

MACRO- AND MICROMORPHOLOGICAL STUDY OF *PHYLLANTHUS ATROPURPUREUS* BOJ. CULTIVATED IN EGYPT

Taha M. Sarg*, Afaf E. Abdel-Ghani, Rawia A. Zayed and May A. El-Sayed

* Pharmacognosy Department, Faculty of Pharmacy, Zagazig University, Zagazig, Egypt

ABSTRACT

The macro- and micromorphological study of *Phyllanthus atropurpureus* Boj., was carried out with the aim of finding the characteristic features of the different organs of the plant in both entire and powdered forms.

INTRODUCTION

Phyllanthus atropurpureus Boj. is a perennial monoecious shrub cultivated in Egypt as an ornamental plant. It belongs to subfamily Phyllanthoideae, family Euphorbiaceae that comprises around 326 genera and about 7750 species distributed mainly in both tropical and temperate regions except arctic regions⁽¹⁾. Recent taxonomical study of subfamily Phyllanthoideae separates this subfamily giving it a new classification termed family Phyllanthaceae on the basis of molecular data and DNA sequence⁽²⁻⁴⁾. Some *Phyllanthus* species were mentioned in several reports for their antioxidant, antihepatotoxic, anticancer and antidiabetic effects⁽⁵⁻¹⁶⁾.

A chemical study of *Phyllanthus atropurpureus* Boj. resulted in the isolation of eight compounds which are mixture of palmitic and stearic acid, mixture of β -sitosterol and stigmasterol, oleic acid, 5, 6, 8, 4'-tetrahydroxy isoflavone (New compound), robustaside A, 6'- (3'', 4''- dihydroxy cinnamoyl) arbutin (New compound), demethoxysudachitin and quercetin-7-O-glucoside⁽¹⁷⁾. Biological evaluation of the ethanolic extract of the aerial parts and roots of the plant proved antihepatotoxic, significant antibacterial and antifungal activities. Robustaside A shows strong anti-tumor activity against hepatocellular carcinoma⁽¹⁸⁾.

The literature review showed no report concerning the macro- and micromorphology of the plant. The present work covers macro- and micromorphological study of the root, stem, leaves and flowers with the aim of finding out the diagnostic features by which the plant and these organs can be easily identified in both entire and powdered forms.

EXPERIMENTAL

Plant Material

The plant materials were collected in June 2004 from plants cultivated in the medicinal plants garden of Faculty of Science, Ain Shams University, and was kindly verified by Dr. Hesham Abdel-Aal Elshamy, Assistant Professor of medicinal, aromatic and ornamental plants, Horticulture Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. The material used for this study was either fresh or preserved in glycerin-alcohol mixture (1:1).

I. Macromorphology:

Phyllanthus atropurpureus Boj. (Figure 1A) is a perennial monoecious shrub. The plant shows a brownish to purple monopodially branched stem and measures 0.5 to 1.5 m in height. It shows green or purple axillary flowers (Figure 1B). Female flowers are present at the top while male flowers are present below. It flowers from June to November.

The plant has well developed highly branched underground part (Figure 1C). It comprises a vertical rhizome which gives on its lower end three to four roots. The rhizome is vertical showing two to three internodes with dark reddish-brown rough, longitudinally wrinkled outer surface. It breaks with fibrous fracture showing reddish-brown narrow outer bark, wide yellowish-white wood and a narrow pith in the center. The rhizome measures 1.5 to 3 cm in length and 1 to 1.5 cm in diameter.

The root is cylindrical and gives few thin branches, both are covered by rootlets. The main roots measure 10 to 25 cm in length and 2 to 4 mm in diameter while the branches measure 10 to 15 cm in length and 1 to 1.5 mm in diameter. The root and its branches have rough, reddish-brown outer surface and break with a fibrous fracture.

The stem (Figures 1A and 2A) is rigid, solid, monopodially branched, cylindrical with brownish rough surface and shows internodes 2.5 - 3.5 cm in length and 1.5 - 3.5 mm in diameter. The fresh stem is flexible but when dry breaks with fibrous fracture.

The leaves (Figures 1B, 2A and 2B) are simple, alternate, ovate, shortly petiolate, stipulate, with obtuse apices showing epiculus, entire margin, symmetric base and reticulate pinnate venation. The leaves have dark olive green smooth glabrous surfaces, mottled with whitish, pale pink or purple coloration; and measure 1.5 to 5.5 cm in length and 0.5 to 3 cm in breadth. The stipules are present, each on both sides of the leaf base; they are triangular in shape with entire margin, acute apex, smooth green surfaces and measure 1.5 mm in length and 0.4 mm in breadth. The petiole of the leaf (Figures 2B) is short cylindrical, solid with dark green to purple smooth surface and measures 0.7 to 1.2 mm in length and 0.47 to 0.75 mm in diameter.

