

CONSIDERATIONS UPON THE MORPHOANATOMICAL FEATURES OF DECORATIVE AQUATIC PLANTS *Hydrocharis laevigata* AND *Lagenandra meeboldii*

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Abstract

Two aquatic plant species were subjected to this study: *Hydrocharis laevigata* synonym *Limnobium laevigatum* (Alismatales: Hydrocharitaceae) and *Lagenandra meeboldii* (Alismatales: Araceae).

The paper presents first insight into the microscopic aspects of cross-sections made through root, petiole and leaves of in-vitro plant *L. laevigatum* and *Lagenandra meeboldii* 'Red' form, biological material purchased from the Romanian market of ornamental aquarium plants.

Considering the invasive potential of South American spongeplant, already well documented for other European countries, this short survey draws attention to the danger represented by releasing decorative aquatic plants from aquarium as a factor involved in a possible future spreading of this species into natural environments.

Key words: aquascaping plants, cross-sections, invasive, morphology, ornamental.

INTRODUCTION

Aquascaping is a concept involving the art and the science of creating sustainable underwater environments, using plants, fishes, rocks or wood, the plant species being chosen to oxygenate the water or to reduce algae (Buta et al., 2013).

Despite their attractiveness for gardeners and aquarists, some aquatic plants can rapidly spread as invasive species representing a significant threat to ecosystems in their non-native range (Pliszko & Górecki, 2021; Garcia-Murillo, 2023). In a highly globalized world, humans are vectors for the increasing number of non-native aquatic plant species in Europe (Grzybowski & Glińska-Lewczuk, 2019).

Aquarium trade is a major pathway for non-native plants introductions and releasing live aquarium species into lakes or streams could hurt the environment (Olson et al., 1998; June-Wells et al., 2012; Pérez & Seewald, 2019).

The floating-leaf aquatic species *Hydrocharis laevigata* (Humb. & Bonpl. Ex Willd.) Byng & Christenh. syn. *Limnobium laevigatum* (Humb. & Bonpl. ex Willd.) Heine (Family Hydrocharitaceae), commonly named South American spongeplant, smooth frogbit or

Amazon frogbit, native to inland South America, was observed in several European freshwater habitats such as ponds, rivers or reservoirs (Garcia-Murillo, 2023). Of six countries (Belgium, Hungary, Iberian Peninsula, Poland, Sweden, Netherlands) where South American spongeplant was recorded, the only known naturalised populations are in Hungary and in Spain (Garcia-Murillo, 2023). This fleshy perennial monocot herb has been also spread in North America, Asia, Australia and Africa (Howard et al., 2016; USDA Plants Database). Introductions of *H. laevigata* outside its natural range were attributed to ornamental plant trade, movements of water birds, fishing gear and boats, eutrophication of inland waters and the effects of global warming, nowadays being considered a harmful weed (Howard et al., 2016; Garcia-Murillo, 2023).

Concerning the description of South American spongeplant, it was stated that this stoloniferous floating and emergent aquatic species has subcircular leaves, glabrous and glossy above with a thick layer of air-filled spongy tissue beneath, spongy aerenchyma tissue upon the underside of the leaf (CABI Compendium, 2016; Pliszko & Górecki, 2021;

Garcia-Murillo, 2023). However, as far as we know, there are still no data involving the microscopic aspects of cross-sections of vegetative plant parts belonging to *H. laevigata* or *L. laevigatum*. Hence, the aim of this research was to provide an update knowledge on the morpho-anatomy traits in such Alismatales species currently found in the Romanian market for decorative aquarium plants.

Summing up the data provided by the aquarium and terrarium websites, in-vitro aquarium plant *Limnobium laevigatum* presents the following features: ideal decorative floating algae-preventive plant, suitable for garden ponds and aquariums, 1-5 cm tall and leaves from 5 to 15 cm wide, with long and decorative roots offering protection to surface fish. The species is also promoted as a valuable plant with good purifying abilities, undemanding and rapid spreading.

