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Insight into the chorology of some endangered, rare and potentially invasive plant species in Serbia

Original Article

Dragana Jenačković Gocić
Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia
draganaj@pmf.ni.ac.rs (corresponding author)

Ljiljana Bolbotinović
Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia
ljiljana.bolbotinovic@pmf.edu.rs

Marina Jušković
Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia
marinaju@pmf.ni.ac.rs

Danijela Nikolić
Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia
danid@pmf.ni.ac.rs

Vladimir Ranđelović
Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia
vladar@pmf.ni.ac.rs

Abstract:

This paper presents the distribution of nine endangered, rare or potentially invasive plant species present in the Serbian flora, based on field investigations, literature and herbarium data. The chorology of the following vascular plants: *Ranunculus lateriflorus, Elatine alsinastrum, Sedum stefco, Galium boreale*, *Ornithogalum narbonense, Cyperus serotinus, Cyperus odoratus, Typha laxmannii* and *Typha shuttleworthii*, is shown on 10 x 10 km^2 UTM maps. The data on the distribution of these endangered and rare species provide a valuable base for estimating and revising their threatened status in Serbia, as well as for conducting adequate conservation measures with regard to their habitats. Chorological data on the *Cyperus odoratus* species in Serbia are significant for getting to know its naturalization history and spreading pathways in both Serbia and its neighbouring countries.

Key words:
distribution, endangered plants, flora, invasive species, new chorological data, rare species, Serbia

Apstract:

Uvid u horologiju pojedinih ugroženih, retkih i potencijalno invazivnih biljnih vrsta u Srbiji

U ovom radu, prikazana je distribucija devet ugroženih, retkih i potencijalno invazivnih vrsta prisutnih u flori Srbije na osnovu terenskih, literaturnih i herbarijumskih podataka. Horologija sledećih vaskularnih biljaka: *Ranunculus lateriflorus, Elatine alsinastrum, Sedum stefco, Galium boreale, Ornithogalum narbonense, Cyperus serotinus, Cyperus odoratus, Typha laxmannii* i *Typha shuttleworthii*, prikazana je na 10x10 km^2 UTM kartama. Podaci o distribuciji ugroženih i retkih vrsta, koji su ovde prikazani, predstvaljaju dragocenu osnovu za procenu i reviziju njihovog statusa ugroženosti na području Srbije, i sprovođenje adekvatnih mera zaštite njihovih staništa. Podaci o distribuciji vrste *Cyperus odoratus* u Srbiji su od velikog značaja za upoznavanje istorije procesa naturalizacije i puteva širenja njenih individua u našoj i susednim zemljama.

Ključne reči:
rasprostranjenje, ugrožene biljke, flora, invazivne vrste, novi horološki podaci, retke vrste, Srbija

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Introduction

It is well-known that continuous monitoring of the floristic composition and abundance of plant species, especially those that are threatened, alien or weed, has enormous significances for biodiversity conservation. Monitoring the population of threatened species has a significant role in conducting protection measures in order to prevent their eventual extinction, while collecting data on the presence and spreading pathways of new, mostly invasive species, is significant for controlling the size of their populations and protecting autochthonous flora.

Despite the intensive study of Serbian flora over the last decades, new species are still being found (Ranđelović et al., 2002; Niketić et al., 2009; Đorđević et al., 2010; Đorđević et al., 2014; Tomović et al., 2016; Stojanović et al., 2017), as well as new localities for rare and endemic plant species (Tomović et al., 2007; Zlatković et al., 2007; Niketić

& Tomović, 2008; Zlatković & Bogosavljević, 2014; Jenačković et al., 2015; Đorđević et al., 2017), which supports the fact that the flora of Serbia has not yet been, and probably never will be, fully explored.

During intensive phytocoenological research conducted in the areas of NE, E and SE Serbia on diverse habitat types, including rivers, ponds, seasonal flooded habitats, wet meadows and rocks over the last three years, new chorological data on some threatened, rare, endemic and potentially invasive plant species have been collected. This research confirms the already known fact that the previously mentioned habitat types are refuges for numerous rare and endangered plants (Stojanović et al., 1994), so they are significant for the conservation of genetic, species and ecosystem diversity. In the regions of NE, E and SE Serbia, they are, unfortunately, poorly investigated, both floristically (Bogosavljević et al., 2007; Petrović et al., 2007; Stanković et al., 2009; Jenačković et al., 2015) and phytocoenologically (Ranđelovć et al., 2007; Ranđelović & Zlatković, 2010; Jenačković et al., 2010; Jenačković, 2017). Generally, publishing new chorological data for the previously mentioned groups of plants enriches knowledge regarding their distribution and provides adequate material for writing and publishing new editions of *Flora of Serbia*, as well as Red list and Red books of the Flora of Serbia and the Serbian List of Invasive plant species. In this paper, the authors give detailed information on the distribution pattern of nine vascular plants in Serbia: *Ranunculus lateriflorus* DC., *Elatine alsinastrum* L., *Sedum stefco* Stefanov, *Galium boreale* L., *Ornithogalum narbonense* L., *Cyperus serotinus* Rottb., *Cyperus odoratus* L., *Typha laxmannii* Lepechin and *Typha shuttleworthii* Koch & Sonder in Koch.

Material and methods

The distribution of each of the species presented in this study is showed on a 10 x 10 km^2 UTM grid based on field, literature and herbarium data. Field investigation of different habitats was carried out in the period 2017-2020 in the areas of NE, E and SE Serbia. Relevant floristic and phytocoenological literature published in the last seventy years was also used as an adequate source of chorological data. Georeferenced data on the distribution of specimens deposited in the Herbarium of the Faculty of Sciences and Mathematics, Department of Biology and Ecology, University of Niš (HMN) and Herbarium of the Institute of Botany and Botanical Garden "Jevremovac", University of Belgrade (BEOU) are showed on UTM grids, too.

Plant material collected during field investigation was determined by using the dichotomic identification keys (Josifović, 1970 – 1980; Tutin et al., 1964 – 1980). The nomenclature of the species recorded was uniformed to the Flora Europaea (Tutin et al., 1964 – 1980). The threatened status for the species mentioned in the section above is considered in terms of IUCN (2000) criteria and categories.

Results and Discussion

Ranunculus lateriflorus DC.

General distribution: *R. lateriflorus* has been recorded in **Europe** (Spain, France, Italy, Austria, Slovakia, Hungary, Romania and all countries of the Balkan Peninsula except Albania**)**, **North Africa** (Morocco and Algeria) and **Asia** (countries of the western Asia, Ukraine and Russia).

Distribution in Serbia: Most published data on *R. lateriflorus* distribution in Serbia are for the **Province of Vojvodina** (Diklić, 1992; Purger, 1993; Panjković et al., 2012; Šturc, 2014) (**Fig. 1**). Other parts of Serbia have been poorly investigated, especially the territory of NW, W, SE and C Serbia, Pomoravlje and regions of Kosovo. Outside of Vojvodina province, *R. lateriflorus* was recorded in the **Šumadija region:** Rakovica and Grocka (Diklić, 1992); **NE Serbia:** Negotin and Kladovo (Diklić, 1992); **E Serbia:** Pirot (Nikolić et al., 1986; Diklić, 1992) and **S Serbia:** Leskovac (Diklić, 1992).

