

**AN INSIGHT INTO THE BRYOPHYTE FLORA
OF THE IBAR GORGE AND ITS SURROUNDINGS
(CENTRAL AND SW SERBIA)**

Full text metadata, citation and similar papers at core.ac.uk

provided by Re

H-1431, Budapest, Pf. 137, Hungary; E-mail: pappbea@bot.nhmus.hu

²Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade
11000 Belgrade, Serbia

(Received 5 May, 2016; Accepted 15 July, 2016)

A total of 126 bryophyte taxa (12 liverworts and 114 mosses) were collected in the Ibar gorge and its surroundings. The climate of the gorge receives Mediterranean influence, hence almost one fourth part of the species found are Mediterranean, sub-Mediterranean, or sub-Atlantic elements. Several rare species in Serbia and in the Balkans can be found in the territory (e.g. *Bryum gemmiferum*, *Dialytrichia mucronata*, *Didymodon nicholsonii*, *Grimmia lisa*, *Gymnostomum viridulum*, *Hygroamblystegium humile*, *Orthotrichum obtusifolium*, *Syntrichia latifolia*). One species (*Buxbaumia viridis*) is included in the Bern Convention and the European Union Habitats and Species Directives. The Ibar gorge maintains a unique bryophyte assemblage due to the serpentine bedrock and continental, Mediterranean climatic influence, which are the main characteristics of the region.

Key words: European red-listed species, liverworts, mosses, rare bryophytes, the Balkans

INTRODUCTION

After the decades of the neglect of bryophyte investigation in Serbia, the last 15 years brought a lot of novelties to the national flora. New species records and the confirmation of old and forgotten bryophyte taxa continuously appear with every new investigation conducted in some area of Serbia. Sabovljević and Stevanović (1999) cited 423 moss species for Serbia, while the subsequent updated checklists (Sabovljević *et al.* 2008: 555 species and Ros *et al.* 2013: 575) show significant growth in the number of species. Similarly, Sabovljević (2000) cited 81 liverwort species for Serbia, and Sabovljević and Natcheva (2006) and Ros *et al.* (2007) cited 118 and 120 liverworts, respec-

tively. Apart from the list of species already published in these references, additional new records can be mentioned, *e.g.* more recently in Papp *et al.* 2014c, d, e, 2015).

The present study brings an overview of the bryophyte species recorded in previously not investigated area of Ibarski kraj, in the region of Central and SW Serbia.

MATERIAL AND METHODS

Study area

The river Ibar flows to north in the area of SW–Central Serbia and forms its lower part through ravines and gorges before enters to the river Western Morava (Zapadna Morava). This part of the lower river flow is surrounded by hills, slopes and also the Stolovi Mts. There, in its lower course the Ibar receives its major tributaries: Raška, Studenica, Jošanica and Lopatnica rivers, and became rather powerful river. In this section, the river has carved the 40 km long and 550 m deep Ibar gorge. The whole area is *ca* 110 km long and 15–20 km wide, and known as Ibarski kraj (Marković 1990). The lower course of Ibar is divided into several valleys among the mountains of Golija, Čemerno, Troglav, Kopaonik, Željina and Stolovi.

The Stolovi Mts is one of the mountains that stretches along the Ibar gorge. It is *ca* 12 km long. The highest peak is Usovica (1,375 m). The southern slopes are quite naked or covered by rocky grasslands. The northern slopes are overgrown by different forests mainly predominated by thermophilous types.

The region of the Ibar gorge and its surroundings (including neighbouring mountains) is geologically mixed and complex with various types of rocks; serpentinite and serpentinised peridotite, basic and ultrabasic igneous rocks, limestone from the Triassic; flysch, dacite-andesite volcanic formations and sediments from the Tertiary and Quaternary (Mladenović 2010). In the Stolovi Mts mainly acidic soils are frequent, naturally overloaded with magnesium and chromium. However, the main characteristics of the region are ultramafic rocks and soils.

The climate has continental and Mediterranean influence with cold winters and hot summers and long summer drought period.

Methods

Our fieldwork was carried out at 11 localities (Fig. 1) in April 2013 (see details below). All main habitat types, such as river bank, rock formations, grasslands and forests were investigated, and bryophytes collected from different substrates (soil, exposed and shaded rocks, tree bark, and decaying wood).

Voucher specimens are deposited in the collections of the Hungarian Natural History Museum, Budapest (BP) and Belgrade University Herbarium (BEOU). Nomenclature follows Grolle and Long (2000) for liverworts and Smith (2004) and Hill *et al.* (2006) for mosses. European distribution of the species is given according to Düll (1983, 1984, 1985).

