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LEAF MICROMORPHOLOGY OF *KALANCHOË LACINIATA* (CRASSULACEAE)

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Abstract. The main aim of the work was to characterize morphology and anatomy of succulent leaves. Morphological and anatomical studies conducted on succulent leaves of *Kalanchoë laciniata*. The anatomy of leaves where studied with the use of light microscopy. This species belongs to the family Crassulaceae and it demonstrates the presence of adaptive traits which are necessary to survive and allow them inhabit in dry environment. Family Crassulaceae occur on arid and semi-arid areas, among the rocks, on the sandy areas and in the mountains. Anatomical studies show that leaves of *K. laciniata* possess a water storage tissue and mesophyll does not consist of palisade and spongy parenchyma. *K. laciniata* like the other species belonging to family Crassulaceae present physiological and morphological adaptations.

Key words: Crassulaceae, *Kalanchoë laciniata*, succulents, leaf, morphology, anatomy

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Plants by various adaptations can occur in areas with different (very high or low) intensity of some factors important to life. Xerophytes plants exhibit a variety of adaptive features (xeromorphysm) which allow them inhabit in areas where is permanent or temporary deficiency of available water for plants. Among group of xerophytic plants are present succulents and sclerophytes, which show different strategy to survive in dry environment. Crassulaceae DC. is a family of mostly leaf succulents and it has about 1500 species. Crassulaceae representatives are most frequent in semi-arid, arid habitats and in the mountainous, often at high altitudes. Family Crassulaceae belongs to succulents which conduct frugal water economy and accumulate water in special tissue – water storage tissue. Depending on locations of the water storage tissue it can be characterize succulent leaves, stems, roots. These succulent organs are clearly thickened, succulent (juicy) and have enlarged volume. Water storage tissue is like magazine that is filled up at periods when the water is available, but during drought it is used to sustain vital needs of the plant (Wyka 2008). Except that the Crassulaceae plant organs are corpulent, they exhibit low surface to volume ratio. Reduction of the surface is associated with a lower transpiration. In addition in reduction of water losses is involved water-tight epidermis. Strongly reduced transpiration is correlated with reduced gas exchange so next to morphological adaptations are also important physiological adaptations – Crassulaceaen acid metabolism. Plants of the family Crassulaceae conduct CAM photosynthesis; fixation of carbon dioxide takes place at night when stomata are open by the enzyme phospoenolpyruvate carboxylase. However, at night due to lack of light do not occur processes of light phase of photosynthesis and carbon dioxide is accumulated in the vacuole as a malic acid. During the day malic acid leaves the vacuole and in the cytoplasm it is decarboxylated with an enzyme malate, releasing carbon dioxide. Crassulaceae occurs predominantly in the temperate and subtropical zones of the northern hemisphere and Africa (Hart 1997).

Genus *Kalanchoë* Adans. belongs to the family Crassulaceae and includes about 150 species (Descoings 2006). It can be observed in the arid areas of East and South-West Africa

Fig. 1. Habit of *Kalanchoë laciniata*.

and on adjacent islands, also in South-East Asia. About half of all described *Kalanchoë* species occur in Madagascan flora as endemic species.

Characteristic feature of genus *Kalanchoë* is presence along leaf margins of the new individuals which develop vegetatively. *K. laciniata* (L.) DC. is native species to Africa, Temperate Asia (Saudi Arabia), Tropical Asia (India) (Descoings 2003). Common name of *K. laciniata* is „Christmas tree plant" and it is a perennial shrub with succulent leaves.

For light microscopy, fragments of *K. laciniata* leaves were fixed in 2.5% formaldehyde (prepared from paraformaldehyde) and 2.5% glutaraldehyde in a 0.1 M cacodylate buffer (pH=7.0) for 4 h at room temperature. After rinsed in the 0.05 M cacodylate buffer material was post-fixed in 2% osmium tetroxide at 4 °C overnight. Washed specimens were treated with 2% uranyl acetate for 1 h. After dehydration in an acetone series the samples were embedded in Spurr's epoxy resin and 0.5-1.0 μm thick specimens were cut with a glass knives on a microtome and stained with toluidine blue 0.