Unpublished chorological data: NE Serbia: Krivelj – EP88 (leg. *Pančić, J.* 2327, 1876, BEOU); **Šumadija region:** Jovanovac – DP97 (leg. *Pančić, J.* 2309, 1870, BEOU); **Banat region:** Melenci – DR44 (leg. *Niketić, M., Tomović, G.* 48059, 23.04.2016, BEOU); Farkaždin – DR50 (leg. *Lakušić, D., Tomović, G.* 47302, 19.04.2016, BEOU; leg. *Lakušić, D., Tomović, G., Kuzmanović, N., Kabaš, E., Đurović, S., Janković, I., Milekić, T.* 47375, 17.05.2016, BEOU).

New chorological data: It has been found in the surroundings of **Donje Međurovo** village (E Serbia – EN69, 43°18'22'' N, 21°50'25'' E, 185 m a.s.l., leg./det. *Jenačković*, *D.* 14367, 29.05.2018, HMN). At this study site, on a seasonally flooded and salted habitat that borders with a cultivated area, a small population of *R. lateriflorus* was recorded, which is under strict protection. It was made up of less than a hundred individuals. Most of the individuals recorded are growing in association with *Eleocharis palustris* and *Oenanthe silaifolia*, and they are part of the composition of the halophilous community, with *Beckmannia eruciformis* being dominant.

Habitat characteristics: *R. lateriflorus* is an annual therophyte that grows and blooms during the spring on wet, sandy and seasonally flooded habitats.

IUCN threatened status in the world: Least concern (LC).

IUCN threatened status in Serbia: Endangered – Vulnerable (EN B1; B2b, c; C1; C2a/VU A1b, c, e;

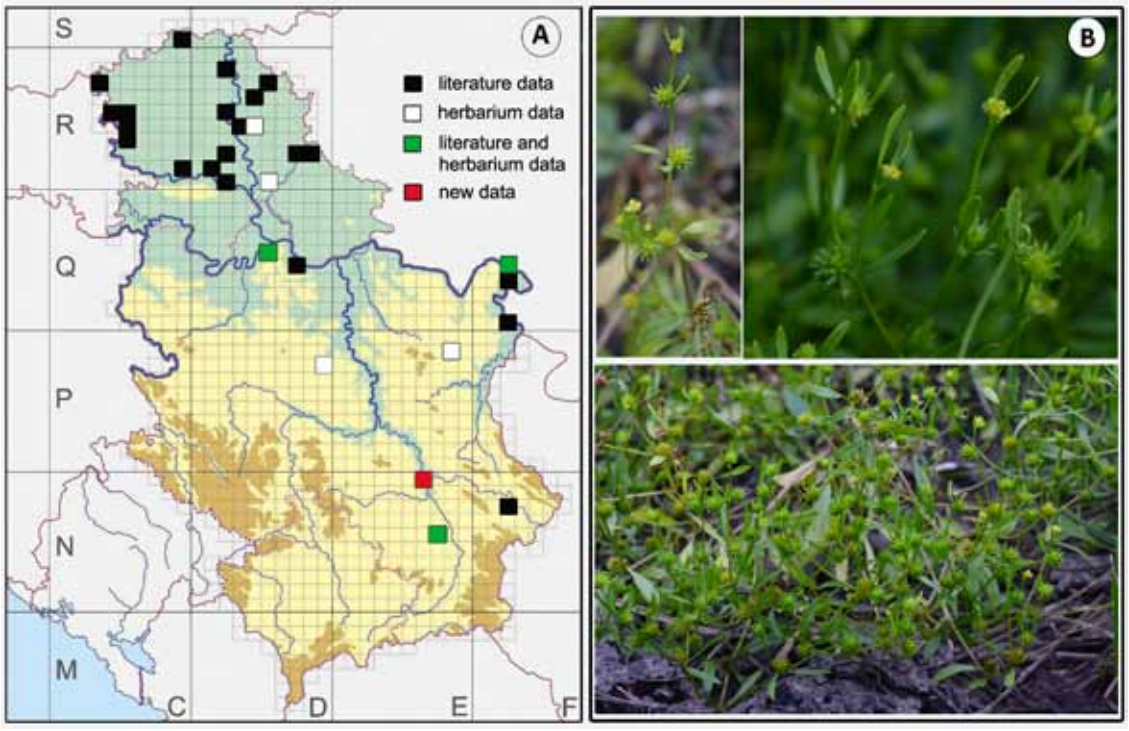

Fig 1. Distribution map of *Ranunculus lateriflorus* in Serbia (A). The photographs show it growing on seasonally flooded habitats in the vicinity of Donje Međurovo village (B).

A2c, e; D1; D2).

According to Király (2007), *R. lateriflorus* is a legally protected species in Hungary, where it is classified in the category NT (Near threatened). Generally, its habitats are exposed to strong negative anthropogenic pressure, which can be seen in the decreasing size of its population, so applying adequate conservation measure is needed not only in Serbia, but also globally.

Elatine alsinastrum L.

General distribution: *E. alsinastrum* is a Euro-Siberian sub-Mediterranean species that grows in temporary water bodies in **Europe** (from the Iberian Peninsula, north to France and Belgium, east to Poland and Ukraine, and in almost all countries in the Mediterranean Basin), **Asia** (Russia, Ukraine, Georgia, Armenia, W Siberia and Kazakhstan) and **North Africa** - Morocco, Algeria and Tunisia (Popiela et al., 2013).

Distribution in Serbia: Although Blečić (1972) stated that the species is often found in Serbia, literature sources and herbarium collections provide little data on *E. alsinastrum* chorology in Serbia (**Fig. 2**). Until now, it has been documented that *E. alsinastrum* grows in ditches in the **Bačka** (Panjković, 2005) and **Srem regions** (Perić et al., 2016).

Unpublished chorological data: During the 19th century, Josif Pančić collected specimens of *E. alsinastrum* at a few locations south of Vojvodina province. He found this species in the area surrounding **Belgrade** (Rakovica – DQ55, leg. *Pančić, J.* 3170*,* 1877, BEOU), **Sobovica** (Bele Bare – DP88, leg. *Pančić, J.* 3168, 1851, BEOU), **Bubanj** – EN69 (leg. *Pančić, J.* 3167, 1885, BEOU) and in the valley of the **Kolubara River** (leg. *Pančić, J.* 14593, BEOU, this data is not shown on **Fig. 2**).

New chorological data: Two years ago, in the area surrounding the village of **Donje Međurovo** (SE Serbia – UTM, 43°18’18” N, 21°50’10” E, 183 m a.s.l.) in seasonally flooded habitats, a community was recorded, with *E. alsinastrum* dominance (**Fig. 2**). The following species: *Eleocharis palustris*, *Alisma plantago-aquatica*, *Veronica anagallis-aquatica*, *Mentha pulegium* and *Beckmannia eruciformis* were part of the composition of the *Elatine alsinastrum* community. Specimens of *E. alsinastrum* are stored in HMN (leg./det. *Jenačković, D.* 14370, 29.05.2018). More than a hundred years ago, Josif Pančić found *E. alsinastrum* in the vicinity of Donje Međurovo (Bubanj – EN69), but he did not publish that record.

