



ORIGINAL RESEARCH PAPER

**A BRIEF OVERVIEW OF THE BRYOFLOTA OF ŠASKO LAKE (ULCINJ, MONTENEGRO) WITH NATURAL CONDITION ASSESSMENT AND PRESSURES IN THE AREA**

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**Ključne riječi:**

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**SYNOPSIS**

In 2016, the briological flora of Šasko Lake and its surroundings was studied for the first time. This article reports 33 taxa (26 mosses and 7 liverworts), including two interesting species: *Fontinalis antipyretica* is included in the Bryophyte Red list of Serbia and Montenegro, and *Physcomitrella patens* is the second indication for the brioflora of Montenegro. Liverworts *Riccia fluitans* and *Riccia cavernosa*, which are not widely distributed in Montenegro, are present with small populations in the studied areas.

**SINOPSIS**

KRATAK PREGLED BRIOFLORE ŠASKOG JEZERA (ULCINJ, CRNA GORA) SA PROCJENOM PRIRODNOG STANJA I PRITISKOM NA PODRUČJU

Tokom 2016., po prvi put je istraživana flora mahovina Šaskog jezera sa okolinom. U radu su predstavljena 33 taksona (26 pravih mahovina i 7 jetrenjača) uključujući dvije interesantne vrste: *Fontinalis antipyretica*, koja je prisutna na Crvenoj listi mahovina Srbije i Crne Gore i *Physcomitrella patens*, što je drugi nalaz za briofloru Crne Gore. Jetrenjače *Riccia fluitans* i *Riccia cavernosa*, na istraživanom području prisutne sa malim populacijama, nemaju široko rasprostranjenje u Crnoj Gori.

**INTRODUCTION**

The beginnings of moss research in Montenegro date back to the second half of the 19<sup>th</sup> century and are actually connected with the Montenegrin coast. The

first moss researcher was Emanuel Weiss, who published two articles on the mosses from the area of Boka Kotorska (Herceg Novi, Kotor) in Vienna (Weiss, 1866; 1867). Since then, the mosses have been studied by numerous, mostly foreign, re-

searchers. Despite the list of more than 100 published references, there is still a spatial and temporal discontinuity in the knowledge of mosses in Montenegro: for some areas there are no data, for others the data are very old or sparse, for some the data were not provided on the basis of systematic research, so they are incomplete for a given area, and so on. According to the latest census, the moss flora of Montenegro includes over 700 taxa (Dragičević & Veljić, 2006; Hodgetts, 2015; Hodgetts & Lochart, 2020).

The area around Šasko Lake and its surroundings is unknown in the briological context, as the only data were obtained from a field trip through the village of Vladimir (wider surroundings of this area), where 20 species were found, including 14 mosses and 6 liverworts (Papp & Erzberger, 2007).

## STUDY AREA

Šasko Lake is an oligotrophic natural lake of elliptical shape, situated in a shallow basin between the hilly foothills of Rumija: to the southwest lies Briska gora (178 m a.s.l.) and to the northeast Šasko brdo (123 m a.s.l.) and Šulani (115 m a.s.l.) (Ulcinj region). Šasko Lake has an area of about 3.6 km<sup>2</sup> (making it the second largest natural lake in Montenegro), a length of 3210 m, a width of 1500 m and a shoreline length of 8600 m. The average depth is 4.1 m and the maximum depth is 6.5 m. During the year, the water level of the lake fluctuates greatly, so that when the water level is high, the surface of the lake rises and floods larger arable land in the vicinity of the lake. The basin of the lake represents the lower part of Brisko polje, with which it forms a depression sloping gently from northwest to southeast, between Gornja

