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## Arable bryophytes from Northeastern Slovenia with new and interesting national records

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### ABSTRACT:

We investigated the arable bryophyte flora in the Northeastern region of Slovenia. We found three new bryophyte taxa for Slovenia: *Bryum violaceum*, *Dicranella staphylina* and *Hydrogonium consanguineum* var. *kurilense*. The presence of the regionally extinct *Ephemerum cohaerens* was confirmed, and several other species from the National Red List of bryophytes were also recorded. A list of 25 bryophyte species growing on the studied arable fields is presented and commented on.

### Keywords:

Slovenia, flora, arable, mosses, liverworts, new national report, Red List

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## INTRODUCTION

Slovenia is one of the wealthiest European countries regarding the biodiversity of bryophytes in terms of surface area. Although it covers only 0.4% of Europe's territory, over 40% of European bryophyte species have been recorded in Slovenia (MARTINČIČ 2016; HODGETTS & LOCKHART 2020). However, several knowledge gaps in bryophyte diversity remain, and approximately 20% of species are classified as data deficient (DD-va) in the Slovenian National Red List (MARTINČIČ 2016). Among the least examined habitats are arable lands, especially in the NE part of Slovenia. More attention has been paid to arable habitats in recent years, leading to the discovery of *Anthoceros agrestis* Paton (STRGULC KRAJŠEK *et al.* 2021), *Ephemerum serratum* (Hedw.) Hampe (LOBNIK CIMERMAN & STRGULC KRAJŠEK 2022), *Bryum klin-graeffii* Schimp. (SABOVLJEVIĆ *et al.* 2021), *Fossombronina wondratzekii* (Corda) Dumort. ex Lindb. (DOLNIČAR *et al.* 2022; SABOVLJEVIĆ *et al.* 2022), several *Riccia* species (LOBNIK CIMERMAN & STRGULC KRAJŠEK 2020; ELLIS *et al.* 2022), and certain other bryophytes which had been overlooked in Slovenia for over 100 years.

The Northeastern, sub-Pannonian part of Slovenia is also under-researched regarding bryophyte biodiversity. Over 60% of the 288 moss taxa listed for the sub-Panno-

nian phytogeographical region in the Checklist of Mosses of Slovenia (MARTINČIČ 2003) are based on records from before 1950. A similar issue applies to liverworts, where the records for just under 50% of the taxa date back to before 1960 (MARTINČIČ 2011).

Therefore, the findings presented in this paper contribute to the knowledge of the bryophyte flora of poorly examined arable habitats in an under-researched part of Slovenia.

## MATERIAL AND METHODS

We sampled the moss flora of six localities in the northeastern part of Slovenia in the region of Prekmurje (Table 1). The region lies at the southwestern edge of the Pannonian Plain; hence the elevation of this area usually does not exceed 200 m a.s.l. This part of the country is highly agricultural, with extensive fields for crop production and less preserved natural vegetation. It is included in the Sub-Pannonian phytogeographical region of Slovenia (MARTINČIČ 2003). Geologically, the studied sites are dominated by gravel and pebbles accumulated by the river Mura. Sand and gravel deposits also occur in flooded areas along the riverbed. In some isolated locations among the river deposits, moorland sediments, such as clay and sandy clay, can be distinguished (GEOZS, <https://>

