Abstract: Phlogacanthus thyrsiflorus Nees commonly known as “Lalbasak” or “Teetaphool” is a well-known medicinal shrub that is used as a source of traditional medicine by different ethnic groups of North Eastern India for treating wounds, tumorous growth and as a blood purifier. Its bitter tasted leaves and flowers are used to relieve cough, stomach ache and scabies. The flowers are also used as antidote to pox, prevents skin diseases like sore, scabies and used in jaundice (Khanikar 2005). It is distributed through the tropics viz. the sub-tropical Himalayas, upper Gangetic Plain, Bihar, North Bengal and in the entire North Eastern region of India. Little is documented on the anatomy and morphology of this plant; therefore, the purpose of this study was to determine its anatomy at the cellular level through various hand sectioning and staining techniques and also its morphology. It was found that many anatomical features of this plant were similar to those of a typical dicotyledonous plant. However, there were some unique features of this plant. These include a layer of suberized parenchyma and a thin layer of lignin in the stem surrounding the vascular tissue, a thick band of secondary xylem in the stem and root and expansion of the Casparian bands in the endodermis consistent with the secondary growth of the vascular tissue in the root. The flowers and the leaves showed the presence of numerous glands.

Key words: Phlogacanthus thyrsiflorus Nees; Medicinal; Anatomy; Micromorphology

Introduction
The family Acanthaceae comprises of about 250 genera and 2500 species mainly distributed in tropical regions of the world with a few members occurring in temperate regions (Braz et al., 2002). Members of this family are generally herbs, subshrubs, shrubs or lianas and rarely trees (Kameyama, 2006). Cytotilths are commonly present in the epidermal cells of the stem and leaves, and the presence of crystals of almost all shapes and types is an important feature of the family (Kameyama, 2006; Villar, 2009). Many species are used for ornamental purposes, with mainly economic importance (Metcalf and Chalk, 1957). In traditional medicine their use in emphasized for treating fever, pain, stomach disorders (Angonese et al., 1992; Chen et al., 1969). The flowers are used as antidote to pox, prevents skin diseases like sore, scabies and used in jaundice (Khanikar 2005) and also used as vegetable by different ethnic groups of North East India (Kanjilal et al., 1939). Curry prepared from its aerial portion is said to relieve cough, stomach ache and scabies. The flowers are also used as antidote to pox, prevents skin diseases like sore, scabies and used in jaundice (Khanikar 2005). It is distributed through the tropics viz. the sub-tropical Himalayas, upper Gangetic Plain, Bihar, North Bengal and in the entire North Eastern region of India (Karthiskeyan, S. et al., 2009; Chakravarty, S. and Kalita, JC. 2012). Apart from the most common names viz. “Teetaphool” or “Rangabacak” in Assamese, they are also known as “Ellor” in Garo; “So-ha-jut”, “Dieng-soh-kajut”, “Dieng-soh-ja-buid”, “Ja-boit”, “Baskabomphag”, “Barsiku” and “Jathang-heh” in Khasi and the Mikirs called it as “Jakan”, “Jaogan” and “Rambhaarong” (Kanjilal et al., 1939).

Materials and Methods
Phlogacanthus thyrsiflorus Nees is a medicinally important species of Acanthaceae that was collected during the periods of 2013-2014 from different parts of Assam. Identification of the collected specimens was verified by consulting different floras (Hooker, 1986; Kanjilal et al., 1934-1940). Voucher specimens were preserved in the form of herbarium as per standard field and herbarium technique (Jain and Rao 1977) and deposited in the Herbarium of Department of Botany, Gauhati University (GUBH).

Fresh, mature plants were observed and the gross morphology of the root, stem and leaf were recorded. To characterize the leaf morphology, characters such as size, shape, texture, colour, margin, venation, midrib and petiole were visually analysed (Hickey, 1973).

Either fresh leaves or preserved specimens were used for epidermal studies. Anatomical study was done...
following the methods described by Dilcher (1974), Wilkinson (1983, 1989), Khatijah and Zaharina (1998), Kadiiri (2006) with some modifications. For foliar epidermal study both fresh and preserved plant materials were used. Leaves were selected, both upper and lower epidermal peels were taken out by scrapping out with the help of blade using a 10% aqueous solution of nitric acid following the technique of Boulou and Beakbane (1971). The peel was stained with 1% aqueous safranin solution and after proper washing semi-permanent slide was prepared and observed under microscope to study the nature of stomata and epidermal cells.

