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Preliminary Anatomical Studies in *Garcinia dhanikhariensis* S.K.Srivastava (Clusiaceae): An Endemic Species from Andaman Islands, India

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Abstract

Garcinia dhanikhariensis is an endemic species reported from the South Andaman Island. It belongs to the family Clusiaceae in the order Malpighiales. The paper presents results of anatomical features of this species including characteristics of leaves, petiole, stem and root. This is the first anatomical report of in this endemic specie. The leaves are dorsiventral, hypostomatic, with a thick cuticle and uniseriate epidermis. Petiole vascular strands appear in an arc shape and are almost fused with each other. Several druses, starch grains, and secretory canals are observed in the ground tissues of the leaf. The stem and roots show secondary growth. The present study could form the basis for improving the understanding about anatomical characteristics of this lesser known endemic species.

Key words: *Garcinia, anatomy, leaves, stem, root.*

Introduction

The Clusiaceae family comprises of several genera, with *Garcinia* being the major one. There are *ca*. 260 reported species in the genus globally. Members of this genus are mostly tropical trees and shrubs (Stevens, 2007). Many species of *Garcinia* are known for their medicinal and economic values.According to the floral checklist of the Andaman and Nicobar Islands, six species are endemic to theseIslands. *Garcinia dhanikhariensis* S.K. Srivastava is an endemic species reported from the South Andaman Island. The species was originally described by S.K. Srivastava (1994) and it was first identified and collected in the Nayashahar Forest area in Dhanikhari, South Andaman. It is a small or medium-sized, straight growing dioecious tree up to 8 m tall, with dark green shining leaves. The leaves are opposite, elliptic-lanceolate, and the fruits sub-globose, *ca*. 3–4 cm in diam., with fleshy edible aril (Srivastava, 1994).

Anatomical features analysis is one of the key investigations in many systematic studies, and it also serves as a useful model for investigating fundamental plant development processes. Anatomical data has been utilized at various levels of the taxonomic system and anatomical traits have been shown to be helpful in identifying evolution patterns at species, genus, family, and ordinal levels. Earlier research has suggested that anatomical studies are crucial for answering taxonomical concern in the family Clusiaceae (Mourao and Beltrati, 2001; Parthirana and Heart, 2004 and Campana et al., 2010). According to Campana et al. (2010), the anatomy of the vegetative organs and embryo are both important among the Clusiaceae, subfamilies and tribes. Likewise, anatomical and morphological studies are crucial for resolving concerns with taxonomy and evolution as well as identifying links among *Garcinia* species (Pathirana and Heart, 2004).

There have been few anatomical studies on the Clusiaceae family. However, so far no efforts have been made to systematically study anatomical features in *G. dhanikhariensis*. As per our knowledge, the present preliminary study is the first report on the anatomical features of the leaf, petiole, stem, and roots of *G. dhanikhariensis.*

Materials and methods

Plant material

The materials for the present investigation were collected from Nayashahar Dhanikhari experimental

garden, which is a Garden-cum-arboretum maintained by the Andaman and Nicobar regional centre of the Botanical Survey of India. The identification of the selected *Garcinia* species was done by the Botanical Survey of India (BSI), Port Blair. The specimens, such as leaves, petiole, young stem, and young root, have been collected from healthy plants.

Preparation of permanent slides

Johansen's method (Johansen, 1940) was used to prepare permanent slides. A formaldehyde-based fixative containing 95% ethanol, 5 ml of glacial acetic acid, 10 ml of formaldehyde (37%), and 35 ml of distilled water was used to kill and fix leaves as soon as they were collected. After 12 hours, the samples are dehydrated in a graded ethyl alcohol or tertiary butyl alcohol series, infiltrated, embedded in paraffin wax, and sectioned by rotary microtome. The transverse sections thus obtained were stained with safranin and toluidine blue O. All the samples collected were treated on the transverse section in this manner and were permanently mounted on DPX. Then slides were observed under an optical microscope (Axio Vert. A1) and a digital camera (Axiocam ERc5s).

