

## Anatomy of stem in some Euphorbiaceae –II

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### Abstract

This communication includes stem anatomical characteristics of 17 species of the 17 euphorbiaceous genera. The observations pertain to the epidermis, hypodermis, cortex, vascular tissues and pith. The cell wall contours have been described in detail. Occurrence of cell inclusions is also noted in different tissues of the stem – axes. The authors are inclined to state that the anatomical features of stem axes are taxonomically significant.

**Keywords:** Stem anatomy, Euphorbiaceae

### INTRODUCTION

The family Euphorbiaceae consists of about 283 genera and 7300 species. (Lawrence, 1951). Anatomy of the family is investigated by different anatomists (*cf.* Metcalfe and Chalk, 1950; Scott *et al.*, 1960; Jassonius, 1929, 1930, 1950; Shah and Jain, 1964; Westra and Koek-Noorman, 2004; Hayden and Brandt, 1984; Menega, 1987; Hayden, 1994; Hayden and Hayden, 1999, 2000). There are still many more taxa which have remained unstudied. The present authors studied stem anatomy of some taxa. It is being presented in this paper in view of its utility in taxonomy and phylogeny of the Euphorbiaceae.

### MATERIALS AND METHODS

The plants were collected from various places at Nakane Dam, Harsul Forest, Radhanagari, and Dajipur Forest in Maharashtra State. They were also obtained from Government Botanical Garden, Ootakamund (Tamil Nadu). Healthy herbarium materials were received from S I N U Botanical Herbarium, Singapore and Rancho Santa Ana Botanic Garden, Claremont, U. S. A. Preserved plant materials were obtained from Auckland War Memorial Museum Auckland, New Zealand. The plant materials were fixed in F.A.A. and preserved in 70% alcohol. Fresh, preserved and herbarium materials were used. Microtome or free-hand sections of stem were stained in 1% safranin and 1% fast green and dehydrated following the method of Johansen (1940). Cellular sketches were with the help of prism type of camera lucida using Olympus microscope. They were inked by camligraph or rotoring isograph pens.

### OBSERVATIONS

#### *Acalypha indica* Linn (Fig.1)

In T.S., it is oval in outline. Small barrel shaped compactly arranged cells constitute outermost delimiting layer. It is single layered. Their outer walls are thicker, thick cuticle is present outside. Non-glandular uniseriate trichomes are present on it. It is followed from inside by 6 – 8 layered cortex, out of which outer two layers are collenchymatous and rest others of parenchymatous. It is followed from within by a continuous ring of vascular tissue. Pith is broad. The cells are fairly large, rounded, parenchymatous and thin walled. Some of the cells of cortex and pith contain sphaeraphides and granular matter.

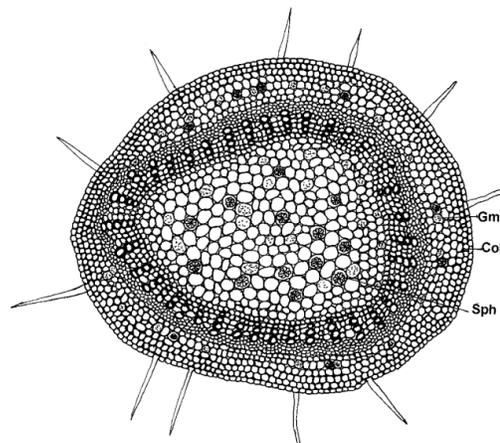


Fig.1.

#### *Agrostistachys indica* Dalz. (Fig.2)

In T.S., it is broadly oval. The outermost delimiting layer is epidermis. It is composed of small barrel shaped cells arranged compactly in one layer. Their outer walls are thicker and have thick cuticle outside. It is then followed from inside by 8-9 layered cortex, out of which the outer two layers are collenchymatous, remaining layers of cortex are parenchymatous, thin walled and medium-sized. It is followed from inside by a narrow ring of vascular tissue. It is collateral. It is surrounded from outside by discontinuous patches of sclerenchymatous pericycle. The pith is broad. The pith cells are fairly large parenchymatous thin walled and rounded. Few layers of pith lining the vascular tissue are smaller. Some of the cells of cortex and pith contain prismatic crystals.

