



Histoanatomical study on the vegetative organs of *Tradescantia spathacea* (Commelinaceae)

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ABSTRACT: The paper presents a detailed histoanatomical description of the vegetative organs (root, stem and leaf), measurements of the leaf epidermal cells and stomata, and microphotographs of an ornamental plant *Tradescantia spathacea* Sw. The roots had a typical primary monocot structure. The stems had a primary structure, the stele comprising two concentric rings of closed collateral vascular bundles. The leaves were heterogeneous, bifacial and hypostomatic, with brachyparatetracytic stomata. However, the upper epidermal cells were larger (186-245 μm long and 112-156 μm wide) than those of the lower epidermis (104-178 μm long and 82-116 μm wide). In addition, the average stomatal length was 57 $\mu\text{m} \pm 2.54$, stomatal index - 16.43 and stomata density - 35.82 stomates/ mm^2 .

KEY WORDS: histoanatomical study, leaf, root, stomata, stem, *Tradescantia spathacea*

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INTRODUCTION

Species of the genus *Tradescantia* belong to the Commelinaceae family. *Tradescantia spathacea* Sw. (boat-lily, oyster plant) (syn. *T. bicolor* Moench, *T. discolor* L' Hér., *Rhoeo discolor* (L'Hér.) Hance, *R. spathacea* (Sw.) Stearn etc.). It occurs naturally in the West Indies, Mexico, and Central America where it spontaneously grows in natural forests and urban areas. The plant has been widely exported to tropical and sub-tropical regions, and has in places (including Florida) escaped cultivation and become firmly established, and invasive for Florida (Category II) (LANGELAND & CRADDOCK BURKS, 1998). It is a succulent plant, with a dense clump of vigorous and long lance-shaped leaves (15-30 cm), stemming from the trunk that can reach up to 20 cm. The leaves have two colors, green above and purple under (HUNT, 1980; WEB 1). The leaves constitute the main decorative element of this plant (Fig. 1) (MIOULANE, 2004). Flowers and seed are produced all year. In China, flowers of this species are used in herbal treatments to cure dysentery, as well as cosmetic treatments in the Yucatan, Guatemala, and Belize (MARIAN, 2002; ZI BEI, 2011).

Few data are known about the anatomy of this species. The aims of the present study were to provide for the first time an analysis of the vegetative organs of *T. spathacea*, especially the leaf anatomy and epidermal and stomata measurements, and to contribute to our knowledge of the vegetative anatomy of this and other species of *Tradescantia*.

MATERIAL AND METHODS

Plant leaves were collected from S.C. Iris International S.R.L. greenhouse. Small pieces of leaves were fixed in FAA (formalin: glacial acetic acid: alcohol 5:5:90). Cross sections of the vegetative organs were made using a freehand technique (BERCU & JIANU, 2003). The cross section samples were stained with alum carmine and iodine green. The leaf epidermises were peeled off and paradermal sections were also prepared. These samples were stained in safranin 1% about 10-15 min and semi-permanent slides were mounted in glycerin. Histological observations and micrographs were performed with a BIOROM-T bright field microscope, equipped with a digital camera attachment TOPICA 6001A.

