

A proposal for updating the list of invasive alien plant species in Bosnia and Herzegovina

Semir Maslo

Primary School, Lundåkerskolan, Södra Storgatan 45, 332 33 Gislaved, Sweden;
semmas@edu.gislaved.se

Received: September 24, 2023 ▷ Accepted: December 07, 2023

Abstract. An updated inventory of the invasive flora of Bosnia and Herzegovina is presented. The checklist includes 66 taxa (63 species, one subspecies and two hybrids), distributed between 46 genera and 28 families. The most common family is *Compositae* (20 taxa; 30.30%) and the most diverse genera are *Amaranthus* (five taxa) and *Erigeron*, with four taxa. The predominant life forms are therophytes (54.54%) and hemicryptophytes (22.73%). Most invasive alien plant species are native in the Americas (46) and Asia (14). Most taxa in the invasive alien flora of Bosnia and Herzegovina (43 taxa, 65.15%) have been introduced accidentally, 19 taxa (28.79%) have been introduced deliberately, whereas the remaining four taxa (6.06%) have been introduced in both ways: deliberately and accidentally. Five invasive alien taxa of concern to the European Union have been recorded in Bosnia and Herzegovina.

Key words: alien plants, Balkans, Bosnia and Herzegovina, invasive plants

Citation: Maslo, S. 2023. A proposal for updating the list of invasive alien plant species in Bosnia and Herzegovina. – *Phytologia Balcanica*, 29(3): 405-420 – ISSN 1310-7771 (print), 1314-0027 (online).

Introduction

Currently, there are no complete lists or analyses of alien flora in Bosnia and Herzegovina. On the other hand, 273 taxa are mentioned in the preliminary list of alien flora of Bosnia and Herzegovina. Cultivated, ornamental or forest taxa that do not show any degree of spontaneity have not been included in the list (Maslo & al. 2020).

The first preliminary checklist of the invasive flora of Bosnia and Herzegovina was published seven

years ago and included 50 species and subspecies (Maslo 2016b). However, in the last seven years, some new floristic and taxonomic data on findings of alien flora for Bosnia and Herzegovina have been announced (Maslo 2016a, 2017; Maslo & Boškailo 2017; Sarajlić & Jogan 2017; Lubarda & Topalić-Trivunović 2020). Furthermore, some invasive alien plant taxa have been recently noted as new for the country (Nobis & al. 2016; Maslo & Šarić 2016, 2019, 2020, 2021). This explains the need for updating the available preliminary list (Maslo 2016b) to summa-

rize the current state of the taxonomic knowledge of invasive alien plant species (IAPS) in Bosnia and Herzegovina.

The first mention of alien plant species, that are now considered invasive in Bosnia and Herzegovina, comes from literature published at the end of the 19th century (see Maslo 2016b), concerning *Abutilon theophrasti*, *Ailanthus altissima*, *Amaranthus retroflexus*, *Datura stramonium*, *Erigeron canadensis*, *Robinia pseudoacacia*, *Sorghum halepense*, and *Xanthium spinosum* (all noticed at the city of Mostar by Struschka 1880).

The aim of this study is to present a comprehensive analysis of the earlier literature by using an updated and coherent nomenclature supplemented by field research, in order to compile a new list of invasive plant taxa of Bosnia and Herzegovina.

Material and methods

The selection of species for the IAPS list in Bosnia and Herzegovina is primarily based on their established presence and invasiveness within the region, as determined through extensive field observations and review of floristic data. While the impact of these alien species on native biodiversity, as highlighted by Blackburn & al. (2011), was considered, the primary criteria for inclusion were their status as invasive to the region and evidence of their establishment and spread beyond initial introduction points. This approach was supplemented by reviewing historical records and recent studies that documented the presence and ecological behaviour of these species within Bosnia and Herzegovina.

In determining the invasiveness of species within Bosnia and Herzegovina, I employed a multifaceted approach. This involved assessing the species' ability to establish, spread, and sustain populations in new environments, their presence in multiple locations across the country, and their capability to reproduce without direct human intervention. Reference to the EU List of Invasive Alien Species and guidelines by Blackburn & al. (2011) provided a foundational

framework. For species like *Commelina communis*, classified as invasive despite the absence of evident impacts, their potential based on behaviour in similar ecological regions was considered. Moving forward, a more critical reassessment will be applied, particularly for species with limited spread and impact, such as *Heracleum mantegazzianum* and *Impatiens parviflora*. This reassessment will prioritize current distribution, ecological adaptability, and comparative impacts in analogous environments to ensure an accurate representation of invasive species within Bosnia and Herzegovina's ecosystems.

Floristic data were obtained in the period from 2016 to 2023. Plant names followed the Euro+Med Check List (Euro+Med PlantBase 2006+, <http://ww2.bgbm.org/EuroPlusMed/query.asp>). The taxon *Reynoutria × bohemica* Chrtek & Chrtková was missing from the above database; therefore, it was listed under Plants of the World Online (POWO 2022), marked with an asterisk in Table 1.

In the list of invasive alien flora (Table 1), the taxa were listed in alphabetical order, followed by life form, mode of introduction, native range, and first record/author. Concerning the biological forms, Raunkiaer's lifeform classification (Raunkiaer 1934) was applied, while data on the origin of areas of the various taxa were taken mostly from the available literature (see References). Modes (pathways) in which the species were introduced into the area have been arranged according to Pyšek & al. (2012) and marked by the following abbreviations: del – deliberate (by planting) and acc – accidental.

Distribution of the taxa in Bosnia and Herzegovina was presented in the map on standard UTM grid 10 × 10 km (Fig. 2; Fig. 4). Geocoded findings originated from three sources: literature, herbarium collection (SARA, abbreviations according to Thiers 2023+), and field observations carried out from 2016 to 2023. Digital photographs were taken in the field (Figs. 1 & 3). The invasiveness status was determined using the terminology according to Blackburn & al. (2011).

The status of the invasive alien plant taxa from the List of Invasive Alien Species of EU, present in BiH, was also discussed (CIR 2016, 2017, 2019).

Results and discussion

The proposed updated list of IAPS in Bosnia and Herzegovina comprises 66 taxa presented in Table 1. Floristic research over the last decade (or seven years) has generated data on 18 invasive alien taxa new to Bosnia and Herzegovina. The checklist presented here contains 18 more taxa, added on the basis of later field observations than in the previous list of IAS published by Maslo (2016b). These added taxa are: *Amaranthus albus*, *A. blitoides*, *A. deflexus*, *A. hybridus*, *Buddleja davidii*, *Ceratochloa cathartica*, *Commelina communis*, *Erigeron sumatrensis*, *Euphorbia nutans*, *Heracleum mantegazzianum*, *Impatiens balfourii*, *I. parviflora*, *Oenothera glazioviana*, *Panicum dichotomiflorum*, *Paspalum dilatatum*, *Reynoutria × bohemica*, *Senecio inaequidens*, and *Sporobolus vaginiflorus*. On the other hand, two taxa (*Solanum elaeagnifolium* Cav. and *Tagetes minuta* L.) have been removed from the pre-

liminary list, since it was impossible to confirm their presence in Bosnia and Herzegovina during the latest field surveys.

In recent times, it has also been shown that some alien woody species have naturalized very successfully in Bosnia and Herzegovina and show characteristics close to invasive species and are potential candidates for this list (e.g. *Acer saccharinum* L., *Fraxinus pennsylvanica* Marshal and *Morus alba* L., which are mostly recorded in the Posavina region (Š. Šarić, pers. comm. 2023). Given that there is no data in the current literature on the known distribution of these species, and that there is currently no systematic monitoring of the introduction of alien species and monitoring of their eventual invasiveness in Bosnia and Herzegovina, these species should be regarded as potentially invasive species in Bosnia and Herzegovina for the time being. Therefore, this list of invasives should be viewed as dynamic and subject to change.