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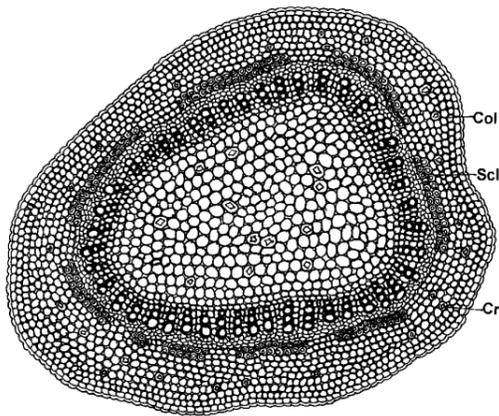


Fig 2.

***Baliospermum axillare* (Wight) Baillon (Fig. 3)**

In T.S., it is circular in outline but wavy. The epidermis is composed of medium-sized barrel-shaped compactly arranged cells. It is one layered. Their outer walls are thicker with thick cuticle. It is followed from within by 8 –10 layered cortex, of which outer two layers are collenchymatous. The remaining layer of cortex are parenchymatous. Few cells contain tannin. They are medium-sized. It is followed from within by a continuous ring of vascular tissue. It is collateral. It is surrounded; outside by 1-2 layered sclerenchymatous pericycle. Pith is very broad. The cells are very large, rounded, parenchymatous and thin walled. Granular matter is present in cortex, phloem and pith.

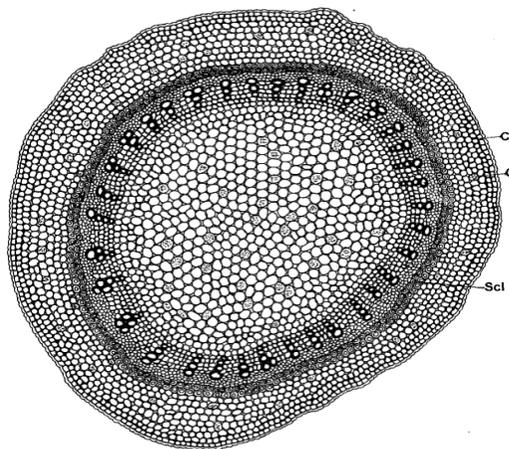


Fig 3.

***Breynia nivosa* (Bull.) Small (Fig. 4)**

In T.S., it is broadly circular in outline and ridged at some places. Epidermis is the outermost delimiting layer. The cells of epidermis are medium-sized. Barrel-shaped compactly arranged in one layer. Their outer wall is thicker and have thick cuticle outside. It is followed from within by 7-12 layered cortex, of which outer three layers are collenchymatous. The remaining part of cortex is parenchymatous. These cells are rounded or oblong. It is then followed from inside by a continuous layer of vascular tissue. It is collateral. It is surrounded by one layered sclerenchymatous pericycle. Pith is narrow. It is composed of large, parenchymatous and thin walled cells. Tannin is present in some of the pith cells.

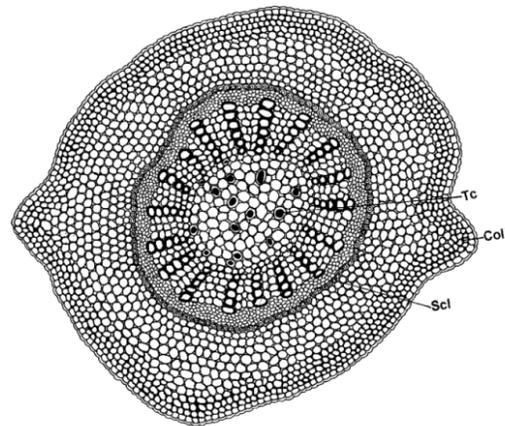


Fig 4.

***Bridelia stipularis* Blume (Fig. 5)**

In T.S., it is circular in outline. The outermost layer is epidermis. It is made up of small barrel-shaped cells arranged in one layer. Uniseriate trichomes are present on epidermis. Their outer walls are thicker and have thick cuticle outside. It is then followed from within by 7-9 layered cortex. The outer two layers just beneath the epidermis are collenchymatous. The cells of remaining layers are parenchymatous, thin walled and rounded. The cortex is followed from inside by a continuous layer of vascular tissue. It is collateral. It is bordered continuously by 2-3 layered sclerenchymatous pericycle. Pith is broad, the cells of which are polygonal, parenchymatous and thin walled. The cells of pith are medium-sized and gradually reduce towards vascular tissue. Tannin is present in epidermis, cortex and medullary cells.

