

CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF CROATIA I. GORSKI KOTAR REGION (W CROATIA)

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During joint field research carried out in 2011 and 2012 in the Gorski kotar Region of Croatia, 231 bryophyte taxa (60 liverworts and 171 mosses) were collected. Five species (*Jungermannia obovata*, *Anoetangium aestivum*, *Philonotis seriata*, *Plagiothecium laetum*, *Tomentypnum nitens*) are reported for the first time in Croatia. Six species included in the Red data book of European bryophytes (*Lophozia ascendens*, *Brachydontium trichodes*, *Buxbaumia viridis*, *Paraleucobryum sauteri*, *Pseudoleskea saviana*, *Rhynchostegiella teneriffae*) were also recorded. Furthermore, 34 taxa (9 liverworts and 25 mosses) are regarded as rare in SE Europe.

Key words: European redlisted species, liverworts, mosses, new national records, rare species

INTRODUCTION

With its rich bryophyte flora, Croatia is bryologically one of the best-known regions of former Yugoslavia and even in SE Europe (SABOVLJEVIĆ *et al.* 2001). During the 19th and early 20th century Croatia had mostly been researched by foreign bryologists. Based on the previous works and own research, PAVLETIĆ (1955) published a comprehensive work about the bryophytes of Croatia (i.e. former Yugoslavia). In his *Prodromus flore briofita Jugoslavije* all published data about the bryophytes and their distributions with author citations were summarised. Afterwards however, only sporadic collections were made and few published records appeared from the country.

Recently updated checklists of the Croatian bryophyte flora can be obtained from the works of SABOVLJEVIĆ (2003, 2006) and additions found in the SE European checklists (SABOVLJEVIĆ and NATCHEVA 2006, SABOVLJEVIĆ *et al.* 2008). According to one of the newest contributions (PAPP and SABOVLJEVIĆ 2009) the Croatian bryoflora counts 644 species (487 mosses and 157 liverworts).

Very recently, two new species were reported (MODRIĆ SURINA *et al.* 2012, ALEGRO *et al.* 2012). In the present paper a detailed list of bryophytes collected in the Gorski kotar Region in 2011 and 2012 is provided with remarks on species new for the Croatian bryophyte flora, and also on rare and threatened species.

MATERIAL AND METHODS

The collecting trips were made in July 2011 and in July 2012 into the investigated area shown in Figure 1. All main habitat types, such as stream valleys, gorges, forests and meadows were explored, and bryophytes collected from different substrates (soil, exposed and shady rocks, tree bark, and decaying wood).

The specimens have been shared between the participating parties and are preserved in the Herbarium of the Hungarian Natural History Museum, Budapest (BP) and the Herbarium Croaticum of University of Zagreb (ZA). The nomenclature follows GROLLE and LONG (2000) for liverworts and HILL *et al.* (2006) for mosses. New floristic results for the country are given according to the checklists of SE Europe and Mediterran (SABOVLJEVIĆ and NATCHEVA 2006, SABOVLJEVIĆ *et al.* 2008, ROS *et al.* 2007) updated with some records included in DEGEN (1938) and DÜLL *et al.* (1999), and new records published in PAPP and SABOVLJEVIĆ (2009).

Study area

Gorski kotar, literally “Mountain region” is a roughly 40 km long karst plateau in the West of Croatia, situated between the Adriatic Sea and the peri-Pannonian lowland (Fig. 1). Elongated mountain ranges (*e.g.* Snježnik 1,506 m, Risnjak 1,528 m, Bjelolasica 1,533 m) raise from its massif with the mean elevation of 700–800 m. Precipitation is high, regularly over 2000 mm yearly, with a maximum of 3,600 mm on the Risnjak peak. Despite of the amount of precipitation, watercourses are very scarce due to the porous karst bedrock, leading most of the water into the karstic system. Yearly temperature mean is around 7 °C, with maximum in July and minimum in January. Geologically, the whole area is rather homogenously built up of Mesozoic carbonates and dolomites. Ecologically very important are the relatively small outcrops of siliceous rocks enabling the development of acidophilous forest types. The general landscape of the Gorski kotar Region is mainly a mosaic of forests and grasslands; over 55% of the area is covered with extensive, natural and old-growth forests. The main forest tree is beech (*Fagus sylvatica*), which forms various communities depending on elevation, exposure, relief and bedrock. The most widespread forest community is composed of beech (*Fagus sylvatica*) and fir (*Abies alba*) recorded as ass. *Omphalodofagetum*. Also, patches of spruce-fir forests (of *Picea abies* and *Abies alba*) con-

tribute to the landscape and biological diversity, as well as thermophilous forests with *Ostrya carpinifolia* and *Fraxinus ornus* mainly in lower elevations.

The core mountain area of Gorski kotar is protected as National Park "Risnjak". The Park covers 6,350 ha with the Snježnik and Risnjak as its highest peaks, characterised by high diversity of forest communities and subalpine grasslands.

Collecting sites

1. Croatia, Gorski kotar Region, Golubinjak forest (protected as Park Forest) near Lokve village, *Omphalodo vernae-Fagetum*, 45° 21' 25.0" N, 14° 45' 53.8" E, 740 m, 20.VII.2011.
2. Croatia, Gorski kotar Region, foot of Mt Bjelolasica at Jasenak, *Bazzanio-Piceetum*, 45° 14' 23.7" N, 15° 01' 49.8" E, 640 m, 21.VII.2011.



Fig. 1. Location of the study area.

3. Croatia, Gorski kotar Region, *Tilia* trees in town Delnice, 45° 23' 42.5" N, 14° 48' 01.4" E, 715 m, 22.VII.2011.
4. Croatia, Gorski kotar Region, at Crni lug village, 45° 25' 14.2" N, 14° 42' 55.5" E, 690 m, 22.VII.2011.
5. Croatia, Gorski kotar Region, Čabar village, canyon of Čabranka river, 45° 36' 02.0" N, 14° 38' 32.4" E, 610 m, 22.VII.2011.
6. Croatia, Gorski kotar Region, Lividraga at Gerovo village, *Aremonio-Piceetum abietis*, 45° 28' 43.4" N, 14° 35' 16.5" E, 955 m, 22.VII.2011.
7. Croatia, Gorski kotar Region, Zalesina village, *Blechno-Abietetum* at the house of forestry, 45° 22' 57.9" N, 14° 52' 20.5" E, 800 m, 24.VII.2011.
8. Croatia, Gorski kotar Region, Čogrljevo jezero at town Moravice, 45° 24' 33.5" N, 15° 01' 09.8" E, 430 m, 20.VII.2012.
9. Croatia, Gorski kotar Region, Mt Kapela, Samarske stijene, 45° 13' 58.5" N, 14° 56' 40.9" E, 1,200 m, 21.VII.2012.
10. Croatia, Gorski kotar Region, Leska at Crni lug village, 45° 25' 09.4" N, 14° 40' 35.1" E, 690 m, 22.VII.2012.
11. Croatia, Gorski kotar Region, Mrzla vodica village, 45° 22' 35.0" N, 14° 40' 35.2" E, 770 m, 22.VII.2012.

