

NEW BRYOPHYTE RECORDS FOR KOSOVO FROM SHARRI NATIONAL PARK

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Krasniqi, Z. & Marka, J.: New bryophyte records for Kosovo from Sharri National Park. *Nat. Croat.*, Vol. 30, No. 1, 13-25, 2021, Zagreb.

The bryoflora of Kosovo is poorly investigated. The aim of this study was to increase that knowledge by investigating *Sharri National Park* for its moss flora. Several field trips were carried out in 2014, 2015 and 2018. About 1900 specimens were collected in various locations of the Park (e.g. Brezovicë, Prevallë, Prroi i Duhlës, Ostrovicë, Restelicë, Mushtishtë, Pashallarë, Burimi i Lumbardhit etc.). Thus far, most of the specimens are identified and represent 159 moss taxa. Seventy-three taxa are new records for Sharri National Park, in which a total of 255 moss taxa have now been recorded. Furthermore, 19 species are new records for Kosovo, which is now known to have a total of 346 moss taxa. The new records are for *Amphidium lapponicum*, *Blindiadelphus recurvatus*, *Brachythecium geheebii*, *Dicranella schreberiana*, *Didymodon rigidulus*, *Grimmia dissimulata*, *G. muehlenbeckii*, *G. trichophylla*, *Kiaeria starkei*, *Paraleucobryum longifolium*, *Pohlia melanodon*, *Ptychostomum elegans*, *Racomitrium affine*, *R. lanuginosum*, *R. macounii* subsp. *alpinum*, *Rhynchostegium murale*, *Schistidium dupretii*, *Thamnobryum alopecurum* and *Weissia brachycarpa*. There is only one species, *Brachythecium geheebii*, which is a red list species at the European level. In addition, several species, e.g. *Grimmia caespiticia*, *G. reflexidens*, *Meesia uliginosa*, *Schistidium papillosum* etc. have conservation value in the context of the Balkans. All this shows for the enormous biodiversity values of Sharri National Park and the need for nature conservation through the institution.

Key Words: biodiversity, conservation, floristic survey, mosses, the Balkans

Krasniqi, Z. & Marka, J.: Novi nalazi mahovina s Kosova iz Nacionalnog parka Šar-planina. *Nat. Croat.*, Vol. 30, No. 1, 13-25, 2021, Zagreb.

Flora mahovina Kosova slabo je istražena. Cilj ovog rada je povećati to znanje istraživanjem flore mahovina Nacionalnog parka Šar-planina. Terenska istraživanja odvijala su se tijekom 2014., 2015. i 2018. godine. Prikupljeno je oko 1900 specimena na različitim lokacijama u Parku (npr. Brezovicë, Prevallë, Prroi i Duhlës, Ostrovicë, Restelicë, Mushtishtë, Pashallarë, Burimi i Lumbardhit itd.). Dosad je određena većina primjeraka, koji predstavljaju 159 svojiti mahovina. Od toga su 73 svojite nove za NP Šar-planina, za koji je sada poznato ukupno 255 svojiti mahovina. Osim toga, 19 vrsta su novi nalazi za Kosovo, za koje je sada poznato 346 svojiti mahovina. Novi nalazi su *Amphidium lapponicum*, *Blindiadelphus recurvatus*, *Brachythecium geheebii*, *Dicranella schreberiana*, *Didymodon rigidulus*, *Grimmia dissimulata*, *G. muehlenbeckii*, *G. trichophylla*, *Kiaeria starkei*, *Paraleucobryum longifolium*, *Pohlia melanodon*, *Ptychostomum elegans*, *Racomitrium affine*, *R. lanuginosum*, *R. macounii* subsp. *alpinum*, *Rhynchostegium murale*, *Schistidium dupretii*, *Thamnobryum alopecurum* i *Weissia brachycarpa*. Jedna je vrsta, *Brachythecium geheebii*, na Crvenoj listi na europskom nivou. Osim toga je nekoliko vrsta, *Grimmia caespiticia*, *G. reflexidens*, *Meesia uliginosa*, *Schistidium papillosum* itd., zaštićeno na razini Balkana. Sve to ukazuje na veliku biološku raznolikost NP Šar-planine, i potrebu za institucionalnom zaštitom.

Ključna riječ: biodiverzitet, zaštita, florističko istraživanje, mahovine, Balkan

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INTRODUCTION

The bryophyte flora of Kosovo is poorly known due to the low number of investigations and lack of local bryologists. A checklist of Kosovo bryoflora, based on a literature review, reported 331 taxa, 303 mosses and 28 liverworts (PANTOVIĆ & SABOVLJEVIĆ, 2017). It is worth mentioning that the above-mentioned figures are based on 13 literature sources and 1068 bryophyte records, which is patently a very low number. In addition, 24 new moss species were recently reported from Germia Regional Park in Pristina district (KRASNIQI & MARKA, 2018). Therefore, the total number of moss species (327) known for Kosovo is still very low considering the neighboring countries on one hand, and the presence of important mountain massifs (e.g. Bjeshkët e Nemuna/Prokletije and Sharri/Šar Planina), various climates and the diverse geology of bedrocks on the other (SABOVLJEVIĆ *et al.*, 2011; PANTOVIĆ & SABOVLJEVIĆ, 2017).

The Sharr Mountains have a remarkable biological diversity (IKMN, 2005; MMPH, 2014; MUSTAFA *et al.*, 2018). The flora and vegetation are rich in species. Of these species, 86 are deemed of international importance, 26 are listed on the European Red List of Endangered Animals and Plants, and 32 are on the IUCN Red List of Threatened Plants (IUCN, 1990). A part of the Sharr Mountains was declared a National Park in 1986 (IKMN, 2005). According to IUCN the Sharr Mountains are listed on the international list of protected areas (IKMN, 2005).