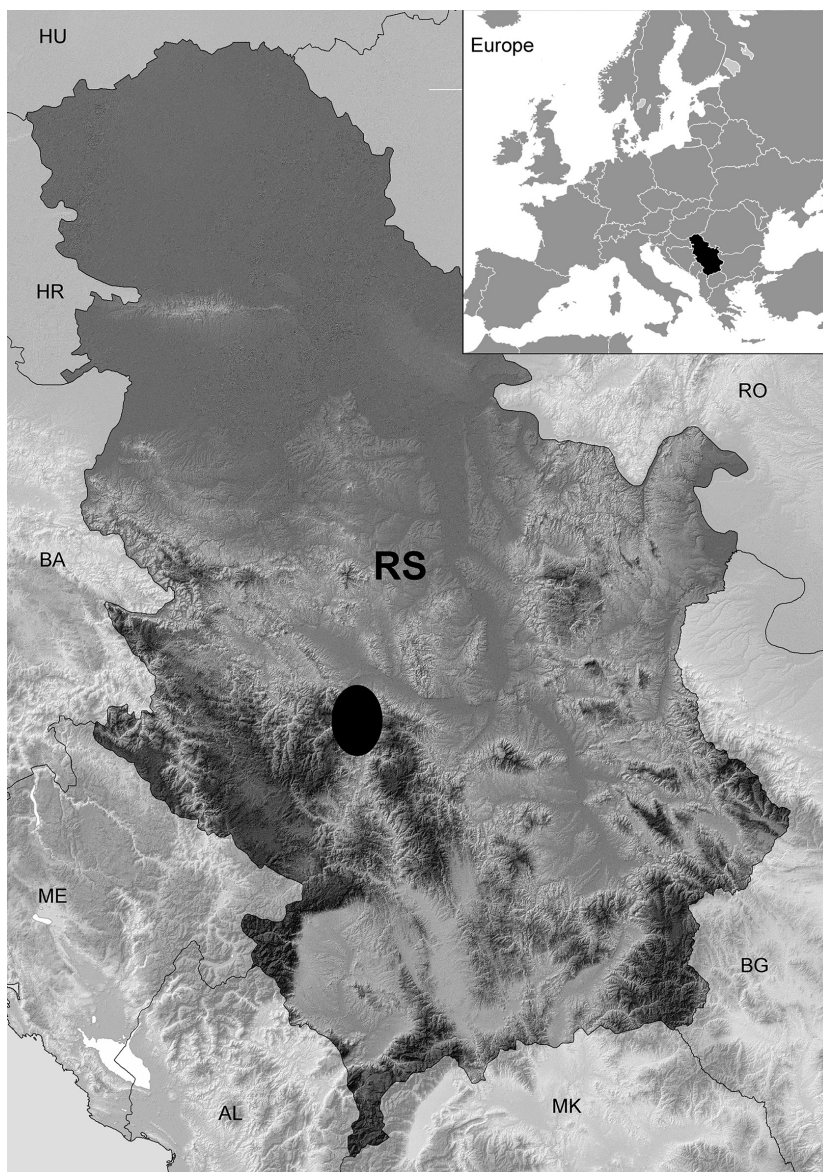


Fig. 1. Location of the studied area

Locality details

1. SW Serbia, Ibar gorge, at Maglič castle, 43° 36' 43.2" N, 20° 33' 09.0" E, 285 m, 24.04.2013.
2. Central Serbia, Stolovi Mts, by town of Kraljevo, 43° 37' 54.2" N, 20° 37' 27.1" E, 780 m, 25.04.2013.
3. Central Serbia, Stolovi Mts, by town of Kraljevo, towards Usovica peak, in *Abieto-Fagetum*, 43° 37' 39.9" N, 20° 36' 28.2" E, 1,080 m, 25.04.2013.
4. Central Serbia, Stolovi Mts, by town of Kraljevo, near Usovica peak, 43° 37' 36.1" N, 20° 35' 48.8" E, 1,170 m, 25.04.2013.
5. Central Serbia, Stolovi Mts, by town of Kraljevo, 43° 37' 55.3" N, 20° 37' 53.8" E, 655 m, 25.04.2013.
6. Central Serbia, Stolovi Mts, by town of Kraljevo, 43° 36' 36.4" N, 20° 40' 09.5" E, 460 m, 25.04.2013.
7. SW Serbia, Ibar gorge, between Ušće and Maglič castle, along the river Ibar, 43° 30' 45.5" N, 20° 36' 53.9" E, 330 m, 26.04.2013.
8. SW Serbia, Ibar gorge, between Ušće and Maglič castle, on the bank of the river Ibar, 43° 33' 27.3" N, 20° 37' 07.0" E, 320 m, 26.04.2013.
9. SW Serbia, Ibar gorge, bank of the river Ibar at Maglič castle, 43° 36' 40.4" N, 20° 33' 12.3" E, 270 m, 26.04.2013.
10. Central Serbia, road side at Bogutovačka banja, 43° 39' 20.4" N, 20° 32' 18.0" E, 340 m, 27.04.2013.
11. Central Serbia, along the road to Bogutovačka banja, 43° 39' 15.9" N, 20° 32' 41.3" E, 255 m, 27.04.2013.

RESULTS AND DISCUSSION

A total of 126 bryophyte taxa (12 liverworts and 114 mosses) were collected in the Ibar gorge and its surroundings. The numerals following the species names refer to the collection sites described above.

Hepaticae

Barbilophozia barbata (Schreb.) Loeske – 1: serpentine grassland

Cephaloziella divaricata (Sm.) Schiffn. – 1, 4: serpentine grassland; 7: shaded serpentine rock

Frullania dilatata (L.) Dumort. – 1: serpentine grassland and bark of *Fraxinus ornus*; 3, 4: serpentine rock; 9: bark of *Alnus*; 11: *Fraxinus* bark

Lophocolea heterophylla (Schrad.) Dumort. – 3: decaying wood

Lophocolea minor Nees – 1: serpentine grassland and along a stream valley; 10: lime-containing schistose rock

Metzgeria conjugata Lindb. – 1: along a stream valley

Metzgeria furcata (L.) Dumort. – 1: along a stream valley; 3: serpentine rock

Pellia endiviifolia (Dicks.) Dumort. – 11: wet, lime-containing schistose rock

Pagiochila porelloides (Torrey ex Nees) Lindenb. – 1: along a stream valley

Radula complanata (L.) Dumort. – 3: serpentine rock; 7: shaded serpentine rock; 11: *Fraxinus* bark

