

THE BRYOPHYTE FLORA OF TARA NATIONAL PARK (W SERBIA, YUGOSLAVIA)

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Tara National Park is one of the important refugia for many relict and endemic species and rare associations in Serbia. With its shaded outcrops and decaying dead wood in its old-growth forests, this area provides home for a large number of bryophytes and maintains a diverse flora. The bryoflora is rich in the wet places, meadows, fens and stream sides. Our investigation recorded 224 bryophytes (44 hepatics and 180 mosses) from this territory. Of this number, 36 taxa (13 hepatics and 23 mosses) are new for Serbia. Six species are included in the Red Data Book of European Bryophytes (ECCB 1995). Three species are European endemics. The bryophyte flora shows close relations to those of the mountainous habitats. Besides the species of the temperate zones of Europe, we recorded many boreal/subboreal species, as well as several montane species with sub-Mediterranean and/or suboceanic distribution.

Key words: bryophyte flora and vegetation, red data list, Serbia, Tara National Park

INTRODUCTION

The bryoflora of the Federal Republic of Yugoslavia (Serbia and Montenegro) is insufficiently known. There are only a few investigated regions and the number of records is far from being complete. During the past years the authors combined their efforts to improve their knowledge and make further exploration of the bryophyte flora of Serbia. Results of a field trip in 2000 to Petnica region near Valjevo city in western Serbia appeared soon after the field work (PAPP and SABOVljević 2001). There, the authors recorded 136 bryophytes (116 mosses and 20 liverworts), at the altitude of only around 200 m a.s.l.; projected to the small area (ca 10 km²), this number represents a very high level of diversity of bryophytes. 15 species were recorded as new for Serbia and 11 for the F. R. of Yugoslavia. With these results, the bryophyte flora of the F. R. of Yugoslavia counts 119 hepatic and 521 moss species, respectively (SABOVljević and STEVANOVIĆ 1999, SABOVljević 2000, PAPP and SABOVljević 2001).

In the present paper the results of four field trips made to Tara National Park are presented. This is a mountainous area, a refugium of key importance for many relict and endemic species and associations. The locus classicus of *Picea omorika*

(Pančić) Purkyne, the Serbian spruce, a peculiar relict of the European flora from the Tertiary, is also in this national park. The present distribution of this tree is very restricted, it can be found only around the middle and upper courses of the Drina river. The most important stands of this spruce in the Tara Mts were visited and the bryophyte flora of these associations was examined. In addition, other forest communities, gorges, stream sides, meadows, fens were also explored. All main habitat types were covered to record the bryoflora as completely as possible.

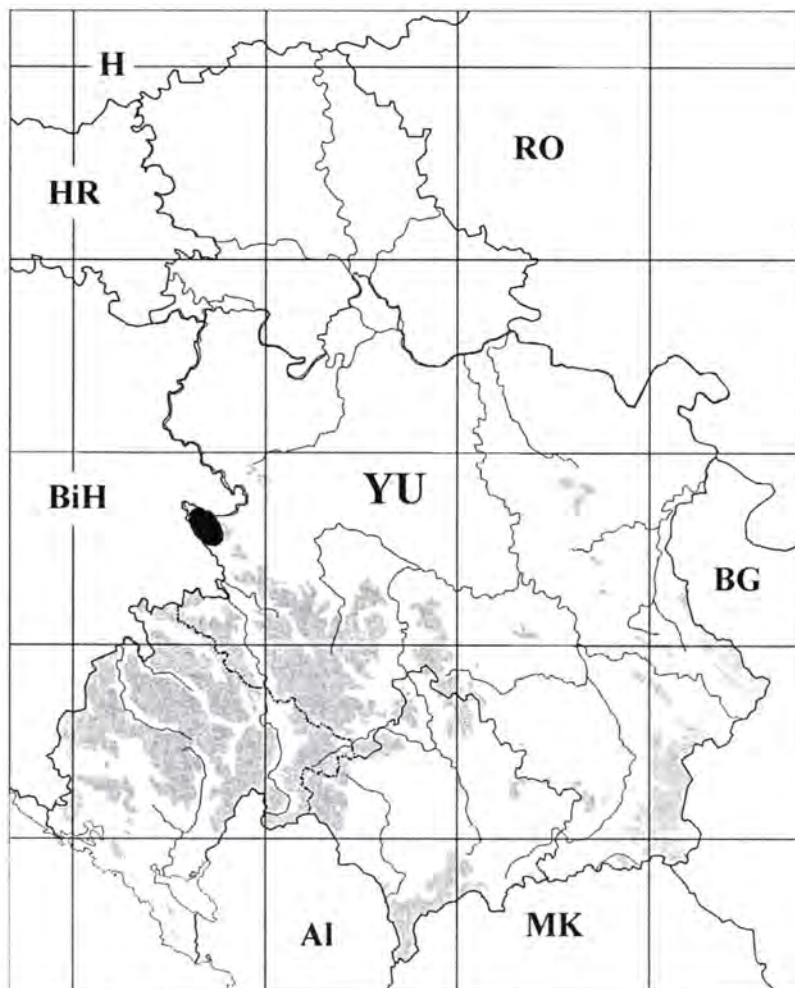


Fig. 1. The full black area shows the position of the investigated area (Tara National Park within the Federal Republic of Yugoslavia). Grey shades mark areas above 1,000 m a.s.l. Abbreviations: YU = Yugoslavia (Serbia and Montenegro), H = Hungary, HR = Croatia, BiH = Bosnia and Herzegovina, RO = Romania, BG = Bulgaria, MK = Former Yugoslav Republic of Macedonia, AI = Albania.