The Sharr Mountains have been investigated for bryophytes by MARTINČIĆ (1980) and by SABOVLJEVIĆ (1998), with 182 taxa reported so far. Overall it should be considered underexplored and further investigations should be encouraged. Therefore, the aim of this study is to increase the knowledge on moss flora in the area of the Sharr Mountains.

MATERIAL AND METHODS

Several field trips were carried out in the Sharri Mountains in 2014, 2015 by the first author and in 2018 by both authors and *ca.*1900 specimens of mosses were collected at various sites (Tab. 1, Fig. 1) and on different ecological substrates. Most of the specimen identification was performed jointly by the contributors during visits of the first author to Tirana University. The voucher specimens are stored in the herbarium collection at Faculty of Education, Hasan Prishtina University, in Pristina. The nomenclature of the taxa is based on HODGETTS *et al.* (2020), floristic elements on SMITH (2004) and red-list comments and distribution in the Balkans on HODGETTS & LOCKHART (2020). The abbreviations used for conservation status are: CR – critically endangered, EN – endangered and VU – vulnerable.

Sharr Mountains

The protected area of the Sharri Mountains extends over 39,000 ha and lies within the boundaries of four municipalities: Prizren, Shtërpçë, Therandë and Kaçanik (IKMN, 2005). The highest peak is Luboteni peak at 2496 m above sea level. The Sharri Mountains have natural heritage values according the criteria of the World Heritage Convention (MUSTAFA *et al.*, 2018).

Geomorphology – The morphological formation of the Sharri Mountains has been influenced by the tectonic movements of the land which have created geomorphologic compressions, as well as external forces which have had an impact on glaciers,

water courses etc. As a result of the glacial action, depths have been created which have later been transformed into glacial lakes such as Meadow Lake, Jazhinca Lake and other very attractive lakes which are popularly known as the “Eyes of the Mountains”. Various rock types took part in the geological formation of Sharr Mountains during the Paleozoic period, e.g. limestone rocks, silicate, marble etc. (IKMN, 2005; MMPH/AMMK, 2013; MMPH, 2014). The Sharr Mountains contain eight features related to glacial relief and three additional features related to pre-glacial relief (MUSTAFA *et al.*, 2018).

Climate – The area has a continental climate characterized by long winters, with heavy snowfall and cool summers. The average annual temperature for the Sharri Mountains at two meteorological stations (the North Macedonia and the Kosovo side) is 8.4°C; with January being the coldest month at 1.8 and –1.3 °C for the two stations, respectively. The annual relative air humidity is about 67–70% for both stations with average rainfalls from 670 to 1200 mm. Wind velocities range from 1 to 16m/s, with the south, southwest and southeast winds dominating (IKMN, 2005; MMPH/AMMK, 2013; MMPH, 2014).

Hydrology – As a result of frequent rainfall, the Sharr Mountains region is extremely rich in waters that encompass a large number of lakes of glacial origin, springs and streams of several rivers. There are outflows of two rivers in the territory of the Sharr Mountains – the Lepenci and the Lumbardhi of Prizren. The Lepenci is formed by the confluence of water courses emanating from the mountains of Cerevc and Jezerc and in its course it receives water from numerous tributaries. Prizren’s Lumbardhi rises in the Prevala region, on the slopes of Mount Bistrica, which also collects many water courses rich in water. It has a length of 31 km and the catchment area is 266 km² (PASHA, 1975; LABUS, 1979). There are 25 lakes in the territory of the Sharr Mountains at 1900 m above sea level, which represent the special natural values of the Sharr Massif (IKMN, 2005; MMPH/AMMK, 2013; MMPH, 2014).

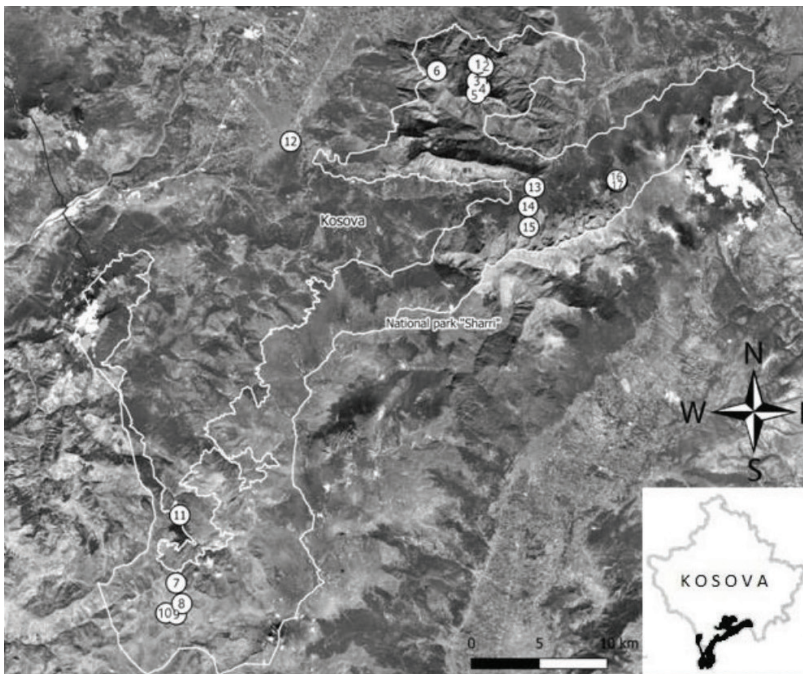
Landscape and vegetation – The Sharr Mountains are distinguished for their alpine scenery and by diverse natural values (ÇAVOLLI & GASHI, 1979; MUSTAFA *et al.*, 2018). Attractive landscapes consist of forests, pastures, meadows accompanied with fallen branches, often created by forest cuttings, through which pass rivers and streams, canyon-like places and gorges with waterfalls or lakes, contributing to the pleasant experience to be had in this beautiful natural setting (IKMN, 2005; MMPH/AMMK, 2013; MMPH, 2014). The Sharr Mountains have a rich flora, with about 2000 plant species and 68 plant associations known thus far – with endemics, relicts and endangered species. Particularly to be mentioned are the forest associations of *Pinus heildreichii*, *P. peuce*, *P. mugo*, *Acer heildreichii*, *Taxus baccata*, *Rhododendron ferrugineum* etc. (IKMN, 2005). Furthermore, 3 endemic or endemic-relict plant associations, are found in the Sharr Mountains (grassland associations: *Achilleoalexandri-regis-Onobrychietum scardicae*, *Sedo-Bornmullerietum dieckii*, and *Potentillo doerfleri-Juncetum trifidi*) (MUSTAFA *et al.*, 2018).