On the other hand, *Lagenandra meeboldii* (Engl.) C.E.C. Fischer is a member of *Lagenandra*, a genus of Araceae family plants endemic to Indian Subcontinent (Sivadasan et al., 2001). Recently been known for aquascaping, including in Romania, *L. meeboldii* 'Red' or Meebold's *Lagenandra* red form is usually described by ornamental websites as a rare submersed plant, with colors ranging from green, bright violet and red often on the same leaf, up to 15 cm tall, with a thick rhizome, leaves from 4 to 8 cm wide and 6-12 cm long and a slow growth rate, being suitable for all aquarium sizes. Yet, as in the case of the previous species from the Alismatales order, there are currently no available data regarding the microscopic description of cross-sections made through this aquatic plant.

MATERIALS AND METHODS

Fresh plant material belonging to South American spongeplant and Meebold's *Lagenandra* aquatic plants was used for the purpose of this study, the source of purchasing being represented by decorative plants available on the Romanian aquarium market: *in vitro* plant *Limnobium laevigatum* and *Lagenandra meeboldii* 'Red' form, respectively. The descriptive data used herein came from the specialized literature, internet

databases such as CABI, EPPO Global Database and USDA PLANTS but also those listed on various websites that advertise and sell these Alismatales ornamental aquatic species.

In addition, several cross-sections (Andrei, 2003) made through root, petiole and leaves of the each analyzed species were performed in the laboratory of Biology Programme, from the Faculty of Agriculture, USAMV of Bucharest. Observations of the wet mount slides and photographs were made under a Motic Panthera binocular microscope.

RESULTS AND DISCUSSIONS

Morpho-anatomic characteristics of *Hydrocharis laevigata* syn. *Limnobium laevigatum*

The analyzed plants belonging to South American spongeplant purchased from Romanian aquatic plants market present petiolate, reniform leaves, with cordate base and entire margins (Figure 1-a).

The root has numerous, rough hairs (Figure 1-b). In cross-section it consists of epidermis, cortical parenchyma and central cylinder. The cortex contains numerous layers of cells (Figure 1-c). The central cylinder shows few liberian fascicles, metaxylem and protoxylem. In the particular case of the analyzed material, four woody and four liberian fascicles were noticed (Figure 1-d).

In cross section, the petiole is semicircular (Figure 1-e). The mixed conducting fascicles (woody and liberian) are numerous in the mass of aerifer parenchyma of the central cylinder (Figure 1-f).

The leaf of investigated specimen is very thick, leathery and has a spongy tissue on the lower side (Figure 1-g). In the Figure 1-h can be noticed the upper epidermis covered by cuticle, the lower epidermis, and in between the mesophyll of the leaf.

The lower surface of the leaf has a aerenchyma filled with spongy and soft parenchyma (Figure 1-i), while the cells on the upper leaf surface are elongated, rich in chloroplasts (Figure 1-j). The conducting tissues are poorly developed.

Morpho-anatomic characteristics of *Lagenandra meeboldii* ‘Red’

The wide leaves of *L. meeboldii* ‘Red’ analyzed specimen (Figure 2-a) are petiolate, ovate lanceolate, with an acute apex, elongated base and entire margins, adventitious roots and a strong rhizome on which the leaves form. As well as the same Araceae family, *Cryptocoryne*, *Lagenandra* genus has many kinds with different leaf shapes and colors, red leaves for *L. meeboldii* ‘Red’ turning green when plant is in a dark environment underwater (Web Aqua Journal, 2020).