Habitat characteristics: *E. alsinastrum* inhabits temporary water bodies or seasonally flooded zones of permanent water bodies.

IUCN threatened status in the world: Near threatened (NT) with decreasing population trend.

IUCN threatened status in Serbia: not threatened.

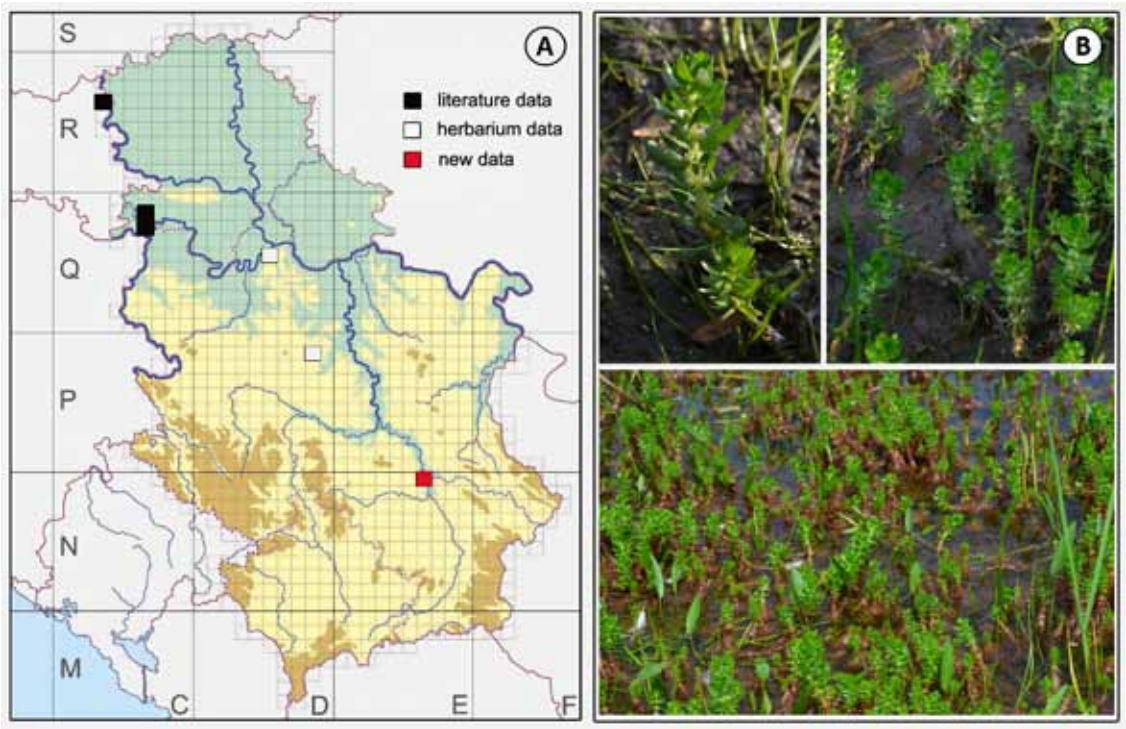

Fig 2. UTM map of the distribution of *Elatine alsinastrum* in Serbia (A). The photographs present its populations that inhabit shallow, ephemeral depressions in the vicinity of Donje Međurovo village (B).

Elatine triandra Schkuhr is the only species from the genus *Elatine* that is protected in Serbia. Based on literature sources and herbarium data, as well as the authors' field experiences, it can be concluded that *E. alsinastrum* is a rare species of Serbian Flora which requires some kind of protection. Its small populations inhabit sensitive habitat types that are threatened by diverse anthropogenic factors, such as the drainage of seasonally inundated land, stabilization of hydrological regimes, agricultural improvement etc. The same problem also exists in other European countries, so *E. alsinastrum* could be considered as rare species throughout most countries in Central Europe (Schnittler & Günther, 1999). *Elatine alsinastrum* is classified as a critically endangered species in Bulgaria (Petrova & Vladimirov, 2009), and near threatened in Hungary (Király, 2007). In Croatia, it is rarely recorded, and known only from old literature and herbarium sources, so it is described as an insufficiently known plant species (DD – data deficient) (Prlić, 2015).

Sedum stefco Stefanov

General distribution: It is an endemic species of the **Balkan Peninsula** that has been recorded in four countries (Serbia, Bulgaria, Macedonia and Greece) so far.

Distribution in Serbia: The first data published on the presence of *S. stefco* in Serbian flora date from the end of the 20th century and refer to **Radan Mountain** (Zlatković et al., 1993; Zlatković & Ranđelović, 1995) and the Pčinja River gorge (Zlatković & Ranđelović, 1995). By publishing data on the geographical position of population of the species *S. stefco* in **E Serbia** (the Temštica gorge) and **S Serbia** (Kozjak Mountain – Monastery Prohor Pčinjski), Tomović et al. (2003) made the previous knowledge of its distribution more complete (**Fig. 3**).

New chorological data: Two populations of the strictly protected species, *S. stefco*, were found on **Stara Planina Mountain** at a locality called Strejnica (E Serbia – FP20, 43°21'20.24'' N, 22°35'31.91'' E, 1501 m a.s.l., leg./det. *Ranđelović*, *V.*, 10.07.2020; E Serbia – FP20, 43°21'20.32'' N, 22°35'31.70'' E, 1550 m a.s.l., leg./det. *Ranđelović*, *V.*, 02.08.2020). Individuals of the *S. stefco* species inhabit fragments of red sandstone with other species characteristic for rocky vegetation, including *Sedum annuum*, *Sedum album*, *Silene lerchenfeldiana*, *Allium carinatum* subsp. *pulchellum*, *Scleranthus perennis*, *Anthemis carpatica*, etc.

Habitat characteristics: In Serbia, *S. stefco* is found on rocks (silicate and red sandstones), rock fragments, and dry, rocky ground at a wide range of altitudes, from 300 m to 1550 m a.s.l.

IUCN threatened status in the world: not threatened.

