

Vascular aquatic macrophytes of Hutovo Blato Nature Park (Bosnia and Herzegovina)

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Abstract: A detailed study of aquatic macrophytes in the area of Nature Park Hutovo Blato was made during the vegetation seasons from 1998 to 2020. In total, 172 plant taxa from 44 families were presented in the list, out of which 16 are newly discovered, where the presence of 10 previously reported taxa was not confirmed. The families with the highest number of taxa were Cyperaceae with 26 taxa (15.12%), followed by Poaceae (15 taxa, 8.82%). The predominant life forms are eucochlorophytes and uliginosophytes with 30 and 28 taxa respectively (17.44% and 16.28%). The chorological spectrum shows a strong prevalence of widespread plants (63 taxa; 36.63%).

Keywords: biodiversity, Mediterranean, vascular plants, wetlands

INTRODUCTION

The Hutovo Blato wetland is situated 20 km inland from the Adriatic Sea in southern Bosnia and Herzegovina. This area was classified as a Nature Park in 1995. It was listed in the Ramsar Convention as an internationally protected wetland in 2001. The total area of Hutovo Blato Park covers 74 km².

Hutovo Blato is partially crypto-depressing, topographically situated on the left bank of the river Neretva, about 5 km southeast of the town of Čapljina. Except on the NW side, the area is completely closed off with karst-mountains. With a limestone ridge called Ostrvo, which descends gradually from the point of Budisavina towards the northwest up to the river Krupa, Hutovo Blato is divided into two morphological units, which in recent times do not have a hydrographic functional connection. Gornje Blato is still a natural morphological unit, but since 1973 due to a manmade dam, Donje or Svitavsko Blato has been turned into Svitavsko Lake. Gornje Blato has retained its natural features and it consists of five separate lakes, namely: Deransko, Škrka, Jelim, Drijen, and Orah (Fig. 1). They are connected by canals and the river Krupa. The river Krupa also drains the hydrological system of Hutovo Blato into the river Neretva (Spahić, 1986).

The geology consists mostly of Cretaceous limestone and Eocene flysh (Hrvatović, 2006). According to Slišković et al. (1962), Eocene flysh occurs only in a narrow zone between

Cretaceous limestones, particularly in the area of Donje Blato. The climate is subMediterranean, with short mild winters with abundant rainfall and long hot summers. With its geographic location and great openness toward the Neretva valley and the sea, the aquatic complex and its surroundings have very prominent Mediterranean influences. The mean annual temperature is 14.6°C (data for the nearest station of Ljubuški for the period 1971-2000, recorded by the Federal Hydrometeorological Institute of the Bosnia and Herzegovina. The average annual rainfall is 1333 mm. The driest month is July with 41 mm of rainfall. With an average of 185 mm, the most precipitation falls in December. The warmest month of the year is July, with an average monthly temperature above 23°C. January has the lowest average temperature of the year, around or above 5°C. The two principal types of ecosystems predominate in the park, the aquatic (60% of the total surface area of the park) and the terrestrial (Jasprica & Carić, 2002). (Fig. 1)

Information about the plant life of Hutovo Blato can be gathered from different works on the topic (Bajić, 1954, 1977; Riter-Studnička, 1975; Bajić & Riter-Studnička, 1978; Lakušić et al., 1982; Bjelčić, 1985, 1988; Lovrić & Rac, 1988; Jasprica & Carić, 2002; Jasprica & Buntić, 2003; Jasprica et al., 2003; Šilić, 2006; Jasprica, 2007, 2009; Hafner et al., 2013; Maslo, 2014). Although there is no published systematic checklist of the vascular flora of the Hutovo Blato Nature Park, according to



Figure 1. Location of the researched area. 1. Škrka 2. Jelim 3. Drijen 4. Orah 5. Deransko and 6. Svitavsko Lake, 7. Krupa River (map by Spahić 1986)

all acquired literature data (see References), and my own field observations, the preliminary list of the vascular flora of Hutovo Blato consists of 793 taxa.

According to Jasprica (2009), the Hutovo Blato aquatic vegetation consists of three ecologically distinguishable vegetation types:

- Free-floating communities that cover the surface of stagnant waters and the edges of poorly flowing streams (Lemnetea).
- The submerged plants and plants rooted in the bottom, the vegetational organs of which develop near or at the water surface (Potametea).
- Helophytic marshes, the park's dominant vegetation (*Phragmites australis*-*Caricetea elatae*).

In total, 45 plant communities (associations) within 16 vegetation classes were documented in the park (Jasprica, 2009).

MATERIALS AND METHODS

Aquatic macrophytes are aquatic photosynthetic organisms, large enough to be seen with the naked eye, that actively grow permanently or periodically submerged below, floating on, or growing up through the water surface (Chambers et al., 2007). Only vascular macrophytes (Pteridophyta and Spermatophyta) were analysed in this work (except trees and shrubs). Even plant species which occur in ephemeral waterbodies (seasonally filled and refilled waters, such as floodplains and temporary ponds) are included in this work.

This study is based on all acquired literature data and my own field investigations carried out from the spring of 1998 to the end of 2020. The nomenclature follows the Euro-Med checklist (EURO+MED, 2020).