The investigated area

The Tara Mts are situated in the westernmost part of Serbia, by the Drina river between Višegrad and Bajina Bašta (Fig. 1). Most of the mountains fall within the National Park area (between 43°52' N and 44°02' N, and 19°15' E and 19°38' E) which covers a surface of 19,175 hectares. Geomorphologically, the Tara Mts are composed of more or less flat highlands with deep valleys of rivers and streams (Solotuški stream, Rača river, Derventa river, Beli Rzav river, Brusnički stream and some smaller ones such as Aluški, Kremički, Jokića, Rovinjski). In the northern and northwestern parts of the national park steep limestone slopes can be found reaching 1,000 m in altitude difference. The highest peak is Veliki Stolac (1673 m a.s.l.). The physiographical features of the mountains show some hydrological, geological peculiarities. Springs and surface waters are either limestone or non-limestone based. Besides limestone, the bedrock may be schist, sandstone, and serpentine. The variety of soil types adds to the diversity observed in the bedrock formation (GAJIĆ 1988).

The Tara Mts lie in a region where confronting cold and hot front lines often cause unstable weather conditions. The average temperature from December to March is below 0 °C, in some regions longer than 6 months. The highest temperatures rarely pass 27 °C even in summer months. Span of absolute minimum and maximum temperatures reaches 49 °C. The annual precipitation is 980 mm, with the peak in May as the most humid month (130 mm), followed by June and July. The rest of the months have an even distribution of rainfall of about 60–80 mm. The number of foggy days is 86 per year, which refers to the relatively high humidity of the region. The average air humidity is 83%. The climate of the Tara Mts is of montane continental to subalpine type, characterised by humid and relatively cool, long summers, and winters of great snow loads (GAJIĆ 1988).

The climax vegetation of the Tara Mts is closed forests. Besides the different old-growth forest types, human made meadows and pastures are also part of the landscape. Low altitude riverine plant communities of the Tara Mts are dominated by *Salix* and *Alnus* species. *Quercetum frainetto-cerris* Rudski (1940) 1949 and *Quercetum montanum* (B. Jovanović, 1948) Černjavski et B. Jovanović, 1953 also occur in the lower altitudes of the mountains. On serpentine, *Pinetum nigrae* Stef. 1954, *Pinetum sylvestris* Stef. 1954 or mixed *Pinetum nigrae-sylvestris* Pavl. 1951 can be found. South-facing limestone slopes are often covered by *Ostryeto-Pinetum nigrae* Čolić, 1965, while in northern exposition *Fagetum montanum* B. Jovanović, 1953 dominates (GAJIĆ 1988). Upward from 850 m, usually relict *Piceeto-Abieto-Fagetum* Čolić, 1965 forests cover the slopes. The most complex relict association is *Omorikae-Pineto-Piceeto-Abieto-Fagetum mixtum* Čolić, 1965. The "character species" of this association is *Picea omorika* (Pančić) Purkyne, the

Serbian spruce, a relict species discovered by Pančić in 1875 in the Tara Mts near Zaovine village. With its very narrow crown, this is the most characteristic and beautiful, endemic conifer species of Yugoslavia. In the nature reserve "Crveni Potok" (also part of the national park) another "polydominant" relict forest (*Picea-Abieto-Fageto-Alnetum* mixtum) is present. This is the site with the largest fen in the Tara Mts.

The vascular flora of Tara National Park contains 958 species (about 30% of the Serbian flora) with many endemic and relict elements (GAJIĆ 1988). Merits of the rich fauna include *Pyrrgomorphella serbica*, an endemic Serbian grasshopper, and over 100 bird and 24 mammal species. Tara is proposed by UNESCO to be protected as a "World Nature and Cultural Heritage" and/or "Man and Biosphere Reserve". The border lines of the national park will be extended into the neighbouring Republic of Srpska (Bosnia and Herzegovina), and the new name of the park will be "Drina".

Concerning the bryoflora of the national park, there is only a few data on the subject. GAJIĆ (1988) mentions 1 hepatic (*Marchantia polymorpha*) and 16 moss species (*Sphagnum magellanicum*, *S. palustre*, *S. recurvum*, *Dicranum scoparium*, *Rhizomnium punctatum*, *Plagiomnium rostratum*, *P. undulatum*, *Climacium dendroides*, *Neckera crispa*, *Isoetecium myosuroides*, *Anomodon viticulosus*, *Thuidium tamariscinum*, *Eurhynchium striatum*, *Hypnum cupressiforme*, *Rhytidiadelphus triquetrus* and *Polytrichum commune*).

METHODS

Field trips were made in May 1998, July 2000, and May and September 2001. All main habitat types, such as gorges, streams, fens and different forest types developed on various bedrocks were visited and bryophytes collected from different substrates (soil, calcareous and non-calcareous, exposed and shaded rocks, tree barks and decaying wood) to record the bryophytes of the national park as completely as possible.

The identification was based mainly on SMITH (1991, 1993), FREY et al. (1995) and CORTINI PEDROTTI (2001); in case of difficult genera other references were used, too (BLOM 1996, KRAMER 1980, LEWINSKY-HAAPASAARI 1995, MAIER and GEISLER 1995, SAUER 1998, SMITH 1997).

The specimens are preserved both in the Herbarium of the Hungarian Natural History Museum, Budapest (BP) and in the Herbarium of Belgrade University (BEOU). Nomenclature of the species follows CORLEY et al. (1981), CORLEY and CRUNDWELL (1991), and SCHUMACKER and VÁÑA (2000). To establish the European distribution types in the floristical evaluation, we followed DÜLL (1983, 1984, 1985, 1992).