To study the anatomy of petiole, stem and root Johansen’s double staining procedure was followed. Thin hand sections were made and they were stained with safranin. The sections were then grade passed in different concentrations of alcohol viz. 30%, 50%, 70%, 90% and 100%. After grade pass they were counterstained with fast green and were mounted in DPX. The slides were appropriately labelled and examined under the light microscope Nikon Eclipse E200 (with Camera DS-Fi1C) and Leica ATC 2000.

The epidermal analysis was done by using scanning electron microscope (SEM). The dried leaf material was mounted directly on stubs using double-side adhesive tape and sputtered with a thin layer of gold. The electron micrographs were obtained in a JEOL JSM-6360 system.

**Taxonomic treatment**


The plant is a shrub up to 3m; stems erect, glabrous, slightly purplish near the inflorescence, lower portions woody; branches quadrangular, swollen at the nodes, nodes are usually darker. Leaves very thick, oblanceolate or elliptic lanceolate, 16-28 X 2.5-8 cm, base cuneate, apex acute or sometimes acuminate, margins entire, primary veins massive, unbranched, secondary veins moderate, unbranched, diverging at 60°-70° to midrib, angle of divergence more acute in upper than lower, upper surface shiny; lateral veins 8-10 on each side of the midrib, the midrib on the abaxial surface of the leaf is very prominent and thicker than that of the adaxial surface, venation brochidodromous, distinctly visible upto 4th order, regularly oriented upto 3rd but 4th veins randomly oriented, areoles large, imperfect, irregular, random, veinlets simple; length of petiole varies from 1.7-2.5cm. Type of leaf is hypostomatous, guard cells varies from 95-100 µm in length and 15-20 µm in breadth. Inflorescence terminal, pubescent, 8.5-20 cm; bracts 3, linear, pubescent, about 1-1.2cm long. Calyx 5-lobed, pubescent, linear, 0.8-1cm long. Corolla 2/3 bilabi, orange-red, tubular, 2.5-2.9cm, wide at mouth, pubescent; stamens 2, polyandrous, epipetalous, filaments hairy at the base; anthers 2-celled, glabrous, dorsifixed. Gynoecium about 2.5cm; style long, filiform; stigma bifid. Fruit capsule about 3.8cm long, linear, elongate, sub-tetragonous (Fig. 1).

**Flowers & Fruits:** January-May.

**Execeratus:** Kamrup, Dutta, B. 05 dated 13.03.2014.

**Distribution:** South East Asia. India: Assam: in all the districts.

Figure 1: Gross morphology of *Phlogacanthus thyrsiflorus* Nees. A. The habit, B. Inflorescence, C. Complete flower, D. Bracts, E. Calyx, F. Corolla with androecium, G. Gynoecium, H. Front part of the bilabiate flower, I. The fruit.

**Anatomy**

The lamina is smooth and even on both surfaces. T.S of leaf blade shows uniseriate adaxial and abaxial epidermis; cells of epidermis are barrel shaped, thinly cuticularised. Adaxial epidermis is thick, devoid of stomata, cells are about 40-45µm in size; abaxial epidermis is thinner than the adaxial epidermis, embedded with stomata, cells are about 20-30 µm in size. One or two celled head glandular trichomes present on the surface of both the epidermal layer. In between the epidermises dorsiventral mesophyll cells are arranged in rows which are differentiated into palisade parenchyma which are present just below the

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adaxial epidermis and spongy parenchyma which are below the palisade cells, both filled with chloroplasts but concentrated more in palisade cells. Palisade 1-2 layered; spongy parenchyma 4-5 layered; cells irregular. Vein bundles embedded in mesophyll; bundle sheath parenchymatous. Acicular and microsphenoidal crystals are embedded in the parenchymatous cells.

Cells of upper epidermis are hexagonal, a few are pentagonal. In the lower epidermis, the subsidiary cells that surround the guard cells have U-shaped sinuses. Stomata are diacytic. Trichome bases seen on the adaxial as well as on the abaxial surfaces, they are hemispherical, sessile, multicellular, about 25-30 µm in diameter and take dark colour when stained with safranin (Fig. 2).

**LS of the midrib has sieve plates with annular and spiral xylem vessels in which numerous prismatic calcium oxalate crystals of about 40-50 µm are deposited.**

The vascular tissue is oval shaped enclosing a vascular bundle towards the inner adaxial side that consisted of metaxylem towards the outer side and protoxylem towards the inner side. Two complementary round vascular bundles are present at the two corners towards the adaxial side. The phloem layer beneath the parenchyma cells consists of numerous phloem fibres (Pf). The metaxylem in the centre is surrounded by protoxylem towards the inner and outer side (Fig. 3).

