



Three aquatic macrophytes new for the flora of Bosnia and Herzegovina

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Abstract

During systematic field research carried out in the wider area of Hutovo Blato (Bosnia and Herzegovina), the following three aquatic macrophytes new for the flora of the country are documented: *Egeria densa*, *Myriophyllum heterophyllum* and *Najas marina* subsp. *armata*. While the first two taxa have been recorded earlier from the region (Croatia), *Najas marina* subsp. *armata* is registered here as new for the flora of the Balkan Peninsula.

Key words

Balkans, invasive plants, macrophytes, naturalization

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Introduction

According to data presented in the *Overview and Status of Biological and Landscape Diversity in Bosnia and Herzegovina* (Redžić & al. 2008), a total of 4569 vascular plant taxa have been registered in Bosnia and Herzegovina, approximately 500 of which can be classified as aliens. However, a complete list of alien plant species is not provided in that study. A recently published preliminary list of alien plant species in Bosnia and Herzegovina (Maslo & al. 2020) comprises 273 taxa, including 193 neophytes, of which only one can be designated as an aquatic neophyte, namely, *Elodea canadensis* Michx.

The Hutovo Blato wetland is situated 20 km inland from the Adriatic Sea in South Bosnia and Herzegovina and is part of the Neretva River Delta. The area was classified as a Nature Park in 1995 and listed in the Ramsar Convention as an internationally protected wetland in 2001.

Only recently, a detailed list of aquatic macrophytes in the area of Hutovo Blato Nature Park has been published

(Maslo 2022). A total of 172 plant taxa were presented in the list, of which only two have been recognized as neophytes, namely, *Elodea canadensis* and *Paspalum distichum* L. The genus *Myriophyllum* L. is represented only by two native taxa in the Hutovo Blato area, as well as in Bosnia and Herzegovina – *Myriophyllum spicatum* L. and *M. verticillatum* L., while *Najas marina* L. is treated only at the species level.

Materials and methods

This study is based on recent field research, examination of herbarium material deposited at the National Museum of Bosnia and Herzegovina (SARA; herbarium acronyms are according to Thiers 2024), and literature data. Photographs have been taken in the field. Herbarium vouchers are collected and stored in the SARA herbarium. Distribution of the newly recorded taxa in Bosnia

and Herzegovina (designated also as B&H across the text) is shown in Table 1. For each record, the name of the collector (leg.) or observer (obs.), precise locality name, date of collecting, and decimal degree coordinates are given and mapped under a standard UTM grid 10×10 km.

Nomenclature follows the Euro+Med (2006+).

Results and discussion

During the period 2023-2024, systematic field research has been carried out in Hutovo Blato and its surrounding areas, as well as in the Neretva River Delta (B&H), in the western part of the Balkan Peninsula. As a result, some new aquatic macrophytes have been recorded. Details are provided below.

The genus *Egeria* Planch. belongs to the family *Hydrocharitaceae* Juss. It comprises two submersed aquatic perennial species native to South America, but only *E. densa* Planch. has become widely naturalized in others parts of the world (Cook & Urmi-König 1984). That species has been recorded in 17 European countries (Uotila 2009a; Rimac & al. 2018) and only recently found in Croatia, which is also stands for its first finding in Southeast Europe and the Balkans (Rimac & al. 2018). Outside of its original range, *E. densa* is considered a threat to aquatic ecosystems, as well as an invasive species in many parts of the world, including in Europe (Hussner 2012). That species threatens the aquatic ecosystems by creating dense stands that can pack the entire water body, thus entailing high economic costs and loss of native biodiversity. *Egeria densa* is included in the List of Invasive Alien Plants suggested by the European and Mediterranean Plant Protection Organization (EPPO 2014).

Egeria densa [syn. *Elodea densa* (Planch.) Casp.] is a fresh-water submersed perennial plant, without rhizomes and stolons, with an erect, elongated stem rooted in the substrate. Stems are up to 3 m long, irregularly branched. Leaf blades are sessile, arranged in whorls of 4-6 per whorl. The lower leaves are remote, the upper ones are crowded. Inflorescences are one-flowered, sessile. Flowers are unisexual, staminate and pistillate on different plants, projected to the surface by a slender, elongated floral tube base, pedicellate; petals are white. A detailed description of the species can be found in Cook & Urmi-König (1984).

