



CONTRIBUTIONS TO THE BRYOFLOTA OF CROATIA: NEW AND RARE RECORDS

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Bučar, M., Rimac, A., Šegota, V. & Alegro, A.: Contributions to the bryoflora of Croatia: new and rare records. Nat. Croat., Vol. 35, No. 2., _____, 2026, Zagreb.

Croatian bryoflora is still quite underexplored, with new studies gradually filling in the gaps. During multiple field surveys conducted between 2022 and 2025 two new and six rare bryophyte species were found. New for the checklist of Croatian bryophytes are *Didymodon umbrosus* (Müll. Hal.) R. H. Zander and *Bartramia ithyphylla* Brid. Species *Cinclidotus danubicus* Schiffn. & Baumgartner is confirmed for Croatia with three new records. Valuable new records are provided for *Fissidens arnoldii* R. Ruthe, *Drepanocladus lycopodioides* (Brid.) Warnst and *Physcomitrium sphaericum* (C. F. Ludw. ex Schkuhr) Brid., previously known from one or two localities each. *Dicranum flagellare* Hedw. is confirmed 93 years since the last record, ultimately providing the fourth known locality of this species in Croatia. New information is gained on the distribution of the rare Mediterranean species *Scorpiurium sendtneri* (Schimp.) M. Fleisch. in Southern Croatia, previously known from six localities, but mostly from the Northern Adriatic.

Key words: Croatia, herbarium collection, mosses, new species, voucher

Bučar, M., Rimac, A., Šegota, V. & Alegro, A.: Doprinosi flori mahovina Hrvatske: novi i rijetki nalazi. Nat. Croat., Vol. 35, No. 2., _____, 2026, Zagreb.

Hrvatska brioflora još je uvijek nedovoljno istražena, a nova istraživanja polako popunjavaju praznine. Tijekom više terenskih istraživanja od 2022. do 2025. pronađene su dvije nove vrste i šest rijetkih vrsta mahovina. Nove na popisu hrvatskih mahovina su *Didymodon umbrosus* (Müll. Hal.) R. H. Zander i *Bartramia ithyphylla* Brid. Potvrđena je prisutnost vrste *Cinclidotus danubicus* Schiffn. & Baumgartner s tri nova nalaza. Zabilježeni su vrijedni novi nalazi vrsta *Fissidens arnoldii* R. Ruthe, *Drepanocladus lycopodioides* (Brid.) Warnst, *Physcomitrium sphaericum* (C. F. Ludw. ex Schkuhr) Brid. koje su do sada bile poznate s dva ili tri lokaliteta. Dobivene su nove informacije o rasprostranjenosti rijetke mediteranske vrste *Scorpiurium sendtneri* (Schimp.) M. Fleisch. u južnoj Dalmaciji, otprije poznate sa šest lokaliteta, no uglavnom iz sjevernog Jadrana.

Ključne riječi: Hrvatska, herbarijska zbirka, mahovine, nove vrste, vaučer

INTRODUCTION

Unlike the continuously explored, conspicuous vascular flora of Croatia, the unassuming bryoflora of Croatia is still inadequately explored (ALEGRO *et al.*, 2012). The

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reasons for this lie in the fact that bryophytes were intensely studied in only two periods. The first was the end of the 19th century and the beginning of the 20th when Croatia was attractive to foreign bryologists as an unexplored part of the Austro-Hungarian monarchy, extending into the first half of the 20th century when few Croatian botanists started valuable, comprehensive work on bryoflora of Croatia, e.g., HORVAT, 1932; PAVLETIĆ, 1955a; see ALEGRO *et al.*, 2012. The second period started in the early 2010s and is still ongoing, aiming not only to discover new bryophyte species (e.g., PAPP *et al.*, 2013a; ALEGRO *et al.*, 2019; RIMAC *et al.*, 2019a,b; 2021; ŠEGOTA *et al.*, 2020, 2021 2023b), but also to broaden our knowledge on the distribution of rare and underrecorded species (e.g. ŠEGOTA *et al.*, 2019, 2024, 2025; BUČAR *et al.*, 2023a,b) and confirm doubtful records from the now outdated checklists (SABOVLJEVIĆ, 2006; ROS *et al.*, 2013). New, updated checklist of hornworts and liverworts was recently published by ALEGRO *et al.* (2021), however the checklist of mosses (*Bryophyta* s.s.) is still under preparation and new studies will further improve its completeness and accuracy. Our current knowledge on the mosses of Croatia is largely based on the historical literature (ALEGRO *et al.* 2012) and the *Herbarium Croaticum* (ZA) (BUČAR *et al.*, 2023c). More recent research in Croatia has focused primarily on protected areas and other sites of particular interest, resulting in comprehensive species lists and the discovery of more than 50 species new to the Croatian flora (e.g., PAPP *et al.*, 2013b,c, 2016; ALEGRO *et al.*, 2014, 2023a,b; RIMAC *et al.*, 2022a; ŠEGOTA *et al.*, 2023a; BRIGIĆ *et al.*, 2025; ŠEGOTA *et al.*, 2026). Each of these studies not only reports novel species but also provides valuable insights into the distribution of common species, whose occurrence in Croatia is still insufficiently documented. This lack of comprehensive knowledge is partly due to the focus on selected areas, which may introduce certain biases and create the impression that some species are rare or that certain sites are "bryophyte-free."