Table 1. An updated checklist of invasive alien plant species (IAPS) in Bosnia and Herzegovina

Note: The proposed new invasive plant species are marked in bold. Abbreviations: Life forms - Ch-Chamaephyte, G-Geophyte, He-Hemicryptophyte, Hy-Hydrophyte, Ph-Phanerophyte, T-Therophyte; Mode of introduction: Acc-Accidental, Del-Deliberate, Del-Acc-both ways.

Taxa	Family	Life form	Mode of introd.	Native range	1st record/ author
<i>Abutilon theophrasti</i> Medik.	Malvaceae	T	Acc	Asia	see Maslo 2016b
<i>Acer negundo</i> L.	Sapindaceae	Ph	Del	America	see Maslo 2016b
<i>Ailanthus altissima</i> (Mill.) Swingle	Simaroubaceae	Ph	Del	Asia	see Maslo 2016b
<i>Amaranthus albus</i> L.	Amaranthaceae	T	Acc	America	Malý 1919
<i>Amaranthus blitoides</i> S. Watson	Amaranthaceae	T	Acc	America	Slavnić 1960
<i>Amaranthus deflexus</i> L.	Amaranthaceae	He	Acc	America	Murbeck 1891
<i>Amaranthus hybridus</i> L.	Amaranthaceae	T	Acc	America	Pichler 1898 /99
<i>Amaranthus retroflexus</i> L.	Amaranthaceae	T	Acc	America	see Maslo 2016b
<i>Ambrosia artemisiifolia</i> L.	Compositae	T	Acc	America	see Maslo 2016b
<i>Amorpha fruticosa</i> L.	Fabaceae	Ph	Del	America	see Maslo 2016b
<i>Artemisia annua</i> L.	Compositae	T	Del-Acc	Asia	see Maslo 2016b
<i>Artemisia verlotiorum</i> Lamotte	Compositae	He	Acc	Asia	see Maslo 2016b

Taxa	Family	Life form	Mode of introd.	Native range	1st record/ author
<i>Asclepias syriaca</i> L.	Apocynaceae	He	Acc	America	see Maslo 2016b
<i>Bidens frondosus</i> L.	Compositae	T	Acc	America	see Maslo 2016b
<i>Bidens subalternans</i> DC.	Compositae	T	Acc	America	see Maslo 2016b
<i>Broussonetia papyrifera</i> (L.) Vent.	Moraceae	Ph	Del	Asia	see Maslo 2016b
<i>Buddleja davidii</i> Franch.	Scrophulariaceae	Ph	Del	Asia	Maslo 2015
<i>Ceratochloa cathartica</i> (Vahl) Herter	Poaceae	He	Del-Acc	America	Maslo 2012
<i>Commelina communis</i> L.	Commelinaceae	T	Del	Asia	Maslo 2014
<i>Cuscuta campestris</i> Yunck.	Convolvulaceae	T	Acc	America	see Maslo 2016b
<i>Datura stramonium</i> L.	Solanaceae	T	Acc	America	see Maslo 2016b
<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants	Chenopodiaceae	T	Acc	America	see Maslo 2016b
<i>Echinocystis lobata</i> (Michx.) Torr. & A. Gray	Cucurbitaceae	T	Acc	America	see Maslo 2016b
<i>Eleusine indica</i> (L.) Gaertn.	Poaceae	T	Acc	Africa	see Maslo 2016b
<i>Elodea canadensis</i> Michx.	Hydrocharitaceae	Hy	Acc	America	see Maslo 2016b
<i>Erigeron annuus</i> (L.) Desf.	Compositae	T	Acc	America	see Maslo 2016b
<i>Erigeron bonariensis</i> L.	Compositae	T	Acc	America	see Maslo 2016b
<i>Erigeron canadensis</i> L.	Compositae	T	Acc	America	see Maslo 2016b
<i>Erigeron sumatrensis</i> Retz.	Compositae	T	Acc	America	Milanović 2019
<i>Euphorbia maculata</i> L.	Euphorbiaceae	T	Acc	America	see Maslo 2016b
<i>Euphorbia nutans</i> Lag.	Euphorbiaceae	T	Acc	America	Malý 1899
<i>Euphorbia prostrata</i> Aiton	Euphorbiaceae	T	Acc	America	see Maslo 2016b
<i>Galinsoga parviflora</i> Cav.	Compositae	T	Acc	America	see Maslo 2016b
<i>Galinsoga quadriradiata</i> Ruiz & Pav.	Compositae	T	Acc	America	see Maslo 2016b
<i>Helianthus tuberosus</i> L.	Compositae	He	Del	America	see Maslo 2016b
<i>Heracleum mantegazzianum</i> Sommier & Levier	Apiaceae	He	Acc	Europe	Maslo 2010
<i>Impatiens balfourii</i> Hook. f.	Balsaminaceae	T	Del	Asia	Bucalo & al. 2007
<i>Impatiens glandulifera</i> Royle	Balsaminaceae	T	Del	Asia	see Maslo 2016b
<i>Impatiens parviflora</i> DC.	Balsaminaceae	T	Acc	Asia	Maslo & Šarić 2019

Taxa	Family	Life form	Mode of introd.	Native range	1st record/ author
<i>Juncus tenuis</i> Willd.	Juncaceae	He	Acc	America	see Maslo 2016b
<i>Lepidium virginicum</i> L.	Brassicaceae	T	Acc	America	see Maslo 2016b
<i>Matricaria discoidea</i> DC.	Compositae	T	Acc	America	see Maslo 2016b
<i>Oenothera biennis</i> L.	Onagraceae	He	Del	America	see Maslo 2016b
<i>Oenothera glazioviana</i> Micheli	Onagraceae	He	Del	Garden / Hybrid	Maslo 2016a
<i>Opuntia humifusa</i> (Raf.) Raf.	Cactaceae	Ch	Del	America	see Maslo 2016b
<i>Panicum capillare</i> L.	Poaceae	T	Acc	America	see Maslo 2016b
<i>Panicum dichotomiflorum</i> Michx	Poaceae	T	Acc	America	Maslo & Šarić 2016
<i>Parthenocissus quinquefolia</i> (L.) Planch.	Vitaceae	Ph	Del	America	see Maslo 2016b
<i>Paspalum dilatatum</i> Poir.	Poaceae	He	Acc	America	Maslo 2014
<i>Paspalum distichum</i> L.	Poaceae	He	Acc	America	see Maslo 2016b
<i>Phytolacca americana</i> L.	Phytolaccaceae	G	Del-Acc	America	see Maslo 2016b
<i>Potentilla indica</i> (Jacks.) Th. Wolf	Rosaceae	He	Acc	Asia	see Maslo 2016b
<i>Pueraria montana</i> var. <i>lobata</i> (Willd.) Sanjappa & Pradeep	Fabaceae	Ph	Del	Asia	see Maslo 2016b
<i>Reynoutria japonica</i> Houtt.	Polygonaceae	G	Del	Asia	see Maslo 2016b
*<i>Reynoutria</i> × <i>bohemica</i> Chrték & Chrtková	Polygonaceae	G	Del-Acc	Hybrid	Jovanović & al. 2018
<i>Robinia pseudoacacia</i> L.	Fabaceae	Ph	Del	America	see Maslo 2016b
<i>Rudbeckia laciniata</i> L.	Compositae	He	Del	America	see Maslo 2016b
<i>Senecio inaequidens</i> DC.	Compositae	Ch	Acc	Africa	Maslo 2014
<i>Solidago canadensis</i> L.	Compositae	He	Del	America	see Maslo 2016b
<i>Solidago gigantea</i> Aiton	Compositae	He	Del	America	see Maslo 2016b
<i>Sorghum halepense</i> (L.) Pers.	Poaceae	G	Acc	Mediterranean	see Maslo 2016b
<i>Sporobolus vaginiflorus</i> (A. Gray) A.W. Wood	Poaceae	T	Acc	America	Nobis & al. 2016
<i>Symphotrichum squamatum</i> (Spreng.) G.L. Nesom	Compositae	T	Acc	America	see Maslo 2016b
<i>Veronica persica</i> Poir.	Plantaginaceae	T	Acc	Asia	see Maslo 2016b
<i>Xanthium orientale</i> subsp. <i>italicum</i> (Moretti) Greuter	Compositae	T	Acc	America	see Maslo 2016b
<i>Xanthium spinosum</i> L.	Compositae	T	Acc	America	see Maslo 2016b

Concise descriptions of the invasive alien taxa proposed for inclusion in the list and their occurrence are listed below in alphabetical order.

