



First record of *Egeria densa* Planch. (Hydrocharitaceae) for the aquatic Flora of Egypt

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Abstract

Egeria densa Planch. is reported for the first time for the aquatic flora of Egypt. This species is a South American aquatic plant species considered highly invasive outside of its original range. In Egypt, the species may have been introduced as an aquarium plant and has long been wrongly identified as *Elodea canadensis*. However, it was collected from wild habitat at the northern lake of Egypt (Idku Lake). The article presents data on the comprehensive morphological and palynological features, distribution, ecological notes, and conservation status in Egypt of the newly recorded taxon, as well as photographs of herbarium samples, were also provided. This species has not been reported in North Africa, except for Algeria. The new record of its presence in Egypt fills the gap in its general distribution in the warm temperate region of the world. Based on the present study Hydrocharitaceae in Egypt, is now represented by 7 genera viz. *Halophila*, *Thalassia*, *Ottelia*, *Vallisneria*, *Elodea*, *Najas* and *Egeria*. The present data indicate that there are insufficient collections of *Egeria densa* in Egypt considering that the aquatic flora of Egypt is poorly known.

Keywords: *Egeria densa*, Egypt, First record, Hydrocharitaceae, Idku Lake

Introduction

Egeria Planch. (Brazilian waterweed) is a submerged, freshwater, perennial genus of the family Hydrocharitaceae, native to subtropical and temperate South America (Cook & Urmi-König 1984). *Egeria* is morphologically distinguished from other Hydrocharitaceae mainly by its paired scale leaves (prophylls) at the base of lateral shoots, intravaginal squamulus with entire margins, leaves with transparent idioblasts (specialized cells lacking chlorophyll) and leaf margins without fiber cells; in addition, the genus shows unisexual flowers, nine stamens, petals much exceeding the sepals; nectaries on male flowers and staminodia on female flowers are yellow or orange (Cook & Urmi-König 1984; Koehler & Bove 2001).

The genus comprises three species viz. *E. densa* Planch., *E. najas* Planch. and *E. heterostemon* S. Koehler & C.P. Bove. *Egeria densa* is distinguished from the other species by its male flowers having homogenous stamens with filaments clavate and strongly

pappilose; staminodes somewhat more attenuate to the apex and bearing a shorter stalk up to 0.2 mm (Koehler & Bove 2001).

Egeria densa Planch. has been introduced in many countries as aquarium plants. However, it has been escaped from cultivation and become naturalized and invasive in many warm temperate and cold subtropical regions of the world. It is native to the coast of southeastern Brazil, Argentina, and Uruguay (Yarrow et al., 2009). The plant is considered naturalized in the Eastern United States (Cook & Urmi-König 1984), North America (Les & Mehrhoff 1999), Asia ((Haramoto & Ikusimsa 1988, Alfasane et al. 2010), Australia (Roberts et al. 1999), Africa (Maire 1952; Simpson 1989; Coetzee et al. 2011) and Europe (Medina & Cirujano 1995; Sergin 2008; Kikodze et al. 2010; Hussner 2012; Medvecká et al. 2012; Millane & Caffrey 2014; Wasowicz et al., 2014; Fominykh et al., 2016 and Rimac et al., 2018). According to Yarrow et al. (2009), *E. densa*

has been successful as an introduced species and a highly efficient invader due to its high biomass production, fast vegetative reproduction and efficient dispersal, and he considered it as an ecosystem engineer that is capable of modifying or regulating important ecosystem process by preventing the re-suspension of sediments and controlling the growth of phytoplankton.