The aim of the present study is to report new species and additional records of rare and underrecorded bryophytes in Croatia.

MATERIALS AND METHODS

The new and noteworthy records were made during various botanical surveys conducted between 2022 and 2025, covering sites across the entire country. Collected specimens were deposited in the bryophyte collection at Herbarium Croaticum (ZA). The nomenclature follows HODGETTS *et al.* (2020) for bryophytes and Plants of the World Online (POWO, 2026) for vascular plants. Geoelements are assigned mostly according to VAN ZUIJLEN *et al.* (2023) and SMITH (2004). Distributional data are based on Flora Croatica Database (ALEGRO & ŠEGOTA, 2026), SMITH (2004), FREY *et al.* (2006), HODGETTS & LOCKHART (2020) and Global Biodiversity Information Facility (GBIF 2026a). The following identification keys and photographic floras were used: SMITH (2004), FREY *et al.* (2006), ATHERTON *et al.* (2010), LÜTH (2019). *Fissidens arnoldii* was identified using ERZBERGER (2016), and *Drepanocladus lycopodioides* using HEDENÄS (2003).

RESULTS AND DISCUSSION

In the period from 2022 to 2025, two new bryophyte species (*Didymodon umbrosus* (Müll. Hal.) R. H. Zander and *Bartramia ithyphylla* Brid.) and five rare or underrecorded species were recorded (*Physcomitrium sphaericum* (C. F. Ludw. ex Schkuhr) Brid., *Drepanocladus lycopodioides* (Brid.) Warnst., *Fissidens arnoldii* R. Ruthe, *Dicranum flagellare* Hedw. and *Scorpiurium sendtneri* (Schimp.) M. Fleisch.), while one species, *Cinclidotus danubicus* is

confirmed for Croatia after the only previously known record was dismissed. Their previously known and current distribution in Croatia is given in Fig. 1 and Fig. 2, for the new and the previously known species, respectively.

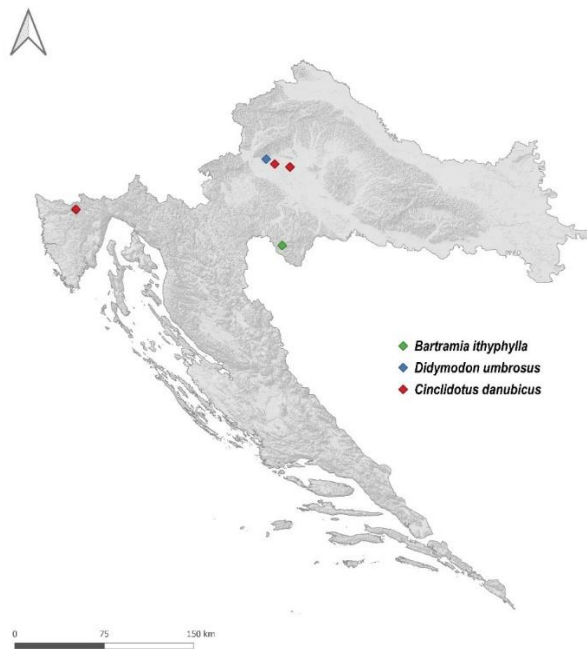


Fig. 1. Distribution of the newly discovered and confirmed species in Croatia.