The flowers occur either single or in small axillary fascicles inflorescences of unisexual flowers, being pistillate at the top of branches, and staminate below. The pedicel of the flower (Figures 3B and D) is short cylindrical, solid with purplish smooth

surface and measures 0.6 to 1.5 mm in length and 0.1 to 0.28 mm in diameter. The flower (Figure 1B) is small, shortly pedicellate, green or purple in colour. The male flower measures 3 to 5.5 mm in length and 0.4 to 1 mm in diameter at the widest part while female flower measures 2 to 4 mm in length and 1.5 to 5.5 mm in diameter. The perianth (Figure 3A) is persistent cupuliform gamosepalous, consists of 6, occasionally 5 sepals with free apical lobes. The apical lobe has entire margin and rounded apex showing fine epiculus. The perianth of female flower is bell-shaped with six spreaded apical lobes, green or purple smooth surfaces and shows pinnately-reticulate venation; with six main veins. They measure 2.5 to 3 mm in length and 0.5 to 1.5 mm in breadth while the tubular part measures 0.1 to 1.6 mm in length and 0.3 to 1.6 mm in diameter at its widest part. The perianth of male flower is funnel-shaped with six small unspreaded lobes which measure 0.6 to 1.7 mm in length and 0.3 to 1 mm in diameter.

The androecium (Figure 3C) consists of 6 monodelphous stamens with 6 free anthers arranged in one whorl. The filaments are united into solid, cylindrical, whitish staminal column measuring 0.7 to 1 mm in length and 0.1 to 0.25 mm in diameter, while the anther is more or less oblong, dorsifixed and bilobed, each lobe shows one pollen sac. It measures 0.54 to 0.6 mm in length and 0.1 to 0.2 mm in diameter. The gynaecium (Figures 3D and E) is formed of superior ovoid tricarpellary trilocular ovary and three gynobasic styles with three ligulate obtriangular with entire margin stigmas. The ovary measures 0.6 to 0.8 mm in length and 0.35 to 0.7 mm in diameter, and the style measures 0.2 to 0.4 mm in length and 0.12 to 0.18 mm in diameter. Each lobe of stigma measures 0.23 to 0.35 mm in length and 0.26 to 0.5 mm in breadth at its widest part.

II- Micromorphology:

The measurements of the different cellular fragments in the course of this study are listed in table 2.

The root and the rhizome:

A transverse section of the young root (Figure 4A) shows a central diarch primary xylem. The transverse section in the old root (Figure 4B) is circular in outline showing an outer brownish cork followed by a wide parenchymatous phelloderm surrounding a cylinder of vascular tissue comprises a narrow phloem and a wide xylem with cambium in between.

The transverse section of the rhizome (Figure 5B) is almost circular in outline showing an outer brown cork, somewhat wide phelloderm, batches of sclerides in the pericycle region and a wide cylinder of vascular tissue traversed by the medullary rays surrounding central narrow parenchymatous pith.

The cork (Figures 4C₁ and 5C) consists of 2 outer rows of flattened, polygonal moderately thick-walled lignified brown- coloured cells followed by 3 to 4 rows of polygonal, moderately thick-walled, suberized cells arranged in radial rows.

The phelloderm (Figure 4C₁) is wide, formed of thin-walled polygonal parenchymatous cells; few mucilage cavities are present. Many of these cells contain brownish granular contents which give bluish black colour with ferric chloride and a yellow colour with caustic alkali. Numerous cluster crystals of calcium oxalate and starch granules are present in some of these parenchymatous cells.

The pericycle of the rhizome (Figure 5A) is parenchymatous interrupted with groups of lignified sclerides. Sclerides (Figure 5B) are rounded to subrectangular in shape with moderately wide lumen and thin lignified pitted walls.

The vascular tissue (Figures 4B and C_{1, 2}) is formed of an outer cellulosic narrow phloem showing brownish granular contents or few rounded or polyhedral starch and a wide lignified central xylem.

