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Rapid Communication

New record of *Hygrophila corymbosa* (Blume) Lindau (Acanthaceae) for Mexico, a highly invasive aquatic weed

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Abstract

The presence of *Hygrophila corymbosa* (Blume) Lindau within the Mexican aquatic flora is recorded for the first time. This species is native to Asia and is commonly used as an ornamental plant in aquariums, so it is possible that its introduction was accidental. Due to its high potential for reproduction and dispersion, *H. corymbosa* represents a great threat to the native aquatic flora of the wetlands of Mexico. More studies are recommended to explore ecological aspects of the plant to facilitate its control and/or eradication.

Key words: aquarium plant, hydrophyte, introduced plant, Tamaulipas, wetland

Introduction

Aquatic ecosystems are seriously threatened today by natural and anthropogenic causes (Mitsch and Gosselink 2000). The activities that have been most damaging to wetlands and their biota are pollution and land use change (Landgrave and Moreno-Casasola 2011). However, the accidental introduction of exotic aquatic species has also contribute to wetland degradation since, in many cases, these species displace native species in many regions of the world (Mendoza and Koleff 2014).

In Mexico, there are a wide variety of wetlands, but currently 62% of them have been damaged for several reasons, including the introduction of exotic species (Landgrave and Moreno-Casasola 2011). At least 13 species of non-native obligate aquatic plants have been registered, some of them exhibiting invasive behavior in Mexican wetlands (Mora-Olivo et al. 2013). Examples of these are *Hydrilla verticillata* (L.f.) Royle (Novelo and Martínez 1989), *Myriophyllum aquaticum* (Vell.) Verdc. (Bonilla-Barbosa and Novelo 1995), *Hygrophila polysperma* (Roxb.) T. Anderson (Mora-Olivo et al. 2008) and *Salvinia molesta* D.S. Mitch. (Mora-Olivo and Yastkievych 2009).

Although the presence of exotic aquatic plants has been reported in most of Mexico, the border and coastal regions are probably the most susceptible to problems of introduced species. This is perhaps because of the lack of strict regulations by the Mexican government on the introduction of plant specimens, seeds and propagules. This is the case in Tamaulipas which, until now, has been the state with the highest number of exotic strict hydrophytes established in both natural and artificial environments (Mora-Olivo et al. 2013).

In this study, the presence of *Hygrophila corymbosa* (Blume) Lindau, a plant typically used as ornamental in tropical aquariums, is registered for the first time in Mexico. This aquatic weed is naturally distributed in regions of Asia such as India, Burma, Malaysia and Indonesia (Paffrath 1979; Hutchinson and Williams 2013). Moreover, has been introduced and naturalized in Taiwan water bodies (Wu et al. 2010) and in the United States of America (Wunderlin et al. 2017) where it is considered a potential