**Table 1.** The sampling localities in the NE part of Slovenia

Site no.	Locality	Habitat
1	Slovenia, Prekmurje, Murska Sobota, Bakovci, Mali Bakovci, N 46.616444°, E 16.127667°, 188 m a.s.l.	extensively managed corn stubble field
2	Slovenia, Prekmurje, Beltinci, Lipovci, W from the town Bratonci, N 46.615889°, E 16.198861°, 182 m a.s.l.	extensively managed wheat stubble field
3	Slovenia, Prekmurje, Beltinci, Lipovci, W from the town Bratonci, N 46.614028°, E 16.200778°, 182 m a.s.l.	extensively managed cornfield
4	Slovenia, Prekmurje, Beltinci, S of the town Dokležovje, E from an old gravel pit, N 46.590028°, E 16.190944°, 182 m a.s.l.	extensively managed cornfield
5	Slovenia, Prekmurje, Črenšovci, Dolnja Bistrica, S of Kolišče Bobri, N 46.530861°, E 16.301611°, 165 m a.s.l.	extensively managed wheat stubble field
6	Slovenia, Prekmurje, Črenšovci, lake Hotiško jezero, E of the lake, N 46.547056°, E 16.317222°, 167 m a.s.l.	extensively managed pumpkin field on humid terrain

ogk100.geo-zs.si/). The localities are mainly arable fields near Murska Sobota, Beltinci and Črenšovci.

The field survey on selected arable fields was carried out on October 19, 2022. Prior to fieldwork, suitable sites such as arable and stubble fields were chosen based on orthophotos, where we prioritised those fields with notable weed vegetation growing among the crops. The bryophyte samples were collected randomly to obtain as many species as possible. The specimens were taken from bare soil among other plants on the field and on the edge of the fields where water occasionally accumulates. The samples were collected in labelled containers and stored in a refrigerator until identification.

The collected specimens were identified using dichotomous keys and guides: CASAS *et al.* (2006), FREY *et al.* (2006), HOLYOAK (2021), LÜTH (2019), PATON (1999) and SCHUMACKER & VÁŇA (2005). As a nomenclatural and taxonomic standard, we used the work of HODGETTS *et al.* (2020). A record was considered new for Slovenia if it was not listed on the national bryophyte checklists (MARTINČIČ 2003, 2011) or in HODGETTS & LOCKHART (2020). The voucher specimens are stored in Herbarium LJU (Department of Biology, Biotechnical Faculty, University of Ljubljana).

## RESULTS

At six sampling sites in Prekmurje (Table 1), we identified 25 taxa of bryophytes (Table 2). One species belonged to

Anthocerotophyta, six taxa to Marchantiophyta and 18 to Bryophyta. Some specimens from the genera *Bryum* and *Riccia* could not be determined at species level due to a lack of developed sporophytes or spores.

Three moss species are new for the bryophyte flora of Slovenia: *Bryum violaceum* Crundw. & Nyholm, *Dicranella staphylinia* H. Whitehouse and *Hydrogonium consanguineum* var. *kurilense* (Ignatova & Ignatov) Jan Kučera. Nine species are listed in the Updated Red List of Bryophytes of Slovenia (MARTINČIČ 2016), where *Ephemerum cohaerens* (Hedw.) Hampe has the status of a regionally extinct (RE) species, *Riccia bifurca* Hoffm. and *Physcomitrium patens* (Hedw.) Mitt. are endangered (EN), *Trichodon cylindricus* (Hedw.) Schimp. vulnerable (VU) and 5 species [*Fossombronina wondraczekii*, *Riccia sorocarpha*, *Bryum klinggraeffii*, *Ptychostomum rubens* (Mitt.) Holyoak & N. Pedersen, and *Tortula acaulon* (With.) R. H. Zander] have the status of data deficient (DD).

## New moss taxa for the bryophyte flora of Slovenia

### *Bryum violaceum* Crundw. & Nyholm, fam. Bryaceae

Synonyms: *Gemmabryum violaceum* (Crundw. & Nyholm) J. R. Spence, *Osculatia violacea* (Crundw. & Nyholm) Ochyra, Plášek & Bedn.-Ochyra

Slovenia: Prekmurje, Črenšovci, Dolnja Bistrica, a wheat stubble field south of Kolišče Bobri, N 46.530861°, E 16.301611°, 165 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

Slovenia: Prekmurje, Črenšovci, Hotiško jezero, a pumpkin field east of the lake, N 46.547056°, E 16.317222°, 167 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