1. *Amaranthus albus* L., Syst. Nat., ed. 10. 2: 1268. 1759 (Fig. 1, a)

Habitat and elevation: ruderal habitats of railway stations, rail tracks, roads, and arable land at 20–640 m a.s.l.

Alien status: Neophyte species native to North America, it can be considered invasive in Bosnia and Herzegovina. Nevertheless, no evident impact has been observed, except in some cases (cultivated fields), in which *A. albus* forms large populations that could provoke a decrease in crop efficiency (economic impact).

Occurrence in Bosnia and Herzegovina: The first records of that species on the territory of Bosnia and Herzegovina were reported for the city of Sarajevo (Malý 1919). Currently known distribution was estimated by means of 28 grid-cell quadrants in BiH (Fig. 2).

2. *Amaranthus blitoides* S. Watson, in Proc. Amer. Acad. Arts 12: 273. 1877 (Fig. 1, b)

Habitat and elevation: ruderal habitats of railway stations, rail tracks, roads, and arable land at 40–600 m a.s.l.

Alien status: Neophyte species native to North America, it can be considered invasive in Bosnia and Herzegovina for threatening the cultivated field crops with loss of crop efficiency (economic impact), and decreasing floristic richness in the urban ecosystems, where *A. blitoides* forms mono- or pauci-specific communities (ecological impact).

Occurrence in Bosnia and Herzegovina: The first records of that species on the territory of Bosnia and Herzegovina were reported for the city of Sarajevo (Slavnić 1960). The currently known distribution was estimated by means of 37 grid-cell quadrants in BiH (Fig. 2).

3. *Amaranthus deflexus* L., Mant. Pl.: 295. 1771 = *Euxolus deflexus* (L.) Raf., Fl. Tellur. 3: 42. 1837 = *Albersia deflexa* (L.) Fourr., Ann. Soc. Linn. Lyon, n.s., 17: 142. 1869 (Fig. 1, c)

Habitat and elevation: along local roads, pave-

ments, asphalted and concrete-clad areas, at the foot of walls, in uncultivated land, flowerbeds and ruderal habitats in the settlements, at 5–300 m a.s.l.

Alien status: Neophyte species native to South America, it can be considered naturalized in Bosnia and Herzegovina. However, no evident impact has been observed, except in some cases (coastal area of Herzegovina), where *A. deflexus* forms mono- or pauci-specific communities, which reduce the floristic richness of the area.

Occurrence in Bosnia and Herzegovina: The first records of that species on the territory of Bosnia and Herzegovina were reported for the city of Mostar (Murbeck 1891). The currently known distribution was estimated by means of 18 grid-cell quadrants in BiH (Fig. 2).

4. *Amaranthus hybridus* L., Sp. Pl. 2: 990. 1753. = *Amaranthus patulus* Bertol., Comm. Itin. Neapol. 19. 1837 (Fig. 1, d)

Habitat and elevation: ruderal habitats of railway stations, rail tracks, roads, and arable land, as weed in fields and gardens, at 20–700 m a.s.l.

Alien status: Neophyte species native to the tropical areas of North and Central America, it can be considered invasive in Bosnia and Herzegovina, threatening the cultivated fields by loss of crop efficiency (economic impact) and decreasing floristic richness in the urban ecosystems (ecological impact).

Occurrence in Bosnia and Herzegovina: The first records of that species on the territory of Bosnia and Herzegovina were reported for the city of Mostar (Pichler 1898/9). The currently known distribution was estimated by means of 33 grid-cell quadrants in BiH (Fig. 2).

5. *Buddleja davidii* Franch., in Nouv. Arch. Mus. Hist. Nat. Paris ser. 2, 10: 65. 1887 = *Buddleja variabilis* Hemsl., J. Linn. Soc., Bot. 26: 120. 1889 (Fig. 1, e)

Habitat and elevation: disturbed areas, roadsides, building-site rubble, riverbanks, edge of forests, at 20–700 m a.s.l.

Alien status: Neophyte species native to China, it can be considered invasive in Bosnia and Herzegovina for threatening the native ecosystems and decreasing floristic richness in the urban ecosystems (ecological impact).

