Research Article

A new invasive neophyte Elodea nuttallii (Planch.) H.St.John for the flora of Türkiye

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Abstract

A new locality of Elodea nuttallii (Planch.) H.St.John (Hydrocharitaceae), native to North America, has been recorded for the first time in Göksu Nature Park (Bolu/Türkiye). Elodea nuttallii is a potentially invasive macrophyte and often confused with Elodea canadensis Michaux, whose existence was previously known in Türkiye. The description, distribution map, notes about the habitat of Elodea nuttallii, and the morphological differences between the two taxa are given in this article.

Key words: aquatic, Bolu, Göksu Nature Park, Hydrocharitaceae, neophyte plants, Northwest Türkiye

Introduction

The genus Elodea Michaux is one of the 14 genera of the Hydrocharitaceae family and is represented by 9 taxa in the world (COL 2022). It is known that any taxa of this genus do not naturally spread in Türkiye (Uotila 1984; GBIF 2001; Bizimbiktikler 2012; Uludağ et al. 2017; POWO 2017; İkinci 2023). However, it could be possible that this is due to the misidentification of Elodea nuttallii (Güneş...
Özkan et al. 2022). In this study, a new *Elodea* species is recorded as a probably invasive neophyte species for the country (Pyšek et al. 2004). Thus, it is confirmed that 2 taxa belonging to the genus *Elodea* occur in Türkiye.

This paper gives the distribution map, a description of the taxon, and notes regarding the habitat where it was found. This study was carried out within the scope of the “Monitoring Plant Species and Identifying Threats in Yedigölle National Park, Kargahi Gölcük and Göksu Nature Parks in Bolu, Aquatic Ecosystem and Habitat Areas” project. The project, financed by Bolu Provincial Directorate of Nature Conservation and National Parks, aims to monitoring plant species and identify threats in aquatic ecosystem and habitats in these areas.

**Materials and methods**

The study area is Aladağ Pond located in the northwest of Bolu, in the A3 square according to the grid system of Davis (1965) and under the effects of the Euro-Siberian Floristic Region. The pond is in Göksu Nature Park, which is located in Çamyayla Village of Bolu Center (Figure 1). Göksu Nature Park with an area of 24.25 hectares, is one of Türkiye’s 262 and Bolu’s 8 nature parks (Tarımorman 2022).

In addition, *Elodea canadensis* specimens were also collected from the same area. Photographs of plant samples collected during fieldwork were taken and morphologically identified (St. John 1965; Uotila 1984; Simpson 1986; Larson 1993; eFloras 2008). Leaf, internode, and bud measurements were made on 20 individuals for each taxon and the specimens compared with the materials of digital herbaria (see section Examined Herbarium Specimens). Since there were no flowers and fruits in the collected samples, that characteristics were compiled from the literature. Measurements were made with Nikon SMZ 745T microscope and microscopic photographs of taxa were taken with Nikon DS-Fi1 camera. Three *Elodea nuttallii* specimens
were recorded in the Herbarium collection of Düzce University Faculty of Forestry (DUOF 10720, 10721, 10722).

The differences between the two taxa are given in the dichotomous key (Ucjeps 1996).

1. Leaves linear, oblong to ovate, 2–5 mm wide, tip obtuse to abruptly pointed; staminate flowers deciduous in late bud or when flowers open, petals ± 5 mm; pistillate sepals ± 2–3 mm ................. *E. canadensis* –

Leaves linear to lanceolate, 0.3–2 mm wide, tip acute; staminate flowers deciduous in bud, petals generally 0 or ± 0.5 mm; pistillate sepals ± 1 mm................................................................................................................................. *E. nuttallii*

**Synonyms and combinations**


**Examined herbarium specimens**

*Elodea canadensis*

CANADA: environs de Montreal, Michaux, (Holotype: P00690054!).


*Elodea nuttallii*

Elodea nuttallii (Planch.) H.St.John in Türkiye


Results

In this study, Elodea nuttallii was found in Türkiye for the first time as a new neophyte record. The first specimens of Elodea nuttallii were detected by the authors in June 2022 in Türkiye. The distribution of the taxon is as follows: TÜRKİYE: A3–Bolu: Göksu Nature Park, at an elevation of 1350 m, in the lake, 09.06.2022, Leg. et Det.: N. Aksoy (8499), N. Güneş Özkan & N. Koçer (Figure 2).