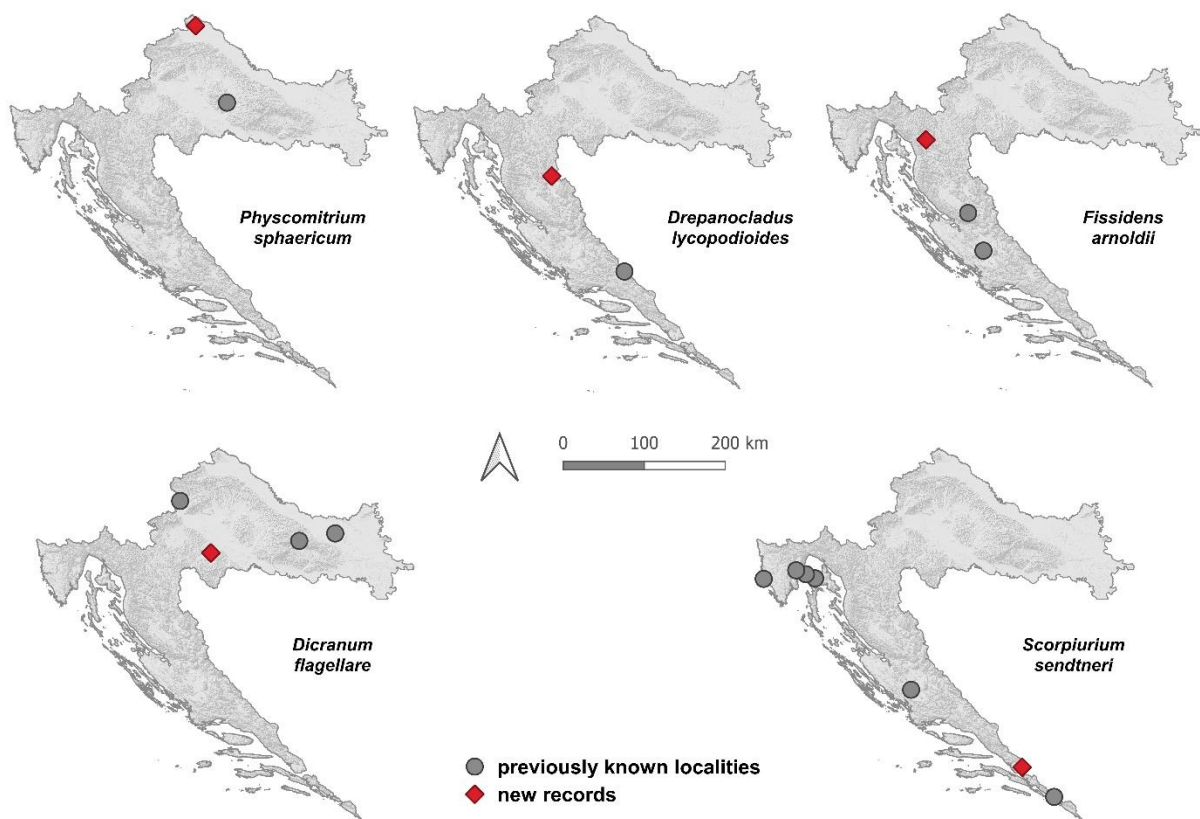


Fig. 2. Distribution of the rare and underrecorded species in Croatia.

Didymodon umbrosus (Müll. Hal.) R. H. Zander

Central Croatia, Zagreb, Botanical garden Faculty of Science, 45.80451° N, 15.97326° E, 115 m a.s.l., March 7th 2023, leg. et det. Rimac, A., Bučar, M. (ZA 83209)

Didymodon umbrosus is an oceanic, Southern-temperate species (VAN ZUIJLEN *et al.*, 2023), hence it is mostly known from the Atlantic part of Europe. In Southeastern Europe, it has only been recorded in Greece and Montenegro so far (HODGETTS & LOCKHART, 2020). According to ATHERTON *et al.* (2010), it grows in moist and shady, calcareous, lowland areas. It is unknown whether *Didymodon umbrosus* is a native or an introduced and naturalized species in Europe, but more bryologists are leaning toward the latter as this species was found in Europe for the first time relatively recently, in 1958 (KUČERA, 1999). In line with this, the majority of its subsequent records include man-made habitats or even gardens as localities (KUČERA, 1999; ECKSTEIN & BURGHARDT, 2008; DE BEER, 2024), which is in accordance to our finding. In Croatia, it was found on the edge of an old concrete circular pool for the aquatic plants in the systematic field of the Zagreb Botanical garden where it was accompanied by *Tortula muralis* Hedw. Microscopically, *D. umbrosus* is distinctive for its crenulate leaf margins and very conspicuously hyaline base with narrow marginal cells (Fig. 3) (SMITH, 2004).