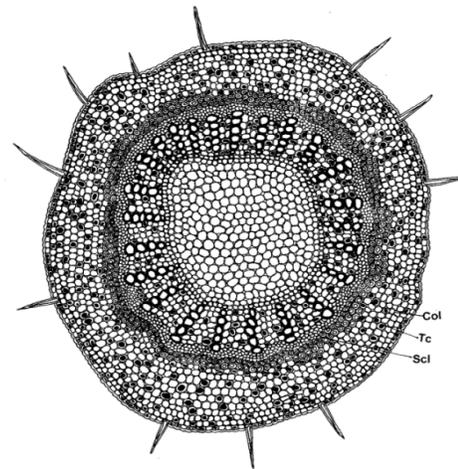


Fig 5.

***Cicca acida* (L.) Merr. (Fig. 6)**

In T.S., it is broadly oval in shape but have slightly wavy outline. Epidermis to the outermost delimiting layer. It is composed of small barrel-shaped compactly arranged cells. It is one layered. Their outer walls are thicker and have thick cuticle outside. It is followed from inside by 8-12 layered cortex. The outer three layers of cortex are collenchymatous and few cells contain tannin. The rest of the layers are parenchymatous and thin walled. The cells of parenchymatous cortex are medium-sized to large. Most of cells of cortex contain tannin. The size of cortical cells diminish towards vascular tissue. It is followed from within by a continuous ring of vascular tissue. It is collateral. Some phloemic cells contain tannin.

Pith is broad and composed of large parenchymatous, thin walled and rounded cells. Some of the cells contain tannin. Pith cells lining the vascular tissues are smaller.

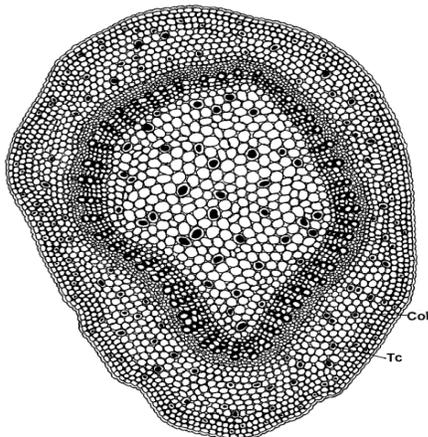


Fig 6.

***Drypetes Veusta* (Wight.) Pax & Hoffm. (Fig. 7)**

In T.S., it is circular in outline. Epidermis of the outermost delimiting layer and composed of small barrel-shaped cells. They are compactly arranged and have outer thick wall with thick cuticle. It is followed from inside by 7-12 layered cortex. Outer three layers of cortex are collenchymatous. Remaining layers are parenchymatous. These cells are thin walled and rounded. Few cells contain prismatic crystals. It is then followed from inside by the continuous layer of vascular tissue. It is collateral and surrounded outside by two-layered sclerenchymatous pericycle. The cells of pith are parenchymatous, thin walled, rounded. Some cells of pith contain prismatic crystals and granular matter.

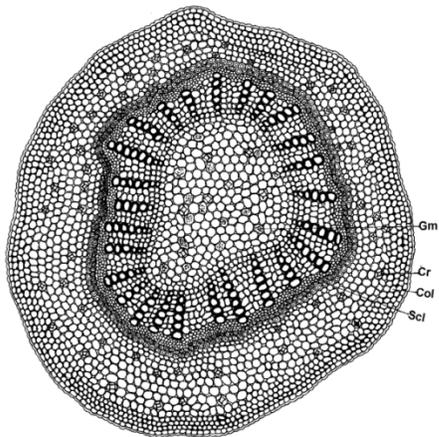


Fig 7.

***Euphorbia leucocephala* Lottsy (Fig. 8)**

In T.S., it is circular in outline. Epidermis is the outermost delimiting layers. It is composed of small, barrel-shaped cells arranged in one layer. They have outer thicker wall and thick cuticle outside. It is followed from inside by 7-8 layered cortex, of which three outer layers are collenchymatous. The remaining layers of cortex are parenchymatous. Few cells of cortex contain granular matter. It is followed from within by a continuous ring of vascular tissue. It is collateral. Two layered patches of sclerenchymatous pericycle are present on outside of vascular tissue. The cells of pith

are rounded, parenchymatous and thin walled. They also contain granular matter.