RESULTS

231 bryophytes (60 liverworts and 171 mosses) were collected in the Gorski kotar Region. Of the full collection 17 taxa (3 liverworts and 14 mosses) proved to be new to Croatia, of which 12 were published recently (PAPP *et al.* 2013) (marked with +), and five are reported here for the first time (marked with ++). The occurrence of 27 liverworts having only very old records according to ROS *et al.* (2007) (marked with *) has been confirmed in the country.

Hepaticae

- Apometzgeria pubescens* (Schrank) Kuwah. – 9: limestone rock and bark of *Acer pseudoplatanus*
 **Bazzania trilobata* (L.) Gray – 1, 7: soil; 2: soil and decaying wood; 6: limestone rock; 10: decaying wood
Blepharostoma trichophyllum (L.) Dumort. – 1, 9: decaying wood; 2: bark of *Abies*
 **Calypogeia azurea* Stotler et Crotz – 7, 10: soil
Calypogeia fissa (L.) Raddi – 2: soil; 11: soil along a rivulet
 +*Calypogeia muelleriana* (Schiffn.) Müll. Frib. – 1, 2, 9: decaying wood
 **Calypogeia suecica* (Arnell et J. Perss.) Müll. Frib. – 1, 2, 9: decaying wood
Cephalozia bicuspidata (L.) Dumort. – 1, 9: decaying wood; 2: soil
Cephalozia catenulata (Huebener) Lindb. – 1, 2, 6, 7, 9, 10: decaying wood
 **Chiloscyphus pallescens* (Ehrh. ex Hoffm.) Dumort. – 2: along a stream; 5, 8: limestone rock; 11: wet meadow
 **Chiloscyphus polyanthus* (L.) Corda – 10: schistose rock in a stream
Cololejeunea calcarea (Lib.) Schiffn. – 1, 5, 8, 9: limestone rock
Cololejeunea rosettiana (C. Massal.) Schiffn. – 1, 9: limestone rock

- Conocephalum conicum* (L.) Dumort. – 2: along a stream; 8: limestone rock at the lake; 10: schistose rock in a stream
- + *Conocephalum salebrosum* Szwejkowski, Buczkowska et Odrzykoski – 1, 5, 6, 9, 10: limestone rock
- * *Diplophyllum albicans* (L.) Dumort. – 7: soil
- Frullania dilatata* (L.) Dumort. – 1: bark of *Aesculus hippocastanum*; 4, 7: bark of *Fagus*
- Frullania tamarisci* (L.) Dumort. – 2: bark of *Abies*
- * *Harpanthus scutatus* (F. Weber et D. Mohr) Spruce – 6, 9: decaying wood
- Jungermannia atrovirens* Dumort. – 1, 5, 8, 9: limestone rock; 10: concrete wall of a canal and schistose rock in a stream
- * *Jungermannia leiantha* Grolle – 1, 6, 9: decaying wood; 7: soil
- + + *Jungermannia obovata* Nees – 8: soil among limestone rocks at the lake
- Leiocolea collaris* (Nees) Schljakov – 1, 5, 6, 8, 9: limestone rock; 10: limestone rock and schistose rock in stream
- Lejeunea cavifolia* (Ehrh.) Lindb. – 1: limestone rock and bark of *Picea*; 5: bark of *Fagus*; 8: limestone rock at the lake
- Lepidozia reptans* (L.) Dumort. – 1, 2, 6, 7, 9, 10: decaying wood
- Lophocolea bidentata* (L.) Dumort. – 2: soil; 8: limestone rock at the lake
- Lophocolea heterophylla* (Schrad.) Dumort. – 1, 2, 9: decaying wood
- * *Lophocolea minor* Nees – 8: soil among limestone rocks
- * *Lophozia ascendens* (Warnst.) R. M. Schust. – 9: decaying wood
- * *Lophozia incisa* (Schrad.) Dumort. – 9: decaying wood
- * *Lophozia ventricosa* (Dicks) Dumort. – 9: soil among limestone rocks
- Marchantia polymorpha* L. subsp. *polymorpha* – 8: limestone rock at the lake
- * *Marchantia polymorpha* L. subsp. *montivagans* Bisch. et Boisselier – 8: limestone rock at the lake
- * *Metzgeria conjugata* Lindb. – 1, 5, 6, 8, 9: limestone rock; 7: decaying wood
- Metzgeria furcata* (L.) Dumort. – 1: bark of *Aesculus hippocastanum* and *Picea*; 2: decaying wood; 7, 10: bark of *Fagus*; 9: limestone rock and decaying wood
- * *Mylia taylori* (Hook.) Gray – 6: limestone rock and decaying wood; 9: decaying wood
- * *Nowellia curvifolia* (Dicks.) Mitt. – 1, 2, 6, 7, 9, 10: decaying wood
- * *Odontoschisma denudatum* (Mart.) Dumort. – 1, 2, 6: decaying wood
- Pedinophyllum interruptum* (Nees) Kaal. – 1, 6, 8, 9: limestone rock; 5: at the stream; 10: schistose rock in a stream
- Pellia endiviifolia* (Dicks.) Dumort. – 1, 5, 8: limestone rock
- * *Pellia epiphylla* (L.) Corda – 1: soil and limestone rock; 2: soil in forest and along a stream; 7: soil; 11: soil along a rivulet
- * *Pellia neesiana* (Gottsche) Limpr. – 10: wet meadow
- Plagiochila asplenioides* (L.) Dumort. – 1, 6: limestone rock
- Plagiochila porelloides* (Torrey ex Nees) Lindenb. – 1, 5, 8, 9: limestone rock; 5: bark of *Fagus*; 9: decaying wood
- Porella arboris-vitae* (With.) Grolle – 1, 8, 9: limestone rock
- Porella baueri* (Schiffn.) C. E. O. Jensen – 1: limestone rock; 3: bark of *Tilia*
- Porella cordaeana* (Huebener) Mohr – 9: limestone rock
- Porella platyphylla* (L.) Pfeiff. – 5: limestone rock in thermophilous forest; 10: bark of *Acer pseudoplatanus*
- Preissia quadrata* (Scop.) Nees – 5: at the stream; 9: limestone rock
- Radula complanata* (L.) Dumort. – 1, 9: limestone rock; 7: bark of *Fagus*
- * *Riccardia latifrons* (Lindb.) Lindb. – 1, 6: decaying wood