IUCN threatened status in Serbia: Near threatened – Least concern (data deficient) (NT-LC

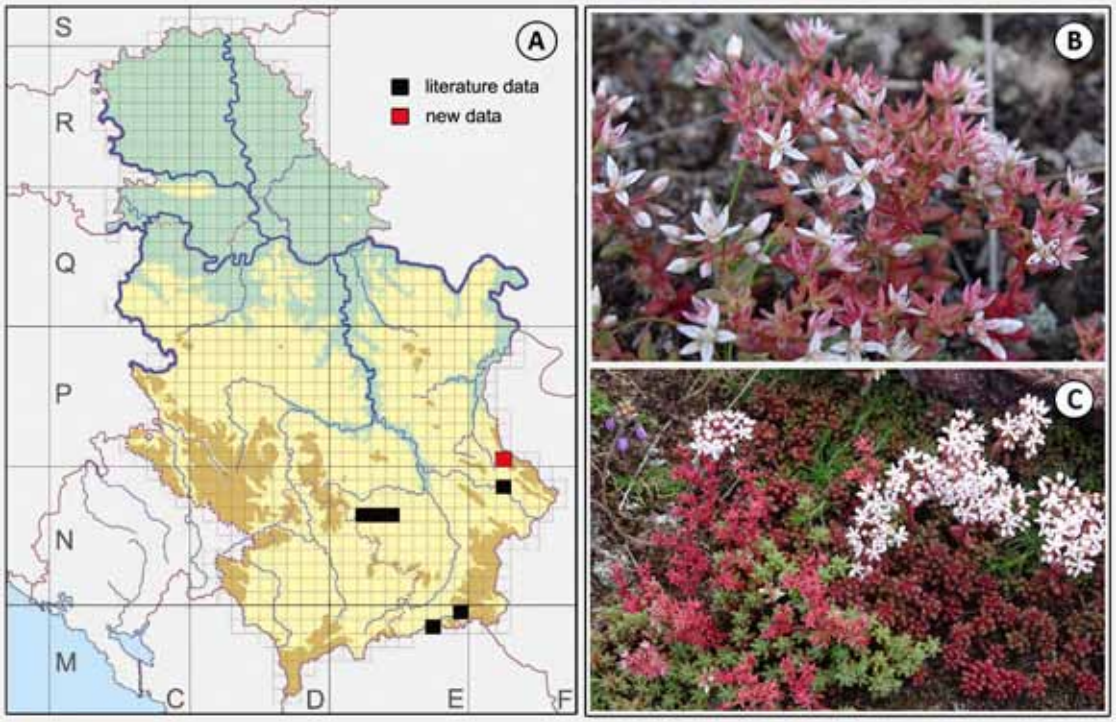

Fig 3. Distribution of *Sedum stefco* in Serbia (A). Photographs of *Sedum stefco* specimens (B) and a mixed community dominated by succulent plant species *Sedum stefco* and *Sedum album* (C), developed on rocky fragments situated on Stara Planina Mountain.

(DD)).

Sedum stefco is classified as near threatened in the Greek Red Data Book (Eleftheriadou et al., 2009), and vulnerable, and it is a legally protected species in the Republic of Bulgaria (Petrova & Vladimirov, 2010).

Galium boreale L.

General distribution: It is distributed over the subarctic and temperate regions of the **Northern Hemisphere**. In Europe, *G. boreale* is rare in the Mediterranean region.

Distribution in Serbia: *G. boreale* is a legally protected species in Serbia. It is recorded in the **Bačka region** (Boža & Vasić, 1986); **NW Serbia:** Maljen Mountain (Gajić, 1973; Popović, 2005); **W Serbia:** Stolovi Mountain (Pavlović, 1974), Tara Mountain (Gajić, 1988), Zlatibor Mountain (Pavlović, 1951; Gajić, 1973; Novaković-Vuković, 2015), the Uvac River gorge (Veljić et al., 2006); **SW Serbia:** Ozren Mountain (Pavlović, 1955; Rakonjac, 2002) and Pešter plateau (Tatić, 1988; Rakonjac, 2002) (**Fig. 4**).

New chorological data: While mapping herbaceous habitat types on Vlasina plateau, individuals of *G. boreale* were recorded at two sites: **Murina Valley** (SE Serbia – FN12, 42°42'51.52'' N, 22°21'39.09'' E, 1264 m a.s.l., leg. *Jenačković Gocić, D.*, det. *Ranđelović, V.* 14383, 29.06.2020, HMN) and **Bratašnica** (SE Serbia – FN02, 42°41'37.39'' N, 22°19'17.48'' E, 1226 m a.s.l., leg./det. *Ranđelović, V.*, 20.07.2020). They were a part of the meadow vegetation composition, together with individuals from the following species: *Sanguisorba officinalis*, *Briza media*, *Holcus lanatus*, *Centaurea jacea*, *Filipendula hexapetala*, *Galium verum*, *Hypericum maculatum* subsp. *immaculatum*, *Potentilla erecta* and *Campanula patula*.

Habitat characteristics: *G. boreale* is a heliophilous species that prefers moist and well drained soils. It can tolerate partial shade and dry conditions. It is found in wet meadows and open woods.

IUCN threatened status in the world: not threatened.

IUCN threatened status in Serbia: Vulnerable – Near threatened (data deficient) (VU-NT (DD)). *Galium boreale* is a vulnerable species in the Bulgarian flora (Petrova & Vladimirov, 2009), too.

Ornithogalum narbonense L.

General distribution: It occurs in **Europe** (Portugal, Spain, France, Italy, Romania and countries on the Balkan Peninsula), **Asia** (Turkey, Azerbaijan, Armenia, Georgia, Syria, Lebanon, Israel and Jordan) and **Africa** (Egypt, Libya, Tunisia, Algeria and Morocco).

Distribution in Serbia: According to Diklić (1975), *O. narbonense* is a species with sporadic occurrence in Serbia. Data on its distribution in

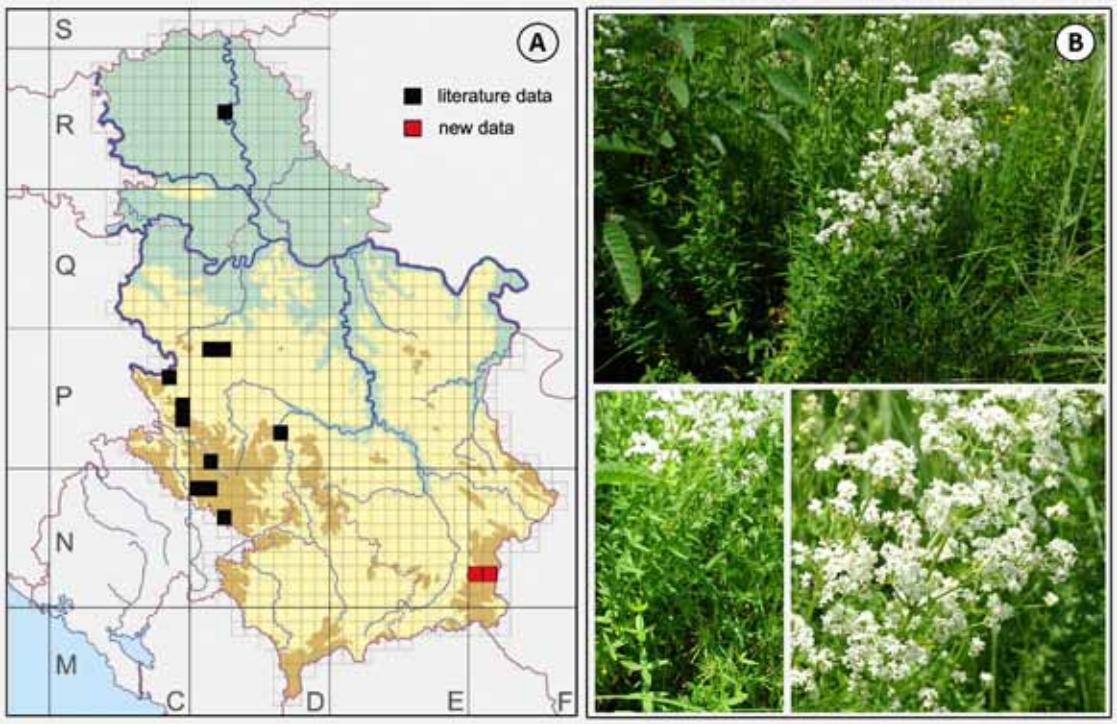

Fig 4. UTM map of the distribution of *Galium boreale* in Serbia (A) and photographs of individual specimens (B).