The cambium (Figure 4C₁) is formed of 3 to 4 layers of thin-walled cellulosic tangentially elongated rectangular meristematic cells. The xylem (Figure 4C₁) is wide, showing vessels, isolated or in radial rows, few tracheides and metatracheal wood parenchyma. Wood fibres (Figure 5B) are spindle-shaped with thick or thin lignified walls with slit-like pits, narrow or wide lumens and acute apices. Tracheides (Figure 5B) are few showing thin lignified walls with rounded bordered pits and blunt apices. Vessels (Figure 5B) are diffused either isolated or in groups, showing lignified, annular, spiral and pitted walls. Wood parenchyma (Figures 4C_{1, 2} and 5B) are formed of moderately thick-walled, pitted and lignified polygonal axially elongated cells. Most of these cells contain brownish granular contents, which give bluish-black colour with ferric chloride (T.S), starch granules (Figure 5B) which are more or less rounded with indistinct hilum and no striations. The medullary rays (Figures 4C₁ and 5B) are usually uni- to biseriate and formed of radially elongated cells with moderately thick lignified walls, in the xylem region and of subrectangular parenchymatous cells with cellulosic walls in the phloem region.

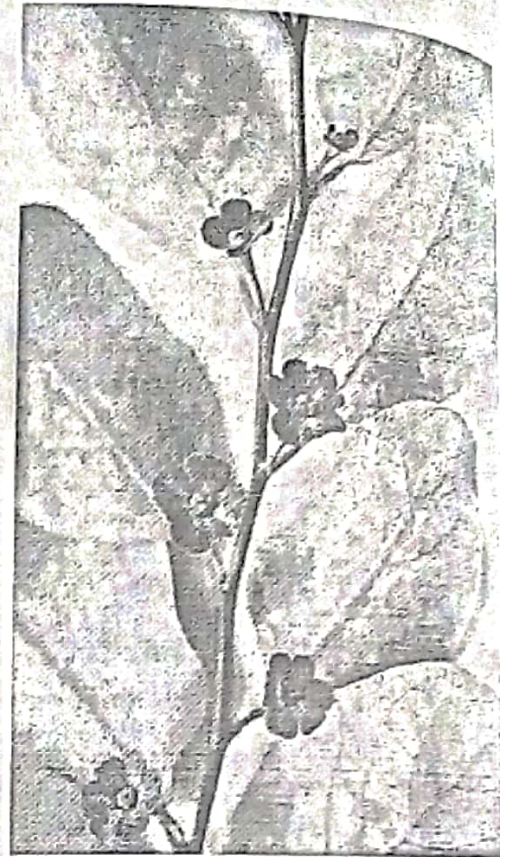
There is a similarity between the root (Figure 4A) and the rhizome (Figure 5A) transverse sections except the presence of sclerides and narrow pith formed of more or less rounded thin-walled cellulosic parenchyma in the rhizome.

Powdered root and rhizome:

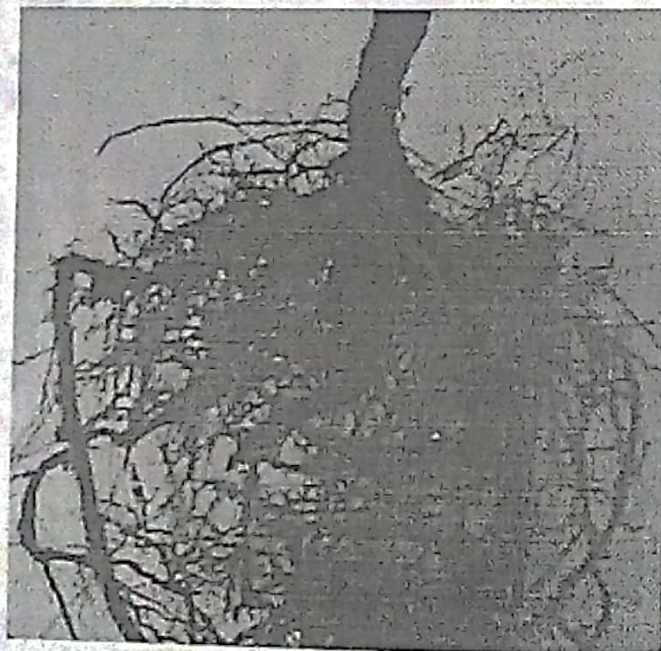
The powdered root and rhizome (Figure 5B) is reddish-brown in colour with bitter taste and faint characteristic dusty odour. It is characterized microscopically by the following features:



A



B



C

Fig. (1): Macromorphology of *Phyllanthus atropurpureus* Boj.