Elodea nuttallii species description

Smaller and more slender than Elodea canadensis. Stems terete, often freely branched. Shoot diameter 7 mm, internodes ca. 5 mm. Buds narrowly, lanceolate, ca. 1.2 × 2.9 mm. Leaves whorls of 3, linear to linear-lanceolate, 6–12 mm long, 0.86–1.80 mm wide, apex narrowly acute to acuminate, margin

Figure 2. Elodea nuttallii and Elodea canadensis in the study area. (Photograph by Google Earth).
Table 1. Morphological differences between *Elodea nuttallii* and *Elodea canadensis*.

<table>
<thead>
<tr>
<th></th>
<th><em>Elodea nuttallii</em></th>
<th><em>Elodea canadensis</em></th>
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<tbody>
<tr>
<td><strong>Habitus</strong></td>
<td>slender</td>
<td>stout</td>
</tr>
<tr>
<td><strong>Internodes</strong></td>
<td>longer, (3–) 4.5–6.5 (–7.5) mm</td>
<td>shorter, (2.7–) 3–4 (–6) mm</td>
</tr>
<tr>
<td><strong>Buds</strong></td>
<td>narrowly, lanceolate, 0.94–1.73 × 2–3.98 mm</td>
<td>broadly, ovoid1–1.91 × 2.5–4.72 mm</td>
</tr>
<tr>
<td><strong>Leaf</strong></td>
<td>shape (linear to linear-lanceolate, narrower 0.86–1.80 × 6–12 mm)</td>
<td>shape (oblong to ovate, broader 2–3.26 × 4–7.33 mm)</td>
</tr>
<tr>
<td></td>
<td>size (narrowly acute to acuminate recurved, undulate)</td>
<td>margin (broadly acute to obtuse flat)</td>
</tr>
<tr>
<td></td>
<td>apex (narrowly acute to acuminate recurved, undulate)</td>
<td>margin (broadly acute to obtuse flat)</td>
</tr>
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*Figure 3. Habitus of *Elodea nuttallii* (A) and *Elodea canadensis* (B). Photographs by Necmi Aksoy.*

recurved, undulate (Table 1). Flowers unisexual; male flowers solitary and sessile in the spathe, sepals ovate, ca. 2 mm long, sometimes reddish; petals lacking or to 0.5 mm long, ovate-lanceolate; stamens 9. Spathes of female flowers borne in upper axils, narrowly cylindric, 9–25 mm long; sepals obovate, ca. 1 mm long; petals white, obovate, longer than the sepals; stigmas slender, shallowly bifid, slightly exceeding the sepals. Fruit narrowly ovoid to fusiform, 5–7 mm long; seeds cylindric or fusiform, 3.5–4.5 mm long. Flowering Jun–Aug (Larson 1993; eFloras 2008).

When compared morphologically with *Elodea canadensis*, there are obvious differences in the following features: habitus is slender, internodes are longer, buds are narrowly lanceolate, leaves linear to linear-lanceolate, narrower, apex narrowly acute to acuminate, margin recurved and undulate (Figures 3 and 4).

*Habitat*

Helophytic plants submerged in the stagnant water of the pond, close to riparian and muddy places vegetation, altitude is 1350 m. (Figure 5). In the habitat where *Elodea nuttallii* grows, the following species accompany it: *Elodea canadensis*, *Polygonum amphibium* L., *Lemna minor* L., *Equisetum arvense* L., *Alisma plantago-aquatica* L.

**Discussion**

Biological invasions are major threats that reduce biodiversity and disrupt ecosystem functioning. Because most of the accessible freshwater in the world is used by humans, it is sensitive compared to terrestrial ecosystems. Thus for freshwater ecosystems, biotic interchange is much more important than terrestrial ecosystems. Some submerged plants, such as *Elodea canadensis* and *Elodea nuttallii*, may build-up a massive biomass, become highly invasive, and cause biotic interchange by replace native plants (Sala...
et al. 2000; OEPP/EPPO 2021). These features can create great pressure on the ecosystem. More efforts are needed to reduce the pressure of alien species on biodiversity and ecosystems. Globally integrated approaches are needed to prioritize, manage, and control them (Latombe et al. 2017). Therefore, first of all, the alien species must be correctly identified and recorded. After that, active monitoring is required.