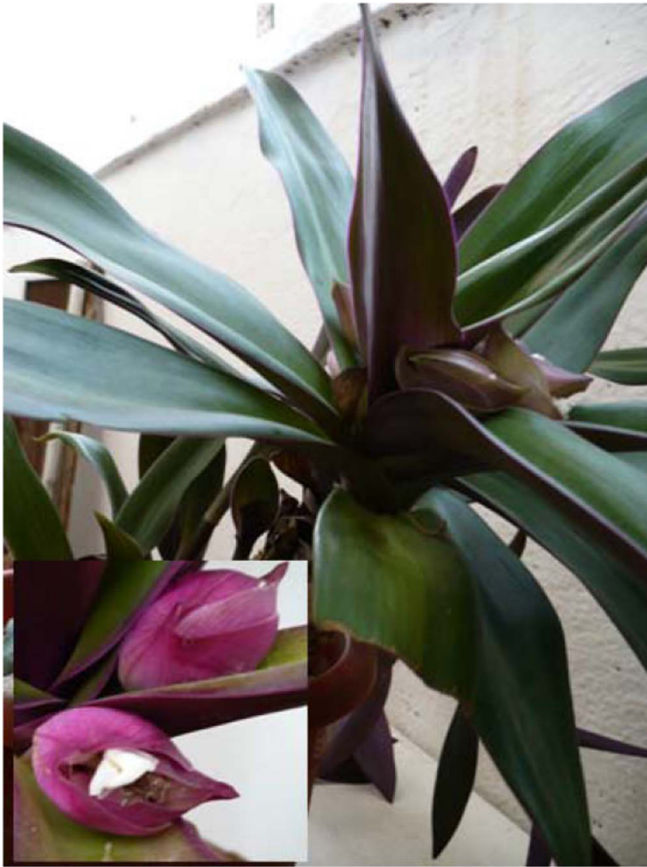


Fig. 1. Natural view of *Tradescantia spathacea* Sw.

RESULTS AND DISCUSSION

The root cross sections showed that the one-layered rhizodermis was made up of large cells, with slightly thickened walls and no intercellular spaces between them. Just below the rhizodermis was the exodermis which consisted of three layers of cells with slightly suberized walls and no spaces between cells. The inner cortex consisted of large cells, parenchyma cells with intercellular spaces among them and numerous starch grains (Fig. 2, A, B).

The innermost layer of the cortex – endodermis - was composed of a single layer of parenchymatous cells tightly joined together. The endodermal cells were partially thickened with lignin (on the side walls and internal walls), conferring a letter U-like form of the cells. In front of the xylem vessels, one or two cells had no thickenings, representing the passage cells, characteristic for monocot roots (BATANOUNY, 1992; BAVARU & BERCU, 2002; TOMA, 2000). Just below the endodermis was the stele consisting of pericycle, made up of a row of cells and the vascular system with radial and alternately arranged vascular bundles of xylem and phloem. Primary pith rows between them were present. The xylem bundles were represented by one metaxylem and 4 protoxylem vessels. The phloem

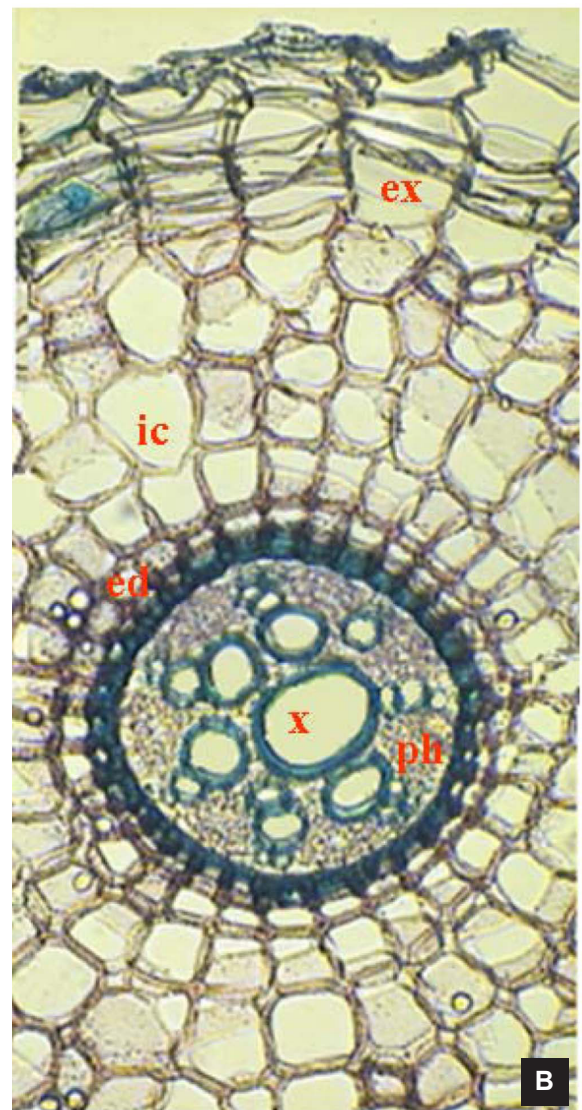
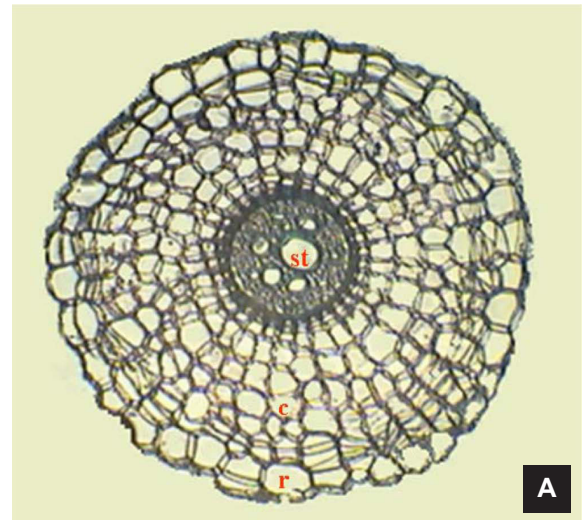


