

# First confirmed record of *Elodea canadensis* Michx. (Hydrocharitaceae) in Greece

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**Key words:** *Elodea canadensis*, Hydrocharitaceae, aquatic macrophytes, invasive plants, Lake Great Prespa, Greece.

**Ključne besede:** *Elodea canadensis*, Hydrocharitaceae, vodni makrofiti, invazivne rastline, Veliko Prespansko jezero, Grčija.

## Abstract

The paper confirms the presence of *Elodea canadensis* Michx. in Greece and outlines the history of contradictory relevant reports. This is also the first report of the species' presence in the transboundary lake Great Prespa.

## Izvleček

V članku smo potrdili prisotnost vrste *Elodea canadensis* Michx. v Grčiji in predstavljamo zgodovino pomembnih, a nasprotujočih si poročil o njenem uspevanju. To je obenem tudi prva potrditev prisotnosti vrste v čezmejnem Velikem Prespanskem jezeru.

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## Introduction

*Elodea canadensis* Michx. is a submerged aquatic macrophyte, originating from North America, being frequently present in the NE United States and SE Canada (Simpson 1984). Since the 19<sup>th</sup> century, it has invaded inland water bodies in all continents except Antarctica, with Europe being particularly affected (CABI 2016). *E. canadensis* produces several flexuous elongated stems, which bear adventitious roots with white or grey-green root-tips. The leaves are oblong-linear, flat, minutely denticulate with a rounded or broadly acute apex. The lower leaves are opposite, while the middle and upper leaves appear in whorls of three with the ones near the apex growing closely together. The species is dioecious with differential abundance of its two sexes in nature. Especially in Europe, the presence of male individuals has been rarely reported and asexual reproduction through vegetative fragments and turions is perhaps the only way of propagation (Dandy 1980, Simpson 1984, 1986, DAI-SIE 2008, Josefsson 2011, CABI 2016).

Lake Great Prespa (“Megali Prespa” in Greek), named this way, so as not to be confused with its adjacent smaller counterpart, Lesser Prespa (“Mikri Prespa”), is a trans-boundary lake, shared by Greece, Albania and the Former Yugoslav Republic (FYR) of Macedonia (Figure 1). It is a high altitude lake with an average surface water level of 849 m a.s.l. It has a maximum depth of 53 m and an average depth of 15 m for the observation period 1951–2000 (Popovska & Bonacci 2007).

Mean annual values of total phosphorus 25 µg/L, chlorophyll-a 6.2 µg/L and Secchi depth 3.7 m, (values for the period 2012–15 provided by the national water monitoring network) indicate mesotrophic conditions according to OECD (1982) criteria (Solimni et al. 2006).

The first indication of the species’ presence in lake Great Prespa was during water sampling for the implementation of the Water Framework Directive (WFD) 2000/60/EC (EC 2000) in Greek lakes, in September of 2014. Floating stem fragments were collected in the little harbor of the village Psarades (site S1), in the southern part of the lake. Although the fragments could be assigned to *E. canadensis*, the lack of rooted specimens prevented us from



**Figure 1:** Map of the lakes Great Prespa, Lesser Prespa and Ohrid.

**Slika 1:** Zemljovid Velikega in Malega Prespanskega jezera in Ohridskega jezera.



reporting the species in case of recent transportation by boat. In the summer of 2015, the research team went back to lake Great Prespa to sample the aquatic macrophyte community, as it constitutes one of the four Biological Quality Elements of the WFD.

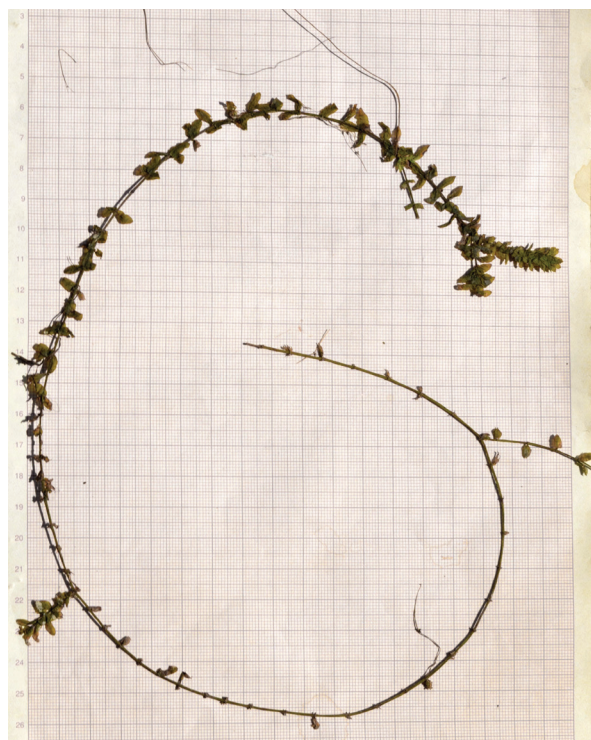
## Materials and methods

Sampling was performed in transects of increasing water depth at intervals of 20 cm with the use of a double-headed grapnel, following the recommendations of Kolada et al. (2009). As the sub-plots are defined through depth gradient, they do not correspond to a fixed area. Species abundance was recorded in a 5-graded DAFOR scale and later transformed to class average as follows: 0.5, 5.5, 17.5, 50 and 87.5 per cent coverage. A total of 12 transects were sampled covering the full extent of the Greek part of the lake's perimeter. A specimen of *Elodea canadensis* has been deposited in the Herbarium of The Goulandris Natural History Museum (ATH) in Athens, Greece. For the identification, all available relevant literature was used (Corell & Corell 1972, Casper & Krausch 1980, Dandy 1980, Simpson 1986, Crow & Hellquist 2000). All species names follow the current nomenclature of Euro+Med PlantBase.

