Scientific Papers. Series A. Agronomy, Vol. LX, 2017
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

MORPHOLOGICAL CHARACTERIZATION OF *Alisma plantago-aquatica* L. (*Alismataceae*): A CASE STUDY AND LITERATURE REVIEW

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Abstract

This study focuses on some structural features noticed in Alisma plantago-aquatica. With plant material collected from Bugeac Lake (Dobrudja), the morphological analysis of water-plantain's vegetative organs is reported herein. In our survey, cross-sections were performed throughout the stem and stalk. Also, we examined the literature knowledge on A. plantago-aquatica, in terms of importance and adaptative changes of this perennial plant to wetland ecosystems highlighted by characteristics of leaves and root system.

Key words*: Alisma plantago-aquatica, wetland, vegetative organs, cross section.*

INTRODUCTION

The species of *Alisma* aquatic genus are mainly found in the northern hemisphere, growing in the muddy edges of marshes and lakes (Robinson, 2004). Common water-plantain, *Alisma plantago-aquatica* L. (Alismatales. Alismataceae) is a shoreline plant, characterized by lance-shaped leaves, with many tiny pale lilac flowers blooming from June to August, each with three petals and three sepals, disposed on a pyramid-shape inflorescence, taller than the rest of the plant (http://www.nzpcn.org.nz/; https://agr.mt.gov/). Also known as devil's spoons, mad dog weed or thumbwort, this wetland perennial plant is a widespread species occurring from Northern Europe to Africa and Southeast Asia and is reported native in Romania (http://www.kew.org/science-conservation/; Lansdown, 2014).

As far as we know, *A. plantago-aquatica* was analyzed before in terms of phytochemical compounds (Chau et al., 2007), water and osmotic potentials (Klymchuk et al., 2008), phenotypic plasticity (Kordyum et al., 2012), embryogenesis (Świerczyńska and Bohdanowicz, 2014), heavy metal adsorption (Ushakumary and Madhu, 2014), genome size (Hidalgo et al., 2015) and biomorphological adaptations (Savinykh et al., 2015). Regarded as a desirable species in wetlands, water-plantain may be used to stabilize the metals in the substrate and can be eaten by animals (Fritioff, 2005; http://www.pir.sa.gov.au/).

The human interest in studying this plant species is based on its use in ornamental gardens and for medicinal purposes (Lansdown, 2014).

The aim of this paper is to list and describe the main features and morpho-anatomical structures, responsible for living of water-plantain in wetland environments.

As Kırım et al. (2014) suggested, all the inhabitants of the wetland have to be protected, since they are important for biological diversity.

MATERIALS AND METHODS

Area description

In a previous study, we described the Bugeac Lake area from southwest of Dobrudja (44°05'30.6"N, 27°25'45.2"E), where another freshwater plant - *Nymphoides peltata* - was collected and cross-sectioned in order to follow the morpho-anatomy adaptations to environment (Săndulescu et al., 2016).

Bugeac Lake, a natural wetland ecosystem hosting several species, including water-plantain is represented in Figure 1.

Biological material

According to IUCN Red List of Threatened Species, *A. plantago-aquatica* is an herbaceous amphibious helophyte (Lansdown, 2014).

For the vegetation of Bugeac Lake, water-plantain was reported as helohydatophyte species, belonging to Schoenoplectetum tabernaemontani association (Dinu and Radu, 2004).

Figure 1. Wetland ecosystem hosting *Nymphoides peltata*, *Butomus umbellatus* and *A. plantago-aquatica* (Bugeac Lake, August 2014)

For this report, we used ethanol preserved material belonging to *Alisma plantago-aquatica*. The plants were collected by hand-pulling, in August 2014 (Figure 2).

Several transversal sections were performed through the stem and stalks of inflorescence (peduncle) of water-plantain, using razor blades.

The morphological features were described with an ML-4M IOR microscope.

Figure 2. *A. plantago-aquatica* growing on the shores of Bugeac Lake (see the arrow)

RESULTS AND DISCUSSIONS

The morphological features of water-plantain from Bugeac Lake

In cross section, the stem of water-plantain (Figure 3a) collected from the lakeshore of Bugeac Lake presented: epidermis, assimilating parenchyma, sclerenchyma (mechanical tissue), conducting fascicules and, in central, the medullary lacuna (Figure 3b).

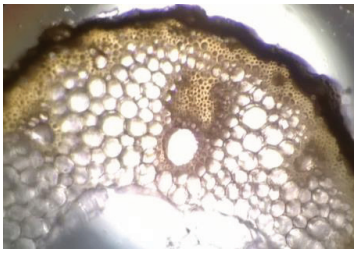

Figure 3 a. *A. plantago-aquatica*: cross section of the stem (magnification x6)

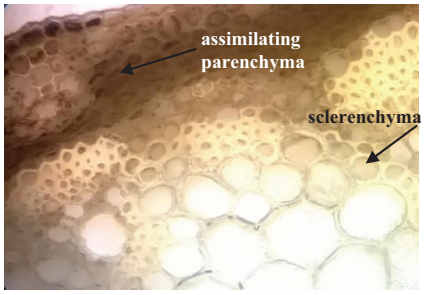

Figure 3 b. Cross section of the stem in *A. plantago-aquatica*, showing parenchyma and mechanical tissues (magnification x20)

The mixed conducting fascicules are collaterally closed-type, arranged in two-three concentric circles.