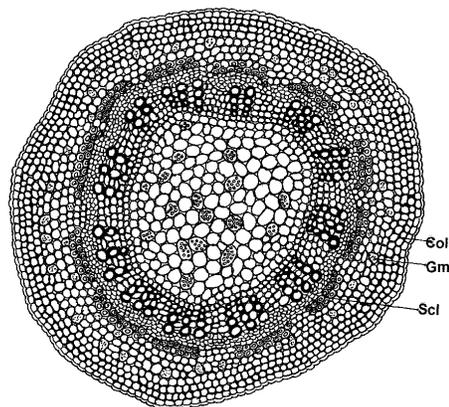


Fig 8.

***Glochidion hohenckeri* Bedd. (Fig. 9)**

In T.S., it is nearly oval in shape. Epidermis is the outermost delimiting layer. It is composed of small, barrel-shaped cells. They contain tannin. It is single layered. Their outer walls are thicker and have thick cuticle outside. They also contain tannin. It is then followed by 5-7 layered cortex. The outer three layers are collenchymatous, whereas the remaining part of cortex is parenchymatous and consists of polygonal, thin walled medium sized cells. The cells of cortex contain tannin. It is then followed inside by a continuous layer of vascular tissue. It is collateral and surrounded from outside by a discontinuous 2-5 layered sclerenchymatous pericycle. The cells of pith are fairly large, parenchymatous and thin walled. They diminish in size towards vascular tissue. Some cells of pith contain tannin and granular matter.

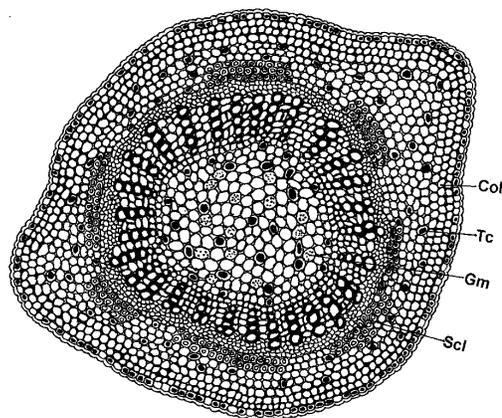


Fig 9

***Homalanthus polyandrus* Cheesm. (Fig. 10)**

In T.S., it is circular in outline. Epidermis is the outermost delimiting layer which consists of small barrel-shaped cells arranged compactly in one layer. Their outer walls are thicker and have thick cuticle outside. It is then followed from within by 10-14 layered cortex, of which two layers are collenchymatous. The remaining layers are parenchymatous and have fairly large cells. The cortex is followed from inside by a continuous layer of vascular tissue. It is collateral. The pith is broad, the cells of which are fairly large, polygonal

parenchymatous and thin walled. They reduce in size towards the vascular tissue. Some cells of cortex and pith contain granular matter.

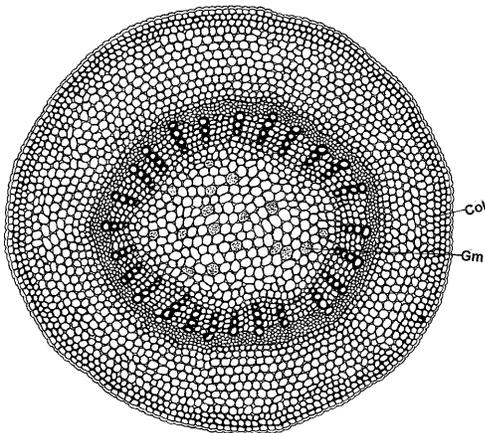


Fig 10.

### *Homonoia riparia* Lour. (Fig. 11)

In T.S., it is broadly oval but wavy in outline. The small sized, barrel-shaped cells arranged compactly constitute the epidermis. It is single layered. They have thick outer walls and have thick cuticle outside. Unicellular trichomes are present all over on it. It is followed from inside by 9-11 layered cortex. The outer three layers of this region are collenchymatous. The remaining layers are parenchymatous and thin walled. These cells are rounded. The cells of collenchyma and parenchyma contain tannin. The cortex is followed from within by continuous wavy ring of vascular tissue. It is collateral. The pith is broad and made up of large thin-walled parenchymatous cells. Few cells contain sphaeraphides and tannin.

