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2. Short scientific communication
3. Professional communication (new localities, nomenclature changes of the flora check-list, taxonomic changes of the flora check-list, revised identification keys, reviews, comments, other professional contributions etc.)
4. Short professional communication (new localities, nomenclature changes of the flora check-list, taxonomic changes of the flora check-list, revised identification keys, reviews, comments, other professional contributions etc.)

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**C/** news and other information related to the work of the Croatian Botanical Society as well as the broader botanical and biological community, and related professions and disciplines.

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Other details on manuscript submission and other specificities could be found on web pages of the Journal (<http://hirc.botanic.hr/Glasnik-HBoD>).

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## Prilozi poznavanju flore Hrvatske / Contributions to the knowledge of the Croatian flora

**Curators in action: intricate genus *Fritillaria* L. (Liliaceae) from ZA, ZAHO, CNHM and ZAGR revised and digitized**

original scientific paper / izvorni znanstveni članak

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**Abstract**

A total of 289 herbarium sheets with 803 specimens from the genus *Fritillaria* within ZA, ZAHO, CNHM and ZAGR collections were digitized. Altogether 23 taxa were registered within studied collections. The exsiccata originate from 20, mostly European countries; however 72% are from Croatia. The revision of the herbarium sheets collected in

Croatia resulted with five native taxa and their historical distributional data for the country. The average age of the collected specimens was 85 years. Based on our herbaria revision, the area of distribution of *F. messanensis* ssp. *gracilis* greatly increased.

**Keywords:** digitization, distribution, Flora Croatica Database, *Fritillaria*, herbarium revision

Šegota, V., Buzjak, S., Vilović, T., Sedlar, Z., Rešetnik, I., Bogdanović, S. (2017): Kustosi u akciji: revizija i digitalizacija roda *Fritillaria* L. (Liliaceae) u herbarijskim zbirkama ZA, ZAHO, CNHM i ZAGR. *Glas. Hrvat. bot. druš.* 5(2): 4-14.

**Sažetak**

Digitalizacijom roda *Fritillaria* (kockavica) u herbarijskim zbirkama ZA, ZAHO, CNHM i ZAGR obuhvaćeno je ukupno 289 herbarijskih listova s 803 jedinke. Zabilježene su ukupno 23 svojte. Eksikati potječu iz 20 uglavnom europskih država, od čega 72 % iz Hrvatske. Revizijom herbarijskih listova

sakupljenih na području Hrvatske zabilježeno je pet autohtonih svojti kockavica te su dobiveni povijesni podaci o njihovoj rasprostranjenosti. Prosječna starost herbarijskih primjeraka je 85 godina. Revizijom herbarijskih primjeraka areal svojte *F. messanensis* ssp. *gracilis* je značajno povećan.

**Ključne riječi:** digitalizacija, Flora Croatica Database, *Fritillaria*, herbarijska revizija, rasprostranjenost



## Introduction

For a long period, there were many ambiguities and confusions in identifying taxa of the genus *Fritillaria* in Croatia, essentially due to numerous synonyms and inadequate identification keys, causing major problems (Kranjčev & Šešok 2016). Therefore, a systematic and comprehensive study into this genus was recently performed, based exclusively on field data and morphometrics of living material (Kranjčev & Šešok 2016). The study revealed the existence of five taxa for the Croatian territory: *F. graeca* Boiss. et Spruner ssp. *thessala* (Boiss.) Rix, *F. meleagris* L., *F. messanensis* Raf. ssp. *gracilis* (Ebel) Rix, *F. messanensis* Raf. ssp. *neglecta* (Parl.) Nyman and *F. montana* Hoppe ex W.D.J.Koch (Kranjčev & Šešok 2016). At the end of that study, the curators of the ZA, ZAHO, CNHM and ZAGR were kindly asked to revise exsiccates from their collections, and the acquired data were published as *specimina visa* in Kranjčev & Šešok (2016). Since herbarium data were not discussed nor analysed in detail by Kranjčev & Šešok (2016), the aim of this article is to present: (i) an update of the distribution data based on herbarium data, (ii) taxa analysis in terms of spatial distribution, collectors, collecting dates and phenophases at collecting time and (iii) comparison and harmonisation of ongoing digitization practices present in different Croatian collections.

Currently, Croatia has eleven officially registered herbarium collections (Thiers 2017) of which ZA, ZAHO and CNHM are the largest ones (Vrbek 1999, Horvat & Plazibat 2007). The herbarium ZA is the oldest and largest in Croatia, founded in 1880, with an estimated 180.000 specimens. The herbarium ZAHO was established in 1983 and keeps ca. 78.000 specimens (Horvat & Plazibat 2007). The herbarium CNHM was founded in 1987 and consists of ca. 100.000 specimens. The Herbarium ZAGR is one of the youngest herbaria in Croatia, established in 2013 with estimated 7.500 to 10.000 specimens (Bogdanović 2013, Bogdanović et al. 2016). All above mentioned herbaria started digitization processes in recent years (CNHM in 2008, ZA, ZAHO and ZAGR in 2015) after the purchase of equipment, extensive testing and technical improvements. The large collection of orchids was chosen for initial digitization testing in ZA (Stančić et al. 2016). Publically accessible Virtual Herbarium databases were designed for CNHM and ZAGR, while during 2017 a similar website is planned for ZA and ZAHO.

## Material and methods

The herbarium specimens of the genus *Fritillaria* (Liliaceae) were searched for within four Croatian herbaria (ZA, ZAHO, CNHM and ZAGR, acronyms are according to Thiers 2017) and used for the purpose of detailed identification and digitization.

Revision of the specimens collected in Croatia and neighbouring countries was done according to the most recent identification key for Croatian taxa (Kranjčev & Šešok 2016), based mostly on flower characters and developed through extensive field research of populations in Croatia. Partial damaging of the dried pressed flowers could not be avoided, since the nectaria had to be carefully checked in order to identify some taxa. Sectioned flowers were, except in CNHM, preserved and mounted on herbarium sheets along with complete ones, but in a way that the inner surface of the tepala with the nectarium could be easily seen. The specimens in fruit could not be identified with certainty; therefore they remained labelled as *Fritillaria* sp. For the specimens in fruits previously identified by the collectors, we left the name; however, those records should be treated with caution.

Since herbarium sheets in the ZA and ZAHO collections were not in a condition allowing easy digitization, e.g. the sheet format was too large for the common A3 scanner and the plant material was not mounted, a pre-digitization process had to be performed first. This process included gentle removal of insecticide powder using forceps and fine brushes, and translocation of plant material to new herbarium sheet format (42.5 x 29 cm) with dimensions adequate for scanning (Fig. 1). Insecticide powder was in use up to the 2000s, after which it has been removed on several occasions. Currently it is present in ZAHO and often within ZA *Herbarium generale* (collection formed via exchange with other world herbaria). After the plant material was translocated, mounting with pH neutral adhesive tape on herbarium sheets and the gluing of herbarium labels with Gaylord pH neutral white adhesive took place. The latter steps are regular procedure within the ZAGR collection as well (Bogdanović et al. 2016). In the CNHM, the plants were not mounted, mostly due to usage of photographic instead of scanning equipment. However, plants from the *Herbarium Trinajstić* within CNHM collection were originally mounted with adhesive tape by collector. After the cleaning, herbarium sheets were placed on the new acid free paper. A stamp with the herbarium ID (ZA, ZAHO, ZAGR), colour plate and ruler were added to each sheet prior to scanning or photographing.



**Figure 1.** Pre-digitization process in ZAHO collection: a, b) removal of insecticide powder, c, d) mounting of *Fritillaria* specimens and label(s).

