

CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF CROATIA III. PLITVIČKA JEZERA NATIONAL PARK AND ADJACENT AREAS

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Bryological field surveys in Plitvička jezera National Park and adjacent areas (Slunjička river and Vrhovinsko polje karst field) carried out in 2012 and 2013 resulted in a list of 207 species (39 liverworts and 168 mosses). Two species are reported for the first time from Croatia (*Ephemerum minutissimum* and *Pohlia annotina*). Six species are included in the Red data book of European bryophytes (*Buxbaumia viridis*, *Dicranum viride*, *Hamatocaulis vernicosus*, *Anomodon rostratus*, *Rhynchostegiella tenuicaulis* and *Taxiphyllum densifolium*). The first three are listed in the Bern Convention and the EU Habitats and Species Directive as well; in addition, other species, especially *Sphagnum* spp. rare in SE Europe were also located in the area.

Key words: liverworts, mosses, new records for Croatia, threatened species

INTRODUCTION

This paper represents the continuation of renewed bryological research in Croatia. Although Croatia sometimes considered (e.g. SABOVLJEVIĆ *et al.* 2001) one of the bryologically best-explored countries in SE Europe, the great majority of data comes from before 1960. On the other hand, comparative statistical analysis of the bryophyte diversity in SE Europe showed that in Croatia a significantly higher number of bryophyte species should be expected (SABOVLJEVIĆ *et al.* 2011). Several recent checklists (SABOVLJEVIĆ 2003, 2006, SABOVLJEVIĆ and NATCHEVA 2006, SABOVLJEVIĆ *et al.* 2008) are mainly new summarisations and compilations of the old data with very sporadic new contributions. This situation aroused an urgent need for gathering new data on Croatia's bryophyte species and their distribution. In order to fill this gap the authors have initiated a series of systematic field studies in different regions of Croatia, and have recently pub-

lished contributions to the bryophyte flora of the Gorski kotar Region, and of the Northern Velebit Mts (PAPP *et al.* 2013a, b), as well as list of new taxa for the bryophyte flora of Croatia (PAPP *et al.* 2013c). Hereby, new contributions for the Lika region, more precisely for the Plitvička jezera National Park and some adjacent areas, Vrhovinsko polje karst field and Slunjčica river, are presented.

Regarding previous bryological surveys of the region concerned, only the tuff barriers of Plitvička jezera had been researched in more detail by Croatian botanist Zlatko Pavletić. The majority of his results were published in coauthority with Croatian zoologist Ivo Matonićkin in a series of papers dealing with the biocenoses and ecology of karst rivers and tuff barriers (MATONIĆKIN and PAVLETIĆ 1960, 1961, 1963, 1964, PAVLETIĆ 1957). Their species lists for Plitvička jezera are concentrated solely on the tuff barriers, with only 25 bryophyte species (listed in alphabetical order with names used by Pavletić in brackets). These are as follows: Liverworts: *Aneura pinguis* (L.) Dumort., *Conocephalum conicum* (L.) Dumort. (*Fegatela conica* Corda), *Jungermannia atrovirens* Dumort. (*Haplozia riparia* (Teyl.) Dum.) and *Pellia endiviifolia* (Dicks.) Dumort. (*P. fabbroniana* Raddi); Mosses: *Brachythecium rivulare* Schimp. (*B. rivulare* (Bruch.) Br. Eur.), *Bryum pseudotriquetrum* (Hedw.) P. Gaertn., B. Mey. et Scherb. (*B. ventricosum* Dicks.), *Bryum erythrocarpum* complex (*B. erythrocarpum* Schwägr.), *Cinclidotus aquaticus* (Hedw.) Bruch et Schimp. (*C. aquaticus* Br. Eur.), *Cratoneuron filicinum* (Hedw.) Spruce (*C. filicinum* Roth), *Didymodon tophaceus* (Brid.) Lisa (*D. tophaceus* Jur.), *Eucladium verticillatum* (With.) Bruch et Schimp. (*E. verticillatum* Br. Eur.), *Fissidens taxifolius* Hedw., *Fissidens adianthoides* Hedw., *Fontinalis antipyretica* Hedw. (*F. antipyretica* L.), *Gymnostomum aeruginosum* Sm. (*G. rupestre* Schl.), *Hygroamblystegium tenax* (Hedw.) Jenn. (*H. irriguum* (Wils.) Loeske), *Hymenostylium recurvirostrum* (Hedw.) Dixon (*Gymnostomum curvirostre* (Ehrh.) Lindb.), *Leptodictyum riparium* (Hedw.) Warnst., *Pohlia wahlenbergii* (F. Weber et D. Mohr) A. L. Andrews var. *calcarea* (Warnst.) E. F. Warb. (*Mniobryum calcareum* (Warnst.) Limpr.), *Orthothecium rufescens* (Dicks. ex Brid.) Schimp. (*O. rufescens* Br. Eur.), *Palustriella commutata* (Hedw.) Ochyra (*Cratoneuron commutatum* (Hedw.) Roth), *Philonotis calcarea* (Bruch et Schimp.) Schimp., *Plagiomnium undulatum* (Hedw.) T. J. Kop. (*Mnium undulatum* Weis), *Platyhypnidium riparioides* (Hedw.) Dixon (*P. rusciforme* Fleisch.), *Rhizomnium punctatum* (Hedw.) T. J. Kop. (*Mnium punctatum* Hedw.).

MATERIAL AND METHODS

Study area

The area of Plitvička jezera is situated in the mountainous areas of Croatia, on the southern edge of the Mt Mala Kapela. Since 1949 Plitvička jezera are

protected as national park and in 1979 they were proclaimed a World Natural Heritage by UNESCO. The Park covers 29,685 ha, which includes 200 ha occupied by 16 lakes, 13,320 ha by forests and the rest are grasslands, shrublands and other habitat types. The elevation ranges from 367 m to 1,279 m a.s.l. (Seliški vrh peak), with an average altitude of 912 m a.s.l. (BOŽIČEVIĆ 1994, GUŠIĆ and MARKOVIĆ 1974, RIĐANOVIĆ 1994). The climate is moderately warm and moist with warm summers. The average annual precipitation is 1,550 mm with maxima in spring and autumn and the snow cover lasts from November to March. The coldest month is January with an average temperature of 2.2 °C, while the warmest is July (average: 17.4 °C) and the annual average is 7.9 °C (GUŠIĆ and MARKOVIĆ 1974, ZANINOVIĆ 2008). The dominant bedrock is limestone (Triassic, Jurassic and Cretaceous). Different types of beech forests compose the climazonal vegetation, of which beech-fir forests (ass. *Omphalodo-Fagetum sylvaticae*) are the most characteristic and widespread. The forest stands at Čorkova uvala have never been managed thus considered unique in European context (ANIĆ and MIKAC 2008, CESTAR *et al.* 1983, PLAVŠIĆ-GOJKOVIĆ *et al.* 1972, PRPIĆ 1972). The area is home to other forest types developed on moist and wet habitats with *Alnus glutinosa*, *Fraxinus excelsior*, *Salix* spp.; on thermophilous habitats with low forests of *Fraxinus ornus* and *Ostrya carpinifolia*; on steep slopes with *Pinus nigra* and *P. sylvestris*; and on localities with temperature inversion with stands of *Picea abies* (CESTAR *et al.* 1976, VUKELIĆ 2012). The grassland vegetation is also very rich, with many associations mainly determined by levels of water availability and pH (ŠEGULJA 2005). The lake vegetation is characterised by the dominance of various *Chara* species, but other macrophytes and helophytes are also present. Very specific for the lakes are the tuff formations, a complex system of barriers and waterfalls, where aquatic bryophyte communities are dominant. One of the best preserved peat bogs in Croatia, Ljeskovačke bare, with a large population of *Drosera rotundifolia* and other characteristic species (SRDOČ *et al.* 1985, TEŠIĆ *et al.* 1985), is also situated within the park. The total vascular flora counts 1,267 species with many rare, protected and red-listed species of the Croatian flora (KRGÁ 1992).

