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ANATOMICAL ASPECTS OF *FICUS LYRATA* WARB. (MORACEAE) LEAF

Rodica BERCU
Faculty of Natural and Agricultural Sciences,"Ovidius" University, Constantza
University Alley, No. 1, B, 900470, Constantza
Corresponding author e-mail: rodicabercu@yahoo.com
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ABSTRACT
The paper presents an anatomical study concerning the leaf structure (petiole and blade) of a well-known Ficus species with ornamental value Ficus lyrata Warb. The petiole outer most layers of cells are suberized, followed by a differentiated cortex and a fascicular vascular system, represented by phloem and xylem elements. The bifacial and hipostomatic blade upper epidermis is followed by a two-layered hypodermis with lithocysts and cystoliths. The mesophyll is heterogeneous. The lower epidermis continuity is interrupted by anomocytic stomata.The mid rib possesses two arcs of conductive tissues vascular system. Remarkable is the presence of the apparently medullary leptocentric bundles and several groups of intraxylary phloem. Laticifers and oxalate crystals are present in the petiole and around the mid rib structure. The thick cuticle, the lignification elements, a multiple epidermis are probably anatomical features of the plant adaptation to xerophytic environments.
KEY WORDS: *anatomy, leaf, laticifers, cystolith, Ficus lyrata*

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INTRODUCTION

Ficus species are trees, epiphytes and shrubs belonging to the Moraceae family. This genus includes about 750 species originating in tropical and subtropical regions of America, Asia, Africa and Australia (Rønsted *et al*, 2008). In cold and temperate regions are grown as house plants (Preda, 1979). *Ficus* species are noted for their medicinal uses for various purposes and the economic interest for the group is distinguished by the presence of species that produce rubber, wood, textiles, and as food and ornamental plants (Araújo *et al.,* 2014).

Ficus lyrata Warb. (known as fiddle-leaf fig) is an evergreen tree or shrub, native to West and Central Africa tropical rain forest, being one of the most demanding and showy *Ficus* species. It is known as a decorative species in Europe and North America (Florida) as well. It can grow 9-12 m in these areas. In the pot it ranges up to 1.5-2 m. Its bright fleshy and leathery green leaves are 30-45 cm length and 25 cm width, pinnate, brachidodrome venation veins and a lyre-shaped blade (Della Beffa, 2007; Fox *et al.,* 2005; Groza, 1996; Mioulane, 2004). The fruits, solitary fleshy synconium, are round green, with 2.5-3 cm diameter (Dressler *et al.,* 2014).

In the literature there is little information on the leaf anatomy of the species considered. Data on the leaf structure of a number of species *Ficus* of Nigeria, where found in the study by Sonibare *et al.* (2006) of which *F. elastica* and *F.lyrata*.

F. maroma leaf structure belongs to Cabrera *et al.* (2009). Some studies relate the presence of the laticifers elements and chemical analysis of the latex found in some *Ficus* species belong to Lazreg-Aref *et al.* (2012) and Metcalfe & Chalk (1983). The latex contains ficin (cysteine proteases), indicating appreciable proteolytic activity (Kajii *et al,* 2014). Other several reports were published on the leaf structures: Souza *et al.* (2000), Dixon (2002), Retana-Salazar & Sanchez-Chacon (2009), Khan *et al.* (2011), Araújo *et al.* (2014).

In Romania, studies concerning the leaf lamina structure, with special reference to the presence of cystoliths and laticifers in *F. elastica* and *F. carica* occur sporadically in some studies (Tarnavschi *et al.,* 1974; Toma *et al,* 1998; Andrei & Predan, 2001; Ianovici, 2010; Bercu & Popoviciu, 2014). A morphometric study of some species of *Ficus* leveas belongs to Bercu & Bavaru (2003).

The aim of this paper is to highlight the anatomical features of *Ficus lyrata* leaf and to contribute with more information concerning the knowledge of this species and its adaptation to the arid or semi-arid regions.