RESULTS

Floristical results

A total of 224 bryophytes (44 hepatics and 180 mosses) was recorded in Tara National Park. Of these, 36 taxa are new to Serbia, among them 13 are hepatics (*Calypogeia fissa*, *C. suecica*, *C. integristipula*, *Cephalozia catenulata*, *Jungermannia leiantha*, *Lophozia ascendens*, *L. badensis*, *L. bantriensis*, *Metzgeria temperata*, *Nowellia curvifolia*, *Scapania calcicola*, *S. lingulata*, *S. aequiloba*) and 23 mosses (*Bartramia stricta*, *Cyrtomnium hymenophylloides*, *Dicranella grevilleana*, *D. humilis*, *Dicranodontium denudatum*, *Dicranum montanum*, *Fissidens incurvus*, *F. rivularis*, *F. serrulatus*, *F. taxifolius* var. *pallidicaulis*, *Hygrohypnum luridum* ssp. *subsphaericarpon*, *Hypnum andoi*, *Orthotrichum philibertii*, *Plagiothecium curvifolium*, *Racomitrium elongatum*, *Schistidium pruinsum*, *Sphagnum angustifolium*, *Tortella densa*, *Tortula subulata* var. *angustata*, *Ulota bruchii*, *U. calvescens*, *Weissia rostellata*, *W. rutilans*).

The complete record of the collections is as follows. After the species name the localities are given by numbers, then it is continued by the substrate.

Localities:

- 1: Entrance of Tara National Park at the Drina reservoir on the way to Predov krst, Rastiste village, 400 m a.s.l.
- 2: Predov krst, *Piceeto-Abieto-Fagetum*, 1,060 m a.s.l.
- 3: Jokića potok, Ljuti breg reserve area, *Piceeto-Abieto-Fagetum*, 960 m a.s.l.
- 4: Tepih Livada, Crveni potok reserve area, 1,050 m a.s.l.
- 5: Zaovine, Vranjak, locus classicus of *Picea omorika*, *Piceeto-Abieto-Fagetum*, 760 m a.s.l.
- 6: Biljeske Stene, Zvezda reserve area, *Piceeto-Abieto-Fagetum*, 1,080 m a.s.l.
- 7: Sedaljka village, *Quercetum* 7 km from Predov krst to Borje and Rastiste villages, 460 m a.s.l.
- 8: Derventa gorge, 250 m a.s.l.
- 9: Between Mitrovac and Zaovine at Konjska reka before Paljevine, serpentine rock, 980 m a.s.l.
- 10: Zaovine, Lazići village, *Picea omorika* stand at Zmajevski potok, serpentine rock, 920 m a.s.l.
- 11: Zaovine, Vranjak, above the reservoir, 800 m a.s.l.
- 12: Karaula Stula, 1,200 m a.s.l.
- 13: Mitrovac, 1,100 m a.s.l.
- 14: Kremna, 800 m a.s.l.
- 15: Čučkovina, between Mitrovac and Kaludjerske bare, 900 m a.s.l.
- 16: Kaludjerske bare, 1,050 m a.s.l.
- 17: Crkvenjakovo, 1,100 m a.s.l.
- 18: Krivi Javor, 1,300 m a.s.l.
- 19: Drina, near road by the river from Perućac to Derventa gorge, 400 m a.s.l.
- 20: Hajdučka česma, between Mitrovac and Kaludjerske bare, 1,000 m a.s.l.

SPECIES LIST

HEPATICS

- Aneura pinguis* (L.) Dum. – 1: artificial calcareous rock wall
Apometzgeria pubescens (Schrank) Kuwah. – 3, 5, 6, 20: shaded limestone rock
Blepharostoma trichophyllum (L.) Dum. – 2, 4, 10: decaying wood; 10: soil in forest
Calypogeia fissa (L.) Raddi – 4: decaying wood
Calypogeia integristipula Steph. – 4: bark of *Abies*; decaying wood
Calypogeia suecica (Arnell. et J. Perss.) Müll. Frib. – 4: decaying wood
Cephalozia catenulata (Hüb.) Lindb. – 10: decaying wood
Chiloscyphus coadunatus (Sw.) J. J. Engel et R. M. Schust. (= *Lophocolea bidentata* (L.) Dum.) – 16, 19: wet calcareous rocks
Chiloscyphus polyanthos (L.) Corda – 4: soil in meadow; decaying wood; 16: soil in forest, edge of the track
Chiloscyphus profundus (Nees) J. J. Engel et R. M. Schust. (= *Lophocolea heterophylla* (Schrad.) Dum.) – 4, 17: decaying wood
Cololejeunea calcarea (Lib.) Schiffn. – 5, 6, 8: shaded limestone rock
Cololejeunea rossettiana (C. Massal.) Schiffn. – 3: shaded limestone rock
Conocephalum conicum (L.) Dum. – 3: wet calcareous rock; 6: shaded limestone rock
Frullania dilatata (L.) Dum. – 2, 6: bark of *Fagus*; 7: bark of *Quercus*
Jungermannia leiantha Grolle – 2: bark of *Abies*; 2, 4: decaying wood; 4: soil in meadow; 10: soil in forest
Lejeunea cavifolia (Ehrh.) Lindb. emend. Buch – 2: bark of *Fagus*; 6, 7, 8: shaded limestone rock; 7: soil in forest
Lepidozia reptans (L.) Dum. – 4: bark of *Abies*; 4, 10: decaying wood; 10: soil in forest
Lophozia ascendens (Warnst.) R. M. Schust. – 4: decaying wood
Lophozia badensis (Gottsche) Schiffn. – 1: artificial calcareous rock wall
Lophozia bantriensis (Hook.) Steph. – 1: artificial calcareous rock wall
Lophozia ventricosa (Dicks.) Dum. – 10: soil in forest; serpentine rock
Marchantia paleacea Bertol. – 5: shaded limestone rock
Metzgeria conjugata Lindb. – 2, 5: shaded limestone rock; 2: bark of *Abies*; 10: soil in forest
Metzgeria furcata (L.) Dum. – 2, 15, 17, 19: decaying wood; 2, 6: bark of *Fagus*
Metzgeria temperata Kuwah. – 17: shaded rock cliff
Nowellia curvifolia (Dicks.) Mitt. – 2, 4: decaying wood
Pedinophyllum interruptum (Nees) Kaal. – 4, 8: shaded limestone rock
Pellia endiviifolia (Dicks.) Dum. – 2: humid soil along the road
Pellia epiphylla (L.) Corda – 4: soil in meadow
Plagiochila asplenioides (L. emend. Tayl.) Dum. – 3, 5: shaded limestone rock
Plagiochila porelloides (Torrey ex Nees) Lindenb. – 4: bark of *Abies*; 5, 7, 8: shaded limestone rock; 10: soil in forest
Porella cordaeana (Hüb.) Moore – 6: shaded limestone rock
Porella platyphylla (L.) Pfeiff. – 2, 6: bark of *Fagus*; 3, 7, 8, 20: shaded limestone rock
Preissia quadrata (Scop.) Nees – 6, 19: shaded limestone rock
Ptilidium pulcherrimum (G. Weber) Vainio – 2, 4, 10: decaying wood; 2, 4: bark of *Abies*; 10: soil in forest
Radula complanata (L.) Dum. – 2, 6: bark of *Fagus*; 5, 7: calcareous rock in forest; bark of *Quercus*

