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Gauche, left, *Sphagnum quinquefarium* (Braithw.) Warnst.; droite, right, *Plagiothecium undulatum* (Hedw.) Schimp.

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Stepping beyond the 700 milestone: four new moss species in the bryophyte flora of Montenegro

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ABSTRACT

Four moss species were recorded during bryological studies for the first time in Montenegro in 2016 and 2017. *Hookeria lucens* (Hedw.) Sm., *Plagiothecium undulatum* (Hedw.) Schimp. and *Sphagnum quinquefarium* (Braithw.) Warnst. were found on Hajla Mt, while *Nyholmiella gymnostoma* (Bruch ex Brid.) Holmen & Warncke was found on Bjelasica Mt. Ecological and chorological remarks are given and the conservation status is discussed for each species. This noteworthy contribution to Montenegrin bryoflora upgraded the number of mosses to 555, while the number of overall bryophytes has reached 704 taxa.

RÉSUMÉ

Quatre espèces nouvelles pour la bryoflore monténégrine.

Quatre espèces de mousse ont été répertoriées lors d'études bryologiques pour la première fois au Monténégro en 2016 et 2017. *Hookeria lucens* (Hedw.) Sm., *Plagiothecium undulatum* (Hedw.) Schimp. et *Sphagnum quinquefarium* (Braithw.) Warnst. ont été trouvées sur le mont Hajla, tandis que *Nyholmiella gymnostoma* (Bruch ex Brid.) Holmen & Warncke a été trouvée sur le mont Bjelasica. Des remarques écologiques et chorologiques sont données, et l'état de conservation est discuté pour chaque espèce. Cette contribution remarquable à la bryoflore monténégrine a porté à 555 le nombre de mousses, tandis que le nombre total de bryophytes a atteint 704 taxons.

KEY WORDS

Balkan countries,
Mediterranean,
SE Europe,
new records.

MOTS CLÉS

Balkans,
Méditerranée,
Europe du Sud-Est,
signalements nouveaux.

INTRODUCTION

The bryological research of Montenegro has a long tradition from mid-19th century heretofore; however both spatial and temporal discontinuity is clearly evident across the period. In fact, this could be applied to the entire region of SE Europe (Sabovljević *et al.* 2001). There have been several attempts of compiling the Montenegro checklists of bryophytes (Sabovljević & Stevanović 1999; Sabovljević 2000; Dragičević & Veljić 2006; Sabovljević & Natcheva 2006; Ros *et al.* 2007, 2013; Sabovljević *et al.* 2008; Hodgetts 2015), yet, from today's perspective, they remained rather incomplete. The country is obviously bryologically understudied, despite being a European country bordering the Mediterranean Sea, with high bryophyte diversity in terms of taxa number per country area (Sabovljević *et al.* 2011). During the last two decades, numerous contributions to national flora, including regional inventories (Kürschner & Parolly 1997; Milikić *et al.* 2001; Dragičević *et al.* 2003, 2007, 2008a; Martinčić 2006; Papp *et al.* 2008, 2013a, 2014a; Papp & Erzberger 2010, 2011) and floristic novelties (Sabovljević & Stevanović 2000; Dragičević *et al.* 2001, 2002, 2008b, 2012, 2017; Cvetić & Sabovljević 2004; Erzberger & Papp 2007; Papp & Erzberger 2007; Erzberger *et al.* 2008; Papp *et al.* 2014b; Ellis *et al.* 2016a, 2016b, 2017; Vulević *et al.* 2017; Anđić *et al.* 2018), led to considerable progress in the knowledge of diversity and distribution of Montenegrin bryophytes. Nevertheless, the bryophyte flora of Montenegro is still far from complete, since the country's territory is quite unevenly studied, with a considerable number of regions fully unexplored.

The main objective of this paper is to provide further additions to the inventory of bryophytes in Montenegro.