FIG. 1. Natural view of *Ficus lyrata*

MATERIALS AND METHODS

Small pieces of petiole and blade were fixed in FAA (formalin: glacial acetic acid: alcohol 5:5:90). Cross sections of the petiole and blade were performed by the freehand made technique (Andrei & Predan, 2003). The samples were stained with alum-carmine and iodine green. Anatomical observations and micrographs were performed with a BIOROM–T bright field microscope, equipped with a TOPICA 6001A video camera. The stomatal type was determinate by Dilcher (1974). The density of stomata/mm^2 was determined by the classical method used in Plant Physiology (Boldor *et al*, 1980; Peterson *et al,* 2008; Abdulrahaman *et al,* 2009; Ianovici *et al*, 2011; Groza *et al,* 2013). The stomatal index was calculated by Stace (1965) formula (S/E+S)100.

RESULTS AND DISCUSSIONS

Cross section of the petiole discloses a circular shape. Externally, the petiole is protected by three layers of flattened slightly suberized cells, followed by cortex. It contains a number of lignified stone cells, which are placed here and there, a

collennchyma layers of cells (15-16 layers of cells) and, just below the collenchyma zone, is present a wide inner zone of parenchymatous cells, the later consisting a number of oxaliferous cells (calcium oxalate crystals) and non-articulated laticifers as well (Fig. 2; 3, a). The pericycle is formed by thin-walled parenchymatous cells interrupted by the presence of groups of pericyclic fibres (Fig. 2,b).

The vascular system is represented by 10-11 dissected bundles interrupted by large parenchymatous pith rays. Sonibare *et al.* (2006), following Tomlinson (1956) description for several vascular bundles arrangement (the main arc, I, abaxial II, adaxial III and forth arc closer to the abaxial epidermis), found for *F. lyrata* petiole vascular system arcs I and III. The pith rays are lignified in the xylem region and non-lignified in the phloem zone. Xylem is represented by xylem vessels radially arranged and slightly lignified xylem parenchyma. The outer phloem is less developed and consists of phloem vessels, companion cells and phloem parenchyma. Some non-articulated laticifers occur. Oxalate crystals are present in some of the pith parenchyma cells. In the pith zone, a number of vasocentric vascular bundlesand several groups of intraxylary phloem are scattered to the periphery of the pith (Fig.3, a, b).

The blade of *Ficus lyrata* is bifacial and hypostomatic. The upper epidermal (adaxial epidermis layer) cells are isodiametrical to sub rectangular in shape and covered by a visible smooth thick cuticle (figure 4, b). It is followed by a sub-epidermal cell layer - hypodermis - formed by large cells with here and there lithocysts (12 µm in length and 12 µm width), giant epidermal cells that protrudes intothe mesophyll. The function of these spcialized cells is unknown. Inside the litocysts, elongated solitary cystoliths (calcium carbonate deposes) are present, hanged from a solitary stalk (attached to the top of the lithocysts). Folowing Ummu-Hani & Noraini (2013) classification, concerning the position of cystoliths, those of *F. lyrata* belongs to group 1 (cystoliths adjacent to the adaxial epidermis layer) (Fig.4, b). Between both epidermis and the mid rib vein, 5-6 layers of uniformly thickened sclerenchyma cells are present, followed by several angular collenchyma layers of cells above (Fig. 4,a).

The mesophyll is heterogenous, composed of palisade and spongy tissue. The two-layered palisade tissue is composed of columnar cells with a large number of chloroplasts, interrupted in the mid rib zone.The palisade tissue is followed by the well-developed spongy tissue (20-25 layers of cells), with more or less rounded parenchyma cells, few choroplasts and numerous large intercelluar spaces between them (Fig.4b).

The mid rib, in transection, is prominent abaxial and less adaxial (Fig. 5a). Concerning the vascular system bundles arrangement, Sonibare (2006) found for this species arcs I, II and III, confirmed as well by our findings, the latter being shorter. Xylem consists of xylem vessels and xylem parenchyma to the upper epidermis and phloem vessels, companion cells and few parenchyma cells to the lower epidermis. In the phloemicroregion, a dissected sclerenchymatous ring is present. In the inner basic

parenchyma of the arches vascular bundles, 5vasocentric vascular bundlesand few groups of intraxylary phloem are present the same as those of the petiole. The cambium is not clear. Oxalate crystals and laticiferous vessels are present as well (Fig. 5, a, b).