The small, external (Figure 4a) and the large, internal ones (Figure 4b) are surrounded by sclerenchyma.

Figure 4. Conducting fasicules in *A . plantago-aquatica*: a. external; b. internal (magnification x 20)

In cross section, the cut edges stalk of the inflorescence (peduncle) has epidermis with one-layer of large cells, covered by well-developed cuticle (Figure 5).

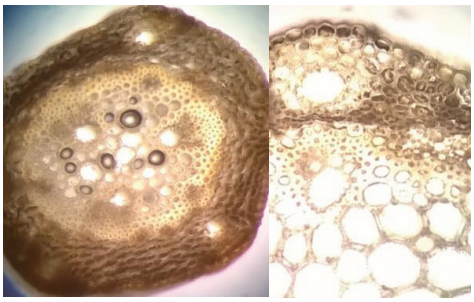

Figure 5. *A. plantago-aquatica*: cross sections (x6; x 20) of the stalk

The conducting tissues of the stalk is represented by both phloem and xylem bundles, collaterally-closed type, irregularly disposed in two rows, surrounded by mechanical tissue of sclerenchyma (Figure 6).

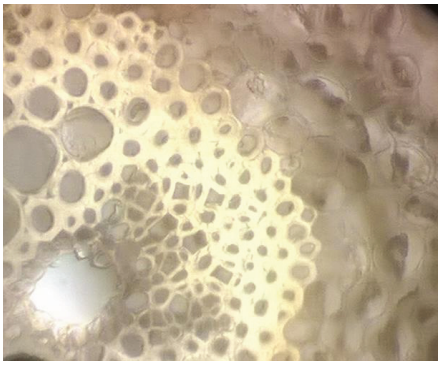

Figure 6. Conducting fascicules in the stalk of *A. plantago-aquatica* (x20)

The supporting tissues represented by sclerenchyma characterized by thickened cell cellulose walls, lead to strength and stiffness involved in aquatic plant resistance (Lamberti-Raverot and Puijalon, 2012).

The morphological features of water-plantain: a literature review

As far as we know, the available data concerning morpho-anatomy of the *Alisma* genus members are still scarce. A Romanian researcher investigated the anatomy of adventitious root, rhizome and leaf in *Alisma cordifolia* L. (Bercu, 2009).

The relatively few studies on *A. plantago-aquatica* reveal some features of leaves and root.

Thus, in water-plantain, aerenchyma – represented by large intercellular spaces designed for oxygen uptake – appears to be present in stem, leaves and root (Kordyum et al., 2012). As Jung et al. (2008) stated, a well-developed aerenchyma is an important feature of wetland plants.

The adventive roots of *A. plantago-aquatica* are characterized by the presence of aerenchyma surrounded with epidermis and one cortex layer. Kordyum et al. (2012) who studied the root anatomy of mature *A. plantago-aquatica*, have noted that the presence or absence of aerenchima depends on changes in water supply: in plant species growing on riverside, the root system has small intercellular spaces, similar to terrestrial plants of the same species.

Furthermore, according to Seago et al. (2005), there are wetland plant roots which do not have any aerenchyma tissue.

The light micrograph of a section through a leaf stalk (petiole) of *A. plantago-aquatica*, showed: an epidermis covered by a thin cuticle, outer cortex represented by three layers of parenchyma cells, middle cortex with lacunar spaces, inner cortex and large vascular bundles consisting in endodermis, a ring of phloem, a ring of xylem and the pith at the centre (http://www.sciencephoto.com/).

CONCLUSIONS

The case study and also the literature survey revealed some structural characteristics and adaptations of water-plantain for living under wetland conditions.

In terms of *A. plantago-aquatica*, we focused to the knowledge of morphological structure of this plant species, by describing the cross section of the stem and stalk. The previous reports investigated mainly the root ant the leaf of this species.

Unlike other reports, in the stem of *A. plantago-aquatica* collected from the shore of Bugeac Lake in summer of 2014 the aerenchyma was not present, instead a central medullary lacuna was present.

As in literature a full study regarding the histoanatomy of *A. plantago-aquatica* almost lack, we anticipate that more research papers are required in order to understand its life and adaptative changes in different environments subject to fluctuating water levels.

ACKNOWLEDGEMENTS

This article was financed by the Faculty of Agriculture, University of Agronomic Sciences and Veterinary Medicine of Bucharest.

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