

Full Length Research Paper

## Foliar anatomical studies of some taxa of Euphorbiaceae

R. Elumalai<sup>1</sup>, R. Selvaraj<sup>1\*</sup>, R. Arunadevi<sup>2</sup> and A. L. A. Chidambaram<sup>1</sup>

<sup>1</sup>Department of Botany, Annamalai University, Annamalainagar - 608 002, Tamil Nadu, India.

<sup>2</sup>Department of Botany, Government Arts College, Cuddalore- 607 001, Tamil Nadu, India.

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**Foliar anatomical studies of fifteen taxa belonging to fifteen genera of Euphorbiaceae were done to understand the foliar structural details in unravelling taxonomical disputes if any. There is a range of characters which varies between genera and species. The presence of single, double and multiple layer of epidermis, palisade parenchyma, spongy parenchyma and other special tissues and storage organs are of taxonomic interest. A combination of these characters may be used to identify the specific species.**

**Key words:** Foliar, anatomy, mesophyll, taxonomy, Euphorbiaceae.

### INTRODUCTION

An anatomical study was done on fifteen plants belonging to Euphorbiaceae. The family Euphorbiaceae is popularly known as the "Spurge" family. The name "spurge" is derived from Medieval French "epurga" referring to the purgative properties of the seeds of *Euphorbia*. The family consists of mostly monoecious herbs, shrubs, trees and sometimes succulent with about 300 genera and 7,500 species that are further characterized by the occurrence of the milky juice. The leaves are mostly alternate but may be opposite or whorled and they are simple, compound and sometimes highly reduced. Stipules are generally present but may be reduced to hairs, glands or spines. Flowers are unisexual and usually actinomorphic. They may be highly reduced by suppression of parts, in the extreme form consisting of naked stamens as a staminate flower and a naked pistil

as a pistillate flower. A specialized type of miniature inflorescence occurs in about 1,500 species comprising the genera *Euphorbia*. It consists of a single naked pistillate flower surrounded by cymes of naked staminate flowers, each consisting of a single stamen. These flowers are all enclosed in cup-like involucre that is provided with peripheral nectarines and petalloid appendages such that the whole aggregations closely resemble a single flower. A comprehensive account of the family was given by Engler and Prantl (1897), Bentham and Hooker (1883), Willis (1966), Webster (1994) and Radcliffe-Smith (2001).

The angiospermic family Euphorbiaceae is one of the most interesting and economically important family. This family is of much importance from the point of view of producing a number of useful products, natural rubber

\*Corresponding author. E-mail: selvarajphd14@yahoo.co.in. Tel: 91+ 94429 09910.

**Table 1.** The list of plants belonging to Euphorbiaceae.

Name of the species	Place of collection	Altitude from M.S.L	Wild or Cultivated
<i>Euphorbia hirta</i> L.	Annamalainagar, South India	50'	Wild
<i>Pedilanthus tithymaloides</i> (L.) Poit.	Sims Park, Ooty, South India	Hills 6000'	Cultivated
<i>Phyllanthus myrtifolius</i> Moon ex Hook.f	Tiruvananthapuram, South India	Hills 3000'	Cultivated
<i>Phyllanthus emblica</i> L.	TNAU, Coimbatore, South India	Plain 1000'	Cultivated
<i>Sauropus androgynus</i> (L.) Merr.	TNAU, Coimbatore, South India	Plain 1000'	Cultivated
<i>Aporosa lindleyana</i> Baill.	Kariavatham, Kerala, South India	Hills 3000'	Wild
<i>Baccaurea courtallensis</i> Arg.	Tiruvananthapuram, South India	Hills 3000'	Wild
<i>Croton sparsiflorus</i> Morong.	Annamalainagar, South India	Plain 50'	Wild
<i>Chrozophora rottleri</i> (Geiseler) A. Juss. ex Spreng.	Annamalainagar, South India	Plain 50'	Wild
<i>Acalypha indica</i> L.	Annamalainagar, South India	Plain 50'	Wild
<i>Ricinus communis</i> L.	Pitchavaram, South India	Plain 50'	Cultivated
<i>Hevea brasiliensis</i> Arg.	Tiruvananthapuram, Kerala, South India	Hills 3000'	Cultivated
<i>Jatropha curcas</i> L.	TNAU, Coimbatore, South India	Plain 1000'	Cultivated
<i>Manihot esculenta</i> Crantz.	Kariavatham, Kerala, South India	Hills 3000'	Cultivated
<i>Excoecaria agallocha</i> L.	Pitchavaram, South India	Plain 50'	Wild

from *Hevea*; biodiesel from *Jatropha*; starch from *Manihot* and castor oil from *Ricinus*. This family possesses number of ornamental plants also. Few of such interesting and familiar plants are *Crotons*, *Euphorbia* and *Pedilanthus*. These horticulture plants are very useful to plant breeders.