A. A photograph of aerial parts (x 0.27)

B. A photograph of female flowers (x 2.05)

C. A photograph of the underground part (x 0.5)

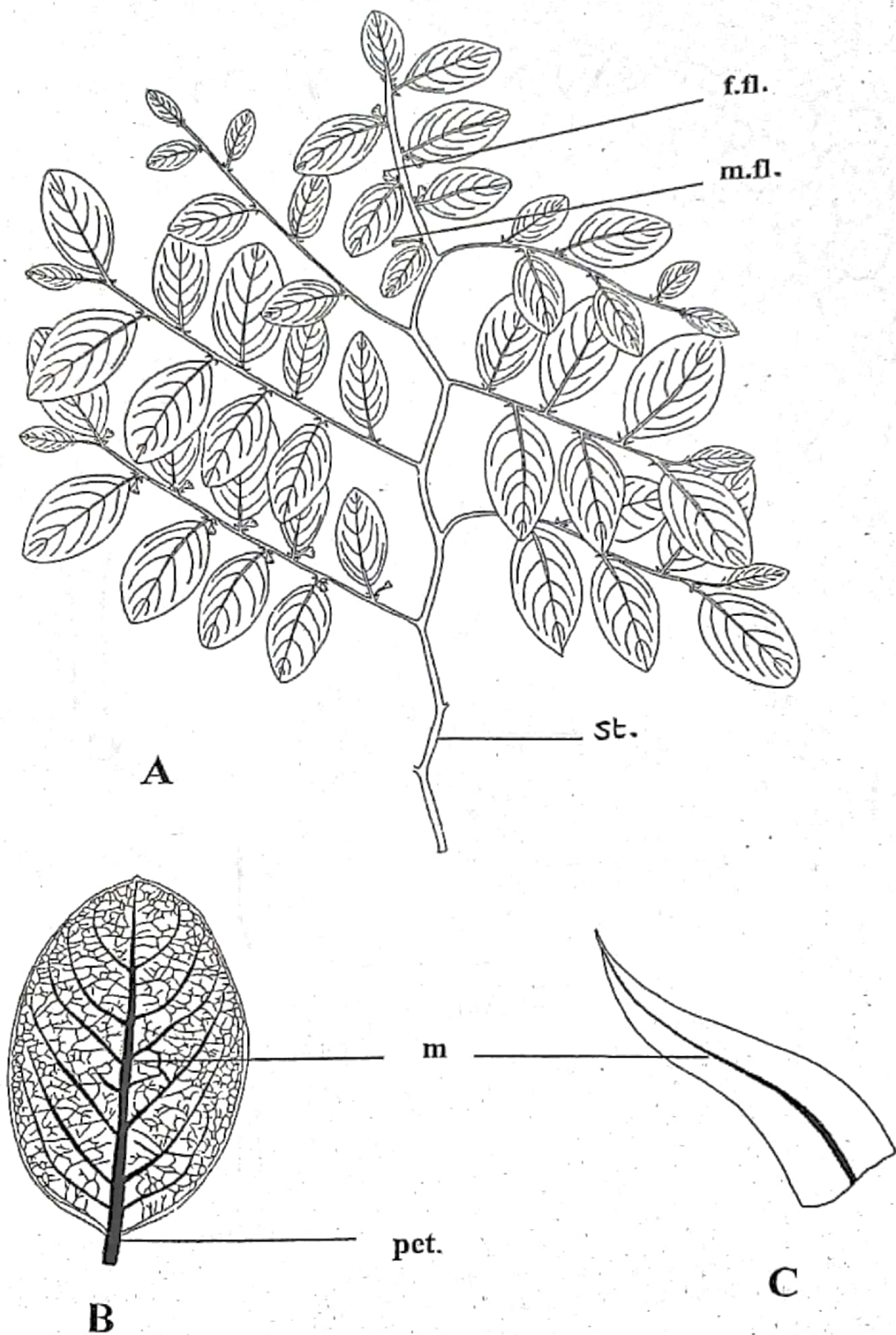


Fig. (2): Macromorphology of *Phyllanthus atropurpureus* Boj.

A. A flowering branch (x 0.54)

B. Leaf (x 3.5)

C. Stipule (x 32.84)

f.fl., female flower; m. midrib; m.fl., male flower; pet., petiole; st., stem.