In the study area we also included Vrhovinsko polje, which is situated outside (precisely, alongside the western border) of Plitvička jezera National Park. It is a typical karst field that has its lowest, central part periodically flooded during winter and early spring. It is covered by grassland vegetation of different communities that show a pattern of distribution closely dependent on water amount and soil pH. Considering the diversity of grassland communities and flora, this is one of the richest and most diverse karstlands in Croatia and therefore from 2013 recognised and protected as Natura 2000 site.

Another locality outside the Park is Slunjšica (or Slušnica) river near the town of Slunj. It is a typical karst river, only 5 km long, with many tuff barriers and clear unpolluted water. It is a tributary of the Korana river, which is flowing out of the Plitvička jezera lakes. It flows into Korana at Rastoke village, where it forms a complex of cascades and waterfalls. Slunjšica River is protected since 1964 as “significant landscape” as well from 2013 as Natura 2000 site.

Methods

The collecting trips were made in July 2012 and 2013. The researched area is presented in Figure 1, and particular collecting sites are listed in the following text. During the field trips special attention was paid to collect bryophytes in all habitat types. The specimens are deposited in the Bryophyte Herbarium of the Hungarian Natural History Museum, Budapest (BP) and the Herbarium Croaticum of the University of Zagreb (ZA). The nomenclature follows SCHUMACKER and VÁŇA (2005) for liverworts (except *Chiloscyphus pallescens* (Ehrh. ex Hoffm.) Dumort., which follows GROLLE and LONG 2000) and HILL *et al.* (2006) for mosses. New species for the bryophyte flora of Croatia are given according to general checklists of SE Europe and the Mediterranean (ROS *et al.* 2007, 2013, SABOVLJEVIĆ 2003, 2006, SABOVLJEVIĆ and NATCHEVA 2006, SABOVLJEVIĆ *et al.* 2008) and taking into consideration new records (ALEGRO *et al.* 2012, MODRIĆ SURINA *et al.* 2012, PAPP and SABOVLJEVIĆ 2009, PAPP *et al.* 2013a, b, c).

Collecting sites

1. Plitvička jezera National Park, Čorkova uvala forest reserve, virgin beech-fir forest (ass. *Omphalodo-Fagetum*), 44° 54' 56.8" N, 15° 29' 57.9" E, 950 m, 23.07.2012.
2. Plitvička jezera National Park, Čorkova uvala, *Fraxinus excelsior* trees at the forest house, 44° 54' 51.3" N, 15° 31' 43.9" E, 885 m, 23.07.2012.
3. Slunj town, limestone rocks of barrier at the mill on Slunjšica river, 45° 06' 44.4" N, 15° 35' 13.7" E, 240 m, 22.07.2013.
4. Plitvička jezera National Park, Čorkova uvala, *Fraxinus excelsior* tree at the forest house, 44° 54' 51.3" N, 15° 31' 43.9" E, 885 m, 23.07.2013.
5. Plitvička jezera National Park, Čorkova uvala forest reserve, virgin beech-fir forest (ass. *Omphalodo-Fagetum*), 44° 54' 56.8" N, 15° 29' 57.9" E, 950 m, 23.07.2013.
6. Plitvička jezera National Park, Plitvički Ljeskovac, Ljeskovačke bare, transitional peat bog (ass. *Drosero-Caricetum echinatae*), surrounded by *Molinia caerulea* meadows, tall herb vegetation of wet habitats (community with *Filipendula ulmaria*, *Lythrum salicaria* and *Lysimachia vulgaris*) and beech-fir forest with limestone rocks, 44° 50' 57.8" N, 15° 36' 01.4" E, 640 m, 24.07.2013.
7. Plitvička jezera National Park, Plitvički Ljeskovac, Crna reka rivulet surrounded by stands of *Alnus glutinosa* and tall herb vegetation dominated by *Petasites hybridus*, 44° 50' 31.7" N, 15° 35' 51.9" E, 665 m, 24.07.2013.

8. Vrhovinsko polje karst field, various grassland and meadow communities, 44° 49' 04.6" N, 15° 29' 05.8" E, 770 m, 25.07.2013.
9. Babin potok village, pine forest (ass. *Helleboro nigri-Pinetum sylvestrae*) on steep slope on dolomite bedrock, 44° 50' 16.9" N, 15° 30' 03.1" E, 780 m, 25.07.2013.
10. Plitvička jezera National Park, Medvedak, beech-fir forest (ass. *Omphalodo-Fagetum*), 44° 53' 04.7" N, 15° 37' 57.7" E, 640 m, 26.07.2013.

RESULTS AND DISCUSSION

207 bryophytes (39 liverworts and 168 mosses) were collected in Plitvička jezera National Park, along the Slunjčica river near the town of Slunj and in Vrhovinsko polje karst field. 11 recorded taxa were recently published as new for Croatia (PAPP *et al.* 2013*a, b, c*) and two are reported here for the first time.

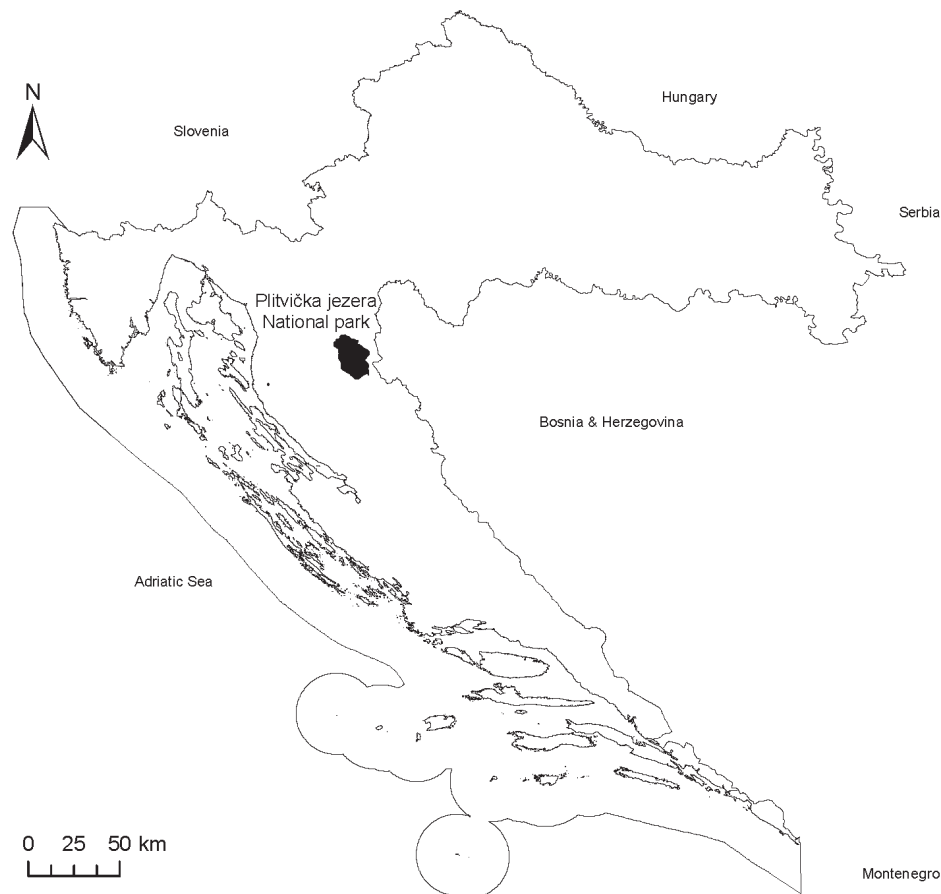


Fig. 1. Location of the study area.