## Results

All the examined specimens corresponded fully with the descriptions within the aforementioned taxonomic literature (Figure 2). As no reproductive organs were found, identification was based solely on vegetative traits. *E. canadensis* was found in two of the 12 transects. In both sites, *E. canadensis* was found exclusively in depths between 2 and 2.20 m. In the little harbor of Psarades (S1), *E. canadensis*' coverage was estimated to 5.5%. The sub-plot was dominated by dense floating stands of *Trapa natans* with a cover of 87.5%, followed by the submerged *Ceratophyllum demersum* with approximately 50% cover. Other species present were *Ranunculus trichophyllus* and *Myriophyllum spicatum* with coverage of nearly 5.5% and *Najas marina* with 0.5% coverage. In the shallower sub-plots of the transect, dense monospecific stands of *Phragmites australis* dominated depths between 1 to 2 m. With increasing depth, *T. natans* gradually decreased and *C. demersum* became dominant from 2.8 m of depth and down to the point of Maximum Colonization Depth (Cmax) at 6 m.

In site S2, in the SE part of the lake, near the border with the FYR of Macedonia, *E. canadensis* had also a cover of 5.5%. The sub-plot was dominated by *Potamogeton perfoliatus* with a cover of nearly 50%. In the next deepest sub-



**Figure 2:** Stem with leaves (Left) and upper leaves (Right). Photos by G. Poulis.

**Slika 2:** Steblo z listi (levo) in zgornji listi (desno). Foto G. Poulis.

plot, the cover of *P. perfoliatus* fell dramatically and the sub-plot was dominated by dense stands of *M. spicatum* with 50% and *Vallisneria spiralis* with 17.5% coverage. In the next sub-plots, dominance constantly shifted among *M. spicatum*, *N. marina* and *C. demersum*, with *P. perfoliatus* reaching the point of Cmax at 4.4 m.

## Discussion

The Invasive Species Compendium of the Centre for Agriculture and Biosciences International (CABI) reports *E. canadensis* being “widespread” in Greece citing Boliotis (1984) as reference. The latter paper is a brief account of the indigenous Greek flora, published in a Greek journal on weed science. Written in Greek, it only makes a quick mention on the species’ presence in the country, without producing any further evidence and it should be regarded as erroneous.

Subsequent literature reviews, focusing either on floristics or invasion biology, do not mention this species’ occurrence in Greece (e.g. Sarika 2005, DAISIE 2008, Zenetos et al. 2009, Arianoutsou et al. 2010, Hussner 2012, Dimopoulos et al. 2013). Zenetos et al. (2009) in their literature review about alien aquatic species in Greece, remark that “the alien freshwater flora of Greece is poorly studied, since several regions and habitats likely to host such species are under-sampled. It is remarkable that certain widespread aquatic aliens have been recorded only locally or remain unrecorded in Greece”.

Hussner (2012) reports the presence of *E. canadensis* in 41 out of 46 European countries: the ones excluded are Greece, Montenegro, Cyprus, Malta and Iceland. Taking into account the current paper and the recent report from Montenegro by Bubanja & Stefanovic (2013), the list of all continental European countries has now been completed.

Apart from being the first record for Greece, the present report is also the first record for the species in the transboundary lake Great Prespa. *E. canadensis* had not been reported by Pavlides (1985, 1997), who did an extensive survey of the Greek National Park’s flora, including hydrophytes. Talevska et al. (2009) sampled the part of the lake belonging to the FYR of Macedonia, without reporting the species. No literature on the Albanian side was found.

The most usual means of dispersal has been reported to be the accidental escape from aquaria (CABI 2016), but this possibility seems rather unlikely for the sparsely inhabited rural Greek side of the lake. However, larger settlements are present in the northern part of the lake in the FYR of Macedonia.

As the species has been reported from the adjacent lake Ohrid (Talevska et al. 2009, Imeri et al. 2010), which lies only a few kilometers away, this could perhaps constitute the origin of the vegetative material that was introduced in lake Great Prespa. Movement of recreational boats and angling equipment between lakes (Brandrud & Mjelde 1999) and transportation through waterfowl (Spicer & Catling 1988) have been suggested as potential vectors of dispersal.

## Conclusions

This report completes the list of all continental European countries invaded by *E. canadensis*. We propose the establishment of a monitoring program, in order to assess the species’ dynamics in the entire lake involving all three countries. As *E. canadensis* has not been reported in the adjacent lake Lesser Prespa, precautionary measures to intercept potential vectors of dispersal, particularly recreational and fishing boats between the two lakes are recommended. Local people, especially the ones participating in boating activities should be informed about the potential threats and available preventive measures.

As this report represents the first confirmed report of *E. canadensis* in Greece, studies towards identifying the potential suitable habitats in Greek freshwater bodies should be carried out through application of species habitat modeling, so as to better assess the vulnerability of water bodies and to better direct available resources for prevention.

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