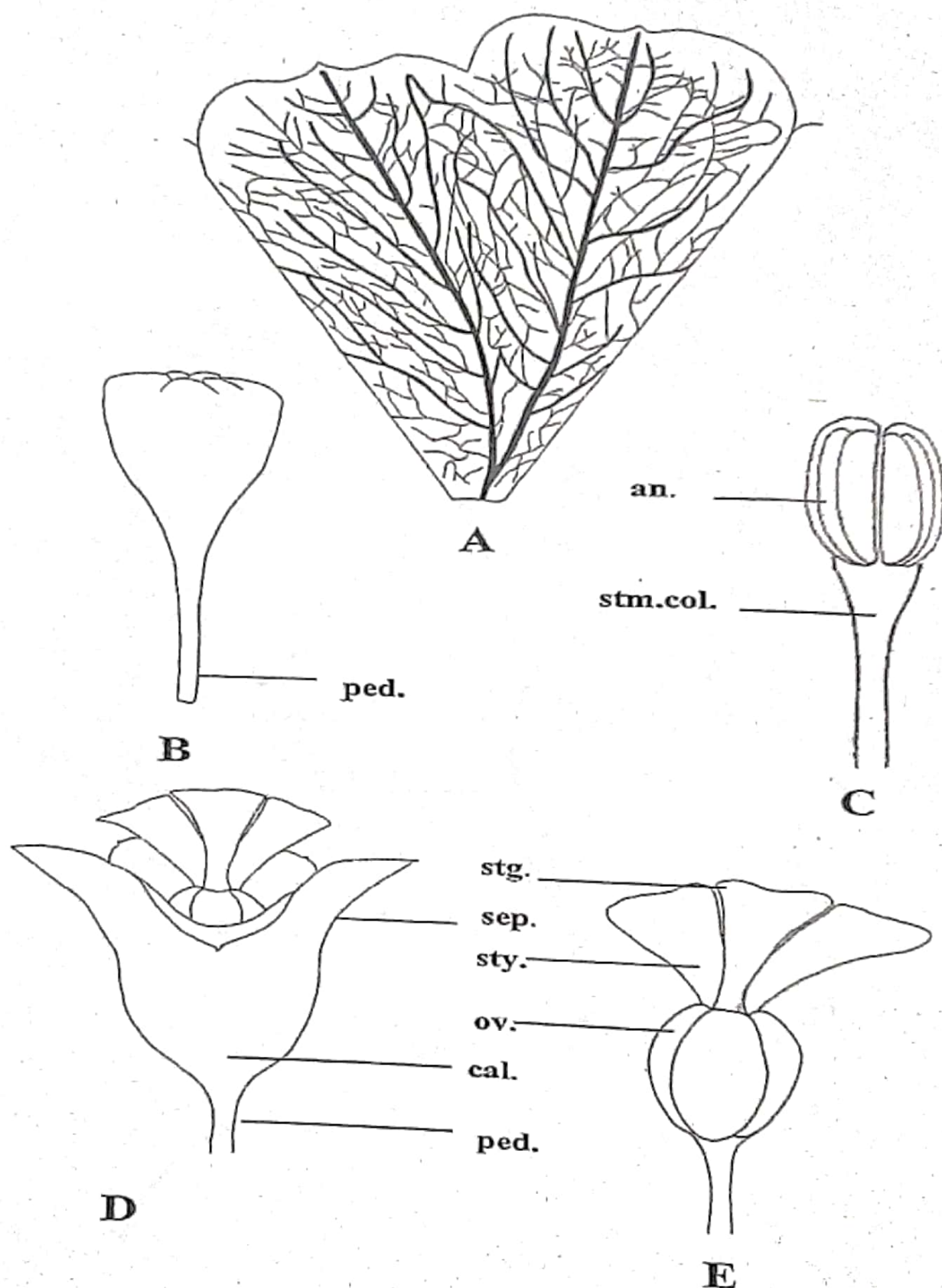


Fig. (3): Macromorphology of *Phyllanthus atropurpureus* Boj.

- A. Two lobes of dissected perianth. (x 24.63)
- C. Androecium. (x 34.93)
- E. Gynaecium (x 21)

- B. Male flower. (x 18.13)
- D. Female flower. (x 15.8)

an., anther; cal., calyx; m. midrib; ov., ovary; ped., pedicel; pet., petiole; sep., sepal; stg., stigma; stm.col., staminal column; sty., style.