In the list of vascular flora (Appendix 1), taxa were listed in the alphabetic order. Designations for: family, life form, chorotype, endemic/threatened status, invasion status, residence time, origin, and first records are provided. The

life-form categories follow Hejný (1957, 1971) and Hejný & Segal (1998) (Appendix 1). Data on the life-forms were taken mostly from the available literature (Hejný, 1957, 1971; Hejný & Husak, 1978; Hejný & Segal, 1998; Jasprica, 2007) (Appendix 1). The analysis of the chorological types was made according to Horvatić (1963) and Horvatić et al. (1976/1968). To indicate the degree of naturalization of a taxon, I used the terms casual, naturalized and invasive, following the definition of Richardson et al. (2000), elaborated by Pyšek et al. (2004) (Appendix 1). Archaeophytes and neophytes were differentiated depending on their introduction before or after 1492/1500 AD., respectively. Abbreviations for endangered taxa are given according to Đug et al. (2013).

RESULTS

The list of the macrophyte flora of the Nature Park Hutovo Blato contains a total of 172 taxa, which is 21.69% of the complete flora of the park (793 taxa). They are classified into 98 genera and 44 families. Families with the highest number of taxa (species and subspecies) were Cyperaceae with 26 taxa (15.12%), followed by Poaceae (15 taxa, 8.82%). The most abundant genera are *Carex* (9 taxa), *Potamogeton* (7 taxa), *Ranunculus* (7 taxa), and *Cyperus* (5 taxa) (Tab. 1). The floristic diversity of aquatic macrophytes of Hutovo Blato Nature Park is compared to that reported for the selected wetlands in Bosnia and Herzegovina (Tab. 2), (Fig. 2).

An analysis of the life forms of the flora of Hutovo Blato (Fig. 2) shows the dominance of euochtophytes with 30 (17.44%), uliginosphytes 28 taxa (16.28%), hydroochtophytes 18 taxa (10.47%), and pelocototherophytes 17 taxa (9.88%). These four groups of life forms together make up more than half of all taxa of macrophytes (54.07%) and they belong to helophytic marshes vegetation (*Phragmites australis*-*Caricetea elatae*) which is, according to Jasprica (2009), the park's dominant

Table 1. The most abundant families and genera of the vascular macrophyte flora of Hutovo Blato

Families	No. of taxa	% of total flora (172)	Genera	No. of taxa	% of total flora (172)
Cyperaceae	26	15.12	<i>Carex</i>	9	5.23
Poaceae	15	8.82	<i>Potamogeton</i>	7	4.07
Compositae	12	6.98	<i>Ranunculus</i>	7	4.07
Lamiaceae	10	5.81	<i>Cyperus</i>	5	2.91
Total	172	100.00	Total	172	100.00

Table 2. A comparison of the floristic diversity of aquatic macrophytes between Hutovo Blato Nature Park and the selected wetlands in Bosnia and Herzegovina.

Wetland	No. of taxa	Reference
HutovoBlato Nature Park	172	
Bardača	100	Kovačević (2015)
BuškoBlato	42	Šilić & Abadžić (1989)
VelikaTišina	129	Bjelčić (1954)