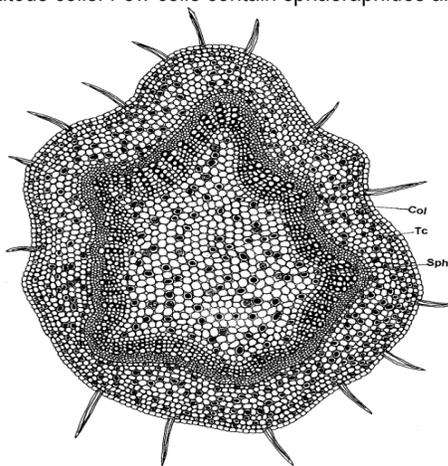


Fig 11.

### *Jatropha panduraefolia* Andr. (Fig. 12)

In T.S., it is circular in outline. The epidermal cells are small, barrel-shaped and compactly arranged in one row. Their outer walls are thicker with thick cuticle outside. It is followed from within by 7-8 layered cortex. The outer three layers of cortex are collenchymatous. The collenchymatous cells are comparatively smaller. The remaining cells of cortex are parenchymatous. Some of the cells of cortex are tanniferous. It is followed from within by continuous layer of vascular tissue. It is collateral. The vascular tissue is lined outside by two-layered sclerenchymatous, pericycle. Pith is broad, the cells of which are large, parenchymatous, thin walled and rounded. Two to

three layers of pith bordering the vascular tissue have smaller cells. Some of the cells of pith are tanniferous.

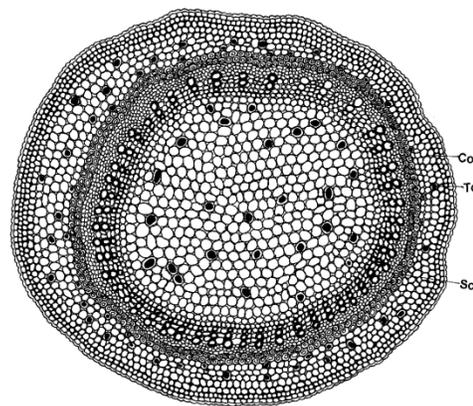


Fig 12.

### *Kirganelia reticulata* (Poir.) Baill. (Fig. 13)

In T.S., the shape shows very interesting variation. The stem-axis is notched conspicuously so that two distinct axes appear jointed. They are unequal in size. The larger one is nearly triangular in shape with obtuse angles, whereas the smaller one is circular in outline. Both of them are joined by a common cortical bridge. They, however, fundamentally show similar structure. The epidermis is the outermost delimiting layer. It is single layered and consists of small barrel-shaped, compactly arranged cells. Their outer walls are thicker and have thick cuticle outside. Uniseriate trichomes and papillae are present all over the epidermal surface. It is then followed from within by 4 – 6 layered cortex. The outer three layers are collenchymatous whereas the remaining layers are parenchymatous. The cells of cortex are polygonal or rounded. It is followed from within by a continuous ring of vascular tissue. It is collateral. It is surrounded by continuous layers of sclerenchymatous pericycle. It is 2 – 3 layered. The vascular cylinder is enclosed inside by it. The cells of pith are larger and gradually diminish towards vascular tissue. Tannin is present in the cells of epidermis, cortex, phloem and trichomes also.

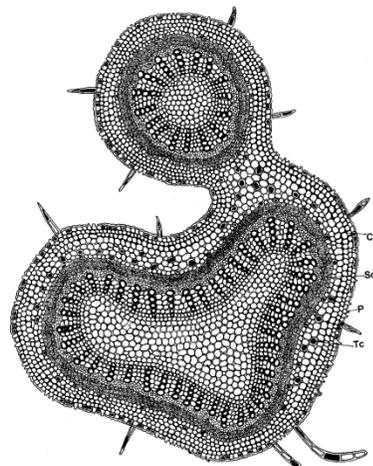


Fig 13.

### *Mallotus stenanthus* Muell. – Arg. (Fig. 14)

In T.S., it is nearly oval in shape. Epidermis is the outermost delimiting layer. It is single layered and composed of compactly

arranged, barrel-shaped cells. The epidermal cells are smaller in size. Their outer wall is thicker and thick cuticle outside. It is then followed from inside by 6-7 layered cortex, of which outer three layers are collenchymatous. The rest of the cortical layers are parenchymatous, thin walled and rounded. It is lined continuously from inside by 2-3 layered continuous layers of sclerenchymatous pericycle. It is then followed from within by continuous ring of vascular tissue. It is collateral. The cells of pith are rounded to polygonal. They are medium-sized but reduce in size towards vascular tissue. They are parenchymatous and thin walled. The cells of cortex phloem and pith contain prismatic crystals.