RESULTS AND DISCUSSION

In total 159 moss taxa were recorded during our field trips in the Sharr Mountains. In this section only the species which are new for Kosovo are listed and those which have conservation interest in the Balkans. Each species is followed by numbers that correspond to the collection sites. The complete list of the species and their occurrence in the study area is given in the Appendix.

Tab. 1. List of collection sites and representative coordinates.

| Site | Name | Altitude | Coordinates | Date |
|------|--------------------------------|----------|----------------------------|-------------------------------|
| 1. | Stanet e Mushtishtit | 1418 m | 42° 15.607'N, 20° 54.745'E | 09/08/2014 |
| 2. | Stanet e Mushtishtit | 1523 m | 42° 15.490'N, 20° 55.050'E | 09/08/2014 |
| 3. | Pashallare | 1746 m | 42° 14.920'N, 20° 54.690'E | 09/08/2014 |
| 4. | Pashallare | 1802 m | 42° 14.640'N, 20° 54.900'E | 09/08/2014 |
| 5. | Pashallare | 2029 m | 42° 14.434'N, 20° 54.665'E | 09/08/2014 |
| 6. | Ostrovicë | 1828 m | 42° 15.323'N, 20° 52.554'E | 09/08/2014 |
| 7. | Restelicë | 1958 m | 41° 55.060'N, 20° 38.716'E | 01/08/2015 |
| 8. | Restelicë | 1851 m | 41° 54.248'N, 20° 39.021'E | 01/08/2015 |
| 9. | Restelicë | 1847 m | 41° 53.820'N, 20° 38.731'E | 01/08/2015 |
| 10. | Restelicë | 1813 m | 41° 53.873'N, 20° 38.175'E | 01/08/2015 |
| 11. | Krushevë – Restelicë | 1250 m | 41° 57.744'N, 20° 38.894'E | 01/08/2015 |
| 12. | Kalaja e Prizrenit | 521 m | 42° 12.522'N, 20° 44.734'E | 15/08/2014 |
| 13. | Prevallë (Gryka e Lumbardhit) | 1585 m | 42° 10.730'N, 20° 57.779'E | 15/08/2014; 01, 02/10/2018 |
| 14. | Prevallë (Burimi i Lumbardhit) | 1560 m | 42° 9.968'N, 20° 57.440'E | 15, 18/08/2014 |
| 15. | Bistra | 1853 m | 42° 9.156'N, 20° 57.485'E | 02/10/2018 |
| 16. | Prroi i Durlës | 1737 m | 42° 11.012'N, 21° 2.175'E | 05/08/2014, 30/09/2018 |
| 17. | Brezovica | 1757 m | 42° 10.947'N, 21° 2.198'E | 05/08/2014 |

**Fig. 1.** Sharri Mountains National Park Kosovo; the numbers indicate the localities explored and correspond with numbers in Tab. 1. Adapted from Google Maps 2019.

New moss species for Kosovo

Amphidium lapponicum (Hedw.) Schimp. – 13: on basic rock crevices. This Circumpolar Boreo-arctic Montane species is recorded in several countries of Balkan Peninsula, except for Croatia, Greece and Montenegro, mainly in high mountains. It was recently recorded in northern Albania (MARKA *et al.*, 2018) near the border with Montenegro. Its distribution in the Balkans is the southern limit of its distribution in SE Europe, its populations are rare and, therefore, it is red listed for Romania (CR) and Bulgaria (VU), and data deficient for Serbia and Slovenia.

Blindiadelphus recurvatus (Hedw.) Fedosov & Ignatov – 16: on acidic rock. This European Boreo-temperate species is reported from many Balkan countries, except for North Macedonia and Serbia. It is red listed for Slovenia (EN) and data deficient for Albania.

Brachythecium geheebii Milde – 13, 14, 16: on acidic rocks. This European endemic species is recorded in all countries of the Balkan Peninsula in the high mountains. *B. geheebii* is a European red-list species (VU). In addition, in the Balkans it is red listed for Bulgaria (EN) and Romania (CR), near threatened for Slovenia and data deficient for Albania.

Dicranella schreberiana (Hedw.) Dixon – 13: in basic humid rock. This Circumpolar Boreo-temperate species is recorded in many countries of the Balkan Peninsula, except for Albania and North Macedonia. It is data deficient for Montenegro, Serbia and Slovenia.