Fig. 2. Cross section of the root. Ensemble (A, x 60). Detail (B, x 285): c- cortex, ed- endodermis, ex- exodermis, ic- inner cortex, ph- phloem, r- rhizodermis, st- stele, x- xylem.

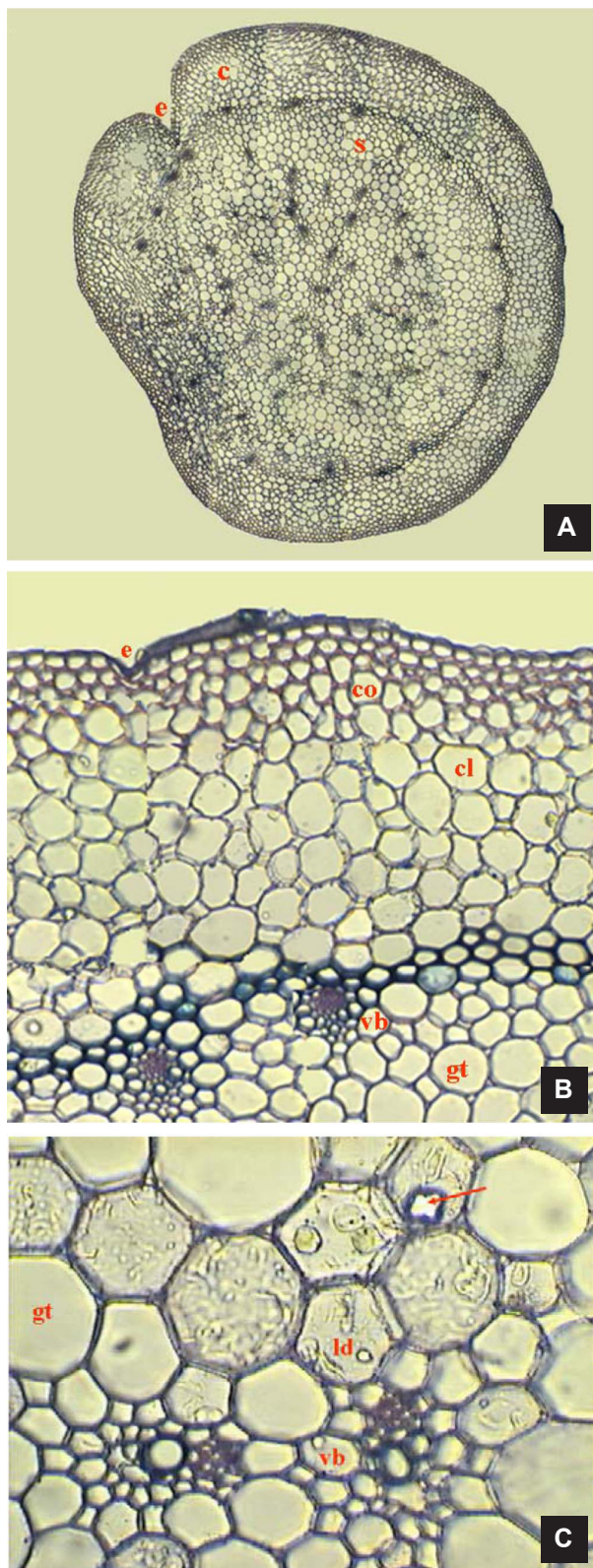


Fig. 3. Cross section of the stem. Ensemble (A, x 95). Portion with cortex and stele (B, x 175). Portion with vascular bundles (C, x 265): c- cortex, cl- chlorenchyma, e- epidermis, gt- ground tissue, ld- lipid droplets, vb- vascular bundle (the arrow indicates a calcium oxalate crystal).

was represented by the phloem vessels with companion cells (Fig. 2, B).