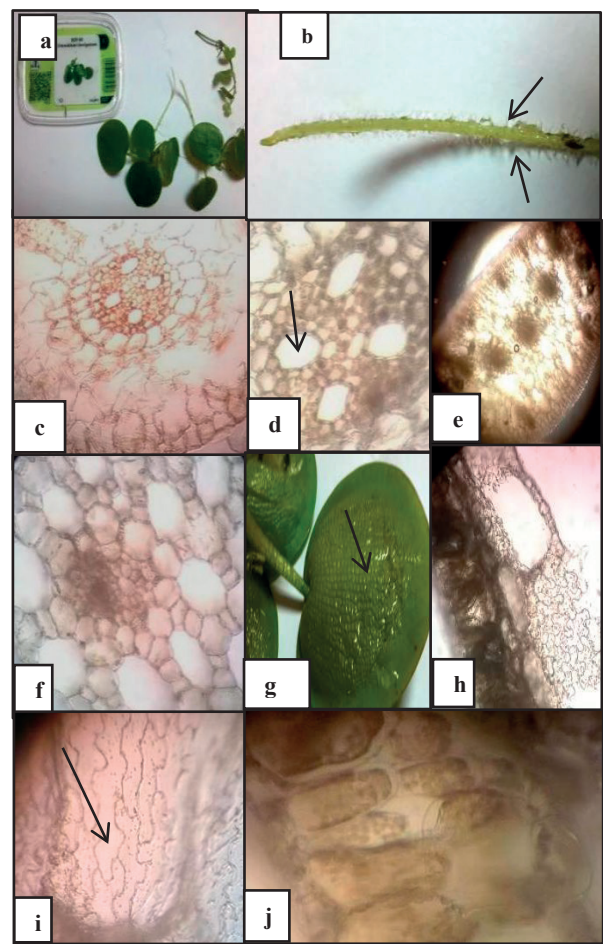


Figure 1. *In vitro* aquatic plant *Limnobium laevigatum* purchased from aquascaping market: a. general aspect; b. root hairs (arrows); c.-d. cross-sections through the root (arrow indicates metaxylem); e.-f. cross-sections of the petiole; g. lower surface of the leaf (spongy tissues: arrow); h.-j. cross-sections through the leaves: spongy parenchyma indicated by the arrow (i); j. chloroplasts of the upper surface

In cross-section, the root (Figure 2-b) presents single layered epidermis, the highlighted exoderm and cortical parenchyma formed by numerous layers of cells. The endoderm is

evident, the cells showing typical thickenings. The central cylinder is condensed, it presents phloem vessels that alternate with woody vessels (metaxylem and protoxylem), numerous but poorly developed.

The petiole of the leaf has a single-layered epidermis covered by a thick cuticle. Oil deposits are possibly present in the parenchyma (Figure 2-c). The conducting tissue is represented by the numerous bundles of mixed phloem and xylem (Figure 2-d) irregularly arranged in the central cylinder.

Single layered epidermis with thick cuticle in the structure of the petiole and single layered epidermis of the root were anatomical characters also observed by Selvakumari (2014) in *Lagenandra toxicaria*, a marsh herb endemic of South India.