Reboulia hemisphaerica (L.) Raddi – 1: serpentine grassland

Riccia sorocarpa Bisch. – 4: serpentine grassland

Musci

- Abietinella abietina* (Hedw.) M. Fleisch. – 1: serpentine grassland; 6: serpentine rock at a stream; 10: lime-containing schistose rock
- Amblystegium serpens* (Hedw.) Schimp. – 1: serpentine grassland and along a stream valley; 7: shaded serpentine rock, bank of the river and bark of *Acer campestre*; 10, 11: lime-containing schistose rock
- Anomodon attenuatus* (Hedw.) Huebener – 7: bark of *Acer campestre*; 10: lime-containing schistose rock
- Anomodon viticulosus* (Hedw.) Hook. et Taylor – 1: serpentine grassland
- Atrichum undulatum* (Hedw.) P. Beauv. – 3: soil
- Barbula convoluta* Hedw. – 1: serpentine grassland; 10: wet, lime-containing schistose rock
- Barbula unguiculata* Hedw. – 1: serpentine grassland; 7, 9: bank of the river; 10: lime-containing schistose rock
- Brachytheciastrum velutinum* (Hedw.) Ignatov et Huttunen – 1: along a stream valley; 2: soil among serpentine rocks; 3: decaying wood; 7: shaded serpentine rock
- Brachythecium albicans* (Hedw.) Schimp. – 1: serpentine grassland
- Brachythecium glareosum* (Bruch ex Spruce) Schimp. – 10: lime-containing schistose rock
- Brachythecium rivulare* Schimp. – 1: along a stream valley
- Brachythecium rutabulum* (Hedw.) Schimp. – 3: decaying wood; 7, 9: bank of the river; 8: bank of the river and bark of *Salix*
- Bryoerythrophyllum recurvirostrum* (Hedw.) P. C. Chen – 1: serpentine grassland; 8: bark of *Salix*; 9: bark of *Alnus*
- Bryum alpinum* Huds. ex With. – 1, 4: serpentine grassland; 2: at a rivulet
- Bryum argenteum* Hedw. – 1: serpentine grassland; 7: shaded serpentine rock
- Bryum caespiticium* Hedw. – 1, 4: serpentine grassland; 10: lime-containing schistose rock
- Bryum capillare* Hedw. – 1: serpentine grassland; 3: decaying wood; 7: shaded serpentine rock
- Bryum dichotomum* Hedw. – 2, 4: soil among serpentine rocks
- Bryum gemmiferum* R. Wilczek et Demaret – 7, 9: bank of the river
- Bryum moravicum* Podp. – 2: soil among serpentine rocks; 7: shaded serpentine rock; 8: bark of *Salix*; 9: bark of *Alnus*; 10: lime-containing schistose rock
- Bryum pallens* Sw. ex anon. – 11: wet, lime-containing schistose rock
- Bryum pseudotriquetrum* (Hedw.) P. Gaertn. et al. – 1, 2: along a rivulet; 5, 6: serpentine rock at a stream
- Bryum ruderale* Crundw. et Nyholm – 4: serpentine grassland; 10: lime-containing schistose rock
- Buxbaumia viridis* (Moug. ex Lam. et DC.) Brid. ex Moug. et Nestl. – 3: decaying wood
- Calliergonella cuspidata* (Hedw.) Loeske – 9: bank of the river
- Campylophyllum calcareum* (Crundw. et Nyholm) Hedenäs – 1: serpentine grassland; 10: lime-containing schistose rock
- Ceratodon purpureus* (Hedw.) Brid. – 4: serpentine grassland; 7: shaded serpentine rock
- Cinclidotus fontinaloides* (Hedw.) P. Beauv. – 9: bank of the river
- Cirriphyllum crassinervium* (Taylor) Loeske et M. Fleisch. – 7: shaded serpentine rock
- Cratoneuron filicinum* (Hedw.) Spruce – 1, 7: along a rivulet; 5, 6: serpentine rock at a stream; 9: bank of the river; 11: wet, lime-containing schistose rock
- Ctenidium molluscum* (Hedw.) Mitt. – 3: serpentine rock
- Dialytrichia mucronata* (Brid.) Broth. – 8: bank of the river and bark of *Salix*
- Dicranum scoparium* Hedw. – 1: serpentine grassland
- Didymodon fallax* (Hedw.) R. H. Zander – 1: serpentine grassland