Egeria densa can be confused with *Elodea canadensis* Michx., an aquatic neophyte recorded in B&H. However, the stems of *Egeria* look very leafy as compared to the stems of *E. canadensis*, and *E. canadensis* has only three leaves per whorl, instead of 4-6 like in *E. densa*. Furthermore, *E. densa* has longer leaves (15-40 mm) than *E. canadensis* (6-17 mm). *Elodea canadensis* is a rather rare species in the flora of B&H. The earliest record from B&H is that of Malý in the Matura stream near Bosanska Gradiška (Malý 1928), as *Helodea canadensis* L.C. Rich, based on material collected from *Alpfelbeck*



Fig. 1. *Egeria densa* in the canals along lake Svitava: habitus (photographs: S. Maslo).

on September 3, 1923 (SARA 00563). Subsequently, the species has been mentioned for only one other locality in B&H, namely, Hutovo Blato (Jasprica & Carić 2002; Maslo 2022). In the Herbarium of the National Museum of B&H (SARA), only three specimens of *E. canadensis* are stored, all from North Bosnia: Donja Dolina near Bosanska Gradiška (*Alpfelbeck*, 03.09.1923, SARA 00563), Starača near Modriča (*Bjelčić*, 1954, SARA 00564), and Lašva near Travnik (*Ritter-Studnička*, 04.07.1958, SARA 49026). No specimens of *E. canadensis* from Hutovo Blato have been found in the SARA collection, which puts under question the statement of Jasprica & Carić (2002), who most likely must be referring then to *Egeria densa*. The latter is supported by the fact that in the Croatian part of the Neretva Delta, not a single *E. canadensis* had been found, contrary to *Egeria densa*, which was recorded in the Croatian part of the Neretva Delta (Rimac & al. 2018; Nikolić 2020).

During the field research in the area of Hutovo Blato, as well as in the Neretva River Delta, the species was recorded in 14 localities (Fig. 4). In some localities in lake Svitava (Fig. 1), it has formed dense stands covering tens of square meters. In the shallow water along the shore of lake Svitava (10-40 cm deep), *E. densa* associated with *Berula erecta*, *Hydrocharis morsus-ranae*, *Myriophyllum verticillatum*, and *Potamogeton perfoliatus*. In the deeper waters of river Krupa, as well as in the Neretva River (100-150 cm deep), *E. densa* associated with *Nuphar lutea*, *Potamogeton lucens*, *P. nodosus*, and *P. perfoliatus*. Mention deserved the fact that in most localities the species bloomed massively.

That species has not been reported before in B&H, although its presence is not surprising on the grounds that it has been recorded earlier in the Neretva Delta in neighbouring Dalmatia, just several hundred meters away from the border with Herzegovina.

Following the framework suggested by Blackburn & al. (2011), we the authors consider *E. densa* an invasive alien

species on the territory of B&H, currently in E category (Fully invasive species, with individuals dispersing, surviving and reproducing at multiple sites across a greater or lesser spectrum of habitats and extent of occurrence).

The genus *Myriophyllum* L. belongs to the family *Haloragaceae* R. Br. It comprises about 68 species of world-wide distribution, occurring in all continents, except in Antarctica (Yu & al. 2002). Within the genus *Myriophyllum*, eight species have been recorded in Europe (Uotila 2009b), including two present in B&H: *M. spicatum* L. and

M. verticillatum L. (Beck-Mannagetta 1927).

Myriophyllum heterophyllum Michx. is an aquatic plant native to the eastern United States, where it often forms dense stands. That species occurs as an alien species in 11 European countries, western USA and South China. In Europe, it is also established in Austria, Belgium, France, Germany, Hungary, the Netherlands, Spain, Switzerland, and the United Kingdom (Uotila 2009b; Diogo & al. 2024). Only recently it was recorded in Croatia and Portugal (Jasprica & al. 2017; Diogo & al.