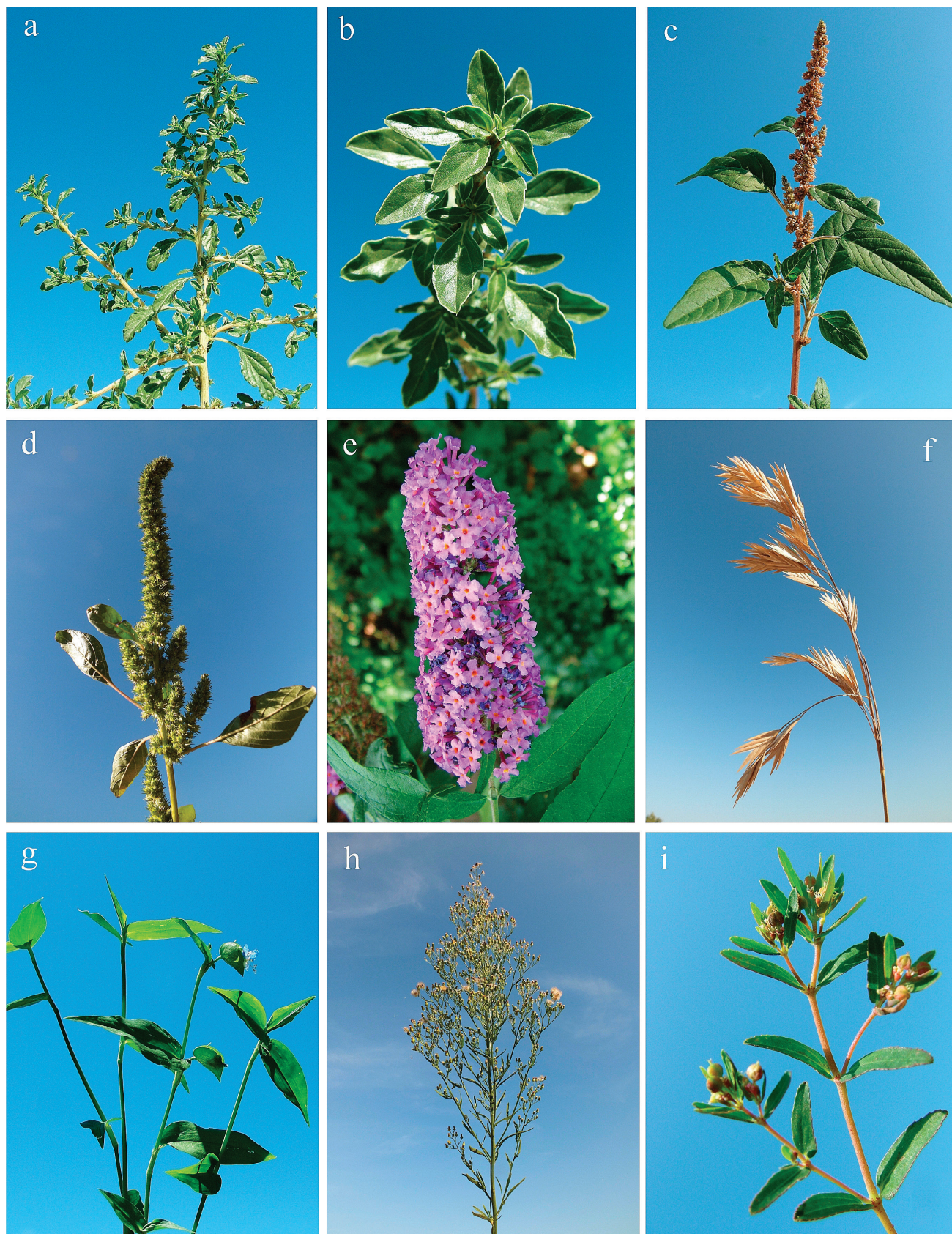
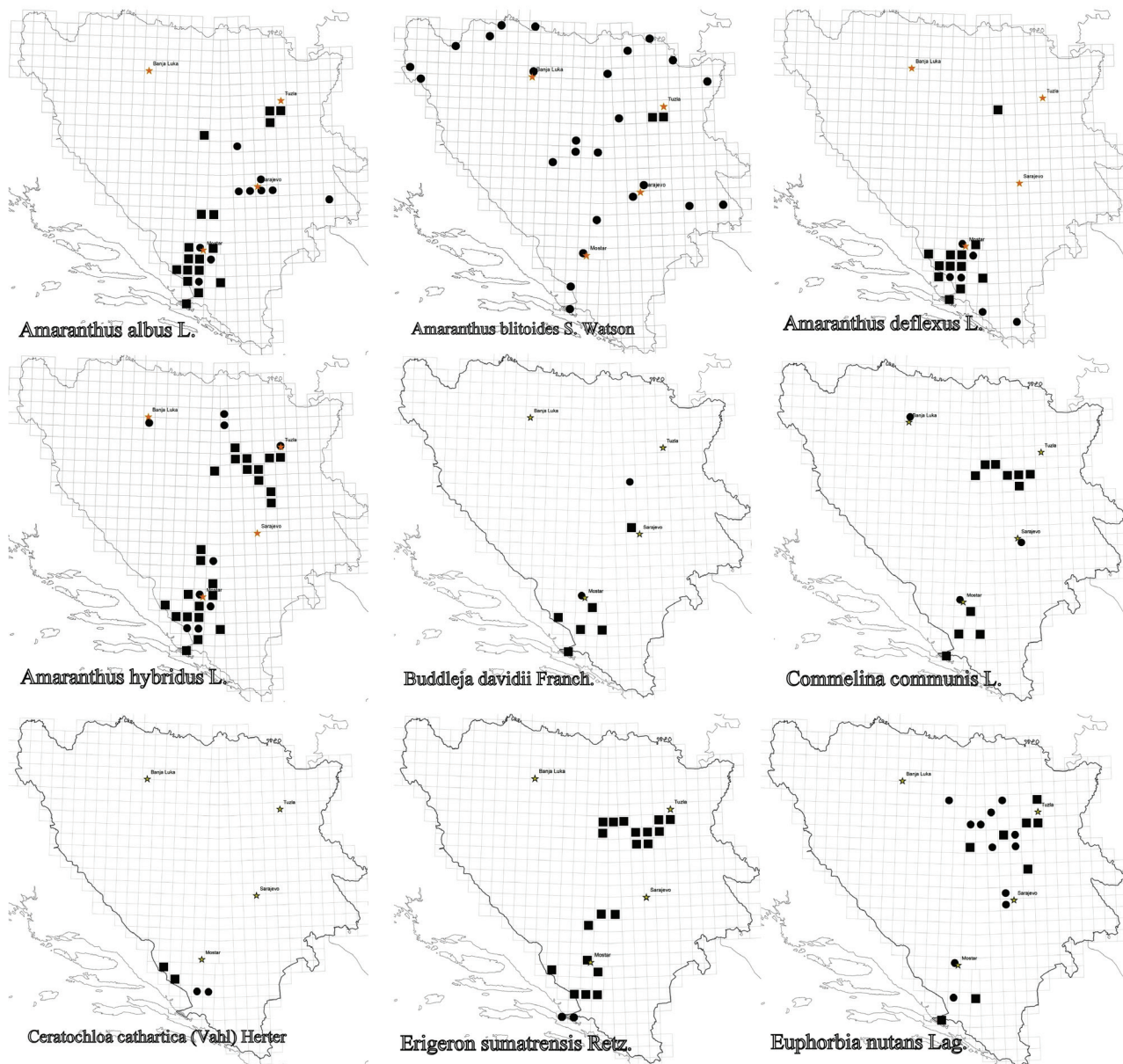


Fig. 1. Some new invasive plants in the flora of BiH: **a**, *Amaranthus albus*; **b**, *A. blitoides*; **c**, *A. deflexus*; **d**, *A. hybridus*; **e**, *Buddleja davidii*; **f**, *Ceratochloa cathartica*; **g**, *Commelina communis*; **h**, *Erigeron sumatrensis*; **i**, *Euphorbia nutans* (photos: S. Maslo).

Fig. 2. Currently known distribution of some new invasive plants in the flora of BiH (old records are indicated by dots, and new by squares).



Occurrence in Bosnia and Herzegovina: The first records of that species on the territory of Bosnia and Herzegovina were reported for the city of Mostar (Maslo 2015). The currently known distribution was estimated by means of eight grid-cell quadrants in BiH (Fig. 2).

6. *Ceratochloa cathartica* (Vahl) Herter, in *Revista Sudamer. Bot.* 6: 144. 1940 \equiv *Bromus catharticus* Vahl, *Symb. Bot.* 2: 22. 1791 (Fig. 1, f)

Habitat and elevation: along local roads, in dis-

turbed soil, gardens and orchards, at 5–50 m a.s.l.

Alien status: Neophyte species native to South America, it can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed, except in some cases, where *C. cathartica* forms mono- or pauci-specific communities, which affect the floristic richness of the area.

Occurrence in Bosnia and Herzegovina: it was discovered in 2005 in the area of Hutovo Blato and was published as a new species for the flora of the country

(Maslo 2012). It was found only in the Mediterranean part of the country and has been currently known only from four grid-cell quadrants in Bosnia and Herzegovina (Fig. 2).

7. *Commelina communis* L., Sp. Pl. 40. 1753 (Fig. 1, g)

Habitat and elevation: in wet areas of crop fields, orchards, ditches, and at roadsides, at 5–500 m a.s.l.

Alien status: Neophyte species native to Temperate Asia, it can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed.

Occurrence in Bosnia and Herzegovina: the first finding of that species for Bosnia and Herzegovina took place in the city of Mostar, on the left bank of Neretva River, northwards of Carinski Bridge, on periodical flood deposits with a lot of organic material (Maslo 2015). During the last seven years, this species has been recorded in about 15 new localities, inhabiting mostly ruderal habitats. The most numerous populations were recorded in Mostar in wet, ruderal places along the banks of the Neretva River, where, without any doubt, the species was dispersing freely. The currently known distribution was estimated by means of 14 grid-cell quadrants in Bosnia and Herzegovina (Fig. 2).