Hepaticae

- Apometzgeria pubescens* (Schrank) Kuwah. – 1, 5: shaded limestone rock
Blepharostoma trichophyllum (L.) Dumort. – 5: decaying wood
Calyptogeia suecica (Arnell et J. Perss.) Müll. Frib. – 1, 5: decaying wood
Cephalozia catenulata (Huebener) Lindb. – 1, 5: decaying wood
Chiloscyphus coadunatus (Sw.) J. J. Engel et R. M. Schust. – 3, 6: shaded limestone rock
Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort. – 3: limestone rock at a mill
Chiloscyphus profundus (Nees) J. J. Engel et R. M. Schust. – 1, 6, 9: decaying wood
Cololejeunea calcarea (Lib.) Schiffn. – 1, 3, 5, 6, 10: shaded limestone rock
Cololejeunea rosettiana (C. Massal.) Schiffn. – 1, 5, 10: shaded limestone rock
Conocephalum salebrosum Szweyk., Buczkowska et Odrzykoski – 1: limestone rock; 3: limestone rock at a mill; 5: shaded limestone rock
Frullania dilatata (L.) Dumort. – 2: bark of *Fraxinus excelsior* tree; 6: shaded limestone rock; 10: bark of *Fagus sylvatica*
Frullania tamarisci (L.) Dumort. – 5: decaying wood; 6: shaded limestone rock
Jungermannia gracillima Sm. – 8: meadow
Jungermannia leiantha Grolle – 1, 5: decaying wood
Jungermannia pumila With. – 3: shaded limestone rock
Lejeunea cavifolia (Ehrh.) Lindb. – 1, 3, 5, 6, 10: shaded limestone rock; 10: bark of *Fagus sylvatica*
Lepidozia reptans (L.) Dumort. – 1, 5: decaying wood
Lophozia badensis (Gottsche) Schiffn. – 6: shaded limestone rock
Lophozia bantriensis (Hook.) Steph. – 1: limestone rock; 6: shaded limestone rock
Lophozia incisa (Schrad.) Dumort. – 1: decaying wood
Lophozia longidens (Lindb.) Macoun – 1: bark of *Abies alba*
Marchantia polymorpha L. subsp. *polymorpha* – 7: limestone rock in the stream
Marchantia polymorpha L. subsp. *montivagans* Bischl. et Boisselier – 7: limestone rock in the stream
Metzgeria conjugata Lindb. – 1, 3, 5, 6, 10: shaded limestone rock; 1: bark of *Fagus sylvatica*
Metzgeria furcata (L.) Dumort. – 5: bark of *Fagus sylvatica*; 9: limestone rock; 10: decaying wood
Nowellia curvifolia (Dicks.) Mitt. – 1, 5: decaying wood
Pedinophyllum interruptum (Nees) Kaal. – 1, 3, 5, 10: shaded limestone rock
Pellia endiviifolia (Dicks.) Dumort. – 3: limestone rock at a mill; 7: limestone rock in the stream; 8: meadow
Plagiochila asplenioides (L. emend. Taylor) Dumort. – 1, 3: shaded limestone rock
Plagiochila porelloides (Torrey ex Nees) Lindenb. – 1, 3, 5, 6, 10: shaded limestone rock; 1, 10: bark of *Fagus sylvatica*; 6: on soil
Porella arboris-vitae (With.) Grolle – 1, 10: bark of *Fagus sylvatica*; 3, 10: shaded limestone rock
Porella platyphylla (L.) Pfeiff. – 1: limestone rock; 5: bark of *Fagus sylvatica*; 10: decaying wood
Preissia quadrata (Scop.) Nees – 6: shaded limestone rock
Radula complanata (L.) Dumort. – 1, 10: bark of *Fagus sylvatica*; 5, 6, 9: shaded limestone rock
Riccardia palmata (Hedw.) Carruth. – 1, 5: decaying wood
Scapania aequiloba (Schwägr.) Dumort. – 6: shaded limestone rock
Scapania aspera M. Bernet et Bernet – 3, 5, 6: shaded limestone rock
Scapania irrigua (Nees) Nees – 8: meadow
Tritomaria exsecta (Schmidel) Schiffn. ex Loeske – 5: decaying wood

Musci

- Acaulon muticum* (Hedw.) Müll. Hal. – 8: meadow
Amblystegium confervoides (Brid.) Schimp. – 10: shaded limestone rock
Amblystegium serpens (Hedw.) Schimp. – 3: shaded limestone rock and bark of *Acer*; 7: limestone rock at the stream
Amblystegium subtile (Hedw.) Schimp. – 3: bark of *Acer*
Anomodon attenuatus (Hedw.) Huebener – 3, 10: shaded limestone rock
Anomodon longifolius (Schleich. ex Brid.) Hartm. – 1, 10: shaded limestone rock
Anomodon rostratus (Hedw.) Schimp. – 1, 5, 10: shaded limestone rock
Anomodon viticulosus (Hedw.) Hook. et Taylor – 1, 3, 5, 9, 10: shaded limestone rock; 3: bark of *Acer*
Antitrichia curtispindula (Hedw.) Brid. – 5, 10: decaying wood
Atrichum undulatum (Hedw.) P. Beauv. – 1, 3: shaded limestone rock; 8: meadow
Aulacomnium palustre (Hedw.) Schwägr. – 6: peat bog; 8: meadow
Barbula crocea (Brid.) F. Weber et D. Mohr – 6: shaded limestone rock
Barbula unguiculata Hedw. – 7: limestone rock at the stream; 8: meadow
Bartramia halleriana Hedw. – 6: shaded limestone rock
Brachytheciastrum velutinum (Hedw.) Ignatov et Huttunen – 1: bark of *Fagus sylvatica*; 9: on soil
Brachythecium mildeanum (Schimp.) Schimp. – 8: meadow
Brachythecium rivulare Schimp. – 7: limestone rock in the stream; 8: meadow
Brachythecium rutabulum (Hedw.) Schimp. – 1, 5, 10: shaded limestone rock; 1: decaying wood; 3: limestone rock at a mill; 7: limestone rock in the stream; 8: meadow
Brachythecium tommasinii (Sendtn. ex Boulay) Ignatov et Huttunen – 1, 5, 10: shaded limestone rock
Bryoerythrophyllum recurvirostrum (Hedw.) P. C. Chen – 7: limestone rock at the stream
Bryum alpinum Huds. ex With. – 8: meadow
Bryum capillare Hedw. – 1: limestone rock; 6: decaying wood in the meadow; 8: meadow; 9: on soil
Bryum elegans Nees – 8: meadow
Bryum moravicum Podp. – 1, 5: shaded limestone rock; 5: decaying wood; 10: bark of *Fagus sylvatica*
Bryum pseudotriquetrum (Hedw.) P. Gaertn., B. Mey. et Scherb. – 6: peat bog; 7: limestone rock in the stream; 8: meadow
Bryum radiculosum Brid. – 8: meadow
Bryum rubens Mitt. – 8: meadow
Bryum ruderale Crundw. et Nyholm – 8: meadow
Buxbaumia viridis (Moug. ex Lam. et DC.) Brid. ex Moug. et Nestl. – 1, 5: decaying wood
Calliergon giganteum (Schimp.) Kindb. – 6: peat bog; 8: meadow
Calliergonella cuspidata (Hedw.) Loeske – 6, 8: meadow
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra – 6: shaded limestone rock
Campylium stellatum (Hedw.) Lange et C. E. O. Jensen – 6: peat bog; 8: meadow
Campylophyllum calcareum (Crundw. et Nyholm) Hedenäs – 3, 6: shaded limestone rock; 3: bark of *Acer*
Campylophyllum halleri (Hedw.) M. Fleisch. – 6: shaded limestone rock
Campylopus introflexus (Hedw.) Brid. – 8: margin of meadow
Ceratodon purpureus (Hedw.) Brid. – 8: meadow; 9: on soil
Cinclidotus aquaticus (Hedw.) Bruch et Schimp. – 3: limestone rock at a mill
Cinclidotus fontinaloides (Hedw.) P. Beauv. – 3: limestone rock at a mill
Cinclidotus riparius (Host ex Brid.) Arn. – 3: limestone rock at a mill