- Riccardia latifrons* (Lindb.) Lindb. – 4: decaying wood
Riccardia multifida (L.) Gray – 4: soil in meadow; decaying wood; 10: humid soil at a spring
Riccardia palmata (Hedw.) Carruth. – 2, 4: decaying wood
Scapania aequiloba (Schwaegr.) Dum. – 10: soil in forest; serpentine rock
Scapania cf. *calicicola* (Arnell et J. Press.) Ingham. – 19: wet, shaded calcareous rocks
Scapania cf. *lingulata* H. Buch – 8: exposed calcareous rock
Scapania nemorea (L.) Grolle – 5, 6: shaded limestone rock; 10: soil in forest; 19: wet, shaded limestone rocks
Trichocolea tomentella (Ehrh.) Dum. – 4: wet, shaded mud

MOSSES

- Amblystegium serpens* (Hedw.) B., S. et G. – 7, 17: calcareous rock in forest; bark of *Corylus*
Amblystegium serpens (Hedw.) B., S. et G. var. *juratzkanum* (Schimp.) Rau et Herv. – 2: soil along the road
Anomodon attenuatus (Hedw.) Hübner. – 4: bark of *Fagus*; 6: shaded limestone rock; 7: calcareous rock in forest
Anomodon rostratus (Hedw.) Schimp. – 6: shaded limestone rock
Anomodon viticulosus (Hedw.) Hook. et Tayl. – 3, 8, 19: shaded limestone rock; 4, 6: bark of *Fagus*
Atrichum undulatum (Hedw.) P. Beauv. – 2, 19: soil in forest
Barbula convoluta Hedw. – 8: shaded limestone rock; 10, 13, 19: soil along the road
Barbula crocea (Brid.) Web. et Mohr – 5: calcareous rock by the stream
Barbula unguiculata Hedw. – 1: artificial calcareous rock wall; 8: exposed calcareous rock
Bartramia pomiformis Hedw. – 2: soil along the road
Bartramia stricta Brid. – 3: bark of *Fagus*; shaded limestone rock; 5: shaded limestone rock
Brachythecium glareosum (Spruce) B., S. et G. – 7: calcareous rock in forest
Brachythecium populeum (Hedw.) B., S. et G. – 7, 15: calcareous rock in forest
Brachythecium rivulare B., S. et G. – 10: humid soil at a spring
Brachythecium rutabulum (Hedw.) B., S. et G. – 1: artificial calcareous rock wall; 2: decaying wood; shaded limestone rock; 3, 12: shaded limestone rock; 6: decaying wood
Brachythecium velutinum (Hedw.) B., S. et G. – 2: soil in forest; 5: shaded limestone rock, 6: decaying wood; 7: soil in forest; calcareous rock in forest; bark of *Corylus*; 9: serpentine rock
Bryoerythrophyllum recurvirostrum (Hedw.) Chen – 6: shaded limestone rock; 7: calcareous rock in forest
Bryum argenteum Hedw. – 9: serpentine rock; 10: soil along the road
Bryum bicolor Dicks. – 9: serpentine rock
Bryum caespiticium Hedw. – 11: rocky soil
Bryum capillare Hedw. – 1: artificial calcareous rock wall; 2, 10, 17: soil in forest; 9: serpentine rock
Bryum elegans Nees ex Brid. – 8: exposed calcareous rock
Bryum flaccidum Brid. – 2, 4, 6: bark of *Fagus*; 7: bark of *Corylus*; 8: shaded limestone rock
Bryum pallens (Brid.) Sw. ex Roehl. – 5: wet calcareous rock
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer et Scherb. – 8, 10: humid soil at a spring or by the water
Bryum radiculosum Brid. – 8: calcareous rock near the stream
Bryum ruderale Crundw. et Nyh. – 9: serpentine rock
Bryum turbinatum (Hedw.) Turn. – 13: wet forest soil