Reports of this genus for most countries may be based on the misidentification of *Elodea canadensis* because these two species are often confused with each other (Larson 1993; Kočić et al. 2014). Some of the specimens identified as *Elodea canadensis* in some previous studies (Altınayar and Onursal 1982; Uotila 1984; Altınayar 1988; Seçmen and Leblebici 1991; Akköz et al. 2000; Altınsaçlı and Altınsaçlı 2005; Kesici et al. 2009; Leblebici 2018; Ersoy and Turan 2019; Karataş 2019; İkinci 2023) in Türkiye may be *Elodea nuttallii*. For this reason, wetlands with a flora record belonging to the genus *Elodea* may need to be reviewed. This taxon was not found in other lakes examined within the scope of the project "Monitoring Plant Species and Identifying Threats in Yedigöller National Park, Kargalı Gölcük and Göksu Nature Parks in Bolu, Aquatic Ecosystem and Habitat Areas". For now, *Elodea nuttallii* seems to occur only in the Aladağ pond located in the Göksu Nature Park. It can be said that it is a neophyte until detailed studies are conducted on its invasiveness (Pyšek et al. 2004). It is stated that *Elodea nuttallii* is even more competitive than *Elodea canadensis* (Sârbu et al. 2006). Therefore, it will probably become invasive also in Türkiye in the future.

There are many introduction pathways for alien and invasive plants. Intensive angling can be one of the pathways these plants reach the study area. On the other hand, the study area is on the migration route of *Podiceps*
Elodea nuttallii (Planch.) H.St.John in Türkiye


Figure 6. Podiceps cristatus L. in the Aladağ Pond. Photograph by Necmi Aksoy.

Podiceps cristatus L. (1758) (Arslangündoğdu 2011; BOW 2022). According to our observations, this bird spends breeding periods in the Aladağ pond. The bird’s behavior of taking a plant out of the water and presenting it to the female during the mating dance (Güleç 2020) or using this plant in the construction of a nest may be another dispersal means for this species (Figure 6).

Intensive recreational activities such as camping and angling in the area are risk factors for the distribution of native plants. Risk analysis studies should be carried out to determine these factors and their effects.

Dense Elodea nuttallii populations reduce water movement and light penetration, producing anaerobic conditions and trapping sediments. Decomposition of the amounts of biomass at the end of the growing season significantly contributes to the deterioration of water quality and intensification of secondary eutrophication altering the nutrient balance of the entire ecosystem. Further, the species affects local populations of aquatic plants and animals. Dense communities of Elodea nuttallii can displace native species and contribute to the reduction of the diversity of aquatic vegetation. For macrophytes, this effect is usually related to competition for space, light, and nutrients, which leads to the displacement of the native species by the invading species and contributes to the reduction of the diversity of aquatic vegetation (Kolada et al. 2022). It is stated that invasive plants like Elodea nuttallii and Elodea canadensis produce more vegetative propagules in areas with high eutrophication (Hrivnák 2002; Xie et al. 2010). For this reason, water quality should be assessed (Figure 7).

On the other hand, one study suggested that to restore native aquatic animal communities of Procambarus clarkii Girard (1852)-infested ecosystems,
priority should be given to preserving aquatic vegetation, like *Elodea nuttallii*, which has more abundant macro-invertebrate communities than emerging and floating leafy vegetation (Sato et al. 2014). Therefore, the possible positive and negative effects of this invasive species on the natural flora and fauna of the pond should be evaluated and risks should be managed accordingly.

**Acknowledgements**

We would like to thank Prof. Dr. Haldun Müderrisoğlu, and Prof. Dr. Engin Eroğlu, for coordination of the project, and Sertaç Kaya for helping in editing some photos. We thank the editors and reviewers for their valuable comments which improved the article.

**Funding declaration**

The findings in this study were obtained within the scope of the R&D projects supported by the Bolu Provincial Directorate of Nature Conservation and National Parks.

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**Web sites and online databases**