Fig. 3. *Didymodon umbrosus*. A – leaf details; B – habitus.

Bartramia ithyphylla Brid.

Banovina Region, Zrinska Gora Mt., near Donji Žirovac, neutrophilic beech forest, 45.15428° N, 16.14980° E, 440 m a.s.l., December 13th 2025, leg. et det. Bučar, M. (ZA 83210)

Bartramia ithyphylla is recorded for the first time in Croatia. It was found by chance in the underexplored Banovina Region, on the Zrinska gora Mt, while sampling larger, more conspicuous species such as *Atrichum undulatum* (Hedw.) P. Beauv., *Eurhynchium striatum* (Hedw.) Schimp. and *Isoetecium alopecuroides* (Lam. ex Dubois) Isov. on the steep mineral soil in a shade of beech forest. *Bartramia ithyphylla* is boreo-arctic montane species (VAN ZUIJLEN *et al.* 2023). To date, this species has been recorded in all countries of Southeastern Europe (HODGETTS & LOCKHART 2020), while its apparent absence from Croatia is likely due to insufficient research of suitable habitats, which are often difficult to access, as the locality reported here was steep and prone to erosion. *Bartramia ithyphylla* is easily distinguished from its congeners by its hyaline sheathing leaf bases and the narrow mid-leaf cells (Fig. 4) (SMITH 2004).

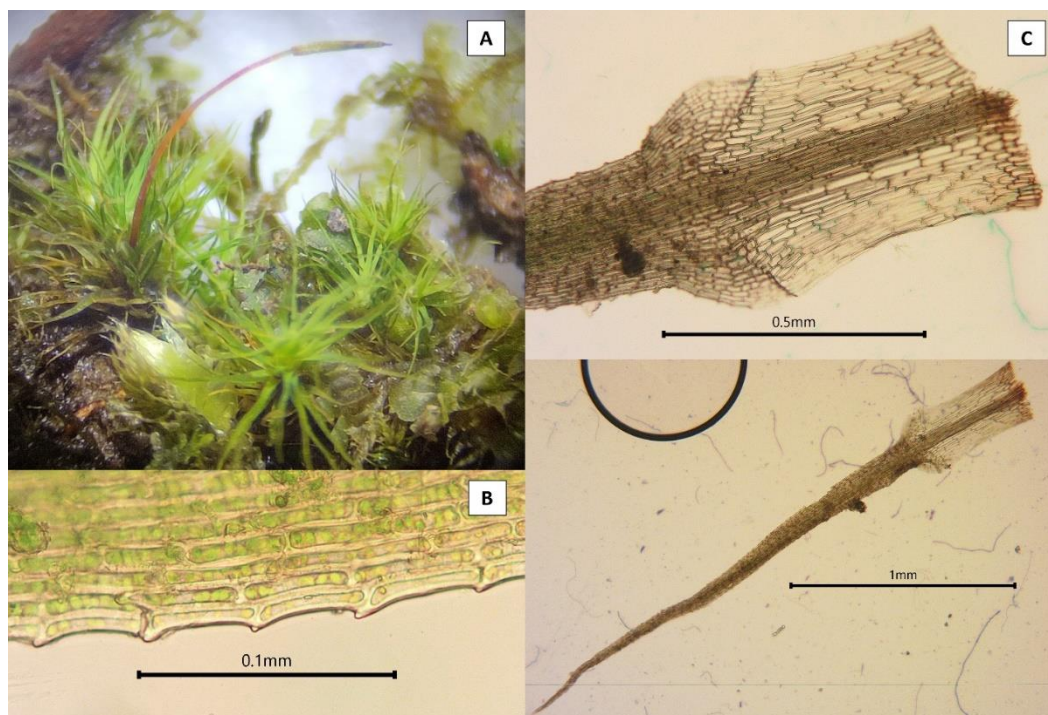


Fig. 4. *Bartramia ithyphylla*. A – habitus; B – leaf margin; C – leaf details.