## MATERIALS AND METHODS

The materials for the present investigation were obtained from diverse localities of southern part of India (Table 1). Herbarium preparations were made from the collected plant twigs and checked with Standard Floras. Voucher specimens were stored in the herbarium section, Botany Department, Annamalai University, Annamalainagar, Tamilnadu. Collection trips were undertaken to Ooty, Coimbatore, Cuddalore, Pitchavaram, Thiruvananthapuram and Annamalainagar. Plant twigs were collected from the selected species for anatomical studies and stored in 70% ethanol for laboratory studies (triplicate - sample of leaves, from third leaf of a branch twig in each species). Anatomical studies of leaf were done with aid of free hand section and observed under the light microscope with an eye piece lens (12.5x) and an objective of low power lens (10x). The sections were stained with saffranin (1%) (the saffranin was prepared by dissolving 1g of saffranin powder in 100 ml of distilled water and filtered) and mounted in 50% glycerine. All of them were photographed. The plants are listed according to the Gamble's Flora of Presidency of Madras (1956).

## RESULTS

The leaf is a variable organ. In Euphorbiaceae leaves are mostly alternate but may be opposite or whorled and they

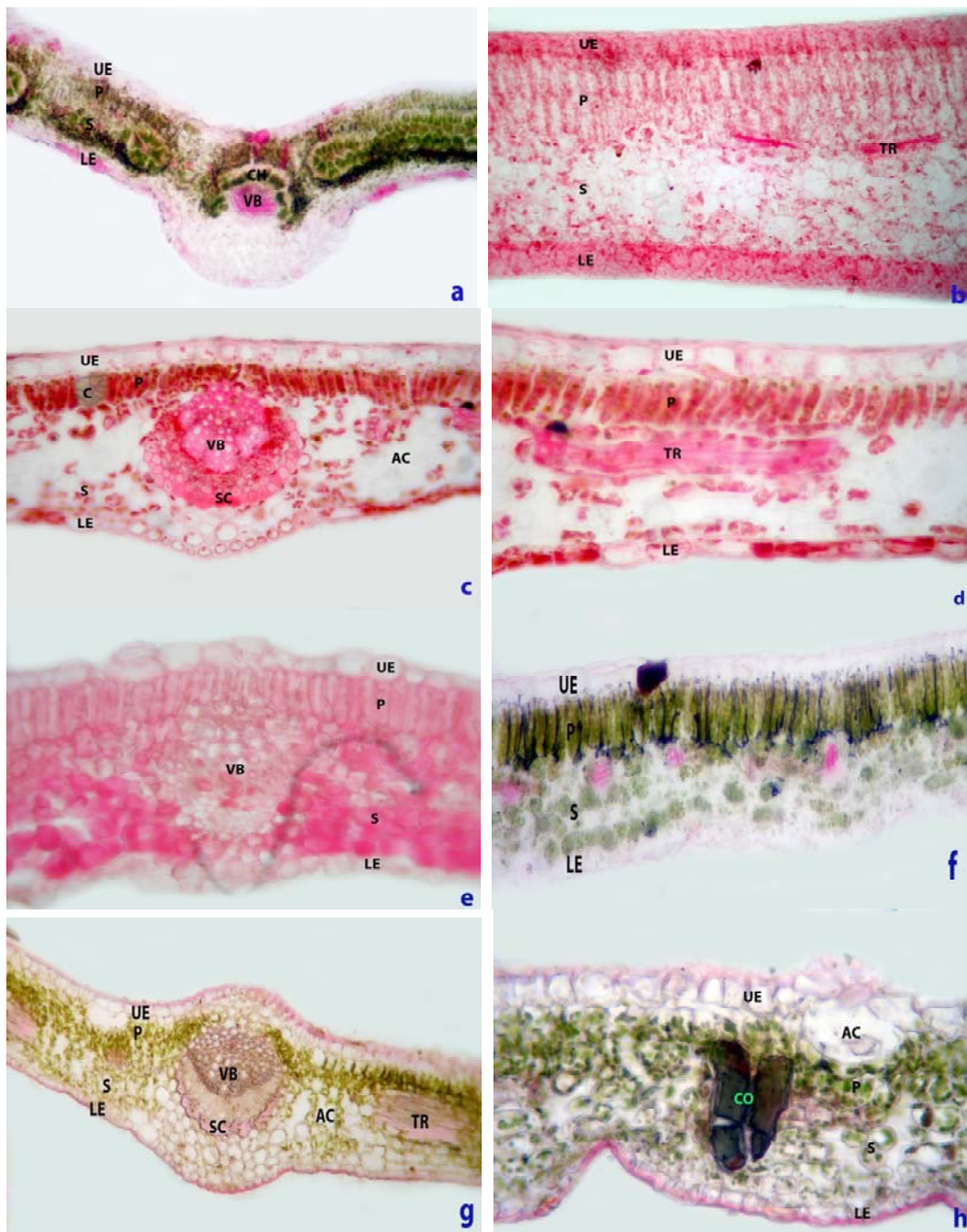
are simple or compound or sometimes highly reduced. Stipules are generally present but may be reduced to hairs, glands or spines. Anatomical work in higher plants has been made by several authors (Cutter, 1971; Ahmad, 1976; Selvaraj and Subramanian, 1979; Ramona Crina Gales and Constantia Tima, 2006; Essiett et al., 2012; Thakur and Patil, 2011; Martins and Zieri, 2003; Hussein et al., 2012; Idu et al., 2009). The leaf anatomy of Euphorbiaceae is unique in the sense that it is latex yielding. The leaf region was made up of latex cells and laticiferous tissues for translocation of latex. The leaf anatomy showed the following details:

### *Euphorbia hirta* L.

The section shows epidermis, mesophyll cells and vascular traces. The vascular traces are surrounded by photosynthetic tissues. The single layer epidermis with packets of chlorophyll pigments. The region of photosynthetic tissues in leaf area are 90% with the storage tissues (Figure 1a).

### *Pedilanthus tithymaloides* (L.) Poit.

The section shows multilayer epidermis and mesophyll tissues. The mesophyll tissues consist of double layer palisade and spongy parenchyma. The region occupying the palisade layer versus spongy parenchyma is in equal proportion (Figure 1b).



**Figure 1.** Anatomy of Euphorbiaceae species (a. *Euphorbia hirta*, b. *Pedilanthus tithymaloides*, c and d. *Phyllanthus myrtifolius*, e. *Phyllanthus emblica*, f. *Sauropus androgynus*, g and h. *Aporosa lindleyana*). UE = Upper epidermis; LE = lower epidermis; P = palisade parenchyma; S = spongy parenchyma; VB = vascular bundle; TR = transfusion tissue; AC = air cavities; C = cystolith; SC = sclerenchyma; CH = chlorenchyma; CO = calcium oxalate.

### ***Phyllanthus myrtifolius* Moon ex. Hook.f**

The section shows a thick walled epidermis, mesophyll tissues, transfusion tissues and vascular bundles. The xylem and phloem are surrounded with sclerenchy-

matous stone cells. Calcium oxalate cystoliths are distributed in mesophyll tissues (Figure 1c).

Transverse section of leaf of *P. myrtifolius* show enlarged view of mesophyll tissues, where, the palisade cells are single row, long elongated cells with many

nucleate conditions (Figure 1d).

***Phyllanthus emblica* L.**

The section shows epidermis, mesophyll tissues and vascular traces with a single row of palisade cells. Five to seven layer spongy parenchyma are also present (Figure 1e).

***Sauropus androgynus* (L.) Merr.**

The section shows epidermis, equal region of palisade and spongy tissues with dense amount of chlorophyll pigments. The leaves are rich in vitamins and commonly known as multivitamin leaves (edible) (Figure 1f).

***Aporosa lindleyana* Baill.**

The section shows epidermis, mesophyll cells, transfusion tissues, vascular bundle (trace) and storage product of raphids and calcium oxalates in the mesophyll zone. Just below the upper epidermis, cavities are present which are full of air and for water storage purposes, and conductive tissues which connect such cavities. There is no differentiation of mesophyll cells and all are spongy parenchymatous in nature (Figure 1g and h).

***Baccaurea courtallensis* Arg.**

The section shows double layer upper epidermis, mesophyll tissues and transfusion tissues. There is a much different palisade parenchyma and up to 10 layered spongy parenchyma are so prominent (Figure 2a).