*Bryum violaceum* is a small dioicous acrocarpous moss with smooth or sometimes finely papillose purple to light violet rhizoids. The numerous small bright or pale purplish-red rhizoidal tubers on long rhizoids represent the distinctive characteristic of this species. They measure up to 90(110) µm in diameter and are roughly spherical, with non-protuberant surficial cells (HOLYOAK 2021). The gametophores are up to 1 cm tall and have ovate-lanceolate to lanceolate or narrowly triangular leaves with an acuminate apex. The leaf margins are finely denticulate near the leaf apex, recurved and scarcely bordered. The costa of the upper leaves is stout at the base, gradually narrowing towards the apex and shortly excurrent in a thin point (SMITH 2004).

To exclude *B. ruderale*, the only other *Bryum* species with bright purple to violet rhizoids, we examined the rhizoids' papillosity and the size of the rhizoidal tubers. Unlike *B. violaceum*, *B. ruderale* has larger rhizoids coarsely papillose and larger rhizoidal tubers, ranging from 125–180 (200) µm in diameter (SMITH 2004; HOLYOAK 2021).

**Table 2.** Species list from the studied localities. Legend: NEW – new species for the bryophyte flora of Slovenia, RS – Updated Red List of Bryophytes of Slovenia (<sup>1</sup>MARTINČIČ 2016), RP – recently published data for Slovenia (<sup>2</sup>STRGULC KRAJŠEK *et al.* 2021; <sup>3</sup>SABOVLJEVIĆ *et al.* 2022; <sup>4</sup>DOLNIČAR *et al.* 2022; <sup>5</sup>ELLIS *et al.* 2022; <sup>6</sup>LOBNIK CIMERMAN & STRGULC KRAJŠEK 2020; <sup>7</sup>SABOVLJEVIĆ *et al.* 2021; <sup>8</sup>LOBNIK CIMERMAN & STRGULC KRAJŠEK 2022; <sup>9</sup>LOBNIK CIMERMAN *et al.* 2022; <sup>10</sup>MARTINČIČ *et al.* 2021).

Taxon	Status SLO	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
<b>Anthocerotophyta</b>							
<i>Anthoceros agrestis</i> Paton	RP <sup>2,9</sup>		+	+		+	+
<b>Marchantiophyta</b>							
<i>Fossombronia wondraczekii</i> (Corda) Dumort. ex Lindb.	RS <sup>1</sup> (DD-va), RP <sup>3,4</sup>		+				
<i>Marchantia polymorpha</i> subsp. <i>ruderalis</i> Bischl. & Boissel.-Dub.		+		+	+	+	
<i>Riccia bifurca</i> Hoffm.	RS <sup>1</sup> (EN), RP <sup>9,10</sup>	+	+	+	+	+	+
<i>Riccia cavernosa</i> Hoffm.	RP <sup>5</sup>					+	
<i>Riccia sorocarpa</i> Bisch.	RS <sup>1</sup> (DD-va), RP <sup>6,10</sup>		+		+		
<i>Riccia</i> sp.						+	+
<b>Bryophyta</b>							
<i>Atrichum undulatum</i> (Hedw.) P. Beauv.			+				
<i>Barbula unguiculata</i> Hedw.		+					
<i>Bryum argenteum</i> Hedw.		+				+	+
<i>Bryum dichotomum</i> Hedw.			+				+
<i>Bryum klinggraeffii</i> Schimp.	RS <sup>1</sup> (DD-va), RP <sup>7,9</sup>						+
<i>Bryum</i> sp.		+				+	
<i>Bryum violaceum</i> Crundw. & Nyholm	NEW					+	+
<i>Ceratodon purpureus</i> (Hedw.) Brid.			+				
<i>Dicranella staphylina</i> H. Whitehouse	NEW		+				+
<i>Dicranella varia</i> (Hedw.) Schimp.						+	
<i>Ephemerum cohaerens</i> (Hedw.) Hampe	RS <sup>1</sup> (RE)					+	
<i>Ephemerum serratum</i> (Hedw.) Hampe	RP <sup>8,9</sup>	+					+
<i>Hydrogonium consanguineum</i> var. <i>kurilense</i> (Ignatova & Ignatov) Jan Kučera	NEW					+	
<i>Physcomitrium patens</i> (Hedw.) Mitt.	RS <sup>1</sup> (EN)					+	+
<i>Ptychostomum rubens</i> (Mitt.) Holyoak & N. Pedersen	RS <sup>1</sup> (DD-va)				+		
<i>Tortula acaulon</i> (With.) R. H. Zander	RS <sup>1</sup> (DD-va), RP <sup>9</sup>	+					
<i>Tortula truncata</i> (Hedw.) Mitt.		+	+	+	+		+
<i>Trichodon cylindricus</i> (Hedw.) Schimp.	RS <sup>1</sup> (VU)		+				