- Buxbaumia viridis* (Moug. ex Lam. et DC.) Brid. et Nestl. – 2: decaying wood; 4: decaying wood; 6: decaying wood
- Calliergon cordifolium* (Hedw.) Kindb. – 4: soil in meadow
- Calliergonella cuspidata* (Hedw.) Loeske – 4, 10: soil in meadow
- Campylium chrysophyllum* (Brid.) J. Lange – 1: artificial calcareous rock wall; 7: calcareous rock in forest
- Campylium stellatum* (Hedw.) C. Jens. – 2: wet decaying wood; 19: wet soil
- Campylium calcareum* Crundw. et Nyh. – 8: shaded soil
- Campylium halleri* (Hedw.) Lindb. – 16: wet ground
- Campylopus* sp. – 10: rocky soil by the road
- Ceratodon purpureus* (Hedw.) Brid. – 2: soil along the road; 9: serpentine rock; 10, 11, 14: rocky soil
- Cirriphyllum tenuinerve* (Lindb.) Wijk et Marg. – 6: shaded limestone rock; 7: soil in forest
- Climacium dendroides* (Hedw.) Web. et Mohr – 15, 16: meadow
- Cratoneuron filicinum* (Hedw.) Spruce – 2: humid soil along the road; wet decaying wood; 3, 5, 7, 8: wet calcareous rock; 10: humid soil at a spring
- Ctenidium molluscum* (Hedw.) Mitt. – 1: artificial calcareous rock wall; 2, 3, 5, 6, 7, 8, 17: shaded limestone rock
- Cyrtomnium hymenophylloides* (Hüb.) Nyh. ex T. Kop. – 6: wet, shaded soil
- Desmatodon* sp. – 10: soil by the road
- Dicranella cerviculata* (Hedw.) Schimp. – 10: soil in the forest
- Dicranella grevilleana* (Brid.) Schimp. – 10: soil by the forest track
- Dicranella heteromalla* (Hedw.) Schimp. – 4: soil in the forest
- Dicranella humilis* Ruthe – 4: swamp forest ground
- Dicranella subulata* (Hedw.) Schimp. – 4: soil in the forest
- Dicranella varia* (Hedw.) Schimp. – 1: artificial calcareous rock wall; 2: humid soil along the road; 5: wet calcareous rock
- Dicranella* sp. – 16: wet soil in the forest
- Dicranodontium denudatum* (Brid.) Britt. – 17: calcareous rock
- Dicranum majus* Sm. – 4: wet decaying tree
- Dicranum montanum* Hedw. – 4: bark of *Abies*; 6: bark of *Fagus*
- Dicranum polysetum* Sw. – 14: wet meadow
- Dicranum scoparium* Hedw. – 2: bark of *Abies*; 5: shaded limestone rock; 6: bark of *Fagus*; 7: soil in forest; 4, 10, 12, 15, 16: soil in forest; decaying wood
- Dicranum tauricum* Sap. – 2: bark of *Abies*; 3: decaying wood; 4: bark of *Abies*; 10: decaying wood
- Didymodon fallax* (Hedw.) Zander – 2: soil in forest; 5: shaded limestone rock; 8: exposed calcareous rock
- Didymodon ferrugineus* (Schimp. ex Besch.) M. Hill – 2: shaded limestone rock
- Didymodon rigidulus* Hedw. – 2: shaded limestone rock; 8: wet calcareous rock, exposed calcareous rock
- Didymodon vinealis* (Brid.) Zander – 13: rocky soil by the road
- Ditrichum flexicaule* (Schwaegr.) Hampe – 5: shaded calcareous rock
- Encalypta streptocarpa* Hedw. – 1: artificial calcareous rock wall; 2: soil along the road; shaded limestone rock; 3, 17: shaded limestone rock; 5, 7: calcareous rock in forest; 8: exposed calcareous rock; 9, 10: serpentine rock; 11: rocky soil
- Eucladium verticillatum* (Brid.) B., S. et G. – 5, 8: wet calcareous rock
- Eurhynchium angustirete* (Broth.) T. Kop. – 2: decaying wood; 3: bark of *Fagus*; 4: soil in meadow; 5: shaded limestone rock; 15: soil in the forest
- Eurhynchium crassinervium* (Tayl.) Loeske et Fleisch. – 3, 8, 17: shaded limestone rock

- Eurhynchium hians* (Hedw.) Sande Lac – 2, 8: wet calcareous rock; 8: shaded and exposed calcareous rock
- Eurhynchium schleicheri* (Hedw.) Jur. – 16: meadow
- Eurhynchium striatulum* (Spruce) B., S. et G. – 8: shaded limestone rock
- Fissidens adianthoides* Hedw. – 4: soil in meadow
- Fissidens bryoides* Hedw. – 7: soil in forest
- Fissidens dubius* P. Beauv. – 1: artificial calcareous rock wall; 2, 3, 5, 6: shaded limestone rock; 10: soil in forest; humid soil at a spring; 19: rock crevices
- Fissidens incurvus* Starke ex Roehl. – 2: humid soil along the road
- Fissidens rivularis* (Spruce) B., S. et G. – 17: soil by the rivulet
- Fissidens serrulatus* Brid. – 14: serpentine rock crevices
- Fissidens taxifolius* Hedw. – 2: soil in forest; humid soil along the road; 5: wet calcareous rock; 17: soil along the road
- Fissidens taxifolius* Hedw. ssp. *pallidicaulis* (Mitt.) Mönk. – 16: soil in forest
- Funaria hygrometrica* Hedw. – 13: burnt soil
- Grimmia donniana* Sm. – 7: calcareous rock in forest
- Grimmia pulvinata* (Hedw.) Sm. – 10: concrete; 14: serpentine rock crevices
- Gymnostomum calcareum* Nees et Hornsch. – 5: shaded calcareous rock
- Hedwigia ciliata* (Hedw.) P. Beauv. – 10: shaded serpentine rock
- Herzogiella seligeri* (Brid.) Iwats. – 2: decaying wood; bark of *Abies*; 4, 6, 16, 18: decaying wood
- Homalia besseri* Lob. – 3, 6, 7: shaded limestone rock
- Homalothecium lutescens* (Hedw.) Robins. – 6, 10, 17: calcareous rock; 9: serpentine rock
- Homalothecium philippeanum* (Spruce) B., S. et G. – 1: artificial calcareous rock wall; 3, 6: shaded limestone rock
- Homalothecium sericeum* (Hedw.) B., S. et G. – 4, 6: bark of *Fagus*; 5, 8: shaded limestone rock; 7: bark of *Quercus*
- Homomallium incurvatum* (Brid.) Loeske – 2, 3, 6, 14: shaded limestone rock; 7: calcareous rock in forest
- Hygrohypnum luridum* (Hedw.) Jenn. – 2, 5, 8: wet calcareous rock
- Hygrohypnum luridum* (Hedw.) Jenn. var. *subsphaericarpon* (Schleich. ex Brid.) C. Jens. – 3: wet calcareous rock
- Hylocomium splendens* (Hedw.) B., S. et G. – 5, 14: shaded limestone rock
- Hypnum andoi* A. J. E. Sm. – 2: bark of *Abies*
- Hypnum cupressiforme* Hedw. – 4: bark of *Abies* and *Fagus*; 7: bark of *Quercus*; 9: serpentine rock; 12, 16: shaded rock
- Hypnum imponens* Hedw. – 8: rock; 10: bark of *Picea*
- Hypnum lacunosum* (Brid.) G. F. Hoffman ex Brid. – 5: on soil in forest
- Hypnum lacunosum* (Brid.) G. F. Hoffman ex Brid. var. *tectorum* (Brid.) J. P. Frahm – 7: on soil in forest
- Isoetium alopecuroides* (Dubois) Isov. – 2: bark of *Abies*; 4, 6: bark of *Fagus*; 7: calcareous rock in forest; bark of *Quercus*; 10: soil in forest
- Lescuraea incurvata* (Hedw.) Lawt. – 3, 6: shaded limestone rock
- Leucodon sciurioides* (Hedw.) Schwaegr. – 2, 6, 15: bark of *Fagus*; 7: bark of *Quercus*
- Mnium ambiguum* H. Muell. – 6: shaded limestone rock
- Mnium hornum* Hedw. – 6: shaded limestone rock; decaying wood
- Mnium marginatum* (With.) Brid. ex P. Beauv. – 3, 6: shaded limestone rock
- Mnium stellare* Hedw. – 2, 12: soil along the road; 6, 8: shaded limestone rock; 6: bark of *Fagus*
- Neckera complanata* (Hedw.) Hüb. – 4, 6: bark of *Fagus*; 7, 8, 16: shaded limestone rock