***Croton sparsiflorus* Morong.**

The section shows epidermis, mesophyll cells (palisade and spongy parenchyma) and vascular traces. The palisade cells are long with dense chlorophyll pigments. Air cavities seen and transfusion cells are available with spongy parenchyma region (Figure 2b).

Enlarged view of T.S of leaf shows epidermis, long palisade cells, 5 to 8 layer of spongy parenchyma (Figure 2c) and star shaped cystolith (calcium oxalate and calcium carbonate); as storage product (Figure 2d). The lower region of mesophyll cells have black coloured substance known as phlallophen (an oxidise product of tannin).

***Chrozophora rottleri* (Geiseler) A.Juss. ex Spreng.**

The section shows a vascular bundle, epidermis and

mesophyll tissues. In the upper region of the leaf large sized parenchyma cells are present and comparatively small sized palisade parenchyma in the lower region. In between these two palisade parenchyma, spongy parenchyma are prominent full of chlorophyll pigments (Figure 2e).

***Acalypha indica* L.**

T.S of leaf shows vascular bundle, mesophyll tissue and upper and lower epidermis. A single row of thickly packed palisade cells and three to five layer spongy parenchyma are present (Figure 2f).

***Ricinus communis* L.**

The section shows multilayered (two to three layer) epidermis, prominent mesophyll tissue and vascular traces in the midrib. The palisade and spongy parenchyma region are equal in proportion (Figure 2g).

An enlarged view of T.S of leaf shows palisade parenchyma and 5 to 7 layer spongy parenchyma with densely packed chlorophyll pigments (Figure 2h).

***Hevea brasiliensis* Arg.**

The section shows a prominent mid-vein having vascular traces with ground tissues (parenchymatous) a multilayer upper epidermis and a single row of lower epidermis with stomata. Distinct mesophyll cells are present (Figure 3a). A much enlarged view of leaf shows epidermis, palisade parenchyma and 6 to 7 layer spongy parenchyma are present (Figure 3b).

***Jatropha curcas* L.**

The section shows epidermis double layer palisade and a few rows of spongy parenchyma. They are densely packed with chlorophyll pigments (Figure 3c).