In cross sections, the stem was circular in shape and disclosed an outer layer of the stem - epidermis - composed of small isodiametric cells, without intercellular spaces. The epidermal cells were covered by a thin cuticle. As with other *Tradescantia* species (CHIMPAN & ŞİPOŞ, 2009), just below the epidermis was the cortex, differentiated into two zones, one zone consisting of 2-3 layers of angular collenchyma interrupted at the level of the stomata and another area made up of several layers of parenchyma cells with chloroplasts (chlorenchyma) (Fig. 3, A, B). Here and there some of the inner cortex cells possessed prismatic crystals of calcium oxalate, starch grains and lipid droplets (Fig. 3, C). The endodermis and pericycle were not evident. Concerning the stem stele, other authors (CHIMPAN & ŞİPOŞ, 2009; EMINAĞAOĞLU *et al.* 2012) described only two circles of close collateral bundles. Our findings in *T. spathacea* showed more vascular bundles, some of them on two circular rings and others were wildly spread in the pith (Fig. 3, B). The larger bundles were present nearer the centre. The vascular bundles of the stele, in general, were poorly developed with phloem to the exterior and xylem to its interior. Sclerenchyma elements were present in the vascular bundles structure and also between the vascular bundles (Fig. 3, A). In the ground [basal?] tissue of parenchyma calcium oxalate crystals were present (Fig. 3, C).

CHIMPAN & ŞİPOŞ (2009) studied the anatomy of *T. pallida purpurea*. In that study, primary stems, hypostomatic lamina, and tetracytic stomata in *T. pallida purpurea* were reported. In addition, it was reported that the leaves of this species have hypodermal layers. Our findings in *T. spathacea* were mostly similar to those of *T. pallida purpurea*. In other *Tradescantia* species such as *T. fulminensis*, the hypodermal layers of cells are absent (EMINAĞAOĞLU *et al.* 2012). However, in *T. spathacea*, mucus cells were detected in the parenchyma tissue of the leaf and not in the stem, while, in the present study, calcium oxalate crystals were observed in the parenchymatic tissue cells of the stem and leaf as well.

Leaf surfaces were glabrous with a bifacial mesophyll. The leaf, in transect, revealed that the epidermal cells of both surfaces were arranged in a single layer, covered by a thin cuticle. As reported for *T. pallida purpurea* by CHIMPAN & ŞİPOŞ (2009), *T. spathacea* possessed anthocyanins in the vacuolar systems of the epidermal cells. In terms of size, upper epidermal cells of the lamina were larger than those of the lower ones. Beneath the upper epidermis was an area of typically multilayered adaxial hypodermis (3-4 layers of large hexagonal cells, filled with mucus that held water and stored indoors). It was followed by the palisade parenchyma, towards the hypodermis, and by a many-layered spongy tissue towards the lower epidermis. Some of the mesophyll cells possessed calcium oxalate crystals (Fig. 4, A).