- Riccardia multifida* (L.) Gray – 1: soil; 11: soil along a rivulet
 **Riccardia palmata* (Hedw.) Carruth. – 1, 2, 7, 9: decaying wood
 **Scapania aequiloba* (Schwägr.) Dumort. – 5, 9: limestone rock
Scapania aspera M. Bernet et Bernet – 1, 5, 6, 9: limestone rock
 **Scapania calcicola* (Arnell et J. Perss.) Ingham – 9: limestone rock
 **Scapania nemorea* (L.) Grolle – 2: soil and decaying wood
 **Scapania umbrosa* (Schrad.) Dumort. – 6, 9: decaying wood
 **Scapania undulata* (L.) Dumort. – 11: schistose rock along a rivulet
 **Tritomaria exsecta* (Schmidel) Loeske – 1, 2, 9: decaying wood

Musci

- ++*Anoetangium aestivum* (Hedw.) Mitt. – 9: limestone rock
Anomodon attenuatus (Hedw.) Huebener – 1, 9: limestone rock
Anomodon longifolius (Schleich. ex Brid.) Hartm. – 9: bark of *Acer pseudoplatanus*
Anomodon viticulosus (Hedw.) Hook. et Taylor – 1: limestone rock
Antitrichia curtispindula (Hedw.) Brid. – 9: bark of *Acer pseudoplatanus*
Atrichum undulatum (Hedw.) P. Beauv. – 1, 2, 7: soil; 10: wet meadow
Barbula crocea (Brid.) F. Weber et D. Mohr – 5, 8: limestone rock
Barbula unguiculata Hedw. – 5: at the stream
Brachydontium trichodes (F. Weber) Milde – 7: sandstone rock
Brachythecium rivulare Schimp. – 1: soil; 2, 5: along a stream; 8: limestone rock at the lake; 10: limestone and schistose rocks in rivulet
Brachythecium rutabulum (Hedw.) Schimp. – 1: limestone rock and bark of *Aesculus hippocastanum*; 7: bark of *Fagus*; 8: limestone rock; 9: limestone rock and decaying wood
Brachythecium salebrosum (Hoffm. ex F. Weber et D. Mohr) Schimp. – 2: decaying wood; 9: limestone rock
Brachythecium tommasinii (Sendtn. ex Boulay) Ignatov et Huttunen – 9: limestone rock and bark of *Acer pseudoplatanus*
Bryoerythrophyllum recurvirostrum (Hedw.) P. C. Chen – 5: limestone rock
Bryum capillare Hedw. – 1, 5, 9: limestone rock; 8: concrete
Bryum pseudotriquetrum (Hedw.) P. Gaertn. et al. – 10, 11: wet meadow
Bryum rubens Mitt. – 8: soil among limestone rocks
Buxbaumia viridis (Moug. ex Lam. et DC.) Brid. ex Moug. et Nestl. – 2, 7: decaying wood
Calliargon cordifolium (Hedw.) Kindb. – 2: along a stream; 11: wet meadow
Calliargon giganteum (Schimp.) Kindb. – 11: wet meadow
Calliargonella cuspidata (Hedw.) Loeske – 2: along a stream; 4: soil; 5: limestone rock; 10, 11: wet meadow
Calliargonella lindbergii (Mitt.) Hedenäs – 10: schistose rock in a stream
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra – 5, 9: limestone rock
 +*Campylium protensum* (Brid.) Kindb. – 5: limestone rock; 10: wet meadow
Campylium stellatum (Hedw.) Lange et C. E. O. Jensen – 9: soil among limestone rocks; 10: wet meadow and limestone rock in a rivulet
Campylophyllum halleri (Hedw.) M. Fleisch. – 9: limestone rock
Ceratodon purpureus (Hedw.) Brid. – 10: concrete wall of a canal
Cinclidotus aquaticus (Hedw.) Bruch et Schimp. – 5: at the stream
Cinclidotus fontinaloides (Hedw.) P. Beauv. – 5: at the stream; 8: limestone rock at the lake
Cirriphyllum crassinervium (Taylor) Loeske et M. Fleisch. – 1, 5, 9: limestone rock

- Cirriphyllum piliferum* (Hedw.) Grout – 4: soil; 10: wet meadow
Climacium dendroides (Hedw.) F. Weber et D. Mohr – 1, 4: soil; 10: wet meadow
Cratoneuron filicinum (Hedw.) Spruce – 5, 8: limestone rock; 10: schistose rock in a stream
Ctenidium molluscum (Hedw.) Mitt. – 1, 5, 6, 9, 10: limestone rock; 8: concrete
Dichodontium pellucidum (Hedw.) Schimp. – 5, 8: limestone rock; 10: concrete wall of a canal
Dicranella heteromalla (Hedw.) Schimp. – 7, 9: soil; 10: decaying wood; 11: soil along a rivulet
Dicranella varia (Hedw.) Schimp. – 10: soil on the bank of a canal
+ *Dicranodontium denudatum* (Brid.) E. Britton – 1, 2, 7: decaying wood
Dicranum scoparium Hedw. – 1, 7, 9: decaying wood; 2: bark of *Abies*; 6, 9: limestone rock
Dicranum tauricum Sapjegin – 9: decaying wood
Didymodon fallax (Hedw.) R. H. Zander – 5: limestone rock
Didymodon ferrugineus (Schimp. ex Besch.) M. O. Hill – 10: concrete wall of a canal
Didymodon rigidulus Hedw. – 5, 9: limestone rock; 8, 10: concrete wall
Didymodon spadiceus (Mitt.) Limpr. – 5: at the stream; 8: limestone rock at the lake; 10: concrete wall of a canal and schistose rock in a stream
Diphyscium foliosum (Hedw.) D. Mohr – 7: soil
Distichium capillaceum (Hedw.) Bruch et Schimp. – 9: limestone rock
Ditrichum flexicaule (Schwägr.) Hampe – 5: limestone rock in thermophilous forest; 9: limestone rock
Ditrichum gracile (Mitt.) Kuntze – 5, 9: limestone rock
Ditrichum heteromallum (Hedw.) E. Britton – 2: soil
Ditrichum pusillum (Hedw.) Hampe – 7: soil
Encalypta streptocarpa Hedw. – 5, 6: limestone rock; 8: concrete wall; 10: schistose rock at a stream
Entodon concinnus (De Not.) Paris – 4: limestone rock
Eurhynchium angustirete (Broth.) T. J. Kop. – 1, 6, 9: limestone rock; 2: decaying wood; 7: soil
Eurhynchium striatum (Hedw.) Schimp. – 1: limestone rock
Fissidens adianthoides Hedw. – 2: along a stream; 10: wet meadow
Fissidens bryoides Hedw. – 8: soil among rocks
Fissidens dubius P. Beauv. – 1, 5, 6, 8, 9, 10: limestone rock; 10: limestone rock in a rivulet
Fissidens gracilifolius Brugg.-Nann. et Nyholm – 1: limestone rock
Fissidens pusillus (Wilson) Milde – 5: at the stream; 8: limestone rock at the lake; 10: schistose rock in a stream
Fissidens taxifolius Hedw. – 1, 6: soil; 2: along a stream; 10: schistose rock at a stream
Fontinalis antipyretica Hedw. – 2: along a stream
Grimmia pulvinata (Hedw.) Sm. – 4: limestone rock; 8: concrete
Gymnostomum calcareum Nees et Hornsch. – 1, 5, 8, 9: limestone rock
Herzogiella seligeri (Brid.) Z. Iwats. – 1, 2, 6, 7, 10: decaying wood
Homalothecium sericeum (Hedw.) Schimp. – 1: bark of *Aesculus hippocastanum*; 5: limestone rock in thermophilous forest; 9: limestone rock; 10: bark of *Acer pseudoplatanus*
Hookeria lucens (Hedw.) Sm. – 1, 4, 10: soil; 7, 11: at a rivulet
Hygrohypnum luridum (Hedw.) Jenn. – 1, 8, 9: limestone rock; 5: at the stream; 10: concrete wall of a canal; 10: limestone rock in a rivulet
Hylocomium splendens (Hedw.) Schimp. – 1: soil; 9: limestone rock
Hymenostylium recurvirostrum (Hedw.) Dixon – 1: limestone rock
Hypnum cupressiforme Hedw. – 1: bark of *Aesculus hippocastanum* and decaying wood; 2: bark of *Abies* and decaying wood; 3: bark of *Tilia*; 7: soil, bark of *Fagus* and decaying wood; 8: limestone rock at the lake; 9: decaying wood
Hypnum jutlandicum Holmen et E. Warncke – 2: soil