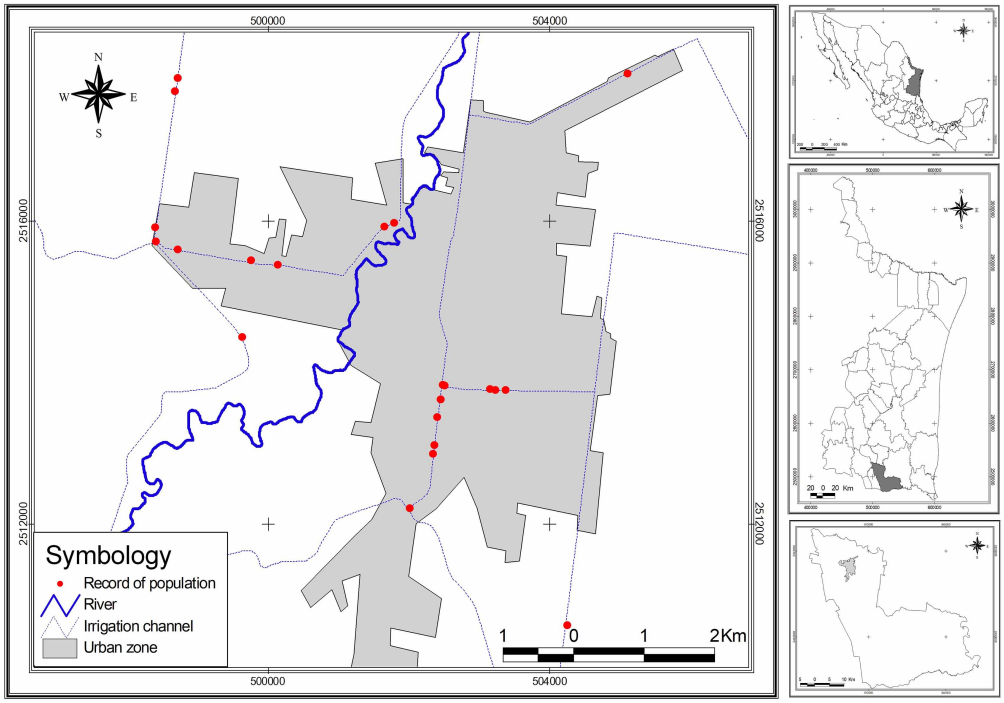

Figure 1. Study area and location of registration sites *Hygrophila corymbosa* in Tamaulipas, Mexico.

danger due to its rapid spread and invasive nature (USDA 2015). The first official record for North America was made by Ramamoorthy and Turner (1992) in San Felipe Springs, a Texas town near the border with Coahuila, Mexico. However, some herbarium collections indicate that this plant has been in Florida since 1987 where it has already naturalized (Hutchinson and Williams 2013). With this report, there are now two species of the genus *Hygrophila* R.Br. (*H. corymbosa* and *H. polysperma*) documented in Tamaulipas that are a threat to native aquatic flora due its invasive character.

Material and methods

Study area

The study was conducted within the municipality of El Mante, in the state of Tamaulipas located in NE Mexico (22º44′5″N; 98º58′29″W), at an altitude of 80 m a.s.l. (Figure 1). The climate is sub-humid, with an average temperature of 40 to 46 °C in the months of June and July, and 4 to 26 °C in the months of November and December. The precipitation reaches 1000 mm in this area. The main river is the Mante and there is also an irrigation net (1 to 3 m of depth) that provides water to the agricultural crops of the region (GET 2013).

Registration and identification

The first visual and photographic records of the plant was in March 2007 in an irrigation water channel of the El Mante. Although the species was not identified then, its characteristics indicated that it belonged to the genus *Hygrophila*. Later, as part of a formal study of the aquatic vascular flora of the El Mante municipality between 2013 and 2017, specimens of the plant species present in natural and artificial aquatic ecosystems were collected. The novel hydrophyte photographically recorded in 2007 was observed to be more common and formed large populations, particularly in the agricultural irrigation water channel habitats. Although most of the observed individuals were submerged and in a vegetative state, some of these were emerging, producing flowers and seeds. Thus fertile material was used for the taxonomic identification of specimens as *Hygrophila corymbosa*, a member of Acanthaceae family (Wunderlin et al. 2017).

Specimens examined

Next, data of two specimens collected from *H. corymbosa* that serve as reference for a collection of herbarium are given. MEXICO: Tamaulipas: Municipality El Mante, irrigation water channels within the