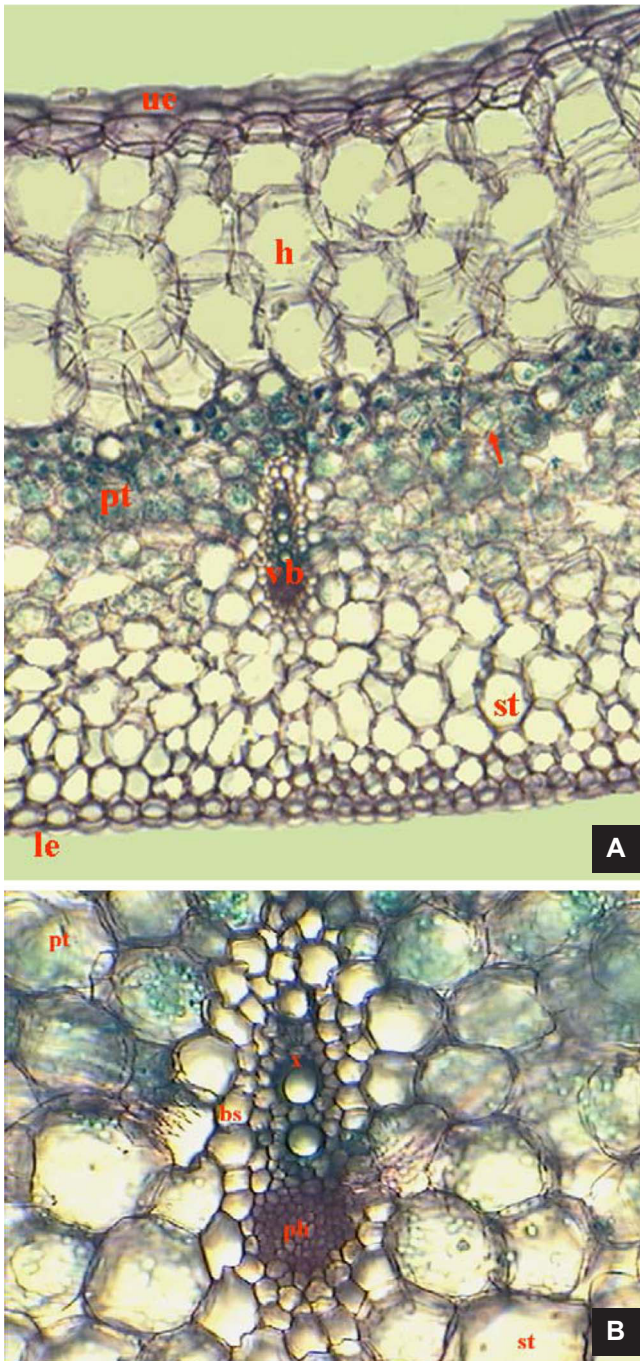


Fig. 4. Cross section of the blade. Portion with mesophyll (A, x 165). A vascular bundle of the vein (B, x 275): bs- bundle sheath, h- hypodermis, le- lower epidermis, m- mesophyll, ph- phloem, pt- palisade tissue, st- spongy tissue, ue- upper epidermis, vb- vascular bundle, x- xylem (the arrow indicates a calcium oxalate crystal).

The main rib was underdeveloped, represented by a collateral vascular bundle with few conductive elements. The xylem vessels, placed to the upper epidermis, were made up of few metaxylem and protoxylem vessels and xylem parenchyma. The phloem was facing the lower epidermis. The entire main rib was enclosed by a parenchyma sheath

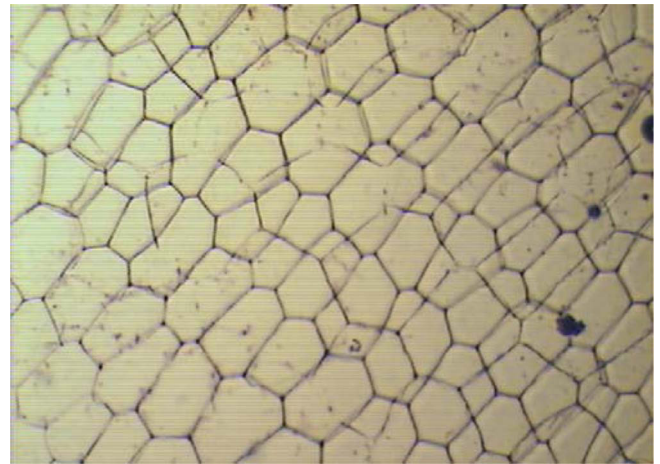


Fig. 5. Portion of the upper epidermis in a paradermal section (x 100).

(Fig. 4, B). A few collenchyma cells were present just below the lower epidermis and the mid rib. The lower epidermal cells possessed purple anthocyanins in their vacuolar systems.

