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Histological Studies of the Leaf and Stem of Two Cleome Species Growing Naturally in Saudi Arabia

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The internal and epidermal structures of the leaf and the stem of *Cleome arabica* and *Cleome africana* have been studied and illustrated. The two species under investigation have several anatomical characters in common, in spite of the remarkable morphological differences between them. The similarity is manifested by the presence of glandular trichomes and absence of covering trichomes; the occurrence of photosynthetic tissue in the stem cortex and below both the adaxial and the abaxial epidermises of the leaf; and the vascular tissues forming a continuous cylinder in the old stem parts of both species.

Members of the genus *Cleome* (L.) DC. (Cleomaceae) are perennial herbs or shrubs, glandular pubescent with white, yellow or purple flowers. Calyx, 4 deciduous sepals. Corolla, 4 hooked petals. Stamens free, commonly 4 to many. Ovary contains numerous ovules, gynophore is absent in many species except *Cleome hamburyana*. Fruit is an elongated capsule. Seeds are kidney-shaped and curled to form an almost continuous ring (Muntasir and Hassib 1956; Compton 1976; Migahid 1978). Some species of *Cleome* L. have been reported to be of medicinal value (Watt and Breyer-Brandwijk 1962; Uphof 1968; Kokwaro 1976). Anatomical studies of this genus indicate the presence of palisade tissue only below the upper epidermis of the leaves; in some species and below both epidermises in other species. Vascular bundles of the leaf petiole are arch-shaped in transverse section. Myrosin cells are present in the leaf mesophyll or closed to the vascular bundles. Aerenchymatous cells occur in the internal part of the stem cortex. Crystals if present, represented by solitary forms. Rays are wide, heterogeneous, 2 to 5 cells in width (Sabins 1921; Metcalfe and Chalk 1950).

Ten species of the genus *Cleome* (L.) DC. were reported in the flora of Saudi Arabia (Migahid 1978), these are widely distributed in various habitats and climatic conditions. The present paper is concerned with the anatomy of two species of *Cleome* (L.) DC.: *Cleome arabica* L. and *Cleome africana* Botsch. They are herbs, glandular pubescent and can be distinguished morphologically by the presence of simple leaves in *Cleome arabica* whereas the lower leaves are trifoliolate and the upper leaves are simple in *Cleome africana*. This study deals with the anatomical characters which had not previously been fully investigated in the two species.

Materials and Methods

Plants were collected during the flowering season from Riyadh region, Saudi Arabia, and immediately preserved in 70% ethanol. Surface preparations were made of leaves and stems by stripping the epidermis and were then mounted in 50% v/v glycerol solution.

Customary methods of dehydration, infiltration and embedding were followed for preparing the sections which were cut at 20 and 30 μm thickness and stained with safranin and light green combination and thin mounted in Canada Balsam for making the drawings. Some sections were mounted either in iodine solution when testing for the presence of starch or in phloroglucirrol solution and hydrochloric acid when examined for lignified elements. Drawings have been made by the aid of Reichert Screen Microprojector.

Results

I. *Cleome arabica* L.

A. Leaf

1. *Epidermal characters*: Upper and lower epidermises: Cells polygonal with slightly thick beaded, sinuous anticlinal walls and covered with thin smooth cuticle; glandular trichomes frequent with biseriate or multiseriate, multicellular stalks and multicellular heads; covering trichomes not observed. Stomata, anomocytic, ovate, absent, over the midrib region frequent on upper epidermis and more dense in lower epidermis (Fig. 1, A and B).

2. *Internal structures*: Mesophyll differentiated into palisade and spongy tissues, palisade tissue, 2 to 4 layers of cells containing chloroplasts, and occurs immediately below both epidermises in the intercostal regions, separated by 2 or 3 layers of spongy tissue with cells containing chloroplasts; in the midrib region palisade tissue