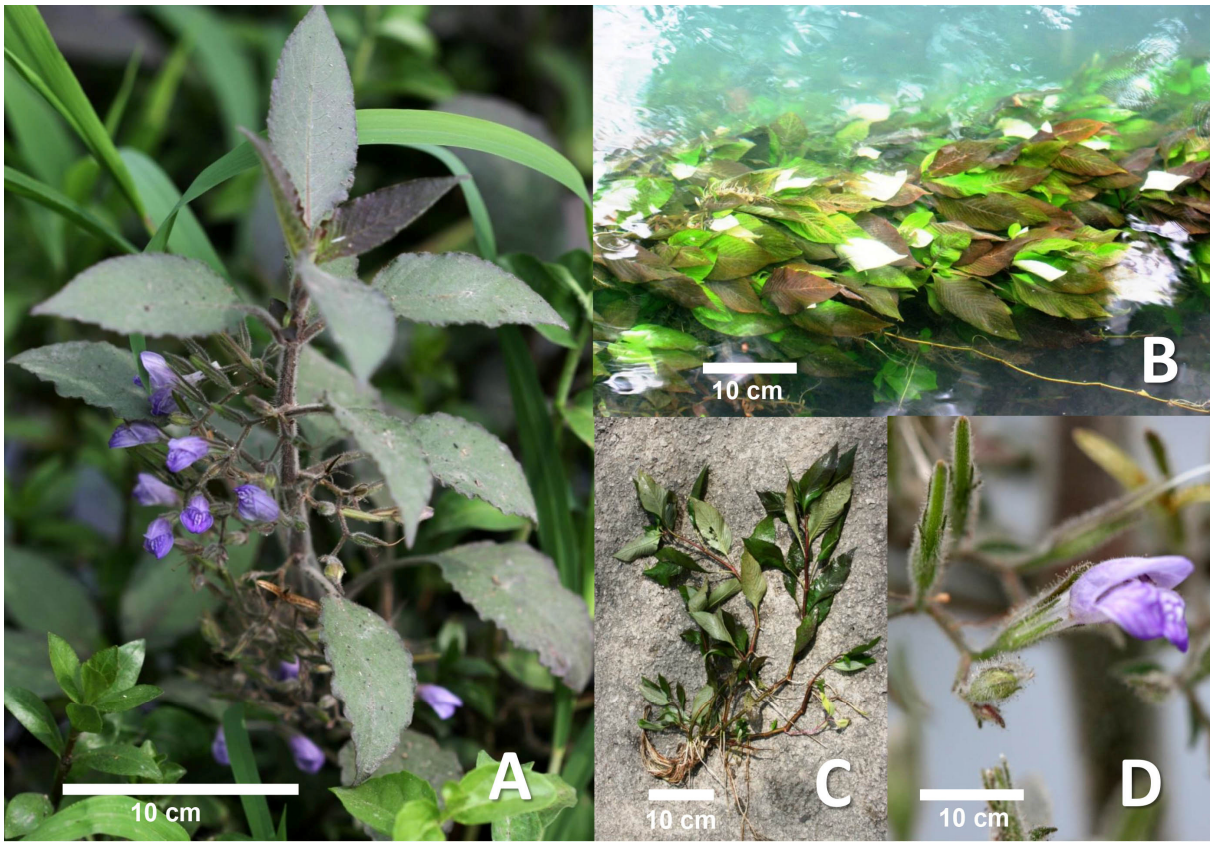

Figure 2. *Hygrophila corymbosa* in Cd. Mante, Tamaulipas, Mexico. (A) emerging plant, (B) submerged plant, (C) complete specimen with roots, (D) flower detail. Photos by Arturo Mora-Olivo.

urban area, 22º44′54.25″N; 99º00′26.89″W, 80 m a.s.l., 2 October 2015, A. Mora-Olivo 15620 (UAT); irrigation water channels, 22º43′56.66″N; 98º58′09.20″W, 83 m a.s.l., March 7, 2014, L.A. Alvarez 121 (UAT).

Results

Description of the species

The registered specimens of *H. corymbosa* are submerged or emergent rooted herbs up to 70 cm in length (Figure 2). Almost the entire plant is covered with dense glandular hairs on the aerial parts. The stems are quadrangular and are rooted in the lower nodes. The leaves are opposite, with blades ovate-lanceolate to ovate-elliptic, 5 to 12 cm long and 2 to 5 cm wide, dark green in the bundle (sometimes reddish in the submerged leaves) and whitish green on the underside, the margin is whole to crenulated or wavy. The flowers are arranged in axillary corymbs and the corolla is purple with small white spots on the lower lip. The fruit is an elongated capsule of 7.5 to 11 mm in length, with numerous discoid seeds.

Description of populations (meadows)

To date, 25 meadows have been documented, distributed along different irrigation water channels, where they currently occupy an area of approximately 5 km^2 (Supplementary material Table S1). Submerged plants grow profusely in the deepest areas, forming monospecific beds or associated with other submerged hydrophytes such as *Hygrophila polysperma*, *Potamogeton illinoensis* Morong and *Ludwigia repens* J.R. Forst. In the margins of the water channels few emergent specimens are found, which are usually associated with species such as *Hymenachne amplexicaulis* (Rudge) Nees, *Paspalum denticulatum* Trin. and *Trichocoronis wrightii* (Torr. & A. Gray) A. Gray.