Results

Leaf

In the transverse section of the leaf lamina, a thick cuticle layer is shown on the outer surface. The epidermal cells are uniseriate. Below the epidermis, a single layer hypodermal cells are present, they are made up of rectangular to barrel-shaped cells. The mesophyll is bifacial (dorsiventral). The palisade parenchyma located under the adaxial side and the spongy parenchyma on the abaxial side with loosely arranged cells are highly chlorophylated cells. The leaves are hypostomatic (stomata mostly on the lower surface); they are hemiparacytic type. The midrib section of the leaf shows a thick cuticle and epidermis. Collenchymatous cells are observed under the upper and lower epidermis. Vascular bundles are conjoint, overlapping with a closed xylem and phloem arrangement. Several druses, starch grains, secretory channels, and resin ducts are observed in the ground tissues (Fig. 1-4).

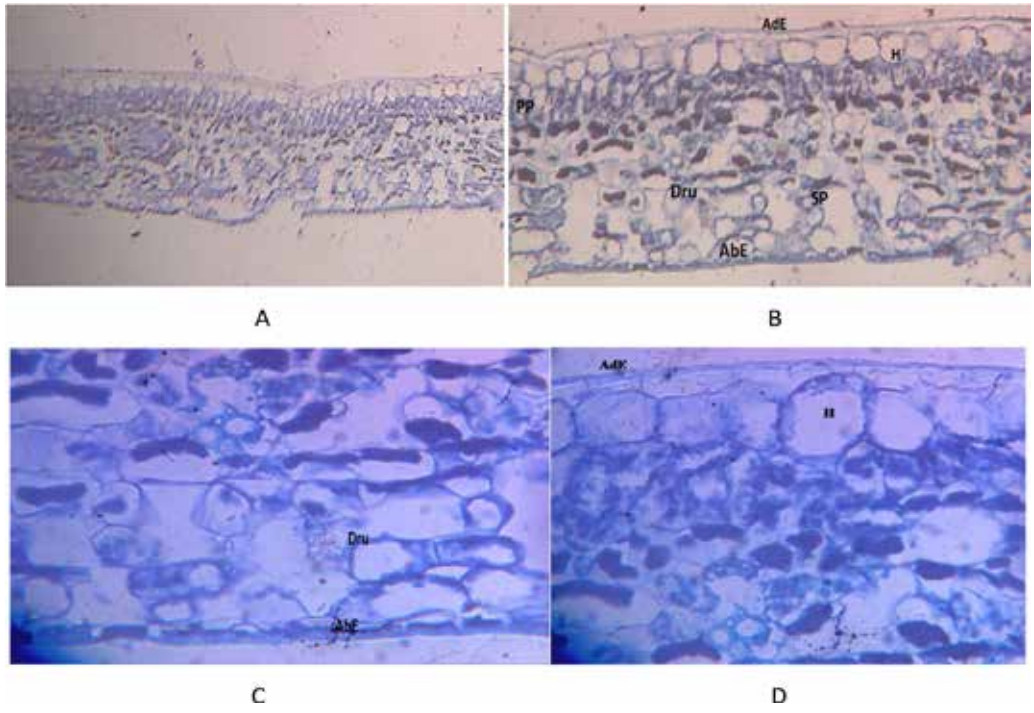
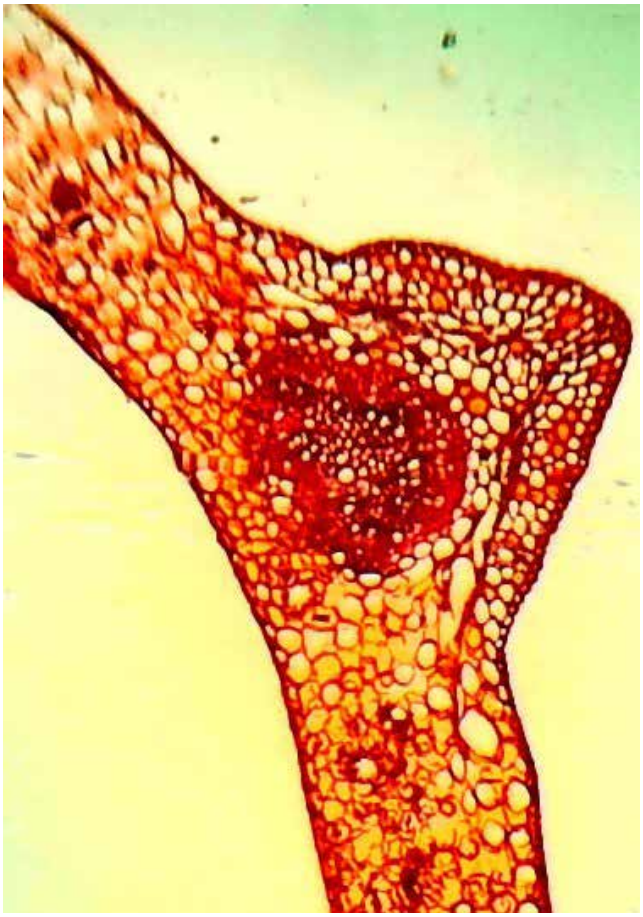
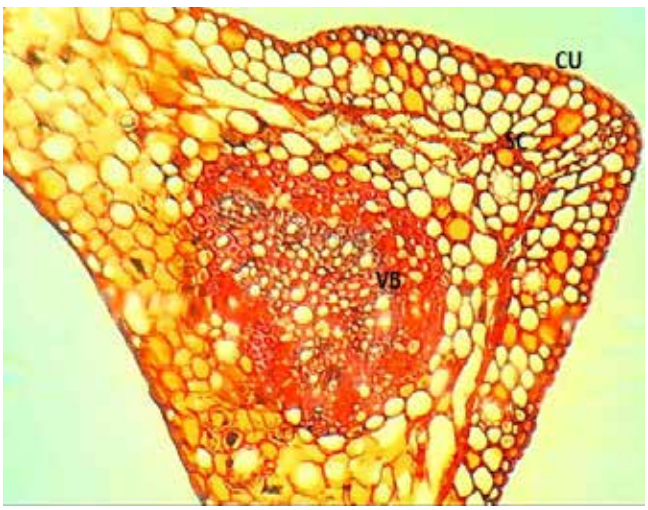