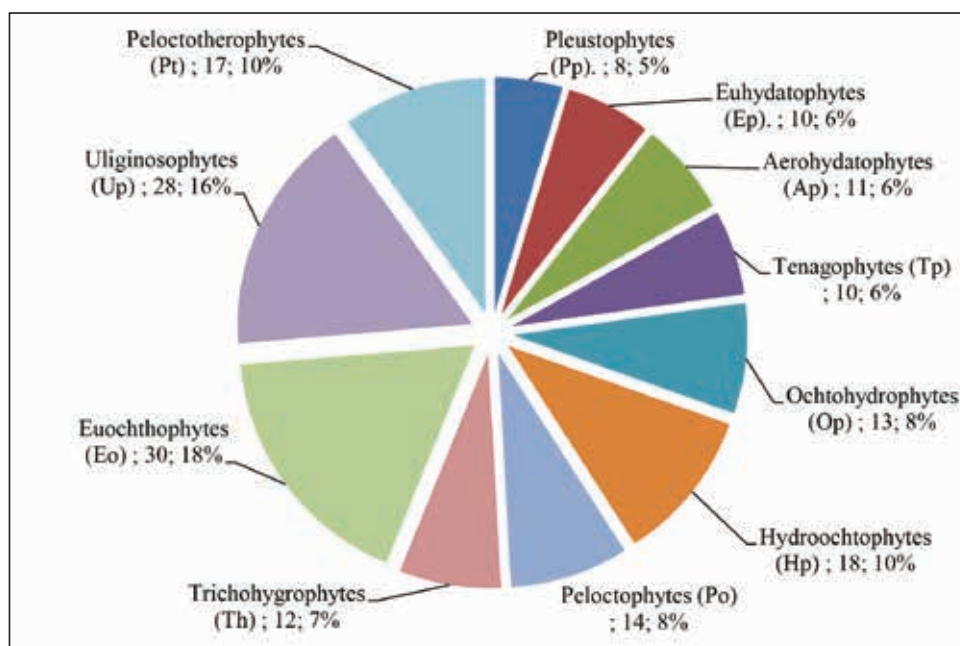


Figure 2. Life form spectrum of the macrophytes in Hutovo Blato

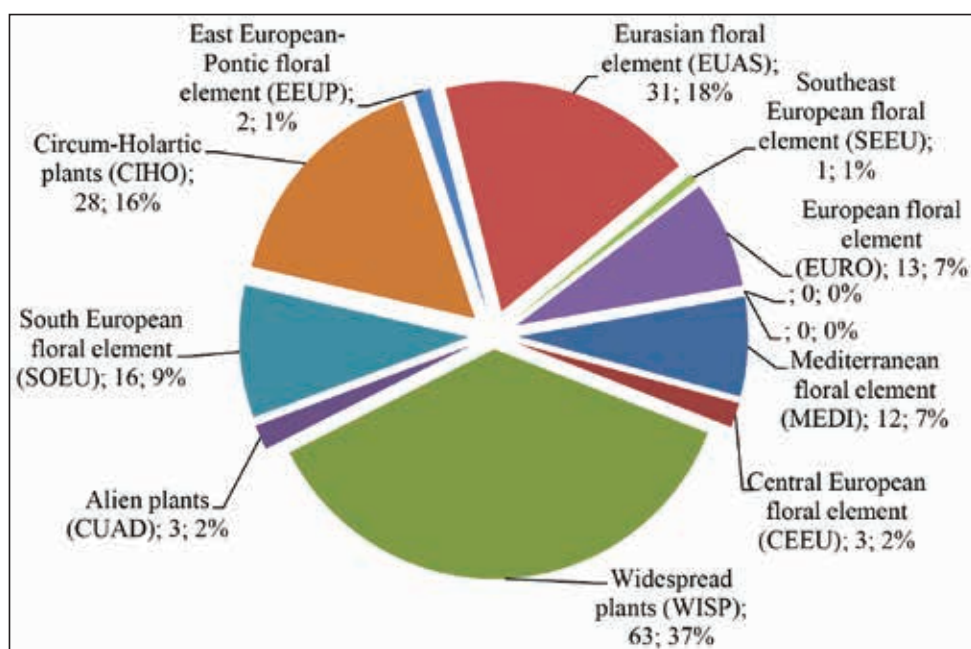


Figure 3. The chorological spectrum of the vascular macrophytes flora of Hutovo Blato

category. The least abundant life form is pleustophytes with only 8 taxa (4.65%).

In the chorological spectrum (Fig. 3), widespread plants are dominant (63 taxa; 36.63%), followed by the Eurasian floral element and Circum-Holarctic plants, 31 respective 28 taxa (18.02% and 16.28%). It is important to stress that the South-east European floral element is represented by only one species. Only three alien species were recorded in the area of the nature park (*Bidens frondosa*, *Elodea canadensis* and *Paspalum*

distichum) and all were recently included in the Preliminary list of invasive alien plant species (IAS) in Bosnia and Herzegovina (Maslo, 2016b). Only one taxon has the status of endemic plant (*Rorippa lippizensis*) and 17 taxa (9.88%) are considered to be threatened (Šilić, 1996; Đug et al. 2013), (Fig. 3).



Figure 4. Some threatened taxa of the vascular macrophytes flora of Hutovo Blato: **a.** *Baldellia ranunculoides* (L.) Parl. **b.** *Butomus umbellatus* L. **c.** *Hippuris vulgaris* L. **d.** *Hydrocharis morsus-ranae* L. **e.** *Hydrocotyle vulgaris* L. **f.** *Lathyrus palustris* L. **g.** *Ludwigia palustris* (L.) Elliott. **h.** *Nymphaea alba* L. **i.** *Utricularia australis* R.Br. (Photo: Semir Maslo).

DISCUSSION AND CONCLUSIONS

Although the flora of the Nature Park Hutovo Blato is relatively well studied, no comprehensive check-list of vascular flora has existed so far. In the researched area, a total of 793 vascular plant taxa were recorded. Even the aquatic ecosystem predominates in the park, (60% of the total surface area of the park) (Jasprica & Carić, 2002), only 172 plant taxa (21.69% of the total flora) were recognized as macrophytes.

Altogether, 16 taxa were recorded for the first time in the area: *Alisma lanceolatum*, *Alopecurus rendlei*, *Carex cuprina*, *Carex vesicaria*, *Carex vridula*, *Chaiturus marrubiastrum*, *Cirsium creticum*, *Epilobium hirsutum*, *Inula britannica*, *Lathyrus palustris*, *Mentha longifolia*, *Ranunculus circinatus*, *Rorippa lippizensis*, *Rumex aquaticus*, *Sonchus arvensis* subsp. *uliginosus*, and *Teucrium scordium* subsp. *scordioides*. Out of the 156 macrophytes previously registered for the Hutovo Blato area, 10 taxa were not confirmed by this research (*Epilobium palustre*, *Isolepis setacea*, *Jacobaea paludosa*, *Marsilea quadrifolia*, *Pulicaria vulgaris*, *Ranunculus ophioglossifolius*, *Ranunculus sceleratus*, *Sagittaria sagittifolia*, *Triglochin palustris* and *Utricularia vulgaris*). Some unconfirmed species probably exist on the researched area but were overlooked. Others probably disappeared during the last 120 years due to anthropogenic impact.

