polytrichum juniperinum Hedw. – 2: limestone grassland; 4: siliceous rock; 5: in alpine grassland; 13: on soil along the road
Polytrichum piliferum Hedw. – 1: on soil; 4: siliceous rock
Pseudoleskeella catenulata (Brid. ex Schrad.) Kindb. – 2, 9, 11: limestone rock
Pseudoleskeella nervosa (Brid.) Nyholm – 9: limestone rock
Pseudoscleropodium purum (Hedw.) M. Fleisch. – 1, 3: on soil
Pseudostereodon procerrimus (Molendo) M. Fleisch. – 11: limestone rock
Pterigynandrum filiforme Hedw. – 1: limestone rock and *Fagus* bark; 4: siliceous rock; 6: limestone rock; 7: *Juniperus* and *Quercus* bark
Ptychostomum capillare (Hedw.) Holyoak et N. Pedersen – 1: on soil; 2: limestone grassland; 3: limestone rock in the water; 6: limestone rock; 8: schistose rock
Ptychostomum elegans (Nees in Brid.) D. Bell et Holyoak – 11: limestone rock
Ptychostomum imbricatum (Müll. Hal.) Holyoak et N. Pedersen – 2: limestone grassland; 8: schistose rock
Ptychostomum inclinatum (Sw. ex Brid.) J. R. Spence – 5: in alpine grassland; 11: limestone rock; 14: on soil among limestone rocks

- Ptychostomum moravicum* (Podp.) Ros et Mazimpaka – 4: siliceous rock; 8: schistose rock; 11: limestone rock
- Ptychostomum pallens* (Sw. ex anon.) J. R. Spence – 5: in alpine grassland; 11: limestone rock; 14: on soil among limestone rocks
- Ptychostomum pallescens* (Schleich. ex Schwägr.) J. R. Spence – 4: siliceous rock; 5: in alpine grassland; 9: on soil; 10: in acidic grassland; 11: limestone rock
- Ptychostomum pseudotriquetrum* (Hedw.) J. R. Spence et H. P. Ramsay ex Holyoak et N. Pedersen – 2, 15: at the lakeshore; 3: limestone rock in the water; 4: in a wetland along a rivulet; 9: at outflow of a source; 12: in wetland; 14: at a stream; 16: at a source
- Ptychostomum schleicheri* (DC.) J. R. Spence ex D. Bell et Holyoak – 12: in wetland
- Ptychostomum turbinatum* (Hedw.) J. R. Spence – 2: at the lakeshore; 11: limestone rock; 14: on soil among limestone rocks
- Pulvigeria lyellii* (Hook. et Taylor) Plášek, Sawicki et Ochyra – 3: bark of *Castanea sativa*; 7: *Quercus* bark
- Racomitrium canescens* (Hedw.) Brid. – 2, 11: limestone grassland; 4: siliceous rock; 8: schistose rock
- Racomitrium elongatum* Ehrh. ex Frisvoll – 2: acidic rock; 10: in acidic grassland
- Racomitrium sudeticum* (Funck) Bruch et Schimp. – 14: siliceous rock
- Rhizomnium punctatum* (Hedw.) T. J. Kop. – 1: limestone rock along a stream; 4: in a wetland along a rivulet; 9: at outflow of a source
- Rhynchostegium murale* (Hedw.) Schimp. – 6: limestone rock
- Rhynchostegium riparioides* (Hedw.) Cardot – 1, 3: limestone rock in the stream
- Saelania glaucescens* (Hedw.) Broth. – 5: in alpine grassland; 13: on soil along the road; 14: on soil among limestone rocks
- Sanionia uncinata* (Hedw.) Loeske – 10: in acidic grassland
- Schistidium apocarpum* (Hedw.) Bruch et Schimp. – 1: limestone rock
- Schistidium atrofusum* (Schimp.) Limpr. – 2: limestone grassland; 11: limestone rock