Cinclidotus danubicus Schiffn. & Baumgartner

Istria Region, Mirna River, Kamenita Vrata near Buzet, 45.39834° N, 13.9389° E, 42 m a.s.l., July 14th 2022, leg. et det. Rimac, A., Bučar, M. (ZA 83215); Central Croatia, Sava River, Petruševac, 45.76834° N, 16.06594° E, 98 m a.s.l., Sava River, Rugvica, 45.74637° N, 16.2297° E, 100 m a.s.l., August 27th 2025, leg. et det. Rimac, A., Bučar, M.

Cinclidotus danubicus was named after the Danube River, where it was first described by Julius Baumgartner in 1906 (SCHIFFNER & BAUMGARTNER, 1906). *Cinclidotus* species grow on inundated, calcareous rocks, as well as on artificial substrata, in watercourses and stagnant waterbodies. They can successfully resist high turbulence and fast flow with their pluristratose leaf margins and scarcely branched, long stems (SMITH, 2004). It is not unusual to find multiple species of *Cinclidotus* growing in the same locality, even on the same rock. Four species of the genus *Cinclidotus* occur in Croatia, all of them aquatic, however, *C. danubicus* is a fairly rare species. The other three species, *C. aquaticus* (Hedw.) Bruch & Schimp., *C. fontinaloides* (Hedw.) P. Beauv. and *C. riparius* (Host ex Brid.) Arn. are common with the latter two having a wide ecological tolerance, and the first more inclined to clean, undisturbed watercourses (RIMAC *et al.*, 2022b). Thankfully, they are easily distinguished based on multiple macro- and microscopical features (Fig. 5). Recently, we discovered three new localities of *C. danubicus*: one the Mirna River in Istria, where it was growing with *C. aquaticus* and *C. fontinaloides*, and in two on the Sava River, 15 kilometers apart, both downstream from Zagreb, where it was growing with *C. riparius*. *Cinclidotus danubicus*, which is endemic in Europe (HODGETTS & LOCKHART, 2020), was previously reported from only one locality in Croatia: the Krka River at the Roški Slap waterfall. However, this record is erroneous due to the mistake in the synonymisation (SABOVLJEVIĆ, 2006) of the species *Cinclidotus herzogii* described by PAVLETIĆ (1955b). In this former study, Pavletić described a new species from Roški Slap and compares its morphology to other European *Cinclidotus* species, including *C. danubicus*. Since this study shows that Pavletić was very well aware of *C. danubicus* and its differences from the described

C. herzogii, the two cannot be synonymized. Also, this study and other Pavletić's studies from the Krka River (PAVLETIĆ, 1957) prove that *C. danubicus* was never recorded there, meaning that the our localities from rivers Mirna and Sava indeed represent the first records of *C. danubicus* in Croatia. Additionally, Pavletić stated that the holotype of *C. herzogii* lies in Herbarium Croaticum, but it was unfortunately never retrieved and is considered to be lost.

