

NEW SPECIES AND NOTEWORTHY RECORDS FROM HERBARIUM CROATICUM (ZA) BRYOPHYTE COLLECTION

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Prior to this research little was known about the historical Herbarium Croaticum (ZA) bryophyte collection. In 2021 and 2022 the historical bryophyte collection from ZA herbarium was systemised, nomenclaturally revised and geocoded within Flora Croatica Database, revealing as many as 1982 specimens of 335 species gathered across Croatia prior to 2000. Among them, *Hylocomiastrum umbratum* and *Timmia barbuloidea* were found to be the new, so-far forgotten species in Croatian bryoflora. From a herbarium voucher, *Heterocladium dimorphum* was finally confirmed for Croatia. Additionally, noteworthy specimens of rare and underrecorded species, the oldest records and new, previously unknown localities, were presented. Ultimately, the discovered herbarium vouchers provide a revision and verification of historical records previously known only from literature.

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

Bučar, M., Šegota, V., Rimac, A., Dianežević, D. & Alegro, A.: Nove vrste i vrijedni nalazi iz mahovinske zbirke Herbarium Croaticum (ZA). Nat. Croat., Vol. 32, No. 1., 189-197, 2023, Zagreb.

Prije ovog istraživanja podaci o mahovinama iz povijesnog dijela herbarijske zbirke Herbarium Croaticum bili su vrlo ograničeni. Tijekom 2021. i 2022. godine povijesna kolekcija mahovina iz zbirke ZA je sistematizirana, nomenklaturno revidirana i geokodirana unutar baze podataka Flora Croatica. Zbirka sadrži 1982 primjerka 335 vrsta sakupljenih u Hrvatskoj prije 2000. godine. Vrste *Hylocomiastrum umbratum* i *Timmia barbuloidea* su nove, do sada zaboravljene vrste u hrvatskoj flori mahovina. Vrsta *Heterocladium dimorphum* je na osnovu pronađenog herbarijskog primjerka napokon potvrđena za Hrvatsku. Dodatno su u radu predstavljeni i vrijedni nalazi rijetkih i slabo bilježenih vrsta, najstariji nalazi te novi, ranije nepoznati lokaliteti nekih vrsta. Pronađeni herbarijski primjerci omogućuju daljnju reviziju i verifikaciju povijesnih nalaza ranije poznatih jedino iz literature.

Cljučne riječi: Hrvatska, herbarijska zbirka, jetrenjarke, rožnjače, mahovine, nova vrsta, dokazni primjerak

INTRODUCTION

Even with the long history of bryological research in the country, bryophytes are still underresearched in Croatia (ALEGRO *et al.*, 2012), as in other countries in the Balkan Peninsula (SABOVLJEVIĆ, 2004). Up until about 10 years ago, when new, extensive bryological research started, it was mostly literature containing sporadic findings that was

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known, alongside some comprehensive checklists like those from HORVAT (1932) and PAVLETIĆ (1955). Even though recent studies shone new light on bryophyte species and their distribution in Croatia, new findings are still expected as Europe's third richest country in plant diversity (NIKOLIĆ, 2001) awaits further exploration.

Herbarium Croaticum (ZA) is the largest and the oldest registered plant collection in Croatia (herbariumcroaticum.biol.pmf.hr). Its vascular plant collection has been in the process of digitisation for the last two decades, resulting in the publication of several papers (ŠEGOTA *et al.*, 2017, 2019, REŠETNIK *et al.*, 2019, 2020, TERLEVIĆ & REŠETNIK, 2020, VILOVIĆ *et al.*, 2020, ZEKO *et al.*, 2020). However, little was known about its bryophyte collection other than from available literature (ALEGRO & ŠEGOTA, 2022).

There is an almost 50-year gap in bryological research in Croatia between the last known literature data dating back to the 20th century (PAVLETIĆ, 1955, 1957, 1960, PAVLETIĆ & MATONIČKIN 1965) and the year 2012 when new recent bryological studies began (eg. PAPP *et al.* 2013, ELLIS *et al.* 2012a, 2012b). So far, contemporary researchers relied mainly on older literature when compiling checklists upon which they built their new findings. Most of the bryophyte material collected in Croatia up to the 20th century is presumed to be held in the Herbarium of the Natural History Museum in Vienna (W), the Hungarian Natural History Museum (BP) and in Herbarium Croaticum (ZA). In 2021 and 2022, all bryophyte specimens within the collection of ZA were systemised, their nomenclature was updated and they were later digitised in Flora Croatica Database - FCD (NIKOLIĆ, 2005-onwards). From that point we have a comprehensive database on bryophyte records in Croatia, including not only literature records but also data from the historical herbarium collection.