MATERIAL AND METHODS

Samples were collected in August 2016 on Bjelasica Mt and in September 2017 on Hajla Mt. The voucher specimens were stored in the herbaria of the Natural History Museum of Montenegro in Podgorica and the University of Zagreb (ZA) in Croatia. The nomenclature follows Ros *et al.* (2007, 2013) for bryophytes and Euro+Med (2017) for vascular flora. During the field trips, notes on habitats, substrates and associated bryophytes were gathered.

STUDY AREAS

The Bjelasica Mt is situated in the NE part of Montenegro, forming a large mountain range with the highest peak at 2137 m a.s.l. Dominant rocks are of volcanic and siliceous origin (Lakušić 1966), which is a unique feature among Montenegrin mountain ranges. Numerous streams, springs and glacial lakes are a part of its very diverse hydrology. On lower elevations acidophilic beech (*Fagus sylvatica* L.) forests dominate, while on higher slopes oromediterranean pine forests with Balkan endemic Heldreich's pine (*Pinus heldreichii* Christ) prevail (Blečić & Lakušić 1976; Petrović

et al. 2012). The mountain is under influence of temperate cold and humid climate with warm or cool, but dry summers (*Dfs"bx"* and *Dfs"cx"* types according to Köppen (1931) criteria), with the influence of the Mediterranean on the precipitation regime (Burić *et al.* 2014). The bryophyte flora of Bjelasica Mt has been recently studied (Papp *et al.* 2013a).

The Hajla Mt is also located in the NE part of Montenegro, on the very border with Kosovo. Its central ridge is 12 km long and belongs to a large Prokletije massif. Several peaks reach above 2000 m. The mountain is dominated by glacial and karstic relief with spacious forests, alpine grasslands and rockeries. Towards the higher altitudes, oak (*Quercus petraea* (Matt.) Liebl.) forests are gradually replaced by beech (*Fagus sylvatica*) and spruce (*Picea abies* (L.) H. Karst.) dominated forests (Lakušić 1970). The mountain is under influence of temperate cold and humid climate with warm or cool summers without Mediterranean influence, expressed in higher precipitation in the warmer part of the year (*Dfwbx"* and *Dfwcx"* types) (Burić *et al.* 2014).

RESULTS AND DISCUSSION

The study of the samples collected allowed identifying four new national records in Montenegro, increasing the richness of Montenegrin moss flora to 555, while the number of overall bryophytes has reached 704 taxa.

Family HOOKERIACEAE Schimp.
Genus *Hookeria* Sm.

Hookeria lucens (Hedw.) Sm.

SPECIMEN EXAMINED. — **Montenegro.** Western slopes of Hajla Mt, road connecting town of Rožaje and village of Bandžov, 42°47'17"N, 20°07'55"E, 1417 m a.s.l., 7.IX.2017, *leg.* V. Šegota, A. Alegro & I. Četković s.n., *det.* A. Alegro & V. Šegota, ZÄ47630.

REMARKS

The species was found in the edge zone of a narrow stream, near the forest road on the margin of elder stands (*Alnus incana* (L.) Moench) within the spruce (*Picea abies*) dominated forest vegetation belt. Similarly, in Europe, it grows on moist clayey soils and earthy banks along forest streams and ditches (Dierßen 2001). This locality is situated outside the Mediterranean part of Montenegro. Only several bright green, glossy succulent patches were found on the moist soil, along with peat mosses *Sphagnum girgensohnii* Russow. and *S. palustre* L. We consider this small population highly endangered, due to road maintenance and a high probability of natural terrain erosion, caused by heavy rains or snow melting. *Hookeria lucens* is a Suboceanic Temperate element (Hill & Preston 1998; Smith 2004) occurring in Europe, W North America, SW Asia, Caucasus, N Turkey and N Africa (Hill & Preston 1998; Krisai & Strobl 2005).