- Didymodon insulanus* (De Not.) M. O. Hill – 1: serpentine grassland; 7: shaded serpentine rock; 11: lime-containing schistose rock
- Didymodon luridus* Hornsch. – 1: serpentine grassland; 8: bank of the river; 10: lime-containing schistose rock
- Didymodon nicholsonii* Culm. – 8: bank of the river
- Didymodon rigidulus* Hedw. – 10, 11: lime-containing schistose rock
- Didymodon sinuosus* (Mitt.) Delogne – 1: along a stream valley; 7: shaded serpentine rock and at a rivulet; 8: bank of the river and bark of *Salix*; 9: bank of the river
- Didymodon topiaceus* (Brid.) Lisa – 1: along a rivulet; 9: bank of the river; 10: wet, lime-containing schistose rock
- Encalypta streptocarpa* Hedw. – 1: serpentine grassland; 10: wet, lime-containing schistose rock; 11: lime-containing schistose rock
- Encalypta vulgaris* Hedw. – 1: serpentine grassland
- Eucladium verticillatum* (With.) Bruch et Schimp. – 10, 11: wet, lime-containing schistose rock
- Fissidens crassipes* Wilson ex Bruch et Schimp. – 7: at a rivulet
- Fissidens dubius* P. Beauv. – 1: along a stream valley; 2: soil among serpentine rocks; 3: serpentine rock; 10: lime-containing schistose rock
- Fissidens gracilifolius* Brugg.-Nann. et Nyholm – 10: wet, lime-containing schistose rock
- Funaria hygrometrica* Hedw. – 1: serpentine grassland; 2: at a rivulet
- Grimmia hartmanii* Schimp. – 3: serpentine rock
- Grimmia laevigata* (Brid.) Brid. – 1: serpentine grassland
- Grimmia lisae* De Not. – 1, 4: serpentine grassland; 5: serpentine rock at a stream
- Grimmia ovalis* (Hedw.) Lindb. – 1: serpentine grassland
- Grimmia pulvinata* (Hedw.) Sm. – 1: serpentine grassland and bark of *Juglans regia*; 4: serpentine rock; 5: serpentine rock at a stream
- Gymnostomum aeruginosum* Sm. – 11: wet, lime-containing schistose rock
- Gymnostomum viridulum* Brid. – 10: wet, lime-containing schistose rock
- Hedwigia ciliata* (Hedw.) P. Beauv. – 1: serpentine grassland
- Herzogiella seligeri* (Brid.) Z. Iwats. – 2: soil among serpentine rocks; 3: decaying wood
- Homalothecium sericeum* (Hedw.) Schimp. – 1: serpentine grassland; 7: shaded serpentine rock; 11: lime-containing schistose rock
- Homomallium incurvatum* (Schr. ex Brid.) Loeske – 7: shaded serpentine rock
- Hygroamblystegium humile* (P. Beauv.) Vanderp., Goffinet et Hedenäs – 7: bank of the river
- Hygroamblystegium varium* (Hedw.) Mönk. – 7, 8: bank of the river
- Hylocomium splendens* (Hedw.) Schimp. – 1: serpentine grassland
- Hypnum cupressiforme* Hedw. var. *cupressiforme* – 1, 4: serpentine grassland; 2, 3: serpentine rock; 7: shaded serpentine rock and bark of *Acer campestre*; 10, 11: lime-containing schistose rock
- Hypnum cupressiforme* Hedw. var. *lacunosum* Brid. – 1: along a stream valley; 6: serpentine rock at a stream
- Isothecium alopecuroides* (Lam. ex Dubois) Isov. – 1: along a stream valley; 3: serpentine rock
- Leptodictyum riparium* (Hedw.) Warnst. – 7: bank of the river
- Leskea polycarpa* Hedw. – 7: shaded serpentine rock, bank of the river and bark of *Acer campestre*; 8: bank of the river; 11: *Fraxinus* bark
- Leucodon sciuroides* (Hedw.) Schwägr. – 1: serpentine grassland; 7: shaded serpentine rock; 11: *Fraxinus* bark
- Mnium lycopodioides* Schwägr. – 7: bank of the river

- Mnium marginatum* (Dicks.) P. Beauv. – 8: bank of the river and bark of *Salix*
Neckera besseri (Lobarz.) Jur. – 7: shaded serpentine rock
Orthotrichum affine Schrad. ex Brid. – 1: bark of *Fraxinus ornus*; 11: *Fraxinus* bark
Orthotrichum anomalum Hedw. – 1: serpentine grassland and bark of *Juglans regia* and *Fraxinus ornus*; 7: shaded serpentine rock
Orthotrichum cupulatum Hoffm. ex Brid. var. *riparium* Huebener – 9: bank of the river
Orthotrichum diaphanum Schrad. ex Brid. – 1: bark of *Juglans regia*
Orthotrichum lyellii Hook. et Taylor – 11: *Fraxinus* bark
Orthotrichum obtusifolium Brid. – 11: *Fraxinus* bark
Orthotrichum pumilum Sw. ex anon. – 1: bark of *Juglans regia* and *Fraxinus ornus*
Orthotrichum striatum Hedw. – 1: bark of *Fraxinus ornus*; 11: *Fraxinus* bark
Oxyrrhynchium hians (Hedw.) Loeske – 1: along a stream valley; 8: bank of the river; 10: lime-containing schistose rock
Oxyrrhynchium pumilum (Wilson) Loeske – 7: at a rivulet
Phascum cuspidatum Hedw. – 1: serpentine grassland
Plagiomnium affine (Blandow ex Funck) T. J. Kop. – 1: along a stream valley
Plagiomnium cuspidatum (Hedw.) T. J. Kop. – 8: bark of *Salix*
Platygyrium repens (Brid.) Schimp. – 7: bark of *Acer campestre*
Platyhypnidium riparioides (Hedw.) Dixon – 1, 7: along a rivulet; 8: bank of the river
Pleurochaete squarrosa (Brid.) Lindb. – 1: serpentine grassland
Polytrichastrum formosum (Hedw.) G. L. Sm. – 2: soil among serpentine rocks; 4: serpentine grassland
Polytrichum piliferum Hedw. – 7: shaded serpentine rock
Pseudocrossidium horschuchianum (Schultz) R. H. Zander – 1: serpentine grassland
Pseudoleskeella nervosa (Brid.) Nyholm – 1: serpentine grassland; 7: bark of *Robinia pseudoacacia*; 11: *Fraxinus* bark
Pseudoscleropodium purum (Hedw.) M. Fleisch. – 1: along a stream valley; 2: soil among serpentine rocks
Pterigynandrum filiforme Hedw. – 3: serpentine rock
Pylaisia polyantha (Hedw.) Schimp. – 1: serpentine grassland; 11: *Fraxinus* bark
Rhynchostegiella tenella (Dicks.) Limpr. – 10: wet, lime-containing schistose rock
Rhynchostegium confertum (Dicks.) Schimp. – 7: shaded serpentine rock
Rhynchostegium murale (Hedw.) Schimp. – 10: lime-containing schistose rock
Schistidium apocarpum (Hedw.) Bruch et Schimp. – 1: serpentine grassland; 3: serpentine rock; 10: lime-containing schistose rock
Schistidium crassipilum H. H. Blom – 1: serpentine grassland; 10: lime-containing schistose rock
Schistidium papillosum Culm. – 5: serpentine rock at a stream
Sciuro-hypnum populeum (Hedw.) Ignatov et Huttunen – 3: serpentine rock; 8: bank of the river
Syntrichia latifolia (Bruch ex Hartm.) Huebener – 9: bark of *Alnus*
Syntrichia montana Nees – 1: serpentine grassland
Syntrichia papillosa (Wilson) Jur. – 1: bark of *Juglans regia*; 11: *Fraxinus* bark
Syntrichia ruralis (Hedw.) F. Weber et D. Mohr – 1: serpentine grassland
Syntrichia virescens (De Not.) Ochyra – 1: bark of *Juglans regia*
Taxiphyllum wissgrillii (Garov.) Wijk et Margad. – 7: at a rivulet
Thuidium assimile (Mitt.) A. Jaeger – 1: serpentine grassland and along a stream valley; 10: lime-containing schistose rock