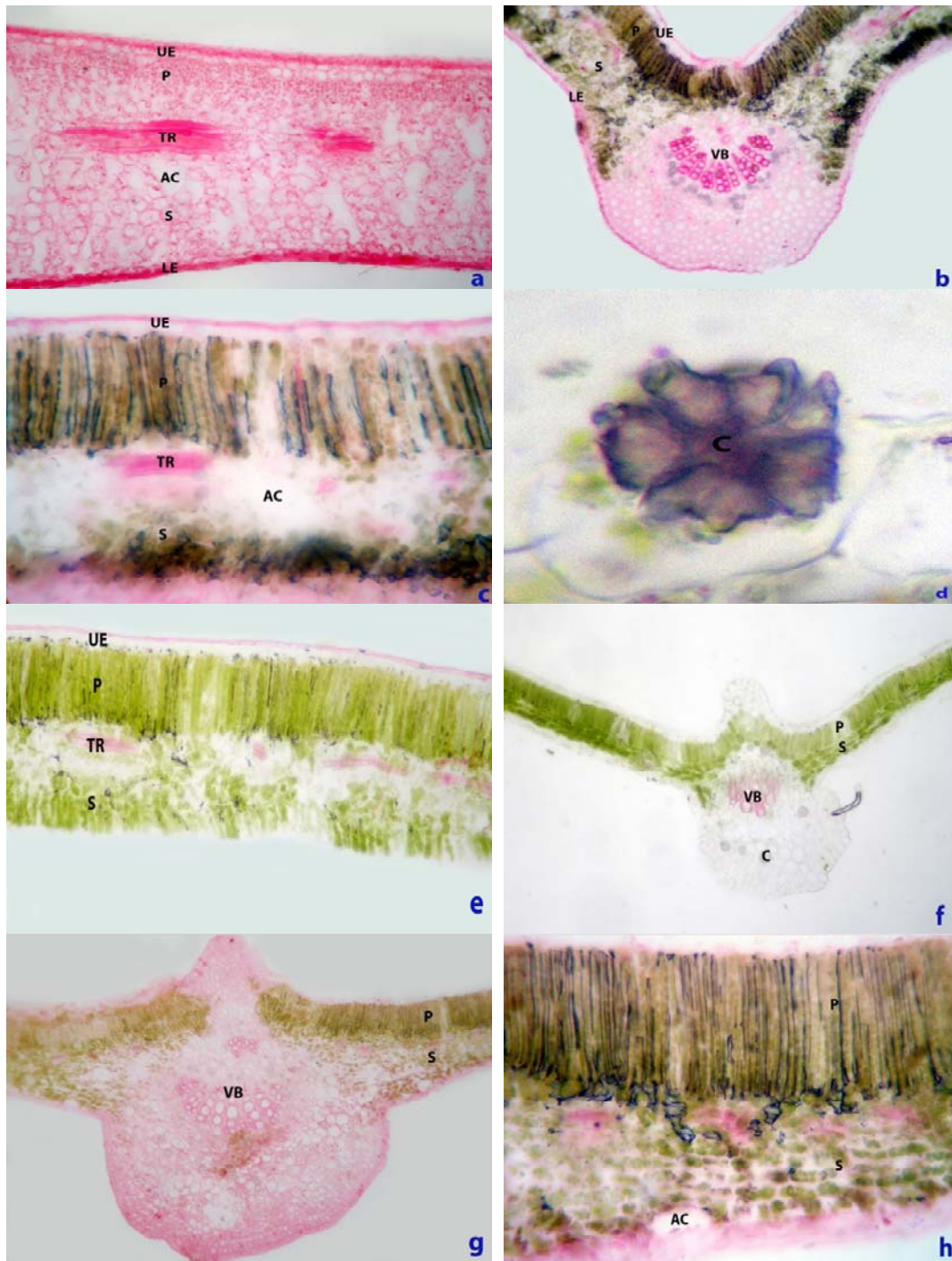
***Manihot esculenta* Crantz.**

The section shows epidermis, mesophyll tissue and vascular traces in the ground tissue with cystolith (Figure 3d).

An enlarged view of leaf section shows multilayered epidermis and well developed palisade parenchyma, spongy parenchyma with air spaces (Figure 3e) and cystolith (calcium oxalate) present in leaf area (Figure 3f).