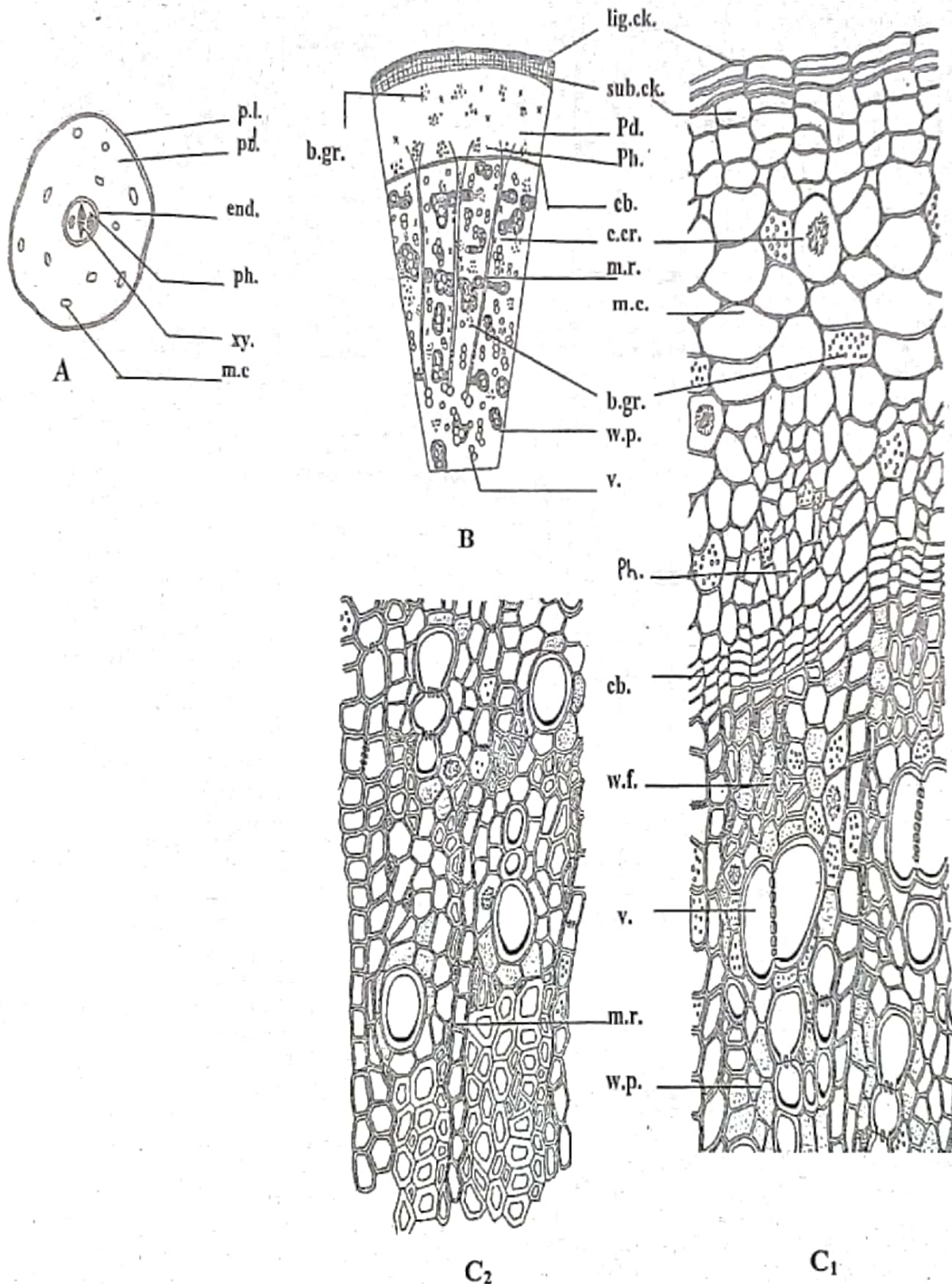


Fig. (4): The root of *Phyllanthus atropurpureus* Boj.

A. Diagrammatic transverse section of the young root.

(x 68)

B. Diagrammatic transverse section of the old root.

(x 22)

C₁ and C₂. Detailed transverse section of the old root.

(x 229)

b.gr., brown granules; c.cr., cluster crystals of calcium oxalate; cb., cambium; lig.ck., lignified cork; m.c., mucilage cavity; m.r., medullary rays; p.l., piliferous layer; pd., phelloderm; ph., phloem; sub.ck., suberized cork; w.f., wood fibre; w.p., wood parenchyma; v., vessels.