Didymodon rigidulus Hedw. – 2, 10, 11, 16: on basic rocks, a spring. This Circumpolar Boreo-temperate species is very common and widespread in the Balkans.

Grimmia dissimulata E.Maier – 14, 15, 16: on basic rocks. This species was described in 2002 (MAIER, 2002); its occurrence seems to be very common in the Balkans.

Grimmia muehlenbeckii Schimp. – 7, 14, 16: on acidic rocks. This species, closely related with *G. trichophylla*, usually occurs in the montane and alpine areas of the Balkans. It is not yet known only from Bosnia & Herzegovina, it is red-listed for both Bulgaria and Romania (VU) and data deficient for Montenegro and Slovenia.

Grimmia trichophylla Grev. – 12, 14, 16: on siliceous rocks. This Circumpolar Wide-temperate species is present in all countries of Balkan Peninsula, typically in acidic rocks, and red listed for Romania (EN).

Kiaeria starkei (F.Weber & D.Mohr) I.Hagen – 14: on siliceous rock. This Circumpolar Arctic-montane species is reported from high mountains of several Balkan countries, except for Croatia, Greece, North Macedonia and Serbia. It is red listed for Slovenia (EN) and data deficient for Montenegro.

Paraleucobryum longifolium (Hedw.) Loeske – 16: on acidic rock. This Circumpolar Boreal-montane species is reported from all Balkan countries, it is red listed for Serbia (VU) and data deficient for Albania.

Pohlia melanodon (Brid.) A.J.Shaw – 17: on basic soil. This Circumpolar Southern-temperate species is reported in all Balkan countries and red listed for Slovenia (EN).

Ptychostomum elegans (Nees in Brid.) Holyoak – 13, 16: on humid basic rocks. This European Boreal-montane species is recorded in all Balkan countries. It is red-listed for both Bulgaria and Slovenia (VU).

Racomitrium affine (F.Weber & D.Mohr) Lindb. – 4, 14, 16: on acidic rocks. This Circumpolar Boreo-temperate element is reported from many Balkan countries, except for Bosnia & Herzegovina and North Macedonia, apparently much less frequently than *R. sudeticum*; and red listed for Bulgaria (VU) and data deficient for Montenegro.

Racomitrium lanuginosum (Hedw.) Brid. –14, 15, 16: on acidic rocks. This Circumpolar Boreo-arctic Montane species is reported from several Balkan countries, except for Albania, Croatia and North Macedonia. However, its threat status is not very well known in the Balkans.

Racomitrium macounii subsp. *alpinum* (E.Lawton) Frisvoll – 14: on acidic rock. This European Boreal-montane element is reported in the Balkans only from Bulgaria and Romania (*R. macounii* subsp. *macounii* for both countries, and *R. macounii* subsp. *alpinum* doubtfully reported for Bulgaria), and red listed for both countries (respectively VU and CR).

Rhynchostegium murale (Hedw.) Schimp. – 6: on beech cortex. This European-temperate element is reported and common in all Balkan countries.

Schistidium dupretii (Thér.) W.A.Weber – 5, 12, 13, 16: on silicate rocks. This Circumboreal-montane species is recorded from several Balkan countries, except for Bosnia & Herzegovina and Bulgaria, and it is data deficient for Montenegro.

Thamnobryum alopecurum (Hedw.) Gangulee – 13: on limestone rock in a stream. This European Temperate element is reported and common in all Balkan countries.

Weissia brachycarpa (Nees & Hornsch.) Jur. – 5: on acidic rock crevices. This Circumpolar Southern-temperate is reported and common in all Balkan countries.

Taxa of conservation interest in the Balkan context

There are several more taxa, some of them formerly European red list candidates (HODGETTS, 2015), which however do have conservation value in the Balkan context.

Distichium inclinatum (Hedw.) Bruch & Schimp. – 13: on calcareous rock. This Circumpolar Boreo-arctic Montane element is previously recorded for the Sharri Mountains in two locations (MARTINČIĆ, 1980). It is recorded from all Balkan countries and red listed (VU) for Bulgaria.

Grimmia caespiticia (Brid.) Jur. –14, 15, 16: on acidic rocks. This Eurosiberian Boreo-arctic Montane element is a new record from Sharri Mountains, meanwhile for Kosovo it has been previously reported from Bjeshkët e Nemuna (Prokletije) in two different localities, respectively in Mt. Gjeravica (Djeravica) and Bistrica (Lumbardhi i Deçanit) (MARTINČIĆ, 2006). *G. caespiticia* is reported from several Balkan countries, except for Bosnia & Herzegovina, Croatia and Slovenia. It has been recently reported from Albania (MARKA, 2018). It is red listed for Montenegro (VU), Romania (CR) and Serbia (VU).

Grimmia reflexidens Müll. Hal. – 14: on acidic rock. This Subarctic-subalpine element is previously reported only from one locality from the Sharri Mountains (SABOVLJEVIĆ, 1998). It is known from several Balkan countries, excluding Bosnia & Herzegovina, Croatia and Slovenia, and it is red listed for Romania (EN) and data deficient for Albania and Montenegro.

Kiaeria starkei – see notes for this species on the previous section of new records for Kosovo.

Lescuraea mutabilis (Brid.) Lindb. ex I.Hagen – 6, 15, 16: on acidic rock, on beech bark. This Circumpolar Boreal-montane element was previously recorded for Sharri Mountains in two locations (MARTINČIĆ, 1980) and (SABOVLJEVIĆ, 1998). It is recorded from all Balkan countries and red listed (VU) for both Bulgaria and Romania.