Fig. 1. TS of lamina showing A: Entire view under low magnification, B: Enlarge of view adaxial and abaxial side showing Hypodermal layer (H), Palisade parenchyma(PP), Druces(Dru), Spongy parenchyma, C: Abaxial epidermis showing druces at mesophyll cells, D-Adaxial epidermis with hypodermal layer.



A



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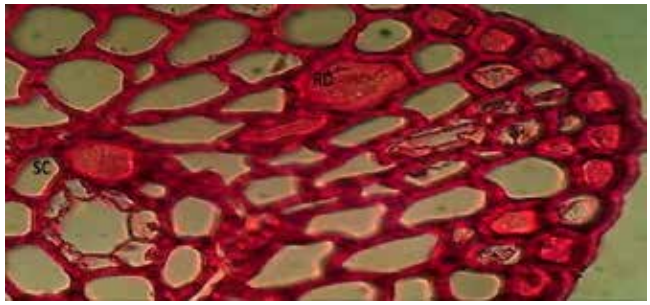

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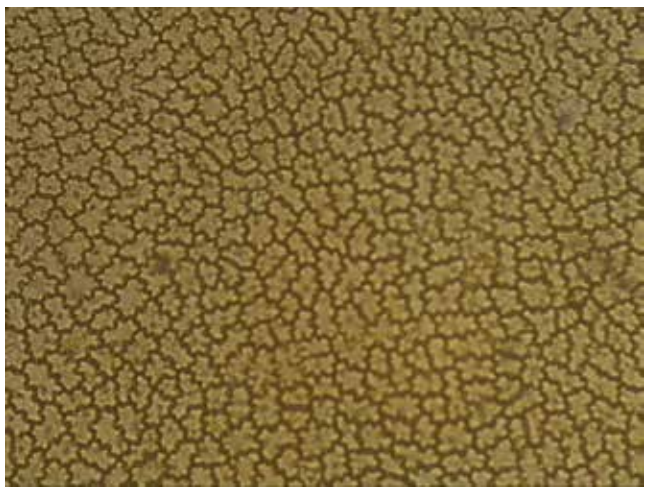
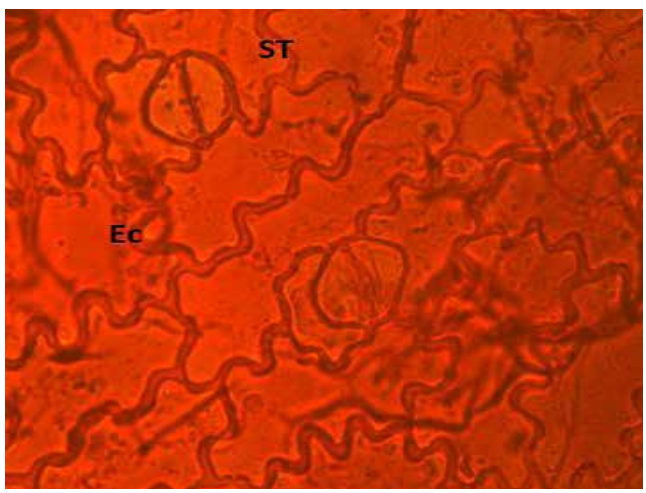
Fig. 2. TS of midrib Showing A: Entire view under low magnification, B: Enlarge view of Vascular bundle, C: Enlarge view of Secretory canals (Sc) and resin duct (RD).



A



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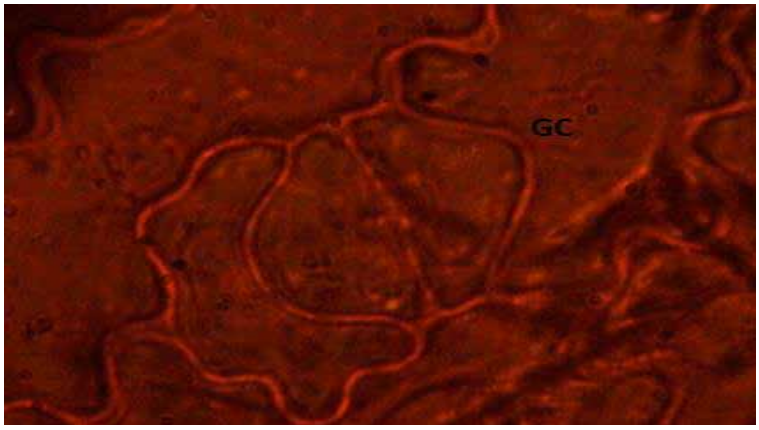
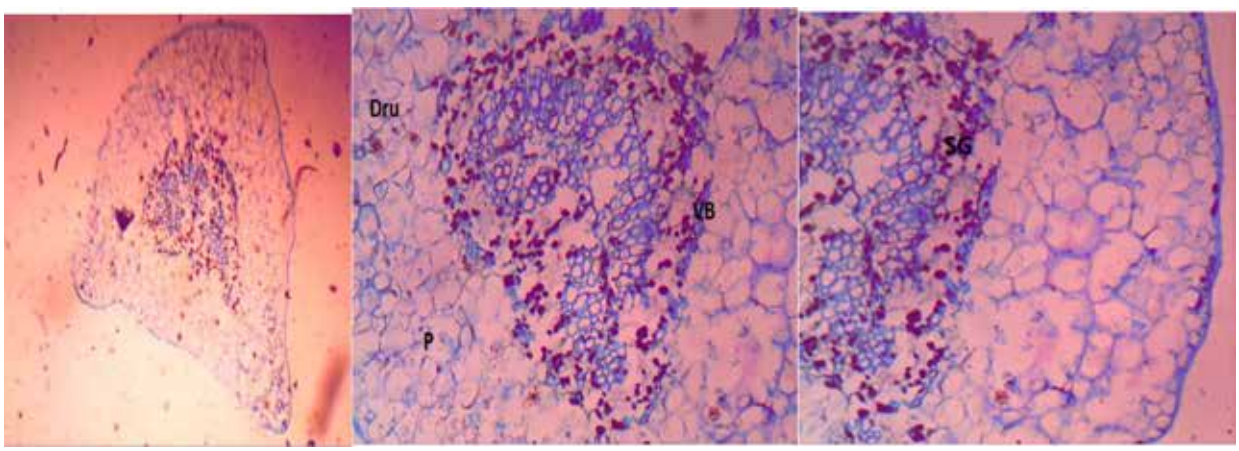