- Cirriphyllum crassinervium* (Taylor) Loeske et M. Fleisch. – 3, 5, 10: shaded limestone rock
Climacium dendroides (Hedw.) F. Weber et D. Mohr – 6: decaying wood in the meadow; 8: meadow
Cratoneuron filicinum (Hedw.) Spruce – 3: limestone rock at a mill; 7: limestone rock in the stream; 8: meadow
Ctenidium molluscum (Hedw.) Mitt. – 1, 3, 5, 6, 9, 10: shaded limestone rock
Dicranella staphylina H. Whitehouse – 8: meadow
Dicranella varia (Hedw.) Schimp. – 8: meadow
Dicranodontium denudatum (Brid.) E. Britton – 5: decaying wood
Dicranum bonjeanii De Not. – 6: peat bog; 8: meadow
Dicranum montanum Hedw. – 1, 5: decaying wood
Dicranum scoparium Hedw. – 1, 5, 10: shaded limestone rock; 1: bark of *Fagus sylvatica*; 5: decaying wood; 9: on soil
Dicranum tauricum Sapjegin – 1: decaying wood; 5: bark of *Fagus sylvatica*
Dicranum viride (Sull. et Lesq.) Lindb. – 10: bark of *Fagus sylvatica*
Distichium capillaceum (Hedw.) Bruch et Schimp. – 6: shaded limestone rock
Ditrichum flexicaule (Schwägr.) Hampe – 6: shaded limestone rock
Ditrichum gracile (Mitt.) Kuntze – 6: shaded limestone rock
Ditrichum heteromallum (Hedw.) E. Britton – 8: meadow
Drepanocladus aduncus (Hedw.) Warnst. – 8: meadow
Drepanocladus polygamus (Schimp.) Hedenäs – 6: peat bog; 8: meadow
Encalypta streptocarpa Hedw. – 3, 6, 10: shaded limestone rock; 7: limestone rock at the stream
Encalypta vulgaris Hedw. – 6: soil among limestone rocks
Ephemerum minutissimum Lindb. – 8: meadow
Eucladium verticillatum (With.) Bruch et Schimp. – 3: shaded limestone rock
Eurhynchium angustirete (Broth.) T. J. Kop. – 1, 5, 6, 10: shaded limestone rock; 9: on soil
Eurhynchium hians (Hedw.) Sande Lac. – 1, 3, 6, 10: shaded limestone rock; 7: limestone rock at the stream
Eurhynchium striatum (Hedw.) Schimp. – 3: shaded limestone rock
Fissidens adiantoides Hedw. – 6: peat bog; 8: meadow
Fissidens bryoides Hedw. – 8: meadow
Fissidens dubius P. Beauv. – 1, 3, 5, 6, 10: shaded limestone rock
Fissidens taxifolius Hedw. – 5: shaded limestone rock; 8: meadow
Fontinalis antipyretica Hedw. – 7: limestone rock in the stream; 8: meadow
Funaria hygrometrica Hedw. – 8: meadow
Grimmia pulvinata (Hedw.) Sm. – 6: shaded limestone rock
Gymnostomum calcareum Nees et Hornsch. – 3, 6: shaded limestone rock
Gyroweisia tenuis (Hedw.) Schimp. – 3: shaded limestone rock
Hamatocaulis vernicosus (Mitt.) Hedenäs – 6: peat bog
Herzogiella seligeri (Brid.) Z. Iwats. – 1, 5, 9: decaying wood
Homalothecium lutescens (Hedw.) H. Rob. – 8: meadow
Homalothecium philippeanum (Spruce) Schimp. – 5: shaded limestone rock
Homalothecium sericeum (Hedw.) Schimp. – 1, 3, 6, 9: shaded limestone rock; 1: bark of *Fagus sylvatica*; 5, 10: decaying wood
Homomallium incurvatum (Schrud. ex Brid.) Loeske – 1, 3, 5, 10: shaded limestone rock
Hylocomiastrum pyrenaicum (Spruce) M. Fleisch. – 8: meadow
Hylocomium splendens (Hedw.) Schimp. – 1, 5: shaded limestone rock; 6, 9: on soil
Hypnum cupressiforme Hedw. var. *cupressiforme* – 1, 9: shaded limestone rock; 5, 6, 10: decaying wood; 8: meadow; 9: on soil; 1, 10: bark of *Fagus sylvatica*