According to a proposal for the Red Book of the flora of Bosnia and Herzegovina (Šilić, 1996) and the Red list of the

flora in the Federation of Bosnia and Herzegovina (Đug et al. 2013), 42 taxa of the total flora (5.30%) are considered to be threatened in the area of Nature Park Hutovo Blato. Even the majority of endangered species are also present on rocky grasslands but 17 taxa of macrophytes belong to some threat category: 2 Critically endangered (CR) taxa: *Baldellia ranunculoides*, *Ludwigia palustris*; 1 Endangered (EN) taxon: *Hottonia palustris*; 9 Vulnerable (VU) taxa: *Hippuris vulgaris*, *Hydrocharis morsus-renae*, *Marsilea quadrifolia*, *Nuphar lutea*, *Nymphaea alba*, *Sagittaria sagittifolia*, *Thelypteris palustris*, *Utricularia vulgaris*, *Veronica anagalloides*; 1 Least concern (LC) taxon: *Butomus umbellatus*. Additionally, 4 taxa are regarded as Data deficient (DD): *Hydrocotyle vulgaris*, *Lathyrus palustris*, *Utricularia australis*, *Zannichella palustris*.

The anthropogenic influence on the biodiversity of macrophytes in the area has been highly expressed in the last 60 years. Despite major past changes in the Hutovo Blato area, as part of Nereva River Delta, it is still one of the most important areas for biodiversity conservation on the eastern Adriatic coast.

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SAŽETAK

U razdoblju između 1998. i 2020. godine izvršena su floristička istraživanja makrofita na području Parka prirode Hutovo Blato. U rezultatima su navedene ukupno 172 biljne svojte iz 44 porodice, od kojih se 17 prvi put navodi za istraženo područje, dok 10 prethodno zabilježenih svojti nije potvrđeno u ovom istraživanju. Porodice s najvećim brojem svojta su Cyperaceae (15,12%) i Poaceae (8,82%). Euhoftiti su dominantni životni oblik (17,44%) dok su biljke širokog rasprostranjenja najzastupljenije (36,63%).

Ključne riječi: bioraznolikost, Mediteran, vaskularne biljke, vodena staništa

APPENDIX 1.

Vascular aquatic macrophytes of Hutovo Blato Nature Park: taxonomy, life form, chorotype, endemic/threatened status, invasion status, residence time, origin, and first record (If the author of the first record is not cited, the species is quoted here for the first time). Legend: Pp-pleustophytes, Ep-Euhydatophytes, Ap-Aerohydatophytes, Tp-Tenagophytes, Op-Ochtohydrophytes, Hp-Hydroochtophytes, Po-Pelocotophytes,

Th-Trichohygrophytes, Eo-Euochtophytes, Up-Uliginosophytes, Pt-Pelocototherophytes; end-endemic species; CR-Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data Deficient; CAS-Casual taxa; NAT-Naturalized non-invasive taxa; INV-Invasive taxa; arc-archaeophytes, neo-neophytes; Am-N, North America.

Taxon	Family	Life-form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Agrostis stolonifera</i> L.	Poaceae	Th	CIHO					Bajić & Riter Studnička 1978
<i>Alisma lanceolatum</i> With.	Alismataceae	Hp	CIHO					
<i>Alisma plantago-aquatica</i> L.	Alismataceae	Hp	WISP					Bajić & Riter Studnička 1978
<i>Alopecurus geniculatus</i> L.	Poaceae	Eo	EUAS					Lakušić et al 1982
<i>Alopecurus rendlei</i> Eig.	Poaceae	Eo	SOEU					
<i>Althaea officinalis</i> L.	Malvaceae	Up	EEUP					Malý 1910
<i>Anacamptis laxiflora</i> (Lam.) R. M. Bateman, Pridgeon & M. W. Chase	Orchidaceae	Eo	MEDI					Jasprica & Carić 2002
<i>Anacamptis palustris</i> (Jacq.) R. M. Bateman, Pridgeon & M. W. Chase subsp. <i>palustris</i>	Orchidaceae	Eo	EURO					Jasprica & Carić 2002
<i>Atriplex prostrata</i> DC.	Chenopodiaceae	Pt	WISP					Bajić 1954
<i>Baldellia nunculoide s(L.)</i> Parl.	Alismataceae	Hp	CIHO	CR				Bajić 1954
<i>Berula erecta</i> (Huds.) Coville	Apiaceae	Hp	CIHO					Bajić & Riter Studnička 1978
<i>Bidens cernuus</i> L.	Compositae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Bidens frondosus</i> L.	Compositae	Pt	CUAD		INV	neo	Am-N	Maslo 2014
<i>Bidens tripartitus</i> L.	Compositae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Bolboschoenus glaucus</i> (Lam.) S. G. Sm.	Cyperaceae	Hp	WISP					Maslo et al 2019
<i>Butomus umbellatus</i> L.	Butomaceae	Hp	EUAS	LC				Bajić & Riter Studnička 1978
<i>Callitriche palustris</i> L.	Plantaginaceae	Tp	WISP					Beck 1927
<i>Callitriche stagnalis</i> Scop.	Plantaginaceae	Tp	EUAS					Bjelčić 1985
<i>Caltha palustris</i> L.	Ranunculaceae	Hp	WISP					Malý 1919
<i>Calystegia sepium</i> (L.) R.Br.	Convolvulaceae	Eo	WISP					Bajić & Riter Studnička 1978
<i>Carex cuprina</i> (Heuff.) A. Kern.	Cyperaceae	Eo	SOEU					
<i>Carex distans</i> L.	Cyperaceae	Eo	EURO					Jasprica & Carić 2002
<i>Carex divisa</i> Huds.	Cyperaceae	Eo	SOEU					Jasprica & Carić 2002