8. *Erigeron sumatrensis* Retz., Observ. Bot. 5: 28. 1788 ≡ *Conyza sumatrensis* (Retz.) E. Walker in J. Jap. Bot. 46: 72. 1971 (Fig. 1, h)

Habitat and elevation: along local roads, pavements, asphalted and concrete-clad areas, and in ruderal habitats within the settlements, as well on sand and gravel riverbanks, at 5–934 m a.s.l.

Alien status: Neophyte species native to South America, it can be considered invasive in Bosnia and Herzegovina for threatening the cultivated fields by loss of crop efficiency (economic impact) and decreasing floristic richness in the urban ecosystems (ecological impact). That species competes with the native plant species for nutrients, light and space.

Occurrence in Bosnia and Herzegovina: the first record of *E. sumatrensis* in Bosnia and Herzegovina date back to 2019, when it was discovered on the Klek Peninsula near Neum town in South Herzegovina (Milanović 2019). The currently known distribution was estimated by means of 22 grid-cell quadrants in

Bosnia and Herzegovina (Fig. 2).

9. *Euphorbia nutans* Lag., Gen. Sp. Pl.: 17. 1816 ≡ *Chamaesyce nutans* (Lag.) Small, Fl. S.E. U.S.: 712. 1903 (Fig. 1, i)

Habitat and elevation: on sandy and rocky soils, in waste land, along roads and railway tracks, as weed in gardens, arable land, grasslands, on sidewalks, cracks in asphalted roads, sandy areas along the rivers, at 5–500 m a.s.l.

Alien status: Neophyte species native to North and Central America, it can be considered invasive in Bosnia and Herzegovina for threatening the cultivated fields by loss of crop efficiency (economic impact) and decreasing floristic richness in the urban ecosystems (ecological impact).

Occurrence in Bosnia and Herzegovina: the first records of that species for the territory of Bosnia and Herzegovina came from the town of Žepče (Ritter-Studnička 1958). The currently known distribution has been estimated by means of 20 grid-cell quadrants in Bosnia and Herzegovina (Fig. 2).

10. *Heracleum mantegazzianum* Sommier & Levier, Gior. Bot. Ital. nov. ser. 2: 79 1895 = *Heracleum giganteum* Hornem., Hort. Bot. Hafn. Suppl.: 32. 1819 (Fig. 3, j)

Habitat and elevation: along roads and railway tracks, along rivers, at 450–550 m a.s.l.

Alien status: Neophyte species native to Caucasus, it can be considered invasive in Bosnia and Herzegovina for threatening by decrease of floristic richness in the urban ecosystems (ecological impact). The species forms dense groups and competes with the native plant species for nutrients, light and space.

Occurrence in Bosnia and Herzegovina: The first record of that species on the territory of Bosnia and Herzegovina was traced to Hadžići town, southwest of Sarajevo (Maslo 2010). Over the last seven years, the size of the population has been increasing, and two individuals were recorded along the bank of the nearby Zujevina River, which indicates that the species has gradually spread in this area. The currently known distribution has been estimated by means of two grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

11. *Impatiens balfourii* Hook. f. in Bot. Mag.: tab. 7878. 1903 (Fig. 3, k)

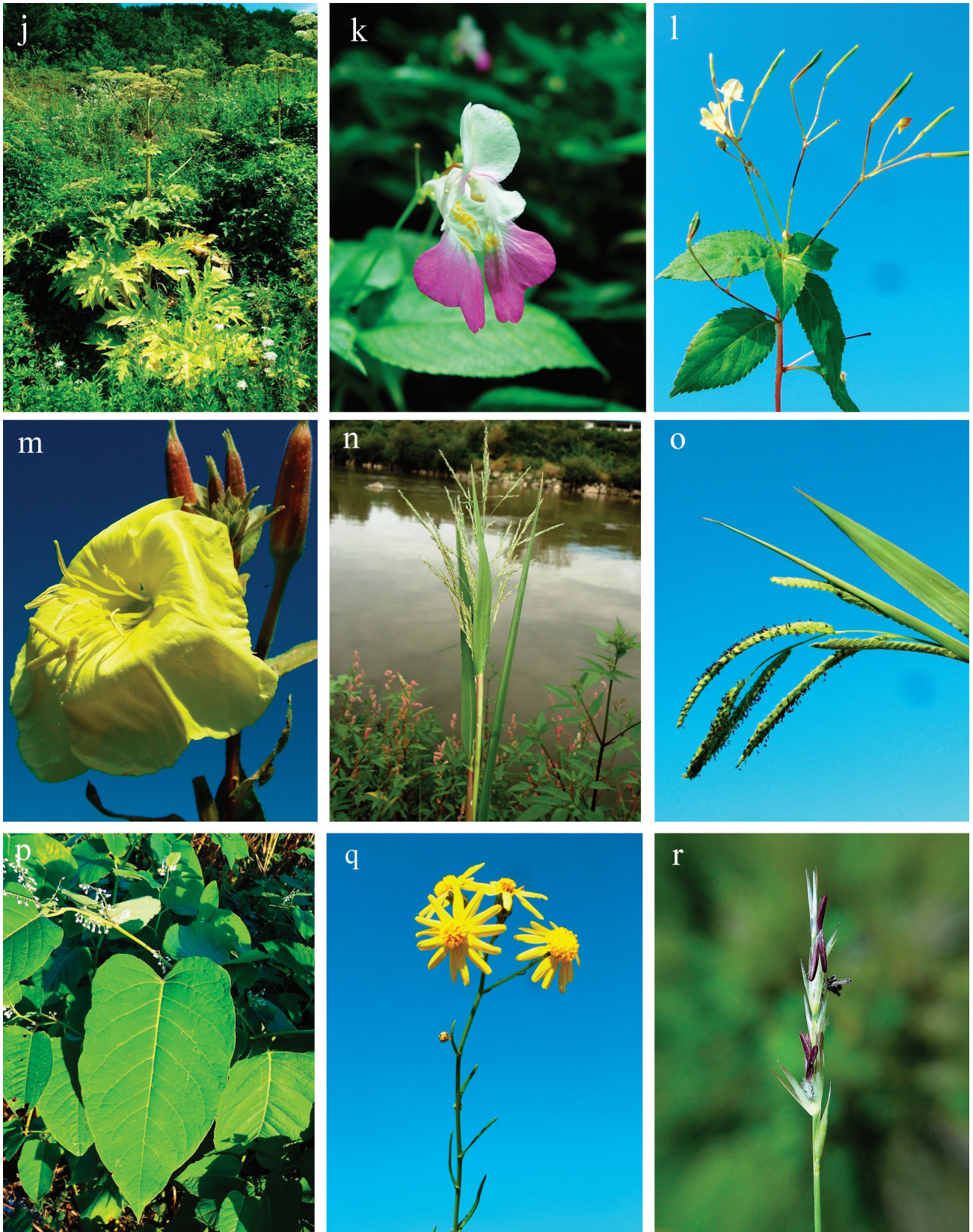
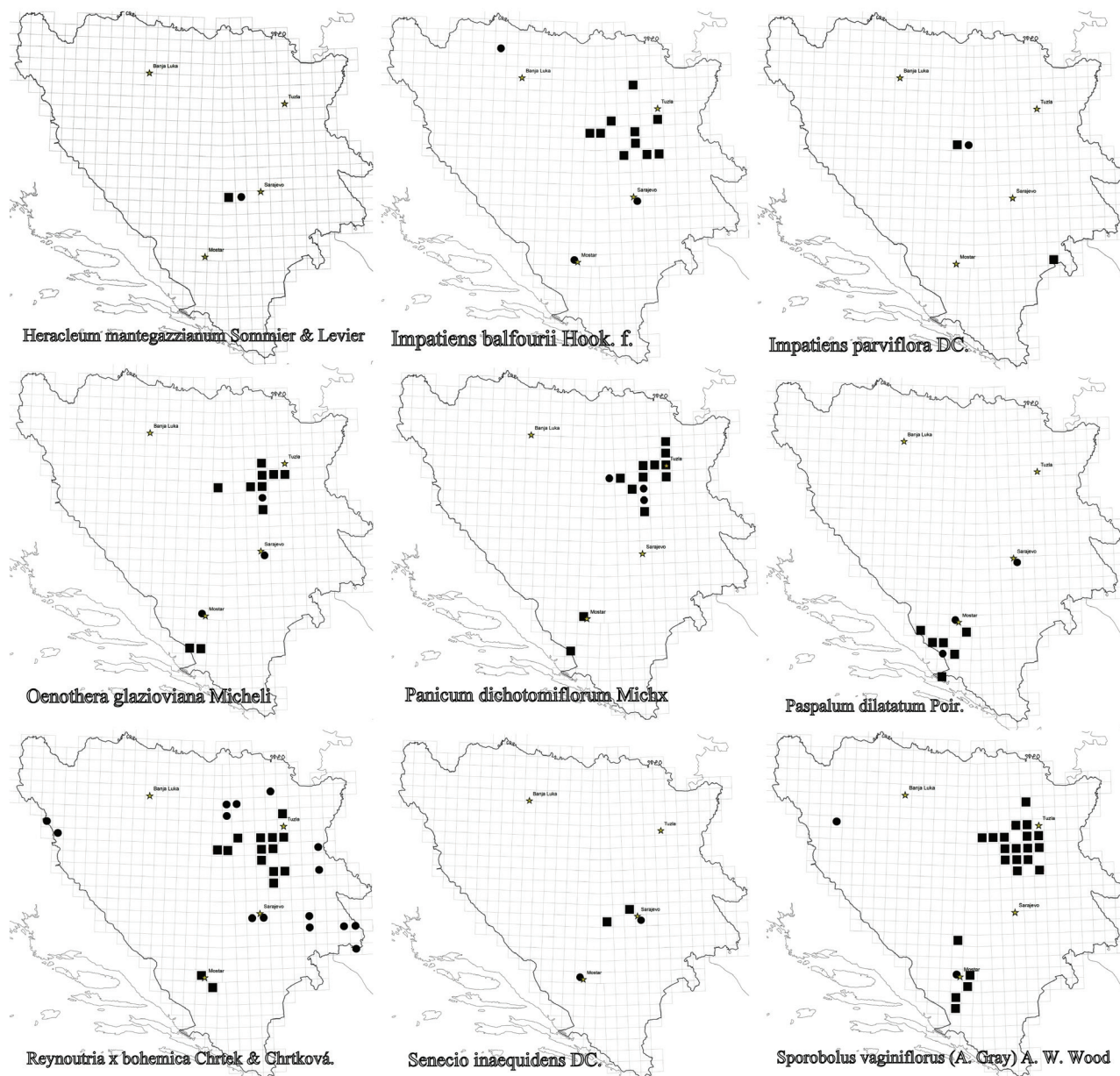