In Egypt, the number of aquatic weed species in the Nile system is about 50, belonging to 28 genera and 22 families (Boulos 2009; Soliman *et al.* 2018): only seven taxa are native in to Egypt. In the last decades, some of these species disappeared such as *Vallisneria spiralis* L., *Elodea Canadensis* Michx., *Wolffia hyalina* (Delile) Hegelm. and *Alisma plantago-aquatica* L., this can be attributed to human activities and continuous cleaning of the water channels (El Ghani *et al.* 2010). Of these, family Hydrocharitaceae is represented by six genera of which *Halophila*, *Thalassia*, *Najas* are native, while *Ottelia*, *Vallisneria*, and *Elodea* are exotic; these genera included 11 species inhabiting both saline and fresh water (Täckholm *et al.* 1941; Täckholm 1974; El Hadidi & Fayed 1994/95; Boulos 2005 & 2009). This paper aims to report *Egeria* as a new record for the aquatic flora of Egypt and to present a new distributed area for this taxon.

Materials and Methods

During the taxonomic revision of the specimens belonging to the family Hydrocharitaceae kept at the different Herbaria in Egypt [Cairo University (CAI), the Agricultural Research Centre, Flora & phytotaxonomy Herbarium (CAIM), National Research Centre, Plant Systematic Herbarium (CAIRC) and Sohag University (SHG)]. The specimens were identified by relevant literatures (Cook & Urmi-König, 1984; Simpson, 1989); as well virtual Herbaria available on line: (<http://apps.kew.org>), Africa plant database (www.tropicos.org), New York Botanical Garden (NYBG), Harvard University Herbaria & Libraries (HUH) and JSTOR global plants database (<http://plants.jstor.org>) acronyms follows Index Herbarium (<http://sweetgum.nybg.org/ih>). Brief

description, phenology and ecology of the newly recorded species have been provided along with photographs for the taxon.

Pollen grains were also studied to confirm the identification. Samples of pollen were taken from mature anthers. For light microscopy (LM), anthers were boiled for a few minutes in water, macerated in a few drops of an aqueous 10% solution of KOH on a clean slide, then stained with Safranin (1% Safranin solution in 50% ethanol), mounted in glycerin jelly and observations were made with a Sterico research microscope under (E 40, 0.65) using a 16x eye piece. For SEM studies, pollen grains and a piece of leaf margin were mounted onto stubs with double sided adhesive, and then these stubs were sputter-coated with gold (Ion-sputter JFC-1100). After coating, they were examined using JEOL JSM 5400LV scanning electron microscope at 15KV, at the Electron Microscopy Unit, National Research Center, Doki, Giza. The description of pollen follows the terminology of Hesse *et al.* 2009.

Results and Discussion

During the preparation of a taxonomic revision of Hydrocharitaceae in Egypt, the authors came across with *Egeria densa* Planch. collected previously from different localities in different seasons. These specimens were cross-checked with the description provided with some literatures (Cook & Urmi-König 1984; Simpson 1989 and Tanaka *et al.* 2004). This newly recorded taxon was wrongly been identified as *Elodea canadensis* Michx., a closely related taxon, which it differs in having larger leaves (10-30 mm long) arranged in whorls of four or more, not three, and in having more conspicuous flowers with larger broader petals (8–10×3–6mm).

Taxonomic treatment:

Egeria densa Planch. in Ann. Sci. Nat. ser. 3, 11:80 (1849). (**Fig. 1**)

Type: Argentina, in ditione Platensi, prope Bonariam, Tweedie 10 (K, holotype)

Synonyms: *Anacharis densa* (Planch.) Vict. Contr. Lab. Bot. Univ. Montréal 18: 41 (1931).

- *Elodea densa* (Planch.) Casp. Monatsber. Königl. Preuss. Akad. Wiss. Berlin 1857: 49 (1857).

- *Philotria densa* (Planch.) Small, Man. S.E. Fl. 28 (1933).