Discussion

Most of the species of the Acanthaceae family are terrestrial, although some genera like *Justicia* Raf. and *Hygrophila* have aquatic representatives. In Mexico, Acanthaceae are among the 15 most diverse families of vascular plants with 36 genera and 376

native species (Daniel 2013; Villaseñor 2016). Of the 100 known species of the genus *Hygrophila* (Jiaqui et al. 2011), three of them (*H. polysperma, H. costata*, and *H. corymbosa*) are currently present in Mexico (Mora-Olivo et al. 2008). Although only *H. costata* is native in Mexico, the three species are considered invasive aquatic weeds in different parts of the world (Csurhes 2008; USDA 2015).

As other species of the same genus, *H. corymbosa* reproduces mainly vegetatively, so a stem fragment may produce new individuals as we observed in this studied area (USDA 2015). Furthermore, during field visits, bees (*Apis mellifera* L.) were found on flowers and the formation of fruits with possibly viable seeds was observed. It has also been observed that *H. corymbosa* develops and disseminates fast along the channels, both submerged and emergent growth forms. Vegetative recruitment abilities, successful reproduction efforts, rapid growth, and tolerance to a wide range of environmental characteristics including the disturbance and excess nutrients (Hutchinson and Williams 2013) make *H. corymbosa* a potential threat to native hydrophytes of Tamaulipas.

Since *H. corymbosa* is a popularly ornamental plant in tropical aquariums, it is possible that it was accidentally introduced by this route in Mexico where varieties are currently sold online (Martínez 2016). Another possible entry could have been through boats and fishing gear, as the area is frequently visited by tourists and fishermen from other regions. Because the collected plants are fertile, there is also the possibility that the seeds have been dispersed to this place by waterfowl, as has been occurred with other vascular hydrophytes in different parts of the world (Green et al. 2002).

Until now, *H. corymbosa* has only been registered in the urban area of the municipality of El Mante, although there is a risk of it expanding its distribution to more northern sites as the invaded irrigation channels flow into the Guayalejo river. This would make it possible in the future for this weed to invade the extensive wetlands of the Guayalejo-Tamesí river basin where the states of Tamaulipas, Veracruz and San Luis Potosí converge; an important area because of the high richness of aquatic flora in the country (Rzedowski 1978; Mora-Olivo and Villaseñor 2007). On the other hand, the presence of *H. corymbosa* in Texas bodies of water that are connected to the Rio Grande could create a supply chainel for this aquatic weed for the Mexican states of Coahuila, Nuevo León or Tamaulipas (Ramamoorthy and Turner 1992).

Although the process of regulating the introduction of invasive species has intensified in Mexico, the results are still insufficient (CANEI 2010; Ortiz-Monasterio 2014). This situation puts the native species that inhabit important wetlands, such as the Guayalejo-Tamesí river lagoon system and Rio Grande delta, at greater risk. For this reason, it is important that Mexican authorities pay special attention to the areas of greatest risk of aquatic invasions, such as border and coastal areas. Particularly in the case of invasive aquatic weeds, further studies on the ecology and dispersal mechanisms of these species are necessary to contribute to their control and/or eradication.

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References

Bonilla-Barbosa J, Novelo A (1995) Manual de Identificación de Plantas Acuáticas del Parque Nacional Lagunas de Zempoala, México. Instituto de Biología, UNAM, México, Serie Cuadernos No. 26, 168 pp

CANEI (2010) Comité Asesor Nacional sobre Especies Invasoras. Estrategia Nacional sobre Especies Invasoras en México, Prevención, Control y Erradicación. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Comisión Nacional de Áreas Protegidas, Secretaría del Medio Ambiente y Recursos Naturales, México, 91 pp

Csurhes S (2008) Pest Plant Risk Assessment. Glush Weed *Hygrophila costata*. The State of Queensland, Department of Primary Industries and Fisheries, Australia, 6 pp

Daniel TF (2013) Mexican Acanthaceae: Updated summary, new or noteworthy distribution records, and a list of taxa in Jalisco, Mexico. *Ibugana* 4: 3–15

GET (2013) Gobierno del Estado de Tamaulipas. Plan Municipal de Desarrollo 2013-2016, del Municipio de El Mante, Tamaulipas. Periódico Oficial del Estado de Tamaulipas, PP28-0009, 30 pp