Although we only expected to find species already listed in the checklists and voucher specimens mentioned in the literature, in the event, new and noteworthy information was revealed.

MATERIALS AND METHODS

Previously identified bryophyte material from the collection was gathered. Older synonyms were updated using PAVLETIĆ (1955) and Ros *et al.* (2007, 2013). The nomenclature used is in accordance with HODGETTS *et al.* (2020) for mosses and SÖDERSTRÖM *et al.* (2016) for liverworts and hornworts. The data from the labels were entered in the FCD, the spatial data were geocoded and the specimens were stored in the collection alphabetically. Finally, herbarium and literature data were compared.

RESULTS AND DISCUSSION

The gathered historical material from the bryophyte collection of ZA consisted of around 6200 specimens representing 1100 species collected before the 21st century. Among them, there were 1982 specimens of 335 species collected in Croatia. Almost all specimens from Croatia were georeferenced (98.7%). The vast majority of herbarium records were confirmed in scientific papers published in the second half of the 19th century and the first half of the 20th century (conf. ALEGRO & ŠEGOTA, 2022). However, 44 specimens found in the collection provided us with new and valuable information, either representing new localities or the oldest known records of several species or being vouchers of rare and underrecorded species only known from the literature. Most importantly, two new moss species for Croatia previously unknown from the literatu-

re were found in the collection. Additionally, one species so far listed only in the checklists but lacking primary literature reference, was ultimately confirmed.

New bryophyte species for Croatia

The bryophyte collection revealed two new bryophyte species for Croatia – *Hylocomiastrum umbratum* (Ehrh. ex Hedw.) M. Fleisch. and *Timmiella barbulooides* (Brid.) Mönk. (Tab. 1). These specimens were revised and the primary identification was confirmed. It is not known why these records were never published.

Tab. 1. Detailed information on two new national bryophyte records from ZA collection.

Species	Collector	Id	Date of collection	Locality	Locality description
<i>Timmiella barbulooides</i> (Brid.) Mönk.	Baumgartner, J.	67375	13/5/1931	Pelješac Peninsula, Trstenik	Pelješac Peninsula, torrent right below Trstenik; lime; 10 m a.s.l.
<i>Hylocomiastrum umbratum</i> (Ehrh. ex Hedw.) M. Fleisch.	Horvat, I.	65457	unknown (presumably 1932)	Samarske stijene	unknown
		65459	unknown (presumably 1932)	Samarske stijene	unknown
		65461	unknown	Mt Obruč	unknown

Hylocomiastrum umbratum (Ehrh. ex Hedw.) M. Fleisch., a large pleurocarpous understory moss, which also grows on boulders and logs (HYLANDER *et al.*, 2002) is a boreo-montane species (HILL & PRESTON, 1998) found in Sweden, France, Italy and Spain, where it is vulnerable according to IUCN criteria, and also in Romania, Slovenia and Serbia, where no threat has been assessed (HODGETTS & LOCKHART, 2020). Three specimens of *Hylocomiastrum umbratum* in ZA (ID: 65457, 65459 and 65461) (Fig. 1) were originally identified as *Hylocomium umbratum* Br. Eur. by the collector Ivo Horvat. The species was found in two localities in the northwestern part of the Croatian Dinarides, Samarske stijene (two specimens) and Mt. Obruč (one specimen), which are approximately 50 km apart. Both localities are in the Gorski Kotar region, the northwestern mountainous region of the Croatian Dinarides continuing into neighbouring Slovenia. Samarske stijene is a mountainous strict nature reserve which represents a diverse karst relief of many unusual formations at altitudes up to 1032 m a.s.l. Further to the north lies Obruč mountain with the peak at 1376 m a.s.l. The dates of the collections are not



Fig. 1. *Hylocomiastrum umbratum* specimen from ZA.

indicated, but in 'A review of the Horvat herbarium (ZAHO) in Zagreb' (HORVAT & PLAZIBAT, 2007), many localities which Ivo Horvat studied are given. According to this paper, Horvat visited Samarske stijene in September of 1932, whereas Obruč mountain and areas nearby were frequently visited by Horvat in July of 1928, 1932, 1952 and 1953 so we might assume that the specimens of *H. umbratum* were collected during some of those visits.