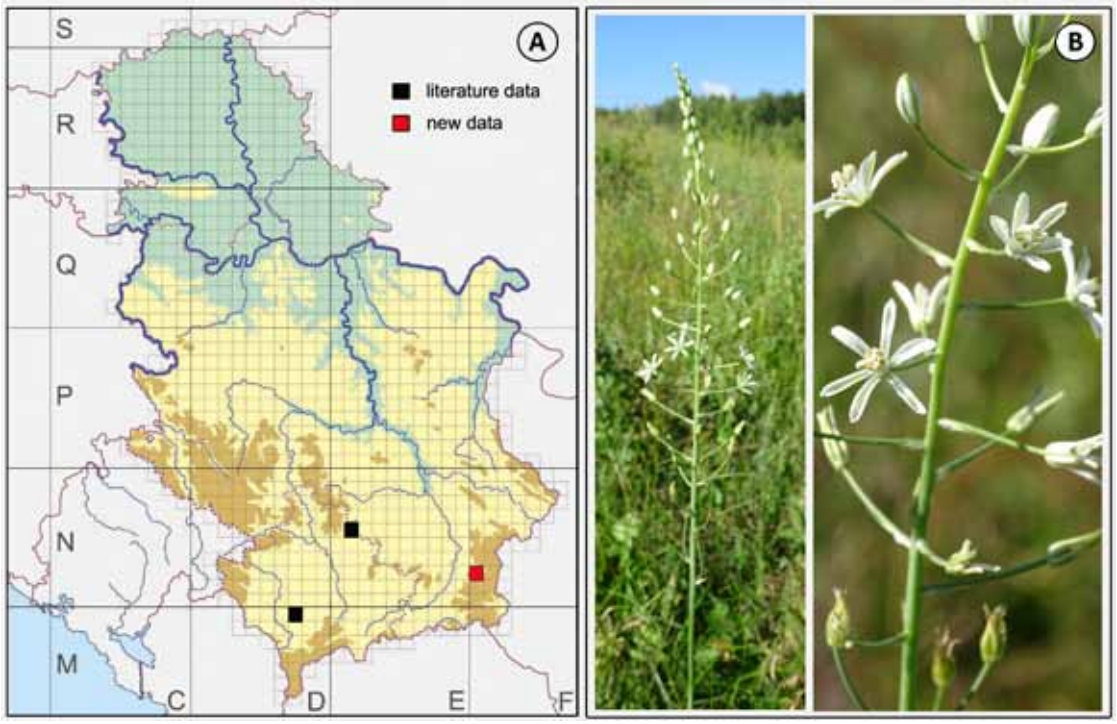

Fig 5. Map of distribution of *Ornithogalum narbonense* in Serbia (A) and photographs of its inflorescence (B).

Serbia are poor. Until now, *O. narbonense* has been recorded at two localities in the **Province of Kosovo:** Podujevo and Orahovac (Nikolić et al., 1986) (**Fig. 5**). Ranđelović et al. (2005) stated that *O. narbonense* inhabits cultivated land in Southeastern Serbia, but did not give precise information on the geographical position of its populations. Further field investigations are needed in order to determine whether *O. narbonense* is a rare or insufficiently investigated species in Serbia.

New chorological data: *O. narbonense* was recorded within meadow vegetation on **Vlasina**

plateau, in a place named Jarčev potok (SE Serbia – FN02, 42°40'11.73'' N, 22°20'12.35'' E, 1234 m a.s.l., leg./det. *Ranđelović*, *V.*, 21.07.2020). *Agrostis capillaris*, *Briza media*, *Achillea millefolium*, *Campanula patula*, *Crepis conyzifolia*, *Dianthus deltoides*, *Galium verum*, *Hypericum maculatum* subsp. *immaculatum*, *Hypochaeris maculata*, *Potentilla argentea* and *Pastinaca hirsuta* are the most abundant species at the site where these individuals of *O. narbonense* were found.

Habitat characteristics: It grows in sunny, grassy and dry places such as grasslands, roadsides, crops and disturbed ground.

IUCN threatened status in the world: not threatened.

IUCN threatened status in Serbia: Vulnerable – Near threatened (data deficient) (VU-NT (DD)).

***Cyperus serotinus* Rottb.**

General distribution: *C. serotinus* is a native species on the **European** and **Asian continents** while it is naturalized in **North America** and **Australia**. On the Eurasian continent, *C. serotinus* is distributed from the Iberia Peninsula through the countries of Central Europe and the Mediterranean Basin, Caucasus, Kazakhstan, Middle East and the Himalayas to Japan, most of China, Taiwan and Vietnam.

Distribution in Serbia: *C. serotinus* is a rare and endangered species that is recorded in the **Banat region**: Deliblato Sands (Budak, 1983), Labudovo okno (Polić, 2006), Žilovo islet, Dolnice bay and Stevan Lowlands (Stevanović et al., 2004); **Šumadija:** on the banks of the Danube River near Belgrade (Čanak, 1976), **NW Serbia:** Loznica (Čanak, 1976), and **C Serbia:** Batušinac Ponds (Ranđelović et al., 2007) (**Fig. 6**).

Unpublished chorological data: In the 21st century, individuals of the *C. serotinus* species were found at a few locations in the Danube River Valley, downstream from Belgrade (**Malo Bavanište embankment** – EQ05, leg. *Stevanović, V.* 49867, 22.09.2002, BEOU; **Mali Lap** – EQ16, leg. *Stevanović, V.* 22335, 26.07.2003, BEOU; **Zatonje** – EQ35, leg. *Stevanović, V.* 50093, 23.11.2013, BEOU; **Prahovo** (Bay Kusjaka) – FQ20, leg. *Stevanović, V.* 50073, 23.07.2013, BEOU).

New chorological data: One population of *C. serotinus* was recorded on the right bank of the Danube River near **Tekija** (NE Serbia – FQ14, 44°41'28'' N, 22°24'56'' E, leg. *Bolbotinović, Lj.*, det. *Ranđelović*, *V. & Jenačković*, *D.* 14368, 25.09.2018, HMN). The first record (unpublished) for this toponymy dates from the 19th century (*Cyperus monti*, Tekija – FQ14, leg. *Pančić J.* 15359, 1877, BEOU; *Cyperus monti*, Tekija – FQ14, leg. *Pančić J.* 12347, 1878, BEOU), but it refers to "old" Tekija, which was submerged after construction of the Đerdap I hydropower dam.

Habitat characteristics: *C. serotinus* grows in seasonally flooded habitats, bays, banks of rivers and standing water bodies.