- Hypnum cupressiforme* Hedw. var. *lacunosum* Brid. – 8: meadow
Isoterygiopsis pulchella (Hedw.) Z. Iwats. – 5: shaded limestone rock
Isothecium alopecuroides (Lam. ex Dubois) Isov. – 1, 5, 6, 9: shaded limestone rock; 1, 5, 10: bark of *Fagus sylvatica*; 10: decaying wood
Isothecium myosuroides Brid. – 1: shaded limestone rock
Leptobryum pyriforme (Hedw.) Wilson – 8: meadow
Leskea polycarpa Hedw. – 3: bark of *Acer*
Leucodon sciuroides (Hedw.) Schwägr. – 2: bark of *Fraxinus excelsior*; 6: shaded limestone rock; 10: bark of *Fagus sylvatica*
Mnium marginatum (Dicks.) P. Beauv. – 1, 3, 10: shaded limestone rock; 7: limestone rock at the stream
Mnium stellare Hedw. – 1, 5: shaded limestone rock; 5: bark of *Fagus sylvatica*; 7: limestone rock at the stream
Neckera complanata (Hedw.) Huebener – 1, 5, 6: shaded limestone rock; 10: bark of *Fagus sylvatica*
Neckera crispa Hedw. – 1, 3, 6, 10: shaded limestone rock; 1, 5: bark of *Fagus sylvatica*; 10: decaying wood
Neckera pumila Hedw. – 6: shaded limestone rock
Orthothecium rufescens (Dicks. ex Brid.) Schimp. – 6: shaded limestone rock
Orthotrichum affine Schrad. ex Brid. – 2: bark of *Fraxinus excelsior*
Orthotrichum anomalum Hedw. – 1: shaded limestone rock
Orthotrichum cupulatum Hoffm. ex Brid. – 6: shaded limestone rock
Orthotrichum lyellii Hook. et Taylor – 2: bark of *Fraxinus excelsior*; 10: bark of *Fagus sylvatica*
Orthotrichum obtusifolium Brid. – 2: bark of *Fraxinus excelsior*
Orthotrichum pallens Bruch ex Brid. – 2: bark of *Fraxinus excelsior*
Orthotrichum pumilum Sw. ex anon. – 2, 4: bark of *Fraxinus excelsior*
Orthotrichum speciosum Nees – 2: bark of *Fraxinus excelsior*
Orthotrichum stramineum Hornsch. ex Brid. – 1: bark of *Fagus sylvatica*
Palustriella commutata (Hedw.) Ochyra – 6: meadow; 7: limestone rock in the stream
Palustriella falcata (Brid.) Hedenäs – 3: limestone rock at a mill
Paraleucobryum longifolium (Hedw.) Loeske – 5: decaying wood
Philonotis fontana (Hedw.) Brid. – 8: meadow
Plagiomnium affine (Blandow ex Funck) T. J. Kop. – 1: shaded limestone rock; 5: decaying wood; 9: on soil
Plagiomnium cuspidatum (Hedw.) T. J. Kop. – 7: limestone rock at the stream; 10: bark of *Fagus sylvatica*
Plagiomnium ellipticum (Brid.) T. J. Kop. – 6: peat bog
Plagiomnium rostratum (Schrad.) T. J. Kop. – 1, 3: shaded limestone rock
Plagiomnium undulatum (Hedw.) T. J. Kop. – 1, 5, 10: shaded limestone rock
Plagiopus oederianus (Sw.) H. A. Crum et L. E. Anderson – 3, 6: shaded limestone rock
Plagiothecium cavifolium (Brid.) Z. Iwats. – 6: shaded limestone rock
Plagiothecium nemorale (Mitt.) A. Jaeger – 1: shaded limestone rock and bark of *Fagus sylvatica*
Plagiothecium platyphyllum Mönk. – 5: decaying wood; 10: shaded limestone rock
Plasteurhynchium striatulum (Spruce) M. Fleisch. – 3, 5: shaded limestone rock
Platyhypnidium riparioides (Hedw.) Dixon – 3: limestone rock at a mill; 7: limestone rock in the stream
Pleuroidium acuminatum Lindb. – 8: meadow
Pleuroidium subulatum (Hedw.) Rabenh. – 8: meadow
Pogonatum urnigerum (Hedw.) P. Beauv. – 8: meadow

- Poblia annotina* (Hedw.) Lindb. – 8: meadow
Poblia melanodon (Brid.) A. J. Shaw – 8: meadow
Polytrichastrum formosum (Hedw.) G. L. Sm. – 1, 5: decaying wood; 6: on soil; 10: shaded limestone rock
Polytrichum commune Hedw. – 8: meadow
Polytrichum juniperinum Hedw. – 8: meadow
Polytrichum piliferum Hedw. – 8: meadow
Polytrichum strictum Menzies ex Brid. – 6: peat bog
Pseudoscleropodium purum (Hedw.) M. Fleisch. – 6, 9: on soil; 8: meadow
Pterigynandrum filiforme Hedw. – 1: bark of *Fagus sylvatica*; 5, 10: decaying wood; 5: shaded limestone rock
Pylaisia polyantha (Hedw.) Schimp. – 3: bark of *Acer*
Racomitrium elongatum Ehrh. ex Frisvoll – 8: meadow
Rhizomnium punctatum (Hedw.) T. J. Kop. – 1, 5: decaying wood
Rhynchostegiella tenuicaulis (Spruce) Kartt. – 1: shaded limestone rock
Rhynchostegium murale (Hedw.) Schimp. – 1, 5, 6, 10: shaded limestone rock
Rhytidiadelphus loreus (Hedw.) Warnst. – 1, 5: shaded limestone rock; 5: decaying wood
Rhytidiadelphus squarrosus (Hedw.) Warnst. – 8: meadow
Rhytidiadelphus triquetrus (Hedw.) Warnst. – 5: shaded limestone rock; 6, 9: on soil
Schistidium crassipilum H. H. Blom – 1, 5, 6, 10: shaded limestone rock
Schistidium elegantulum H. H. Blom – 10: shaded limestone rock
Scorpidium cossonii (Schimp.) Hedenäs – 6: peat bog
Seligeria pusilla (Hedw.) Bruch et Schimp. – 3: shaded limestone rock
Sphagnum capillifolium (Ehrh.) Hedw. – 8: meadow
Sphagnum denticulatum Brid. – 8: meadow
Sphagnum flexuosum Dozy et Molk. – 6: peat bog
Sphagnum palustre L. – 6: peat bog; 8: meadow
Sphagnum squarrosus Crome – 6: peat bog
Sphagnum subnitens Russow et Warnst. – 8: meadow
Sphagnum teres (Schimp.) Ångstr. – 6: peat bog; 8: meadow
Syntrichia ruralis (Hedw.) F. Weber et D. Mohr – 1, 5: shaded limestone rock
Taxiphyllum densifolium (Lindb. ex Broth.) Reimers – 1, 5: shaded limestone rock
Taxiphyllum wissgrillii (Garov.) Wijk et Margad. – 1, 3, 5, 10: shaded limestone rock
Tetraphis pellucida Hedw. – 1, 5: decaying wood
Thamnobryum alopecurum (Hedw.) Gangulee – 1, 3, 5, 10: shaded limestone rock
Thuidium assimile (Mitt.) A. Jaeger – 8: meadow
Tomentypnum nitens (Hedw.) Loeske – 6: peat bog
Tortella bambergi (Schimp.) Broth. – 5: shaded limestone rock
Tortella inclinata (R. Hedw.) Limpr. – 6, 10: soil among limestone rocks
Tortella tortuosa (Hedw.) Limpr. – 5, 6: shaded limestone rock
Trichodon cylindricus (Hedw.) Schimp. – 8: meadow
Trichostomum brachydontium Bruch – 3: shaded limestone rock
Ulotia bruchii Hornsch. ex Brid. – 4: bark of *Fraxinus excelsior*; 10: bark of *Fagus sylvatica*
Ulotia crispa (Hedw.) Brid. – 10: bark of *Fagus sylvatica*
Warnstorfia exannulata (Schimp.) Loeske – 8: meadow
Weissia brachycarpa (Nees et Hornsch.) Jur. – 8: meadow
Zygodon rupestris Schimp. ex Lorentz – 5: bark of *Fagus sylvatica*; 10: decaying wood

Species reported for the first time from Croatia

During our bryophyte surveys in the period 2011–2012 30 species new for Croatia were found (PAPP *et al.* 2013a, b, c) 11 of which were recorded again during this research: *Conocephalum salebrosum*, *Lophozia longidens*, *Dicranodontium denudatum*, *Plagiothecium platyphyllum*, *Pterigynandrum filiforme*, *Racomitrium elongatum*, *Rhynchostegiella tenuicaulis*, *Trichodon cylindricus*, *Tomentypnum nitens*, *Tortella bambergi* and *Zygodon rupestris*.

However, the research of the Plitvička jezera lakes and adjacent areas resulted in two additional new species for the Croatian bryophyte flora.

Ephemerum minutissimum is a sub-Atlantic species according to DÜLL *et al.* (1999). In SE Europe it is very rare or probably overlooked, known only from the coastal parts of Montenegro (DÜLL *et al.* 1999, SABOVLJEVIĆ *et al.* 2008). In the past it was not separated at species level from the related *E. serratum*, which is known from almost all SE European countries (SABOVLJEVIĆ *et al.* 2008). From the neighbouring countries *E. minutissimum* is known from Hungary, where it is treated as near-threatened (NT) in the national red list (PAPP *et al.* 2010) and from Italy (CORTINI PEDROTTI 1992). Here, the species was found on open soil of meadow edges in Vrhovinsko polje, which is a typical, periodically flooded karstland with a variety of grassland communities determined by water amount and soil pH.