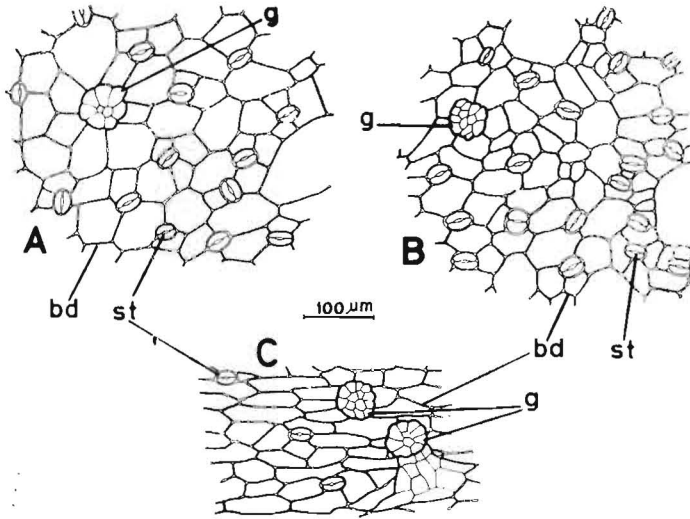


Fig. 1. Leaf and stem of *Cleome arabica* L. A-Leaf, upper epidermis. B-Leaf, lower epidermis. C-Stem epidermis.

occurs below the upper epidermis followed by several layers of rounded parenchymatous cells, devoid of chloroplasts. Vascular bundles ovate and surrounded by conspicuous bundle sheaths devoid of chloroplasts and starch grains (Fig. 2, A-C).

B. Stem

1. *Epidermal characters*: Epidermal cells elongated, polygonal with slightly thick straight beaded anticlinal walls; cuticle, stomata and glandular trichomes similar to those of the leaf upper epidermis; covering trichomes not observed (Fig. 1, C).

2. *Internal structures*: Cortex consists of a discontinuous subepidermal layer of cells with thick walls and devoid of chloroplasts, followed by several layers of rounded chlorenchymatous cells with conspicuous intercellular air spaces then several layers of parenchymatous cells devoid of chloroplasts. Vascular tissues: Primary phloem fibres occur in separate strands of cells with thick unligified walls in young stem parts becoming lignified in the old stem parts; phloem consists of several strands in the apical part of the stem, forming a continuous cylinder towards the basal part of the stem; xylem elements forming a continuous cylinder either in young or old stem parts. Medulla composed of rounded parenchymatous cells with thin cellulosic walls and conspicuous intercellular spaces (Fig. 3, A-C).

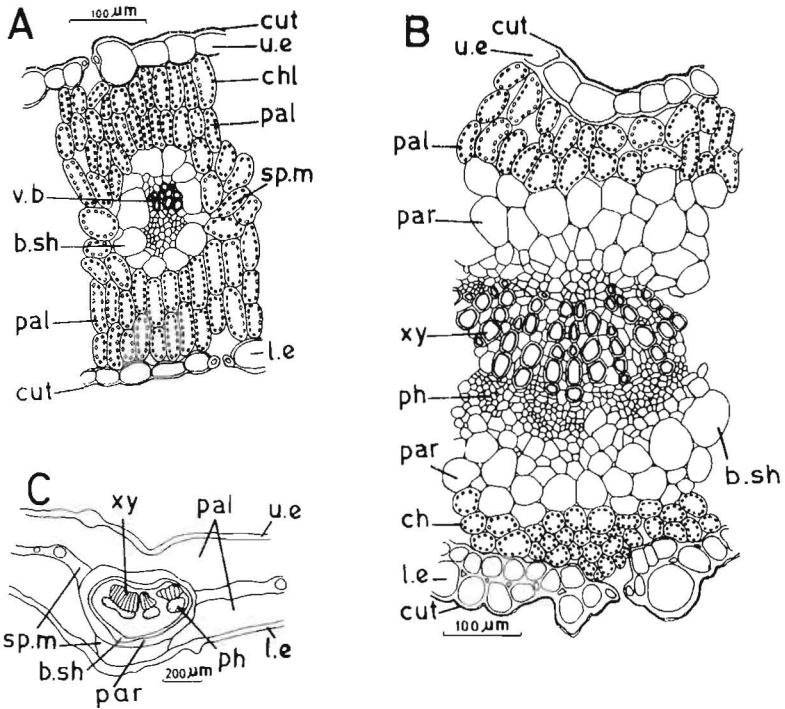


Fig. 2. Transverse section of leaf of *Cleome arabica* L. A-Leaf, intercostal region. B-Leaf, midrib region. C-Leaf.