Fig. 3. Some new invasive plants in the flora of BiH: **j**, *Heracleum mantegazzianum*; **k**, *Impatiens balfourii*; **l**, *I. parviflora*; **m**, *Oenothera glazioviana*; **n**, *Panicum dichotomiflorum*; **o**, *Paspalum dilatatum*; **p**, *Reynoutria* × *bohémica*; **q**, *Senecio inaequidens*; **r**, *Sporobolus vaginiflorus* (photos: S. Maslo except photos **n**, **p** and **r** - Šemso Šarić).

Fig. 4. Currently known distribution of some new invasive plants in the flora of BiH (old records are indicated by dots, and new by squares).



Habitat and elevation: on forest margins and roadsides, riverbanks, at 50–500 m a.s.l.

Alien status: Neophyte species native to Central Asia. It can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed, except in some cases, where *I. balfourii* forms mono- or pauci-specific communities, which reduce the floristic richness of the area.

Occurrence in Bosnia and Herzegovina: It was noted for the first time for Bosnia and Herzegovina on

Mt Kozara (Bucalo & al. 2007). The currently known distribution has been estimated by means of 13 grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

12. *Impatiens parviflora* DC., Prodr. 1: 687. 1824 (Fig. 3, l)

Habitat and elevation: along railway tracks and forest edges, at 300–1000 m a.s.l.

Alien status: Neophyte species native to Central Asia. It can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been ob-

served, except in some cases, where *I. parviflora* forms mono- or pauci-specific communities, which reduce the floristic richness of the area.

Occurrence in Bosnia and Herzegovina: In Bosnia and Herzegovina the species was first discovered in 2018, near the town of Vranduk, along the Zenica-Vranduk railway line (Maslo & Šarić 2019). A huge population was recorded in this area. A few thousand individuals grow along the edges of the railway, penetrating into the nearby forest, which indicates that the species was present here long before the first recorded find in 2018. The currently known distribution has been estimated by means of three grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

13. *Oenothera glazioviana* Micheli., in Martius, Fl. Bras. 13(2): 178. 1875 = *Oenothera erythrosepala* Borbás., in Magyar Bot. Lapok 2: 245. 1903 (Fig. 3, m)

Habitat and elevation: on riverbanks, in ruderal areas, at roadsides and along rail tracks, at 20–300 m a.s.l.

Alien status: It has probably appeared in Europe as a result of hybridization or mutation and can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed.

Occurrence in Bosnia and Herzegovina: The first records of that species on the territory of Bosnia and Herzegovina came for the city of Mostar (Maslo 2016a). The currently known distribution has been estimated by means of 13 grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

14. *Panicum dichotomiflorum* Michx., Fl. Bor.-Amer. 1: 48. 1803 = *Panicum chloroticum* Nees ex Trin., Gram. Panic.: 236. 1826 (Fig. 3, n)

Habitat and elevation: along roads, in disturbed soil, along the rivers, at 5–500 m a.s.l.

Alien status: Neophyte species native to North America, it can be considered invasive in Bosnia and Herzegovina for threatening the cultivated fields by loss of crop efficiency (economic impact) and decreasing floristic richness in the urban ecosystems (ecological impact).

Occurrence in Bosnia and Herzegovina: It was discovered in 2015 on the banks of Krivaja River and was published as a new species for the flora of the country (Maslo & Šarić 2016). The currently known distribution has been estimated by means of 15 grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

15. *Paspalum dilatatum* Poir., in Lamarck, Encycl. 5: 35. 1804 = *Digitaria dilatata* (Poir.) Coste, Fl. Descr. France 3: 553. 1906 (Fig. 3, o)

Habitat and elevation: along roads, in disturbed soil, along the rivers, at 5–500 m a.s.l.

Alien status: Neophyte species native to South America, it can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed, except in some cases, where *P. dilatatum* forms mono- or pauci-specific communities reducing the floristic richness of the area.

Occurrence in Bosnia and Herzegovina: It was first recorded in the city of Mostar in 1996 (Maslo 2015). The currently known distribution has been estimated by means of 10 grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

16. *Reynoutria × bohemica* Chrtek & Chrtková, in Čas. Nár. Mus., Odd. Přír. 152: 120. 1983 = *Fallopia × bohemica* (Chrtek & Chrtková) J.P. Bailey in Watsonia 17: 443. 1989 = *Polygonum × bohemicum* (Fig. 3, p)

Habitat and elevation: in disturbed habitats along the river banks, roads or rail tracks, at 50–500 m a.s.l.

Alien status: Hybrid of *Reynoutria japonica* Houtt. and *R. sachalinensis* (F.S. Petrop.) Nakai spontaneously developed in Europe, it can be considered invasive in Bosnia and Herzegovina. It forms monodominant, dense communities along rivers, replacing the native species, and in forests, where it is regarded as a weed species and out competes the saplings due to its rapid growth (ecological impact).