Dioecious, submerged freshwater herbs, growing in shallow water. It grows up to 1.5 meters. *Stem* monomorphic, elongate, cylindrical, trailing and producing roots at intervals along the stem, sometimes branched. *Branches* one per axil, subtended at the base by a pair of scale-like brownish leaves (*prophylls*), ovate, 2–3 × 2–3.5mm. *Internodes* short, up to 10mm long, give it a very leafy appearance. *Leaves* sessile arranged in whorls of four to five, narrowly oblong to linear-lanceolate, 10–30 × 2–3 (-5) mm, spreading, flaccid, bright green, somewhat translucent, one-veined; gradually attenuate to acute apex; margin shallowly serrulate. *Apex* and *margin* bearing unicellular, thick-walled prickly hairs (Fig. 2A). *Flowers* unisexual; *male spathes* solitary in leaf-axil, sessile, narrowly ovoid, 8–10×3–4 mm, translucent; *male flowers* 2–4 in each spathe, pedicellate, *pedicel* long 40–80 mm long. *Sepals* 3, free, green, ovate and boat-shaped, 2.5–3×1.2–2.3mm,

membranous; *petals* 3, free, white, delicate, widely elliptic, 8–10×3–6mm. *Stamens* 9, homogeneous, 5–7mm long; *filaments* clavate and papillose above, constricted below the yellow *anthers*; *Pollen grains* monads, isodiametric, medium sized, spheroidal, 45–50µm in diameter, inaperturate, *exine sculpture* echinate with fine granules in between (Fig. 2B-D). *Nectaries* obscure.

According to Rimac *et al.* (2018) only male flowers have generally been observed across the whole introduced range, while the plant reproduces via vegetative shoot fragments. In Egypt, the plant has not been observed with female flowers and fruits.

Phenology. - Flowering period in Egypt: August - September

Representative specimens. - Idku Lake, Nile Delta, 19.9.1977; A. Fiky s.n. (CAI)– Beheira Province, Idku, 19.8.1987, A. Amer 12743 (CAI) -Faculty of Science Garden, Alexandria, 1.6.1975; A. Gazzar s.n. (CAI)-Giza; 10.4.1931; E. Greiss s.n. (CAI) - Giza, Faculty of Science garden, 14.3.1936; A. Soliman s.n. (CAI).



Fig. 1. Image of Herbarium specimen of *Egeria densa* (CAI)