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Carex elata</i> All. subsp. <i>elata</i>	Cyperaceae	Eo	EURO					Bajić & Riter Studnička 1978
<i>Carex hirta</i> L.	Cyperaceae	Th	EUAS					Lakušić et al 1982
<i>Carex pseudocyperus</i> L.	Cyperaceae	Up	CIHO					Bajić & Riter Studnička 1978
<i>Carex riparia</i> Curtis	Cyperaceae	Eo	EUAS					Bjelčić 1988
<i>Carex vesicaria</i> L.	Cyperaceae	Eo	CIHO					
<i>Carex viridula</i> Michx.	Cyperaceae	Eo	CIHO					
<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Ceratophyllum submersum</i> L.	Ceratophyllaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Chaiturus marrubiastrum</i> (L.) Ehrh. ex Rchb.	Lamiaceae	Eo	EEUP					
<i>Cirsium creticum</i> (Lam.) d'Urv.	Compositae	Up	CIHO					
<i>Cladium mariscus</i> (L.) Pohl	Cyperaceae	Op	WISP					Beck 1903
<i>Crypsis alopecuroides</i> (Piller & Mitterp.) Schrad.	Poaceae	Po	MEDI					Bajić 1954
<i>Crypsis schoenoides</i> (L.) Lam.	Poaceae	Po	MEDI					Bajić 1954
<i>Cyperus flavescens</i> L.	Cyperaceae	Po	WISP					Bajić 1954
<i>Cyperus fuscus</i> L.	Cyperaceae	Tp	WISP					Bajić 1954
<i>Cyperus longus</i> L.	Cyperaceae	Op	SOEU					Bajić 1954
<i>Cyperus michelianus</i> (L.) Link	Cyperaceae	Po	SOEU					Bajić 1954
<i>Cyperus serotinus</i> Rottb.	Cyperaceae	Op	CIHO					Bajić 1954
<i>Eleocharis acicularis</i> (L.) Roem. & Schult.	Cyperaceae	Tp	WISP					Bajić 1954
<i>Eleocharis ovata</i> (Roth) Roem. & Schult.	Cyperaceae	Po	CIHO					Malý 1910
<i>Eleocharis palustris</i> (L.) R. Br.	Cyperaceae	Hp	WISP					Bajić & Riter Studnička 1978
<i>Eleocharis quinqueflora</i> (Hartmann) O. Schwarz	Cyperaceae	Po	EURO					Bajić & Riter Studnička 1978
<i>Elodea canadensis</i> Michx.	Hydrocharitaceae	Ep	CUAD		INV	neo	Am-N	Jasprica & Carić 2002
<i>Epilobium hirsutum</i> L.	Onagraceae	Eo	EUAS					
<i>Epilobium palustre</i> L.	Onagraceae	Pt	CIHO					Bajić & Riter Studnička 1978
<i>Epilobium parviflorum</i> Schreb.	Onagraceae	Eo	EUAS					Beck 1927
<i>Equisetum palustre</i> L.	Equisetaceae	Pt	CIHO					Bajić & Riter Studnička 1978
<i>Euphorbia palustris</i> L.	Euphorbiaceae	Up	WISP					Fiala 1893
<i>Fimbristylis bisumbellata</i> (Forssk.) Bubani	Cyperaceae	Po	MEDI					Malý 1910
<i>Galium elongatum</i> C. Presl	Rubiaceae	Up	SOEU					Malý 1910
<i>Galium palustre</i> L.	Rubiaceae	Up	WISP					Bajić & Riter Studnička 1978

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Glyceria fluitans</i> (L.) R. Br.	Poaceae	Hp	WISP					Bjelčić 1988
<i>Glyceria maxima</i> (Hartm.) Holmb.	Poaceae	Op	EUAS					Bjelčić 1988
<i>Gratiola officinalis</i> L.	Plantaginaceae	Up	WISP					Beck et al 1967
<i>Hippuris vulgaris</i> L.	Plantaginaceae	Hp	CIHO	VU				Ritter Studnička 1975
<i>Hottonia palustris</i> L.	Primulaceae	Ap	EURO	EN				Beck et al 1967
<i>Hydrocharismorsus-ranae</i> L.	Hydrocharitaceae	Pp	EUAS	VU				Bajić 1954
<i>Hydrocotyle vulgaris</i> L.	Apiaceae	Eo	WISP	DD				Bajić 1954
<i>Hypericum tetrapterum</i> Fr.	Clusiaceae	Eo	EUAS					Malý 1910
<i>Inula britannica</i> L.	Compositae	Eo	EUAS					
<i>Iris pseudacorus</i> L.	Iridaceae	Eo	EUAS					Bajić & Riter Studnička 1978
<i>Isolepis setacea</i> (L.) R. Br.	Cyperaceae	Po	EURO					Bajić 1954
<i>Jacobaea erratica</i> (Bertol.) Fourr.	Compositae	Up	MEDI					Malý 1910
<i>Jacobaea paludosa</i> (L.) G. Gaertn. & al.	Compositae	Up	CEEU					Bajić & Riter Studnička 1978
<i>Juncus anceps</i> Laharpe	Juncaceae	Up	EURO					Bajić & Riter Studnička., 1978
<i>Juncus articulatus</i> L.	Juncaceae	Tp	CIHO					Malý 1910
<i>Juncus bufonius</i> L.	Juncaceae	Po	WISP					Bajić & Riter Studnička 1978
<i>Juncus compressus</i> Jacq.	Juncaceae	Th	WISP					Bajić & Riter Studnička 1978
<i>Juncus subnodulosus</i> Schrank	Juncaceae	Up	WISP					Bajić & Riter Studnička 1978
<i>Laphangium luteoalbum</i> (L.) Tzvelev	Compositae	Po	WISP					Beck et al 1983
<i>Lathyrus palustris</i> L.	Fabaceae	Up	CIHO	DD				
<i>Leersia oryzoides</i> (L.) Sw.	Poaceae	Pt	WISP					Bajić & Riter Studnička 1978
<i>Lemna minor</i> L.	Lemnaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Lemnatisulca</i> L.	Lemnaceae	Pp	WISP					Bajić 1954
<i>Leucojum aestivum</i> L.	Amaryllidaceae	Eo	SOEU					Fiala 1896
<i>Lotus angustissimus</i> L.	Fabaceae	Tp	SOEU					Malý 1912
<i>Lotus pedunculatus</i> Cav.	Fabaceae	Tp	EURO					Lakušić et al 1982
<i>Lotus tenuis</i> Willd.	Fabaceae	Tp	WISP					Bajić 1954
<i>Ludwigia palustris</i> (L.) Elliott	Onagraceae	Tp	WISP	CR				Bajić & Riter Studnička 1978
<i>Lycopus europaeus</i> L.	Lamiaceae	Eo	EUAS					Bajić & Riter Studnička 1978
<i>Lysimachianumularia</i> L.	Primulaceae	Th	EURO					Beck et al 1967