II. *Cleome africana* Botsch.

A. Leaf

1. **Epidermal characters:** Upper and lower epidermises: Cells, cuticle, stomata and glandular trichomes similar to those of *C. arabica*; covering trichomes not observed (Fig. 4, A and B).

2. **Internal structures:** Mesophyll differentiated into palisade and spongy tissues; palisade tissue, 2 or 3 layers of cells containing chloroplasts with conspicuous intercellular spaces and occurs below the adaxial and abaxial epidermises, separated with 2 or 3 layers of irregular chlorenchymatous cells with conspicuous intercellular spaces in the intercostal regions; palisade tissue extends through the midrib region only below the adaxial epidermis and followed by 2 to 4 layers of parenchymatous cells devoid of chloroplasts surrounding the vascular bundle; spongy tissue occurs immediately below the abaxial epidermis only in the midrib region. Vascular bundles rounded, surrounded by conspicuous parenchymatous bundle sheaths, devoid of

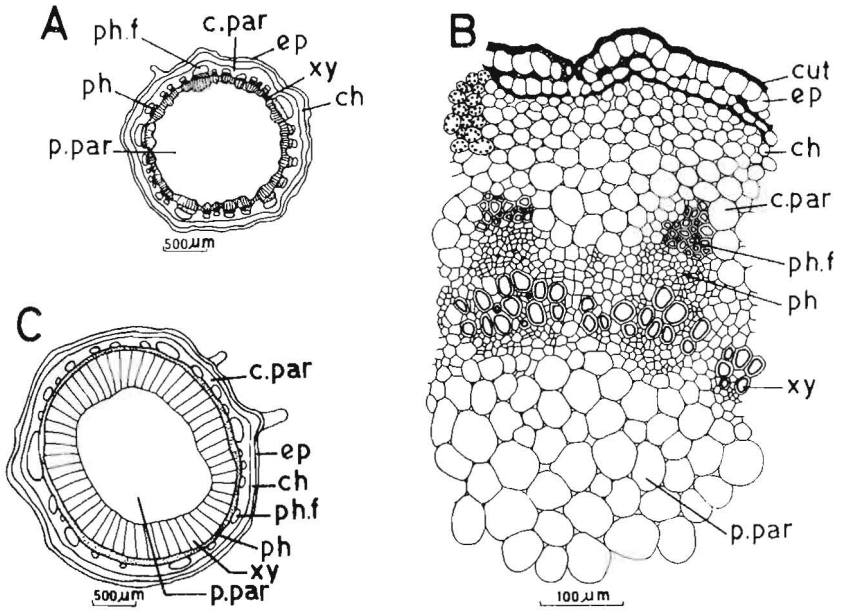


Fig. 3. Transverse section of stem of *Cleome arabica* L. A-Stem, upper part. B and C-Stem, basal part.

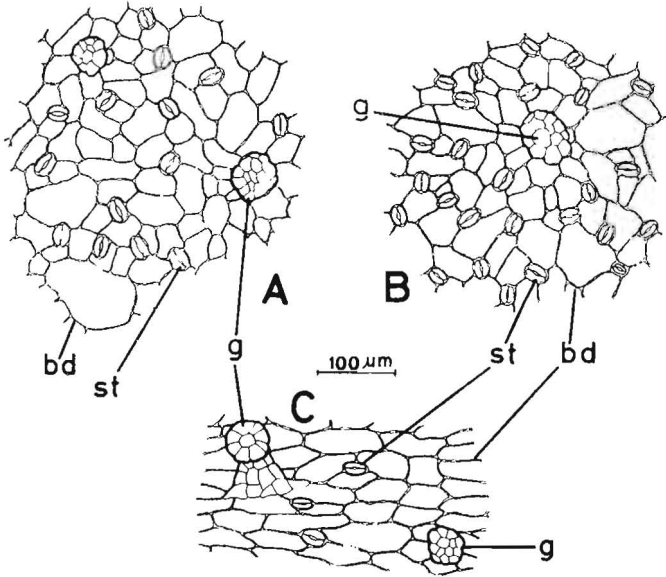


Fig. 4. Leaf and stem of *Cleome africana* Botsch. A-Leaf, upper epidermis. B-Leaf, lower epidermis. C-Stem epidermis.

chloroplasts and with thin walls; xylem consists of several separated strands connected with several rows of fibres (Fig. 5, A-C).