- Isopterygiopsis pulchella* (Hedw.) Z. Iwats. – 8: limestone rock
- Isothecium alopecuroides* (Lam. ex Dubois) Isov. – 1, 6: limestone rock; 2: bark of *Abies*; 7: bark of *Fagus*; 9: limestone rock and decaying wood; 10: decaying wood
- Isothecium myosuroides* Brid. – 1: limestone rock and decaying wood; 2: bark of *Abies* and decaying wood; 7: soil and decaying wood; 9: limestone rock and decaying wood; 10: bark of *Fagus*
- Leucobryum glaucum* (Hedw.) Ångstr. – 1, 7: decaying wood; 2 soil
- Leucobryum juniperoideum* (Brid.) Müll. Hal. – 2: decaying wood; 7: soil
- Leucodon sciuroides* (Hedw.) Schwägr. – 1: bark of *Aesculus hippocastanum*; 10: bark of *Acer pseudoplatanus*
- Mnium marginatum* (Dicks.) P. Beauv. – 1, 6: limestone rock; 5: at the stream
+ *Mnium spinosum* (Voit) Schwägr. – 9: decaying wood
- Mnium stellare* Hedw. – 8: limestone rock
- Mnium thomsonii* Schimp. – 1, 6, 8, 9: limestone rock; 5: at the stream
- Myurella julacea* (Schwägr.) Schimp. – 9: limestone rock
- Neckera complanata* (Hedw.) Huebener – 1, 6, 8, 9: limestone rock; 10: bark of *Acer pseudoplatanus*
- Neckera crispa* Hedw. – 1, 5, 8, 9: limestone rock
- Neckera pumila* Hedw. – 1: bark of *Aesculus hippocastanum*; 4, 7: bark of *Fagus*
- Orthothecium intricatum* (Hartm.) Schimp. – 5: limestone rock
- Orthothecium rufescens* (Dicks. ex Brid.) Schimp. – 1, 5, 8, 9: limestone rock
- Orthotrichum affine* Schrad. ex Brid. – 3: bark of *Tilia*; 4: bark of *Fagus*
- Orthotrichum anomalum* Hedw. – 4: limestone rock
- Orthotrichum cupulatum* Hoffm. ex Brid. – 1: limestone rock; 5: limestone rock in thermophilous forest; 10: concrete wall of a canal
- Orthotrichum lyellii* Hook. et Taylor – 1: bark of *Aesculus hippocastanum*; 3: bark of *Tilia*; 4, 7: bark of *Fagus*
- Orthotrichum obtusifolium* Brid. – 3: bark of *Tilia*
- Orthotrichum pallens* Bruch ex Brid. – 3: bark of *Tilia*
- Orthotrichum pumilum* Sw. ex anon – 3: bark of *Tilia*
- Orthotrichum speciosum* Nees – 3: bark of *Tilia*; 4: bark of *Fagus*
- Orthotrichum stramineum* Hornsch. ex Brid. – 1: bark of *Aesculus hippocastanum*; 4: bark of *Fagus*
- Orthotrichum striatum* Hedw. – 4: bark of *Fagus*
- Oxyrrhynchium hians* (Hedw.) Loeske – 1, 5: limestone rock; 10: schistose rock in a stream
- Oxyrrhynchium schleicheri* (R. Hedw.) Röhl – 1: soil
- + *Oxystegus tenuirostris* (Hook. et Taylor) A. J. E. Sm. – 1: limestone rock
- Palustriella commutata* (Hedw.) Ochyra – 1, 5: limestone rock; 10: limestone and schistose rocks in a stream
- Palustriella falcata* (Brid.) Hedenäs – 10: wet meadow
- Paraleucobryum longifolium* (Hedw.) Loeske – 9: bark of *Fagus*
- Paraleucobryum sauteri* (Bruch et Schimp.) Loeske – 9: decaying wood
- + + *Philonotis seriata* Mitt. – 10: wet meadow
- Plagiobryum zierii* (Hedw.) Lindb. – 1, 5, 9: limestone rock
- Plagiomnium affine* (Blandow ex Funck) T. J. Kop. – 1, 2: decaying wood; 8, 9: limestone rock; 10, 11: wet meadow
- Plagiomnium cuspidatum* (Hedw.) T. J. Kop. – 4: soil
- Plagiomnium rostratum* (Schrad.) T. J. Kop. – 6, 8: limestone rock
- Plagiomnium undulatum* (Hedw.) T. J. Kop. – 1: bark of *Aesculus hippocastanum*; 2, 7: soil; 8: limestone rock at the lake; 10: limestone rock in a rivulet
- Plagiopus oederianus* (Sw.) H. A. Crum et L. E. Anderson – 1, 9: limestone rock