Klezna and the Bojana River. In the southeastern part of the depression lake sediments and alluvial deposits have been deposited, while in the upper part flysch from the Eocene is found. The surroundings of Šasko Lake are formed by gentle relief structures consisting of uplifted and stratified limestone with intermediate layers of dolomite, extending as far as Upper Cretaceous. The formation of such relief structures - the basin of Šasko Lake, Brisko polje and the surrounding elevations - was influenced by the Međurječka River, which rises below Rumija Mountain. It is the only tributary of the lake, which also receives water from the surrounding springs as well as from the Bojana River when its level is higher than that of the lake. The tributary of Šasko Lake was a natural channel, widened and dug over a length of about 700 m, connecting the lake and Bojana (there are also two narrower channels) (Radojičić, 2005; Bojbaša, 1974). The climate in the Ulcinj region is Mediterranean, with significantly less precipitation compared to other parts of the Montenegrin coast, but significantly more hours of sunshine (Radojičić, 2008).

The species diversity of this area is presented to the Environmental Study for Lake Šasko and its surroundings: about 450 species and subspecies of vascular plants; 19 species of fungi belonging to the division of Basidiomycota; in the phytoplankton community, the presence of 93 alga taxa was noted; the presence of 9 benthic groups (Oligochaeta, Gastropoda, Bivalvia, Amphipoda, Ephemeroptera, Plecoptera, Trichoptera, Diptera and Nematoda) in the benthic fauna of Šasko Lake; among invertebrates, there are 45 species of ants, 2 species of scorpions, 1 species of wild bees, 5 species of freshwater snails, 2 species of non-native

molluscs, Opiliones, spiders; 9 species of fish, 11 amphibians, 14 reptiles, 226 birds and 7 large and small mammals. This study also provides data for the bryoflora, which is discussed in more detail in this paper (Grupa autora, 2016).

## MATERIAL AND METHODS

Field work included the collection of natural material (bryophyta) from various macro (lake shore, water, forest, stream, and meadow) and micro habitats

(soil, rocks, stones, tree bark, stream banks, and rotten twigs).

The research was conducted in the northern and southern and south-western parts of Šasko Lake (fig. 1), at a total of six points ( $T_{1-6}$ ). The Results section contains data for each point at which the material was sampled: sampling date, coordinates, altitude, habitat, substrate). The eastern coast is inaccessible (wetland area, macrophytic vegetation), and the western part consists mostly of cultivated, planted areas or fenced meadows.



**Figure 1: Map of the investigated area with charted localities (points) where moss sampling was performed (source: Google Earth).**

Before collection, specific types of bryophytes were also photographed in the field. Coordinates and altitude were determined with the help of GPS. Bryophyta were collected in paper bags, on which the field data (date, location, habitat, and substrate) were recorded. After returning from the field, the material was first dried in the laboratory without pressure; the drying process took about 10 days in a ventilated and dry

place. Species identification (with microscope, magnifying glass and standard bryological literature) then began.

Nomenclature is given by Hodgetts et al. (2020), and the status of endangerment according to: Sabovljević et al., 2004; Hodgetts, 2015; Hodgetts et al., 2019; Hodgetts & Lochart, 2020; Rješenje o stavljanju pod zaštitu rijetkih, proriđjenih, endemičnih i ugroženih biljnih i životinjskih vrsta, 2006.

Briological material is kept in Collection of the Bryophyta in the Natural History Museum of Montenegro, where it is preserved in the form of exiccates available for further research.

The list of species contains the Latin names of the species, the coordinates of the points at which the material was sampled, habitat and substrate, as well as the endangered status. Specific details for some bryophyta are given as notes.

## RESULTS AND DISCUSSION

The northern shore of Šasko Lake is densely overgrown with macrophytic vegetation, with prevailing reeds and sedges; in the coastal strip, shrubby vegetation with chaste tree (*Vitex agnus-castus*) and willows (*Salix* sp.) is present. This part, as well as the flood-meadows between the groves (*Populus*, *Salix*, *Alnus*, *Quercus*, *Fraxinus*, *Ulmus*), were inaccessible during field research (dense

### Liverworts

*Cephalozia bicuspidata* (L.) Dumort., N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, shadow, with *Pellia* sp..