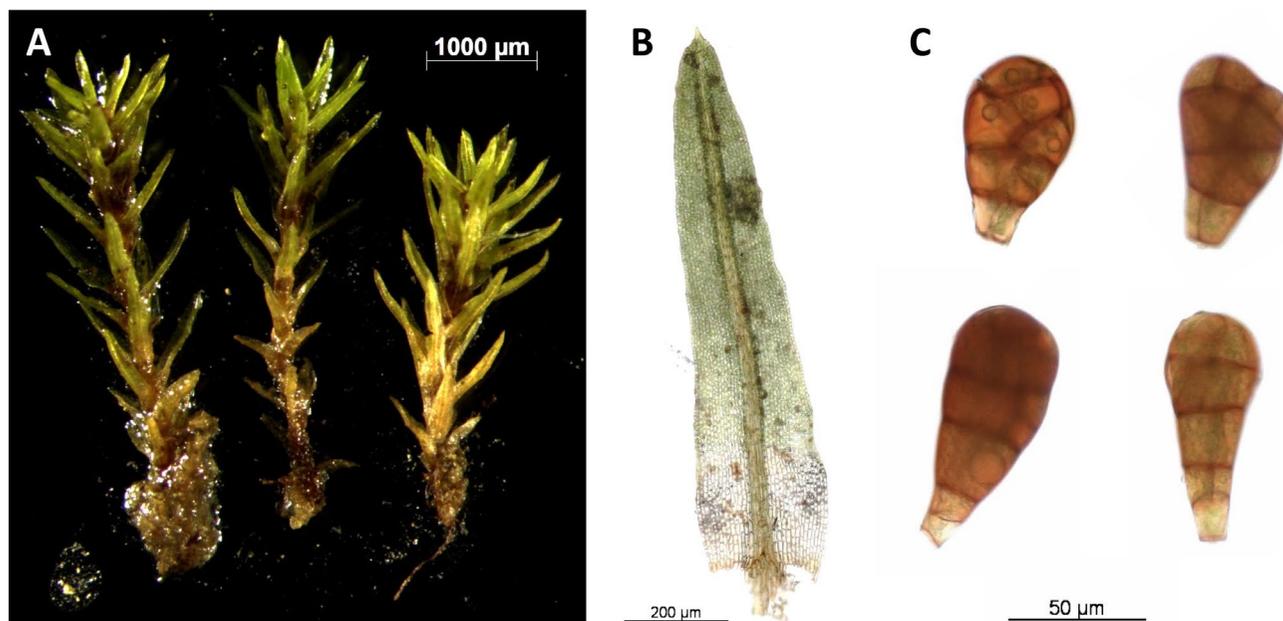
Both the collected specimens grow on slightly acidic, open soil in two arable fields near the river Mura. According to HOLYOAK (2021), *B. violaceum* is a common ephemeral moss found in arable fields and disturbed sites which survives disturbances through the presence of persistent rhizoidal tubers. The species also thrive in other temporarily open habitats, such as earth banks, graveyards, soil heaps, roadsides, and waste grounds on calcareous to slightly acidic bedrock (HOLYOAK 2021).