B. Stem

1. *Epidermal characters*: Epidermal cells elongated, polygonal with slightly thick, straight beaded anticlinal walls and covered with thin, smooth cuticle; stomata and glandular trichomes occur frequently, similar to those of the stem of *C. arabica*; covering trichomes absent (Fig. 4, C).

2. *Internal structures*: Cortex consists of a continuous subepidermal layer with cells having thick walls and devoid of chloroplasts, and several layers of chlorenchymatous cells with thin walls and conspicuous intercellular spaces, followed by 2 to 4 layers of parenchymatous cells with thin walls, large intercellular spaces and devoid of chloroplasts. Vascular tissues: Primary phloem fibres occur in separate groups of cells with thick unligified walls in young stem parts, becoming thick lignified in older ones; phloem forming separate strands in the apical parts of the stem which forms a continuous ring in the basal parts; xylem elements forming a

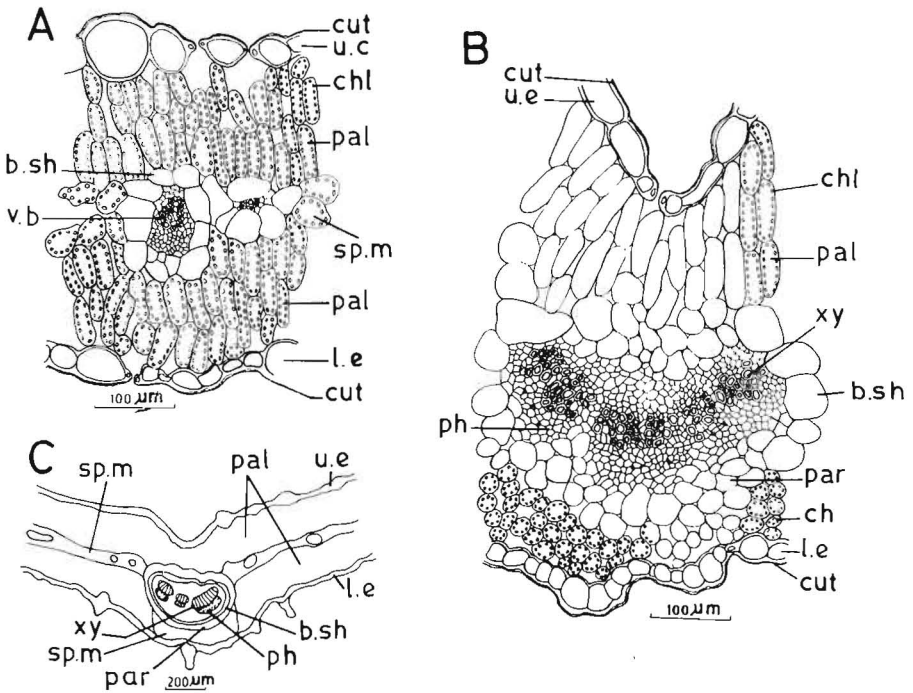


Fig. 5. Transverse section of leaf of *Cleome africana* Botsch. A-Leaf, intercostal region. B-Leaf, midrib. C-Leaf.