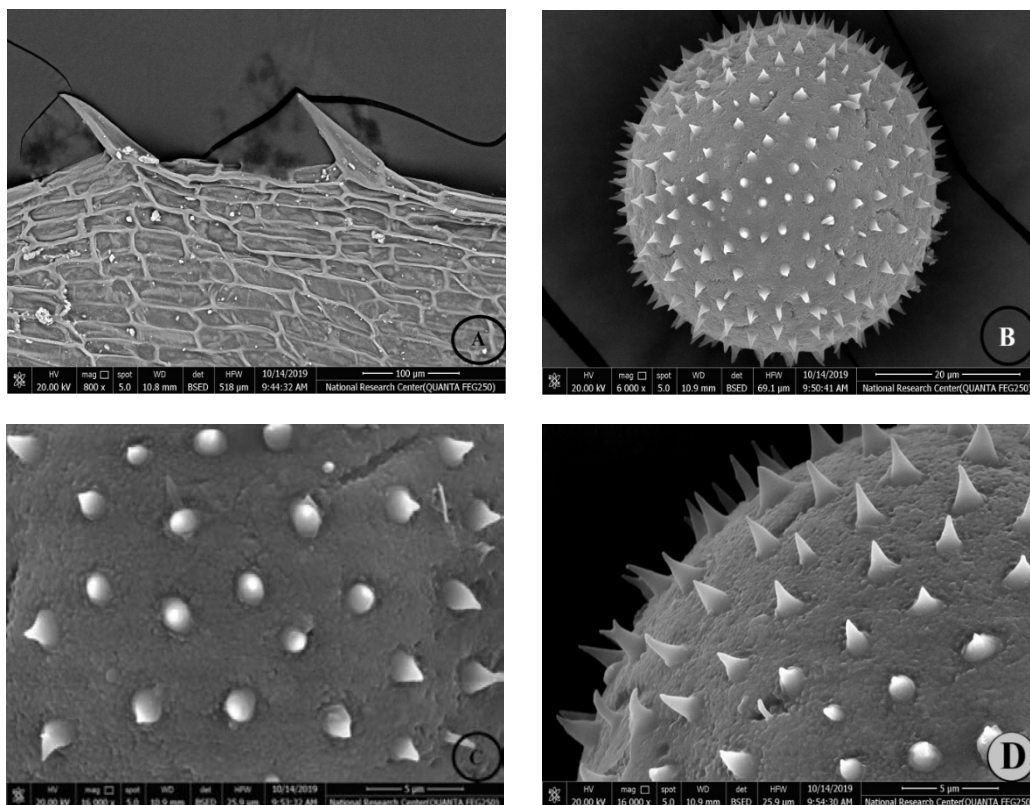


Fig. 2- SEM micrographs of Hair and Pollen grains of *Egeria densa*. **A:** Unicellular, prickly-hairs on the margin of the leaf. **B:** Whole Pollen grain (Spheroidal & symmetric pollen). **C & D:** Exine sculpture (echinate with fine granules in between).

Habitat and Ecology. - *Egeria densa* is frequently dominant in clear water with low light attenuation and is relatively constant in the range between 16° C and 28° C (Carrillo *et al.* 2006, Barko & Smart 1981). The species was found in Lake Edku (Nile Delta) in clear and slow flowing water associated with *Lemna gibba* L., *Potamogeton crispus* L., *Najas marina* L.

The Lake Edku is one of the northern coastal lakes in Egypt, located at the western part of the Nile Delta east of Alexandria and west of Rosetta (Rashid), Situated at 30 km NE of Alexandria. It is one of four coastal deltaic lakes that are connected to the Mediterranean Sea; between altitudes 30° 8' to 30° 28' E & latitudes 31° 10' to 31° 8' N. It has an area of 126 km² and water depth ranging from 50-150 cm. The Lake receives huge amounts of drainage water from three main drains namely, Edku, Bousaly, El-Khairiy and Berseek, which open into the eastern basin of

the lake (Abdel Halim *et al.* 2013; Alnagaawy *et al.* 2018). The lake suffers from many problems as drying up large areas from its water body, over-fishing, chemical and biological pollution and drainage of untreated sewage water in it. Its area has decreased from 28.5 x 10³ to about 12 x 10³ Fadden's as a result of agricultural reclamation (Shaltout *et al.* 2005; Abdel Halim *et al.* 2013).

Taxonomic affinities. - Based on molecular studies, *Egeria* is closely related to genus *Elodea* and treated as sister group of *Apalanthe* (Les *et al.* 1997; Koehler & Bove 2001). The invasive aquatic plants *Hydrilla* and *Lagarosiphon* are also strongly resemble the genus *Egeria*, it can be distinguished from the other genera by its larger size, showy flowers, the leaf whorls and the longest leaves (Simpson 1989).

Conservation Status: The southern part of Lake Edku was dried up and reclaimed with

some parts of our skirting deserts to increase the area of the arable land (El Hadidi 2000); in addition, the climatic changes and environmental factors and pollution affect the diversity and distribution of macrophytic vegetation in the Nile Delta of Egypt (El-Ghani *et al.*, 2010). These may lead to the disappearance of this species from Egypt.

Distribution: Native to Eastern South America (SE Brazil, coast of Argentina, and coast of Uruguay), now widely introduced as aquarium plant and naturalized in other parts of the world including N America, Europe, Asia (Japan, Bangladesh, Indonesia, Nepal), Africa (Algeria, Kenya, South Africa) and Australia. In Egypt, here recorded from the Nile Delta, Lake Edku. (Fig. 3).