The original metadata from all *Fritillaria* herbarium sheets: herbarium ID, inventory number (CNHM), taxon name, locality, habitat, geographical coordinates, collector(s) and identifier(s), collecting dates and collection number were stored consecutively within the Flora Croatica Database. The full transcription of the original label's text, accompanied by an up-to-date interpretation of collection locality was provided. This was a useful starting point in preparation of as accurate as possible distribution maps for all the taxa within the GIS environment (ESRI 2013). In addition, the number of specimens on each herbarium sheet was counted; moreover, the number of blooming individuals as well as those in fruit was carefully noted.

Finally, the prepared sheets were scanned (ZA, ZAHO, ZAGR) or photographed (CNHM) using available scanning or photography equipment (Fig. 2). Generally, the scanners are considered less adequate for herbarium digitization, because they require inverse placement of the specimens,

resulting in damage and loss of material (Berendsohn et al. 2005). In order to avoid that, in the ZA and ZAHO collections a special electric mobile stalk for inversed scanning has been designed and constructed, enabling the safe handling with sensitive plant material.

The entire herbarium sheets of *Fritillaria* specimens were scanned or photographed with the image resolution sufficiently high to show details of the plants and label texts. Those high resolution images were uploaded in Flora Croatica Database (Nikolić 2017), and are accessible in ZAGR Virtual Herbarium database<sup>1</sup> and CNHM Virtual herbarium database<sup>2</sup> as well.

In addition, all available photographs in the Flora Croatica Database Gallery were carefully examined and revised, excluding photographs of the plants in fruit. The updates within the database were done in cooperation and with permission of the authors of the photographs.



**Figure 2.** Digitization equipment: a) inversed Epson Expression 11000XL Pro A3 scanner (ZA & ZAHO), b) Microtek ScanMaker 9800 XY Plus scanner (ZAGR), c) DSLR digital camera Canon EOS Digital Rebel XSi 450D with Canon 18 - 55 mm focal length (CNHM).

<sup>1</sup> <http://herbarium.agr.hr/>

<sup>2</sup> <http://www.hpm.hr/Odjeli%20i%20zbirke/Botani%C4%8Dki%20odjel/CNHM%20-%20Virtualni%20herbarij>

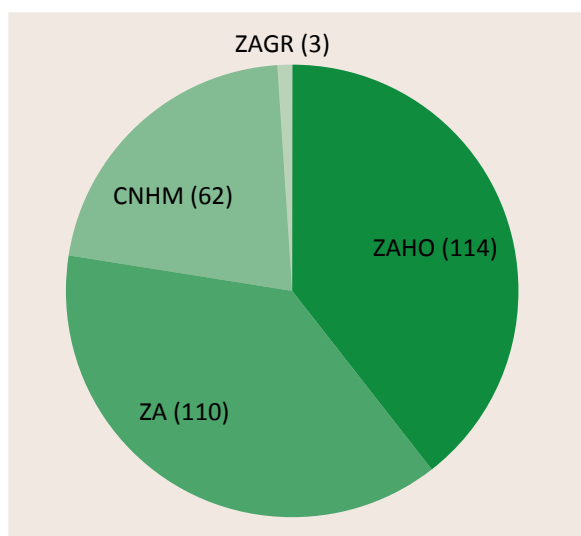
## Results and discussion

In total, 289 herbarium sheets were found within four studied collections. Almost 80% of the herbarium sheets are stored within the ZAHO and ZA collections, followed by CNHM (21%) and ZAGR (1%) collections (Fig. 3). In most cases, several specimens were stored per sole herbarium sheet, the most common numbers being three (35%) and two (24%) (Fig. 4). Altogether, 803 specimens were collected and stored in studied herbaria.

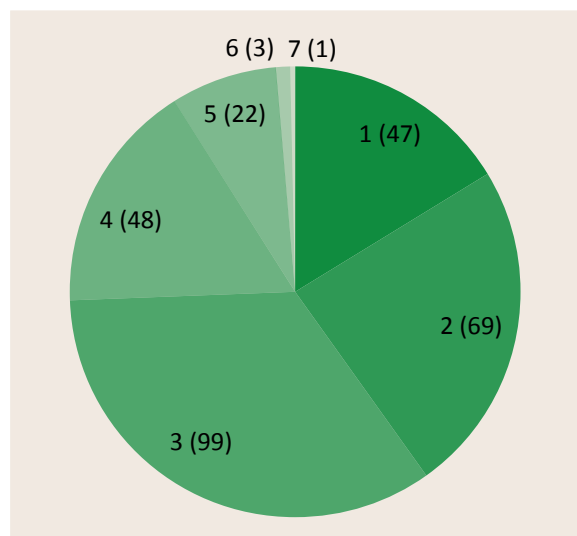
A *make-over* during the pre-digitization process was performed on all the herbarium specimens (224) from ZA and ZAHO and partly from CNHM (*Herbarium Trinajstić*), mostly old and in poor condition (Fig. 5).

There are 23 taxa found within studied collection, five of them being native in Croatia. The taxonomic

revision which included the specimens collected in Croatia, revealed the existence of five native and one ornamental *Fritillaria* taxa in Croatia, among which *F. meleagris* occurred on the largest number of the herbarium sheets (88), followed by *F. messanensis* ssp. *neglecta* (63) and *F. montana* (47) (Tab. 1). The other two native taxa (*F. messanensis* ssp. *gracilis* and *F. graeca* ssp. *thessala*) were collected rarely. For ten specimens it was not possible to identify the species rank, mostly due to the lack of flowers. The highest number of *Fritillaria* taxa was found in ZA collection (23, with all 5 native Croatian taxa included), followed by CNHM (3), ZAHO (2) and ZAGR (1), all with only native taxa from Croatia.



**Figure 3.** The number of herbarium sheets with *Fritillaria* specimens stored in studied collections (ZA - Herbarium Croaticum, ZAHO - Herbarium of Ivo and Marija Horvat, CNHM - Herbarium of Croatian Natural History Museum, ZAGR - Herbarium of the Faculty of Agriculture, University of Zagreb).



**Figure 4.** The number of specimens stored on a sole herbarium sheet. Numbers of herbarium sheets are shown in brackets.



**Figure 5.** Herbarium sheet of *Fritillaria messanensis* Raf. ssp. *neglecta* (Parl.) Nyman (ZAH041621) before (A) and after (B) the restoration, revision and digital imaging.

**Table 1.** The number of herbarium sheets for each taxon across the studied collections. The taxa native in Croatia are bolded.

Taxa	Total	ZAHO	ZA	CNHM	ZAGR
<i>Fritillaria bithynica</i> Baker	1	-	1	-	-
<i>Fritillaria collina</i> Adams	2	-	2	-	-
<i>Fritillaria conica</i> Boiss.	1	-	1	-	-
<i>Fritillaria ehrhartii</i> Boiss. et Orph.	1	-	1	-	-
<i>Fritillaria graeca</i> Boiss. et Spruner	2	-	2	-	-
<b><i>Fritillaria graeca</i> Boiss. et Spruner ssp. <i>thessala</i> (Boiss.) Rix</b>	3	-	1	2	-
<i>Fritillaria imperialis</i> L.	2	-	2	-	-
<i>Fritillaria kotschyana</i> Herb.	1	-	1	-	-
<i>Fritillaria lusitanica</i> Wikstr.	1	-	1	-	-
<b><i>Fritillaria meleagris</i> L.</b>	110	71	37	2	-
<i>Fritillaria meleagris</i> ssp. <i>burnatii</i> (Planch.) Rix	1	-	1	-	-
<i>Fritillaria messanensis</i> Raf.	5	-	5	-	-
<b><i>Fritillaria messanensis</i> Raf. ssp. <i>gracilis</i> (Ebel) Rix</b>	6	-	6	-	-
<b><i>Fritillaria messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman</b>	63	33	5	21	3
<b><i>Fritillaria montana</i> Hoppe ex W.D.J.Koch</b>	59	-	24	37	-
<i>Fritillaria oranensis</i> Pomel	1	-	1	-	-
<i>Fritillaria orientalis</i> Adams	4	-	4	-	-
<i>Fritillaria pinardii</i> Boiss.	1	-	1	-	-
<i>Fritillaria pudica</i> (Pursh) Spreng.	1	-	1	-	-