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
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<i>Lysimachia vulgaris</i> L.	Primulaceae	Eo	EUAS					Bajić & Riter Studnička 1978
<i>Lythrum hyssopifolia</i> L.	Lythraceae	Po	WISP					Bajić 1954
<i>Lythrum salicaria</i> L.	Lythraceae	Eo	WISP					Beck 1927
<i>Marsilea quadrifolia</i> L.	Marsileaceae	Tp	CIHO	VU				Malý 1905
<i>Mentha aquatica</i> L.	Lamiaceae	Eo	WISP					Riter Studnička 1975
<i>Mentha arvensis</i> L.	Lamiaceae	Th	CIHO					Bjelčić 1988
<i>Mentha longifolia</i> (L.) L.	Lamiaceae	Up	WISP					
<i>Mentha pulegium</i> L.	Lamiaceae	Th	EUAS					Bajić 1954
<i>Molinia caerulea arundinacea</i> Schrank	Poaceae	Op	EUAS					Bajić & Riter Studnička 1978
<i>Myosotis scorpioides</i> L.	Boraginaceae	Eo	CIHO					Beck 1967
<i>Myriophyllum spicatum</i> L.	Haloragaceae	Ap	WISP					Bajić & Riter Studnička 1978
<i>Myriophyllum verticillatum</i> L.	Haloragaceae	Ap	CIHO					Beck 1927
<i>Najas marina</i> L.	Najadaceae	Ep	WISP					Bajić 1954
<i>Najas minor</i> All.	Najadaceae	Ep	WISP					Bajić 1954
<i>Nasturtium officinale</i> W. T. Aiton	Brassicaceae	Eo	WISP					Bajić & Riter Studnička 1978
<i>Nuphar lutea</i> (L.) Sm.	Nymphaeaceae	Ap	EUAS	VU				Beck 1909
<i>Nymphaea alba</i> L.	Nymphaeaceae	Ap	EUAS	VU				Fiala 1893
<i>Nymphoides peltata</i> (S. G. Gmelin) Kuntze	Menyanthaceae	Ap	CIHO					Bajić & Riter Studnička 1978
<i>Oenanthe aquatica</i> (L.) Poir.	Apiaceae	Hp	EUAS					Malý 1910
<i>Oenanthe fistulosa</i> L.	Apiaceae	Hp	WISP					Lakušić et al 1982
<i>Oenanthe silaifolia</i> M. Bieb.	Apiaceae	Hp	SOEU					Malý 1919
<i>Oxybasis glauca</i> (L.) S. Fuentes & al.	Chenopodiaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Paspalum distichum</i> L.	Poaceae	Tp	CUAD		INV	neo	Am-N	Bajić 1954
<i>Persicaria amphibia</i> (L.) Delarbre	Polygonaceae	Ap	EUAS					Fiala 1893
<i>Persicaria dubia</i> (Stein) Fourr.	Polygonaceae	Pt	EURO					Malý 1912
<i>Persicaria hydropiper</i> (L.) Delarbre	Polygonaceae	Pt	CIHO					Bajić & Riter Studnička 1978
<i>Persicaria lapathifolia</i> (L.) Delarbre	Polygonaceae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Persicaria maculosa</i> Gray	Polygonaceae	Pt	WISP					Jasprica & Carić 2002
<i>Peucedanum palustre</i> (L.) Moench	Apiaceae	Op	EURO					Bajić & Riter Studnička 1978
<i>Phalaris aquatica</i> L.	Poaceae	Eo	MEDI					Maslo 2016a
<i>Phalaroides arundinacea</i> (L.) Rauschert	Poaceae	Eo	CIHO					Malý 1919