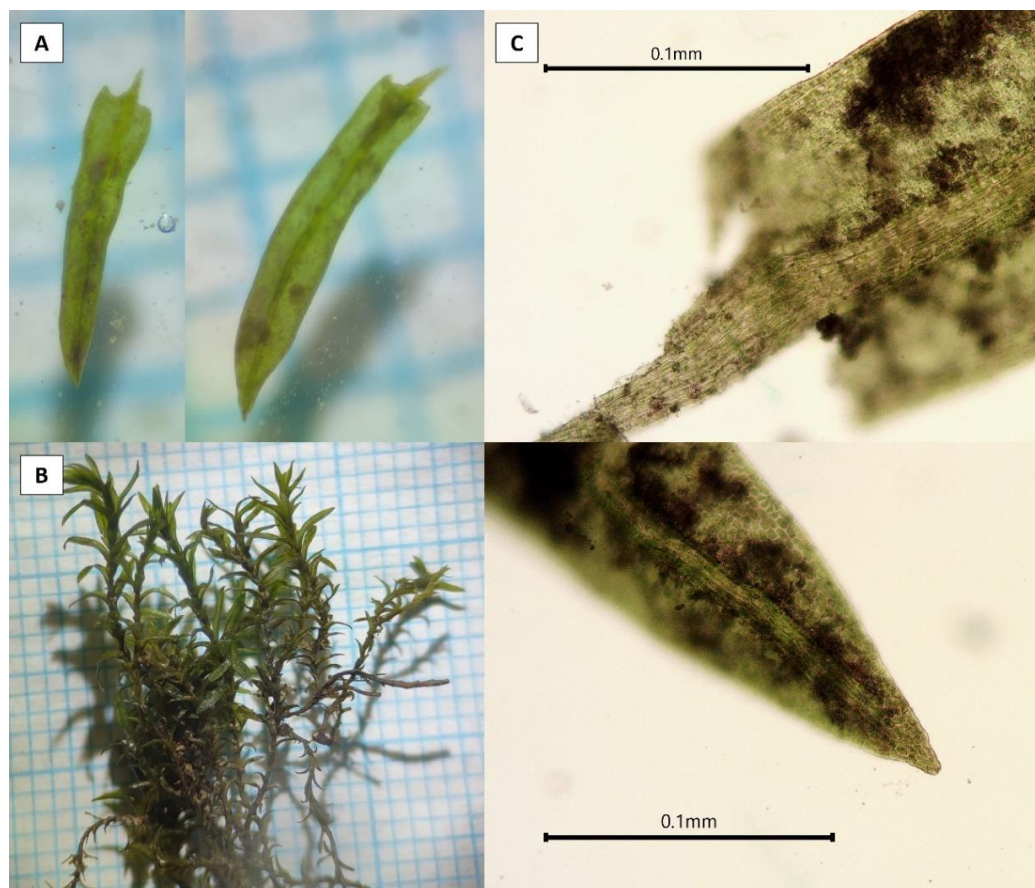


Fig. 5. *Cinclidotus danubicus*. A – leaves; B – habitus; C – leaf base and leaf tip details.

Physcomitrium sphaericum (C. F. Ludw. ex Schkuhr) Brid.

Međimurje Region, north of the city of Čakovec, periodically drained retention of pond Mačkovec, 46.43048° N, 16.42452° E, 193 m a.s.l., July 28th 2022, leg. Šegota, V., det. Rimac, A., Šegota, V. (ZA 83211)

Physcomitrium sphaericum is a small, ephemeral species of Eurasian temperate geoelement (VAN ZUIJLEN *et al.*, 2023). It only grows up to 4 mm tall and is sporadic and rare, so it is very easily overlooked. It is distinguished by its spherical capsules on a short seta, and entire leaf margins. The typical habitat is on the mud of dried-out ponds, lakes and reservoirs (SMITH 2004). It is Vulnerable in Europe according to HODGETTS *et al.* (2019). In Southeastern Europe it is only known from Bosnia and Herzegovina, Romania and is Data Deficient in Hungary (HODGETTS & LOCKHART, 2020). *Physcomitrium sphaericum* was recorded in Croatia for the first time in 2020 (ELLIS *et al.*, 2020) on the banks of the Garešnica River incorporated in the dwarf-cyperaceous vegetation (*Isoëto-Nanojuncetea* Br.-Bl. et Tx. in Br.-Bl. *et al.* 1952). Similarly, in this new, second locality on the mud of the drained retention, it was found alongside other typical species of this vegetation type (MUCINA *et al.*, 2016) such as *Gnaphalium uliginosum* L., *Cyperus michelianus* (L.) Delile and *Eleocharis ovata* (Roth) Roem. et Schult.

Drepanocladus lycopodioides (Brid.) Warnst.

