

EUROPEAN INVASION IN PROGRESS: MYRIOPHYLLUM HETEROPHYLLUM MICHX. (HALORAGACEAE) IN CROATIA

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In Europe, *Myriophyllum heterophyllum* Michx. (Haloragaceae) has had the status of invasive species in freshwater ecosystems since 2012. During phytosociological research in the Neretva River Delta in July 2016, we noted a high coverage of species *Myriophyllum heterophyllum* within vegetation of rooted leaf-floating macrophytes of the *Nymphaeion albae* Oberd. 1957 alliance (the order *Potamogetonetalia* Koch 1926). In this paper, alongside the finding of the new locality with *M. heterophyllum* in Croatia, its phytosociology is reported.

Keywords: alien taxon, freshwater ecosystems, the *Nymphaeion albae* alliance, the Neretva River delta, Croatia, NE Mediterranean

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Sjevernoamerička vrsta *Myriophyllum heterophyllum* Michx. (Haloragaceae) u Europi ima status invazivne vrste od 2012. godine. Tijekom fitocenoloških istraživanja u delti Neretve u srpnju 2016., utvrdili smo visoku pokrovnost vrste *Myriophyllum heterophyllum* u vegetaciji zakorijenjenih makrofita sveze *Nymphaeion albae* Oberd. 1957 (*Potamogetonetalia* Koch 1926). Prema dosadašnjim podacima, to je drugi nalaz te vrste u Hrvatskoj.

Ključne riječi: alohtona vrsta, slatkovodni ekosustavi, sveza *Nymphaeion albae*, delta Neretve, Hrvatska, SI Sredozemlje

INTRODUCTION

Myriophyllum heterophyllum is an aquatic plant native to the eastern United States, where it often forms dense stands (Brown *et al.*, 2014). The species is commonly used in aquaria and for ornamental purposes in ponds. It was included in the European and

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Mediterranean Plant Protection Organization (EPPO) alert list in 2009 and subsequently transferred to the List of Invasive Alien Plants in 2012 (EPPO, 2009, 2014). It has shown a fast rate of spread in western parts of Europe (HUSSNER, 2012; LAFONTAINE *et al.*, 2013, etc.).

Myriophyllum heterophyllum is present as an alien species in nine European countries: Austria, Belgium, France, Germany, Hungary, the Netherlands, Spain, Switzerland and the United Kingdom (HUSSNER, 2012; EPPO, 2015; BRUNDU, 2015). Throughout the world it is invasive in southern China (YU *et al.*, 2003) and Guatemala in Central America (EPPO, 2016). In addition, according to the Euro+Med Plantbase (Euro+Med, 2006-2016) it was reported only for the United Kingdom, Austria, Germany, Switzerland and Spain. According to EPPO (2016), no presence of the taxon in SE Europe has yet been found (Fig. 1).

In fact, the presence of the taxon in Croatia has been overlooked and not included in EPPO. Actually, it was found for the first time in Croatia on the island of Krk, northeastern Adriatic, in the small Lake Ponikve in 2000 (STARMÜHLER, 2009). In this study, we report the most southern Croatian locality with *Myriophyllum heterophyllum* and shortly describe its phytosociology.

