SOME GENERAL ANATOMCAL ASPECTS OF *FICUS BENJAMINA* L. CV DANIELLE (MORACEAE) LEAF

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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 benjamina L. cv Danielle. The outermost layers of cells are rectangular, 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 one-layered hypodermis with lithocysts and cystoliths to the upper and lower epidermis. The mesophyll is heterogeneous. The lower epidermis continuity is interrupted by anisocytic stomata. The mid rib possesses arcs I and III of conductive tissues of the vascular system. Remarkable is the presence of the apparently medullary leptocentric bundles.

Laticifers and oxalate crystals are present in the petiole and around the mid rib vascular elements. The thick cuticle with epicuticular wax, the lignification elements and the presence of hypodermis are probably anatomical features of the plant adaptation to xerophytic environments.

INTRODUCTION

Ficus species are trees or shrubs belonging to the Moraceae family which also include *Ficus carica* (the fig tree) and *Ficus elastica* (the Indian rubber tree). This genus includes over 800-2000 species originating in tropical regions of America, Asia, Africa and Australia. In cold and temperate regions are grown as houseplants (Henley and Poole, 1989).

Ficus benjamina L. (syn. *Ficus benjaminii*) (known as Benjamin's fig or Ficus tree) is an evergreen tree or shrub, native to India, Burma southern China, Malayezia and northern Australia, being one of the most demanding and showy *Ficus* species. It is evergreen shrub, known as a decorative species in Europe and can grow up to 15 m in these areas. (Mioulane, 2004; Della Beffa, 2007; Fox et al., 2005).

Fig. 1. Natural view of *Ficus benjamina* L. cv 'Danielle'

Ficus benjamina cv 'Danielle' (Weeping fig) is a tropical evergreen species of tree or large shrub. It can reach 30 m in height outside in its original habitat and 2-4 m indoors. The plant has shiny, pointed, oval leaves which are toxic and its sap is an irritant (Fig. 1). Usually, this species is not flourishes. The fruits, solitary fleshy synconium, aresmall, round, green and insignificant (Dressler et al., 2014).

In literature is little information on the leaf anatomy of the species considered. Data on the leaf structure of a number 28 *Ficus* species from Nigeria, where found in the study by Sonibare et al. (2006) for example *F. elastica* and *F. lyrata* and Mamoucha et al. (2016) for *Ficus carica. Ficus 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 Ali et al. (2012), Lazreg-Aref et al., (2012) and

Metcalfe & Chalk (1983). Recent and remarkable studies of *Ficus* leaf epidermis and the presence of cystolith in a number of *Ficus* species belongs to Ummu-Hani and Noraini,, 2013 and Klimko and Truchan, 2006 and so on.

In Romania, studies concerning the leaf lamina structure of ornamental *Ficus* leaves, with special reference to the presence of litocysts, cystoliths and laticifers in *F. elastica* and *F. carica* occur sporadically in some textbooks of Morphology and anatomy of plants (Tarnavschi et al., 1974). Leaf morphology and anatomy of *Ficus carica*, *F. elastica* and *F. lyrata* belong to Bercu and Popoviciu (2014) and Bercu (2015a, b). Biometric and morphologic study of some species of *Ficus* leveas belongs to Bercu and Bavaru (2003b),

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

MATERIAL AND METHODS

The plant leaves were collected form S.C. Bricostore Romania S.A., Constantza in February, 2014. 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 (Bercu and Jianu, 2003a; Niculescu, 2004). 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. It was measured the lithocysts length and width and the cystholiths length. 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. 1960; Peterson et al., 2008). The stomatal index was calculated by Stace (1965) formula – (S/E+S)100. In this paper we used the scientific name of *Ficus benjamina* species used by Roger Spenser et al. (2007), in accordance with The International Code of Nomenclature for Cultivated Plants (Trehane, 2004).

RESULTS AND DISCUSSION

Cross section of the petiole discloses a semicirculaar shape with a slightly concave adaxial surface. Externally, the petiole is protected by a layer of more or less rectangular shaped cells with lateral and inner cutinized cells. The epidermal external walls are covered by a thick cuticle, supplemented with vegetal wax. The epidermis is followed by cortex. The cortex is differentiated into two zones. Just below the epidermis is an external zone of angular collenchyma tissue (7- layers of cells), followed by a parenchyma one of 6-7 layers of cellulosic-walled cells, the later consisting a number of crystal cells (rhombic calcium oxalate crystals and druses.) and non-articulated laticifers as well. A number of periphloemic fibers are present (Fig. 3, a).