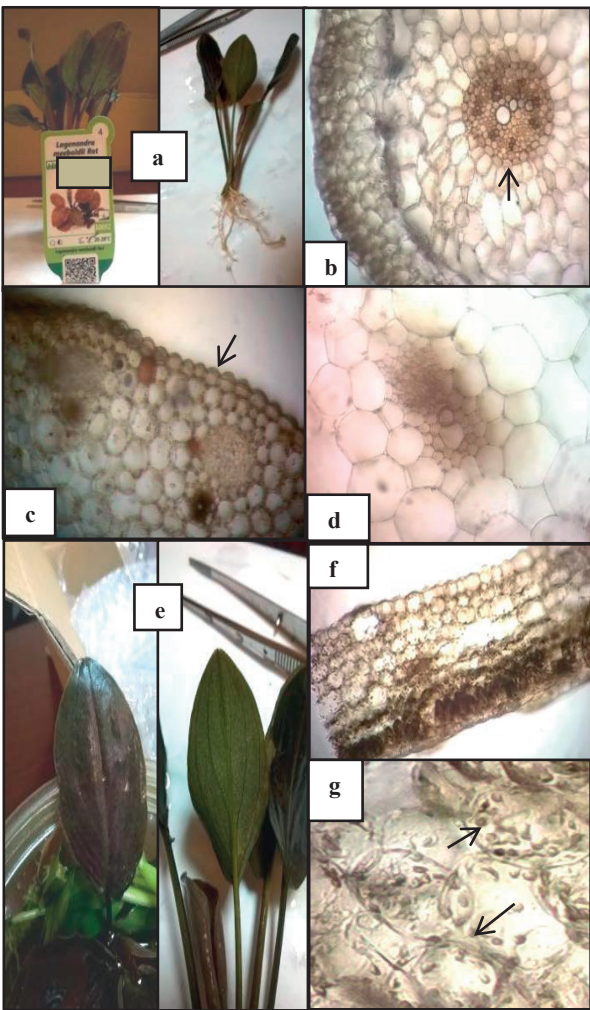


Figure 2. *Lagenandra meeboldii* ‘Red’ form: a. general aspect; b. cross-section of the root (arrow: central cylinder); c, d. cross-sections of the petiole (cuticle indicated by the arrow); e. leaf - upper and lower surface; f. cross-sections through the leaf; g. chloroplasts (arrows)

The leaf of *L. meeboldii* (Figure 2-e) consists of the upper epidermis (single layer of cells), the lower epidermis, and the mesophyll in between (Figure 2-f). The cells of the upper epidermis, rich in chloroplasts (Figure 2-g), are protected by a developed cuticle. The conducting tissue is represented by the mixed phloem and xylem fascicles.

In a previous study (Săndulescu et al., 2014) upon the morpho-anatomic features of some aquatic plants, another two Alismatales species were analyzed: *Hydrocharis morsus-ranae* (Hydrocharitaceae) and *Anubias barteri* (Araceae).

Concerning a comparison between *H. morsus-ranae*, a free-floating annual herbaceous aquatic plant, with leaves becoming emergent when the vegetation is dense enough (O'Neil, 2007) and *H. laevigata* subjected to the present report, it can be noticed that the leaf has the same structure with the difference as in *Hydrocharis laevigata* syn. *Limnobium laevigatum* the aerenchyma is filled with more spongy tissue. The petiole of both Hydrocharitaceae plants present aerenchyma well developed.

As for a parallel between *Anubias barteri*, West African species that survives either totally or partially submersed (www.liveaquaria.com) and *Lagenandra meeboldii* herein, the following remarks can be outlined: both Araceae species present the exoderm in the root structure and numerous woody and liberian conducting bundles; the petiole of both shows numerous mixed (liberian and woody) conductive bundles arranged irregularly in the parenchyma; the structure of the leaf is similar, with cells rich in chloroplasts under the upper epidermis, and no observed developed aerenchyma.

An aerenchyma more developed existing in the two mentioned members of Hydrocharitaceae compared to the two Araceae species could be explained by the fact that first family include floating, while the latter fixed to the substrate aquatic plants.

CONCLUSIONS

Lagenandra meeboldii is rather considered a rare plant, whose introduction is not yet regarded as dangerous in Romania. The same

cannot be stated about South American spongeplant, whose invasive potential has been well documented so far in other countries. Although in our country there have been no reports of the presence of *Hydrocharis laevigata* syn. *Limnobium laevigatum* in natural environments, it may only be a matter of time until the South American spongeplant can be identified in freshwater ecosystems as invasive species.

On the occasion of this morphological study, the attention is drawn to the awareness of invasion of *H. laevigata*, possibly by aquatic nursery trade, as predicted for other European territories.

Future research will focus on tracking the releasing and spreading of these ornamental Alismatales species in the Romanian natural aquatic landscapes.

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