Lescuraea radicata (Mitt.) Mönk. – 6, 12, 14: on acidic rock, on beech bark. This species has previously been recorded for Sharri Mountains in two locations (MARTINČIĆ, 1980; SABOVLJEVIĆ, 1998). It is recorded from many Balkan countries, but not for Bosnia & Herzegovina and Croatia, and is near threatened for Bulgaria and Romania.

Lescuraea saxicola (Schimp.) Molendo – 6: on rock. This Circumpolar Boreal-montane element is recorded for the first time for the Sharri Mountains. It is recorded from many Balkan countries, but not for Bosnia & Herzegovina and Croatia, and is red listed (VU) for Bulgaria, Romania and Slovenia.

Meesia uliginosa Hedw. – 14: on calcareous rock. This Circumpolar Boreo-arctic Montane element is previously recorded for Sharri Mountains in two different localities (MARTINČIĆ, 1980). It is known from many Balkan countries, but not for Albania and Serbia, and it is red listed for both Bulgaria and Montenegro (VU).

Oligotrichum hercynicum (Hedw.) Lam. & DC. – 14, 15, 16: on acidic soil. This Circumpolar Boreo-arctic Montane element was previously recorded for Sharri Mountains in one locality (MARTINČIĆ, 1980). It is recorded from several Balkan countries, but not for Albania, Croatia, Greece and Montenegro, and is red listed (VU) for Serbia.

Palustriella decipiens (De Not.) Ochyra – 2, 3, 4, 7, 16: on silicate rocks near the stream. This European Boreo-arctic Montane element is previously recorded for Sharri Mountains in two localities (MARTINČIĆ, 1980; SABOVLJEVIĆ, 1998). It is recorded from many Balkan countries, but not for Croatia, and is red listed (VU) for Bulgaria. However, *P. decipiens* and the next two following species are threatened, since as wetland species their habitats are very threatened in the Balkans by climate change.

Philonotis seriata Mitt. – 7, 8, 9, 10, 14, 15, 16: on wet acidic rocks. This Eurosiberian Boreo-arctic Montane element has previously been recorded for the Sharri Mountains (RANDELOVIĆ *et al.*, 1998). It is recorded from Balkan countries, except for Croatia, and is red listed (EN) for Slovenia.

Rhizomnium pseudopunctatum (Bruch & Schimp.) T.J.Kop. – 14, 16: on wet rock. This Circumpolar Boreal-montane element has previously been recorded for the Sharri Mountains (SABOVLJEVIĆ, 1998). It is recorded from many Balkan countries, though not for Croatia and Greece, and data deficient for Bulgaria.

Schistidium papillosum Culm. – 14: on acidic rock. This Circumpolar Boreo-arctic Montane element was previously recorded for Sharri Mountains in one locality (MARTINČIĆ, 1980). It is recorded from many Balkan countries, but not for Bosnia & Herzegovina and Croatia, and is data deficient for Albania, Bulgaria, Montenegro and Slovenia.

Sciuro-hypnum starkei (Brid.) Ignatov & Huttunen – 14, 16: on basic rock. This Circumpolar Boreal-montane element has now been recorded for the first time for the Sharri Mountains. It is recorded from all Balkan countries and is red listed (VU) for Bulgaria, near threatened for Romania and data deficient for Montenegro.

Timmia norvegica J.E.Zetterst. – 13: on limestone rock. This Circumpolar Boreo-arctic Montane element has been recorded now for the first time for Sharri Mountains. It is recorded from Albania, Bulgaria, Bosnia & Herzegovina and Romania, and it is red listed (CR) for Bulgaria and (VU) for Romania.

CONCLUSIONS

Of the 159 species found in the Sharr Mountains, 73 species are reported for the first time for the range. And 19 of them are reported as new for Kosovo. Hence, with this study the number of moss species in the Sharr National Park rises to 255 and the number of moss species in Kosovo to 346. There is only one species, *Brachythecium geheebii*, which is a red list species (VU) at the European level. In addition, several species, e.g. *Grimmia caespiticia*, *G. Reflexidens*, *Lescuraea mutabilis*, *L. Saxicola*, *Meesia uliginosa*, *Oligotrichum hercynicum*, *Palustriella decipiens*, *Schistidium papillosum*, *Timmia norvegica* etc. Have conservation value in the context of the Balkans. All this shows the enormous biodiversity values of Sharri National Park and the need for nature conservation by institutions and authorities.

ACKNOWLEDGMENTS

The authors are grateful to Mr. Xhavit Malaj, from the Directorate of Sharr National Park, for being a field guide during all the field trips. The first author is grateful to the Department of Biology (Faculty of Natural Sciences, University of Tirana) for permission to use facilities and labs during research visits. Finally, the authors are also grateful to the anonymous reviewers for their valuable suggestions on improving the manuscript.

Received March 24, 2020

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APPENDIX 1.

Full list of 159 taxa recorded. Given for each species is the distribution in the study area and the substrate. Furthermore, symbols indicate the following: * – new reports for Kosovo, ** – new records for Sharri.

Abietinella abietina (Hedw.) Fleisch. – 12, 13, 16: on soil and basic rocks.

**Amphidium lapponicum* (Hedw.) Schimp. – 13: on basic rock crevices.

***Amphidium mougeotii* Bruch & Schimp. – 14: on acidic rock.

Andreaea rupestris Hedw. – 14: on siliceous rock.

***Antitrichia curtispindula* Timm ex Hedw.) Brid. – 13: on basic rock.

***Atrichum undulatum* (Hedw.) P. Beauv. – 10, 13, 16: on wet basic rocks and wet soil.

***Barbula unguiculata* Hedw. – 7: on limestone rock.

Bartramia halleriana Hedw. – 13, 16: on wet rock, on basic rock.