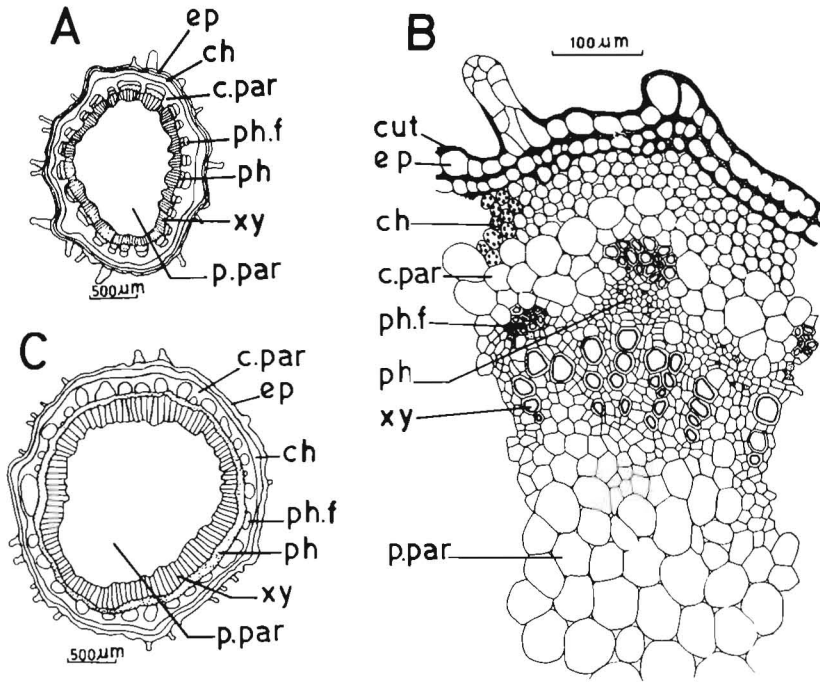


Fig. 6. Transverse section of stem of *Cleome africana* Botsch. A-Stem, upper part. B and C-Stem.

continuous cylinder either in young or old stem parts, vessel elements arranged in radial rows. Medulla consists of parenchymatous cells with thin, un lignified walls and conspicuous intercellular spaces (Fig. 6, A-C).

Discussion

The morphological characters of the two species under investigation as described by many investigators and show conspicuous differences between them: (1) simple leaves with three conspicuous veins on the lower epidermises in *C. arabica* while the lower leaves are trifoliate and the upper ones are simple in *C. africana*, (2) *C. arabica* is a perennial herb with many branches while *C. africana* is an annual herb with few branches (Migahid 1978).

In spite of the morphological differences between the two species they have been found to be so closely similar in their internal structure. This is confirmed by the following characters: (1) A single layer of cells with thick un lignified walls, and devoid of chloroplasts, occurs below stem epidermis. (2) Cortex consists of several

layers of parenchymatous cell peripheral layers contain chloroplasts, i.e. photosynthetic tissue. (3) Primary phloem fibres forming separate strands in either young or old stem parts. (4) Phloem forming separate strands only in young stem parts. (5) Vascular tissues constitute a continuous cylinder in old stem parts. (6) Xylem elements forming separate strands joined with bands of fibres to form a continuous ring. (7) Palisade tissue is present below the adaxial and the abaxial epidermises of the leaf in the intercostal regions. It extends through the midrib region only in the adaxial side while in the abaxial side it is replaced by 2 to 4 layers of rounded chlorenchymatous cells. (8) Vascular bundles are surrounded by a single layer of large parenchymatous cells with thin walls and devoid of chloroplasts. (9) Glandular trichomes occurring on the leaves and stems of both species consist of biseriate or multiseriate, multicellular stalks with multicellular heads. (10) Covering trichomes not observed on both species.

The foregoing results indicate that the two species have most of their anatomical characteristics in common which are in general agreement with the anatomical features of the genus *Cleome* L. reported by Sabins (1921) and Metcalfe and Chalk (1950). However, aerenchyma, crystals and myrosin cells reported by these authors to occur in some species of the family were not observed in these species.

Abbreviations used in the figures

bd, beading; b.sh, bundle sheath; ch, chlorenchyma; cht, chloroplasts; c.par, cortical parenchyma; cut, cuticle; ep, epidermis; g, glandular trichomes; l.e, lower epidermis; pal, palisade tissue; par, parenchyma; ph, phloem; ph.f, primary phloem fibres; p.par, pith parenchyma, sp.m, spongy mesophyll; st, stomata; u.e, upper epidermis; v.b, vascular bundle; xy, xylem.

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دراسات هستولوجية لورقة وساق نوعين من نبات الكلوم الناميين طبيعيا في المملكة العربية السعودية

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