***Dicranella staphylina* H. Whitehouse, fam. Dicranellaceae**

Slovenia: Prekmurje, Beltinci, Lipovci, a wheat stubble field to the west of the town of Bratonci, N 46.615889°, E 16.198861°, 182 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

Slovenia: Prekmurje, Črenšovci, Hotiško jezero, a pumpkin field east of the lake, N 46.547056°, E 16.317222°, 167 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

One of the tiniest representatives of this genus, *Dicranella staphylina*, is a temperate species up to 1 cm tall. It usually has erect to patent leaves when moist, with a plane or recurved margin below and a few obscure teeth towards the apex. The leaf costa ends below the apex. We differentiated the specimens from other *Dicranella* species according to the mid-leaf cells, which are 10–14 µm wide and the presence of ubiquitous brownish rhizoidal gemmae of irregular or isodiametric shape, which were in the size range for this species (50–100 × 50–80 µm). These key morphological traits helped us to distinguish *D. staphylina* from the similar *D. varia* and *D. rufescens* (SMITH 2004).



**Fig. 1.** *Hydrogonium consanguineum* var. *kurilense* (Ignatova & Ignatov) Jan Kučera from NE Slovenia. A. Three gametophores with several light brown gemmae on the leaves (photo: A. Kladnik), B. Ventral side of the leaf, C: Gemmae.

*Dicranella staphylina* was collected from bare disturbed soil in two arable fields. *D. staphylina* is a species characteristic of early succession stages. It is also common in various disturbed habitats, such as molehills, along paths and roads, riverbanks, gardens, bare patches in grassland, gravel pits etc. (SMITH 2004; PRESTON 2010).

***Hydrogonium consanguineum* (Thwaites & Mitt.)**

**Hilp. var. *kurilense* (Ignatova & Ignatov) Jan Kučera, fam. Pottiaceae**

Slovenia: Prekmurje, Beltinci, a cornfield south of the town of Dokležovje, to the east of an old gravel pit, N 46.590028°, E 16.190944°, 182 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

The revision of the genus *Barbula* (KUČERA *et al.* 2013) transferred *Barbula consanguinea* (Thwaites & Mitt.) A. Jaeger to a separate genus, *Hydrogonium*. Three varieties of the species *Hydrogonium consanguineum* were described: *H. consanguineum* var. *consanguineum*, which occurs in Asia, var. *cancellatum* (Müll. Hal.) Jan Kučera from North America, and var. *kurilense* (Ignatova & Ignatov) Jan Kučera from Asia and Europe (KUČERA *et al.* 2013). According to KÖCKINGER *et al.* (2012), European representatives of *H. consanguineum* are well characterised by clusters of small, brown and mostly clavate axillary gemmae, a lanceolate leaf shape without a distinct sheathing leaf base, a partially recurved leaf margin, and doubly prorate superficial cells on the dorsal side of the costa. All the described traits were recognised in the specimens we found in Slovenia (Fig. 1).

This species is typical for early pioneer sites on moist, base-rich, more or less calcareous silt, sand and gravel in the alluvia of lowland streams (KÖCKINGER *et al.* 2012). Our specimens were found on the moist bare soil of a corn field near the river Mura.

**Other noteworthy moss species for the bryophyte flora of Slovenia**

***Ephemerum cohaerens* (Hedw.) Hampe, fam. Pottiaceae**

Slovenia: Prekmurje, Beltinci, a cornfield south of the town of Dokležovje, to the east of an old gravel pit, N 46.590028°, E 16.190944°, 182 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

*Ephemerum cohaerens* is a minute pseudo-dioicous ephemeral species with persistent protonema. Its leaves are patent to recurved. The upper and perichaetial leaves are lanceolate and acuminate with dentate margins. In the upper leaves, the costa ends below the apex. The mid-leaf cells measure 10–20 × 50–80 µm. The spores are coarsely papillose with a diameter of 60–70 µm (SMITH 2004). The production of abundant large spores, rhizoidal tubers, and rapid growth demonstrate the species' adaptation to disturbed habitats (HUGONNOT 2019).