- Tortella tortuosa* (Hedw.) Limpr. – 1: serpentine grassland; 10: wet, lime-containing schistose rock; 11: lime-containing schistose rock
Tortula inermis (Brid.) Mont. – 1: serpentine grassland
Tortula muralis Hedw. – 1: serpentine grassland; 7: shaded serpentine rock; 10: lime-containing schistose rock
Tortula subulata Hedw. – 7: shaded serpentine rock; 10, 11: lime-containing schistose rock
Weissia brachycarpa (Nees et Hornsch.) Jur. – 1: serpentine grassland; 2: soil among serpentine rocks; 10: lime-containing schistose rock
Weissia controversa Hedw. – 1: serpentine grassland and along a stream valley
Weissia longifolia Mitt. – 1: serpentine grassland; 2: soil among serpentine rocks

Bryophyte vegetation and its nature conservation merit

In the serpentine grasslands on slopes of the valley the occurrence of several sub-Mediterranean and Mediterranean elements are characteristic, e.g. *Didymodon insulanus*, *D. luridus*, *Encalypta vulgaris*, *Grimmia laeovigata*, *G. lisae*, *Pleurochaete squarrosa*, *Pseudocrossidium horschuchianum*, *Syntrichia montana*, and *Tortula inermis*. *Grimmia lisae* has been recently reported for the first time in Serbia from this collection (Papp *et al.* 2016). It has a very large population in the grasslands at Maglič castle. Many common species of temperate zone of Europe are also abundant in the grasslands like *Barbula* species (*B. convoluta*, *B. unguiculata*), *Bryum* species (*B. argenteum*, *B. caespiticium*, *B. capillare*, *B. dichotomum*), *Didymodon fallax*, *Grimmia pulvinata*, *Orthotrichum anomalum*, *Phascum cuspidatum*, *Syntrichia ruralis*, and *Weissia* species (*W. brachycarpa*, *W. controversa*, *W. longifolia*).

Many sub-Mediterranean species occur in the riverbank of Ibar and along streams, rivulets flowing into the river, like *Cinclidotus fontinaloides*, *Dialytrichia mucronata*, *Didymodon luridus*, *D. nicholsonii*, *D. sinuosus*, *Fissidens crassipes*, *Oxyrrhynchium pumilum*. In spite of its southern distribution *Dialytrichia mucronata* is rare in most of the Balkan countries and it has been recently reported in Serbia from this collection (Papp *et al.* 2016). *Didymodon nicholsonii* is known only from Greece (Sabovljević *et al.* 2008) and it has been recently reported from Montenegro (Papp *et al.* 2014a) and Serbia (Papp *et al.* 2015). *Oxyrrhynchium pumilum* is red-listed as critically endangered (CR) in Romania (Ștefănuț and Goia 2012) and as endangered (EN) in Bulgaria (Natcheva 2015). In the Red data book of the Republic of Bulgaria (Natcheva 2015) only two known localities are mentioned from western Bulgaria, although several populations were reported from the Strandzha Mts (Papp *et al.* 2011). In Serbia it is known from Petnica region (Papp and Sabovljević 2001) and from the Djerdap National Park (Papp *et al.* 2006).

Another rare species in the Balkans, which is living in the riverbank, is *Bryum gemmiferum*, a southern sub-Atlantic element, known only from Roma-

nia and Serbia. In both countries it is red-listed; critically endangered (CR) in Romania (Ștefănuț and Goia 2012), vulnerable (VU) in Serbia (Sabovljević *et al.* 2004).

Moreover, mainly common species of the temperate zone of Europe (e.g. *Amblystegium serpens*, *Barbula unguiculata*, *Brachythecium rutabulum*, *Oxyrrhynchium hians*) and temperate hygrophytes (like *Bryum pseudotriquetrum*, *Calliergonella cuspidata*, *Cratoneuron filicinum*, *Didymodon tophaceus*, *Hygroamblystegium humile*, *H. varium*, *Leptodictyum riparium*, *Leskea polycarpa*, *Orthotrichum cupulatum* var. *cupulatum*, and *Platyhypnidium riparioides*) predominate in the riverbank and along streams, rivulets. *Hygroamblystegium humile* is red-listed as vulnerable (VU) in Bulgaria (Ganeva 2015) and in Slovenia (Martinčič 1992). In Serbia it is known only from Petnica region (Papp and Sabovljević 2001) and from the Jerma gorge (E Serbia) (Papp and Erzberger 2009). Some boreal, subboreal species also appear, like *Brachythecium rivulare*, *Mnium lycopodioides*, *M. marginatum*, *Plagiochila porelloides*. *Mnium lycopodioides* is red-listed as vulnerable (VU) in Bulgaria (Natcheva 2015) and in Romania (Ștefănuț and Goia 2012).