Timmiella barbuloidea (Brid.) Mönk. is widespread in the Mediterranean Basin with records from Portugal, Spain, France (where it is at risk, according to national criteria), Italy, Malta, Cyprus (HODGETTS & LOCKHART, 2020), Morocco, Algeria, Tunis and others (Ros-Espín *et al.*, 2013), whereas in Southeastern Europe, it is only found in three Mediterranean countries - Albania, Montenegro and Greece. (HODGETTS & LOCKHART, 2020). The specimen from ZA (Fig. 2) was collected in 1931 by Julius Baumgartner in Trstenik, a settlement situated on the southern coast of the central part of the Pelješac Peninsula, mostly built of limestone rocks (JASPRICA & KOVAČIĆ, 2011). FADEL *et al.* (2020) state saxicolous, moist soil, moist limestone rocks and hydromorphic soil as suitable substrates for this species, which is in accordance with the locality description of this Croatian record.

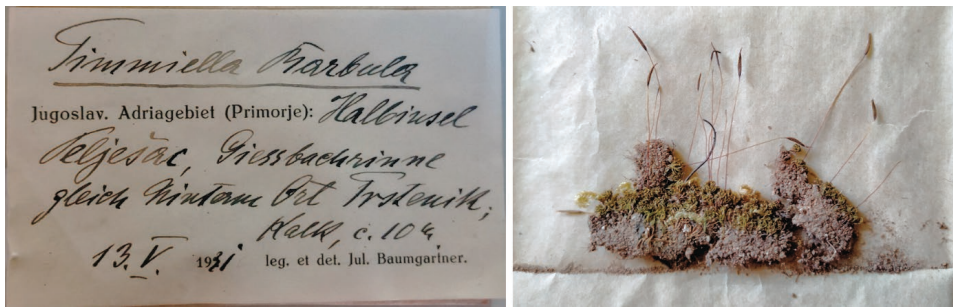


Fig. 2. *Timmiella barbuloidea* specimen from ZA.

Other important data

Heterocladium dimorphum (Brid.) Schimp. was mentioned for Croatia in checklists of Croatia (SABOVljević, 2006), Yugoslavia (MARTINČIĆ *et al.*, 1968, DULL *et al.*, 1999), SE Europe (SABOVljević *et al.*, 2008) and the Mediterranean (Ros-Espín *et al.*, 2013). However, all the checklists lack links to any primary literature or herbarium reference, thus the species was considered dubious. Similarly, several liverwort and hornwort species had to be excluded from the newest checklist as there was no proof to back up those records (ALEGRO *et al.*, 2021). During the revision of ZA collection, a specimen of *H. dimorphum* collected by C. Loitlesberger from Istrian Peninsula was discovered and subsequently the label revealed matching literature – 'Schedae ad «Kryptogamas exsiccatas» editae a Museo Palatino Vindobonensi. Centuria XX' published in 'Annalen des Naturhistorischen Museums in Wien' (ZAHLEBRUCKNER, 1912). This provides us with a final confirmation of this species for Croatia.

In addition, 25 herbarium specimens revealed new, previously unknown localities across Croatia, for 20 species (Tab. 2). It is interesting to notice Baumgartner's herbarium specimens from the island of Rab as this information gives us ten new species for that island: *Crossidium squamiferum* (Viv.) Jur., *Drepanocladus aduncus* (Hedw.) Warnst.,

Entosthodon muhlenbergii (Turner) Fife, *Homalia lusitanica* Schimp., *Microbryum rectum* (With.) R. H. Zander, *Microbryum starckeanum* (Hedw.) R. H. Zander, *Oxyrrhynchium speciosum* (Brid.) Warnst., *Phymatoceros bulbiculosus* (Brot.) Stotler, W. T. Doyle et Crand.-Stotl., *Pohlia wahlenbergii* (F. Weber et D. Mohr) A. L. Andrews var. *calcareo* (Warnst.) E. F. Warb. and *Riccia warnstorffii* Limpr. ex Warnst. In total, Baumgartner's herbarium specimens provide us with new localities of 12 species, including *Timmiella barbulooides* (Brid.) Mönk. as the first national record. Baumgartner collected bryophytes along the whole of the Croatian coast but he published only a small part of those findings, while most of his specimens are deposited in Vienna (W) with duplicates in Budapest (BP) (ALEGRO *et al.*, 2021). This is, however, not the first instance new national records for Croatia have been discovered from his collections. Namely, PAPP & SABOV-LJEVIĆ (2009) reported 12 new species for Croatia which were deposited in the Collection of the Hungarian Natural History Museum in Budapest (Bryophyte collection BP). Six out of those 12 new species were represented by specimens collected by Baumgartner.