Threat status: LC (Hodgetts et al., 2019).

*Conocephallum conicum* (L.) Dumort., N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, shadow, with *Dicranella varia*.

Threat status: LC (Hodgetts et al., 2019).

*Pellia* sp., N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, shadow, with *Cephalozia bicuspidata*.

vegetation, swampy areas, fenced meadows, steep and rocky parts of the littoral zone). The open rocky areas, which were accessible, featured very poor bryophyte vegetation, despite the fact that mosses are competitive with other plants in such places. In morphological terms, these parts are very similar to the southern shore of the lake (rocky terrain, macchia, and macrophytic vegetation along the shore). The lower course of the Međurječka River (which in this part could be said to have the appearance of a stream with fast, clean and cold water) exhibits completely different ecological conditions, so the presence and diversity of mosses here is evident, and the composition of their communities is different (in the river, on the banks).

During field research in the period June - August 2016, 33 species of mosses (26 mosses and 7 liverworts) were observed in the area of Šasko Lake.

Note: we didn't find a sexual structures on the talus of *Pellia* sp. which taxonomically separate three species of this genus, *Pellia epyphylla*, *P. endiivifolia*, *P. neesiana*, all three represented in the moss flora of Montenegro.

*Riccia cavernosa* Hoffm., N 41°58'49.68", E 19°20'07.15" (T<sub>3</sub>), along the path, the small place where the fire burned, moist.

Threat status: LC (Hodgetts et al., 2019).

*Riccia fluitans* L., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>); N 41°58'51.34", E 19°19'47.41" (T<sub>4</sub>), rotten twigs, in lake water, together with *Fontinalis antipyretica*; near streams, meadows, ground, together with *Reboulia hemishaerica*.

Threat status: LC (Hodgetts et al., 2019).

Note: all findings of this species for Montenegro need to be verified because the morphological characteristics of *Riccia fluitans* and *Riccia rhenana* are difficult to distinct, though they differ in the number of chromosomes. The contribution on *Riccia rhenana* and the first finding for the moss flora of Montenegro were given by Dragićević, Natcheva and Vuksanović, who collected this species near the mouth of the Sušica in Zeta (Elis et al., 2020).

*Riccia* sp., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>), near stream, meadow, soil.

Note: we didn't found spores in the talus which are important taxonomic character.

*Reboulia hemisphaerica* (L.) Raddi, N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>); N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), near stream, meadow, soil, with *Riccia fluitans* and out of the riverbed, out of the water, in the shadow.

Threat status: LC (Hodgetts et al., 2019).

## Mosses

*Amblystegium serpens* (Hedw.) Schimp., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>), near stream, meadow, soil.

Threat status: LC (Hodgetts et al., 2019).

*Barbula unguiculata* Hedw., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>), near stream, meadow, soil.

Threat status: LC (Hodgetts et al., 2019).

*Brachythecium rutabulum* (Hedw.) Schimp., N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, in the shadow, with *Oxyrhygium hians*.

Threat status: LC (Hodgetts et al., 2019).

*Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen, N 41°58'49.68", E 19°20'07.15" (T<sub>2</sub>), soil, with *Physcomitrella patens*.

Threat status: LC (Hodgetts et al., 2019).

*Bryum argenteum* Hedw., N 41°58'49.68", E 19°20'07.15" (T<sub>3</sub>), along the path, soil.

Threat status: LC (Hodgetts et al., 2019).

*Bryum capillare* Hedw., N 41°58'49.68", E 19°20'07.15" (T<sub>3</sub>), along the path, the small place where the fire burned, moist, with *Dicranella varia*.

Threat status: LC (Hodgetts et al., 2019).

*Calliergonella cuspidata* (Hedw.) Loeske, N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, in the shadow, together with several species.