Such as Emygdio-De-Mello-Filho & De-Jesus-Neves (1978) and not mentioned by Sonibare *et al.* (2006), and confirmed by our findings, the biseriate lower epidermis (abaxial epidermis) has isodiametric to sub rectangular smaller cells, in comparison with those of the upper one, covered by thick smooth cuticle. The epidermis continuity is interrupted by the presence of stomata. Paradermal sections of the abaxial epidermis disclose polygonal epidermal cells with straight to arched walls and paracytic stomata (Fig.6). The stomatal density is 227.941 stomata/mm^2 and the stomatal index (SI) 18.50.

CONCLUSIONS

The petiole consists three layers of suberized cells, a differentiated cortex (collenchyma and parenchyma) and a fascicular vascular system, represented by of phloem and xylem separated by large pith rays.The upper epidermis of the blade covered by a thick cuticle is followed by a hypodermis with lithocysts and cistolyths inside, whereas the lower epidermis is interrupted by the presence of a large number of anisocytic stomata. The bifacial blade has a heterogeneous mesophyll (two layers of palisade tissue and a number of spongy tissues layers). Notable is the presence of the apparently medullary leptocentric bundles and some groups of intraxylary phloem. The secretive elements are represented by laticifers and oxalate crystals both present in petiole and blade. The anatomical features highlighted in this paper do these species of *Ficus* adaptable for the semi-arid and arid regions.

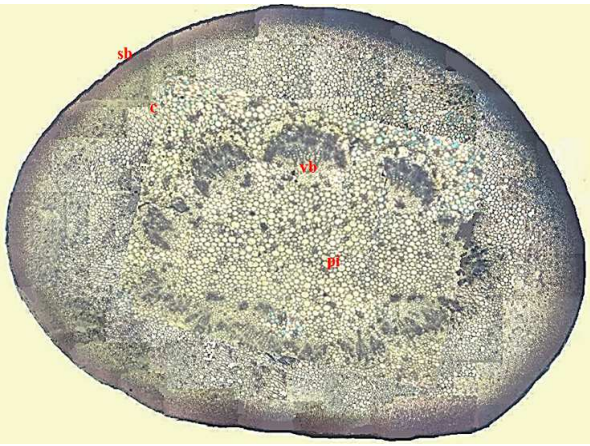

FIG. 2.Cross section of the petiole – ensemble (x 60): c- cortex, pi- pith, sc- suberized cells, vb- vascular bundle.

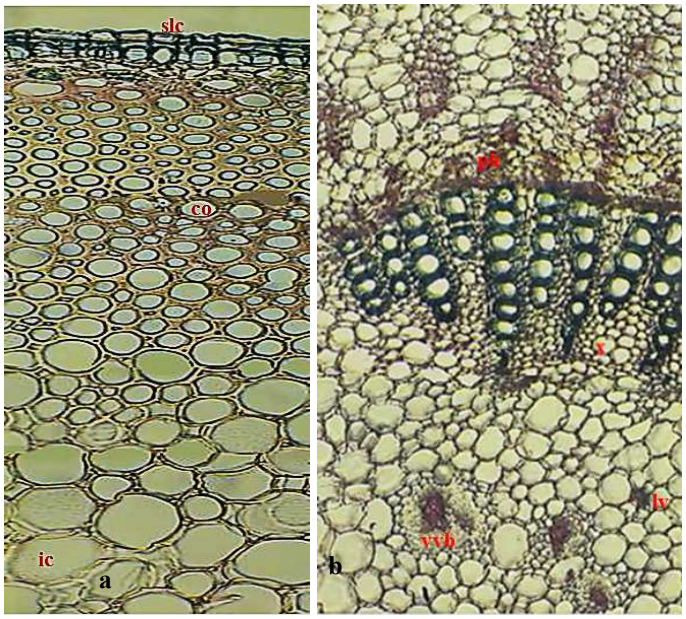

FIG. 3.Transections of the petiole. Portion with suber and cortex (a, x 180). Portion with vascular bundle (b, x 140): alb- apparently leptocentric bundles, co- collenchyma, ic- inner cortex, ph- phloem, slc- suberized layers of cells, x- xylem.