Taxa	Total	ZAHO	ZA	CNHM	ZAGR
<i>Fritillaria pyrenaica</i> L.	6	-	6	-	-
<i>Fritillaria ruthenica</i> Wikstr.	3	-	3	-	-
<i>Fritillaria sibthorpiana</i> (Sm.) Baker	1	-	1	-	-
<i>Fritillaria tubiformis</i> Gren. et Godr.	3	-	3	-	-
<i>Fritillaria</i> sp.	10	10	-	-	-
Grand total:	289	114	110	62	3

Herbarium specimens originate from 17 European countries and from Turkey, Algeria and USA (Fig. 6, Fig. 7). The vast majority of herbarium sheets were collected in Croatia (72%). Regarding the Croatian territory, the collecting sites of taxa from ZA are scattered throughout the country, while the localities from ZAHO and CNHM are localized mostly on Velebit Mt, which reflects field activities of the main collectors of those two collections (Ivo Horvat and Ivo Trinajstić, respectively) (Fig. 8).

In the ZA *Herbarium generale* several interesting specimens were discovered. This part of the collection consists of taxa generally not native in Croatia and was formed via exchange with mostly European botanists and herbaria between 1860s and 1930s. During the systematization of these specimens the comparison with available digitalized specimens from other major European herbaria via virtual herbaria (WU, W, JE, B and P) revealed the existence of three probable type specimens. The specimen of *Fritillaria bithynica* Baker present in ZA has the same collector and collection date (Sintenis P.E.E and 1883-04, respectively) and therefore belongs to the same collection as three

specimens kept in JE (JE00008722, JE00008723, JE00008724) and provisionally designated as *Typus* probabiler for *Fritillaria schliemannii* Sint. ex Rodigas published in Ill. Hort. 31: 106 (1884), which is regarded as a synonym of *Fritillaria bithynica* Baker. The specimen of *Fritillaria ehrhartii* Boiss. et Orph. has the label identical to the three specimens stored in JE and WU (JE 00008720, WU0079067, WU0065169) and provisionally designated as *Syntypus* of *Fritillaria ehrhartii* Boiss. et Orph. published in Diagn. pl. orient. sér. 23 (4): 105 (1859). The specimen of *Fritillaria pinardii* Boiss. also belongs to *Iter orientale* 3931 of collector Sintenis, P.E.E. and belongs to the same collection which was used to describe the taxon *Fritillaria alpina* Freyn et Sint. [protologue by Freyn, 1894: "Paphlagoniae: Tossia in monte Giaurdagh, in pratis alpinis die 17. majo 1892 leg. Sintenis! (Exsicc. no. 3931)"] and therefore the specimen in ZA can also be referred to as *Isotypus* for *Fritillaria alpina* Freyn et Sint. just like the specimens kept in B, JE, KFTA, P and WU (B 10 0279976, JE00009937, JE 00006319, KFTA0002200, MNHN-P-P00730841, MNHN-P-P00730842, WU0065170).

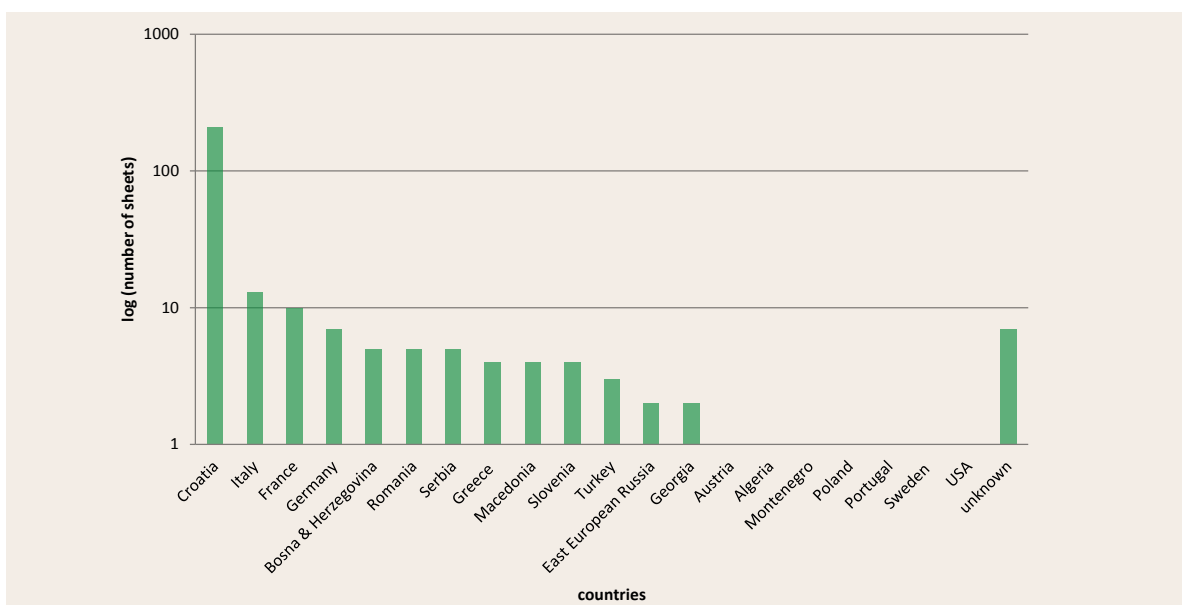


Figure 6. Geographical origin of the *Fritillaria* herbarium sheets stored across studied collections.



Figure 7. Distribution map of *Fritillaria* herbarium sheets from ZA collection. The record from USA is not shown on the map.

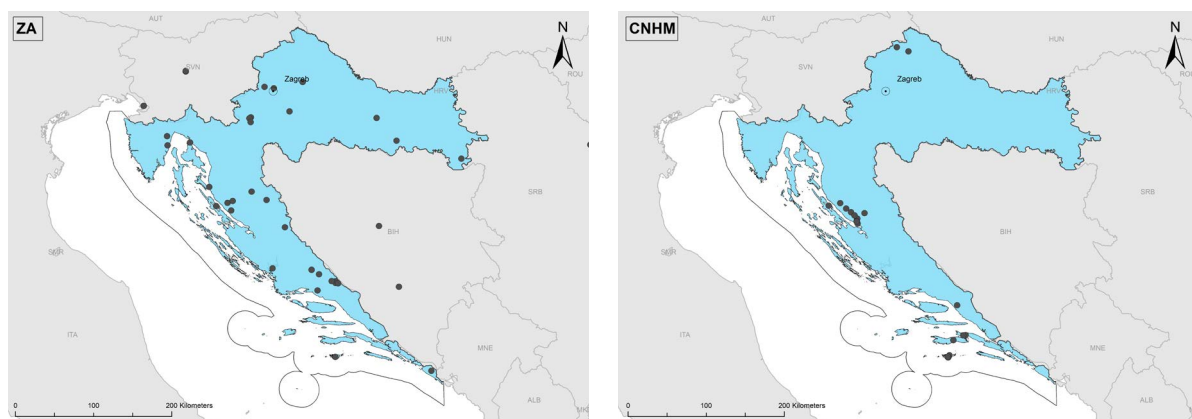
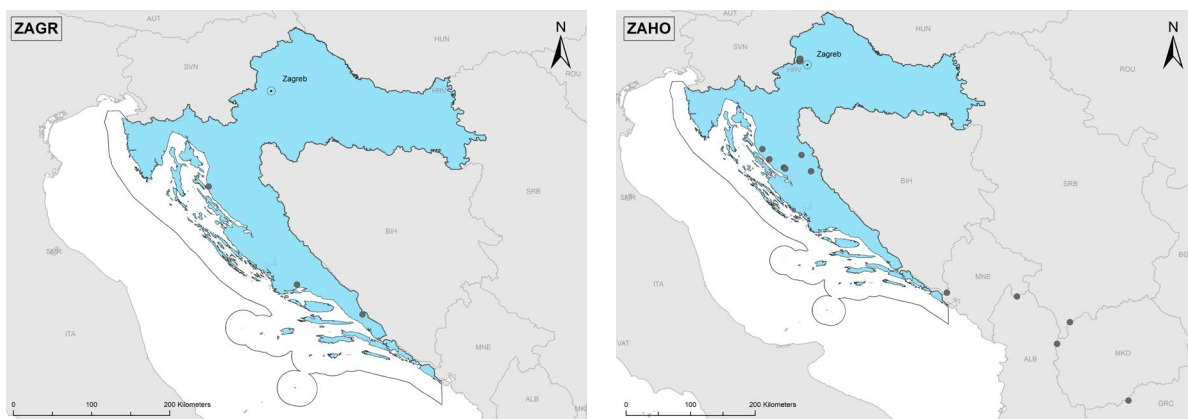