- Plagiothecium cavifolium* (Brid.) Z. Iwats. – 1: decaying wood
+ *Plagiothecium curvifolium* Schlieph. ex Limpr. – 2: soil and decaying wood; 6: limestone rock and decaying wood; 10: bark of *Fagus*
- Plagiothecium denticulatum* (Hedw.) Schimp. – 5: bark of *Fagus*
+ *Plagiothecium laetum* Schimp. – 9: limestone rock
+ *Plagiothecium platyphyllum* Mönk. – 1: decaying wood; 2: soil and along a stream; 8: limestone rock at the lake
- Plagiothecium undulatum* (Hedw.) Schimp. – 1, 2, 7, 10: soil
- Plasteurhynchium striatulum* (Spruce) M. Fleisch. – 1, 8, 9: limestone rock; 10: limestone rock in a rivulet
- Platydictya jungermannioides* (Brid.) H. A. Crum – 5: limestone rock
- Platyhypnidium riparioides* (Hedw.) Dixon – 5: at the stream; 8: limestone rock at the lake; 10: schistose rock in a stream
- Pleurozium schreberi* (Willd. ex Brid.) Mitt. – 10: soil along a rivulet
- Pogonatum aloides* (Hedw.) P. Beauv. – 9: soil
- Pogonatum urnigerum* (Hedw.) P. Beauv. – 2, 7: soil
- Poblia cruda* (Hedw.) Lindb. – 9: limestone rock
- Poblia melanodon* (Brid.) A. J. Shaw – 2, 5: along a stream; 10: soil on the bank of a canal
- Poblia wahlenbergii* (F. Weber et D. Mohr) A. L. Andrews – 1: limestone rock
- Polytrichastrum formosum* (Hedw.) G. L. Sm. – 1, 6, 9: limestone rock; 2, 7: soil; 10: soil along a rivulet
- Polytrichum commune* Hedw. – 2: along a stream; 10: wet meadow
- Pseudoleskea incurvata* (Hedw.) Loeske – 9: limestone rock
- Pseudoleskea saviana* (De Not.) Latzel – 9: decaying wood
- Pseudoleskeella catenulata* (Brid. ex Schrad.) Kindb. – 9: limestone rock
- Pseudoleskeella nervosa* (Brid.) Nyholm – 9: bark of *Fagus* and *Acer pseudoplatanus*
- Pseudoscleropodium purum* (Hedw.) M. Fleisch. – 2: soil
- Pseudotaxiphyllum elegans* (Brid.) Z. Iwats. – 10: soil
- + *Pterigynandrum filiforme* Hedw. – 1: bark of *Aesculus hippocastanum*; 3: bark of *Tilia*; 4: bark of *Fagus*
- Rhizomnium punctatum* (Hedw.) T. J. Kop. – 1, 2: decaying wood; 5: at the stream; 6, 8: limestone rock; 7: soil; 10: limestone rock in a rivulet; 11: soil along a rivulet
- Rhynchostegiella teneriffae* (Mont.) Dirkse et Bouman – 5: at the stream
- Rhynchostegium murale* (Hedw.) Schimp. – 1, 4, 6, 8, 9: limestone rock
- Rhytidiadelphus loreus* (Hedw.) Warnst. – 1, 2: decaying wood; 6, 9: limestone rock
- Rhytidiadelphus squarrosus* (Hedw.) Warnst. – 2, 4: soil; 10: wet meadow
- Rhytidiadelphus triquetrus* (Hedw.) Warnst. – 1: soil and limestone rock; 2: soil; 9: limestone rock
- Sanionia uncinata* (Hedw.) Loeske – 1: decaying wood; 6: limestone rock
- Schistidium brunnescens* Hedw. subsp. *griseum* (Nees et Hornsch.) H. H. Blom – 5: limestone rock in thermophilous forest
- Schistidium crassipilum* H. H. Blom – 4, 9: limestone rock; 8, 10: concrete wall
- Schistidium elegantulum* H. H. Blom – 1: limestone rock
- Schistidium helveticum* (Schkuhr) Deguchi – 5: limestone rock in thermophilous forest
- Seligeria pusilla* (Hedw.) Bruch et Schimp. – 5: at the stream
- Sphagnum auriculatum* Schimp. – 7: at a rivulet
- Sphagnum girgensohnii* Russow – 2: along a stream; 7: at a rivulet; 10: soil under the forest
- Sphagnum palustre* L. – 2: along a stream; 7: at a rivulet
- Sphagnum russowi* Warnst. – 10: soil under the forest

- Sphagnum subsecundum* Nees – 11: wet meadow
Syntrichia latifolia (Bruch ex Hartm.) Huebener – 3: bark of *Tilia*
Syntrichia ruralis (Hedw.) F. Weber et D. Mohr – 9: bark of *Acer pseudoplatanus*
Syntrichia virescens (De Not.) Ochyra – 3: bark of *Tilia*
Taxiphyllum wissgrillii (Garov.) Wijk et Margad. – 1: limestone rock
Tetraxis pellucida Hedw. – 1, 2, 6, 7, 9: decaying wood
Thamnobryum alopecurum (Hedw.) Gangulee – 1: limestone rock; 5: at the stream; 8: limestone rock at the lake; 9: bark of *Acer pseudoplatanus*; 10: schistose rock in a stream
Thuidium assimile (Mitt.) A. Jaeger – 4: soil
Thuidium tamariscinum (Hedw.) Schimp. – 1: decaying wood; 2: soil and bark of *Abies*; 7: soil; 8, 9: limestone rock; 11: soil along a rivulet
+ *Tomentypnum nitens* (Hedw.) Loeske – 10: wet meadow
+ *Tortella bambergeri* (Schimp.) Broth. – 5: limestone rock in thermophilous forest
+ *Tortella fragilis* (Hook. et Wilson) Limpr. – 5: limestone rock in thermophilous forest
Tortella tortuosa (Hedw.) Limpr. – 1, 4, 5, 6, 8, 9: limestone rock
Tortula muralis Hedw. – 5: limestone rock in thermophilous forest
Trichostomum crispulum Bruch – 5: limestone rock and limestone rock in thermophilous forest
Ulota bruchii Hornsch. ex Brid. – 2: bark of *Abies*; 7, 10: bark of *Fagus*
Ulota crispa (Hedw.) Brid. – 4, 7, 10: bark of *Fagus*
Weissia brachycarpa (Nees et Hornsch.) Jur. – 5: limestone rock in thermophilous forest
Weissia controversa Hedw. – 8: soil among limestone rocks
+ *Zygodon rupestris* Schimp. ex Lorentz – 10: bark of *Acer pseudoplatanus*

SPECIES REPORTED FOR THE FIRST TIME IN CROATIA

New species for the Croatian bryophyte flora found in 2011 were published separately in PAPP *et al.* (2013). These are: *Calypogeia muelleriana*, *Conocephalum salebrosum*, *Campylium protensum*, *Dicranodontium denudatum*, *Oxystegus tenuirostris*, *Plagiothecium curvifolium*, *P. platyphyllum*, *Pterigynandrum filiforme*, *Tortella bambergeri*, *T. fragilis*, *Zygodon rupestris*. *Mnium spinosum* is also reported in the above-mentioned paper, but it was found in Mt Velebit in 2011. In 2012 it was collected in the Gorski kotar Region, too.