The vascuar system is fascicular, represented by 10-12 vascular bundles, giving the impression of a continuous ring, but is interrupted here and there by thin parenchymatous pith rays (Fig.2; 3 b). Xylem is represented by radial xylem vessels 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 (Metcalfe and Claeck, 1983). Oxalate crystals are present in some of the centrally parenchyma cells. In the pith zone, apparently medullary leptocentric bundles are present (Fig. 2; 3, b).

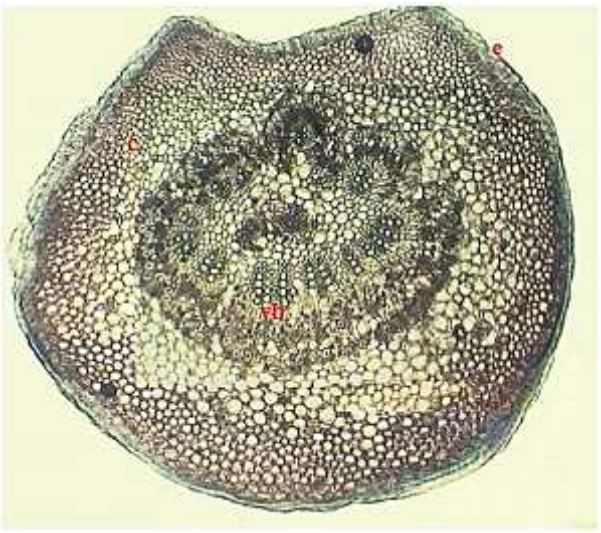

Fig. 2. **Cross section of the petiole – ensemble** (x 80): c- cortex, e- epidermis, vb- vascular bundle.

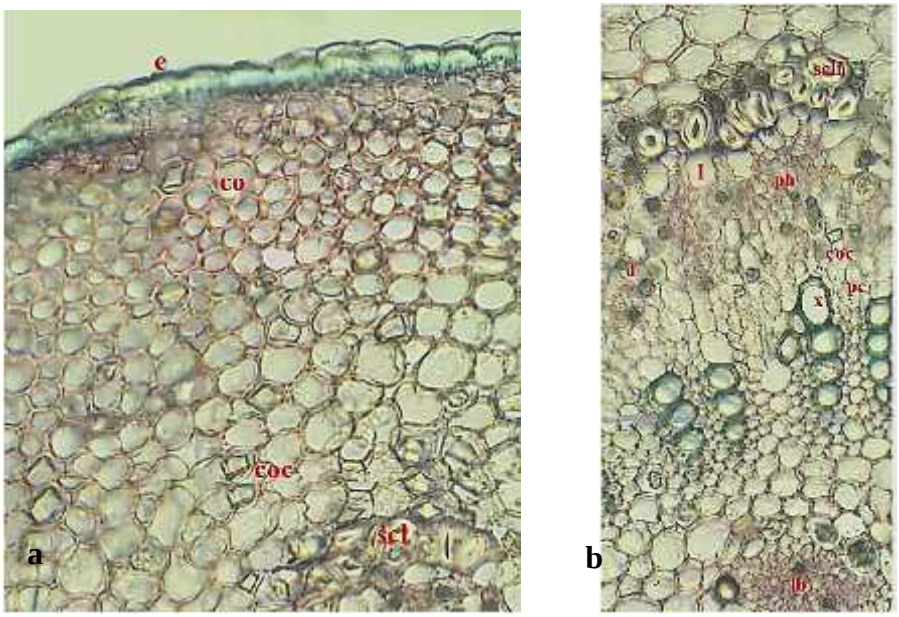

Fig. 3. Transections of the petiole. Portion with epidermis and cortex (a, x 180). Portion with vascular bundles (b, x 140): co- collenchyma, coc- calcium oxalate crystals, d- druse, e- epidermis, lb- leptocentric bundles, l – laticifer, ph- phloem, pc- parenchyma cells, scl- sclerenchyma cells, x- xylem.