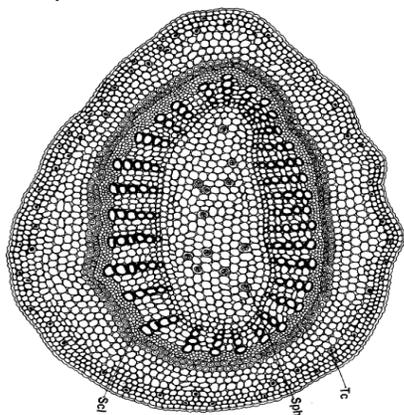


Fig 14.

**Neoscortechinia kingii** Hook. f. (Fig. 15)

In T.S., It is circular in outline. The barrel-shaped cells arranged compactly in one layer constitutes epidermis. Their outer walls are thicker and thick cuticle present outside. Few non-glandular trichomes are present on it. It is followed from inside by 6-8 layered cortex, of which outer two layer are collenchymatous. The remaining layers of cortex parenchymatous. It is then followed from within by a continuous ring of vascular tissue. It is collateral. It is surrounded outside by two layered sclerenchymatous pericycle. The cells of pith are large, rounded, parenchymatous and thin walled. They reduce in size towards vascular tissue. Some of the pith cells contains tannin.

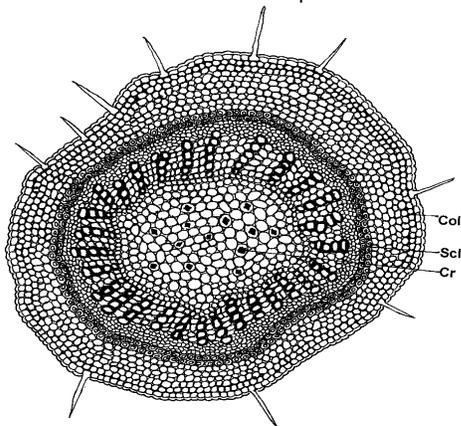


Fig 15.

**Securinega virosa** (Roxb. ex Willd.) Baillon (Fig. 16)

It is circular in outline in T.S.. The outermost delimiting layer is the epidermis. It has small-sized, barrel-shaped cells. Their outer walls are thicker with thick cuticle outside. It is followed from within

by 6-7 layered cortex. The outer two layers of it are collenchymatous. The cells of collenchymatous layer are smaller and usually contain tannin. Remaining cells of cortex are parenchymatous, rounded. Some of cells contain tannin. It is followed from inside by a continuous broad ring of vascular tissue. It is collateral. Some cells of phloem contain tannin. It is surrounded outside by patches of sclerenchymatous pericycle in a ring. These patches are 2-3 layered. The pith is comparative narrower. The cells of pith are parenchymatous thin walled and rounded. The inner cells are large. Large number of cells of pith contain tannin.

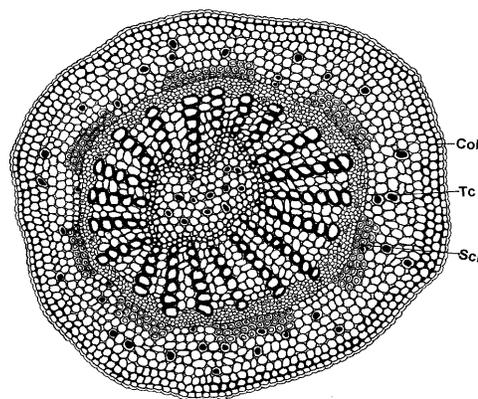


Fig 16.

**Tragia involucrata** Smith. (Fig. 117)

In T.S., it is circular in outline. The outermost layer is epidermis. It consists of small barrel-shaped cells arranged compactly in one layer. Their outer walls are thicker and thick cuticle is present on outside. Unicellular trichomes are present on it. It is followed from within by 4-7 layered cortex, of which outer three layers are collenchymatous. The remaining layers are parenchymatous. They are usually rounded. The cortex from within is followed by a continuous ring of vascular tissue. The vascular tissue is bordered outside by single layered sclerenchymatous pericycle. The pith is broad. The cells of pith are large rounded and thin walled.