In paradermal sections, the pentagonal epidermal cells had straight anticlinal walls (Fig. 5). Typical adaxial epidermal cells were 186-245 μm long and 112-156 μm wide. Abaxial epidermal cells were 104-178 μm long and 82-116 μm wide. However, the upper epidermal cells were larger than those of the lower one.

The mesophyll was made up of palisadic tissue below the hypodermis and spongy parenchyma, towards the lower one. The leaf mesophyll represented around 68% of the thickness of the entire lamina (Fig. 4, A). The mesophyll of other *Tradescantia* species represents a lower percent of the entire lamina, such as reported by CHIMPAN & ŞİPOŞ (2009) for *T. pallida purpurea* (25%).

Stomata cells occurred only on the abaxial surface of the leaf (hypostomatic) (Fig. 5, A, B). The average of stomatal length was $57 \mu\text{m} \pm 2.54$ and stomatal index was 16.43. Stomata density was 35.82 stomata/ mm^2 . Stomata type was tetracytic (CUTLER *et al.* 2007; METCALFE & CHALK, 1979). Tetracytic stomata type is commonly found in *Commelinaceae*, such as previously reported by RAUNKIAER (1937) and recently by ABID *et al.* (2007). The tetracytic type has also been reported by CHIMPAN & ŞİPOŞ (2009) for *Tradescantia pallida purpurea* and EMINAĞAOĞLU *et al.* (2012) for *T. fulminensis*. In our findings, we also report the brachyparateracytic feature of the tetracytic stomata in *Tradescantia spathacea* lamina (DILCHER, 1974) (Fig. 6, A, B).

CONCLUSIONS

The root had a typical primary structure characteristic to monocots. The stem possessed a primary structure with a differentiate cortex in two zones. The stele was

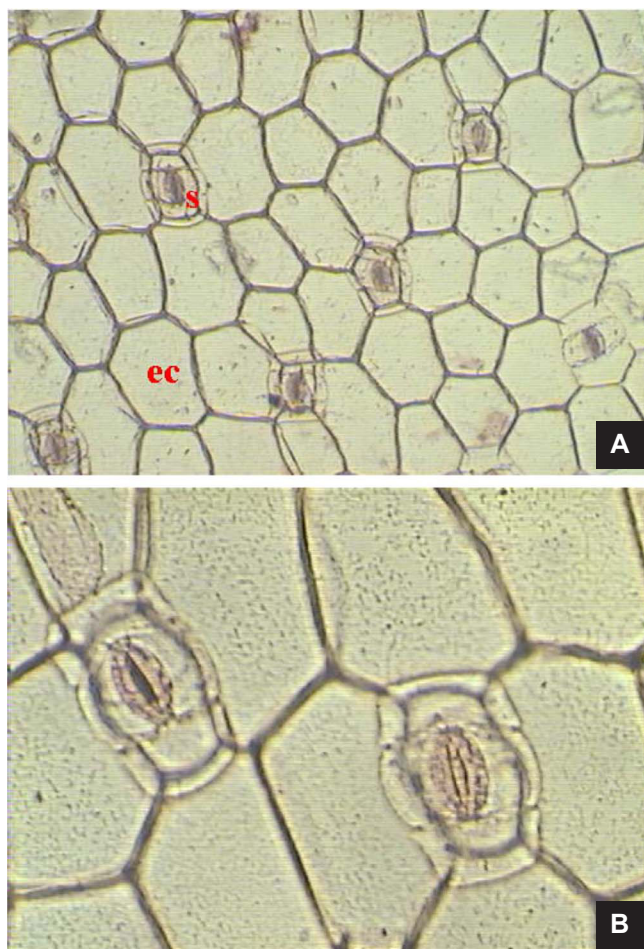


Fig. 6. Portion of the lower epidermis in a paradermal section: ensemble (A, x 110) and detail (B, x 280).

represented by two concentric rings of poorly-developed close collateral vascular bundles. Toward the center some vascular bundles occurred.