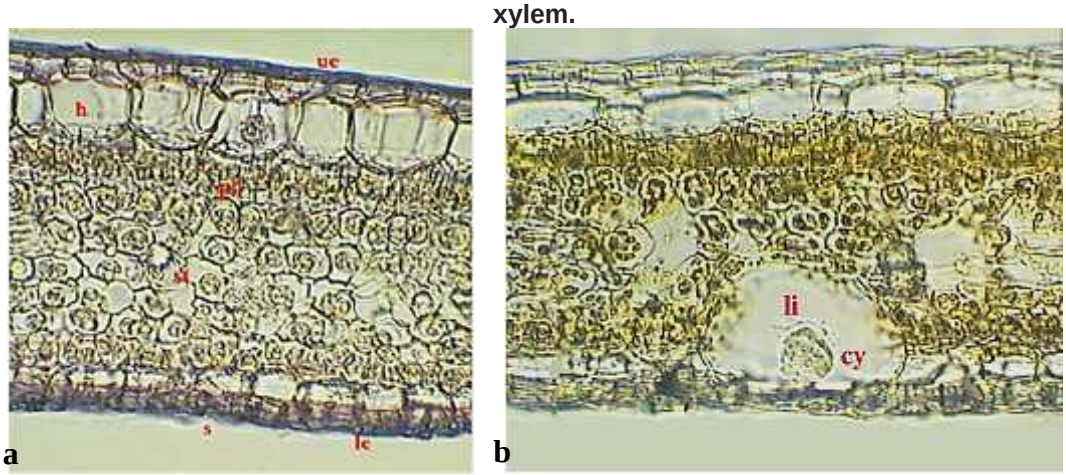

Fig. 4. Transection of the blade. Portions of the mesophyll with stomata and cistolith (a x 180; b, x 300): cy- cystolith, h- hypodermis, le- lower epidermis, li- lithocyst, m- mesophyll, s- stoma, ue- upper epidermis.

The blade of *Ficus lyrata* is bifacial and hypostomatic. The upper epidermal (adaxial epidermis layer) cells are rectangular in shape and covered by a visible cuticle covered by epicuticular wax (Fig. 4, a, b) such as Berg (2003a, b, c), Metcalfe and Clarck (1950b) and Rogwer (1993) reported for many *Ficus* species, mainly for abaxial blade surface. In the mid rib zone the epidermal cells are smaller and tangnetial elongated.

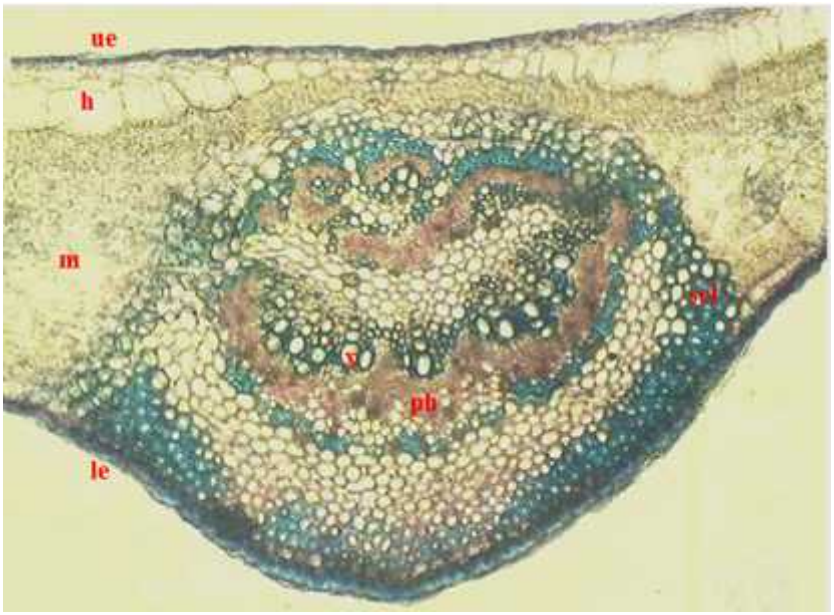

Fig. 5. Cross section of the blade in the mid rib zone - ensemble (x 100): h- hypodermis, le- lower epidermis, m- mesophyll, ph- phloem, scl- sclerenchyma, ue- upper epidermis, x- xylem.

It is followed by a sub-epidermal cell layer - hypodermis - formed by large cells with here and there large lithocysts (giant epidermal cell that protrudes into the mesophyll). In the mid rib zone the hypodermal cells are smaller. Inside the litocysts, as Metcalfe and Chalk (1950a) underline for *Ficus* genus and other Moraceae genus species, are the veritable cystoliths. Inside *Ficus benjamina* cv Danielle adaxial litocysts are almost oblong-shaped cystoliths (calcium carbonate deposes) with stalk (peg) and rounded solitary cystoliths, hanged by a shorter stalk to the abaxial epidermis. (Fig. 4, a, b). As Esau (1965) and Foster (1949) reported, the *Ficus* cystoliths appear in the cells of a multiple epidermis but in our findings they may apper in the unistratose epidermal hypodermis as well.