Figure 8a. Distribution maps of *Fritillaria* herbarium sheets from Croatia and neighbouring countries within each studied collection (ZA - Herbarium Croaticum, CNHM - Herbarium of Croatian Natural History Museum).



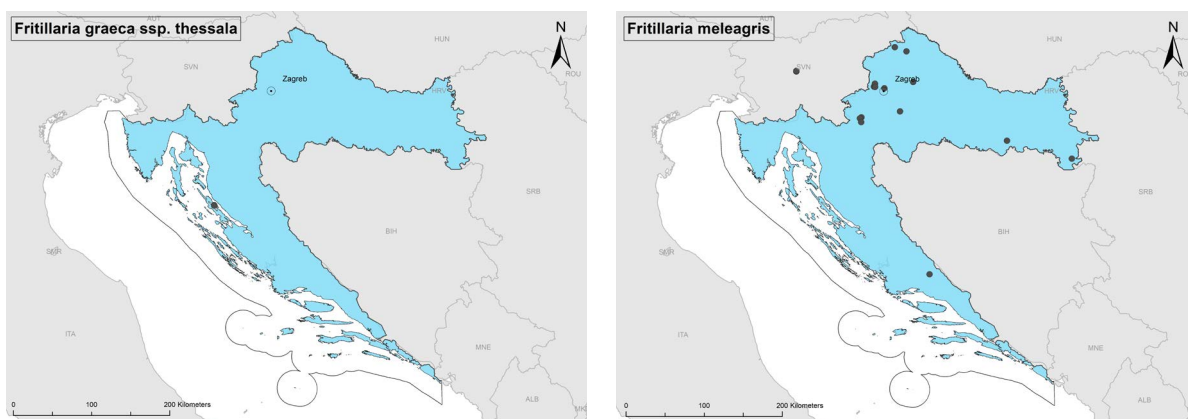
**Figure 8b.** Distribution maps of *Fritillaria* herbarium sheets from Croatia and neighbouring countries within each studied collection (ZAGR - Herbarium of the Faculty of Agriculture, University of Zagreb, ZAHO - Herbarium of Ivo and Marija Horvat).

The distribution based on herbarium data showed large overlaps with the field record data made by Kranjčev & Šešok (2016), with an exception of *F. messanensis* ssp. *gracilis*. Beside a limited area of distribution in Southern Dalmatia, known prior to our revision, several new, remote localities were recorded (four in Lika and Quarnero, and two in Bosnia & Herzegovina) (Fig. 9). Interestingly, this taxon has been recently recorded in Campania (Southern Italy), too (Peruzzi et al. 2017).

The most productive collector of the studied herbarium material was Ivo Horvat (113 herbarium sheets), who is the lone collector of the ZAHO collection. However, his collection is rather poor in terms of number of taxa and localities. Namely, Horvat collected only two taxa, *F. meleagris* and *F. messanensis* ssp. *neglecta*. He regularly made large

collections from the same locality (e.g. Southern Velebit, NW Croatia, Lika). The largest collection of *F. meleagris* counts as much as 71 herbarium sheets holding 216 specimens, but lacking any locality description, except Croatia. Ivo Trinajstić stored 53 herbarium sheets, mostly in CNHM, Ljudevit Rossi eight, while other 66 collectors contributed with less than seven herbarium sheets each. As much as 17 sheets, exclusively from ZA, are lacking the information about the collector(s) or the collector's name is illegible.

In terms of collecting period, the majority of specimens were collected between 1920s and 1960s (Fig. 10), consisting mostly of the Ivo Horvat's fieldwork. As much as 86 herbarium specimens lack data on collecting period. The average age of the collected specimens is approximately 85 years.



**Figure 9a.** Individual distribution maps for *Fritillaria* taxa native to Croatia stored across studied collections.

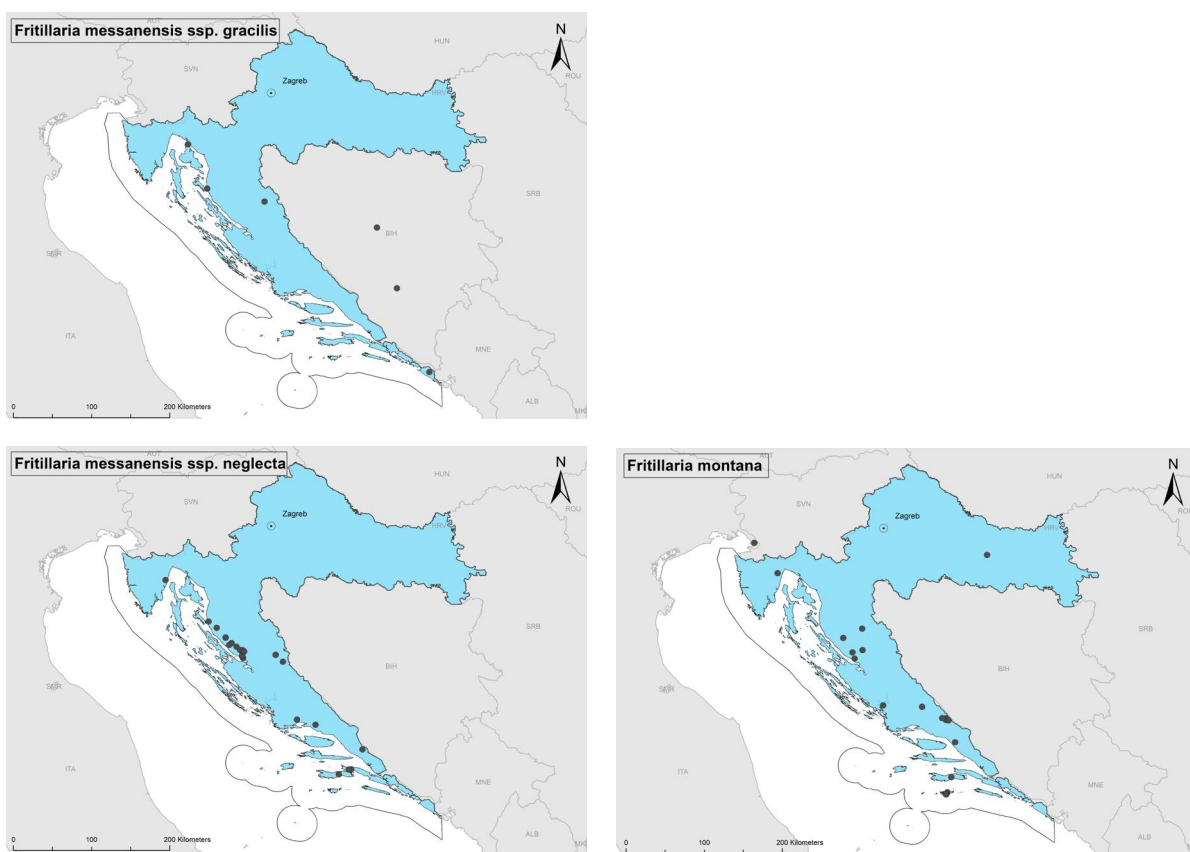


Figure 9b. Individual distribution maps for *Fritillaria* taxa native to Croatia stored across studied collections.