Occurrence in Bosnia and Herzegovina: It was discovered in 2015 around Vlasenica and was published as a new taxon for the flora of the country (Jovanović & al. 2018). The currently known distribution has been estimated by means of 30 grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

17. *Senecio inaequidens* DC., Prodr. 6: 401. 1838 = *Senecio harveianus* MacOwan in J. Linn. Soc., Bot. 25: 388. 1890 (Fig. 3, q)

Habitat and elevation: near rail tracks and roads, at 50–500 m a.s.l.

Alien status: Neophyte species native to South Africa, it can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed.

Occurrence in Bosnia and Herzegovina: The species

was first recorded in the city of Mostar in 1996, on the rubbish dumps near the railway station, in the Pasjak Residential Quarter (Maslo 2015). The currently known distribution has been estimated by means of four grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

18. *Sporobolus vaginiflorus* (A. Gray) A.W. Wood, Class-book Bot. (ed. 1861): 775. 1861 \equiv *Vilfa vaginiflora* A. Gray, N. Amer. Gram. 1: no. 3. 1834 (Fig. 3, r)

Habitat and elevation: along main roads, on serpentine soil, as well as on sand and gravel riverbanks, at 5–1000 m a.s.l.

Alien status: Neophyte species native to North America, it can be considered invasive in Bosnia and Herzegovina. However, no evident impact has been observed, except in some cases, where *S. vaginiflorus* forms mono- or pauci-specific communities reducing the floristic richness of the area.

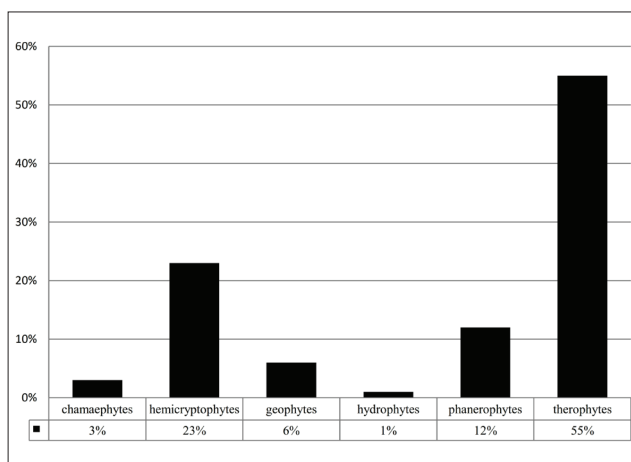
Occurrence in Bosnia and Herzegovina: The first record of *S. vaginiflorus* in Bosnia and Herzegovina dates back to 2016, when it has been discovered near Bosanski Petrovac town in Northwest Bosnia (Nobis & al. 2016). The currently known distribution has been estimated by means of 24 grid-cell quadrants in Bosnia and Herzegovina (Fig. 4).

This checklist includes 66 taxa (63 species, one subspecies and two hybrids) belonging to 28 families of angiosperms, most of which (24 families with 56 taxa) belong to Dicotyledons. Monocotyledons are represented only by four families with ten taxa (Table 1). The family with the highest number of IAPS is *Compositae* (20 taxa; 30.30%) and the most diverse genera are *Amaranthus* (5 taxa) and *Erigeron* (4 taxa). Other families with a considerable number of invasive taxa are *Poaceae* (8 taxa - 12.12%) and *Amaranthaceae* (5 taxa - 7.58%) (Table 2).

Table 2. Families most abundant in invasive alien flora of Bosnia and Herzegovina

Family	No. of taxa	% of total IAPS (66)
<i>Compositae</i>	20	30.30
<i>Poaceae</i>	8	12.12
<i>Amaranthaceae</i>	5	7.58
<i>Balsaminaceae</i>	3	4.54
<i>Euphorbiaceae</i>	3	4.54
<i>Fabaceae</i>	3	4.54

Fig. 5. Spectrum of the Raunkiaer life forms in the invasive alien flora of Bosnia and Herzegovina



The predominant life forms are therophytes (36 taxa - 54.54%), and hemicryptophytes (15 taxa - 22.73%). Only one taxon belongs to the hydrophyte (*Elodea canadensis*) (Fig. 5). Most IAPS in Bosnia and Herzegovina originate from the Americas (46 taxa - 69.70%) and Asia (14 taxa - 21.21%) (Table 3). Most taxa in the invasive alien flora of Bosnia and Herzegovina (43 taxa - 65.15%) have been introduced accidentally, 19 taxa (28.79%) have been introduced deliberately, whereas the remaining four taxa (6.06%) have been introduced in both ways, deliberately and accidentally (Table 1).

Table 3. Analysis of the geographical origin of the invasive alien flora of Bosnia and Herzegovina

Native range	No. of taxa	% of total IAPS (66)
America	46	69.70
Asia	14	21.21
Africa	2	3.03
Europe	1	1.52
Mediterranean	1	1.52
Garden origin & hybrids	2	3.03

There are five vascular plant taxa of EU concern present in Bosnia and Herzegovina: *Ailanthus altissima*, *Asclepias syriaca*, *Heracleum mantegazzianum*, *Impatiens glandulifera* and *Pueraria montana* var. *lobata*.

The greatest risk represented by IAS is in terms of threats to biodiversity, especially by the species capable of vegetative reproduction, such as *Ailanthus altissima*, *Broussonetia papyrifera*, *Pueraria montana* var. *lobata*, *Reynoutria japonica*, *R. × bohémica* and *Robinia pseudoacacia*. All these species have been recorded in several localities and have spread to the native habitats, thus, representing the greatest risk for the native plant species of Bosnia and Herzegovina. The localities of these species will need further monitoring and, whenever necessary, their spreading populations must be eradicated.

On the other hand, the annual invasive plants grow mostly in ruderal and agricultural lands, but some still invade the natural habitats and by their massive presence crowd out the natural vegetation (e.g., *Erigeron* and *Impatiens* taxa).

Besides the above-mentioned impact, some invasive alien plant taxa occasionally affect negatively human health, e.g., *Ambrosia artemisiifolia* and *Heracleum montegazzianum*.

Compared to the neighbouring countries, the number of IAPS detected in BiH is clearly higher than in Montenegro (50 taxa: Stešević & Petrović 2010), and approximately the same as in Croatia (70: Nikolić & al. 2014) and Serbia (68: Stojanović & al. 2021).

Acknowledgements. The author would like to thank Aldin Boškailo for mapping the distribution of the species in Bosnia and Herzegovina, and Lanna Maslo for improving the English language of this paper.

References

- Blackburn, T.M., Pyšek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarošík, V., Wilson, J.R. & Richardson, D.M. 2011. A proposed unified framework for biological invasions. – *Trends Ecol. Evol.*, **26**(7): 333-339.
- Bucalo, V., Brujić, J., Travar, J. & Milanović, Đ. 2007. Flora of Kozara National Park. Fac. of Forestry, Univ. of Banja Luka (in Bosnian).
- CIR. 2016. Commission implementing regulation (EU) 2016/1141 of 13 July 2016 adopting a list of invasive alien species of Union concern pursuant to Regulation (EU) No 1143/2014 of the European Parliament and of the Council. – *Off. J. EU*, **L 189**: 4-8.
- CIR. 2017. Commission implementing regulation (EU) 2017/1263 of 12 July 2017 updating the list of invasive alien species of Union concern established by Implementing Regulation (EU) 2016/1141 pursuant to Regulation (EU) No 1143/2014 of the European Parliament and of the Council. – *Off. J. EU*, **L 182**: 37.
- CIR. 2019. Commission implementing regulation (EU) 2019/1262 of 25 July 2019 amending Implementing regulation (EU) 2016/1141 to update the list of invasive alien species of Union concern. – *Off. J. EU*, **L 199**: 1-4.
- Euro+Med PlantBase. 2006+. Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity. – <http://ww2.bgbm.org/EuroPlusMed/> (accessed 17 April 2023).
- Jovanović, S., Hlavati-Širka, V.M., Lakušić, D., Jogan, N., Nikolić, T., Anastasiu, P., Vladimirov, V. & Šinžar-Sekulić, J. 2018. *Reynoutria* niche modelling and protected area prioritization for restoration and protection from invasion: A Southeast Europe case study. – *J. Nat. Conservation*, **41**: 1-15.
- Lubarda, B. & Topalić-Trivunović, Lj. 2020. Alien flora of the city of Banja Luka (Bosnia and Herzegovina). – *Nat. Croatica*, **29**(2): 217-226.