Pohlia annotina is a subboreal species (DÜLL *et al.* 1999). It is known from most of the SE European countries (SABOVLJEVIĆ *et al.* 2008), and from Hungary (PAPP *et al.* 2010) and Italy (CORTINI PEDROTTI 1992) as neighbouring countries. This species was also found on soil in Vrhovinsko polje, in its lower, more humid part.

Among the new records for the Croatian bryophyte flora another species, *Campylopus introflexus* needs to be mentioned. It was found for the first time in Croatia during our field trip in 2013 on decaying *Pinus* trunk and on soil at the edge of meadow in Vrhovinsko polje, but this record was published separately (ALEGRO *et al.* 2014). This is an invasive species living on acidic soil, whose expansion started from Britain in 1940 and it keeps spreading towards east (HASSEL and SÖDERSTRÖM 2005). It has already reached northeastern and southeastern Europe according to records from Lithuania (VELLAK *et al.* 2009), Turkey (YAYINTAŞ 2009), and Slovenia (SZÜCS and BIDLÓ 2014). Currently, no other records are known from the Balkans.

Conservation merits of the bryophyte flora

Plitvička jezera National Park has a high conservation value due to presence of three species (among in total four in Croatian bryophyte flora) listed in

the Bern Convention and the European Union Habitats and Species Directive: *Buxbaumia viridis*, *Dicranum viride* and *Hamatocaulis vernicosus*.

Buxbaumia viridis is a boreal, montane species (DÜLL *et al.* 1999) living on well-decayed wood in humid forests. According to the Red data book of European bryophytes (ECCB 1995) it is a vulnerable species. In spite that historical data in Croatia for this species are scarce (BAUMGARTNER 1938, HORVAT 1932), recent field surveys showed that this species is not rare in virgin, but even in managed old-growth beech-fir (ass. *Omphalodo-Fagetum*) and fir (ass. *Blechno-Abietetum*) forests of the Gorski kotar Region and the Northern Velebit Mts (PAPP *et al.* 2013a, b), where it has considerably large populations (20–30 sporophytes on 50–100 trees). The species was found in virgin beech-fir forest in Čorkova uvala, where it inhabits dozens of decayed tree trunks.

Dicranum viride is a sub-continental species (DÜLL *et al.* 1999) living as epiphyte on bark of old trees. Historically, it is recorded on the foothills of Mt Papuk (STOIZNER 1870), in the Maksimir park forest in Zagreb (HORVAT 1932) and in Bunjevačka draga in the Velebit Mts (BAUMGARTNER 1938). On the first two localities it was not confirmed during recent field surveys, while the Bunjevačka draga is a mine suspicious area and therefore inaccessible, but Baumgartner's specimen is preserved in the Hungarian Natural History Museum (BP 31775). Therefore, the Medvedak forest in the Plitvička jezera National Park is currently the single known locality of this species in Croatia. Here it grows in beech-fir forest, in a few small patches on beech bark.

Hamatocaulis vernicosus is a boreal species (DÜLL *et al.* 1999) growing in oligotrophic and mesotrophic, neutral to slightly acidophilous fens and transitional bogs (NEBEL 2001). To date the single finding site of the species in Croatia is Dubravica peat bog in the Hrvatsko zagorje region (NW Croatia) (HORVAT 1932). It was found there in bog vegetation of ass. *Rhynchosporium albae*. Unfortunately, nowadays this bog is only a small remnant of its previous extent and diversity, with uncertain occurrence of *H. vernicosus*. Therefore, the recently found population in Ljeskovačke bare is the only certainly known and really viable population of this species in Croatia. It was found in transition between bog communities *Drosero-Caricetum echinatae* and *Caricetum lasiocarpae*. The population is vigorous, with typically developed individuals.

Among other species included in the Red data book of European bryophytes *Anomodon rostratus*, *Rhynchostegiella tenuicaulis* and *Taxiphyllum densifolium* should be mentioned.

Anomodon rostratus is a sub-Mediterranean-montane species (DÜLL *et al.* 1999) occurring on shaded limestone rocks and rock crevices. In the Red data book of European bryophytes it is treated as rare species (ECCB 1995). It was reported for the first time in Croatia (Velebit Mts) by BAUMGARTNER (1938) and

it was confirmed there during recent surveys (PAPP *et al.* 2013b). Our new record is the first one outside the Velebit Mts. The species was found in beech-fir virgin forests in Čorkova uvala and Medvedak. The plant grows on strongly shaded limestone rocks in the forest interior, especially in dolina bottoms.

Rhynchostegiella tenuicaulis is a montane species of the temperate zones of Europe (DÜLL 1985). In the Red data book of European bryophytes (ECCB 1995) it is quoted as insufficiently known. The species is rare in SE Europe, known only from Bulgaria, Greece and Romania (SABOVLJEVIĆ *et al.* 2008). It was recently found in the Velebit Mts on shaded limestone rocks of Štirovača and Jovanovića snižnica ice hole (PAPP *et al.* 2013b, c). In Plitvička jezera National Park it also grows on shaded limestone rocks, in virgin beech-fir forest in Čorkova uvala.

Taxiphyllum densifolium is an eastern European species distributed sporadically in a range from Slovakia, Poland, Hungary and Romania extending the Caucasus (FREY *et al.* 2006, VAJDA 1955). Besides Hungary, the only neighbouring country, where it occurs is Serbia (SABOVLJEVIĆ *et al.* 2008). It was recently reported from Croatia; a specimen of *Taxiphyllum wissgrillii*, collected near Fiume (Rijeka) in 1909 was revised to *T. densifolium* (PAPP and SABOVLJEVIĆ 2009). According to the Red data book of European bryophytes (ECCB 1995) it is rare in Europe. We found it in Čorkova uvala in virgin beech-fir forest (ass. *Omphalodo-Fagetum*) on shaded limestone rocks.

Another group of mosses, which is not included in the Red data book of European bryophytes, but of special local importance, are the peat mosses. All *Sphagnum* species in Croatia are rare, each with only a few localities or even a single one. Most of them are threatened due to habitat loss and vegetation succession. In the researched area, seven species were found on two localities. The first is Ljeskovačke bare peat bog, where the following species were documented in a transitional bog belonging to ass. *Drosero-Caricetum echinatae*: *Sphagnum flexuosum*, *S. palustre*, *S. squarrosum* and *S. teres*. The last one is dominant and this population is the largest one in Croatia. The second locality with peat mosses is Vrhovinsko polje karst field, just outside the border of the national park. Here, the peat mosses grow on the lowest part of the karstland, which is periodically flooded, but completely dry during summer time. The following species were found there: *Sphagnum capillifolium*, *S. denticulatum*, *S. palustre*, *S. subnitens* and *S. teres*. Both localities are characterised by open habitats, which are threatened by secondary vegetation succession of local trees and shrubs, which will eventually change the water regime, leading to conditions unsuitable for peat mosses.

Calliargon giganteum, *Dicranum bonjeanii*, *Drepanocladus polygamus*, *Plagiommium ellipticum*, *Polytrichum strictum*, *Scorpidium cossonii* and *Tomentypnum nitens* are additional species growing in wet meadows and bogs, rare in SE Europe, and for this reason of special conservation importance.