Taxon	Family	Life-form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
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<i>Phragmites australis</i> (Cav.) Steud.	Poaceae	Op	WISP					Bajić & Riter Studnička 1978
<i>Plantago altissima</i> L.	Plantaginaceae	Po	SOEU					Bajić 1954
<i>Plantago major</i> subsp. <i>intermedia</i> (Gilib.) Lange	Plantaginaceae	Po	CIHO					Bajić 1954
<i>Poa trivialis</i> subsp. <i>sylvicola</i> (Guss.) H.Lindb.	Poaceae	Po	MEDI					Lakušić et al 1982
<i>Polypogonmon speliensis</i> (L.) Desf.	Poaceae	Pt	WISP					Bajić & Riter Studnička 1978
<i>Potamogeton acutifolius</i> Link	Potamogetonaceae	Ep	CEEU					Bajić & Riter Studnička 1978
<i>Potamogeton crispus</i> L.	Potamogetonaceae	Ep	WISP					Fiala 1893
<i>Potamogeton lucens</i> L.	Potamogetonaceae	Ep	WISP					Malý 1919
<i>Potamogeton natans</i> L.	Potamogetonaceae	Ap	WISP					Fiala 1893
<i>Potamogeton nodosus</i> Poir.	Potamogetonaceae	Ap	WISP					
<i>Potamogeton perfoliatus</i> L.	Potamogetonaceae	Ep	WISP					Jasprica et al 2003
<i>Potamogeton pusillus</i> L.	Potamogetonaceae	Ep	WISP					Bajić & Riter Studnička 1978
<i>Potentilla reptans</i> L.	Rosaceae	Th	WISP					Lakušić et al 1982
<i>Pulicaria dysenterica</i> (L.) Bernh.	Compositae	Up	SOEU					Lakušić et al 1982
<i>Pulicaria vulgaris</i> Gaertn	Compositae	Pt	SOEU					Bajić 1954
<i>Ranunculus circinatus</i> Sibth.	Ranunculaceae	Ap	CIHO					
<i>Ranunculus lingua</i> L.	Ranunculaceae	Up	CIHO					Malý 1910
<i>Ranunculus ophioglossifolius</i> Vill.	Ranunculaceae	Up	SOEU					Bajić 1954
<i>Ranunculus repens</i> L.	Ranunculaceae	Th	WISP					Lakušić et al 1982
<i>Ranunculus sardous</i> Crantz	Ranunculaceae	Th	WISP					Beck 1914
<i>Ranunculus sceleratus</i> L.	Ranunculaceae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Ranunculus trichophyllus</i> Chaix	Ranunculaceae	Ap	EURO					Bajić & Riter Studnička 1978
<i>Rorippa amphibia</i> (L.) Besser	Brassicaceae	Hp	EUAS					Fiala 1896
<i>Rorippa lippizensis</i> (Wulfen) Rchb.	Brassicaceae	Th	SEEU					
<i>Rorippa sylvestris</i> (L.) Besser	Brassicaceae	Th	EUAS					Bajić & Riter Studnička 1978
<i>Rumex aquaticus</i> L.	Polygonaceae	Up	EUAS					
<i>Rumex crispus</i> L.	Polygonaceae	Pt	WISP					Lakušić et al 1982
<i>Rumex hydrolapathum</i> Huds.	Polygonaceae	Up	EURO					Jasprica et al 2003
<i>Sagittaria sagittifolia</i> L.	Alismataceae	Hp	EUAS	VU				Fiala 1896
<i>Samolus valerandi</i> L.	Primulaceae	Up	WISP					Beck et al 1967

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Schoenoplectus lacustris</i> subsp. <i>glaucus</i> (Sm.) Bech.	Cyperaceae	Hp	WISP					Bajić 1954
<i>Schoenoplectus lacustris</i> (L.) Palla subsp. <i>lacustris</i>	Cyperaceae	Op	WISP					Beck 1903
<i>Schoenoplectus riqeter</i> (L.) Palla	Cyperaceae	Hp	SOEU					Bajić & Riter Studnička 1978
<i>Scirpoides holoschoenus</i> (L.) Soják	Cyperaceae	Op	MEDI					Bajić & Riter Studnička 1978
<i>Scutellaria galericulata</i> L.	Lamiaceae	Eo	CIHO					Malý 1910
<i>Sium latifolium</i> L.	Apiaceae	Hp	CEEU					Malý 1910
<i>Solanum dulcamara</i> L.	Solanaceae	Up	WISP					Becket al 1967
<i>Sonchus arvensis</i> subsp. <i>uliginosus</i> (M. Bieb.) Nyman	Compositae	Up	WISP					
<i>Sparganium erectum</i> L.	Sparganiaceae	Op	EUAS					Malý 1910
<i>Sparganium neglectum</i> Beeby	Sparganiaceae	Op	CIHO					Bajić & Riter Studnička 1978
<i>Spirodela polyrhiza</i> (L.) Schleid.	Lemnaceae	Pp	WISP					Bjelčić 1988
<i>Stachys palustris</i> L.	Lamiaceae	Up	CIHO					Malý 1910
<i>Stuckenia pectinata</i> (L.) Börner	Potamogetonaceae	Ep	WISP					Bajić 1954
<i>Taraxacum palustre</i> (Lyons) Symons	Compositae	Pt	EUAS					Jasprica et al 2003
<i>Teucrium scordium</i> subsp. <i>scordioides</i> (Schreb.) Arcang.	Lamiaceae	Up	MEDI					
<i>Teucrium scordium</i> L. subsp. <i>scordium</i>	Lamiaceae	Up	EUAS					Becket al 1950
<i>Thelypteris palustris</i> Schott	Thelypteridaceae	Up	WISP	VU				Bajić & Riter Studnička 1978
<i>Trifolium fragiferum</i> L.	Fabaceae	Pt	WISP					Bajić & Riter Studnička 1978
<i>Triglochin palustris</i> L.	Juncaginaceae	Eo	WISP					Bajić 1954
<i>Typha angustifolia</i> L.	Typhaceae	Op	WISP					Bajić & Riter Studnička 1978
<i>Typha latifolia</i> L.	Typhaceae	Op	WISP					Beck 1903
<i>Utricularia australis</i> R.Br.	Lentibulariaceae	Pp	MEDI	DD				Bjelčić 1988
<i>Utricularia vulgaris</i> L.	Lentibulariaceae	Pp	MEDI	VU				Beck et al 1950
<i>Veronica anagallis - aquatica</i> L.	Plantaginaceae	Up	SOEU					Becket al 1967
<i>Veronica anagalloides</i> Guss.	Plantaginaceae	Up	SOEU	VU				Bajić & Riter Studnička 1978
<i>Veronica beccabunga</i> L.	Plantaginaceae	Up	MEDI					Bajić & Riter Studnička 1978
<i>Zannichellia palustris</i> L.	Zannichelliaceae	Ep	WISP	DD				Bajić 1954