Folowing Ummu-Hani and Noraini (2013) classification, concerning the position of cystoliths, those of *F. benjamina* 'Danielle' belong to group 3 (cystoliths adjacent to the abaxial and adaxial epidermis layer). Bellow the lower epidermal 6-7 layers of schlerenchyma cells are present (Fig. 5). The mesophyll is heterogenous (palisade and spongy tissues) and has a thickness of 373 µm. The two-layered palisade tissue is composed of columnar palisade cells with a large number of chloroplasts, and measure 325 µm in length, followed by the spongy tissue (5-6 layers of cells), with few choroplasts and large intercelluar spaces between them (Fig. 4, a, b). The mid rib, in transection, is prominent abaxial. Concerning the vascular system arrangement, Tomlinson (1956) reported that the vascular bundles are arranged in several arcs. So, the main arc as I, the abaxial as II, adaxial as III and the arc closer to the adaxial epidermis as IV. In our findings may be I and III arcs, the latter being shorter (Fig. 5). 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 periphloemic zone, a dissected sclerenchymatous ring is present. In the inner basic parenchyma, few apparently leptocentric bundles are present the same as those of the petiole. Druses and prismatic

oxalate crystals and laticiferous elements are present in the vicinity of the mid rib zone (Fig. 6).

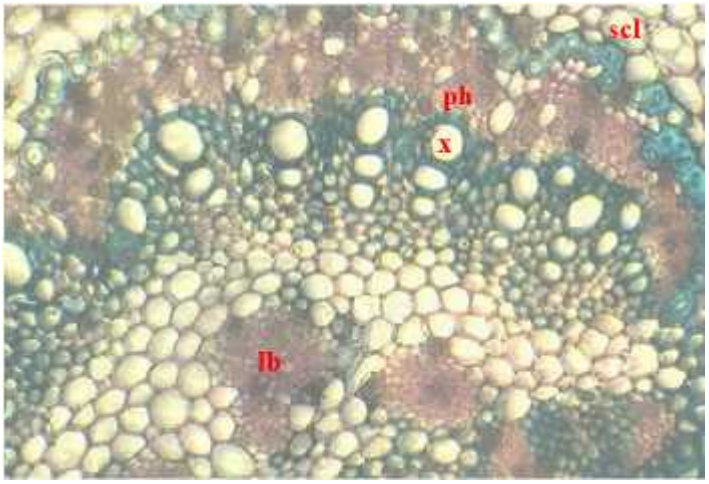

Fig. 6. Cross section of the blade with mid rib – detail (x 220): ph- phloem, lb- leptocentric bundle, scl- sclerenchyma, x – xylem.

The lower epidermis (abaxial epidermis) has rectangular cells smaller in comparison with those of the upper one, covered by cuticle and wax. The epidermis continuity is interrupted by the presence of stomata (Fig. 4, b; 5).

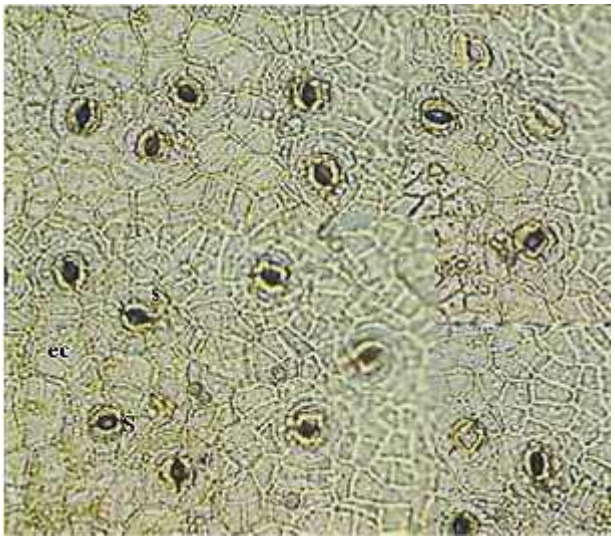

Fig. 7. Paradermal section of the abaxial epidermis (x 200): ec- epidermal cell, s- stoma.

Paradermal section of the lower epidermis discloses polygonal epidermal cells with straight walls regularly and anisocytic stomata (figure 7).

The stomatal density is 158 stomata/mm^2 and the stomatal index (SI) avergae 0.67 ± 2,87.

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CONCLUSIONS

The petiole has a one-layered epidermis, a differentiated cortex (collenchyma and parenchyma) and a fascicular vascular system, represented by 10-12 bundles. The upper

epidermis of the blade is covered by a thick cuticle, supplemented with wax, followed by a hypodermis with lithocysts and cistolyths inside such as the lower one which is interrupted by the presence of anisocytic stomata. The bifacial blade has a heterogeneous mesophyll. Notable is the presence of the apparently medullary leptocentric bundles in the petiole and mid rib vein.

The secretive elements are represented by laticifers and oxalate crystals both present in petiole and blade.

The anatomical features highlighted in this paper such as the thick cuticle with epicuticular wax, heavy lignification and the presence of hypodermis do *Ficus benjamina* cv Danielle to be adaptable as an ornamental plant for the semi-arid and arid Romanian regions.

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