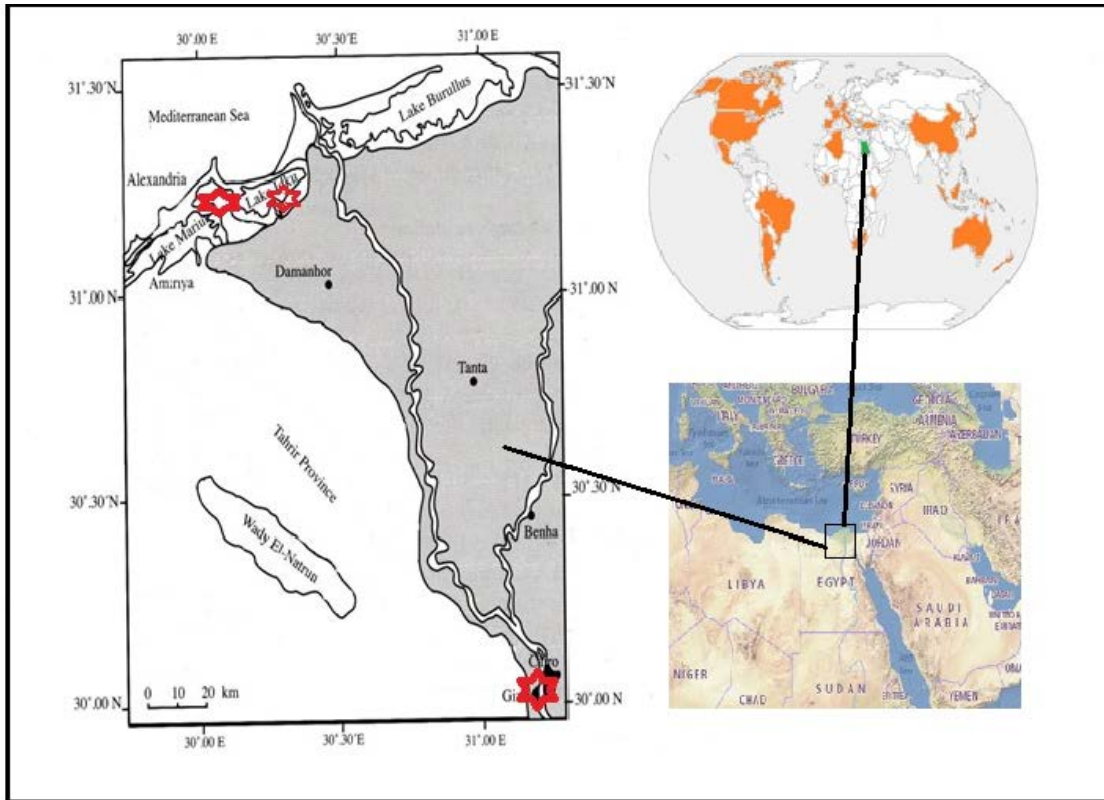


Fig. 3. Distribution map of *Egeria densa* in the world and in Egypt (★).

Conclusion

This species may have been introduced to Egypt through introduction as aquarium plant as it was found growing mostly in gardens. However, some were collected from wild habitat at the northern lake of Egypt (Idku Lake, altitudes 30° 8' to 30° 28' E & latitudes 31° 10' to 31° 8' N), which receive the main bulk of drainage water from the Nile Delta. This species has not been reported yet in the North Africa, except for from Algeria (Maire 1952) and is the first record in Egypt. The new record of its presence in Egypt fills the gap in its general distribution in the warm temperate region of the world. Based on the present study, the Hydrocharitaceae are now

represented by 7 genera viz. *Halophila*, *Thalassia*, *Ottelia*, *Vallisneria*, *Elodea*, *Najas* and *Egeria* in Egypt. The present data indicates that there are insufficient collections of *Egeria densa* in Egypt. Considering that the aquatic flora of Egypt is poorly known, the distribution of the *Egeria densa* in this study may be a much larger than currently known; more work is needed.

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