Green AJ, Figuerola J, Sánchez MI (2002) Implications of waterbird ecology for the dispersal of aquatic organisms. *Acta Oecologica* 23: 177–189, https://doi.org/10.1016/S1146-609X(02)01149-9

Hutchinson J, Williams C (2013) *Hygrophila corymbosa* – A "rare" but potentially invasive plant from San Felipe Springs, Del Rio, Texas. *Aquatics* 35(2): 14–18

Jiaqui Hu, Yunfee D, Daniel TF (2011) *Hygrophila*. *Flora of China* 19: 430–432

Landgrave R, Moreno-Casasola P (2011) Evaluación cuantitativa de la pérdida de humedales en México. *Investigación Ambiental* 4(1): 19–35

Martínez H (2016) AquaplantasMx. https://aquaplantasmx.com/products/hygrophila-corymbosa-siamensis-53b-1?variant=1654085633 (accessed 8 October 2016)

Mendoza RE, Koleff P (2014) Especies acuáticas invasoras en México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, 308 pp

Mitsch WJ, Gosselink JG (2000) Wetlands. John Wiley & Sons Inc. New York, 920 pp

Mora-Olivo A, Villaseñor JL (2007) Diversidad y distribución de la flora vascular acuática de Tamaulipas, México. *Journal of the Botanical Research Institute of Texas* 1: 511–527

Mora-Olivo A, Yatskievych G (2009) *Salvinia molesta* in Mexico. *American Fern Journal* 99: 56–58, https://doi.org/10.1640/0002-8444-99.1.56

Mora-Olivo A, Daniel TF, Martínez M (2008) *Hygrophila polysperma* (Acanthaceae), una maleza acuática registrada por primera vez para la flora mexicana. *Revista Mexicana de Biodiversidad* 79: 265–269

Mora-Olivo A, Villaseñor JL, Martínez M (2013) Las plantas vasculares acuáticas estrictas y su conservación en México. *Acta Botanica Mexicana* 103: 27–63, https://doi.org/10.21829/abm103.2013.50

Novelo A, Martínez M (1989) *Hydrilla verticillata* (Hydrocharitaceae), problemática maleza acuática de reciente introducción en México. *Anales del Instituto de Biología Universidad Nacional Autónoma de México, Serie Botánica* 58: 97–102

Ortiz-Monasterio A (2014) Gestión de las especies exóticas invasoras: análisis de la legislación mexicana. In: Mendoza R, Koleff P (eds), Especies Acuáticas Invasoras en México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, pp 169–184

Paffrath K (1979) *Hygrophila corymbosa* (Blume). *Aqua Planta* 4(3): 9–10

Ramamoorthy TP, Turner BL (1992) *Nomaphila stricta* (Acanthaceae), a newly discerned aquatic weed in Texas, and the first report for North America. *Sida* 5: 115–117

Rzedowski J (1978) La Vegetación de México. Limusa. Mexico, D.F., 504 pp

USDA (2015) United States Department of Agriculture. Weed Risk Assessment for *Hygrophila corymbosa* (Blume) Lindau (Acanthaceae) – Temple plant. Animal and Plant Health Inspection Service, Version 1, Raleigh, 16 pp

Villaseñor JL (2016) Checklist of the native vascular plants of Mexico. *Revista Mexicana de Biodiversidad* 87: 559–902, https://doi.org/10.1016/j.rmb.2016.06.017

Wu S-H, Yang TYA, Teng Y-C, Chang C-Y, Yang K-C, Hsieh CF (2010) Insights of the latest naturalized flora of Taiwan: Change in the past eight years. *Taiwania* 55(2): 139–159

Wunderlin RP, Hansen BF, Franck AR, Essig FB (2017) Atlas of Florida Plants [S. M. Landry and K. N. Campbell (application development), USF Water Institute.] Institute for Systematic Botany, University of South Florida, Tampa. http://florida.plantatlas.usf.edu/ (accessed 16 September 2017)

Supplementary material

The following supplementary material is available for this article:

Table S1. Meadows of *Hygrophila corymbosa* in irrigation water channels in Mante, Tamaulipas, Mexico: site, locality, coordinates, height, life form, associated species.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2018/Supplements/BIR_2018_Mora-Oliva_etal_Table_S1.xlsx