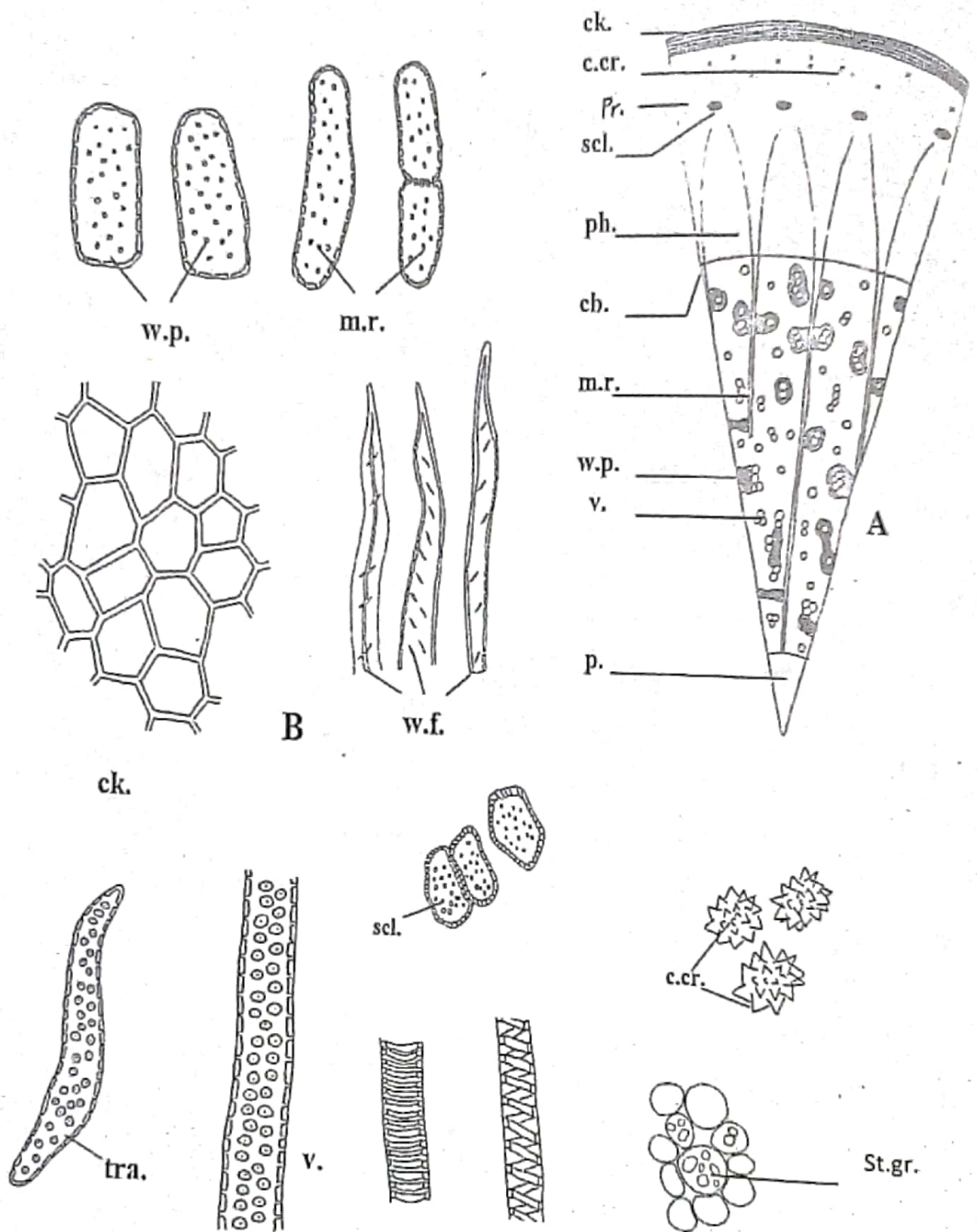


Fig. (5): The rhizome of *Phyllanthus atropurpureus* Boj.

A. Diagrammatic transverse section of the rhizome.

B. Some elements of the root and rhizome.

(x 21.11)

(ck. x 259.4, c.cr. x 440.8, st. gr. x 220, w.f., tra. and v. x 311 and scl., w.p. and m.r. x 288)
 C.cr., cluster crystals of calcium oxalate; cb., cambium; ck., cork; end., endodermis; m.c., mucilage cavity; m.r., medullary rays; pd., phelloderm; ph., phloem; pr., pericycle; scl., scleride; st. gr., starch grain; tra., tracheid; w.f., wood fibres; w.p., wood parenchyma; v., vessels; xy., xylem.

1. Fragments of polygonal thick-walled lignified or suberized cork cells.
2. Lignified sclerides isolated or in groups with moderately wide lumen and thin lignified walls.
3. Fragments of lignified annular, spiral and pitted vessels showing rounded or oval bordered pits.
4. Fragments of lignified wood fibres, each with moderately thick, lignified walls with slit-like pits, moderately wide lumen and acute apices.
5. Fragments of lignified, thick-walled and pitted wood parenchyma showing brownish contents or starch grains.
6. Fragments of the phelloderm parenchymatous cells containing starch granules, cluster crystals of calcium oxalate and/or brownish granular contents.