C

Fig. 3. TS of Stomata. A: Adaxial side showing absence of stomata, B: Abxial side showing epidermal cells and stomata, C: Enlarge view of hemiparacytic type of stomata.

Petiole

In transverse section, the petiole is semi-circular in outline, with a thick cuticle and uniseriate epidermal cells. Trichomes are absent. The vascular bundle is in an arc shape. The two adaxial ends of the main vascular strand are curved and are almost fused with each other. The ground tissue is made up of large collenchymatous cells, starch grains, and druses were observed (Fig. 4).



A B C

Fig. 4. TS of petiole showing A: Entire view under low magnification, B: Enlarge view of vascular bundle (Vb) and C: enlarge view of parenchymatous cells showing starch grains, druces.

Stem

The transverse section of the stem is circular in outline. The epidermis is covered with a thick cuticle. Trichomes are absent. Collenchymatous tissue is located under the epidermis. The cortex consists of parenchymatous cells with starch grains. Vascular bundles are open, collateral, and endarch. Endodermis is not distinguished clearly. The outer boundary of the phloem has a layer of sclerenchymatous cells with numerous tanniferous cells. Xylem is present in a continuous ring and consists of vessels, xylem parenchyma, and xylem fibre. The vascular

cylinder consists of secondary xylem, secondary phloem. Stem consists of parenchymatous pith in center. Fibres or sclerieds, starch, tannins, and druses are also found in some cells (Fig. 5).