Threat status: LC (Hodgetts et al., 2019).

*Cratoneuron filicinum* (Hedw.) Spruce, N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, in the shadow, together with several species.

Threat status: LC (Hodgetts et al., 2019).

*Cinclidotus fontinaloides* (Hedw.) P. Beauv., N 41°58'3.88", E 19°19'59.57" (T<sub>5</sub>), macchia, rock slopes, from the bark of *Vitex agnus-castus*.

Threat status: LC (Hodgetts et al., 2019).

*Ctenidium molluscum* (Hedw.) Mitt., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>), macchia, rock slopes, stone.

Threat status: LC (Hodgetts et al., 2019).

*Dicranella varia* (Hedw.) Schimp., N 41°58'49.68", E 19°20'07.15" (T<sub>3</sub>); N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), along

the path, the small place where the fire burned, moist, with *Bryum capillare*; in the riverbed, out of the water, in the shadow, with *Conocephalum conicum*.

Threat status: LC (Hodgetts et al., 2019).

***Fissidens taxifolius*** Hedw., N 41°58'49.68", E 19°20'07.15" (T<sub>2</sub>); N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), small deciduous forest, from the bark of *Fraxinus*; in the riverbed, out of the water, in the shadow.

Threat status: LC (Hodgetts et al., 2019).

***Fontinalis antipyretica*** Hedw., N 41°58'51.34", E 19°19'47.41" (T<sub>4</sub>), in the lake, small dry branches, with *Riccia fluitans*.

Threat status: LC (Sabovljević et al., 2004; Hodgetts et al., 2019).

Note: Common moss, in cold clean waters in Montenegro. It is bioindicator species of fresh and clean waters (Stevanović et al., 1995).

***Funaria hygrometrica*** Hedw., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>); N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), near streams, meadows, soil; near river, meadow, soil.

Threat status: LC (Hodgetts et al., 2019).

***Homalothecium lutescens*** (Hedw.) H. Rob., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>); N 41°58'3.88", E 19°19'59.57" (T<sub>5</sub>), along the path, macchia, rock slopes, stone.

Threat status: LC (Hodgetts et al., 2019).

***Homalothecium sericeum*** (Hedw.) Schimp., N 41°58'47.72" E 19°20'13.47" (T<sub>1</sub>); N 41°58'3.88", E 19°19'59.57" (T<sub>5</sub>), along the path, stone; macchia, rock slopes, from the bark of *Punica granatum*.

Threat status: LC (Hodgetts et al., 2019).

***Oxyrrhynchium hians*** (Hedw.) Loeske, N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>); N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), near stream, meadow, soil; in the riverbed, out of the water, in the shadow, with *Brachythecium rutabulum*.

Threat status: LC (Hodgetts et al., 2019).

***Oxyrrhynchium speciosum*** (Brid.) Warnst., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>); N 41°58'42.25"; E 19°17'57.44" (T<sub>6</sub>), near stream, meadow, soil; in the riverbed, out of the water, in the shadow, with *Plagiomnium undulatum*.

Threat status: LC (Hodgetts et al., 2019).

***Physcomitrella patens*** (Hedw.) Mitt., N 41°58'49.68", E 19°20'07.15" (T<sub>2</sub>), along the path, the small place where the fire burned, moist; soil, with *Brachytheciastrum velutinum*.

Threat status: Data deficient (DD) (Hodgetts, 2015; Hodgetts & Lochart, 2020).

In the Red List of European bryophyta has the status of the species with the Least Concern (LC) (Hodgetts et al., 2019).

NOTE: It was found only on the island at the confluence of the Morača and Skadar lakes, on sandy-clay soil, in the community with *Riccia cavernosa* (Dragičević, 2008; Dragičević et al., 2008)

***Plagiomnium undulatum*** (Hedw.) T.J. Kop., N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, in the shadow, with *Oxyrrhynchium speciosum*.