- Neckera crispa* Hedw. – 2, 3, 5, 6, 8, 16: shaded limestone rock; 4: bark of *Fagus*
- Orthothecium rufescens* (Brid.) B., S. et G. – 5: shaded limestone rock
- Orthotrichum affine* Brid. – 7: bark of *Quercus*
- Orthotrichum anomalum* Hedw. – 4, 6: shaded limestone rock; 8, 10, 17: exposed calcareous rock
- Orthotrichum intricatum* (Hartm.) B., S. et G. – 19: tree bark
- Orthotrichum lyellii* Hook. et Tayl. – 2: bark of *Fagus*
- Orthotrichum pallens* Bruch – 2: bark of *Fagus*
- Orthotrichum philibertii* Vent. – 6: bark of *Fagus*
- Orthotrichum speciosum* Nees – 7: bark of *Quercus*
- Orthotrichum stramineum* Hornsch. – 6: decaying wood; 7: bark of *Quercus*
- Orthotrichum striatum* Hedw. – 2: bark of *Fagus*; 7: bark of *Quercus*
- Palustriella commutata* (Hedw.) Ochyra – 5, 8: wet calcareous rock
- Plagiomnium cuspidatum* (Hedw.) T. Kop. – 7: calcareous rock in forest; 10: soil in the forest
- Plagiomnium elatum* (B., S. et G.) T. Kop. – 12: soil in forest
- Plagiomnium ellipticum* (Brid.) T. Kop. – 3: shaded limestone rock
- Plagiomnium undulatum* (Hedw.) T. Kop. – 6, 7: shaded limestone rock
- Plagiopus oederi* (Brid.) Limpr. – 16: rocky soil by the road
- Plagiothecium curvifolium* Schlieph. – 2, 4: bark of *Abies*; 4: soil in meadow
- Plagiothecium denticulatum* (Hedw.) B., S. et G. – 4, 17: decaying wood
- Platydictia subtilis* (Hedw.) Crum – 6: bark of *Fagus*; decaying wood
- Pleuroidium acuminatum* Lindb. – 14: soil along the road
- Pogonatum aloides* (Hedw.) P. Beauv. – 2, 16: soil in forest
- Pogonatum nanum* (Hedw.) P. Beauv. – 4: soil along the forest track
- Pohlia melanodon* (Brid.) Shaw – 2: humid soil along the road
- Polytrichum formosum* Hedw. – 2, 4: soil in forest
- Polytrichum juniperinum* Hedw. – 2, 14: soil along the road
- Polytrichum piliferum* Hedw. – 16: rocky soil by the road
- Pseudoleskeella catenulata* (Brid. ex Schrad.) Kindb. – 3, 4, 6: shaded limestone rock
- Pseudoleskeella nervosa* (Brid.) Nyh. – 3: shaded limestone rock; 6: bark of *Fagus*; 7: calcareous rock in forest; 20: shaded rock
- Pterigynandrum filiforme* Hedw. – 2: bark of *Fagus*; bark of *Abies*; 6, 12: bark of *Fagus*; decaying wood
- Racomitrium canescens* (Timm ex Hedw.) Brid. – 2, 14, 16: soil along the road; 7: soil in forest
- Racomitrium elongatum* Frisvoll – 14: soil in the meadow
- Rhizomnium punctatum* (Hedw.) T. Kop. – 2: decaying wood; 4: soil in meadow; 10: humid soil at a spring
- Rhodobryum roseum* (Hedw.) Limpr. – 4: wet forest ground
- Rhynchostegiella tenella* (Dicks.) Limpr. – 4: shaded wet rock
- Rhynchostegium megapolitanum* (Web. et Mohr) B., S. et G. – 9: serpentine rock
- Rhynchostegium murale* (Hedw.) B., S. et G. – 1: artificial calcareous rock wall; 8: shaded limestone rock
- Rhynchostegium riparioides* (Hedw.) C. Jens. – 5: humid soil at a spring, wet calcareous rock; 7, 8: wet calcareous rock
- Rhyidiadelphus triquetrus* (Hedw.) Warnst. – 1: artificial calcareous rock wall; 4, 14: soil in forest; 5: shaded limestone rock; 10: serpentine rock
- Sanionia uncinata* (Hedw.) Loeske – 2, 6: decaying wood; 14: wet soil
- Schistidium apocarpum* (Hedw.) B. et S. compl. – 2, 3, 7: shaded limestone rock; 8: calcareous rock; 9: serpentine rock; 10: rock