Stem is straight and stout, nodes 1-8 cm apart, the distance from first node to second node towards the apex is hardly 1cm, from the second to the third node it is 2.7 cm and the distances between the rest nodes are found to be 7-8 cm, internodes towards the base are longer than that towards the apex, leaf scars of fallen leaves prominent.
T.S of stem is four angled with distinct wings and flat laterally. Epidermis is two layered with calcium oxalate crystals in druse (DR) form and a very few sessile bicellular glandular trichomes. Cortex is heterogenous with thin, long stele and wide pith. 2-3 layered chlorenchyma reaches epidermis interrupting collenchymatous hypodermis below the angles. Cortex has 6-7 layered collenchymatous hypodermis followed by 1-2 layered sclerenchyma cells which is then followed by 7-8 layered parenchyma cells. Endodermis and pericycle are not distinct. Vascular bundle is collateral with phloem towards the outer side and xylem towards the inner side and these are traversed by elongated, radiating medullary rays. This xylem towards the inner side is the secondary xylem with the presence of both metaxylem and protoxylem. Some patches of phloem fibres were also found in the phloem. Some of these phloem fibres bear hair like outgrowths. Microsphenoidal (M Cy) and acicular (A Cy) calcium oxalate crystals was found to be deposited throughout the parenchyma, vascular bundles and pith. The pith is wide with angular, compact cells and in between some sclerenchyma cells (SC) were also deposited (Fig. 4).

Figure 4: A-I. Stem of Phlogacanthus thyrsiflorus Nees 40x. A. T.S of stem showing epidermis with sessile bicellular glandular trichome (GT), 100µm; B. Sclerenchyma layer (SC) and Calcium oxalate druse (DR), 100µm; C. Parenchyma cells with microsphenoidal crystals, 100µm; D. Vascular bundles with Phloem fibres (Pf), 100µm; E. Microsphenoidal Calcium oxalate crystals (M Cy) throughout the vascular bundles, 100µm; F. Hair like outgrowths from Phloem fibres, 100µm; G. Microsphenoidal (M Cy) and Acicular (A Cy) calcium oxalate crystals deposited in Sclerenchyma (SC) of pith, 100µm; H. Chlorenchyma (CH) cells in the winged part of the stem, 100µm; I. Sclerenchyma (SC) cells in the pith, 100µm.

The lower epidermis of SEM observation showed the presence of numerous diacytic stomata at a magnification of 750x with trichome bases and a very few unicellular non-glandular trichomes about 70-80µm in length at a magnification of 1000x on the midvein. Whereas on the upper epidermis with 2000x magnification only trichome bases about 10 µm radius was observed (Fig. 5).

Figure 5: A-D. SEM micrograph of upper and lower epidermis A. Stomata and Trichome bases on lower epidermis. B. Unicellular trichome with flattened trichome base on the midvein of lower epidermis. C.
Numerous trichome bases on upper epidermis. D. Trichome base zoomed.

Roots had few root hairs. T.S of root showed the presence of several distinct tissue layers. Epidermis is multilayered which is followed by a 3-layered exodermis. The next is 3-4 layered angular collenchyma (AC). Cortex is homogenous and parenchymatous. Endodermis and pericycle are not very distinct. Vascular bundle arrangement is radial and forms a broken ring. Metaxylem and protoxylem are intermingled and scattered. Conjunctive tissue becomes meristematic and results in secondary growth. Rays are uniseriate. Patches of phloem scattered in secondary xylem. Pith is very small with closely packed parenchyma cells (Fig. 6).

**Figure 6:** A-D. Root of *Phlogacanthus thyrsiflorus* Nees. A. T.S of root showing cortex (C), Endodermis (En) and Pericycle (Per) 4.5x; B. Zoom view of Secondary Xylem (SX), 4.5x; C. Cortex with epidermis, 4.5x; D. Multilayered Epidermis (E), 4.5x.

**Conclusion**

*Phlogacanthus thyrsiflorus* belonging to Acanthaceae is used in folk medicine for treatment of diabetes, cough and cold, to reduce blood pressure by some ethnic groups. Although it is distributed in almost all the districts of Assam yet very little has been documented about its morphology and anatomy. Anatomical details are recorded for the first time in the present study. The microscopic characters reported in this paper could be used as tool for authentication of this medicinal plant. The work would serve as information for further phytochemical and pharmacological study.

**Acknowledgement**

Authors are thankful to the Head, department of Botany, Gauhati University for providing the necessary laboratory facilities and to the UGC for providing financial assistance in the form of SAP-DRS-I for carrying out this work under its special assistance.

**References**


Source of support: UGC, SAP-DRS-I, India

Conflict of interest: None Declared