Bartramia ithyphylla Brid. – 15, 16: on shaded basic rocks.

Bartramia pomiformis Hedw. – 7, 8, 9, 10, 11: on acidic rocks.

***Blindia acuta* (Hedw.) Bruch & Schimp. – 13, 14, 15: on wet basic rocks.

***Blindia delphus recurvatus* (Hedw.) Fedosov & Ignatov. – 16: on acidic rock.

Brachytheciastrum velutinum (Hedw.) Schimp. – 3, 4, 5, 6, 13, 14, 15, 16: on soil, stone and basic rocks, beech bark.

***Brachythecium albicans* (Hedw.) Schimp. – 3, 4, 5, 13, 14, 15: on soil, on silicate rocks.

**Brachythecium geheebii* Milde – 13, 14, 16: on acidic rocks.

Brachythecium glareosum (Spruce) Schimp. – 3, 4, 5, 8, 9, 10, 11, 13, 16: on soil and basic rocks.

Brachythecium mildeanum (Schimp.) Schimp. – 16: on basic rock in stream.

Brachythecium rivulare Schimp. – 7, 8, 9, 10, 11, 13, 14, 15, 16: on wet basic rocks alongside streams.

***Brachythecium rutabulum* (Hedw.) Schimp. – 5, 13, 16: on rocks alongside streams and wet basic rocks.

***Brachythecium salebrosum* (Hoffm. ex F.Weber & Mohr) – 16, 17: on rocks.

***Brachythecium tommasinii* (Sendtn. ex Boulay) Ignatov & Huttunen – 1, 2, 13, 14, 15, 16, 17: on soil and rocks.

Calliergonella cuspidata (Hedw.) Loeske – 7, 8, 9, 10, 11, 13, 14, 15: on stream and wet rocks.

Campylium protensum (Brid.) Kindb. – 15, 16: wet limestone rock, near and on the stream.

Campylium stellatum (Hedw.) Lange & C.E.O. Jensen – 13, 14, 15, 16: wet rock, near streams, on soil.

***Campylophyllopsis calcarea* (Crundw. & Nyholm) Hedenäs – 16: on limestone rock.

Campylophyllum halleri (Hedw.) M.Fleisch. – 9: on wet basic rock near stream.

Ceratodon purpureus (Hedw.) Brid. – 7, 8, 11, 14, 16: on soil, on acidic rocks.

Cirriphyllum crassinervium (Taylor) Loeske & M.Fleisch. – 16: on basic rock.

***Cirriphyllum piliferum* (Hedw.) Grout – 14, 15, 16: on wet rock, on basic rock.

Climacium dendroides (Hedw.) F.Weber & D.Mohr. – 14, 15, 16: on poor soil, on wet basic rock.

Cratoneuron filicinum (Hedw.) Spruce – 3, 4, 5, 13, 14, 16: on wet basic rocks.

***Dichodontium pellucidum* (Hedw.) Schimp. – 6, 7, 14, 16: on wet rock, on basic rock.

**Dicranella schreberiana* (Hedw.) Dixon – 13: in basic humid rock.

Dicranum scoparium Hedw. – 1, 2, 3, 4, 5, 12, 13, 14, 15, 16: on rock, on silicate rock.

***Dicranum tauricum* Sapjegin – 16: on pine bark.

***Didymodon acutus* (Brid.) K.Saito – 16: basic rock.

***Didymodon luridus* Hornsch – 14: on calcareous rock.

**Didymodon rigidulus* Hedw. – 2, 10, 11, 16: on basic rocks, fountain.

***Didymodon vinealis*, (Brid.) R.H.Zander – 14: on basic rock.

Distichium capillaceum (Hedw.) Bruch & Schimp. – 7, 13: on calcareous rock.

Distichium inclinatum (Hedw.) Bruch & Schimp. – 13: on calcareous rock.

Encalypta streptocarpa Hedw. – 13: on calcareous rock.

Encalypta vulgaris Hedw. – 12: on calcareous rock.