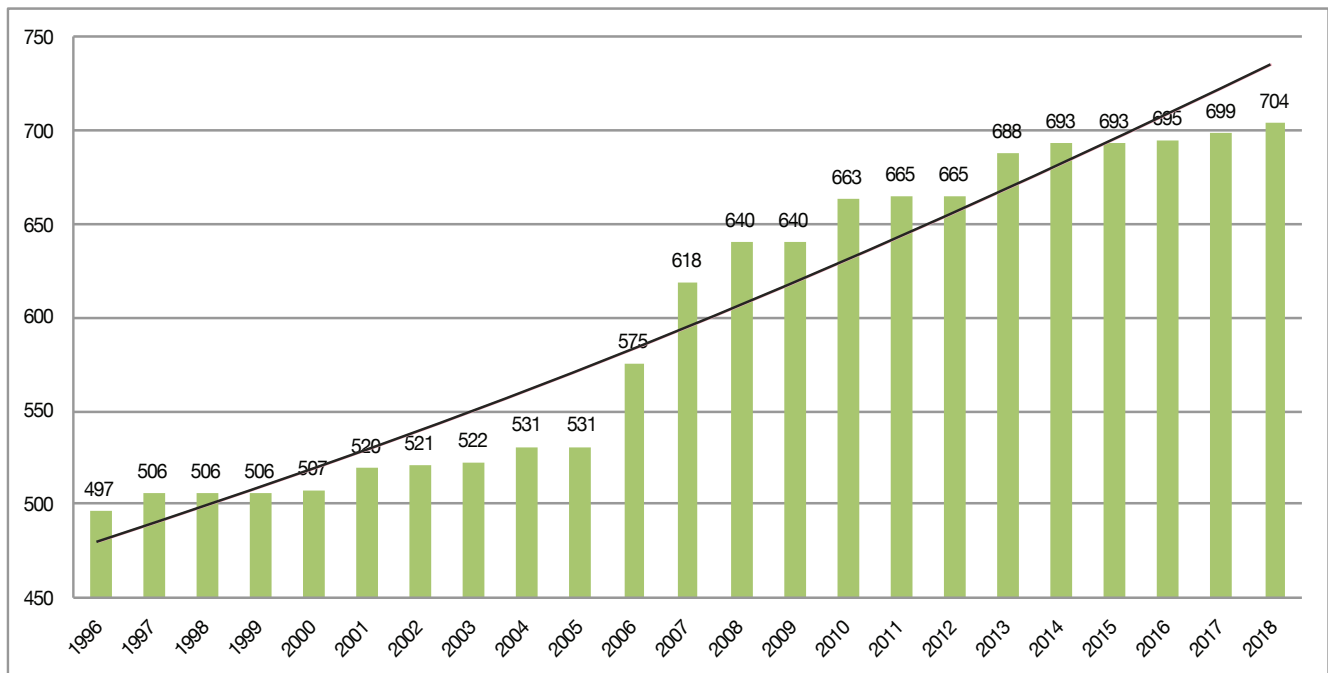


FIG. 1. — Number of bryophyte taxa reported from Montenegro in the period 1996–2018 (data considered for 2018 include the data published in this paper).

The species is widespread across the European continent (Hodgetts 2015), however in SE Europe it becomes less abundant, thus it is known only from Bosnia and Herzegovina (Głowacki 1906), Croatia (Pavletić 1955; Papp *et al.* 2013b), Romania (Stefănuț & Goia 2012), Serbia (Papp & Erzberger 2005) and Slovenia (Martinčič 2003). Rather recently the species has been found also in Hungary (Ellis *et al.* 2011). The species is known in other Mediterranean areas such as the Iberian and Apennine peninsulas, France, Tunisia, Turkey and islands of Azores, Corsica and Madeira (Ros *et al.* 2013). In the context of SE Europe and Mediterranean, the species is recognized as vulnerable only in Romania (Stefănuț & Goia 2012).

Family ORTHOTRICHACEAE Arn.
Genus *Nyholmiella* Holmen & Warncke

Nyholmiella gymnostoma (Bruch ex Brid.) Holmen & Warncke

SPECIMEN EXAMINED. — **Montenegro.** Gradac Hill, above the town of Mojkovac, on the slopes of Bjelasica Mt, 42°57'01"N, 19°37'53"E, 1152 m a.s.l., 23.VIII.2016, *leg.* and *det.* S. Dragičević s.n., Natural History Museum of Montenegro herbarium no. 1656/134.