***Excoecaria agallocha* L.**

T.S of leaf shows epidermis, two to three layer palisade

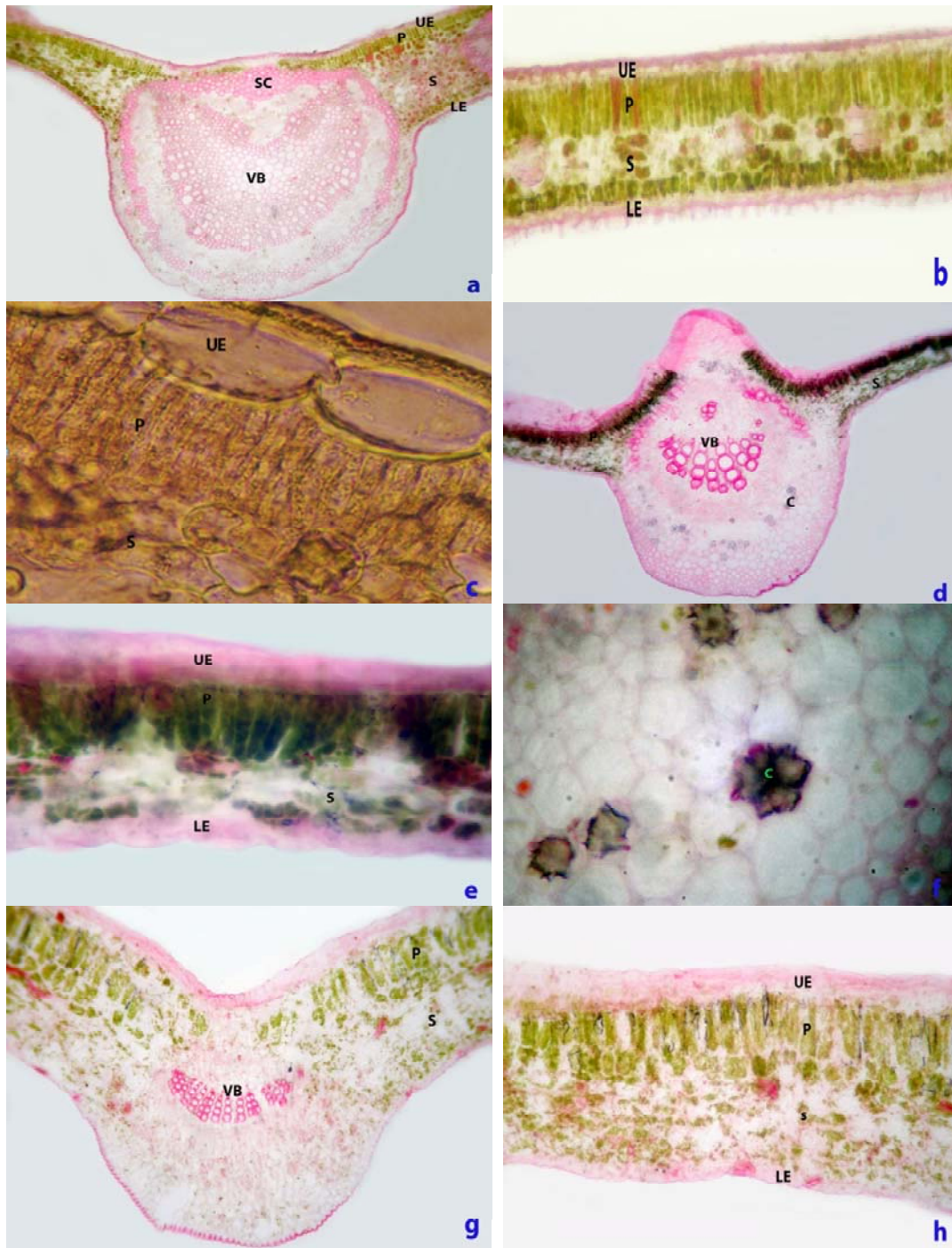


**Figure 2.** Anatomy of Euphorbiaceae species (a. *Baccaurea courtallensis*, b, c and d. *Croton sparsiflorus*, e. *Chrozophora rottleri*, f. *Acalypha indica*, g and h. *Ricinus communis*). UE = Upper epidermis; LE = lower epidermis; P = palisade parenchyma; S = spongy parenchyma; VB = vascular bundle; TR = transfusion tissue; AC = air cavities; C = cystolith; SC = sclerenchyma; CH = chlorenchyma; CO = calcium oxalate.

parenchyma, 7 rows of spongy parenchyma and air cavities (Figure 3g and h).

There are several elaborate work of leaf anatomical studies including foliar epidermal studies, by different

authors. Such studies have been successfully utilized to solve the problems of taxonomical interrelationship of plants. All the features described, were noted in this present study and re-confirmed.



**Figure 3.** Anatomy of Euphorbiaceae species (a and b. *Hevea brasiliensis*, c. *Jatropha curcas*, d, e and f. *Manihot esculenta*, g and h. *Excoecaria agallocha*). UE = Upper epidermis; LE = lower epidermis; P = palisade parenchyma; S = spongy parenchyma; VB = vascular bundle; TR = transfusion tissue; AC = air cavities; C = cystolith; SC = sclerenchyma; CH = chlorenchyma; CO = calcium oxalate.

## DISCUSSION

Foliar anatomical studies with special reference to anatomical characters have been made in fifteen taxa of

Euphorbiaceae. In this study, anatomical leaf sections of all the species in Euphorbiaceae revealed unique and species specific. The following characters were observed and may be concluded that the 15 taxa of Euphorbiaceae

studied show the polyphyletic origin and evolution. The following points are key characters:

1. Thick cuticle were observed in all the species studied.
2. In upper epidermis, single row of epidermal cells (parenchyma) occurred in all the species except *P. tithymaloides*, *R. communis* and *M.utilissima*; where there are two or three rows.
3. The mesophyll tissues are differentiated into palisade and spongy parenchyma in all the species studied except in *A. lindleyana* where the mesophyll tissues are only spongy parenchyma.
4. The occurrence of single row of palisade parenchyma have been observed in all the species, except *P. tithymaloides*; *J. curcas*; and *E. agallocha*. In all the above mentioned species, there are two or rarely three rows of palisade parenchyma cells present, to enhance the photosynthetic rate and efficiency; for quick growth and regeneration.
5. In *C. rottleri*, the occurrence of palisade parenchyma on both sides of the lamina surfaces (upper and lower side) and spongy parenchyma and vascular bundles occur in between them. Hence, *C. rottleri*, is considered as a unique and species specific with regard to the distribution of mesophyll tissue.
6. The vascular bundles in mid-vein, lateral vein in the mesophyll tissues and in the lamina surfaces are uniform throughout the species studied here.
7. The latex, laticiferous tissues, latex vessel and resinous ducts are known in Euphorbiaceae.
8. Thus, this study is an attempt to investigate the 15 taxa of the family Euphorbiaceae which forms an attainment towards an advancement of knowledge.

### Conflict of Interests

The author(s) have not declared any conflict of interests.

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