Table 1. Georeferenced data on the distribution of *Egeria densa*, *Myriophyllum heterophyllum* and *Najas marina* subsp. *armata* in Bosnia and Herzegovina.

Taxa	Number and name of the locality, observers/collectors, dates for the observations (Herbarium/collection number)	WGS coordinates	Altitude	UTM quadrant
<i>Egeria densa</i>	1. Svitava, canals along the Svitava Lake, leg. A. Mesterházy, 25.08.2024 (SARA 54267)	43°01'05"N 17°46'52"E	3 m	YH26
<i>E. densa</i>	2. Svitava, canals along the Svitava Lake, leg. S. Maslo, 28.10.2024 (SARA 54260)	43°01'05"N 17°46'52"E	3 m	YH26
<i>E. densa</i>	3. Svitava, Svitava Lake, leg. S. Maslo 28.10.2024 (SARA 54261)	43°00'55"N 17°48'00"E	2 m	YH26
<i>E. densa</i>	4. Krupa River, obs. A. Boškailo, 17.10.2024	43°0'54"N 17°47'50"E	2 m	YH26
<i>E. densa</i>	5. Krupa River, obs. A. Boškailo, 17.10.2024	43°0'51"N 17°47'39"E	2 m	YH26
<i>E. densa</i>	6. Krupa River, obs. A. Boškailo, 17.10.2024	43°0'52"N 17°47'18"E	8 m	YH26
<i>E. densa</i>	7. Krupa River, obs. A. Boškailo, 17.10.2024	43°0'60"N 17°47'9"E	4 m	YH26
<i>E. densa</i>	8. Krupa River, obs. A. Boškailo, 17.10.2024	43°1'1"N 17°46'34"E	6 m	YH26
<i>E. densa</i>	9. Krupa River, obs. A. Boškailo, 17.10.2024	43°1'12"N 17°46'8"E	5 m	YH26
<i>E. densa</i>	10. Neretva River, obs. A. Boškailo, 01.10.2023	43°2'59"N 17°39'46"E	7 m	YH16
<i>E. densa</i>	11. Neretva River, obs. A. Boškailo, 01.10.2023	43°2'57"N 17°39'51"E	6 m	YH16
<i>E. densa</i>	12. Neretva River, obs. A. Boškailo, 01.10.2023	43°3'6"N 17°39'50"E	1 m	YH17
<i>E. densa</i>	13. Krupa River, obs. A. Boškailo, 17.05.2024	43°2'39"N 17°44'36"E	1 m	YH26
<i>E. densa</i>	14. Krupa River, obs. A. Boškailo, 17.05.2024	43°2'23"N 17°44'59"E	0 m	YH26
<i>Myriophyllum heterophyllum</i>	1. Svitava, canals along the Svitava Lake, leg. A. Mesterházy, 25.08.2024 (SARA 54269)	43°00'49"N 17°48'19"E	2 m	YH26
<i>M. heterophyllum</i>	2. Svitava, canals along the Svitava Lake, leg. S. Maslo, 28.10.2024 (SARA 54262)	43°00'49"N 17°48'19"E	2 m	YH26
<i>Najas marina</i> subsp. <i>armata</i>	1. Hutovo Blato, Škrka Lake, leg. S. Maslo, 11.07.1999 (SARA 54263)	43°05'02"N 17°44'29"E	3 m	YH27
<i>N. marina</i> subsp. <i>armata</i>	2. Hutovo Blato, Krupa River, leg. S. Maslo, 11.07.1999 (SARA 54260); 30.06.2007 (SARA 52830)	43°03'30"N 17°45'14"E	2 m	YH27
<i>N. marina</i> subsp. <i>armata</i>	3. Hutovo Blato, Škrka Lake, leg. A. Mesterházy, 25.08.2024 (SARA 54267)	43°04'58"N 17°44'29"E	3 m	YH27
<i>N. marina</i> subsp. <i>armata</i>	4. Krupa River, obs. A. Boškailo, 20.09.2023	43°2'39"N 17°44'36"E	1 m	YH26