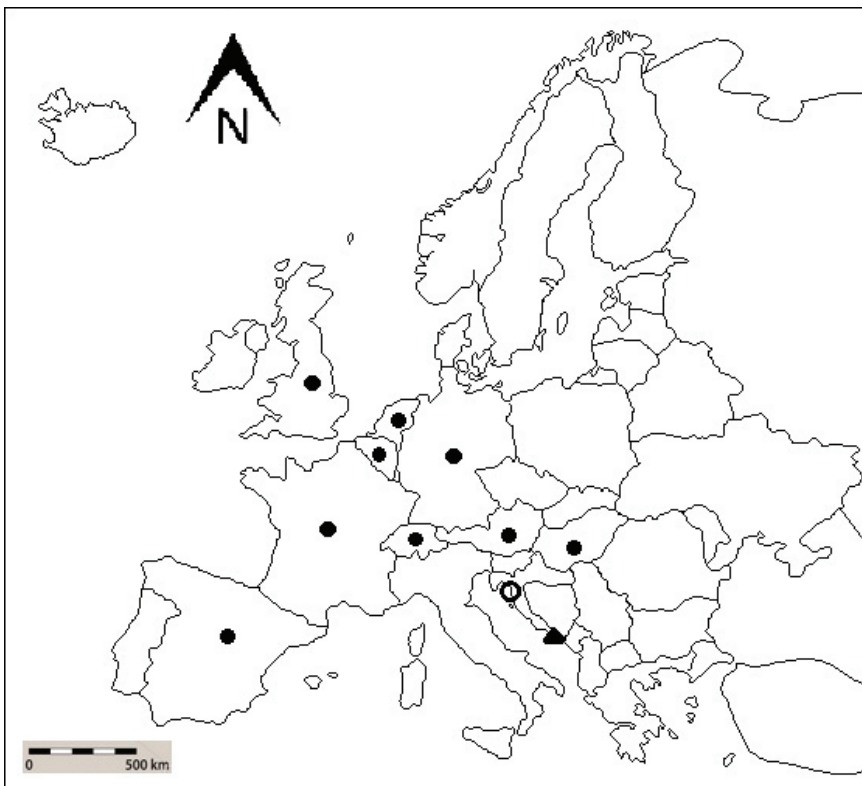


Fig. 1. European countries where *Myriophyllum heterophyllum* Michx. occurs (●). In Croatia, symbols indicate its presence from a previously known locality (○) and that found in this study (▲).

MATERIALS AND METHODS

Study area

From a biogeographic viewpoint, the study area is included in the Epiro-Dalmatian sector of the Adriatic province (RIVAS-MARTÍNEZ *et al.*, 2004). The Neretva River delta consists of numerous channels that empty into the Eastern Adriatic Sea and several lakes, each of which is a karstic crypto-depression. Looking downstream, Lake Desne is located in the NW part of the delta i.e. on the right side of the Neretva River. Lake water originates mostly from underground karstic springs. It is oligotrophic, poorly mineralized, generally contains a small quantity of dissolved carbon dioxide (as bicarbonate), and often is turbid (JASPRICA & HAFNER, 2005). Additional details on the lake's trophic status and the study area, in general, are given by JASPRICA & HAFNER (2005), and JASPRICA *et al.* (2005).

Sampling and identification

Surveys were conducted according to methodology described by LASIĆ & JASPRICA (2016). This phytosociological relevé was carried out using the 7-grade scale of BRAUN-BLANQUET (1964). In the Result and Discussion section, coverage values of the taxa in the relevé are indicated by symbols in the brackets. *Myriophyllum heterophyllum* was determined according to WIMMER (1997), YU *et al.* (2003), BAILEY (2007) and LEBRETON (2013), etc., while other macrophytes were determined using the standard determination keys, books and guides (for details see JASPRICA & MILOVIĆ, 2016). "*Chara globularis* Thuillier group" was determined according to HAAS (1994) and PUKACZ *et al.* (2011). Nomenclature of plant species follows the EURO+MED PLANTBASE (EURO+MED, 2006-2016). The syntaxonomic system proposed by MUCINA *et al.* (2016) was followed. *Myriophyllum heterophyl-*