***Eurhynchiastrum diversifolium* (Schimp.) J. Guerra – 7, 16: on calcareous rock.

***Eurhynchiastrum pulchellum* (Hedw.) Ignatov & Huttunen – 16: on rock.

***Fissidens taxifolius* Hedw. – 14: on rock crevices.

***Flexitrichum gracile* (Mitt.) Ignatov & Fedoso – 8, 9, 14, 16: on rock.

- ***Funaria hygrometrica*** Hedw. – 5: on rock.
- ***Grimmia alpestris*** (F.Weber & D.Mohr) Schleich. – 5, 16: on acidic rock.
- ***Grimmia caespiticia*** (Brid.) Jur. – 14, 15, 16: on siliceous rock.
- **Grimmia dissimulata*** E. Maier – 14, 15, 16: on basic rocks.
- ***Grimmia hartmanii*** Schimp. – 1, 2, 3, 4, 5, 12, 13, 14, 15, 16, 17: on rocks and stones.
- ***Grimmia montana*** Bruch & Schimp. – 14, 16: on acidic rock.
- **Grimmia muehlenbeckii*** Schimp. – 7, 14, 16: on acidic rocks.
- ***Grimmia ovalis*** (Hedw.) Lindb. – 3, 4, 5, 6, 13, 14, 15, 16: on acidic rocks.
- ***Grimmia pulvinata*** (Hedw.) Sm. – 16: on basic rock.
- Grimmia ramondii*** (Lam. & DC.) Margad – 14, 15, 16: on acidic rock.
- Grimmia reflexidens*** Müll. Hal. – 14: on acidic rock.
- **Grimmia trichophylla*** Grev. – 12, 14, 16: on siliceous rocks.
- ***Gymnostomum calcareum*** Nees & Hornsch. – 14: on wet soil, on calcareous rock.
- ***Hedwigia ciliata*** (Hedw.) P.Beauv. – 9, 16: on wet acidic rock.
- Heterocladiella dimorpha*** (Brid.) Ignatov & Fedosov. – 7, 13, 14: on acidic rock, on soil.
- Homalothecium lutescens*** (Hedw.) H. Rob. – 1, 12, 16: on soil, on beech bark.
- Homalothecium philipeanum*** (Spruce) Schimp. – 2, 6: on basic rock, on beech bark.
- ***Homalothecium sericeum*** (Hedw.) Schimp. – 1, 6, 12: on beech bark.
- Hygrohypnum luridum*** (Hedw.) Jenn. – 7: on wet basic rock.
- Hylocomiadelphus triquetrus*** (Hedw.) Ochyra & Stebel – 7, 16: on rock.
- Hylocomium splendens*** (Hedw.) Schimp. – 14, 16: on rock.
- Hymenoloma crispulum*** (Hedw.) Ochyra – 5, 7, 12, 14, 15, 16: on acidic rock.
- Hypnum cupressiforme*** Hedw. – 12: on rock.
- Hypnum resupinatum*** Taylor. – 16: on wet rock.
- Imbricbryum alpinum*** (Huds. ex With.) N. Pedersen – 5, 16: on rock.
- Isothecium alopecuroides*** (Lam. ex Dubois) Isov. – 5, 13, 14, 15, 16: on wet and dry rocks.
- **Kiaeria starkei*** (F. Weber & D. Mohr) I. Hagen – 14: on siliceous rock.
- Lescuraea incurvata*** (Hedw.) E. Lawton – 5, 6, 7, 14, 16: on rock, on beech bark.
- Lescuraea mutabilis*** (Brid.) Lindb. ex I.Hagen – 6, 15, 16: on acidic rock, on beech bark.
- ***Lescuraea patens*** Lindb. – 13, 14: on basic rock.
- Lescuraea plicata*** (Schleich. ex F.Weber & D. Mohr) Broth. – 13, 14, 15, 16: on rock.
- Lescuraea radicata*** (Mitt.) Mönk. – 6, 12, 14: on acidic rock, on beech bark.
- ***Lescuraea saviana*** (De Not.) E. Lawton – 1, 6, 14, 15, 16: on basic rock, on beech bark.
- ***Lescuraea saxicola*** (Schimp.) Molendo – 6: on rock.
- Leucodon sciuroides*** (Hedw.) Schwägr. – 1, 2, 5, 6, 12, 16: on rock, on beech bark.
- ***Lewinskya speciosa*** (Nees) F. Lara, Garilleti & Goffinet – 13: on beech trunk.
- ***Lewinskya striata*** (Hedw.) F. Lara, Garilleti & Goffinet – 6, 14, 17: on beech and oak bark.
- Meesia uliginosa*** Hedw. – 16: on calcareous rock.
- Mnium thomsonii*** Schimp. – 16: on calcareous rock.
- Oligotrichum hercynicum*** (Hedw.) Lam. & DC. – 14, 15, 16: on acidic soil.

- ***Orthotrichum anomalum*** Hedw. – 5: on limestone rock.
- ***Orthotrichum cupulatum*** Hoffm. ex Brid. – 14: on limestone rock.
- Orthotrichum stramineum* Hornsch. ex Brid. – 6, 13, 14, 15: on beech and willow bark.
- Oxyrrhynchium schleicheri* (R. Hedw.) Röhl – 13: on soil.
- Palustriella commutate* (Hedw.) Ochyra – 14, 15, 16: on wet rock near the stream, on humid soil.
- Palustriella decipiens* (De Not.) Ochyra – 2, 3, 4, 7, 16: on silicate rock near the stream.
- Palustriella falcata* (Brid.) Hedenäs – 7, 8, 9, 10, 16: on wet rock near the stream.
- **Paraleucobryum longifolium*** (Hedw.) Loeske – 16: on acidic rock.
- Philonotis calcarea* (Bruch & Schimp.) Schimp. – 7, 16: on wet rock.
- Philonotis fontana* (Hedw.) Brid. – 7: wet rock.
- Philonotis seriata* Mitt. – 7, 8, 9, 10, 14, 15, 16: on wet acidic rock.
- Plagiomnium elatum* (Bruch & Schimp.) T. J. Kop. – 16: on wet rock.
- Plagiomnium undulatum* (Hedw.) T.J.Kop. – 13, 16: on wet rock and soil.
- Plagiopus oederianus* (Sw.) H.A.Crum & L.E.Anderson – 14: on calcareous rock.
- ***Plagiothecium denticulatum*** (Hedw.) Schimp. – 13, 14, 16: on rock, on rock by the stream.
- ***Plagiothecium laetum*** Schimp. – 13, 16: on rock, on rock by the stream.
- Plagiothecium nemorale* (Mitt.) A. Jaeger – 12, 13, 14: on rock, on rock by the stream.
- Pleurozium schreberi* (Willd. ex Brid.) Mitt. – 14: on soil.
- Pogonatum aloides* (Hedw.) P. Beauv. – 16: on acidic soil.
- Pogonatum urnigerum* (Hedw.) P. Beauv. – 14, 15, 16, 17: on rock, on acidic soil.
- Pohlia cruda* (Hedw.) Lindb. – 7, 13, 14, 16: on shaded rock, on acidic soil.
- **Pohlia melanodon*** (Brid.) A. J. Shaw – 17: on soil.
- Polytrichastrum alpinum* (Hedw.) G. L. Sm. – 7, 14, 16: acidic rock, wet rock.
- Polytrichum commune* Hedw. – 13, 14, 16: on rock.
- Polytrichum formosum* Hedw. – 3, 4, 7, 8, 14: on silicate rock.
- Polytrichum juniperinum* Hedw. – 3, 4, 5, 7, 13, 16, 17: on acidic rock.
- Polytrichum piliferum* Hedw. – 5, 8, 14, 16: on acidic rock.
- Pseudoleskeella nervosa* (Brid.) Nyholm. – 1, 2, 3, 4, 5, 13, 14, 15, 16: on beech and oak bark, on calcareous rock.
- Pterigynandrum filiforme* Hedw. – 1, 2, 5, 6, 13, 16: on beech and oak bark, on rock.
- ***Ptychostomum capillare*** (Hedw.) Holyoak & N. Pedersen – 6, 14, 15: on rock.
- **Ptychostomum elegans*** (Nees) D. Bell & Holyoak – 13, 16: in humid basic rocks.
- ***Ptychostomum moravicum*** (Podp.) Ros & Mazimpaka – 13, 16: on beech and *Platanus* bark, on rock.
- Ptychostomum pseudotriquetrum* (Hedw.) J. R. Spence & H. P. Ramsay ex Holyoak & N. Pedersen – 5, 7, 16, 17: on wet basic rocks.
- ***Ptychostomum pseudotriquetrum*** var. *bimum* (Schreb.) Holyoak & N. Pedersen – 13: on wet rock.
- Ptychostomum schleicheri* (DC.) J. R. Spence ex D. Bell & Holyoak – 7, 8, 9, 10, 11, 16: on stream and wet rocks.
- ***Racomitrium aciculare*** (Hedw.) Brid. – 14, 17: on rock, on rock in the stream.