On shaded serpentine rocks some sub-Mediterranean, sub-Atlantic elements also appear (e.g. *Cirriphyllum crassinervium*, *Rhynchostegium confertum*), but mainly species of the temperate zone of Europe are characteristic (e.g. *Cephaloziella divaricata*, *Amblystegium serpens*, *Brachytheciastrum velutinum*, *Bryoerythrophyllum recurvirostrum*, *Bryum capillare*, *B. moravicum*, *Homalothecium sericeum*, *Hypnum cupressiforme*, *Leucodon sciuroides*, *Orthotrichum anomalum*, *Radula complanata*) accompanied by some subboreal species, like *Hedwigia ciliata*, *Homomallium incurvatum*, *Tortula subulata* or subcontinental elements as *Neckera besseri*.

Trees in the river valley maintain rich epiphytic flora, mainly species of the temperate zone of Europe, like *Frullania dilatata*, *Orthotrichum affine*, *O. anomalum*, *O. diaphanum*, *O. pumilum*, *Syntrichia virescens*, *S. papillosa*. A rare species in the Balkans, *Syntrichia latifolia*, was found on the bark of *Alnus* in the riverbank. This is red-listed in Romania as vulnerable (VU) (Ștefănuț and Goia 2012) and in Bulgaria as critically endangered (CR), where only its two small populations are known (Ganeva 2015).

On wet, lime-containing schistose rocks at Bogutovačka banja calciphilous species were collected, like the boreal *Bryum pallens*, *Gymnostomum aeruginosum*, the Mediterranean *Gymnostomum viridulum*, the sub-Mediterranean, sub-Atlantic *Eucladium verticillatum*, *Campylophyllum calcareum*, and *Rhynchostegiella tenella*. *Gymnostomum viridulum* is rare in many Balkan countries and it has been recently reported in Serbia from this collection (Papp *et al.* 2016). On bark of old *Fraxinus* trees near Bogutovačka banja a red-listed (VU-vulnerable) species in Serbia (Sabovljević *et al.* 2004), the subcontinental *Orthotri-*

chum obtusifolium was found accompanied by other sub-Mediterranean, sub-Atlantic *Orthotrichum* species (*O. lyelii*, *O. striatum*) and temperate elements as *Frullania dilatata*, *Orthotrichum affine*, *Radula complanata* and *Syntrichia papillosa*.

Above 1,000 m a.s.l. in the Stolovi Mts in *Abieto-Fagetum* forests a few boreal, subboreal species appear on decaying logs as *Buxbaumia viridis*, *Herzogiella seligeri* and on serpentine rocks *Pterigynandrum filiforme*, *Grimmia hartmanii*. *Buxbaumia viridis* is included in the Bern Convention and the European Union Habitats and Species Directives and vulnerable in Europe according to the Red data book of European bryophytes (ECCB 1995). Several extant populations are known in Serbia (Papp *et al.* 2009, 2014b) and in the neighbouring Balkan countries, such as Croatia (Papp *et al.* 2013a, b, Alegro *et al.* 2014), Montenegro (Dragičević *et al.* 2011), and the Republic of Macedonia (Papp and Erzberger 2012).

Besides of these, several common species of the temperate zone of Europe also occur; e.g. *Brachytheciastrum velutinum*, *Brachythecium rutabulum*, *Bryum capillare*, *Lophocolea heterophylla* on decaying wood, *Ctenidium molluscum*, *Sciuro-hypnum populeum*, *Fissidens dubius*, *Frullania dilatata*, *Hypnum cupressiforme*, *Isothecium alopecurum*, *Metzgeria furcata*, *Radula complanata*, *Schistidium apocarpum* on shaded, serpentine rocks.

Another *Schistidium* species rare in the Balkans, *S. papillosum* was collected from exposed serpentine rocks along a stream in the Stolovi Mts accompanied by *Grimmia* species (*G. lisae*, *G. pulvinata*).

CONCLUSIONS

The climate of the Ibar gorge can be characterised by quite strong Mediterranean influence, which in combination with specific dry bedrock is highly reflected in the bryophyte flora. Almost one fourth (24.3%) of the bryophyte species found are Mediterranean, sub-Mediterranean, sub-Atlantic elements, although the predominance of species of temperate zone of Europe (50.2%) is obvious. Sub-Mediterranean, Mediterranean elements are very abundant in the serpentine grasslands of the Ibar gorge and on the river bank. Several rare species in Serbia and in the Balkans can be found in these habitats and the adjoining valleys (e.g. *Bryum gemmiferum*, *Dialytrichia mucronata*, *Didymodon nicholsonii*, *Gymnostomum viridulum*, *Hygroamblystegium humile*, *Orthotrichum obtusifolium*, *Syntrichia latifolia*). *Grimmia lisae* has a very large population in the grasslands at Maglič and this is its only known locality in Serbia. At higher elevation in the Stolovi Mts boreal, subboreal species also appear. In a managed *Abieto-Fagetum* forest, the boreal *Buxbaumia viridis*, a species included in the Bern Convention and the European Union Habitats and Species Directives, was also found in spite of that the forest seemed to be quite dry. The

boreal, subboreal leafy liverworts, which are usual accompanying species of *B. viridis* on decaying logs, were lacking; only the subboreal moss, *Herzogiella seligeri* and the temperate *Lophocolea heterophylla* occurred together with *B. viridis*. The species was rare on the spot, detected only on 2–3 logs. Another interesting finding in the Stolovi Mts is *Schistidium papillosum*, a rare species in the Balkans, collected from exposed serpentine rocks along a stream.