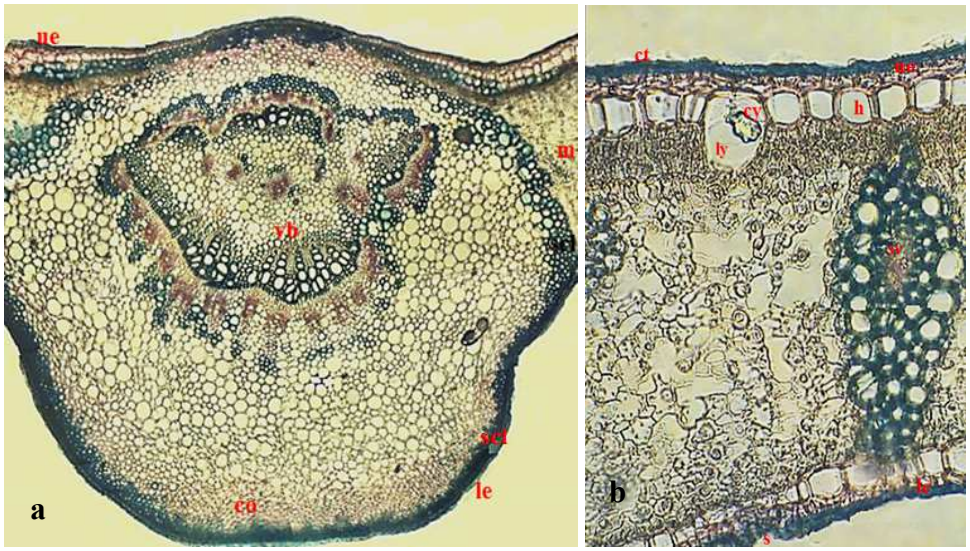

FIG. 4.Transection of the blade. Ansamble of the mid rib zone (a, x 100). Portion of the mesophyll with cistolith and a secondary vein (b, x 200): co- collenchyma, ct- cuticle, cy- cystolith, h- hypodermis, le- lower epidermis, ly- lithocyst, m- mesophyll,s- stoma, Scl- sclerenchyma, sv- secondary vein,ue- upper epidermis, vb- vascular bundle.

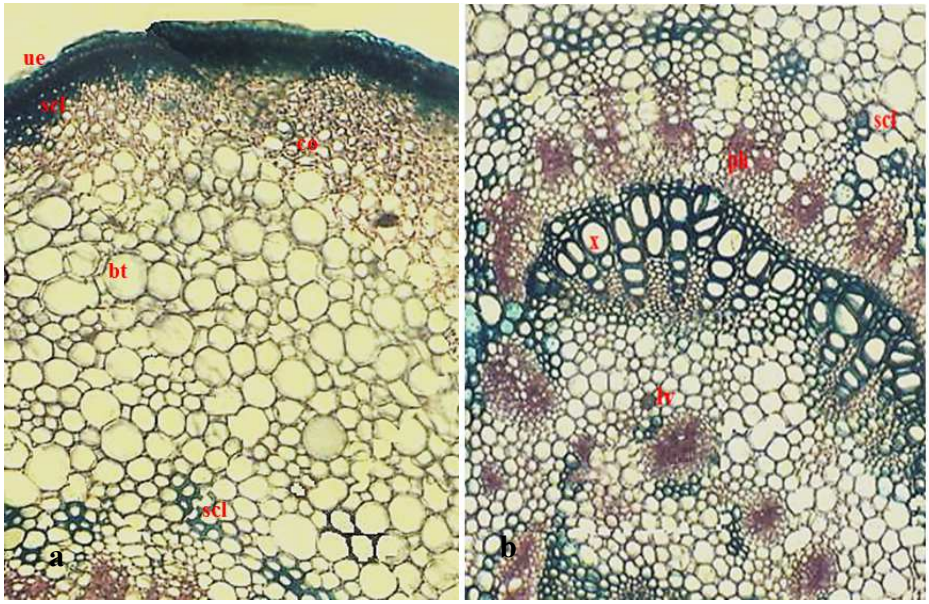

FIG. 5.Cross section of the mid rib zone blade.Portion with the mid rib. Portion of the vascular system (a, b, x 180): bt- basic tissue, co- collenchyma, lv- laticiferous vessel,scl- sclerenchyma, ue- upper epidermis.

FIG. 6. Paradermal section of the abaxial epidermis (x 200): ec- epidermal cell, s- stoma.

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