Lika Region, National Park Plitvice Lakes, alkaline fen near Vrelo Koreničko, 44.77003°N, 15.68425°E, 672 m a.s.l., June 14th 2025, leg. Šegota, V., Alegro, A., det. Rimac, A., Bučar, M. (ZA 83212)

Three years after the first record of *Drepanocladus lycopodioides* (Fig. 6) in Croatia was made in the Dalmatian Hinterland (ELLIS *et al.*, 2023), a second locality was found in the National Park Plitvice Lakes during the mapping of wetland vegetation. It was found in an alkaline fen next to the rivulet Korenička Rijeka alongside *Ptychostomum pseudotriquetrum* (Hedw.) J. R. Spence & H. P. Ramsay ex Holyoak & N. Pedersen, *Fissidens adianthoides* Hedw. and *Campylium stellatum* incl. *protensum*. *Drepanocladus lycopodioides* is a boreo-temperate species (SMITH, 2004), which grows in open and wet calcareous sites (VAN ZUIJLEN *et al.*, 2023), such as alkaline fens, seasonal pools, turloughs and dune-slacks (SMITH, 2004; SHEEHY SKEFFINGTON & SCOTT, 2008; ATHERRTON *et al.*, 2010; PETERKA *et al.*, 2017). The species is classified as Vulnerable at the European level (HODGETTS *et al.*, 2019). In Southeastern Europe, it has been recorded in Montenegro (PETERKA *et al.*, 2017), in Slovenia, where it is also considered Vulnerable, and in Romania and Hungary, where it is classified as Endangered (HODGETTS & LOCKHART, 2020).



Fig. 6. Branches of *Drepanocladus lycopodioides* with falcate leaves.

Fissidens arnoldii R. Ruthe

Lika Region, Drežničko Polje, near settlement Drežnica, Sušik stream, 45.14551° N, 15.07813° E, 462 m a.s.l., August 29th 2025, leg. et det. Rimac, A. (ZA 83213)

Fissidens arnoldii (Fig. 7) is a small but easily distinguishable aquatic bryophyte, which is Vulnerable in Europe (HODGETTS *et al.*, 2019). In Southeastern Europe, it has only been recorded in Bulgaria, where it is Data Deficient and Romania, where it is considered Endangered. In countries neighbouring Croatia, it has only been recorded in Hungary where it is also classified as Vulnerable (HODGETTS & LOCKHART, 2020). *Fissidens arnoldii* grows on large calcareous rocks in clean streams. Due to its specific habitat and extremely small size,

with mature individuals being up to 3.5 mm high (ERZBERGER, 2016), it is often overlooked. In the Sušik stream, it was accompanied by a number of aquatic mosses, which tolerate shading and extended periods of drought such as *Chiloscyphus pallescens* (Ehrh.) Dumort., *Cinclidotus fontinaloides* (Hedw.) P. Beauv., *Cratoneuron filicinum* (Hedw.) Spruce, *Fontinalis antipyretica* Hedw., *Hygrohypnum luridum* (Hedw.) Jenn. and *Leptodictium riparium* (Hedw.) Warnst. This represents the third record of this species in Croatia. Previous records are from the Krka River (DÜLL, 1999) and the Ričica stream near Obrovac (RIMAC *et al.*, 2022a). Given the availability of suitable habitats, additional records may be expected in the future, depending on the true rarity of the species.



Fig. 7. *Fissidens arnoldii*. A – habitus under the microscope. B – leaf lamina detail.

Dicranum flagellare Hedw.

Banovina Region, Hrastovačka Gora Hill, close to village Pecki, sessile oak and sweet chestnut forest, 45.39088° N, 16.25166 °E, 265 m a.s.l., October 13th 2024, leg. et det. Bučar, M. (ZA 83214)

Dicranum flagellare is a boreo-temperate, circumpolar species (VAN ZUIJLEN *et al.*, 2023), much more common in the northern parts of Europe rather than South and Southeastern Europe (GBIF, 2026b). According to SMITH (2004) this species is easily recognized due to its specific habitat and unique propaguliferous flagelliform branches, which stand upright between the sterile stems that bare leaves typical for the genus (Fig. 8). It grows on dead and decaying tree stumps and logs (ATHERTON *et al.*, 2010); therefore, its presence indicates unmanaged forests with a high level of naturalness, or well-managed forests with a good practice where deadwood is intentionally retained. In general, leaving deadwood is important for ecosystem health, forest productivity, biodiversity conservation, etc. (LOMBARDI & MALI, 2016). In Croatia, there have been three records of this species so far, all of them more than 93 years old. The first record is from the lowland forest Obod close to the settlement Klokočevac in Slavonia from 1866 (SCHULZER V. MÜGGENBURG *et al.*, 1866), the second from Papuk Mt. from 1930 (ALEGRO & ŠEGOTA, 2026), and the third from the forest Dubrava close to the mire Dubravica, one of the few remaining mires in Croatia, from 1932 (HORVAT, 1932). Recently, we recorded the fourth locality, also from a dead tree stump in a sessile oak and sweet chestnut forest on Hrastovačka Gora Hill in Banovina Region. Since the continental part of Croatia is very rich in forests, which are also mostly managed, this species is expected to be found more often in the future, but in forests with lower management intensity and rich in deadwood.