Here we report five additional new species for the Croatian bryophyte flora found in 2012 in the Gorski kotar Region.

Jungermannia obovata is a boreal, montane liverwort (DÜLL 1983). In SE Europe it was known only from Bulgaria, Romania and Serbia according to SABOVLJEVIĆ and NATCHEVA (2006). Later on it was reported from Slovenia (MARTINČIČ 2011). It was found at Čogrljevo jezero (Moravice village) among limestone rocks by the lake.

Anoetangium aestivum is a rare, subarctic, subalpine moss (DÜLL 1984) living on shaded limestone rocks. In SE Europe it was known only from Romania (SABOVLJEVIĆ *et al.* 2008). Recently it was also reported from Montenegro (PAPP and ERZBERGER 2011). In the Gorski kotar Region it was collected at Samarske stijene from limestone rock.

Philonotis seriata is a boreal, montane species (DÜLL 1985) occurring in wetlands around sources and along rivulets, streams. It is known in almost all SE European countries (SABOVLJEVIĆ *et al.* 2008) except Croatia and the European part of Turkey. It was found in a basiphilous fen belonging to ass. *Carici-Blysmetum compressi* at Leska area near Crni lug village.

Plagiothecium laetum is a boreal species (DÜLL 1985) known from several SE European countries (SABOVLJEVIĆ *et al.* 2008) except Albania, Croatia, Former Yugoslav Republic of Macedonia and the European part of Turkey. It was found at Samarske stijene from limestone rock.

Tomentypnum nitens is a boreal species (DÜLL 1985) known from many SE European countries (SABOVLJEVIĆ *et al.* 2008) except Albania, Croatia, Greece, Former Yugoslav Republic of Macedonia and the European part of Turkey, but seems to be rare on the Balkans. It was collected in a basiphilous fen belonging to ass. *Carici-Blysmetum compressi* at Leska area near Crni lug village.

CONSERVATION MERITS OF THE BRYOPHYTE FLORA OF GORSKI KOTAR REGION

Six species found in the Gorski kotar Region are included in the Red data book of European bryophytes. These are as follows.

Lophozia ascendens is a boreal, montane leafy hepatic (DÜLL 1983). It is categorised as rare (R) in the Red data book of European bryophytes (ECCB 1995). It lives on decaying wood in humid habitats. In SE Europe it was recorded only in Bulgaria, Croatia, Romania and Serbia (SABOVLJEVIĆ and NATCHEVA 2006). Later it was reported from Montenegro (ERZBERGER *et al.* 2008) and Slovenia (MARTINČIČ 2011). In the Gorski kotar Region it was collected from decaying wood at Samarske stijene.

Brachydontium trichodes is a sub-Atlantic, montane species (DÜLL 1984) occurring on shaded acidic rocks. It is categorised as rare (R) in the Red data book of European bryophytes (ECCB 1995). It was recorded only in Bulgaria, Bosnia-Herzegovina, Romania and Slovenia (SABOVLJEVIĆ *et al.* 2008) and recently reported for the first time in Croatia based on a revised specimen collected in 1968 and deposited in the bryophyte herbarium of the Hungarian Natural History Museum (PAPP and SABOVLJEVIĆ 2009). As hereby reported we collected it from a sandstone rock near Zalesina village.

Buxbaumia viridis is a boreal, montane species (DÜLL 1984) living on well-decayed wood in constantly humid forests, sheltered or shaded places, rarely on humus-rich acidic soil. The Red data book of European bryophytes rates it as vulnerable and it is listed in the Bern Convention and the European Union Habitats and Species Directive (ECCB 1995). It is known from all SE European countries

except the European part of Turkey (SABOVLJEVIĆ *et al.* 2008). Apparently it is not rare in virgin forests, and also appears in managed old-growth forests in the Gorski kotar Region. A small population (few sporophytes on 4–5 trees) was found in the Golubinjak protected forest and quite a large population (sometimes 20–30 sporophytes on 50–100 trees) at Jasenak and around Zalesina village in managed forests.

Paraleucobryum sauteri is a sub-Atlantic, montane species (DÜLL 1984) living on shaded rocks and bases of trees. It is categorised as rare (R) in the Red data book of European bryophytes (ECCB 1995). It is known from almost all SE European countries except Albania, Former Yugoslav Republic of Macedonia, Romania and the European part of Turkey (SABOVLJEVIĆ *et al.* 2008). It was found on decaying wood at Samarske stijene. Generally, it has been known from the Gorski kotar Region; in the bryophyte collection of the Hungarian Natural History Museum there are two specimens in Degen's herbarium collected around Snježnik in 1904 and 1905.

Pseudoleskea saviana is a species of shaded volcanic rocks, but sometimes found on tree bark mainly at the bases of trunks. Listed in the regionally threatened (RT) category in the Red data book of European bryophytes (ECCB 1995), it is a continental-subalpine species found in the Alps and other areas towards east (DÜLL 1985) known from all SE European countries except the European part of Turkey (SABOVLJEVIĆ *et al.* 2008). It does not appear to be rare in SE Europe, evidenced by several collections in Albania, Bulgaria, Greece, Montenegro, Serbia, and the Former Yugoslav Republic of Macedonia (PAPP *et al.* 2009a, 2010, 2011a, PAPP and ERZBERGER 2009, 2010, 2012). It was collected from decaying wood at Samarske stijene.

Rhynchostegiella teneriffae is an Atlantic, sub-Mediterranean, montane species (DÜLL 1985) occurring on wet rocks along streams. It is categorised as rare (R) in the Red data book of European bryophytes (ECCB 1995) known from almost all SE European countries except Albania, Bulgaria, Former Yugoslav Republic of Macedonia and the European part of Turkey (MARTINČIČ 2003, SABOVLJEVIĆ *et al.* 2008). Recently, it was also reported from Bulgaria (PAPP *et al.* 2011b). In the Gorski kotar Region it was found on wet limestone rocks in Čabranka river.