The suitable habitats of the species are located in the lowlands, on non-calcareous soil on moist banks and at the edges of reservoirs (SMITH 2004), and rarely in stubble fields (HUGONNOT 2019). In Europe, it was found along rivers such as the Danube, Rhine, and Rhone and their tributaries (PAPP *et al.* 2020).

We found this species in a moist cornfield near a gravel pit, where water retention and fine-textured substrates are present.

***Trichodon cylindricus* (Hedw.) Schimp.,  
fam. Dittrichaceae**

Synonym: *Dittrichum cylindricum* (Hedw.) Grout  
Slovenia, Prekmurje, Beltinci, Lipovci, a wheat stubble field west of the town of Bratonci, N 46.615889°, E 16.198861°, 182 m a.s.l., 21.10.2022., Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek (Herbarium LJU).

*Trichodon cylindricus* is a common annual arable moss which can be easily overlooked (PORLEY 2008). The plant grows up to 5 mm and has 2–2.5 mm long leaves with an expanded sheathing leaf base which is abruptly contracted to the blade. It can be difficult to distinguish from vegetative specimens of *Dicranella scaberiana*, *Leptobryum piriforme* and *Pleuridium subulatum* (PRESTON 2010).

We found this species in a stubble field on bare soil.

***Physcomitrium patens* (Hedw.) Mitt.,  
fam. Funariaceae**

Synonyms: *Aphanorrhagma patens* (Hedw.) Lindb., *Physcomitrella patens* (Hedw.) Bruch & Schimp.

Slovenia: Prekmurje, Beltinci, a cornfield south of the town of Dokležovje, to the east of an old gravel pit, N 46.590028°, E 16.190944°, 182 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

Slovenia: Prekmurje, Črenšovci, Hotiško jezero, a pumpkin field east of the lake, N 46.547056°, E 16.317222°, 167 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

*Physcomitrium patens* is a minor annual representative of the family Funariaceae. It is recognisable by a spherical capsule with very short seta. The leaf cells are lax and easily visible through a hand lens (HODGETTS 2010).

We found it in two localities, growing on moist open soil.

***Ptychostomum rubens* (Mitt.) Holyoak & N. Pedersen,  
fam. Bryaceae**

Synonyms: *Bryum rubens* Mitt., *Osculatia rubens* (Mitt.) Ochyra, Plášek & Bedn.-Ochyra

Slovenia: Prekmurje, Beltinci, Lipovci, an extensively managed cornfield west of the town of Bratonci, N 46.614028°, E 16.200778°, 182 m a. s. l., leg. & det. Žan L. Cimerman, Darja Kopitar, Simona Strgulc Krajšek, 21.10.2022. (Herbarium LJU).

*Ptychostomum rubens* is a small representative of Bryaceae, widespread in Europe (HOLYOAK 2021). The species is a very common arable bryophyte, recognisable by

the leaf border and the presence of red spherical rhizoidal tubers measuring 100–260 µm in diameter. They are also often present in the axils of the basal leaves (HOLYOAK 2021).

We found this species in an extensively managed cornfield on bare soil.

## DISCUSSION

*Bryum violaceum* is widespread in primarily temperate regions of Europe and North America; however, additional isolated records which may have resulted from introductions have been noted elsewhere (HOLYOAK 2021). The species has no conservation status in Europe (HODGETTS *et al.* 2019). It is known from all the neighbouring countries of Slovenia except Croatia (HODGETTS & LOCKHART 2020); therefore, its presence in Slovenia is in line with expectations. In Italy, it was first found in Campania in 2006 (BLOCKEEL *et al.* 2010), and the first record for Hungary, where authors suggest the species is underrecorded, is from 1976 (ERZBERGER & SCHRÖDER 2013). Being a small and inconspicuous moss which can only be accurately identified using a microscope, it is likely to be overlooked and underrecorded in Slovenia. With additional research on arable habitats, we expect to add to the knowledge of the species distribution.