Tab 2. New localities of 20 species from ZA collection.

Species	Collector	Year/date of collection	New locality from herbarium	Previously known localities from literature
<i>Bryum weigelii</i> Spreng.	Horvat, I.	1923/1926*	Central Croatia, Mt. Moslavačka gora, forest Josipovača	N Dalmatia, Krka River
<i>Buxbaumia aphylla</i> Hedw.	Horvat, I.	1923	NW Croatia, Hrvatsko Zagorje, forest Dubrava	E Croatia, Mt. Papuk
<i>Crossidium squamiferum</i> (Viv.) Jur.	Baumgartner, J.	1921	island of Rab, Supetarska Draga, limestone, 15 m a.s.l.	peninsula Istria; Rijeka, Kvarner gulf; S Dalmatia, Dubrovnik
<i>Dicranella rufescens</i> (Dicks.) Schimp.	Horvat, I.	1924	NW Croatia, Hrvatsko Zagorje, Savski Marof	E Croatia, Mt. Papuk area
<i>Dicranum undulatum</i> Schrad. ex Brid.	Klinggräff, H. von	1826–1862	Central Croatia, Zagreb area	E Croatia, Mt. Papuk; peninsula Istria
<i>Entosthodon muhlenbergii</i> (Turner) Fife	Baumgartner, J.	1931	island of Rab, Supetarska Draga, sand, 10 m a.s.l.,	along the Adriatic coast
<i>Leptobarbula berica</i> (De Not.) Schimp.	Baumgartner, J.	1931	S Dalmatia, peninsula Pelješac, path from Trstenik to Pijavičino, limestone rock, 200 m a.s.l.	S Dalmatia, Dubrovnik
<i>Microbryum rectum</i> (With.) R. H. Zander	Baumgartner, J.	1931	island of Rab, Rab, sandstone, 15 m a.s.l.,	S Dalmatia, island of Mljet; Dubrovnik; peninsula Istria
<i>Microbryum starckeanum</i> (Hedw.) R. H. Zander	Baumgartner, J.	1931	island of Rab, pine forest near the town of Rab, sandstone, 2 m a.s.l.	along the Adriatic coast
<i>Oxyrrhynchium speciosum</i> (Brid.) Warnst.	Baumgartner, J.	1931	island of Rab, Supetarska Draga, sand, 3 m a.s.l.	along the Adriatic coast; Dalmatian hinterland, Krka River; Central Croatia, Mt. Medvednica

Tab 2. Continued

Species	Collector	Year/date of collection	New locality from herbarium	Previously known localities from literature
<i>Phymatoceros bulbiculosus</i> (Brot.) Stotler, W. T. Doyle et Crand.-Stotl.	Baumgartner, J.	1931	island of Rab, forest Kalifront, on sand in <i>Ericetum</i> , 50 m a.s.l.	S Dalmatia, island of Lastovo
<i>Pohlia wahlenbergii</i> (F. Weber et D. Mohr) A. L. Andrews var. <i>calcareo</i> (Warnst.) E. F. Warb.	Baumgartner, J.	1931	island of Rab, spring below St. Ilija, limestone, 20 m a.s.l.	S Dalmatia, Dubrovnik; Dalmatian hinterland, Zrmanja River; Krka River; N Dalmatia, island of Pag; Lika Region, Plitvice Lakes
<i>Riccia warnstorfi</i> Limpr. ex Warnst.	Baumgartner, J.	1931	island of Rab, forest Kalifront, on sand in <i>Ericetum</i> , 50 m a.s.l.	S Dalmatia; N Dalmatia, island of Ugljan
<i>Ptychostomum creberrimum</i> (Taylor) J. R. Spence et H. P. Ramsay	Horvat, I.	15/8/1919	N Croatia, Dubravica	island of Rab
<i>Drepanocladus aduncus</i> (Hedw.) Warnst.	Baumgartner, J.	23.3.1931	island of Rab, Supetarska Draga, sand, 3 m a.s.l.	E Croatia, Srijem, Osijek; peninsula Istria; island of Krk; S Dalmatia, Dubrovnik; Lika Region
<i>Gymnostomum viridulum</i> Brid.	Podpera, J.	8.1913	S Dalmatia, Dubrovnik, Mala Petka	island of Rava; peninsula Istria; Mt. Žumberak
<i>Pleuroidium acuminatum</i> Lindb.	Horvat, I.	unknown	N Croatia, Dubravica, Brezje	island of Rab; Lika Region, Vrhovinsko polje
<i>Neckera menziesii</i> Drumm.	Baumgartner, J.	1.7.1911	Dalmatia, Mt. Mosor, northern slopes, limestone, 850 m a.s.l.	Lika Region, Mt. Lička Plješivica, Mt. Velebit; Dalmatian hinterland, Zrmanja spring; C Croatia, Karlovac
		17.6.1911	Dalmatia, Mt. Biokovo, northern slopes above Zagvozd, 1000 m a.s.l.	
<i>Homalia lusitanica</i> Schimp.	Baumgartner, J.	31.3.1910.	island of Vis, Slatina bay, limestone, 50–60 m a.s.l.	peninsula Istria; Lika Region, Mt. Lička
		26.3.1931	island of Rab	Plješivica, Una spring
<i>Syntrichia virescens</i> (De Not.) Ochyra	Horvat, I.	13.4.1923	Central Croatia, Mt. Moslavačka gora, grassland near Jelenska	Gorski Kotar Region; Northern Velebit; peninsula Istria; C Croatia, Karlovac; Lika Region, Gospić and Sv. Rok settlements
		unknown	Mt. Lička Plješivica, eastern slopes of Gola Plješivica, on rocks, 1580 m a.s.l.	
		27.6.1929	Mt. Lička Plješevica, Poštak	
		22.6.1922	Lika Region, village Borik near Vrhovine settlement	