An additional 34 taxa (9 liverworts and 25 mosses) are regarded as rare in SE Europe.

Several liverworts found in the Gorski kotar Region are rare in SE Europe exemplified by species of *Calypogeia*, which generally seem to be rare on the Balkans.

Calypogeia fissa, a sub-Atlantic-Mediterranean species (DÜLL 1983), is endangered (EN) in Serbia (SABOVLJEVIĆ *et al.* 2004) and in Bulgaria (NATCHEVA

et al. 2006) according to their national red lists. It is already known from all SE European countries as it has recently been reported from the Former Yugoslav Republic of Macedonia (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007, PAPP and ERZBERGER 2012).

Calypogeia muelleriana is a subboreal, montane species (DÜLL 1983). It is categorised as critically endangered (CR) in Serbia. According to SABOVLJEVIĆ and NATCHEVA (2006) and ROS *et al.* (2007) in SE Europe it was known only from Bulgaria, Romania, Serbia, Slovenia and the European part of Turkey. It was recently reported from Albania (MARKA and SABOVLJEVIĆ 2011), the Former Yugoslav Republic of Macedonia (PAPP and ERZBERGER 2012) and from our current collection as new for the Croatian bryophyte flora (PAPP *et al.* 2013). In the Gorski kotar Region it is a common species on decaying wood.

Numerous sub-Atlantic, montane liverworts (DÜLL 1983), among them another *Calypogeia* species, are also rare on the Balkans; these are *Calypogeia suecica*, *Cephalozia catenulata*, *Harpanthus scutatus*, *Mylia taylori*, *Odontoschisma denudatum* usually living on decaying wood in humid forests. According to ROS *et al.* (2007) most of these taxa have only very old records from Croatia.

Calypogeia suecica is known from almost all SE European countries except Albania, Greece, and the Former Yugoslav Republic of Macedonia and Montenegro (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007). Later it was also reported from Montenegro (ERZBERGER *et al.* 2008); it is endangered (EN) in Serbia (SABOVLJEVIĆ *et al.* 2004) and vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006). We found that it is a common species in the Gorski kotar Region.

Cephalozia catenulata is known from almost all SE European countries except Albania, and the Former Yugoslav Republic of Macedonia and Montenegro (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007), but it has recently been reported also from Montenegro (PAPP and ERZBERGER 2010). It is vulnerable (VU) in Serbia (SABOVLJEVIĆ *et al.* 2004), and endangered (EN) in Bulgaria (NATCHEVA *et al.* 2006); it is frequent in the Gorski kotar Region.

Harpanthus scutatus is known only from Bulgaria, Bosnia-Herzegovina, Croatia, Romania, Slovenia and the European part of Turkey (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007). According to the red list of Bulgaria (NATCHEVA *et al.* 2006) it is in the data deficient (DD) category.

Mylia taylori is reported only from Croatia, Romania, Serbia, Slovenia and the European part of Turkey (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007).

Odontoschisma denudatum is known only from Croatia, Romania and Slovenia (SABOVLJEVIĆ and NATCHEVA 2006). In Romania it is in the critically endangered (CR) category according to the red list of the country (ȘTEFĂNUȚ and GOIA 2012). It is frequent in the Gorski kotar Region.

Some liverwort species of the temperate zones of Europe (DÜLL 1983) are also rare in the Balkans. They are as follows.

Riccardia multifida is known from almost all SE European countries except the Former Yugoslav Republic of Macedonia and Montenegro (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007); subsequently, it was also reported from Montenegro (ERZBERGER and PAPP 2007). It thrives in wet places around springs and along rivulets. This liverwort is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006) and only a few recently discovered populations are known on the Balkans, e.g. in Serbia the Tara National Park (PAPP and SABOVLJEVIĆ 2002), the Golija-Studenica Biosphere Reserve (PAPP and ERZBERGER 2005) and the surroundings of Vlasina lake (PAPP *et al.* 2012).

Tritomaria exsecta is another liverwort occurring on decaying wood. It is known in SE Europe only from Bulgaria, Bosnia-Herzegovina, Croatia, Romania, Slovenia and the European part of Turkey (SABOVLJEVIĆ and NATCHEVA 2006, ROS *et al.* 2007). It is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006). According to ROS *et al.* (2007) it had only some very old records from Croatia.

Some moss species of wet meadows are also considered rare in SE Europe, these include *Calliargon giganteum*, *Tomentypnum nitens*, and species of *Sphagnum*.

Calliargon giganteum is a vulnerable (VU) species in Serbia and Montenegro (SABOVLJEVIĆ *et al.* 2004) and endangered (EN) in Bulgaria (NATCHEVA *et al.* 2006). There is only one earlier record (from 1909) of the species from Croatia (Mt Velebit) in the Degen's herbarium deposited in the Hungarian Natural History Museum. In Montenegro, only one existing population is known at Barno jezero in the Durmitor Mts (PAPP and ERZBERGER 2010).

Tomentypnum nitens is an endangered (EN) species in Serbia (SABOVLJEVIĆ *et al.* 2004) and in Bulgaria (NATCHEVA *et al.* 2006). It has only one recently known population in Serbia at Vlasina lake (PAPP *et al.* 2012). In Montenegro also only one existing population is known, in the same place as *C. giganteum*, at Barno jezero in the Durmitor Mts (PAPP and ERZBERGER 2010). It is reported here as a species new for the Croatian bryophyte flora.

Sphagnum species are usually endangered in SE Europe due to the rarity, small extent and vulnerability of *Sphagnum* bogs and wetlands. All *Sphagnum* species are vulnerable (VU) in Serbia (SABOVLJEVIĆ *et al.* 2004). Concerning the species found by us in Gorski kotar Region, *Sphagnum auriculatum* is vulnerable (VU), while *S. subsecundum* is near threatened (NT) in Romania (ȘTEFĂNUȚ and GOIA 2012).

Several Atlantic, sub-Atlantic species (DÜLL 1984, 1985) occurring in the Gorski kotar Region become rare at locations approaching their eastern range of distribution, as in other parts of the Balkans. Such species include *Barbula crocea*, *Entodon concinnus*, *Hookeria lucens*, *Isoetecium myosuroides*, *Neckera pumila*,

Plagiothecium platyphyllum, *P. undulatum*, *Platydictya jungermannioides*, *Thuidium tamariscinum*, *Ulota bruchi*, and *Zygodon rupestris*.

Barbula crocea is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006), near threatened (NT) in Romania (ȘTEFĂNUȚ and GOIA 2012), and data deficient (DD) in Serbia (SABOVLJEVIĆ *et al.* 2004).

Entodon concinnus is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006), and near threatened (NT) in Romania (ȘTEFĂNUȚ and GOIA 2012).