It can be summarised that the Ibar gorge maintains a unique bryophyte assemblage due to the serpentine bedrock and the continental, Mediterranean climatic influence.

*

Acknowledgement – The study was supported by the bilateral project of the Hungarian Academy of Sciences and the Serbian Academy of Sciences and Art (2013–2015) entitled “Investigations on cryptogam flora (bryophytes, lichens) and biodiversity in Serbia and Hungary, especially in the habitats of rare species”.

REFERENCES

- Alegro, A., Papp, B., Szurdoki, E., Šegota, V., Šapić, I. and Vukelić, J. (2014): Contributions to the bryophyte flora of Croatia III. Plitvička jezera National Park and adjacent areas. – *Studia bot. hung.* **45**: 49–65. <http://dx.doi.org/10.17110/StudBot.2014.45.49>
- Dragičević, S., Papp, B. and Erzberger, P. (2011): Distribution of *Buxbaumia viridis* (Moug. ex Lam. et DC.) Brid. ex Moug. et Nestl. (Bryophyta) in Montenegro. – *Acta Bot. Croat.* **71**(2): 1–6. <http://dx.doi.org/10.2478/v10184-011-0066-1>
- Düll, R. (1983): Distribution of the European and Macaronesian liverworts (Hepaticophytina). – *Bryol. Beitr.* **2**: 1–115.
- Düll, R. (1984): Distribution of the European and Macaronesian mosses (Bryophytina) I. – *Bryol. Beitr.* **4**: 1–109.
- Düll, R. (1985): Distribution of the European and Macaronesian mosses (Bryophytina) II. – *Bryol. Beitr.* **5**: 110–232.
- ECCB (1995): *Red data book of European bryophytes*. – European Committee for Conservation of Bryophytes, Trondheim, 291 pp.
- Ganeva, A. (2015): *Syntrichia latifolia*, *Leptodyctium humile*. – In: Peev, D. (ed.): Red data book of the Republic of Bulgaria. 1. Plants and fungi. BAS and MoEW, Sofia, pp. 81, 124.
- Grolle, R. and Long, D. G. (2000): An annotated check-list of the Hepaticae and Anthocerotae of Europe and Macaronesia. – *J. Bryol.* **22**: 103–140. <http://dx.doi.org/10.1179/jbr.2000.22.2.103>
- Hill, M. O., Bell, N., Bruggeman-Nannenga, M. A., Brugués, M., Cano, M. J., Enroth, J., Flatberg, K. I., Frahm, J.-P., Gallego, M. T., Garilleti, R., Guerra, J., Hedenäs, L., Holyoak, D. T., Hyvönen, J., Ignatov, M. S., Lara, F., Mazimpaka, V., Muñoz, J. and Söderström, L. (2006): An annotated checklist of the mosses of Europe and Macaronesia. – *J. Bryol.* **28**(3): 198–267. <http://dx.doi.org/10.1179/174328206X119998>
- Marković, J. Đ. (1990): *Enciklopedijski geografski leksikon Jugoslavije Svetlost*. – Sarajevo.