K. laciniata – perennial or biennial shrublets, may grow to 1.5 meters in height and has succulent, divided leaves which represent the opposite arrangement on the stem. The leaves of this species are glossy and have pale green to dark green color (Fig. 1). Leaf blade is narrow oblong and the leaf edge is dentate or crenate. The petiole is fleshy (Descoings 2003). Along the leaf margin or on the leaf surface red or purple color can be observed due to the presence of anthocyanins in the vacuoles of some epidermal cells.

The results of the microscopic observations showed that the epidermis is composed of a single layer of closely adhering cells (Fig. 2). Epidermal cells on the adaxial and abaxial surface do not differ significantly between themselves in size and number, but it can be observed that the cells of the abaxial epidermis are little more numerous. Epidermal cells have more or less oblong shape; the outer cell wall is convex and covered with cuticle. However, cells near hydathodes have visibly different shape and size in compared to other epidermal cells. The leaves of *K. laciniata* are amphistomatic so the stomata are present on both surfaces of leaf. Stomata are on the same level as the other cuticular cells and the stomatal pores can be closed or open. Mesophyll cells located under the epidermis, near the stomata are clearly more loosely arranged and form air-exchange chambers.

The chlorenchymatic tissue of *K. laciniata* leaves is relatively uniform, because it is not differentiated into the palisade and spongy layers. Cells of chlorenchymatic tissue have

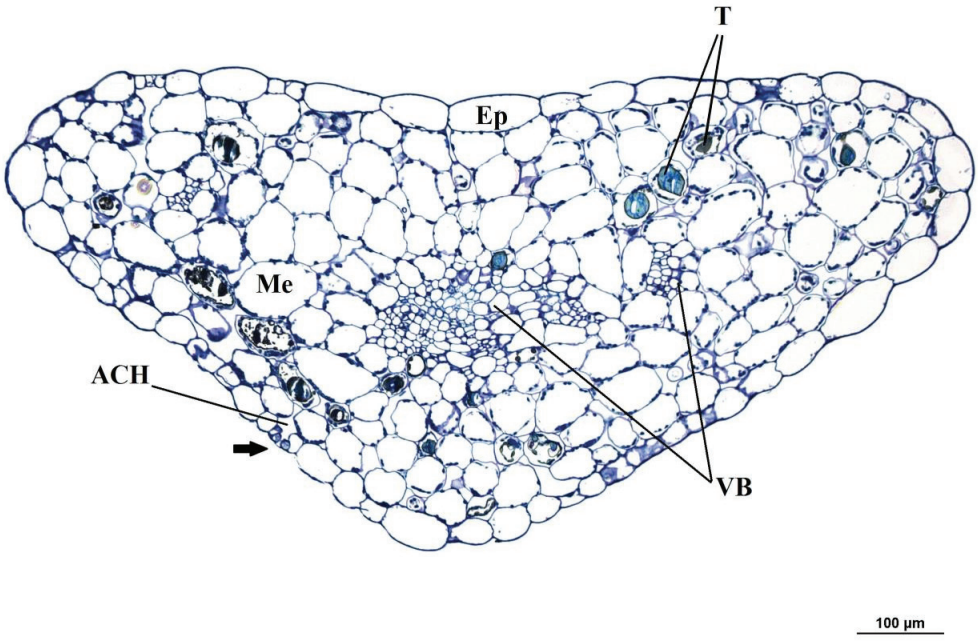

Fig. 2. Transverse section of *Kalanchoë laciniata* leaf. Light micrograph: **ACH** – air-exchange chamber; **Ep** – epidermis; **Me** – mesophyll cells; **T** – tannin cells; **VB** – vascular bundles; **Arrow** – stoma.

irregular shape (spherical to ellipsoidal). They closely adjacent to each other, but the intercellular spaces are visible. Parenchymatous cells which are located closer to the epidermis are smaller then cells which are located deeper into the leaf. However, mesophyll cells near to the vascular bundles are smaller and more closely arranged. In central part of the mesophyll cells is located one, big central vacuole, while the cellular components like cytoplasm and chloroplasts are near the thin cell wall. Vacuoles of some mesophyll cells located near to the epidermis, vascular bundles and hydathodes contain phenolic compounds.

Leaves of *K. laciniata* demonstrate the presence of adaptive traits that enable it survive in dry environment; this was observed in other species *Kalanchoë* (Chernetskyy & Weryszko-Chmielewska 2008; Chernetskyy 2009, 2012). New reports about the structure of leaf may provide knowledge that would be useful in solving problems with nomenclature and taxonomy of the subfamily Kalanchoideae Berg.

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