Hookeria lucens is known in SE Europe only from Bosnia-Herzegovina, Croatia, Romania, Serbia and Slovenia (SABOVLJEVIĆ *et al.* 2008). It was recently reported from Serbia (PAPP and ERZBERGER 2005) and until now this is its only known locality in the country. It is vulnerable (VU) in Romania (ȘTEFĂNUȚ and GOIA 2012). It can be regarded as common in the Gorski kotar Region on wet soils around springs and rivulets.

Isothecium myosuroides is included in CR category for Bulgaria (NATCHEVA *et al.* 2006). It has been recently reported as new species in the bryophyte flora of Albania (PAPP *et al.* 2010) only from a single locality in the country. It is a rather common species in the Gorski kotar Region mainly on tree barks.

Neckera pumila is endangered (EN) in Bulgaria (NATCHEVA *et al.* 2006), vulnerable (VU) in Romania (ȘTEFĂNUȚ and GOIA 2012), and data deficient (DD) in Serbia and Montenegro (SABOVLJEVIĆ *et al.* 2004).

Plagiothecium platyphyllum is already known from almost all SE European countries except Albania and Bosnia-Herzegovina as it has recently been recorded in Greece (SABOVLJEVIĆ *et al.* 2008, PAPP *et al.* 2011a). From a recent collection it is reported as new for the Croatian bryophyte flora (PAPP *et al.* 2013). It is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006) and near threatened (NT) in Romania (ȘTEFĂNUȚ and GOIA 2012).

Plagiothecium undulatum was reported only from Bulgaria, Bosnia-Herzegovina, Croatia, Romania, Serbia and Slovenia in SE Europe (SABOVLJEVIĆ *et al.* 2008). It is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006). It is common in the Gorski kotar Region on wet soils.

Platydictya jungermannioides is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006), and near threatened (NT) in Romania (ȘTEFĂNUȚ and GOIA 2012).

Thuidium tamariscinum is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006). It is a common and even abundant species in the Gorski kotar Region on soils, decaying wood and shaded rocks.

Ulota bruchi was reported in SE Europe only from Bosnia-Herzegovina, Croatia, Romania, Serbia and Slovenia (SABOVLJEVIĆ *et al.* 2008). It has recently been recorded in Bulgaria (PAPP *et al.* 2011b) and Montenegro (ERZBERGER *et al.* 2008). It is vulnerable (VU) in Serbia (SABOVLJEVIĆ *et al.* 2004) and data deficient (DD) in Romania (ȘTEFĂNUȚ and GOIA 2012).

Zygodon rupestris has been reported in SE Europe only from Greece, Montenegro, Romania, Serbia, Slovenia and the European part of Turkey (SABOVLJEVIĆ *et al.* 2008). It has recently been recorded in Bulgaria (NATCHEVA 2008), the Former Yugoslav Republic of Macedonia (PAPP and ERZBERGER 2012) and from this collection as new for the Croatian bryophyte flora (PAPP *et al.* 2013). It is in data deficient (DD) category in Romania (ȘTEFĂNUȚ and GOIA 2012).

Some boreal, montane or subalpine, subarctic species (DÜLL 1984, 1985) found in Gorski kotar are rare in SE Europe, e.g. *Anoetangium aestivum*, *Dicranodontium denudatum*, *Isopterygiopsis pulchella*, *Orthothecium rufescens*, *Plagiobryum zierii*, and *Tortella fragilis*.

Anoetangium aestivum is a very rare moss in SE Europe living in limestone rock crevices. It is known only from Romania (SABOVLJEVIĆ *et al.* 2008). It is reported here as a species new for the Croatian bryoflora. From Montenegro, it has also been recently reported (PAPP and ERZBERGER 2011) and until now this is the only known locality of the species in the country. It is near threatened (NT) in Romania (ȘTEFĂNUȚ and GOIA 2012). In the Gorski kotar Region only a small patch of the species was found at Samarske stijene.

Dicranodontium denudatum is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006). It has recently been reported from our current collection as new for the Croatian bryophyte flora (PAPP *et al.* 2013). This species is frequent and even abundant on decaying wood in Gorski kotar Region.

Isopterygiopsis pulchella is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006) and recorded in the lower risk (LR) category in Serbia and Montenegro (SABOVLJEVIĆ *et al.* 2004).

Orthothecium rufescens is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006). The recently known populations in Serbia and Montenegro are usually small (PAPP and ERZBERGER 2007, 2009, 2010, PAPP *et al.* 2008).

Plagiobryum zierii is already known from almost all SE European countries except Greece and the European part of Turkey as it has recently been recorded in Albania (SABOVLJEVIĆ *et al.* 2008, PAPP *et al.* 2009b). It is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006) and is in the lower risk (LR) category in Serbia and Montenegro (SABOVLJEVIĆ *et al.* 2004). The recently known populations in Serbia and Montenegro are usually small (PAPP and ERZBERGER 2007, 2010, PAPP *et al.* 2004, 2008).

Tortella fragilis is known in SE Europe only from Bulgaria, Bosnia-Herzegovina, Montenegro, Romania, Serbia and Slovenia according to SABOVLJEVIĆ *et al.* (2008). It has recently been reported from our current collection as new for the Croatian bryophyte flora (PAPP *et al.* 2013). It is vulnerable (VU) in Bulgaria (NATCHEVA *et al.* 2006).

Additionally, *Syntrichia latifolia*, an epiphyte species of temperate zones of Europe (DÜLL 1984) seems to be also rare on the Balkans. It is critically endangered in Bulgaria (NATCHEVA *et al.* 2006) and vulnerable (VU) in Romania (ȘTEFĂNUȚ and GOIA 2012).

CONCLUSIONS

Gorski kotar Region maintains a very high level of bryophyte diversity thanks to its rich geological diversity (limestones, dolomites, siliceous rocks), favourable climatic conditions (montane climate regimes with locally high yearly precipitation) and habitat diversity (wetland remnants, extended old-growth forests, an abundance of rocky outcrops). Based on our collections the bryophyte flora seems to be very rich in species that are usually rare on the Balkans. Several Atlantic, sub-Atlantic elements reach the margin of their eastern distribution here, and become very rare towards east on other parts of SE Europe. Additionally, numerous rare boreal, alpine bryophyte species also occur in this mountainous area, which – thanks to its continuity towards the alpine system westward – represents a bridge between the Alpine and Dinaric phytogeographical regions. Occurrence of these species is possible because of suitable environmental conditions, first of all by humid climate and prevalence of limestone bedrocks. The numerous populations of European redlisted species that turned up in our recent collections also highlight the importance of this area from the aspect of bryophyte conservation.

*

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