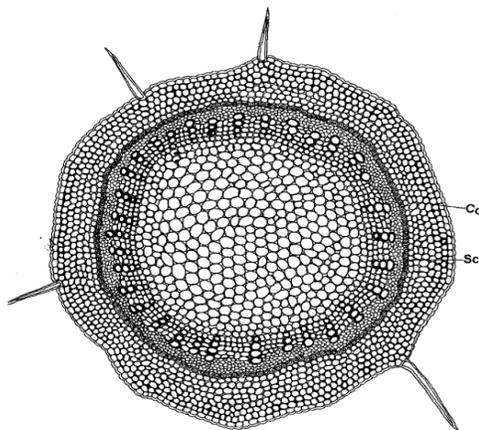


Fig 17.

**DISCUSSION**

The stem is circular or oval in outline (in T.S.). In all species, except *Kirganelia reticulata*, the stem-axis is notched conspicuously

in this species so that two distinct axes are jointed. The outermost delimiting layer is the epidermis. It is generally single layered and composed of barrel-shaped, small or medium-sized cells. They are thick walled. Their outer walls are generally thicker than the inner ones. Cuticle is always thick. Trichomes interrupt the epidermis in some species e.g. *Acalypha indica*, *Bridelia stipularis*, *Homonoia riparia*, *Kirganelia reticulata*, *Neoscortechinia kingii*, and *Tragia involucrata*. Rarely, papillate are present in *Kirganelia reticulata*. The epidermis is generally followed from within by the hypodermis. It is usually collenchymatous. It is two layered in *Acalypha indica*, *Agrostistachys indica*, *Baliospermum axillare*, and *Bridelia stipularis*. It is three layered in *Breynia nivososa*, *Cicca acida*, *Drypetes venusta*, *Euphorbia leucocephala* and *Glochidion hohenckeri*. The hypodermis is then followed by few to many-layered cortex. The cortex is generally broad and rarely narrow. The cells are parenchymatous, rounded or polygonal and moderately thickened. Majority of species exhibits 5 – 9 layered cortex, whereas others show 10 – 14 layered broad cortex.

It is the vascular tissue that follows the cortex from within. The vascular tissue extends in stem-axes in the form of a continuous ring. It is collateral. It is either in the form of a continuous ring or a ring of sclerenchyma patches. A vascular tissue is worthy of note in *Kirganelia reticulata*. The stem axis is notched and contains two distinct vascular rings joined by cortical tissue. The constitution of vascular tissue is, however, basically similar to each other. However, in major species, it is clearly present e.g. *Agrostistachys indica*, *Baliospermum axillare*, *Breynia nivososa*, *Bridelia stipularis*, *Euphorbia leucocephala*, *Drypetes venusta*, *Glochidion hohenckeri*, *Jatropha panduraefolia*, *Kirganelia reticulata*, *Manihot esculenta*, *Neoscortechinia kingii*, *Securinega virosa* and *Tragia involucrata*.

It is pith that occupies the central region of the stem-axis. The pith region is generally broader, except few cases. It is narrow in case of *Breynia nivososa* and *Securinega virosa*. The cells of pith are usually thin walled and parenchymatous. They are mostly rounded or polygonal in shape. The cells of pith are, in general, are larger than their cortical cells. They are very large in case of *Breynia nivososa*. Clustered crystals are occasionally observed in some species. They are found in cortical cells in *Acalypha indica*, *Homonoia riparia* and *Manihot esculenta*. They do occur in the cortical cells as well as in the pith e.g. *Baliospermum axillare* and *Drypetes venusta*,

Different types of crystals have been recorded in the members of Euphorbiaceae by Metcalfe and Chalk (1950). The granular matter is observed in the pith cells in e.g. *Acalypha indica*, *Drypetes venusta*, and *Glochidion hohenckeri*. It is also present in cortex as well as in pith cells in case of *Baliospermum axillare*, *Euphorbia leucocephala* and *Homalanthus polyandrous*. The epidermal cells are tanniferous in case of *Bridelia stipularis*, *Glochidion hohenckeri* and *Kirganelia reticulata*. Tannin cells are also found in the cortex e.g. *Baliospermum axillare*, *Bridelia stipularis* and *Cicca acida*. All anatomical features can be employed in taxonomy of the family.

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