- Martinčič, A. (1992): Rdeci seznam ogroženih listnatih mahov (Musci) v Sloveniji. – *Varstvo Narave* **18**: 1–190.
- Mladenović, A. (2010): *Geophysical model of the tertiary basin between Čačak and Kraljevo*. – Proceedings of the congress of the geologists of Serbia, pp. 669–673.
- Natcheva, R. (2015): *Eurhynchium pumilum*, *Mnium ambiguum*. – In: Peev, D. (ed.): Red data book of the Republic of Bulgaria. 1. Plants and fungi. BAS and MoEW, Sofia, pp. 97, 126.
- Papp, B. and Sabovljević, M. (2001): Contribution to the knowledge of the bryoflora of the region of Petnica (W Serbia, Yugoslavia). – *Studia bot. hung.* **32**: 107–120.
- Papp, B. and Erzberger, P. (2009): Contribution to the bryophyte flora of South-Eastern Serbia: Suva Planina Mts and its surroundings. – *Studia bot. hung.* **40**: 125–142.
- Papp, B. and Erzberger, P. (2012): Contribution to the bryophyte flora of the Former Yugoslav Republic of Macedonia (FYROM). – *Polish Bot. J.* **57**(1): 205–221.
- Papp, B., Erzberger, P. and Sabovljević, M. (2006): Contribution to the bryophyte flora of Djerdap National Park (E. Serbia). – *Studia bot. hung.* **37**: 131–144.
- Papp, B., Alegro, A., Šegota, V., Šapić, I. and Vukelić, J. (2013a): Contributions to the bryophyte flora of Croatia I. Gorski kotar Region (W Croatia). – *Studia bot. hung.* **44**: 193–211.
- Papp, B., Alegro, A., Šegota, V., Šapić, I. and Vukelić, J. (2013b): Contributions to the bryophyte flora of Croatia II. The northern Velebit. – *Studia bot. hung.* **44**: 213–228.
- Papp, B., Dragičević, S. and Erzberger, P. (2014a): Contributions to the bryophyte flora of the Komovi Mts (Montenegro). – *Studia bot. hung.* **45**: 17–31. <http://dx.doi.org/10.17110/StudBot.2014.45.17>
- Papp, B., Erzberger, P. and Sabovljević, M. (2009): European red-listed bryophyte species collected during the expeditions of the Hungarian Natural History Museum in Serbia between 2000–2006. – In: Ivanova, D. (ed.): *Plant, fungal and habitat diversity investigation and conservation. Proceedings of IV Balkan Botanical Congress, Sofia, 20–26 June 2006*. Institute of Botany, Sofia, pp. 541–546.
- Papp, B., Natcheva, R. and Ganeva, A. (2011): The bryophyte flora of Northern Mt Strandzha. – *Phytol. Balcan.* **17**(1): 21–32.
- Papp, B., Szurdoki, E., Pantović, J. and Sabovljević, M. (2014b): Contributions to the bryophyte flora of the Pešter plateau, SW Serbia. – *Studia bot. hung.* **45**: 33–47. <http://dx.doi.org/10.17110/StudBot.2014.45.33>
- Papp, B., Pantović, J., Sabovljević, M. and Szurdoki, E. (2014c): *Myurella sibirica*, a moss species new to Montenegro and Serbia: its range extension towards south-eastern Europe. – *Cryptogamie, Bryol.* **35**(3): 321–326. <http://dx.doi.org/10.7872/cryb.v35.iss3.2014.321>
- Papp, B., Pantović, J., Sabovljević, M. and Szurdoki, E. (2014d): Interesting and new species for the bryophyte flora of Serbia. – *Herzogia* **27**(1): 221–225. <http://dx.doi.org/10.13158/hea.27.1.2014.221>
- Papp, B., Szurdoki, E. and Sabovljević, M. (2014e): *Bryum canariense* (Brid.) Bruch. & Schimp. [Serbia]. In: Ellis, L. T. (ed.): New national and regional bryophyte records 40. – *J. Bryol.* **36**(3): 224. <http://dx.doi.org/10.1179/1743282014Y.0000000115>
- Papp, B., Szurdoki, E. and Sabovljević, M. (2015): *Didymodon nicholsonii* Culm. [Serbia]. In: Ellis, L. T. (ed.): New national and regional bryophyte records, 44. – *J. Bryol.* **37**(3): 228–241. <http://dx.doi.org/10.1179/1743282015Y.0000000014>

- Papp, B., Szurdoki, E., Pantović, J. and Sabovljević, M. (2016): New records of Mediterranean/Atlantic mosses in the flora of Serbia. – *Herzogia* **29**(1): 185–189. <http://dx.doi.org/10.13158/hea.29.1.2016.185>
- Ros, R. M., Mazimpaka, V., Abou-Salama, U., Aleffi, M., Blockeel, T. L., Brugués, M., Cano, M. J., Cros, R. M., Dia, M. G., Dirkse, G. M., El Saadawi, W., Erdağ, A., Ganeva, A., González-Mancebo, J. M., Herrnstadt, I., Khalil, K., Kürschner, H., Lanfranco, E., Losada-Lima, A., Refai, M. S., Rodríguez-Nuñez, S., Sabovljević, M., Cérquio, C., Shabbara, H., Sim-Sim, M. and Söderström, L. (2007): Hepatics and Anthocerotales of the Mediterranean, an annotated checklist. – *Cryptogamie, Bryol.* **28**(4): 351–437.
- Ros, R. M., Mazimpaka, V., Abou-Salama, U., Aleffi, M., Blockeel, T. L., Brugués, M., Cros, R. M., Dia, M. G., Dirkse, G. M., Draper, I., El Saadawi, W., Erdağ, A., Ganeva, A., Gabriel, R., González-Mancebo, J. M., Granger, C., Herrnstadt, I., Hugonnot, V., Khalil, K., Kürschner, H., Losada-Lima, A., Luís, L., Mifsud, S., Privitera, M., Puglisi, M., Sabovljević, M., Sérgio, C., Shabbara, H. M., Sim-Sim, M., Sotiaux, A., Tacchi, R., Vanderpoorten, A. and Werner, O. (2013): Mosses of the Mediterranean, an annotated checklist. – *Cryptog. Bryol.* **34**(2): 99–283. <http://dx.doi.org/doi/10.782/cryb.v34.iss2.2013.99>
- Sabovljević, M. (2000): Checklist of hepatics of the Federal Republic of Yugoslavia. – *Lindbergia* **25**: 37–42.
- Sabovljević, M. and Natcheva, R. (2006): A check-list of the liverworts and hornworts of Southeast Europe. – *Phytol. Balcan.* **12**: 169–180.
- Sabovljević, M. and Stevanović, V. (1999): Moss conspectus of Federal Republic of Yugoslavia. – *Fl. Medit.* **9**: 65–95.
- Sabovljević, M., Cvetić, T. and Stevanović, V. (2004): Bryophyte red list of Serbia and Montenegro. – *Biodiversity and Conservation* **13**: 1781–1790. <http://dx.doi.org/10.1023/B:BIOC.0000029338.97776.66>
- Sabovljević, M., Natcheva, R., Tsakiri, E., Dihoru, G., Dragičević, S., Erdağ, A. and Papp, B. (2008): Check-list of the mosses of SE Europe. – *Phytol. Balcan.* **14**: 207–244.
- Smith, A. J. E. (2004): *The moss flora of Britain and Ireland*. – University Press, Cambridge, 739 pp.
- Ștefănuț, S. and Goia, I. (2012): Checklist and red list of the bryophytes of Romania. – *Nova Hedwigia* **95**(1–2): 59–104. <http://dx.doi.org/10.1127/0029-5035/2012/0044>