Beyond all the above, in the researched area there are even more bryophyte species rare in SE Europe, which makes the flora peculiar, biogeographically interesting, and highly important for nature conservation. As to flora elements, they are Atlantic and sub-Atlantic species (*Calypogeia suecica*, *Cephalozia catenulata*, *Barbula crocea*, *Ephemerum minutissimum*, *Isothecium myosuroides*, *Neckera pumila*, *Plagiothecium platyphyllum*, *Ulota bruchii* and *Zygodon rupestris*), native to the temperate zones of Europe with montane character (*Jungermannia pumila*, *Tritomaria exsecta*, *Tortella bambergeri*) or they are boreal, subalpine and subarctic species (*Lophozia badensis*, *L. bantriensis*, *L. longidens*, *Dicranodontium denudatum*, *Hylocomiastrum pyrenaicum*, *Isopterygiopsis pulchella*, *Orthothecium rufescens*, *Pohlia annotina* and *Scorpidium cossonii*).

CONCLUSIONS

Plitvička jezera National Park and the adjacent regions possess high bryophyte diversity (with 207 recorded species) making this region comparable with other recently researched areas: Gorski kotar Region with 231 taxa and the Northern Velebit Mts with 191 taxa (PAPP *et al.* 2013a, b). Here, the high diversity and the occurrence of many rare species are attributed to the habitat diversity. Most widespread are the different forest communities, with beech-fir forests as the zonal ones and represented by several virgin stands. These stands can support vigorous populations of European red-listed bryophytes, including *Buxbaumia viridis*, *Anomodon rostratus*, *Rhynchostegiella tenuicaulis* and *Taxiphyllum densifolium*. Furthermore, the single known population of *Dicranum viride* in Croatia also thrives in these forests. Also, important habitat types are the wetlands, with tuff-forming waterfalls, rivulets, lakes, fens, peat bogs, wet and periodically flooded meadows. Each of these habitat types support characteristic bryophyte assemblages with many species rare in SE Europe. In a peat bog *Hamatocaulis vernicosus* and several *Sphagnum* species, all rare in Croatia and the Balkans, were found. For the *Sphagnum* species the periodically flooded meadows at Vrhovinsko polje are of special importance. On open soil near the meadow edge in Vrhovinsko polje *Ephemerum minutissimum*, a rare (or probably overlooked) species in SE Europe and new for the Croatian bryophyte flora, was found. *Pohlia annotina* is another new species for the country from the same locality.

It needs to be stressed that Plitvička jezera have great conservation value by the occurrence of three bryophyte species listed in the Bern Convention and the European Union Habitats and Species Directive. Furthermore, the presence of many species generally rare in SE Europe, belonging to different flora elements, also marks the importance of this area for bryophyte diversity and its conservation.

REFERENCES

- ALEGRO, A., ŠEGOTA, V. and SABOVLJEVIĆ, M. (2012): *Ditrichum gracile* (Mitt.) Kuntze. [Croatia]. In: ELLIS, L. T. (ed.): New national and regional bryophyte records, 32. – *J. Bryol.* **34**: 236. <http://dx.doi.org/10.1179/1743282012Y.0000000019>
- ALEGRO, A., PAPP, B., SZURDOKI, E., ŠEGOTA, V., ŠAPIĆ, I. and VUKELIĆ, J. (2014): *Campylopus introflexus*, a new invasive species in the Croatian flora. – (in press).
- ANIĆ, I. and MIKAC, S. (2008): Struktura, tekstura i pomlađivanje dinarske bukovo-jelove prašume Čorkova uvala. (Structure, texture and regeneration of Dinaric beech-fir virgin forest of Čorkova uvala). – *Šumarski list* 11–12, **132**: 505–515.
- BAUMGARTNER, J. (1938): *Bryophyten*. – In: DEGEN, A. (ed.): *Flora Velebitica*, 3, Verlag d. Ungar. Akad. Wiss., Budapest, 595 pp.
- BOŽIČEVIĆ, S. (1994): *Hidrogeološki problemi na području Plitvičkih jezera*. – In: Proceedings, Plitvička jezera – nacionalno dobro Hrvatske – svjetska baština. Uprava NP Plitvička jezera & HAZU, Zagreb, pp. 43–51.
- CESTAR, D., HREN, V., KOVAČEVIĆ, Z., MARTINOVIĆ, J. and PELCER, Z. (1976): Ekološko-gospodarski tipovi šuma na području Nacionalnog parka Plitvička jezera. – *Radovi* 28, Šumarski institut, Jastrebarsko, 87 pp.
- CESTAR, D., HREN, V., KOVAČEVIĆ, Z., MARTINOVIĆ, J., PELCER, Z., BEZAK, K., KREJČI, V., KRZMAR, A., LINDIĆ, V., MEDVEDOVIĆ, J. and VRBEK, B. (1983): Prirodni šumski rezervat “Čorkova uvala – Čudinka”. – *Radovi* 53, Šumarski institut, Jastrebarsko, 44 pp.
- CORTINI PEDROTTI, C. (1992): Check-list of the mosses of Italy. – *Flora Medit.* **2**: 119–221.
- DÜLL, R. (1985): Distribution of the European and Macaronesian mosses (Bryophytina) II. – *Bryol. Beiträge* **5**: 110–232.
- DÜLL, R., GANEVA, A., MARTINČIČ, A. and PAVLETIĆ, Z. (1999): Contributions to the bryoflora of former Yugoslavia and Bulgaria. – *Bryol. Beiträge* **11**: 1–99.
- ECCB (1995): *Red data book of European bryophytes*. – European Committee for Conservation of Bryophytes, Trondheim, 291 pp.
- FREY, W., FRAHM, J.-P., FISCHER, E. and LOBIN, W. (2006): *The liverworts, mosses and ferns of Europe*. – Harley Books, Martins, Great Horkesley, Colchester, 512 pp.
- 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>
- GUŠIĆ, B. and MARKOVIĆ, M. (ed.) (1974): *Plitvička jezera – čovjek i priroda*. – Nacionalni park Plitvice, Zagreb, 260 pp.
- HASSEL, K. and SÖDERSTRÖM, L. (2005): The expansion of the alien mosses *Orthodontium lineare* and *Campylopus introflexus* in Britain and continental Europe. – *J. Hattori Bot. Lab.* **97**: 183–193.
- HILL, M. O., BELL, N., BRUGGEMAN-NANNENGA, M. A., BRUGUÉS, M., CANO, M. J., ENROTH, J., FLATBERG, K. I., FRAHM, J.-P., GALLEGU, M. T., GARILLETI, R., GUERRA, J., HEDENÅS, 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>
- HORVAT, I. (1932): Građa za briogeografiju Hrvatske. – *Acta Bot. Croat.* **7**: 73–127.
- KRGA, M. (1992): Flora Nacionalnog parka Plitvička jezera. – *Plitvički bilten* **5**: 27–56.
- MATONIČKIN, I. and PAVLETIĆ, Z. (1960): Biološke karakteristike sedrenih slapova u našim krškim rijekama. – *Geografski glasnik* **22**: 43–56.