*Dicranella staphylina* was described in England by WHITEHOUSE (1969). It has no conservation status in Europe (HODGETTS *et al.* 2019), as it is widespread over the continent (HODGETTS & LOCKHART 2020). It is also present in all the neighbouring countries of Slovenia (HODGETTS & LOCKHART 2020). It is reported from several scattered localities in Austria (KÖCKINGER *et al.* 2008; PÖLTL *et al.* 2019; PÖLTL & BERG 2022), Italy (SCHÄFER-VERWIMP *et al.* 2019; ALEFFI *et al.* 2020) and Croatia (ALEGRO & ŠEGOTA 2018). In these countries, the species has no conservation status. In Hungary, where it is probably under-recorded and overlooked (PAPP *et al.* 2010), it is considered near threatened (NT) (HODGETTS & LOCKHART 2020). Although it has been an expected species in Slovenia due to its distribution in neighbouring countries, it was found only recently because of the lack of floristic bryological research in arable habitats. However, in the last few years, additional localities from other parts of Slovenia have been discovered, but have not been published yet. The specimens from Central Slovenia, in the Gorenjska and Štajerska regions, collected by Ž. L. Cimerman and S. Strgulc Krajšek are deposited in the Herbarium LJU. For a better understanding of the species distribution in Slovenia, additional samplings are needed.

*Hydrogonium consanguineum* var. *kurilense* is distributed in Central and Southern Europe. It is reported from all the neighbouring countries of Slovenia and Switzerland (HODGETTS & LOCKHART 2020). It falls under the data deficient (DD) category in the European

Red List (HODGETTS *et al.* 2019); it also has DD status in Hungary and Switzerland (HODGETTS & LOCKHART 2020). Our record aligns well with the biogeographical distribution of this taxon; therefore, it was only a matter of time before it was discovered in Slovenia.

*Ephemerum cohaerens* is one of Europe's rarest representatives of the genus *Ephemerum* (HUGONNOT 2019). It is considered rare and threatened in Europe and is classified as a vulnerable taxon (VU) in the European Red List of Bryophytes (HODGETTS *et al.* 2019). In several European countries where it occurs, *E. cohaerens* is red-listed: extinct (0) in Austria; critically endangered (CR) in Spain, Switzerland, and Romania; endangered (EN) in Great Britain, Germany, and Poland; vulnerable (VU) in Ireland; and data deficient (DD) in the Czech Republic, Slovakia, and Hungary (HODGETTS & LOCKHART 2020). It is also known from the Azores, France, Italy, Belgium, the Netherlands, and Croatia, where the species does not have any conservation status (HODGETTS & LOCKHART 2020). According to the Red list of Bryophytes (MARTINČIČ 2016), the species is considered regionally extinct in Slovenia (RE). The only discovery in Mestni log, Ljubljana, dates back to 1882 (MARTINČIČ 2016). The species was found near a clay excavation area, where it no longer occurs as its habitat was destroyed. Our find is the first recent record of this species in Slovenia. The species has been overlooked and may be under-recorded in Slovenia due to its small size, seasonality and lack of floristic-bryological research in arable habitats.

*Trichodon cylindricus* has no conservation status on the European level (HODGETTS *et al.* 2019); however, in Slovenia, it is considered vulnerable (VU) (MARTINČIČ 2016). There is only one recent record for Slovenia from Kozjak, the region near the border with Austria (leg. Martinčič, 2003, Herbarium LJU). Another two specimens are stored in the Herbarium LJU, from Trnovski gozd in SW Slovenia (leg. Grom, 1956) and the Goričko region in NE Slovenia (leg. Wraber, 1963). The locality from Prekmurje is the first recent find of this species in the NE part of Slovenia. We expect additional records of this species from other Slovene regions in the following years, as it is a common annual arable moss in Europe which can be easily overlooked (PORLEY 2008).