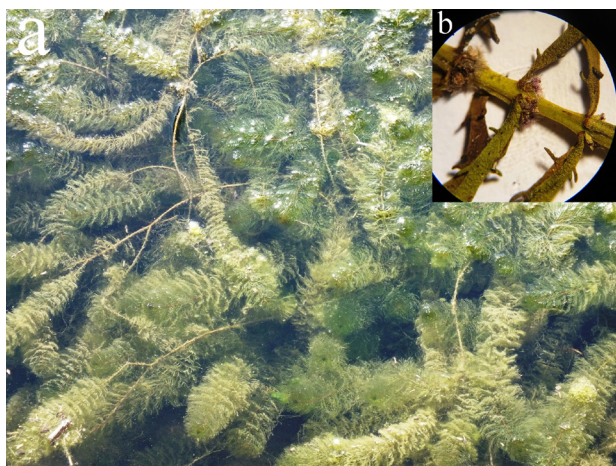


Fig. 2. *Myriophyllum heterophyllum* in the canals along lake Svitava, near the village of Svitava: **a**, habitus; **b**, part of the spike with floral bracts (photographs: a. S. Maslo, b. A. Mesterházy).

2024). The report from Croatia is the first documented finding for Southeast Europe and the Balkans. *Myriophyllum heterophyllum* has shown a fast rate of distribution in the western parts of Europe (Hussner 2012).

The species forms dense mats on the surface of water bodies, reducing penetration of light and dissolved oxygen, which, in turn, reduces the suitable habitats of native plants. It is included in the List of Invasive Alien Plants suggested by the European and Mediterranean Plant Protection Organization (EPPO 2016).

Myriophyllum heterophyllum is a perennial evergreen submersed aquatic herb, with both submersed and emergent leaves. Stems are simple or branching, up to 1 m long, with leaves in whorls of 4-6. The submersed leaves are pinnate, 2-5 cm long, with 7-10 pairs of pinnae per leaf; the amphibious leaves are slightly indented, the emergent leaves and bracts are firm, lanceolate, entire or serrate. Spikes usually extend above water, 3-35 cm long. Flowers are sessile, in whorls of 4-6, in the axils of the upper leaves. Floral bracts are linear, serrate and much longer than the flowers. A detailed description of the species can be found in Yu & al. (2002).

Although *M. heterophyllum* is very similar to the native species of genus *Myriophyllum* in B&H, it stands out due to its conspicuous floral bracts, which makes it impossible to confuse it with other species. However, in the absence of flowers the species is easily overlooked. During the field research in the Hutovo Blato region in August 2024, the species has been recorded for the first time in B&H. It occurs in the canals along lake Svitava, in Svitava village itself (Table 1, Fig. 2). Only one population has been found, covering about six square meters, flowering in monodominant stands and growing in almost stagnant and shallow water (about 50 cm deep). The finding of that species in Hutovo Blato has not been surprising, since it was recently recorded in the Croatian

part of the Neretva Delta (Jasprica & al. 2017). Based on the fact that the species was recorded from 17 localities in the neighbouring Neretva Delta (Nikolić 2020), it could be assumed that it was more widely distributed in the Hutovo Blato area, which has yet to be confirmed by further field research.

Following the framework proposed by Blackburn & al. (2011), the authors consider *M. heterophyllum* as a naturalized alien on the territory of B&H, currently in **D2** category (Self-sustaining population in the wild, with individuals surviving and reproducing a significant distance from the original).

The genus *Najas* L. belongs to the family *Hydrocharitaceae* Juss. There are about 40 widely distributed species, with the greatest diversity in tropical and subtropical regions, but absent from the very cold areas (Triest 1988). Seven species are recognized in Europe but only two taxa of the genus have been present in Bosnia and Herzegovina: *Najas marina* subsp. *major* (All.) Viinikka and *N. minor* All. (Malý 1928). According to Bräuchler (2015), the correct name of *N. marina* subsp. *major* (All.) Viinikka is *N. major* All., but in this study, the nomenclature follows the Euro+Med (2006+).