- Schistidium crassipilum* Blom. – 10, 20: exposed calcareous rock
Schistidium pruinatum (Wils. ex Schimp.) Roth. – 14: serpentine rock
Scleropodium purum (Hedw.) Limpr. – 2: soil along the road; 5, 14: shaded limestone rock; 7: soil in forest
Scorpidium scorpidioides (Hedw.) Limpr. – 15: rock and soil in forest
Sphagnum angustifolium (C. Jens. ex Russ.) C. Jens. – 4: fen
Sphagnum centrale C. Jens. – 4: fen
Sphagnum fallax (Klinggr.) Klinggr. – 4: fen
Sphagnum girgensohnii Russ. – 4: fen
Sphagnum palustre L. – 4: fen
Sphagnum rubellum Wils. – 4: fen
Sphagnum squarrosum Crome – 4: fen
Taxiphyllum wiszgrillii (Garov.) Wijk et Marg. – 3, 8: shaded limestone rock
Tetraphis pellucida Hedw. – 4: bark of *Abies*; decaying wood
Thamnobryum alopecurum (Hedw.) Gang. – 3: wet calcareous rock
Thuidium abietinum (Hedw.) B., S. et G. – 7: soil in forest; 10: soil along the road
Thuidium delicatulum (Hedw.) B., S. et G. – 7: soil in forest; calcareous rock in forest
Thuidium philibertii Limpr. – 7, 16, 19: soil in forest
Thuidium tamariscinum (Hedw.) B., S. et G. – 2: decaying wood; 4: soil in forest
Tortella densa (Lor. et Mor.) Crundw. et Nyh. – 2: on shaded limestone rock; 17: rock crevices
Tortella inclinata (Hedw.) Limpr. – 14: serpentine rock crevices
Tortella tortuosa (Hedw.) Limpr. – 1: artificial calcareous rock wall; 2: soil along the road; 2, 5, 6, 10, 12, 16: shaded limestone rock; 7: bark of *Quercus*; 8: exposed calcareous rock; 11: rocky soil
Tortula calcicolens W. Kramer – 11: rocky soil
Tortula intermedia (Brid.) de Not. – 10, 17: rock crevices
Tortula muralis Hedw. – 8: exposed calcareous rock; 11: rocky soil
Tortula subulata Hedw. – 2: soil along the road; 7, 10: soil in forest; calcareous rock in forest
Tortula subulata Hedw. var. *angustata* (Schimp.) Limpr. – 6: shaded limestone rock
Trichostomum brachydontium Bruch – 5, 10, 14: shaded limestone rock
Trichostomum crispulum Bruch – 5: shaded limestone rock; 14: serpentine rock crevices; 19: limestone rock crevices
Ulota bruchii Hornsch. ex Brid. – 2, 3, 4: bark of *Fagus*
Ulota calvescens Wils. – 16: bark of *Fagus*
Ulota crispa (Hedw.) Brid. – 7: bark of *Quercus*
Weissia brachycarpa (Nees et Hornsch.) Jur. – 8, 16: exposed calcareous rock; 9, 14: serpentine rock
Weissia condensa (Voit) Lindb. – 8: exposed calcareous rock
Weissia controversa Hedw. – 2: shaded limestone rock; 9, 14: serpentine rock
Weissia rostellata (Brid.) Lindb. – 19: calcareous rock crevices
Weissia rutilans (Hedw.) Lindb. – 14: rock crevices

The floristical analysis (Fig. 2) shows the dominance of the bryophytes of the temperate zones of Europe (35%). The percentage of boreal, subboreal species is relatively high (21% and 14%, respectively). Several species are sub-Mediterranean/Mediterranean, suboceanic, but most of these species have montane character as well (submed-mont, suboc-mont). The subcontinental, oceanic, subarctic-subalpine elements are in the category of "others". The high rates of bo-

real/subboreal species (with sub-Mediterranean and/or suboceanic distribution) in the bryoflora of Tara National Park corresponds to that of mountainous habitats.

Bryophyte vegetation

Forests are the most important habitat types in the Tara Mts. In low elevations the open oak forests predominate with high amounts of light. On the bark of the trees several helio-thermophilous and xerotolerant species were recorded, such as *Frullania dilatata*, *Radula complanata*, *Orthotrichum* spp., *Leucodon sciuroides*. These are not common in the forests of higher altitudes, in *Piceeto-Abieto-Fagetum* and *Omorikae-Pineto-Piceeto-Abieto-Fagetum* mixtum, where the most common epiphyte species are sciophilous, such as *Metzgeria* spp., *Ptilidium pulcherrimum*, *Pterigynandrum filiforme*, *Dicranum tauricum*, *D. scoparium*, *Hypnum cupressiforme*, *Isothecium alopecuroides*. The shaded limestone rocks in these forests are very rich in bryophytes. Many liverworts occur in such places, e.g. *Apo-metzgeria pubescens*, *Cololejeunea* spp., *Lejeunea cavifolia*, *Metzgeria conjugata*, *Pedinophyllum interruptum*, *Plagiochila* spp., *Porella* spp., *Preissia quadrata*, *Scapania* spp. Of the mosses *Anomodon* spp., *Bartramia stricta*, *Brachythecium* spp., *Bryoerythrophyllum recurvirostrum*, *Ctenidium molluscum*, *Didymodon* spp., *Encalypta streptocarpa*, *Eurhynchium* spp., *Fissidens dubius*, *Homalothecium* spp., *Homomallium incurvatum*, *Lescuraea incurvata*, *Mnium* spp.,