- Malý, K.** 1899. Floristische Beiträge. – Glasn. Zemaljsk. Muz. Bosni Hercegovini, **11**: 127-150 (in Bosnian).
- Malý, K.** 1919. Contributions to the flora of Bosnia and Herzegovina V, VI. – Glasn. Zemaljsk. Muz. Bosni Hercegovini, **31**: 61-94 (in Bosnian).
- Maslo, S.** 2010. Giant hogweed *Heracleum mantegazzianum* Somier & Levier – a new non-indigenous species in the flora of Bosnia and Herzegovina. – *Herbologia*, **11**(2): 17-24.
- Maslo, S.** 2012. Rescue grass *Bromus catharticus* Vahl. A new alien species in the flora of Bosnia and Herzegovina. – *Herbologia*, **13**(1): 31-36.
- Maslo, S.** 2014. The urban flora of the city of Mostar (Bosnia and Herzegovina). – *Nat. Croatica*, **23**(1): 101-145.
- Maslo, S.** 2015. Alien flora of the city of Mostar (Bosnia and Herzegovina). – *Herbologia*, **15**(2): 1-16.
- Maslo, S.** 2016a. Contribution to the flora of Bosnia and Herzegovina (New neophytes in the flora of Bosnia and Herzegovina). – Glasn. Zemaljsk. Muz. Bosne Hercegovine (PN) NS, **36**(1): 43-61.
- Maslo, S.** 2016b. Preliminary list of invasive alien plant species (IAS) in Bosnia and Herzegovina. – *Herbologia*, **16**(1): 1-14.
- Maslo, S.** 2017. Alien grasses of Bosnia and Herzegovina. – *Herbologia*, **16**(2): 1-27.
- Maslo, S. & Boškailo, A.** 2017. Vascular flora of the old town of Počitelj and its surrounding area (South Bosnia and Herzegovina). – Glasn. Zemaljsk. Muz. Bosne Hercegovine (PN) NS, **37**: 19-46.
- Maslo, S. & Šarić, Š.** 2016. Fall Panic Grass *Panicum dichotomiflorum* Michx. – A new alien species in the flora of Bosnia and Herzegovina. – *Herbologia*, **16**(1): 15-21.
- Maslo, S. & Šarić, Š.** 2019. Small balsam *Impatiens parviflora* DC. (*Balsaminaceae*): A new alien species in the flora of Bosnia and Herzegovina. – *Phytol. Balcan.*, **25**(1): 31-35.
- Maslo, S. & Šarić, Š.** 2020. *Erigeron sumatrensis* Retz. (*Compositae*), a recently recognized invasive alien species in Bosnia and Herzegovina. – *J. Croat. Bot. Soc.*, **8**(2): 88-93.
- Maslo, S. & Šarić, Š.** 2021. Invasion of *Sporobolus vaginiflorus* (*Poaceae*) in Bosnia and Herzegovina. – *Phytol. Balcan.*, **27**(3): 167-171.
- Maslo, S., Wong, L.J. & Pagad, S.** 2020. GRIIS Checklist of Introduced and Invasive Species, Bosnia and Herzegovina. Version 1.3. Invasive Species Specialist Group ISSG. Checklist dataset. – www.gbif.org (accessed on 24th Jan 2023).
- Milanović, Đ.** 2019. Novelties for the flora of Bosnia and Herzegovina from Klek Peninsula. – In: **Randelović, V. & al.** (eds), 13th Symposium on the Flora of SE Serbia and Neighboring Regions, p. 5. Dept. Biol. & Ecol., Fac. Sci. & Math., Univ. Niš.
- Murbeck, S.** 1891. Beiträge zur Kenntnis der Flora von Sudbosnien und der Hercegovina. – *Lunds Univ. Årssk.*, **27**: 1-182.
- Nikolić, T., Mitić, B. & Boršić, I.** 2014. Flora of Croatia: Invasive Plants. Alfa d.d., Zagreb (in Croatian).
- Nobis, M., Nowak, A., Piwowarczyk, R., Ebel, A.L., Király, G., Kushunina, M., Sukhorukov, A.P., Chernova, O.D., Kipriyanova, L.M., Paszko, B., Seregin, A.P., Zelewska-Galosz, J., Denysenko, M., Nejfald, P., Stebel, A. & Gudkova, P.D.** 2016. Contribution to the flora of Asian and European countries: new national and regional vascular plant records, 5. – *Bot. Lett.*, **163**(2): 159-74.
- Pichler, A.** 1898/9. Pictures from the Flora of Mostar. The Fifth Annual Report of the Large Upper Secondary School in Mostar (in Bosnian).
- POWO.** 2022. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew, <http://www.plantsoftheworldonline.org/> (accessed 17 April 2023)
- Pyšek, P., Danihelka, J., Sádlo, J., Chrtek, J. Jr., Chytrý, M., Jarošík, V., Kaplan, Z., Krahulec, F., Moravcová, L., Pergl, J., Štajerová, K. & Tichý, L.** 2012. Catalogue of alien plants of the Czech Republic (2nd edition): checklist update, taxonomic diversity and invasion patterns. – *Preslia*, **84**: 155-255.
- Raunkiaer, C.** 1934. The Life Forms of Plants and Statistical Plant Geography. Clarendon Press, Oxford.
- Ritter-Studnička, H.** 1958. Contributions to the flora of Bosnia and Herzegovina III. – *God. Biol. Inst. Univ. Sarajevu*, **11**(1-2): 95-122 (in Bosnian).
- Sarajlić, N. & Jogan, N.** 2017. Alien flora of the city of Sarajevo (Bosnia and Herzegovina). – *Biol. Nyssana*, **8**(2): 129-136.
- Slavnić, Ž.** 1960. Ueber die Einwanderung, Verbreitung und Einbürgerung einiger Adventivpflanzen i Bosnien und Herzegovina. – *God. Biol. Inst. Univ. Sarajevu*, **13**(1-2): 117-146 (in Bosnian).
- Stešević, D. & Petrović, D.** 2010. Preliminary list of plant invaders in Montenegro. – *Biol. Nyssana*, **1**(1-2): 35-42.
- Stojanović, V., Bjedov, I., Jovanović, I., Jelić, I., Nešić, M., Obratov, D. & Nedeljković, D.** 2021. Selected Invasive Alien Species in the Flora of Serbia – material for the creation of national regulations on preventing the introduction and spread of invasive alien species and their management. Zavod Za Zaštitu Prirode Srbije, Beograd (in Serbian).
- Struschka, H.** 1880. Die umgebung Mostars, eine geographisch-naturwissenschaftliche Studie (Jahresb. k. k. Staats-Gymnas., 1880), Kremsier.
- Thiers, B.** 2023+. Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff. New York Bot. Gard., New York. Retrieved from <http://sweetgum.nybg.org/science/ih>