Threat status: LC (HODGETTS ET AL., 2019).

***Rhynchostegium riparioides*** (Hedw.) Cardot, N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), in the riverbed, out of the water, in the shadow.

Threat status: LC (Hodgetts et al., 2019).

*Tortella flavovirens* (Bruch) Broth., N 41°58'3.88", E 19°19'59.57" (T<sub>5</sub>), macchia, rock slopes, stone.

Threat status: LC (Hodgetts et al., 2019).

*Tortella inclinata* (R.Hedw.) Limpr., N 41°58'42.25", E 19°17'57.44" (T<sub>6</sub>), near stream, small deciduous forest, soil.

Threat status: LC (Hodgetts et al., 2019).

*Tortella squarrosa* (Brid.) Limpr., N 41°58'47.72", E 19°20'13.47" (T<sub>1</sub>), near stream, meadow, soil.

Threat status: LC (Hodgetts et al., 2019).

*Tortella tortuosa* (Hedw.) Limpr., N 41°58'3.88", E 19°19'59.57" (T<sub>5</sub>), macchia, rock slopes, stone.

Threat status: LC (Hodgetts et al., 2019).

*Weissia controversa* Hedw., N 41°58'3.88", E 19°19'59.57" (T<sub>5</sub>), macchia, rock slopes, soil.

Threat status: LC (Hodgetts et al., 2019).

The paper presents 26 mosses and 7 liverworts. Most of the species have already been recorded in numerous other places in Montenegro. The mosses found during this year's field research are not protected by national and international laws. *Fontinalis antipyretica* is on the list Bryophyte Red of Serbia and Montenegro (Sabovljević et al., 2004) (fig. 2), and for *Physcomitrella patens* the area of Šasko Lake is the second finding in Montenegro (fig. 3), so its populations should be monitored in the coming period.



Figure 2. Willow tree with *Fontinalis antipyretica* as epiphyte, a good indicator of clean water (photo: S. Dragićević).



**Figure 3.** *Physcomitrella patens* with sporophyte (photo: S. Dragičević).

The findings of species of the genus *Riccia* are quite interesting, as they are not widespread in Montenegro; moreover, their populations are generally not numerous. For example, *Riccia cavernosa* (fig. 4) was first recorded for the moss flora of Montenegro as a very small population on the island at the confluence of the artificial branch of the Morača River and Skadar Lake (Dragičević, 2008). Later it was recorded only in the hinterland of Velika plaža, in Ulcinj (Grupa autora,

2012). *Riccia fluitans* (fig. 5) was previously recorded in the area of Skadar Lake (together with *Ricciocarpos natans*, but this locality was completely destroyed) (Biberdžić et al., 2006) and in Durmitor (Papp & Erzberger, 2010); the older finding refers to the Risan area (Pavletić and Pulević, 1980). Species *Riccia* sp. collected at point 1 ( $T_1$ ) will be further investigated, as there are indications that it is a new species for the moss flora of Montenegro.



Figure 4. A very small population of the liverwort *Riccia cavernosa* was registered on an area of about 5 m<sup>2</sup>, on the remains of a fire next to a footpath, near the restaurant Šas (photo: S. Dragićević).

#### Assessment of the condition of the area from the aspect of endangered bryophytes

During field research, the natural eutrophication process of Šasko Lake was observed. This process has an adverse effect on the composition, number and diversity of moss communities. Moreover, anthropogenic, negative impacts on biological/biological diversity were evident in the investigated localities: back-

filling of the lake, construction of roads around the lake (north side), grazing, trampling, garbage disposal (smaller areas), camping, fires (most often caused by human factor), creation of agricultural complexes and more. All these activities lead to the change of autochthonous habitats in the entire research area, which results in a change in the composition of moss communities, i.e. the number of species and the size of populations.