- MATONIČKIN, I. and PAVLETIĆ, Z. (1961): Biljni i životinjski svijet na sedrenim slapovima jugoslavenskih krških voda. – *Biološki glasnik* **14**: 105–128.
- MATONIČKIN, I. and PAVLETIĆ, Z. (1963): Prethodna ekološko–biocenoška istraživanja opskrbnih voda plitvičkih jezera. – *Acta Bot. Croat.* **22**: 141–174.
- MATONIČKIN, I. and PAVLETIĆ, Z. (1964): Prilozi tipologiji biocenoza na sedrenim slapovima jugoslavenskih krških rijeka. – *Acta Musei mac. sc. nat.* **9**: 122–146.
- MODRIĆ SURINA, Ž., RANDIĆ, M. and ALEGRO, A. (2012): *Calypogeia sphagnicola* (Arnell & J. Pers.) Warnst. & Loeske. In: ELLIS, L. T. (ed.): New national and regional bryophyte records, 31. – *J. Bryol.* **34**: 125. <http://dx.doi.org/10.1179/1743282012Y.0000000009>
- NEBEL, M. (2001): *Amblystegiaceae*. – In NEBEL, M. and PHILLIPI, G. (eds): Die Moose Baden-Württembergs, 2. Verlag E. Ulmer, Stuttgart (Hohenheim), pp. 282–355.
- PAPP, B. and SABOVljević, M. (2009): Notes on some new and interesting bryophyte records from Croatia. – *J. Bryol.* **31**: 272–279. <http://dx.doi.org/10.1179/037366809X12469790518448>
- 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., ALEGRO, A., ŠEGOTA, V., ŠAPIĆ, I. and VUKELIĆ, J. (2013c): Additions to the bryophyte flora of Croatia. – *J. Bryol.* **35**(2): 140–143. <http://dx.doi.org/10.1179/1743282013Y.0000000046>
- PAPP, B., ERZBERGER, P., ÓDOR, P., HOCH, Zs., SZÖVÉNYI, P., SZURDOKI, E. and TÓTH, Z. (2010): Updated checklist and red list of Hungarian bryophytes. – *Studia bot. hung.* **41**: 31–59.
- PAVLETIĆ, Z. (1957): Ekološki odnosi briofitske vegetacije na slapovima Plitvičkih jezera. – *Acta Bot. Croat.* **16**: 63–88.
- PLAVŠIĆ-GOJKOVIĆ, N., PLAVŠIĆ, M. and GOLUBOVIĆ, U. (1972): Prilog poznavanju biljno-sociološkog sastava i elemenata građe prašumskog rezervata Čorkova Uvala (Nacionalni park Plitvička jezera). – *Šumarski List* **96**(9–10): 348.
- PRPIĆ, B. (1972): Neke značajke prašume Čorkova uvala. – *Šumarski list* **96**(9–10): 325–333.
- RIBANOVIĆ, J. (1994): *Geografski smještaj (položaj) i hidrografske značajke Plitvičkih jezera*. – In: Proceedings, Plitvička jezera – nacionalno dobro Hrvatske – svjetska baština. Uprava NP Plitvička jezera & HAZU, Zagreb, pp. 29–42.
- ROS, R. M., MAZIMPAKA, V., ABOU-SALAMA, U., ALEFFI, M., BLOCCKEEL, T. L., BRUGUÉS, M., CANO, M. J., CROS, R. M., DIA, M. G., DIRKSE, G. M., EL-SAADAWI, W., ERDAŽ, 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., SÉRGIO, 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., BLOCCKEEL, T. L., BRUGUÉS, M., CROS, R. M., DIA, M. G., DIRKSE, G. M., DRAPER, I., EL-SAADAWI, W., ERDAŽ, 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. – *Cryptogamie, Bryol.* **34**(2): 99–283. <http://dx.doi.org/doi/10.782/cryb.v34.iss2.2013.99>
- SABOVljević, M. (2003): The hepatic check-list of Croatia. – *Arhiv Biol. Nauka* **55**: 59–66.
- SABOVljević, M. (2006): The check list of mosses of Croatia. – *Arhiv Biol. Nauka* **58**: 45–53.

- SABOVLJEVIĆ, M. and NATCHEVA, R. (2006): A check-list of the liverworts and hornworts of Southeast Europe. – *Phytol. Balcan.* **12**: 169–180.
- SABOVLJEVIĆ, M., GANEVA, A., TSAKIRI, E. and ŞTEFĂNUŢ, S. (2001): Bryology and bryophyte protection in south-eastern Europe. – *Biol. Cons.* **101**: 73–84.
[http://dx.doi.org/10.1016/S0006-3207\(01\)00043-X](http://dx.doi.org/10.1016/S0006-3207(01)00043-X)
- SABOVLJEVIĆ, M., ALEGRO, A., SABOVLJEVIĆ, A., MARKA, J. and VUJIČIĆ, M. (2011): An insight into diversity of the Balkan peninsula bryophyte flora in the European background. – *Rev. Écol. (Terre Vie)* **66**: 399–413.
- SABOVLJEVIĆ, M., NATCHEVA, R., TSAKIRI, E., DIHORU, G., DRAGIĆEVIĆ, S., ERDAĞ, A. and PAPP, B. (2008): Check-list of the mosses of SE Europe. – *Phytol. Balcan.* **14**: 207–244.
- SCHUMACKER, R. and VÁŇA, J. (2005): *The identification keys of the liverworts and hornworts of Europe and Macaronesia*. – Sorus, Poznań, 209 pp.
- ŠEGULJA, N. (2005) Vegetacija travnjaka, cretišta i močvarnih staništa Nacionalnog parka Plitvička jezera. (Vegetation of grassland, moor and swamp habitats in Plitvička jezera National Park). – *Natura Croatica* **14** (Suppl. 2): 1–194.
- SRDOČ, D., OBELIĆ, B., HORVATINČIĆ, N., CULIBERG, M., ŠERCELJ, A. and SLIEPČEVIĆ, A. (1985): Radiocarbon dating and pollen analyses of two peat bogs in the Plitvice national park. – *Acta Bot. Croat.* **44**: 41–46.
- STOIZNER, C. (1870): Nachtrag zu Flora von Slavonien II. – *Verh. zool.-bot. Ges. Wien* **10**: 1009–1013.
- SZŰCS, P. and BIDLÓ, A. (2014): *Campylopus introflexus* (Hedw.) Brid. [Slovenia]. In: ELLIS, L. T. (ed.): New national and regional bryophyte records, 41. – *J. Bryol.* **36**(4): 308.
<http://dx.doi.org/10.1179/1743282014Y.0000000123>
- TEŠIĆ, Ž., BOGDANOVIĆ, M., TODOROVIĆ, M., STOJANOVIĆ, S. and GIGOV, A. (1985): Plitvička tresava i osobine njenog treseta. (The Plitvice peat-bog and the properties of its peat). – *Zemljište i biljka* **34**: 159–179.
- VAJDA, L. (1955): *Plagiothecium densifolium* (Lindb.) Broth. in Ungarn. – *Mitt. d. Thüring. Bot. Gesell.* **1**(2–3): 225–230.
- VELLAK, K., INGERPUU, N., KANNUKENE, L. and LEIS, M. (2009): New Estonian records: liverworts and mosses. – *Folia Cryptog. Estonica* **45**: 91–93.
- VUKELIĆ, J. (2012): *Šumska vegetacija Hrvatske*. – Šumarski Fakultet, Sveučilište u Zagrebu & Državni zavod za zaštitu prirode, Zagreb, 403 pp.
- YAYINTAŞ, Ö. T. (2009): *Campylopus introflexus* (Hedw.) Brid. [Turkey]. In: BLOCKEEL, T. L. (ed.): New national and regional bryophyte records, 20. – *J. Bryol.* **31**: 55.
<http://dx.doi.org/10.1179/jbr.2009.31.1.64>
- ZANINOVIĆ, K. (ed.) (2008): *Klimatski atlas Hrvatske*. (Climate atlas of Croatia). – DHMZ, Zagreb, 200 pp.