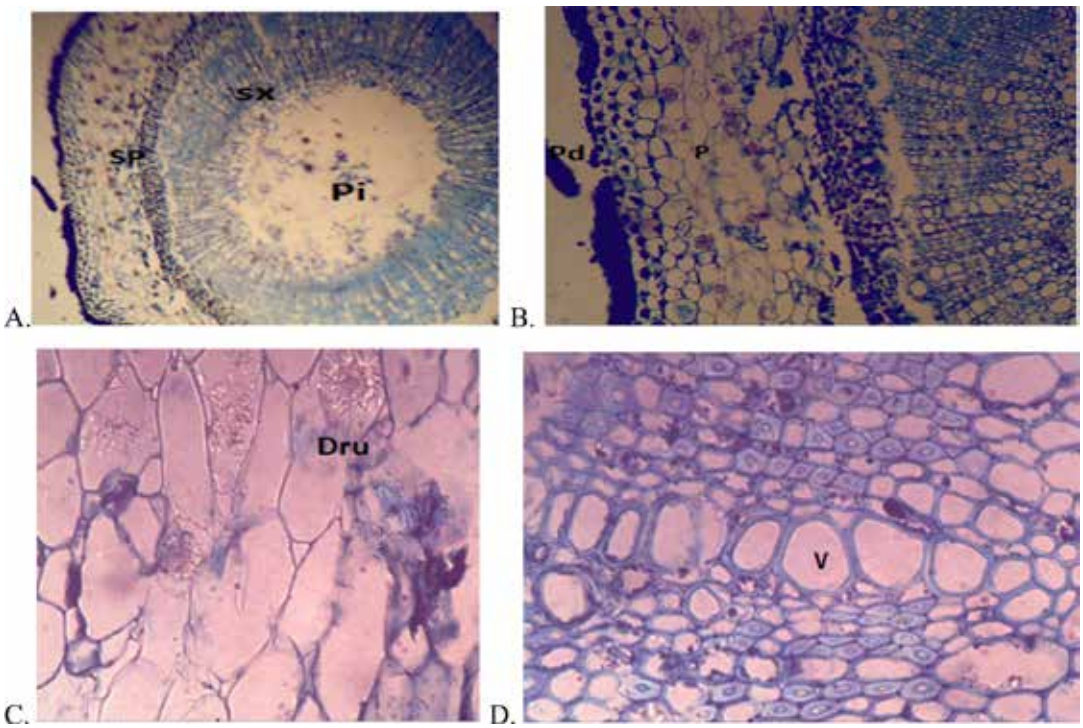
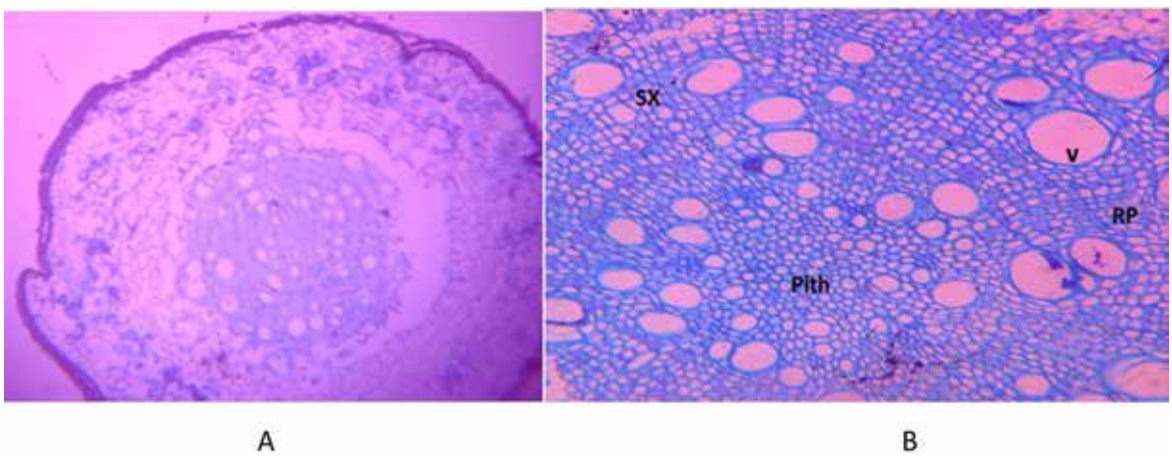


Fig. 5. TS of stem showing A: Entire view in circular in outline, B: enlarge view of secondary xylem (SX), secondary phloem (SP), C: druces on parenchymatous cells, D: rays of fibres and vessel.

Root

The transverse section of the root is irregular in outline with a thick periderm layer. Below the periderm layer, there is a cortex tissue made up of parenchymatous cells that contains secretory canals. Cambium is present in the vascular bundle and it shows secondary growth. The phloem layer is located outside the xylem, and the xylem is located in the innermost layer. Xylem elements consist of vessels, fibres, with lignified cells. The central layer is occupied by parenchymatous pith without any intercellular spaces and contains a starch grains (Fig. 6).