Najas marina L. is a polymorphic, submersed, dioecious plant. Stems are slender, strongly branched, 30-100 cm long. The stems and abaxial surface of leaves are usually spiny. Leaves are 1.5-3.0 cm × 2.0-3.5 mm, spinose-dentate. Flowers are solitary, yellowish-green. Fruits are elliptic, 3-5 mm long. A detailed description of the species, as well as an identification key can be found in Triest (1988).

In Europe, *Najas marina* is represented by five subspecies, of which only two have been so far recorded in the Balkans, namely, *N. marina* subsp. *major* and *N. marina* subsp. *marina* (Uotila 2009a). So far, only *N. marina* subsp. *major* has been recorded in B&H. During the recent field research conducted in the Hutovo Blato area, a different taxon has been found, which has not been documented earlier in B&H. A detailed examination of the collected material and a comparison with the identification key presented by Triest (1988) have allowed the authors to determine it undeniably as *N. marina* subsp. *armata* Horn. The taxon is very similar to *N. marina* subs. *major*, recorded earlier in the northern part of the country (Malý 1928). *Najas marina* subsp. *major* has significantly larger seeds (4-6 mm, versus 2.5-4.0 mm in *N. marina* subsp. *armata*), although the most noticeable difference of *N. marina* subsp. *armata* is its very spiny stem and back of midrib (Fig. 3a), contrary to *N. marina* subsp. *major* (Fig. 3b). A detailed identification key can be found in Triest (1988) and Troia (2022).

Najas marina is a rather rare species in the flora of B&H. The earliest record was that of Malý in the Tinja stream near Brčko (Malý 1928) as *N. marina*, based on material collected from *Alpfelbeck* on September 30, 1923 (SARA 00508). However, in the same paper, Malý had also mentioned (in parentheses) *N. major* as a synonym for that species. Based on that comment by Malý (1928), it could be concluded that only the taxon *N. marina* sub-