REMARKS

The species was found on bark of *Populus tremula* L., growing on the forest edge of mixed deciduous and conifer woodland, on medieval archaeological locality Brskovo, geographically situated outside the Mediterranean part of Montenegro, but still under some influence of Mediter-

anean on the precipitation regime. Specimens formed only three tiny tufts on the tree trunk, at the 1.4 m height. Generally, the species is related to bark of the *Populus* trees (Dierßen 2001; Smith 2004; Atherton *et al.* 2010). No capsules were found, and a tiny liverwort, *Radula complanata* (L.) Dumort., was noticed among the leaves of the moss. *Nyholmiella gymnostoma* is a Boreal-montane element, beside Europe known also in central Asia, Japan and rarely in N America (Hill & Preston 1998; Smith 2004; Vitt 2014). It is most common in boreal Europe (Hill & Preston 1998; Lara & Estébanes 2014), while in central and E Europe it is rare (Nebel & Philipp 2001). In SE Europe it is extremely rare, or at least under-recorded, being only known from Bulgaria (Natcheva & Ganeva 2005), Romania (Stefănuț & Goia 2012) and Slovenia (recorded at the end of 19th century and published in Pavletić 1955). After being recorded for the first time in Mediterranean area, in Calabria (Italy) (Lara *et al.* 2004), several new records from Mediterranean countries appeared. In Albania and Greece, the species has been recorded very recently, in Drilon National Park, on trunk of *Tilia* (Ellis *et al.* 2012) and in Epirus region (NW Greece) on trunk of *Juglans regia* L. (Ellis *et al.* 2016b), respectively. Additionally, the species has been found in Spain, in the autonomous community Castille-La Mancha (Cezón & Muñoz 2013). The population in Romania is critically endangered (Stefănuț & Goia 2012), while that in Bulgaria is vulnerable (Natcheva *et al.* 2006). Our record seems to be the only recent finding of the species in W Balkans. Since our specimens have been found on the *Populus tremula* trees growing within the archaeological excavation site, possible tree cut could represent a major threat to the species.

Family PLAGIOTHECIACEAE (Broth.) M.Fleisch.
Genus *Plagiothecium* Schimp.

Plagiothecium undulatum (Hedw.) Schimp.

SPECIMEN EXAMINED. — **Montenegro.** Western slopes of Hajla Mt, on the way to the mountain cabin Grope, 42°45'43"N, 20°09'37"E, 1752 m a.s.l., 8.IX.2017, *leg.* and *det.* A. Alegro & S. Dragičević s.n., Natural History Museum of Montenegro herbarium no. 1657/135.

REMARKS

The species was recorded within the high mountain spruce forest, which encompasses a large, transitional peat bog area, exceptionally rich in diverse *Sphagnum* species. This locality is situated outside the Mediterranean part of Montenegro. The moss formed small patches in close vicinity of the forest brook, overgrowing thick deposits of partially decomposed acidic litter originating from spruce needles. The species grew together with *Rhizomnium punctatum* (Hedw.) T. J. Kop. and *Rhodobryum roseum* (Hedw.) Limpr. According to Dierßen (2001) it is a true acidophyt, which in Europe usually forms patches in acid woodlands including coniferous plantations, in heathlands, leached acid grasslands, etc. *Plagiothecium undulatum* is a Suboceanic Boreo-temperate element (Hill & Preston 1998; Smith 2004), beside Europe present also in Asia (China, Middle East and Siberia), Pacific Islands (New Guinea) and N America (Smith 2004; Ireland 2014). It grows in majority of N, W and central European countries (Ireland 2014; Hodgetts 2015). In SE Europe is rather under recorded than rare, known only from Bosnia & Herzegovina (Pavletić 1955), Bulgaria (Natcheva *et al.* 2006), Croatia (Pavletić 1955; Papp *et al.* 2013b), Romania (Stefănuț & Goia 2012), Serbia (Sabovljević & Natcheva 2006) and Slovenia (Martinčič 2003). It is also present in other Mediterranean countries and islands (France, Italy, Portugal, Sicily, Spain and Turkey) (Ros *et al.* 2013; Hodgetts 2015). In SE Europe the species has been assessed as endangered only in Bulgaria with the category of vulnerable (Natcheva *et al.* 2006). In the case of our population, we found no direct threats due to the absence of human impact in these, almost primeval, high mountain spruce forests.