The sessile leaf is bifacial and hypostomatic with a heterogenous mesophyll. The upper epidermal cells were larger than those of the lower one, possessing a multi-layered hypodermis. The mid rib had vascular elements arranged in large bundles and the secondary veins in small collateral bundles. Both upper and lower epidermises were uniseriate and the lower one possessed brachyparatetracytic stomata.

The mechanical tissue, present in the stem and less in the leaf, was poorly developed and represented by collenchyma cells as well as some sclerenchymatous elements.

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REFERENCES

- ABID R., SHARMEEN S. & PERVEEN A. 2007. Stomatal types of monocots within flora of Karachi Pakistan. *Pakistan J Botany* **39**: 15-21.
- BATANOUNY KH. 1992. *Anatomy of plants*, University Press Cairo.
- BAVARU A & BERCU R. 2002. *Morphology and anatomy of plants*. Ex Ponto Constantza.
- BERCU R & JIANU DL. 2003. *Practicum of Morphology and Anatomy of Plants*. "Ovidius" University Press, Constantza, 2003.
- CHIMPAN C & ȘIPOȘ M 2009. Anatomy of the vegetative organs of *Tradescantia pallida* cv. *purpurea*. *Bihorean Biologist* **3**: 1-4.
- CUTLER DF, BOTHA T & STEVENSON DW. 2007. *Plant anatomy an applied approach*. Blackwell Publishing Press Oxford.
- DILCHER DL. 1974. Approaches to the identification of angiosperm leaf remains. *Bot. Rev.* **40**: 1-157.
- EMINAĞAOĞLU Ö, MELAHAT Ö & KÜLTÜR Ş. 2012. Contributions to the leaf and stem anatomy of *Tradescantia fulminensis* an alien species new to the flora of Turkey. *Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi* **13**(2): 270-277.
- HUNT DR. 1980. Sections and series in *Tradescantia*. American Commelinaceae: IX. *Kew Bull.* **35**: 437-442.
- LANGELAND K & CRADDOCK BURKS K. (eds.). 1998. *Identification and Biology of Non-Native Plants in Florida's Natural Areas*. 1st ed. University of Florida Gainesville.
- MARIAN I. 2007. (Editor in Chief): *1000 de plante medicinale (1000 Kräuter)*. Aquila, Oradea'93 Oradea.
- METCALFE CR & CHALK L. 1979. *Anatomy of Dicotyledons*. Vol I. 2nd ed. Clarendon Press Oxford.
- MIOULANE P. 2004. (Editor in Chef): *Encyclopedia Truffault*. 2004, Grădini și plante de interior. Editorial Group RAO, Bucharest.
- RAUNKIAER C. 1937. *Plant Life Forms*. Clarendon Press Oxford.
- TOMA C. 2000. *Histologie vegetala*. Editura Junimea Jassy.
- ZI BEI WNQ. 2011. *Tradescantia spathacea* Sw. In: ZHENGYI W, RAVAN PH, & HONG D. (eds), *Flora of China* **24**, pp. 38, Science Press (Beijing, Missouri Botanical Garden, St. Louis).
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http://plant.climb.com.tw/modules/mediawiki/index.php/Tradescantia_spathacea

Botánica SERBICA



REZIME

Histoanatomija vegetativnih organa *Tradescantia spathacea* (Commelinaceae)

Rodica BERCU

U radu se navode histoanatomski detalji vegetativnih organa (koren, stablo i list), mere epidermalnih ćelija, stoma i slike poprečnih preseka ukrasne biljke *Tradescantia spathacea* Sw. Uočeno je da korenovi imaju tipičnu strukturu monokotila. Listovi stabla imaju primarnu strukturu gde se stele sastoje od dva koncentrična kruga koji zatvaraju provodne snopiće. Listovi su heterogeni i mogu biti bifacijalni ili hipostomatični sa brahiparatetracitičnim stomama. Ćelije epiderma lica su veće (186-245 μm duge i 112-156 μm široke), nego ćelije epiderma naličja (104-178 μm duge i 82-116 μm široke). Prosečna dužina stoma iznosi 57 $\mu\text{m} \pm 2.54$, indeks stoma je 16.43 a gustina stoma 35.82 stoma/ mm^2 .

Key words: histoanatomija, list, koren, stome, stablo, *Tradescantia spathacea*