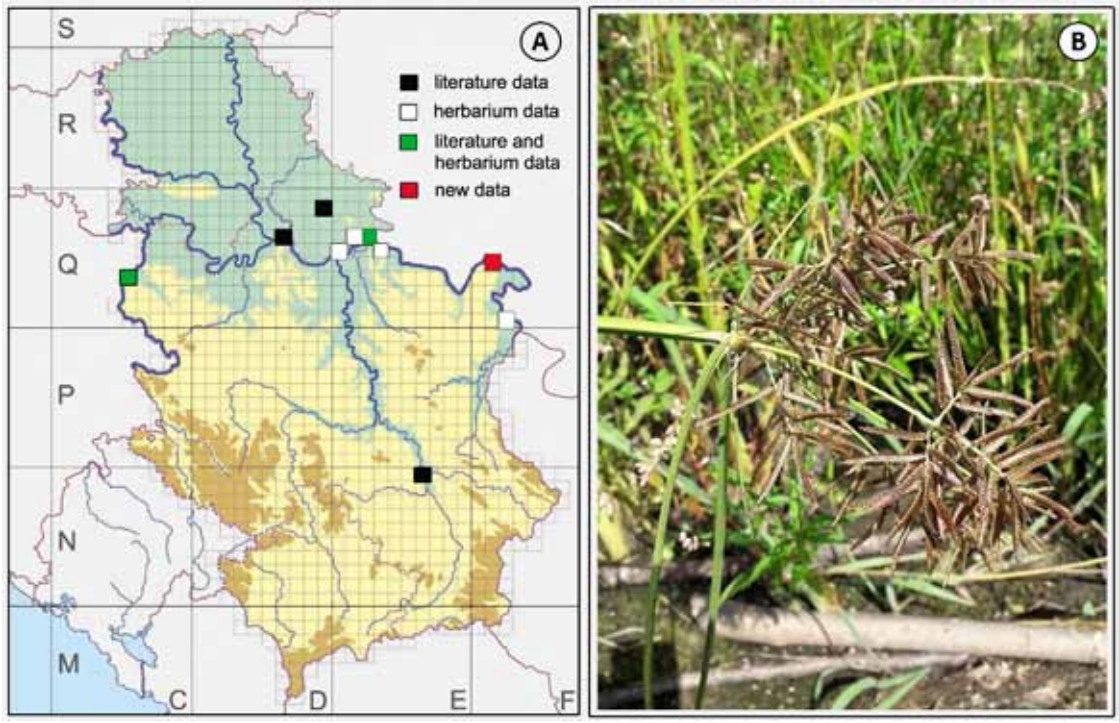

Fig 6. UTM maps of the distribution of *Cyperus serotinus* (A) and a photograph of its inflorescence (B).

IUCN threatened status in the world: Least concern (LC).

IUCN threatened status in Serbia: Near threatened – Least concern (data deficient) (NT – LC (DD)). According to Nikolić & Topić (2005), *C. serotinus* is a vulnerable plant species in Croatian flora.

***Cyperus odoratus* L.**

General distribution: *C. odoratus* is a pantropic species which has been naturalized in Europe (Spain, Italy, Serbia, Bulgaria and Romania) (Verloove, 2014).

Distribution in Serbia: For a long time, *C. odoratus* has been confused with *C. strigosus* and other species from the *Cyperus* genus, so its exact naturalization history in Serbia is not known. After the revision of herbarium specimens deposited in BEOU, Verloove (2014) concluded that the first record of *C. odoratus*, under the erroneous binomial *C. strigosus*, was published at the beginning of the 21st century by Stevanović et al. (2004, 2005). It refers to Mali Lap marsh situated near the village of Dubovac (**Banat region** – EQ15) (**Fig. 7**). Stevanović et al. (2005) stated that *C. strigosus* grows in several places in the Danube Basin (km 1090 – 1075): Žilovo islet, Mali Lap marsh, Dolnice bay and the Stevan Lowlands. After the revision of herbarium material deposited in BEOU, the authors confirmed the presence of *C. odoratus* at **Žilovo islet** – EQ15 (*Cyperus* sp., leg. *Stevanović, V., Stevanović, B., Sekulić, N., Šinžar-Sekulić, J.* 49877, 08.09.2002, BEOU), while the presence of *C. odoratus* at Dolnice bay and Stevan Lowlands remains unconfirmed. Verloove (2014) stated that individuals from the *C. odoratus* species form small populations at numerous localities along the Danube River, from Kovin to Mihajlovac near Đerdap II hydropower dam, but he did not give precise information on the localities.

Unpublished chorological data: After revision of specimens from the *Cyperus* genus stored in BEOU, the authors established that *C. odoratus* grows in one more place in the **Banat region** (Malo Bavanište – EQ05, leg. *Stevanović, V.* 49860, 22.09.2002, BEOU; leg. *Stevanović, V.* 49866, 22.09.2002, BEOU). During 2020, individuals from the *C. odoratus* species were recorded at localities situated northwest of the places mentioned in earlier published papers (Stevanović et al. 2005, Verloove 2014): **Ada Ciganlija** (DQ56 – 44°47'43.05" N, 20°25'31.15" E, leg. *Pantović, J., Stevanoski, I., Ćosić, M.* 69151, 16.10.2019, BEOU) and **Pančevački rit** (DQ66 – 44°49'53.41" N, 20°30'14.35" E, leg. *Pantović, J., Stevanoski, I., Ćosić, M.* 69160, 24.10.2019, BEOU) (**Fig. 7**).

New chorological data: *C. odoratus* was found at three locations (44°41'27" N, 22°24'56" E; 44°41'20" N, 22°24'47" E; 44°40'34" N, 22°24'70" E) on seasonally flooded habitat positioned in surrounding of **Tekija**, near the Danube River (NE Serbia – FQ14, leg. *Bolbotinović, Lj.*, det.