Family SPHAGNACEAE Dumort.
Genus *Sphagnum* L.

Sphagnum quinquefarium (Braithw.) Warnst.

SPECIMEN EXAMINED. — **Montenegro.** Western slopes of Hajla Mt, forest road connecting town of Rožaje and village Bandžov, c. 1.5 km downstream from the spring of the River Ibar. 42°47'56"N, 20°06'30"E, 1216 m a.s.l., 7.IX.2017, *leg.* and *det.* A. Alegro, V. Šegota, S. Dragičević, I. Četković s.n., ZA47631.

REMARKS

The species grew on very steep, almost vertical, wet, slippery and highly inaccessible siliceous rocks, located above the bridge at the crossroad between the forest road and Ibar

River, a locality which is outside the Mediterranean part of Montenegro. Identical to other parts of Europe, the species grows in mountain sites with scattered blocks, forming mats on cliffs where the dripping of water is present, or on rocks in seepage areas (Dierßen 2001). Green plants dominated, however, several patches demonstrated a mix of green and reddish colour, as already reported in literature (e.g. Brugués *et al.* 2007). On the same rocks several other mosses occurred: *Dicranum scoparium* Hedw., *Hylocomium splendens* (Hedw.) Schimp., *Polytrichum formosum* Hedw. and *Pleurozium schreberi* (Willd. ex Brid.) Mitt. Vascular flora assemblage with *Deschampsia flexuosa* (L.) Trin., *Gentiana asclepiadea* L., *Hieracium murorum* L., *Huperzia selago* (L.) Bernh. ex Schrank & Mart., *Luzula luzuloides* (Lam.) Dandy & Wilmott, *Rubus hirtus* Waldst. & Kit., *Vaccinium myrtillus* L. and *Veronica urticifolia* (Jacq.) Fourr. clearly demonstrates acidic and humid conditions on the habitat. *Sphagnum quinquefarium* is a Suboceanic Boreal-montane element (Hill & Preston 1998; Smith 2004), outside Europe distributed in E Asia and the Atlantic and Pacific coastal areas of N America (Daniels & Eddy 1985). It is present throughout the most of Europe and is most common in S Scandinavia, in mountain areas of Iberian, Apennine and Balkan peninsulas (Daniels & Eddy 1985; Hölzer 2010). In SE Europe it is known from Bosnia & Herzegovina (Pavletić 1955), Bulgaria (Düll *et al.* 1999; Natcheva *et al.* 2006), Croatia (Alegro & Šegota 2010) and Slovenia (Martinčič 2003). In other Mediterranean areas the species was recorded only in France (Ros *et al.* 2013), Italy (Aleffi *et al.* 2008) and Spain (Brugués *et al.* 2007). The species is listed on the European Union habitats and Species Directive (European Commission 2007). No direct threats to Montenegrin population have been observed, however, longer droughts due to climate changes could present a serious risk in the future.

CONCLUSIONS

Until the 2000s, the state of knowledge of the bryophyte flora of SE Europe (except from Romania) was largely insufficient, mostly due to the lack of local bryologists (Sabovljević 2004). In the last two decades there has been a high increase in the activity of bryophyte investigation of the region. Consequently, data on bryoflora have been constantly increasing (Sabovljević *et al.* 2011), especially in former Yugoslav republics (Croatia, Macedonia, Montenegro and Serbia). The knowledge on Montenegrin bryoflora has undergone a true renaissance, when as many as 207 new taxa have been recorded since 1996 (Fig. 1). With our newest contribution, the list of bryophytes in Montenegro grew over the number of 700 taxa. Accordingly, Montenegro continues to be one of the Balkan countries richest in terms of taxa diversity per country area (Sabovljević *et al.* 2011). Nonetheless, it remains the SE European country where most records of new species are expected, due to the number of regions still fully unexplored.

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