Fig. 8. *Dicranum flagellare* on the sweet chestnut tree stump.

Scorpiurium sendtneri (Schimp.) M. Fleisch.

Southern Dalmatia Region, bank of the Mislina River, close to the settlement Bijeli Vir, 43.00593° N, 17.63924° E, 3 m a.s.l., June 3rd 2024, leg. Rimac, A., Šegota, V., det. Rimac, A., Bučar, M. (ZA 83218)

Scorpiurium sendtneri is a rare Mediterranean epiphyte and lithophyte indicative of warm and well-lit, base-rich habitats (VAN ZUIJLEN *et al.*, 2023). In Southeastern Europe, it has been recorded in Croatia, Greece, Slovenia and Albania. It is considered Endangered in Slovenia, Data Deficient in Albania (HODGETTS & LOCKHART, 2020). It is also considered to be doubtful in Montenegro (PAPP *et al.*, 2023). In Croatia, there are six previous records, four of them from the Northern Adriatic (Istria and the Quarnero Bay Islands) (DÜLL, 1999), while two are from Dalmatia – one from Krka National Park (GBIF, 2026c) and the other from the vicinity of the city of Dubrovnik (DÜLL, 1999). The habitus of *S. sendtneri* and the other two species, *S. circinatum* (Bruch) M. Fleisch. & Loeske and *S. deflexifolium* (Solms) M. Fleisch. & Loeske, resembles a scorpion tail, which inspired the genus name, however, compared to *S. circinatum* which is very common in the Mediterranean region, *S. sendtneri* has longer, less curved and terminally thinner branches and much weaker margin teeth (Fig. 9) (FREY *et al.*, 2006).

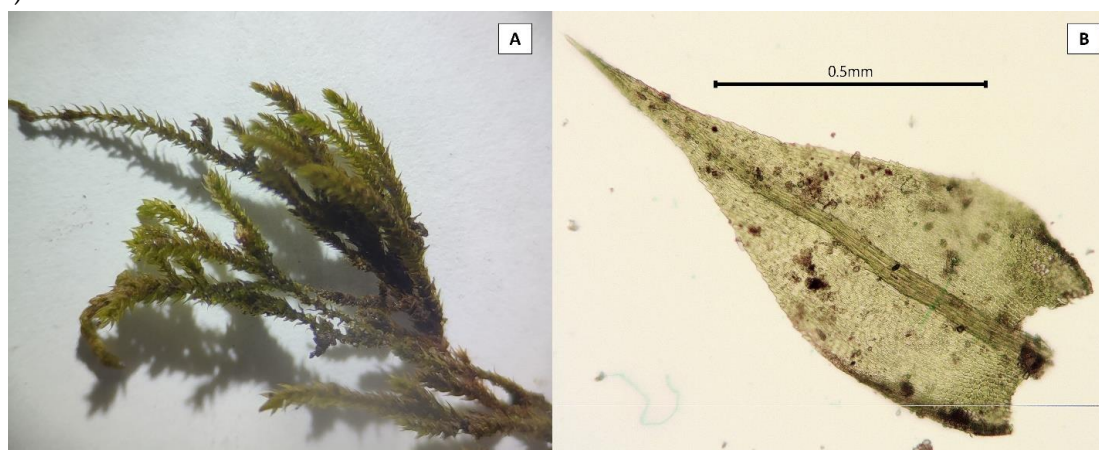


Fig. 9. *Scorpiurium sendtneri*. A – habitus; B – leaf.

Continuous bryological research remains essential for the knowledge of biodiversity and the value of different types of habitats in Croatia. The deposition and preservation of collected plant material in the herbarium collections enables permanent documentation of floristic data which can be used in future research.

ACKNOWLEDGEMENTS

We gratefully acknowledge Līga Strazdiņa and Stefan Gey for their confirmation of *Dicranum flagellare*.

Received February 10, 2026

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