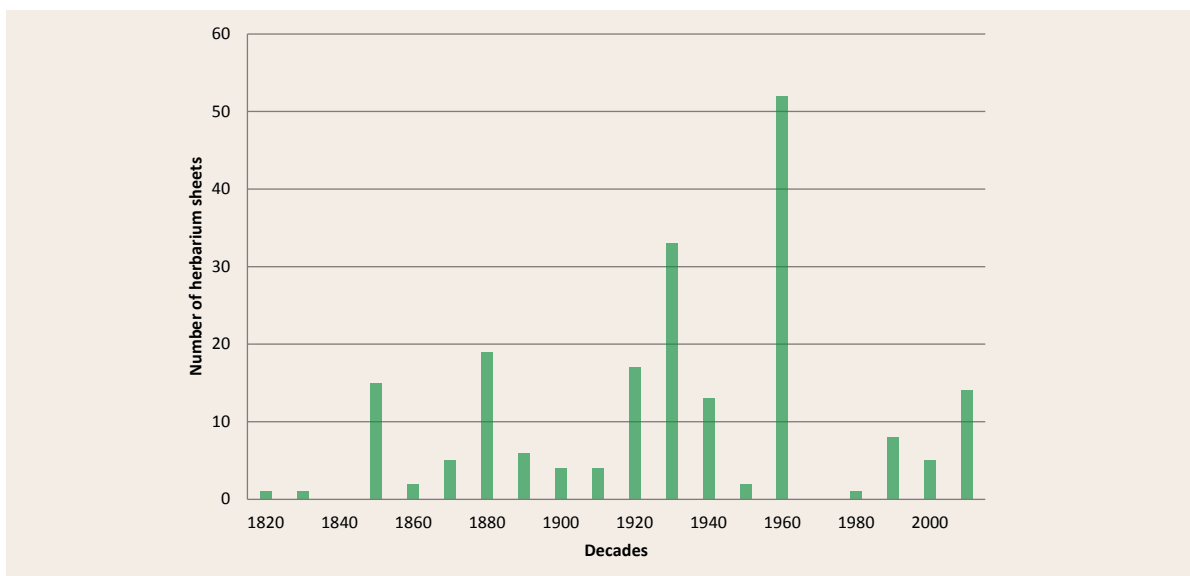


Figure 10. Temporal distribution of the herbarium specimens based on collection period shown in decadal scale.

As expected, 90% of the specimens were collected in flowering season (Fig. 11), when the plants are noticeable in the nature, while the

rest were found in fruit, thus being unable for identification to species rank.



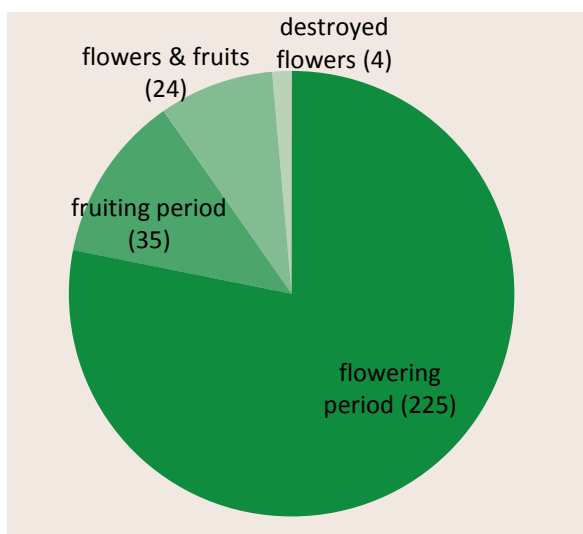


Figure 11. Phenophases of the collected specimens.

In addition, 113 photographs stored in Flora Croatica Database Gallery were carefully checked and revised (Tab. 2), including those that were not designated as public. The majority of revision included *F. messanensis* group and *F. montana*. Several pictures taken on Southern Velebit might lead us to *F. graeca* ssp. *thessala*, a taxa recorded only on the island of Pag (Kranjčev & Šešok 2016). However, visiting the locality in Southern Velebit by the second author in April 2017 has not resulted in finding of *F. graeca* ssp. *thessala*, but only *F. messanensis* ssp. *neglecta* and *F. montana*. Therefore, this photographic record needs further check.

Table 2. The *Fritillaria* taxa revised within Flora Croatica Database Gallery.

ID	Original taxa	Author	Revised taxa
113211	<i>F. messanensis</i> Raf.	Ivica Ljubičić	<i>F. montana</i> Hoppe ex W.D.J.Koch
8433	<i>F. messanensis</i> Raf.	Darko Mihelj	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
8434	<i>F. messanensis</i> Raf.	Darko Mihelj	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
8158	<i>F. messanensis</i> Raf.	Čedomir Šilić	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
8159	<i>F. messanensis</i> Raf.	Čedomir Šilić	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
9585	<i>F. messanensis</i> Raf. ssp. <i>messanensis</i>	Jasenka Topić	<i>F. montana</i> Hoppe ex W.D.J.Koch
9586	<i>F. messanensis</i> Raf. ssp. <i>messanensis</i>	Jasenka Topić	<i>F. montana</i> Hoppe ex W.D.J.Koch
3710	<i>F. messanensis</i> Raf. ssp. <i>gracilis</i> (Ebel) Rix	Gordan Lukač	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
12039	<i>F. montana</i> Hoppe ex W.D.J.Koch	Antun Alegro	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
12040	<i>F. montana</i> Hoppe ex W.D.J.Koch	Antun Alegro	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
12041	<i>F. montana</i> Hoppe ex W.D.J.Koch	Antun Alegro	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
12042	<i>F. montana</i> Hoppe ex W.D.J.Koch	Antun Alegro	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
12043	<i>F. montana</i> Hoppe ex W.D.J.Koch	Antun Alegro	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
11671	<i>F. montana</i> Hoppe ex W.D.J.Koch	Dubravko Šincek	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
72689	<i>F. montana</i> Hoppe ex W.D.J.Koch	Miroslav Marić	<i>F. messanensis</i> Raf. ssp. <i>neglecta</i> (Parl.) Nyman
43049	<i>F. montana</i> Hoppe ex W.D.J.Koch	Dubravko Šincek	? <i>F. graeca</i> Boiss. et Spruner ssp. <i>thessala</i> (Boiss.) Rix
116712	<i>F. montana</i> Hoppe ex W.D.J.Koch	Dubravko Šincek	? <i>F. graeca</i> Boiss. et Spruner ssp. <i>thessala</i> (Boiss.) Rix
116713	<i>F. montana</i> Hoppe ex W.D.J.Koch	Dubravko Šincek	? <i>F. graeca</i> Boiss. et Spruner ssp. <i>thessala</i> (Boiss.) Rix

## Conclusion

The fruitful cooperation among the curators of four major Croatian herbaria collections through revision and digitization of *Fritillaria* specimens

resulted in a model useful for future processing of other taxonomically difficult plant groups.

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### Tankolisni goliš (*Anogramma leptophylla* (L.) Link) u uzgoju Botaničkog vrta PMF-a u Zagrebu

#### kratko stručno priopćenje / short professional communication

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Kovačić, S. (2017): Tankolisni goliš (*Anogramma leptophylla* (L.) Link) u uzgoju Botaničkog vrta PMF-a u Zagrebu. Glas. Hrvat. bot. druš. 5(2): 14-17.