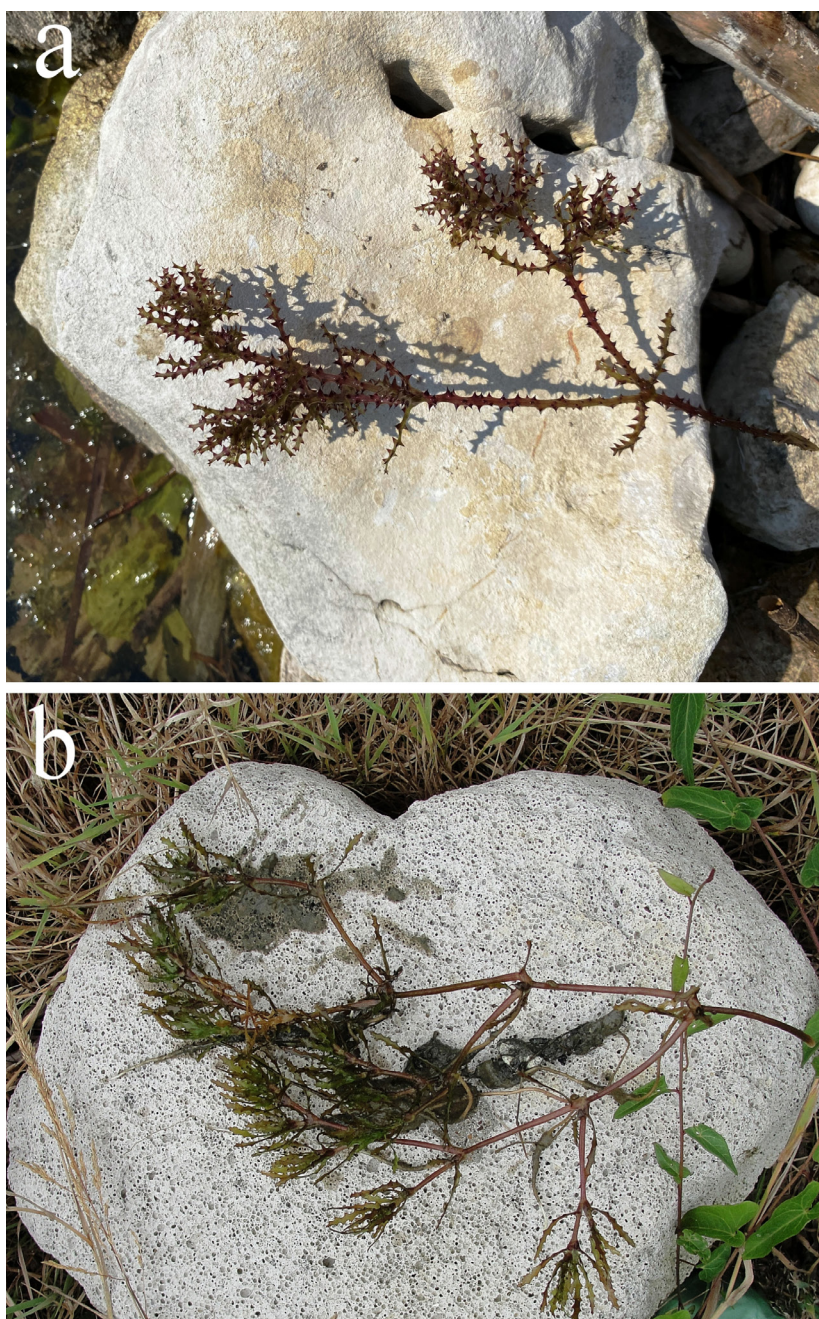


Fig. 3. a, *Najas marina* subsp. *armata* in Herzegovina, Hutovo Blato, lake Škrka; **b**, *Najas marina* subsp. *major* in Bosnia, Lukavac, lake Modrac (photographs: a. A. Mesterházy; b. Š. Šarić).

sp. major was recorded in North Bosnia. Subsequently, the species was mentioned for only one other locality in B&H, namely, Hutovo Blato (Bajić 1954; Jasprica & Carić 2002; Maslo 2022). In the Herbarium of the National Museum of B&H (SARA), only five specimens of *N. marina* were stored: three specimens from North Bosnia – Tinja near Brčko (Alpfelbeck, 30.09.1923, SARA 00508), Velika Tišina (Bjelčić, 1955, SARA 00507) and lake Modrac near Lukavac (Šarić & Maslo, 08.2021, SARA 53350); and two specimens from Hutovo Blato (Ritter-Studnička, 28.06.1973, SARA 49196 and Maslo, 20.06.2007, SARA

52330). In all mentioned localities, *N. marina* was determined only at the species level. Reviews of the herbarium collection of SARA and the private herbarium of the first author helped state with certainty that in North Bosnia only *N. marina* subsp. *major* occurred, while in the area of Hutovo Blato only *N. marina* subsp. *armata* was found. That was supported by the recent field research in the area of Hutovo Blato conducted in 2023/24, when only *N. marina* subsp. *armata* was recorded. Based on the revision of the herbarium material stored in the SARA collection, as well as on the detailed analysis of the material collected