* It is assumed the specimen was collected in one of the noted years based on information provided by HORVAT & PLAZIBAT (2007).

The specimens of *Buxbaumia aphylla* Hedw., *Bryum weigelii* Spreng. and *Ptychostomum creberrimum* (Taylor) J. R. Spence et H. P. Ramsay collected by Ivo Horvat around the 1920s (Tab. 2) provided information on new localities. This data are also the oldest records of these species in Croatia. It is also unclear why these records were never published. *Bryum weigelii* was later found by Zlatko Pavletić in the Dalmatian hinterland close to the Krka River (PAVLETIĆ, 1957), *Ptychostomum creberrimum* on the island of Rab (DÜLL *et al.*, 1999), while *Buxbaumia aphylla* was recorded rather recently on Papuk mountain (DEME *et al.*, 2017). These records were thought to be the first and only records of these species before our herbarium revision. All of these species are rare in Croatia and so far only known from two localities each.

Even though the majority of the findings from the bryophyte collection of ZA were published in the scientific papers of the second half of the 19th century and the first half of the 20th century, before the present paper, it was unknown whether their vouchers existed in the herbarium collection. Now it is possible to check and revise most of the old records previously known only from literature. Moreover, it was revealed that ZA collection holds noteworthy specimens of 16 rare or underrecorded species known from only one or two localities in the literature. Namely, specimens of *Acaulon triquetrum* (Spruce) Müll. Hal., *Andreaea rupestris* Hedw., *Aulacomnium androgynum* (Hedw.) Schwägr., *Campylopus flexuosus* (Hedw.) Brid., *Campylopus pyriformis* (Schultz) Brid., *Cleistocarpidium palustre* (Bruch et Schimp.) Ochyra et Bednarek-Ochyra and *Didymodon giganteus* (Funck) Jur. from our bryophyte collection represent the vouchers of the single record of these species from Croatia, previously known only from the literature.

Vouchers of one of only two known localities from the literature were also found for additional species: *Timmia bavarica* Hessel., *Timmia norvegica* J. E. Zetterst., *Sphagnum contortum* Schultz, *Sphagnum cuspidatum* Ehrh. ex Hoffm., *Sphagnum obtusum* Warnst., *Racomitrium aquaticum* (Brid. ex Schrad.) Brid., *Dicranoweisia cirrata* (Hedw.) Lindb., *Dicranum fulvum* Hook., *Fissidens osmundoides* Hedw., *Saelania glaucescens* (Hedw.) Broth. and *Warnstorfia fluitans* (Hedw.) Loeske. Moreover, both herbarium specimens of *Calypogeia neesiana* (C. Massal. et Carestia) Müll. Frib from two localities confirmed the previously known literature records of the species (HORVAT, 1932).

CONCLUSIONS

Prior to this research little was known about the bryophyte collection in Herbarium Croaticum other than from available literature. With the recently systemised and digitised herbarium vouchers, it has become possible to revise and verify the old historical records, previously known only from literature. This paper accentuates the importance of herbarium collections. By maintaining the collections in appropriate conditions, we are preserving important data not only as verification of much of the published literature, but also as an important part of the history of biodiversity.

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