#### Sažetak

Jedna od najrjeđih paprati hrvatske flore, tankolisni goliš (*Anogramma leptophylla* (L.) Link), pronađena je u Hrvatskoj (Mljet) nakon gotovo 80 godina. Iz primjerka herbariziranog 2010. uzete su zrele spore, iz kojih je u laboratoriju Botaničkog

vrta PMF-a tijekom zime 2016. uzgojeno stotinjak protalija. Uzgojene biljke čuvat će se u zbirci papratnjača Botaničkog vrta kao dio Programa uzgoja i ex-situ očuvanja rijetkih vrsta hrvatske flore.

**Ključne riječi:** *Anogramma leptophylla*, Botanički vrt PMF-a, ex-situ očuvanje, otok Mljet, rijetka paprat

**Kovačić, S. (2017): Annual Fern (*Anogramma leptophylla* (L.) Link) growing in Botanical Garden of the Faculty of Science, University of Zagreb. Glas. Hrvat. bot. druš. 5(2): 14-17.**

### Abstract

One of the rarest ferns in Croatian flora, Annual Fern (*Anogramma leptophylla* (L.) Link) was found in the Island of Mljet for the first time after almost 80 years. Mature spores were extracted from the sample dried and stored in 2010, from which

around one hundred protalia were grown in the Botanical Garden laboratory. Plants will be kept in Fern-collection of the Botanical Garden, within the *Programme of ex-situ protection of Croatian rare species*.

**Keywords:** *Anogramma leptophylla*, Botanical Garden Zagreb, *ex-situ* conservation, Island of Mljet, rare fern

Tankolisni goliš (*Anogramma leptophylla* (L.) Link, Pteridaceae) jedna je od najrjeđih paprati hrvatske flore i jedina europska pripadnica tog neotropskog roda, koji sadrži samo nekoliko vrsta (Tutin 1993, Nikolić 2017, Šegota i sur. 2017). Ta neobična vrsta većinu života provede u stadiju mirujućeg, višegodišnjeg gomoljastog gametofita, dok se zeleni listovi sa sporangijima (sporofit) pojavljuju povremeno i žive kao jednogodišnja biljka (Sl. 1). Takva je životna strategija za paprati vrlo rijetka i naziva se „mahovinskom“ (*Bryophyte-like* life strategy, Proskauer 1964 u Pangua i sur. 2011).

Kroz Program istraživanja ekologije klijanja i *ex-situ* očuvanja rijetkih vrsta hrvatske flore (Sandev i sur. 2013, Kovačić i sur. 2014) u Botaničkom vrtu PMF-a u Zagrebu uzgojili smo posljednjih godina više desetaka vrijednih svojti: dijelom „Natura 2000-vrsta“ s Popisa divljih vrsta od interesa za Europsku uniju koje se redovito pojavljuju na teritoriju Republike Hrvatske (Anonimus 2013a, 2015), a dijelom vrsta od interesa za našu zemlju, sukladno *Pravilniku o strogo zaštićenim vrstama* (Anonimus 2013b, 2016). Papratnjače, međutim, dosada nismo uzgajali, prije svega zato što je uzgoj iz spora složen i dugotrajan proces koji zahtijeva posebne uvjete, pribor i opremu (Jones 1998, Moran 2009), s upitnim izgledima za uspjeh. Uređenjem malog laboratorija u Botaničkom vrtu, nabavkom posebne opreme i supstrata, slijedeći raznovrsne protokole iz hortikulture literature (Jones 1987, Aikins 1997, Olsen 1998) te neprestano prilagođavajući životne uvjete biljkama u razvoju, tijekom 2016. godine uzgojila sam četrdesetak vrsta paprati za zbirke toplog staklenika Botaničkog vrta. Slijedeći recepturu koja se pokazala uspješnom (sterilizirani kupovni treset, dvostruko destilirana voda, dezinficirano posuđe; strogi režim temperature i svjetlosti; što rjeđe otvaranje posuda u kojima kliju spore - prema Olsen 1998) na isti sam način uzgojila i

prokličnice (protalije) tankolisnog goliša.

Spore tankolisnog goliša odvojene s herbarijskog primjerka (ZA 43133) sabranog 2010. na Mljetu, pročišćene od ostataka sporangija i raspršene po površini sterilnog treseta u dezinficiranim Petrijevim zdjelicama, postavila sam na isključivanje u kontroliranim uvjetima 16. studenog 2016. (temperatura trajno iznad 23°C, fotoperiod od 14 sati svjetla i 10 tame, povremeno kratko otklapanje posudica zbog rošenja destiliranom vodom). Već nakon mjesec dana, 18. prosinca 2016., pod lupom su bili vidljivi prvi protaliji. Polaganim rastom, uz održavanje konstantnih uvjeta (Sl. 1b), protaliji su do 24. siječnja 2017. (Sl. 1c) narasli dovoljno da mogu biti rasađeni u prozirne kutije s poklopcima, kakve su se pokazale najpogodnijima za daljnji uzgoj paprati. Tresetna podloga pritom je zamijenjena steriliziranim kompostom, bogatim organskim tvarima. Do 5. travnja 2017. protaliji su narasli do promjera od gotovo dva centimetra (Sl. 1d, e) i trenutačno se nalaze u fazi „debljanja“ podzemnog gomoljčića. Hoće li se, i kad, na protalijima razviti rasplodni organi te po oplodnji i sporofiti (jednogodišnji listovi), nemoguće je predvidjeti. Naime, još nije posve jasno što točno potiče stvaranje sporofita kod tankolisnog goliša (Jones 1987, Pangua i sur. 2011): gametofit te vrste može mirovati više godina, dok nakon oplodnje ne razvije po jedan do pet krhkih listova (Sl. 1e) koji žive samo toliko koliko je potrebno da se razviju sporangiji i dozrele sjajnocrne spore (Sl. 1f). Listovi nakon toga ugibaju, a biljka se ponovo „povlači“ u podzemni život gomoljčića.

Hortikulturni stručnjaci (Jones 1987, Moran 2009) savjetuju da se goliši u dugotrajnom stadiju gametofita drže u malim loncima s ilovastom zemljom na zasjenjenom mjestu, i povremeno rose kišnicom: više vlage i sunca trebaju samo u fazi sporofita. Tako ćemo s njima postupati i u Botaničkom vrtu PMF-a.





**Slika 1.** a) gametofit tankolisnog goliša s gomoljčićem i mladim sporofitima (Foto: R. C. Moran, 2010.; Kostarika, Biološka postaja Cuerici, hrastova šuma, 2400 m/nm), b - e) protaliji (gametofit) tankolisnog goliša u fazama nakon klijanja (18. 12. 2016.): 13. 1. 2017., 24. 1. 2017., 10. 3. 2017., 5. 4. 2017. (Foto: S. Kovačić i D. Mihelj, laboratorij Botaničkog vrta PMF-a u Zagrebu), f) sporofiti (zeleni listovi) tankolisnog goliša, g) naličje plojke sa sporangijima (Foto: A. Alegro, travanj 2016.; Italija, Agro Romano, Castelporziano, nisko nad morem - u pukotini zida melioracijskog kanala i na okolnom tlu u šumi hrastova).