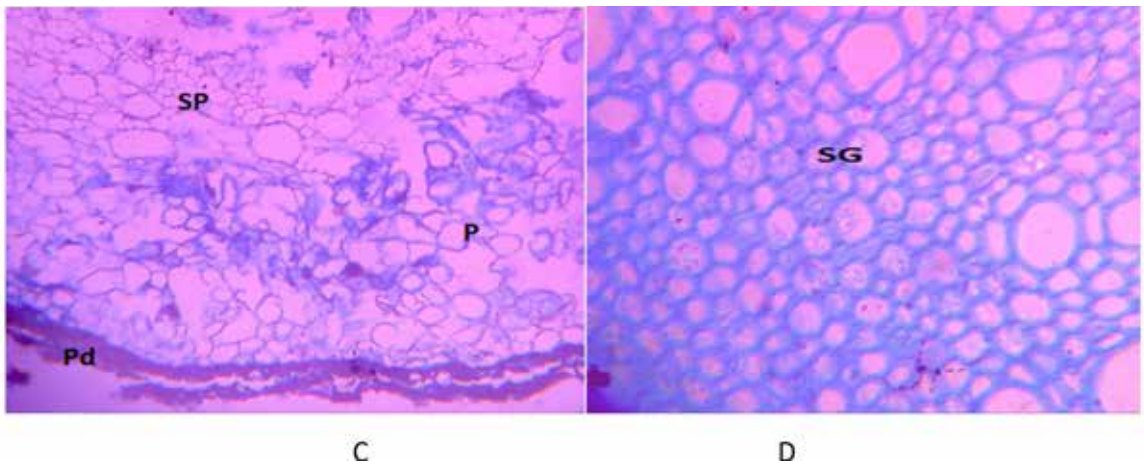


Fig. 6. TS of root showing A: Entire view, B and C: Enlarge view of secondary xylem (sx), secondary phloem, Ray parenchyma (RP), D-Starch grains.

Discussion

The morphological and anatomical identification of any plant species is the first step towards its characterization. The leaves, petiole, stem, and root of *G. dhanikhariensis* were examined for the first time in the present study. According to the findings, the leaf lamina has a thick cuticle, a uniseriate epidermis, and a thick cuticle. The leaves are dorsiventral. The thickness of the cuticle and epidermis, sinuosity of epidermal cells, characterization, distribution, and presence of secretory canals as well as the kind of midrib vascular bundle are the important traits in the identification of the clusiaceae family Metcalfe and Chalk, 1950. The thickness of cuticle, uniseriate epidermis, and dorsiventral leaves are also reported in Sri Lankan *Garcinia* species (Pathirana and Herat, 2004; Amanda et al., 2013; Gupta et al., 2018 and Priya et al., 2018).

The leaf is hypostomatous (stomata mostly on the lower surface). The stomata are hemiparacytic in *G. dhanikhariensis*, showing only one subsidiary cell parallel to the larger stomatal axis, longer or shorter than the guard cells. According to Pathirana and Herat (2004), the most common stomatal type in *Garcinia* is Paracytic. The petiole shows a thick cuticle and epidermis. The vascular bundle is in an arc shape. The two adaxial ends of the main vascular strand are curved and almost fused in *G. dhanikhariensis*. Pathirana and Herat (2004) reported the same trait in Sri Lankan *Garcinia* species. The ground tissue is densely packed with druses and starch grains. The curved and incurved nature of the vascular bundle was reported in two species of *Garcinia* (Rutuja et al., 2017).

Metcalfe and Chalk (1950), reported a general anatomical studies in the Clusiaceaefamily.Inour findings, T.S., the stem is circular in outline. The epidermis is covered with a thick cuticle. Absent trichomes, collenchymatous tissue is located under the epidermis. The tanniferous cells were found to be the cortex. On the outer surface of the pericycle, a sclerenchymatous or a continuous ring of fibres is present. Xylem is present in a continuous ring and consists of vessels,xylem parenchyma and xylem fibre. Vascular bundles are endarch. Tannins, druses, and scleried were observed in the secondary growth of the stem.

The transverse section of the root is irregular in outline, with a thick periderm layer. Below the periderm layer, there is a cortex tissue made up of parenchymatous cells that contains secretory canals. Cambium is present in the vascular bundle and it shows secondary growth. Xylem elements consist of vessels, fibres, and lignified cells. The central layer is occupied by parenchymatous pith without any intercellular spaces and contains a starch grains. There are few works in the literature concerning the stem and root anatomy of clusiaceae species. Hence,

the present preliminary work would be the basic for understanding *Garcinia* species.

Conclusion

G. dhanikhariensis leaf and petiole anatomy has resemblance with other *Garcinia* and Clusiaceae species, but this species exhibits differences that could provide support for evolutionary research and plant taxonomy. Anatomical studies on the Clusiaceae family are uncommon. The current study gives a preliminary idea of the types of data required for plant taxonomy and physiology.

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