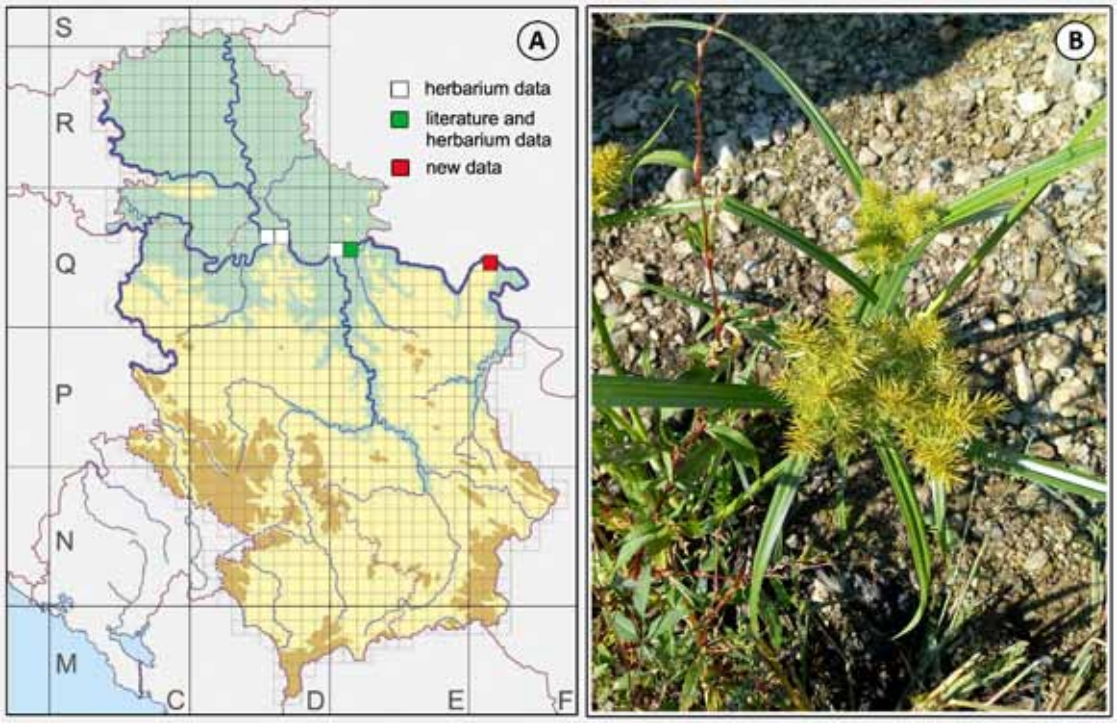

Fig 7. Map of distribution of *Cyperus odoratus* in Serbia (A) and a photograph of individual specimens (B).

Jenačković, *D. & Ranđelović*, *V.* 14369, 25.09.2018, HMN).

Habitat characteristics: In Europe, *C. odoratus* is mostly found on mud flats, gravelly or sandy river banks, estuaries, and in riparian woodland, drainage channels and ditches (Verloove, 2014). They form pure or mixed communities with other emergent macrophytes, such as *C. serotinus*. Otherwise, *C. odoratus* occupies new pitches very quickly and behaves like an invasive environmental weed (Verloove, 2014), so the knowledge of its distribution pattern and population status is important for determining how it spreads and how it can eventually be controlled.

IUCN threatened status in the world: not threatened.

IUCN threatened status in Serbia: not threatened.

Typha laxmannii Lepechin

General distribution: *T. laxmannii* is distributed from Europe through Siberia, the Caucasus, the Middle East, Kazakhastan and Mongolia to the Russian Far East, China and Japan.

Distribution in Serbia: The first chorological data for *T. laxmannii* in Serbia are from Budak (1986), and they refer to the **Banat** and **Bačka** regions (**Fig. 8**). Radulović (2005) stated that individuals from the *T. laxmannii* species compose a community with *Typha latifolia* dominance in **Carska Bara** Special Nature Reserve. In the 21st century, a few authors have published data on *T. laxmannii* distribution outside the borders of Vojvodina province. Until now, it has been recorded in the following localities: **Batušinac Ponds** (Ranđelović et al., 2007), **Šarpance village**, **Vražji Kamen**, the vicinity of **Dimitrovgrad** town, **Vranjska Banja** (Zlatković et al., 2007), **Rgotina lake** (Zlatković & Bogosavljević, 2014), **Smilovsko lake** (Jenačković, 2017) and **Zlatibor Mountain** (Tomović et al., 2020) (**Fig.8**).

New chorological data: During the summer of 2020, a small population of *T. laxmannii* was recorded in a canal, positioned east of the dam, through which water enters **Vlasina Lake** (SE Serbia – FN03, 42°44'59.01"N, 22°19'43.34"E, 1222 m a.s.l., leg. *Nikolić, D.*, *Jušković, M.*, *Savić, A.*, det. *Ranđelović*, *V.* 14388, 01.08.2020, HMN). At this site, *T. laxmannii* grows mainly in association with *Typha latifolia*, *Juncus effusus*, *Centaurium erythraea*, etc.

Habitat characteristics: It prefers permanently flooded habitats with shallow waters or seasonally flooded habitats, such as the margins of ponds, pools, canals, rivers, streams and lakes.

IUCN threatened status in the world: Least concern (LC).

IUCN threatened status in Serbia: Near threatened (NT).

Typha laxmannii is classified as a critically

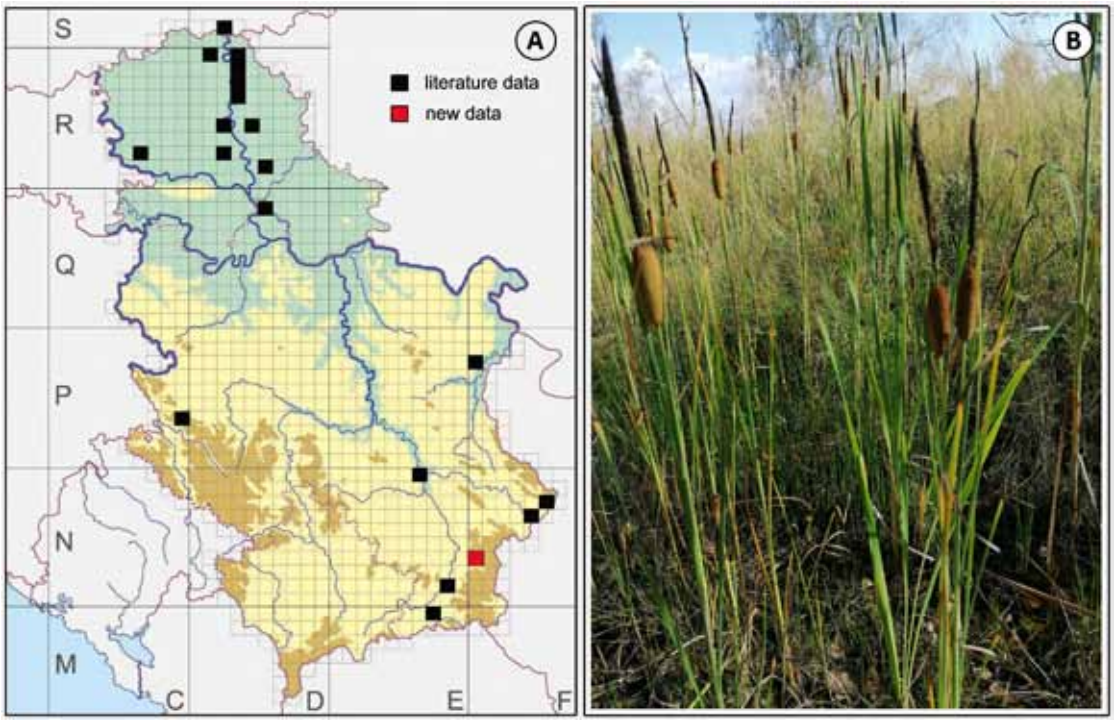

Fig 8. UTM maps of the distribution of *Typha laxmannii* (A) and a photograph of the population recorded at Vlasina plateau (B).