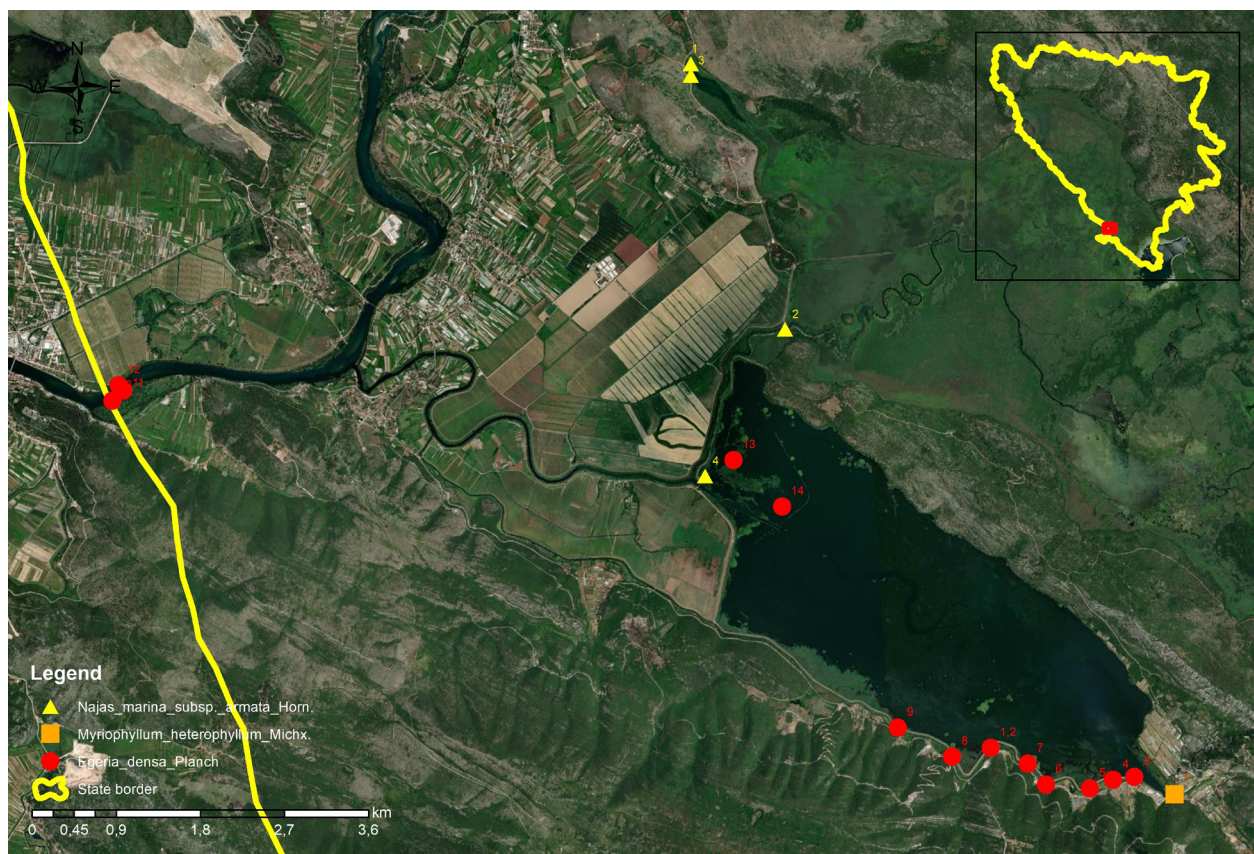


Fig. 4. Currently known distribution of the three aquatic macrophytes new for the flora of B&H.

in the localities mentioned in literature, the authors have concluded that *N. marina* subsp. *armata* is present in B&H since 1954. The fact that the taxon was not listed earlier could be explained by the circumstance that in the area of Hutovo Blato *N. marina* was determined earlier only at the species level. The presence of that North African taxon in B&H was important, since so far it has been reported only for Portugal, Spain and some Mediterranean islands (Troia 2022). Based on data on the distribution of that taxon in Europe presented by Troia (2022), it could be concluded that its Bosnian localities are the northernmost in Europe.

During the recent field research, that taxon was recorded in four localities (Fig. 4). At two localities in lake Škrka, only a few individuals were recorded in shallow water along the shore of the lake (10-40 cm deep). On the other hand, in river Krupa, the taxon was found in several localities, in dense stands with a diameter of 1 to 2 meters next to the river bank, at a depth of approximately 1 m. In those localities, the taxon was associated with *Alisma plantago-aquatica*, *Mentha aquatica*, *Nuphar lutea*, *Oenanthe aquatica*, and *Typha angustifolia*.

According to Troia (2022), the spread of that taxon towards the European part of the Mediterranean can be explained by the influence of climate change and indicates a natural expansion of its range. On this basis, the taxon should be treated as a native plant in B&H.

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