*Physcomitrium patens* is a moss species chosen as a model organism for non-seed plants (RENSING *et al.* 2020). It occurs in Europe, North America, and East Asia and grows in moist open soil along paths, fields, or seasonally wet areas such as the flood plains of lakes (RENSING *et al.* 2020). The species has no conservation status on the European level (HODGETTS *et al.* 2019). In Slovenia, it is considered endangered (EN) (MARTINČIČ 2016). Until recently, there were only a few old records from central and eastern parts of Slovenia (MARTINČIČ 2003); however, in 2021, one new locality from the vicinity of Ljubljana was discovered and published (MARTINČIČ *et al.* 2021). Our record from Prekmurje is the

second recent find of this species in Slovenia. We expect additional records for this species in the following years given that it is widespread in all the neighbouring countries of Slovenia, except Hungary, where it has the status of a near threatened species (NT) (HODGETTS & LOCKHART 2020).

In Slovenia, *Ptychostomum rubens* is listed as a data deficient species (DD-va) with 14 known localities, but the most recent is from 1912 (MARTINČIČ 2016). Although the species has been found several times in the last few years in several Slovene regions (the specimens collected by S. Strgulc Krajšek, Ž. L. Cimerman, M. Bačič and C. Berg are stored in the Herbarium LJU), the new records have not been published yet. The species has no conservation status in Europe (HODGETTS *et al.* 2019). As it is common in all the neighbouring countries of Slovenia, we also expect it to be widespread in Slovenia, but currently overlooked.

*Fossombronia wondraczekii* (Corda) Dumort. ex Lindb., *Riccia sorocarpa* Bisch., *Bryum klinggraeffii* Schimp. and *Tortula acaulon* (With.) R. H. Zander, which are listed as DD-va in the Slovene National Red List, and *Riccia bifurca* Hoffm. from the category EN (MARTINČIČ 2016) (Table 2), were also among the bryophytes of the fields in the NE part of Slovenia. All these species also have recent records from Slovenia (LOBNIK CIMERMAN & STRGULC KRAJŠEK 2020; MARTINČIČ *et al.* 2021; SABOVljević *et al.* 2021, 2022; DOLNIČAR *et al.* 2022; LOBNIK CIMERMAN *et al.* 2022).

Further field excursions are needed to complement the knowledge about the distribution of arable bryophyte species in Slovenia. We believe that several species which are now listed in different categories on the Slovene National Red List (MARTINČIČ 2016), for example, *Tortula acaulon*, *Riccia bifurca*, *R. sorocarpa*, *Fossombronia wondraczekii*, *Trichodon cylindricus*, *Dicranella staphylina*, *Ptychostomum rubens* and *Physcomitrium patens*, are common species of extensive fields in several regions of Slovenia. These species are also common in the neighbouring countries of Slovenia (HODGETTS & LOCKHART 2020) and have no conservation status in Europe (HODGETTS *et al.* 2019). We predict they are overlooked in Slovenia and could be transferred to the category of LC after a few years of research.

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## REZIME



Botonica  
SERBICA

## Briofite sa obradivih površina severoistočne Slovenije sa novim i interesantnim nacionalnim nalazima

Žan LOBNIK CIMERMAN, Darja KOPITAR i Simona STRGULC KRAJŠEK

Istraživana je flora briofita sa obradivih površina iz severoistočne Slovenije. Konstatovane su 3 nove vrste briofita za Sloveniju: *Bryum violaceum*, *Dicranella staphylina* i *Hydrogonium consanguineum* var. *kurilense*. Potvrđeno je prisustvo regionalno iščezle *Ephemerum cohaerens*, a takođe su zabeležene ostale vrste sa nacionalne Crvene liste briofita. Predstavljena je i diskutovana lista od 25 vrsta briofita koje rastu na istraživanim obradivim površinama.

**Ključne reči:** Slovenija, flora, obradive površine, mahovine, jetrenjače, novi nacionalni izveštaj, Crvena lista