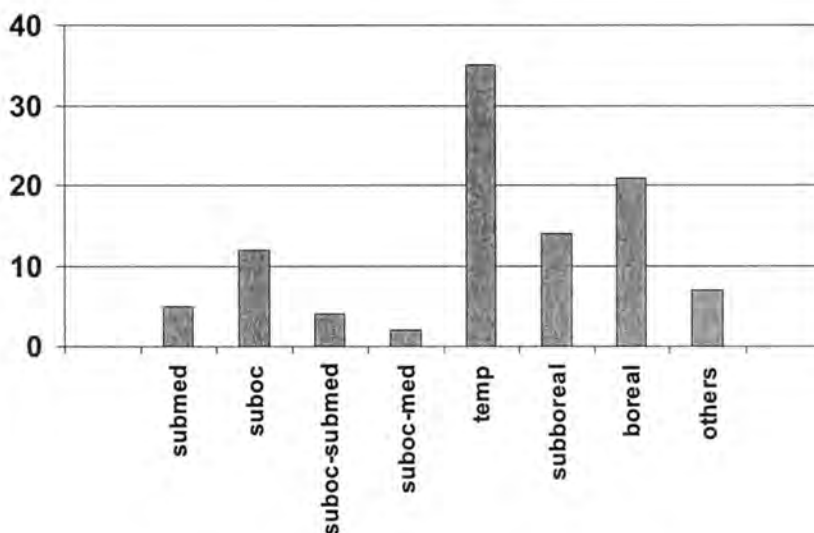


Fig. 2. Areal types among bryophytes in the Tara Mts (%).

Neckera spp., *Plagiomnium* spp., *Pseudoleskeella* spp., *Taxiphyllum wissgrillii*, *Tortella densa*, *T. tortuosa*, *Trichostomum* spp. can be mentioned. Along the forest roads *Dicranella* spp. and *Pohlia melanodon* are characteristic on wet mud. On the forest floor several acidophilous species appear, like *Dicranum scoparium*, *Polypodium* spp., *Pogonatum aloides*, *Racomitrium canescens*. Decaying wood provides very important habitats for bryophytes. Among liverworts living on this substrate *Blepharostoma trichophyllum*, *Calypogeia* spp., *Chiloscyphus profundus*, *Jungermannia leiantha*, *Lepidozia reptans*, *Lophozia ascendens*, *Nowellia curvifolia*, *Ptilidium pulcherrimum*, *Riccardia latifrons*, *R. palmata* may be mentioned; most of them are rare species. Some mosses are also characteristic on decaying wood, such as *Buxbaumia viridis*, *Eurhynchium angustirete*, *Herzogiella seligeri*, *Plagiothecium denticulatum*, *Sanionia uncinata*, *Tetraphis pellucida*.

There are only a few meadows, fens in Tara National Park, but the bryophyte vegetation of these sites is very valuable. Seven *Sphagna* and several other wetland species were found including *Chiloscyphus polyanthos*, *Pellia epiphylla*, *Riccardia multifida*, *Calliergon cordifolium*, *Calliergonella cuspidata*, *Climacium dendroideum*, *Fissidens adianthoides*, *Rhizomnium punctatum*.

Along streams and near springs *Brachythecium rivulare*, *Bryum pallens*, *B. pseudotriquetrum*, *Cratoneuron filicinum*, *Conocephalum conicum*, *Eucladium verticillatum*, *Hygrohypnum luridum*, *Palustriella commutata*, *Rhynchostegium riparioides*, *Thamnobryum alopecurum* are frequent.

On the exposed rocks numerous *Bryum* species (*B. argenteum*, *B. bicolor*, *B. capillare*, *B. elegans*, *B. rudemale*), *Didymodon fallax*, *D. rigidulus*, *Orthotrichum anomalum*, *Tortella tortuosa*, *Tortula muralis* and several *Weissia* species (*W. brachycarpa*, *W. condensata*, *W. controversa*) occur.

Nature conservation value of the bryoflora

Six species are included in the Red Data Book of European Bryophytes (ECCB 1995). Among them, four species are in the rare (R) category: *Anomodon rostratus*, *Dicranella humilis*, *Lophozia ascendens*, *Weissia rostellata* and two are vulnerable (V), these are *Buxbaumia viridis* and *Orthotrichum philibertii*.

Anomodon rostratus lives on shaded limestone rock crevices. It was first reported from Serbia by the authors from Petnica region (PAPP and SABOVLEVIĆ 2001). The locality in the Tara Mts is the second record of the species. As the distribution of the species is sub-Mediterranean-montane, we expect to find several new localities of the species in Serbia in the future. *Buxbaumia viridis* and *Lophozia ascendens* occur on large, well-decayed wood in constantly humid forests. These species are indicators of old-growth forests with rotting woods of different decay-

ing stadium and large size. The first species was reported from other places from Serbia (two localities) and Montenegro (one locality) (SABOVLJEVIĆ et al. 1999), while for the latter species this is the first recorded locality in Serbia. *Dicranella humilis* lives on wet muddy soil, *Weissia rostellata* is a species of shaded rocky places, while *Orthotrichum philibertii* occurs on barks of broad-leaved trees. These three species are new to Serbia and this is their first locality recorded in the country.

Three species are European endemics: *Tortella densa*, *Ulota bruchii*, *U. calvescens*; these are also recorded for the first time in Serbia.

CONCLUSIONS

Since the knowledge on the bryoflora of the F. R. of Yugoslavia is far from being complete, the bryofloristical studies of the protected areas has great importance. The bryophyte flora of Tara National Park is very rich and valuable. In general terms, this bryoflora is of mountainous character. Enjoying a humid climate, especially the old-growth forests are very rich in liverworts. The shaded rocks and decaying wood are very important habitats for bryophytes and provide habitats for a very diverse flora. Also the wet places, meadows, fens, stream sides are rich in mosses. Several species considered rare in Europe, and European endemics occur within the study area. During our recent investigations the number of bryophyte species known from Serbia has increased by 36 taxa.

Since the whole area of the Tara Mts is included in the national park and it is listed among the most important natural heritage regions of Europe, we do hope that the protection of its valuable flora and fauna, its diversity of habitats and vegetation receives the necessary attention and protection.

* * *

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