Chorological types, according to Horvatić (1963) and Horvatić et al. (1976/1968).

- Mediterranean floral element (MEDI)
- Illyrian-Balkan floral element (ILBA)
- South European floral element (SOEU)
- East European-Pontic floral element (EEUP)
- Southeast European floral element (SEEU)
- Central European floral element (CEEU)
- European floral element (EURO)
- Eurasian floral element (EUAS)
- Circum-Holarctic plants (CIHO)
- Widespread plants (WISP)
- Alien plants (CUAD)

Categories of life forms, modified according to Hejný (1957, 1971).

- Pleustophytes (**Pp**). They are usually a non-rooted group of species occupying the water level. Rooting in the soil occurs only temporarily during the limosalecophase.
- Euhydatoxiphytes (**Ep**). They are a group of species attached to the soil by roots, sporadically by rhizomes. Only submerged leaves are formed. Generative organs develop in the water medium or immediately above the water level.
- Aerohydatoxiphytes (**Ap**) They are a group of species attached to the soil by rhizomes or roots and capable of passing through their life cycle in the hydrophase, littoral, and limosalecophases. These plants develop submerged and floating leaves and generative organs are usually aerial.
- Tenagophytes (**Tp**) They are a group of plants permanently attached to the soil by fine roots and capable of passing through their full life cycle in the littoral and limosalecophases. These plants develop submerged, floating and aerial leaves and generative organs are formed in both water and air.
- Ochtohydrophytes (**Op**) They are a group of plants attached to the soil and capable of passing through their life cycle in the littoral, limosal, and terrestrial ecophases, partly also in the hydrophase. They develop submerged, floating and aerial leaves. Generative organs are usually aerial.
- Hydroochtohydrophytes (**Hp**) They are a group of species attached to the soil by rhizomes or roots and capable of passing through their life cycle in the hydrophase, littoral, limosal, and terrestrial ecophases. They develop aerial or, sporadically, floating leaves.

- Pelocotophytes (**Po**) They are a group of species attached to the soil by caespitous roots, and capable of passing through their life cycle in the limosal and terrestrial ecophases. Only areal leaves are developed. The plants survive flooding in anabiosis as generative diaspores.
- Trichohydrophytes (**Th**) They are a group of species adapted to different habitats. Germination, flowering, and maturation of the seed take place in the terrestrial ecophase when the soil is still moist. A long limoseecophase offers favourable conditions and a secondary flooding is tolerated.
- Euochtohydrophytes (**EO**) They are a group of plants which occurs in the littoral ecophase, with a short hydrophase, while the limose phase and the terrestrial phase are prolonged. Only aerial leaves are developed.
- Uliginosophytes (**Up**) Germination and initial growth take place in the littoral ecophase, which is short, or the limoseecophase. The biggest part of the development occurs in the limoseecophase and partly in the terrestrial ecophase.
- Pelocototherophytes (**Pt**) Germination and initial growth take place between limosal and terrestrial ecophases. The greatest part of the development occurs in the terrestrial ecophase. Their growing season is very short. They are a group of species which inhabit ruderal habitats, wet fields, and river banks.

Categories depending on the degree of naturalization: casual taxa (CAS.), naturalized non-invasive taxa (NAT.), and naturalized invasive taxa (INV.) according to Richardson et al. (2000) and Pyšek et al. (2004).

- CASUAL (TRANSIENT, EPHEMERAL) PLANTS. Alien plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence.
- NATURALIZED PLANTS. Alien plants that reproduce consistently and sustain populations over many life cycles without direct intervention by humans; they often recruit offspring freely, usually close to adult plants, and do not necessarily invade natural, semi-natural or human-made ecosystems.
- INVASIVE PLANTS (PLANT INVADERS). Naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants, and thus have the potential to spread over a large area.