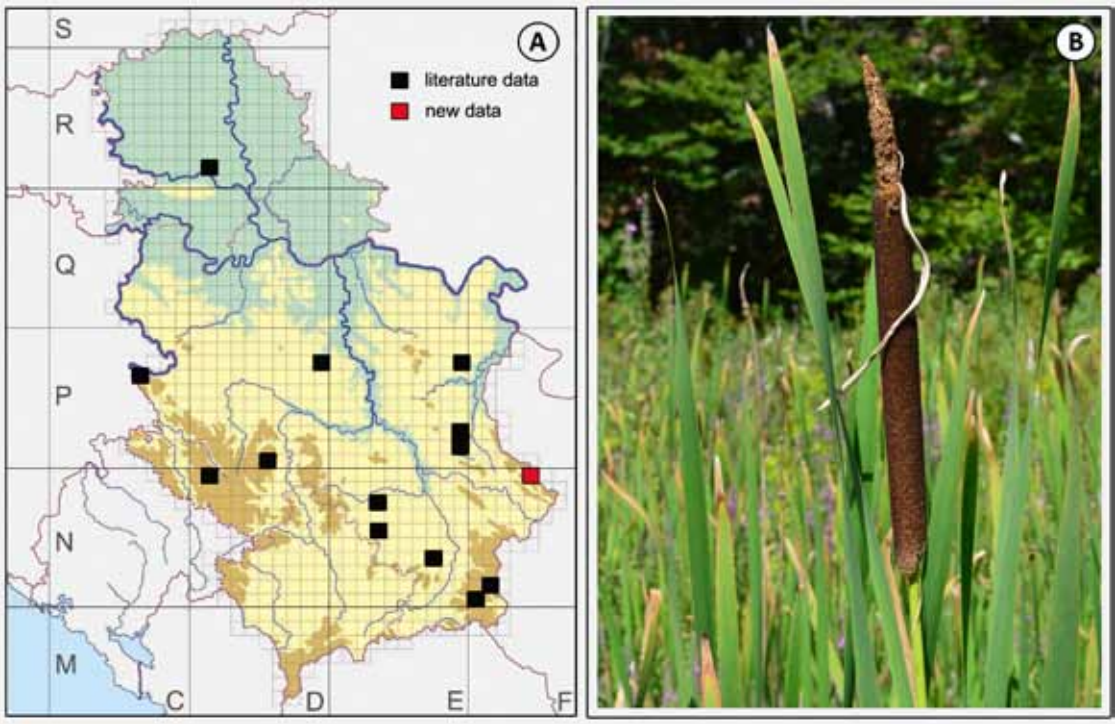

Fig 9. Map of distribution of *Typha shuttleworthii* in Serbia (A) and a photograph of its inflorescence (B).

endangered species of Croatian flora (Nikolić & Topić, 2005), and it was recorded during summer 2000 for the first time (Topić & Ozimec 2001).

Typha shuttleworthii Koch & Sonder in Koch

General distribution: It occurs in Europe (from France east through the Czech Republic and Hungary to Romania and the Ukraine), the Caucasus and Asia (Turkey).

Distribution in Serbia: *T. shuttleworthii* was considered to be a critically endangered species in Serbia during the 20th century (Ranđelović, 1999) because it was known at only a few localities: the spring of Jabukovačka River on **Kukavica Mountain**, the area surrounding **Novi Sad**, **Kragujevac** and **Sjenica** (Jovanović, 1986) (**Fig. 9**). Its status changed from critically endangered to endangered after establishing new sites in **Eastern Serbia:** Crna Reka gorge, Svrljiški Timok gorge and the environs of Bosilegrad (Topli Dol and Musulj) (Tomović et al., 2009). The first data on *T. shuttleworthii* distribution in **C Serbia** (Radan Mountain – Gornji Gajtan and Kosmača) and **W Serbia** (Tara Mountain – Kurjačine and Kozulja; Golija Mountain – Izubra) were published this year (Tomović et al., 2020).

New chorological data: A small population of the strictly protected species *T. shuttleworthii* was recorded in a flooded depression on **Stara Planina Mountain**, next to the road leading to Tupavica waterfall (E Serbia – FN49, 43°15'42'' N, 22°46'26'' E, 975 m a.s.l., leg./det. *Ranđelović*, *V. & Jenačković*, *D.* 14384, 22.07.2018, HMN).

Habitat characteristics: *T. shuttleworthii* usually builds small populations that cover a few square meters, mostly in anthropogenic habitats such as roadside ditches (Tomović et al., 2020), river and stream valleys, swamps and wet meadows (Kozłowska et al. 2011).

IUCN threatened status in the world: Data deficient (DD).

IUCN threatened status in Serbia: Endangered (EN B1 ab(i,ii,iii); B2 ab(i,ii,iii); C1) (Tomović et al. 2009).

There is a need for additional field investigation due to the possibility of its wider distribution in Serbia. It is considered that its significant morphological similarity with *T. latifolia* is the main reason for the insufficient study of its distribution in Serbia (Tomović et al., 2020). The same problem exists in Bulgaria and Croatia, so *T. shuttleworthii* is classed as data deficient in these countries (Petrova & Vladimirov, 2009; Nikolić & Topić, 2005). Király (2007) stated that *T. shuttleworthii* is extinct in Hungary.

Conclusion

The chorological data presented in this paper are a valuable base for better understanding the distribution patterns in Serbia of the vascular plants analyzed in this study, as well as estimating and potentially reevaluating their threatened status, and controlling

the size of their populations.

The strictly protected and endangered plant species, *R. lateriflorus*, is poorly investigated outside the borders of Vojvodina province, especially in W Serbia and the Province of Kosovo. It mostly grows in shallow, seasonally flooded depressions that are affected by negative anthropogenic factors, so continuous monitoring of its population is needed due to a possible decrease in its population size.

Similar habitat types are preferred by *E. alsinastrum*, a globally near threatened species whose distribution in Serbia has not been researched enough. Although it is not recognized as threatened in Serbia, the authors suggest that its status in this country should be reconsidered in accordance with the data provided in this research.

According to existing floristic data, the Balkan endemic species *S. stefco* is distributed in the southern and eastern parts of Serbia. The border of its geographic range in Serbia is expanding to the north by establishing its existing population on Stara Planina Mountain.

Individuals from the legally protected and vulnerable species *G. boreale* were mainly recorded within wet meadows and open woods in Western Serbia. The borders of its geographic range have moved significantly to the east after establishing its presence on Vlasina plateau.

The poorly studied, vulnerable species of Serbian flora, *O. narbonense*, requires additional investigation in order to collect information with regard to its presence in other parts of Serbia (except the province of Kosovo and Vlasina plateau) and to reevaluate its threatened status.

Populations of the near threatened plant species *C. serotinus* are recorded at only a few sites in Serbia, mainly in the valleys of the great lowland rivers including the Danube, Drina and Južna Morava.

A recently recorded species in Serbia, *C. odoratus* spreads quickly on gravelly and sandy substrates along the Danube and Sava rivers, by forming a mixed community with the autochthonous macrophyte species. It is considered important to monitor its populations due to its huge potential to inhabit new pitches.

Based on literature data and field experience, the authors consider that *T. laxmanii* has wider distribution in Serbia than currently known. Its habitats are insufficiently researched, especially south of Vojvodina province, so additional field investigations are needed in order to adequately estimate its threatened status.

During the 21st century, the amount of chorological data on the strictly protected species, *T. shuttleworthii*, has significantly increased, so its threatened status has changed from critically endangered to endangered in Serbian flora. Collecting data on its distribution and population size is important, not only for reevaluating its threatened status at a national level, but also for globally estimating the category of its vulnerability.

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