- Schistidium brunnescens* Limpr. subsp. *brunnescens* – 11: limestone rock
- Schistidium brunnescens* Limpr. subsp. *griseum* (Nees et Hornsch.) H. H. Blom – 11: limestone rock
- Schistidium confertum* (Funck) Bruch et Schimp. – 4, 14: siliceous rock; 5: in alpine grassland
- Schistidium crassipilum* H. H. Blom – 1, 6: limestone rock
- Schistidium papillosum* Culm. – 1, 4: siliceous rock
- Schistidium pruinatum* (Wilson ex Schimp.) G. Roth – 5: in alpine grassland; 10: in acidic grassland
- Schistidium rivulare* (Brid.) Podp. – 14: at a stream
- Sciuro-hypnum reflexum* (Starke) Ignatov et Huttunen – 9: limestone rock
- Seligeria pusilla* (Hedw.) Bruch et Schimp. – 6: limestone rock
- Streblotrichum convolutum* (Hedw.) P. Beauv. var. *commutatum* (Jur.) J. J. Amann – 2: limestone grassland
- Streblotrichum convolutum* (Hedw.) P. Beauv. var. *convolutum* – 1: on soil; 4: in a wetland along a rivulet; 11: limestone rock; 14: on soil among limestone rocks
- Syntrichia handelii* (Schiffn.) S. Agnew et Vondr. – 6, 11: limestone rock
- Syntrichia montana* Nees – 2: limestone rock; 8: schistose rock
- Syntrichia norvegica* F. Weber – 11: limestone rock; 14: siliceous rock
- Syntrichia ruralis* (Hedw.) F. Weber et D. Mohr – 1: *Fagus* bark; 4: siliceous rock; 7: *Quercus* bark; 9, 11: limestone rock
- Syntrichia subpapillosissima* (Bizot et R. B. Pierrot ex W. A. Kramer) M. T. Gallego et J. Guerra – 1, 6, 11: limestone rock; 4: siliceous rock; 5: in alpine grassland; 14: on soil among limestone rocks
- Syntrichia virescens* (De Not.) Ochyra – 7: *Quercus* bark
- Taxiphyllum wissgrillii* (Garov.) Wijk et Margad. – 1, 6: limestone rock

- Thamnobryum alopecurum* (Hedw.) Gangulee – 1: limestone rock along a stream; 6: limestone rock
Thuidium assimile (Mitt.) A. Jaeger – 3: on soil
Timmia austriaca Hedw. – 5: in alpine grassland; 6, 11: limestone rock
Timmia bavarica Hessel. – 6, 11: limestone rock
Tortella fasciculata (Culm.) Culm. – 2: limestone rock; 4: siliceous rock
Tortella inclinata (R. Hedw.) Limpr. – 2: limestone grassland; 14: on soil among limestone rocks
Tortella pseudofragilis (Thér.) Köckinger et Hedenäs – 11: limestone rock, 16: on rock at a source
Tortella tortuosa (Hedw.) Limpr. – 1: on soil and limestone rock along a stream; 2: limestone grassland; 4: siliceous rock; 5: in alpine grassland; 6, 11, 14: limestone rock
Tortula lindbergii Broth. – 8: schistose rock
Tortula muralis Hedw. – 1: limestone rock; 8: schistose rock
Tortula schimperii M. J. Cano, O. Werner et J. Guerra – 1: on soil
Tortula subulata Hedw. – 5: in alpine grassland; 6, 11: limestone rock; 8: schistose rock; 10: in acidic grassland; 14: on soil among limestone rocks
Trichostomum brachydontium Bruch – 2: limestone grassland
Trichostomum crispulum Bruch – 2: limestone grassland; 5: in alpine grassland; 6: limestone rock
Weissia condensata (Voit) Lindb. – 14: on soil among limestone rocks
Weissia controversa Hedw. – 1: on soil; 13: on soil along the road