- **Racomitrium affine* (F. Weber & D. Mohr) Lindb. – 4, 14, 16: on acidic rocks.
Racomitrium canescens (Hedw.) Brid. – 4, 5, 14, 16: on rock, on soil.
***Racomitrium elongatum* Ehrh. ex Frisvoll. – 5, 7, 14, 16: on rock.
**Racomitrium lanuginosum* (Hedw.) Brid. – 14, 15, 16: on acidic rocks.
**Racomitrium macounii* Kindb.subsp. *alpinum* (E. Lawton) Frisvoll – 14: on acidic rock.
Racomitrium sudeticum (Funck) Bruch & Schimp. – 14: on acidic rock.
Rhizomnium pseudopunctatum (Bruch & Schimp.) T. J. Kop. – 14, 16: on wet rock.
Rhizomnium punctatum (Hedw.) T. J. Kop. – 7, 16: on wet rock.
***Rhodbryum roseum* (Hedw.) Limpr. – 15: on soil.
**Rhynchostegium murale* (Hedw.) Schimp. – 6: on beech bark.
Rhynchostegium riparioides (Hedw.) Cardot. – 16: on wet rock.
***Rhytidiadelphus loreus* (Hedw.) Warnst. – 7, 14: on rock.
Rhytidiadelphus squarrosus (Hedw.) Warnst. – 14, 16: on soil.
Rhytidium rugosum (Hedw.) Kindb. – 14, 15: on basic rock.
Saelania glaucescens (Hedw.) Broth. – 5, 16: on rock crevices.
Sanionia uncinata (Hedw.) Loeske. – 13, 16: on rock, soil, rotten wood.
Schistidium apocarpum (Hedw.) Bruch & Schimp. – 7, 13, 16: on basic rocks.
***Schistidium crassipilum* H. H. Blom. – 3, 4, 13: on rock.
**Schistidium dupretii* (Thér.) W. A. Weber – 5, 12, 13, 16: on silicate rocks.
Schistidium papillosum Culm. – 14: on acidic rock.
***Sciuro-hypnum populeum* (Hedw.) Ignatov & Huttunen – 14: on rock.
***Sciuro-hypnum reflexum* (Starke) Ignatov & Huttunen – 14, 15, 16: on stone and rock.
***Sciuro-hypnum starkei* (Brid.) Ignatov & Huttunen – 14, 16: on rock.
Streblotrichum convolutum (Hedw.) P. Beauv. – 16: on rock.
***Syntrichia montana* Nees. – 14, 16: on limestone rock.
Syntrichia norvegica F. Weber. – 7: on rock.
Syntrichia ruralis (Hedw.) F. Weber & D. Mohr. – 6, 7, 12, 13, 16: on soil, rocks and tree barks.
***Syntrichia virescens* (De Not.) Ochyra – 6: on beech bark.
**Thamnobryum alopecurum* (Hedw.) Gangulee – 13: on stones nearby stream.
Timmia austriaca Hedw. – 14, 16: on rubble, on rocks crevices.
***Timmia norvegica* J. E. Zetterst. – 13: on limestone rock.
Tortella tortuosa (Hedw.) Limpr. – 5, 6, 7, 8, 9, 14, 15, 16, 17: on basic rocks.
Tortula muralis Hedw. – 2: on concrete.
Tortula subulata Hedw. – 5, 6, 7, 13: on acidic soil.
**Weissia brachycarpa* (Nees & Hornsch.) Jur. – 5: on rock.
***Weissia condensa* (Voit) Lindb. – 5: on rock.