Vrijedi navesti i ovu zanimljivost: osim spora tankolisnog goliša skupljenih na Mljetu 2010. (ZA 43133), posijala sam i malu količinu spora skupljenih uz primjerke po herbarijskom listu u Herbariju (ZA 3132) Botaničkog zavoda PMF-a u Zagrebu, koje je davne 1868. na Lapadu skupio dubrovački biskup i prirodoslovac Mato Vodopić. Iz tih je spora niklo 12 protalija: jedan izgledom posve nalik onima s Mljeta, a ostalih 11 različitih, što ukazuje na vjerojatno zagađenje uzroka - ili još unutar herbarija ili tijekom postavljanja u pokus (oku nevidljive spore vrlo lako se raznose zrakom). Prema mišljenju stručnjaka za papratnjače iz njujorškog botaničkog vrta (Moran

2017, osobni kontakt), spore goliša vijabilne su tri do pet godina, tako da se ovdje gotovo pouzdano radi o kontaminaciji uzorka. Međutim, kako su vrlo brzo i gusto proklijale i spore herbarijskog uzorka (ZA 43133) skupljenog na Mljetu 2010. (dakle, u trenutku sjetve već starije od šest godina), možda će nas klijavost ove neobične „jednoljetnice“ ipak još iznenaditi.

Tankolisni goliš pronađen je otada i na otoku Lastovu (Šešok i Kranjčev 2015, FCD Id opažanja 25629), što pokazuje da bi ta vrsta u Hrvatskoj mogla biti i šire rasprostranjena, no kao povremenu (efemernu) vrstu teško ju je prepoznati jer se rijetko susreće u stadiju sporofita.



## Zahvala

Zahvaljujem Vedranu Šegoti (Herbarij Botaničkog zavoda PMF-a u Zagrebu) na sporama tankolisnog goliša i vrijednim sugestijama; izv. prof. dr. sc. Antunu Alegro (Botanički zavod

PMF-a u Zagrebu) na fotografijama iz Italije; te dr. sc. Robbinu C. Moranu (Botanički vrt grada New Yorka, SAD) na fotografijama iz Kostarike.

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## Under-recorded and critically endangered *Scirpus supinus* L. in Croatia – new records from the City of Slatina

short professional communication / kratko stručno priopćenje

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Prlić, D. (2016): Under-recorded and critically endangered *Scirpus supinus* L. in Croatia – new records from the City of Slatina. *Glas. Hrvat. bot. druš.* 5(2): 18-21.

### Abstract

The paper presents two new localities for the critically endangered *Scirpus supinus* L. (Cyperaceae) which was recorded during botanical surveys in surroundings of the City of Slatina in Slavonia. The species is associated with the alliance *Nanocyperion* and was found in damp

microdepressions on agricultural land. Previously, only two localities had been known for *S. supinus* in Croatia, both of which are herbarium vouchers dating back to the mid-twentieth century and should be confirmed at those areas during future research.

**Keywords:** critically endangered, Cyperaceae, flora, *Scirpus supinus*, Slavonia

Prlić, D. (2016): Rijetko bilježena i kritično ugrožena vrsta *Scirpus supinus* L. u Hrvatskoj – novi nalazi s područja grada Slatine. *Glas. Hrvat. bot. druš.* 5(2): 18-21.

### Sažetak

Rad donosi dva nova nalazišta za kritično ugroženu vrstu *Scirpus supinus* L. (Cyperaceae) zabilježenu tijekom botaničkih istraživanja u okolici grada Slatine u Slavoniji. Vrsta se javlja unutar sveze *Nanocyperion* u vlažnim mikrodepresijama

među obradivim površinama. Dosad su za vrstu *S. supinus* bila poznata samo dva lokaliteta u Hrvatskoj, oba kao herbarijski primjerci iz sredine prošloga stoljeća koje u budućim istraživanjima valja potvrditi na terenu.

**Ključne riječi:** Cyperaceae, flora, kritično ugrožena, *Scirpus supinus*, Slavonija

*Scirpus supinus* L. is an annual caespitose sedge, a member of the Cyperaceae family, usually growing above water level as an indicator of flooding and moist soils. Its typical habitats are temporary pools, depressions, inundated agricultural land, rice fields, alluvial flats, inundated sandy lands, damp places and around lakes, reservoirs and ponds (Josifović et al. 1976, Lansdown 2014). The plant usually grows up to a height of 30 cm (Bojnansky & Fargašova 2007) and needs open, sandy places to establish a population. It has a wide distribution, but is scattered throughout its range and probably under-recorded (Lansdown 2014). Among other species within the genus *Scirpus*, it can be distinguished by its apparently lateral inflorescence, stem-like bract which overtops the spikelets by up to 15 cm and shortly apiculate, reddish or brownish glumes with a green midvein (Tutin et al. 1993).

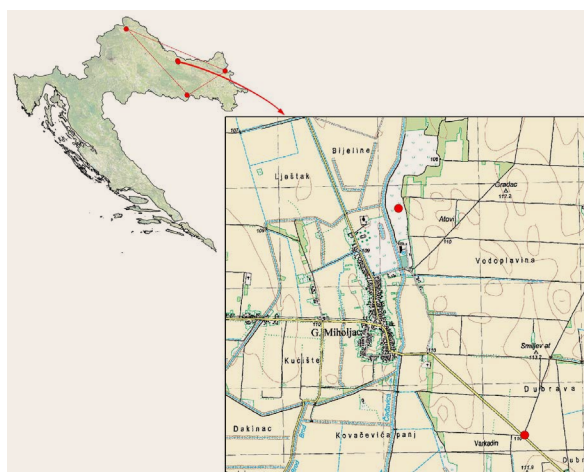
According to The Plant List (2013) database, the currently accepted nomenclature for the species is *Schoenoplectiella supina* (L.) Lye. (Lidia 6: 27. 2003), but was originally published under the name *Scirpus supinus* L. (Sp. Pl. 49. 1753) which is also

accepted by Flora Croatica Database (Nikolić 2016) and used in this paper. The following names are listed as known synonyms:

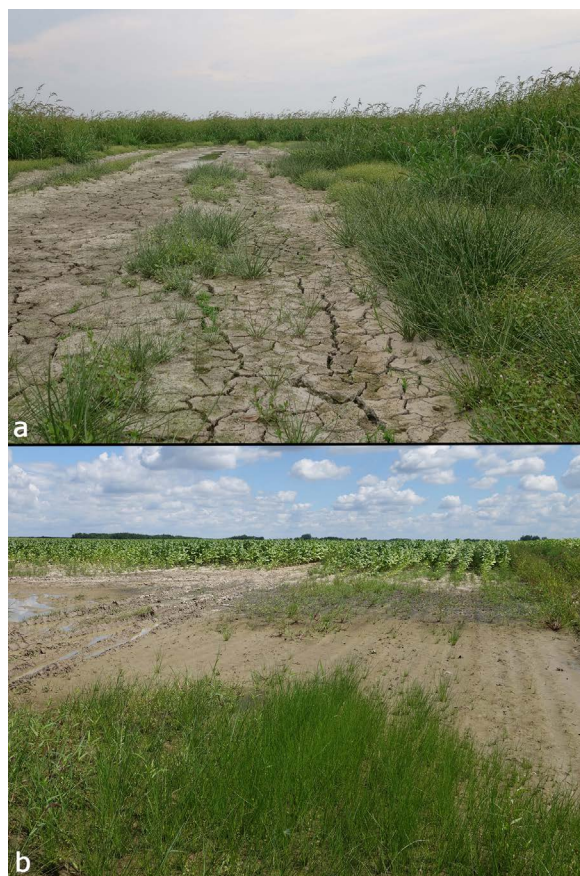
- *Cyperus supinus* (L.) Missbach & E.H.L.Krause (Deutschl. Fl. ed. 2, 2: 20. 1900);
- *Heleophylax supinus* (L.) Schinz & Thell. (Vierteljahrsschr. Naturf. Ges. Zürich 53: 587. 1908);
- *Isolepis pentasticha* Boeckeler (Flora 42: 446. 1859);
- *Isolepis simillima* Steud. (Syn. Pl. Glumac. 2: 95. 1855);
- *Isolepis striolata* Nees ex Boeckeler (Linnaea 36: 700. 1870);
- *Isolepis supina* (L.) R.Br. (Prodr. Fl. Nov. Holl. 221. 1810);
- *Schoenoplectus melanospermus* (C.A.Mey.) Grossh. (Fl. Kavkaza 1: 146. 1928);
- *Schoenoplectus supinus* (L.) Palla (Bot. Jahrb. Syst. 10: 299. 1888);
- *Scirpus adscendens* Willd. ex Kunth (Enum. Pl. 2: 198. 1837);