Figure 5. *Riccia fluitans* was found on the northern shore of the lake, in water and on rotten twigs, out of water, together with *Fontinalis antipyretica* and *Reboulia hemisphaerica* (photo: B. Gobović).

## CONCLUSION

Environmental research conducted during June-August 2016 in the area of Šasko Lake have shown that this area is interesting from the aspect of the occurrence of bryophyta, because the material was collected during only one season (the summer) and the results of processing recorded 33 species (26 mosses and 7 liverworts). It is realistic to assume that the list of bryological taxa would be much larger if the material had been collected during all seasons. The data presented can serve as a basis for future, more detailed and systematic research, on the basis of which a more realistic picture of the abundance and diversity of mosses in this area could be obtained. The recorded pressures on the composi-

tion and richness of bryophytes of the subject area are: eutrophication of habitat, infrastructural works, trampling, grazing, fires, littering, and movement of tourists. Banning the construction of infrastructure and facilities, waste disposal, incineration of waste, fires, banning grazing in the part with the recognized richness and diversity of species would put an end to the devastation and achieve conservation. Based on the obtained data, the northern shore of Šasko Lake (from point T<sub>1</sub> to point T<sub>4</sub>) and the area of the Međurječka River (point T<sub>6</sub>) can be considered the most briologically important localities of Šasko Lake and its surroundings (fig. 6). The findings of the species: *Fontinalis antipyretica*, *Physcomitrella patens*, three species of the genus *Riccia* are interesting.

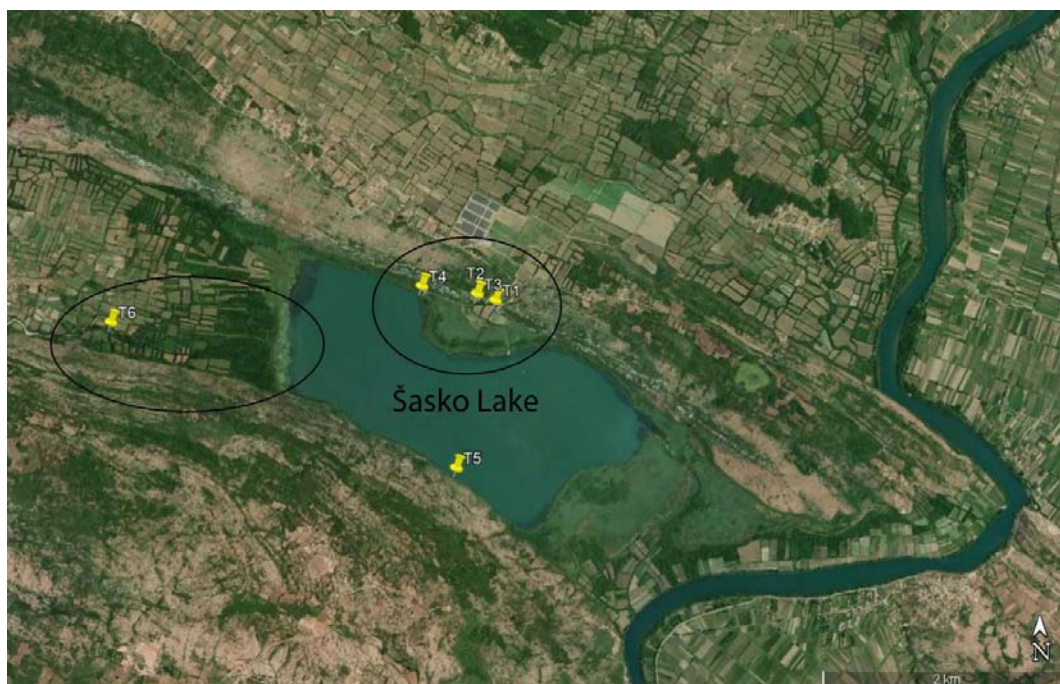


Figure 6. The area of Šasko Lake (source: Google Earth) with an emphasis on briologically important localities.

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