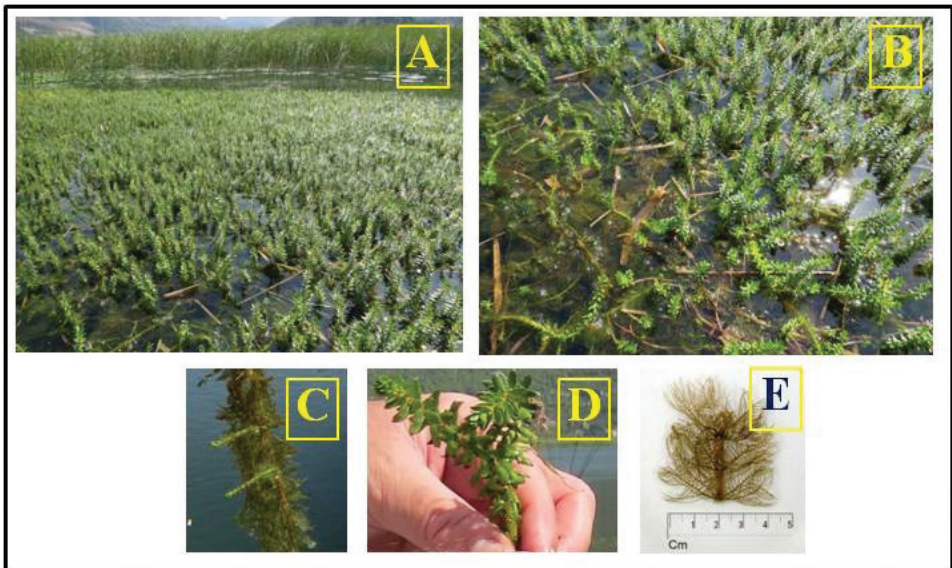


Fig. 2. *Myriophyllum heterophyllum* Michx. in submersed macrophyte community in the lower Neretva river Delta on July 26, 2016 (A), habitus (B), details on submerged and emergent leaves (C, D), submerged leaves (E).

lum herbarium specimens are housed in the University of Dubrovnik, Institute for Marine and Coastal Research, Laboratory for Terrestrial Flora and Fauna, code NJ-NRD-2016-1; *Leg. et det.* N. Jasprica.

RESULTS AND DISCUSSION

Myriophyllum heterophyllum was found within vegetation of rooted leaf-floating macrophytes in Lake Desne (43°03'35.9" N, 17°31'08.45" E) within the *Nymphaeion albae* Oberd. 1957 alliance and the *Potamogetonetalia* Koch 1926 order in July 2016 (Fig. 2). In our case, the community occurs in shallow (up to 1 m), almost stagnant waters, and it covers a surface area of 25 m². Similarly, THUM & LENNON (2010) reported *M. heterophyllum* from "higher order" lakes characterized as large, low elevation systems with relatively high pH, alkalinity and conductivity. The optimum temperature for *M. heterophyllum* is about 20°C (HUSSNER & JAHNS, 2015). According to STARMÜHLER (2009), the taxon was found in a 3-10 m deep lake on the island of Krk, northern Adriatic.

The community described in this report is characterized by a carpet of large leaves and flowers of the species *Myriophyllum heterophyllum* (5), *Nymphaea alba* L. (1) and *Nuphar lutea* (L.) Sm. (+), as well as others like *Najas marina* L. (+), *Chara globularis* group (+), *Nitella* sp. (+) and *Schoenoplectus lacustris* (L.) Palla (r). The community can be referred to the *Nymphaetum albae* Vollmar 1947 [= *Myriophyllo verticillati-Nupharetum lutei* Koch 1926] association, but in this case, *M. verticillatum* is completely missing (cf. LASIĆ & JASPRICA, 2016).

The species could inhabit the whole of Europe, except the Scandinavian tundra and taiga areas (EPPO, 2016). Climate change is likely to increase the ecologically suitable area. The risk of the species inhabiting additional countries is high as movement through irrigation and river systems acts to connect countries, facilitating spread regionally (BRUNEL *et al.*, 2010; LAFONTAINE *et al.*, 2013). Habitats within the endangered area include riparian systems, slow moving rivers, canals, irrigation canals, lakes, reservoirs and wetlands. The spread of *M. heterophyllum* occurs predominately via vegetative propagation. The spread may be accelerated by recreational activities in water bodies invaded by the weed (BRUNDU *et al.*, 2013).

Our finding contributes to the knowledge of the chorology and ecology of *M. heterophyllum*, the floristic richness and vegetation diversity of Croatia, but also emphasizes the further spreading of newcomers to accommodating freshwater habitats.

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