- *Scirpus guaraniticus* Pedersen (Bot. Tidsskr. 57: 42. 1961);
- *Scirpus halleri* Vitman (Summa Pl. 1: 150. 1789);
- *Scirpus lateralis* Forssk. (Fl. Aegypt.-Arab. 15. 1775);
- *Scirpus melanospermus* C.A.Mey. (Mém. Sav. Étr. Acad. St. Pétersbourg 1: 199. 1831);
- *Scirpus mucronatus* Roxb. nom. illeg. (Fl. Ind. 1: 219. 1820.);
- *Scirpus natans* Bojer nom. illeg. (Hortus Maurit. 383. 1837.);
- *Scirpus polycoleus* De Not. (Index Seminum (GE) 1847: 27. 1847);
- *Scirpus tristachyos* Zoll. ex Steud. (Syn. Pl. Glumac. 2: 96. 1855).

During botanical field surveys in 2015 and 2016, two new localities for *S. supinus* were found in the surrounding area of the village Gornji Miholjac, situated in the northern part of the City of Slatina (Fig. 1-2). The terrain configuration varies from horizontal plains, with scattered microdepressions that usually retain moisture throughout the vegetation period, to gently undulating contours within the elevation range of 108 – 112 m across the eastern administrative part of the village. From the aspect of land use, agriculture is generally dominant with a large share of sandy loam soils and the accompanying tobacco cultivation. With its affinities for the alliance *Nanocyperion*, the established ecological conditions appear very favourable for the occurrence and development of *S. supinus* (Fig. 3) in the area of Slatina. Both sites, however, appear threatened because of the enclosing weed vegetation and agriculture.



**Figure 1.** Known sites (red dots) of *Scirpus supinus* L. in Croatia, with delineated extent of occurrence (red triangle); enlarged map shows two recent records near the village of Gornji Miholjac (City of Slatina).



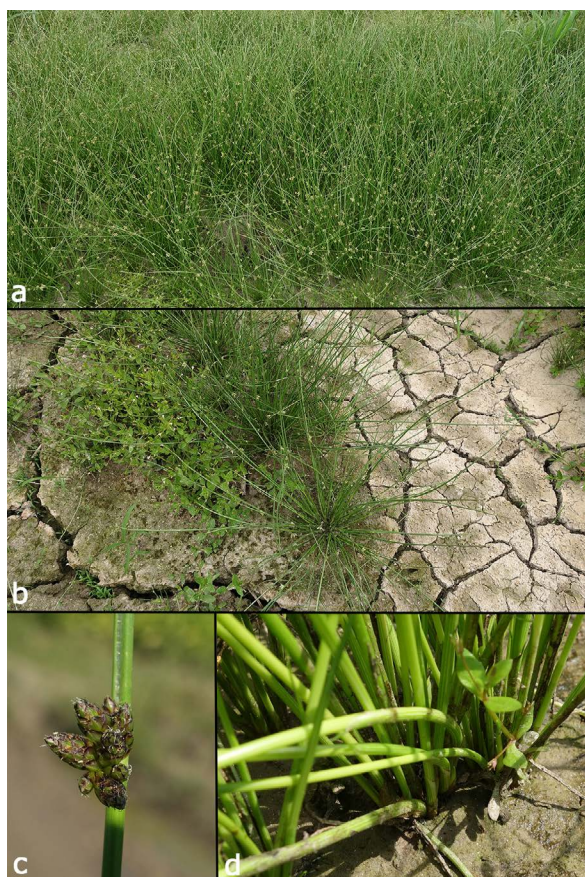
**Figure 2.** Habitat setting of *Scirpus supinus* L. at: a) north of village Gornji Miholjac Bijeline, surrounded by *Echinochloa crus-galli* (L.) P.Beauv. (25 July 2015), b) southeast of village Gornji Miholjac, Dubrava, with *Nicotiana tabacum* L. cultivated above the waterlogged soil (13 August 2016). (Photo: D. Prlić).

The following descriptions contain date and geographical details of the two newly recorded sites (Fig. 1), including GPS coordinates based on the HTRS96 national coordinate system (Lapaine & Tutić 2007):

- 1) North of village Gornji Miholjac, Bijeline, coordinates: E590454, N5070859, 108 m a. s. l., 25 July 2015;
- 2) Southeast of village Gornji Miholjac, Dubrava, coordinates: E591712, N5068604, 109 m a. s. l., 13 August 2016.

According to the available distribution data for *S. supinus* in Flora Croatica Database (Nikolić 2016), with just three previously known localities the species had therefore been largely under-recorded in Croatia. Two of the earlier records were herbarium vouchers stored in Herbarium Croaticum (ZA): one was collected by Stjepan Horvatić on 5 August 1949 as a weed species at "Jelas polje" near Slavonski Brod (ZA 11405), while





**Figure 3.** Details of *Scirpus supinus* L.: a) Dense overgrowth (25 July 2015), b) Caespitose habit, with *Lindernia procumbens* (Krock.) Philcox underneath (25 July 2015), c) Inflorescence with typical brownish glumes (13 August 2016), d) Tufts emerging from the soil (13 August 2016) (Photo: D. Prlić).

the other specimen was collected by Ruža Koščec in the surrounding area of Varaždin on moist soil near the Drava River (ZA 11404), dating back to 27 July 1943. Due to their date of collection, both records should be confirmed during floristic surveys of those localities in the future. The herbarium contains three additional vouchers, of which one belongs to foreign plant material, while the other two have undefined collection sites. Croatian herbaria ZAHO (Herbarium Ivo and Marija Horvat)

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and CNHM (Croatian Natural History Museum) keep no vouchers of *S. supinus*. The third known locality was recorded during vegetation research in the area between the Drava-Danube confluence and the forest Haljevo in Baranya region (Jovanović 1965). A detailed interpretation of the exact locality was not given, however, considering its ecological preferences, *S. supinus* most likely exists within the borders of Kopački rit Nature Park.

Currently, the species is listed as a strictly protected (Anonymous 2013, 2016) and a critically endangered (Nikolić & Topić 2005) vascular plant in Croatia. However, due to the restricted geographic distribution and probable habitat degradation, it is important to assess its threat category according to the new IUCN Red List guidelines (IUCN Standards and Petitions Subcommittee 2016). Taking into account all five known localities up to date, both extent of occurrence (EOO) and area of occupancy (AOO) have been calculated. The EOO is calculated as the minimum convex polygon (convex hull), whereas the area of occupancy (AOO) is estimated by calculating the total area of all 2x2 km grid cells with *S. supinus* occurrence. As a result, the EOO equals 7781.5 km<sup>2</sup> (Fig. 1) and AOO amounts to a total of 5 grid cells equalling an area of 20 km<sup>2</sup>. As a consequence of wide dispersion of localities, the EOO value falls within the range for Vulnerable (VU) species, yet the AOO and small number of localities qualify as conditions for an Endangered (EN) species. It should also be taken into account that *S. supinus*, as a habitat specialist, has an increased risk of extinction because of its fragmented range and restricted habitat type which is susceptible to threats such as hydroamelioration and agriculture. The taxon should therefore be downlisted from Critically Endangered (CR) to the category of Endangered (EN) species, following the subcriteria EN B2ab(iii, iv).

New field observations have been added to the Flora Croatica Database (ID 25507) and should serve as an invitation to increase research efforts in agricultural areas, particularly for inundated microdepressions, as habitats for various plant taxa possibly under-recorded on the national level.



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