The stem:

A transverse section of the old stem (Figure. 6A) is circular in outline. It shows an outer cork, followed by a parenchymatous cortex. The pericycle is parenchymatous and showing groups of non-lignified fibres enclosing a continuous ring of vascular bundle surrounding narrow parenchymatous pith. The young stem shows an outer epidermis followed by a parenchymatous cortex with collenchymatous hypodermis and distinct endodermis. The pericycle is collenchymatous. The vascular tissue is formed of a complete ring of 16 to 20 vascular bundles surrounding wide parenchymatous pith.

The young stem (Figure 7A) shows an outer epidermis followed by a parenchymatous cortex with collenchymatous hypodermis and distinct endodermis. The pericycle is collenchymatous. The vascular tissue is formed of a complete ring of 16 to 20 vascular bundles each with an outer phloem and inner xylem surrounding wide parenchymatous pith.

The epidermal cells of the young stem, in surface view, (Figure 7C) are polygonal, slightly axially elongated with straight anticlinal walls and covered with thin, smooth cuticle. Stomata (Figure 7C) are few, of the paracytic type and no trichomes are present.

The cork (Figures 6B₁ and 6B) consists of 6 to 7 rows of radially arranged polygonal to rectangular cells with moderately thick lignified walls and brown contents.

The cortex (Figure 6B₁) is formed of 5 to 7 rows of more or less rounded parenchymatous cells showing tangentially elongated lacunae. The endodermis is formed of tangentially elongated rectangular parenchymatous cells. In young stem (Figure 7A), the cortex shows one row of more or less rounded collenchymatous hypodermal layer of moderately thick walled cells. Numerous cluster crystals of calcium oxalate are scattered in the cortical cells.

The pericycle (Figure 6B₁) is formed of parenchymatous tissue interrupted with batches of non-lignified pericyclic fibres, surrounding the vascular tissue. The pericyclic fibres (Figure 7D) are

spindle-shaped with smooth thick non-lignified walls, moderately narrow lumens and blunt apices.

The vascular tissue (Figures 6A and B_{1, 2}) is formed of an outer cellulosic phloem and a wide lignified inner xylem. The phloem (Figure 6B₁) shows scattered elongated lacuna containing tannin. The xylem (Figures 6B_{1, 2} and 7B) is formed of numerous wood fibres (Figure 7D) having spindle-shaped with thick or thin lignified walls, narrow or wide lumens and acute or blunt apices. Vessels (Figure 7D) are lignified, diffused being spiral and annular. Wood parenchyma (Figure 7D) is polygonal, usually axially elongated cells with thick-walled, pitted and slightly lignified walls. The medullary rays (Figures 6A, B and 7D) are mostly uniseriate rarely biseriate. The cells are rectangular radially elongated with lignified thick pitted walls in the xylem and rectangular parenchymatous with cellulosic walls in phloem.

The pith (Figures 6A and B₂) is formed of slightly thick pitted-walled rounded or polyhedral cells. In young stem, the pith is formed of more or less rounded thin-walled cellulosic parenchyma. Cluster crystals of calcium oxalate and rounded or oval-shaped simple starch granules with no hilum or striations are present in the parenchyma of pith.

Powdered stem:

The powdered stem (Figure 7D) is greenish-brown in color with slight characteristic odour and faint characteristic taste. It is characterized microscopically by:

1. Fragments of polygonal cork cells with moderately thick lignified walls and brown contents.
2. Fragments of polygonal elongated epidermal cells with straight anticlinal walls, thin smooth cuticle, and shows few paracytic stomata.
3. Fragments of wood showing fibres with thin or thick lignified pitted walls, wide or narrow lumens and blunt apices.
4. Numerous cluster crystals of calcium oxalate and simple starch granules free or in parenchymatous cells.
5. Fragments of non-lignified pericyclic fibres, being spindle-shaped with moderately narrow lumens and straight, thick walls and blunt or pointed apices.
6. Fragments of lignified annular, spiral and pitted vessels showing rounded or oval bordered pits and wood parenchyma with simple pits.

The leaf:

A transverse section of the leaf (Figure 8A) shows a dorsiventral mesophyll with an upper palisade interrupted by collenchyma in the midrib region. The midrib is more prominent on the lower surface and shows a parenchymatous cortex with peripheral collenchyma and is traversed longitudinally by a crescent-shaped vascular bundle; with a collenchymatous pericycle above and below the vascular bundle.

The upper epidermal cells (Figure 9A) are polygonal isodiametric with thin straight anticlinal walls and covered with thin smooth cuticle. Some cells are projecting into papillae. Lower epidermal cells (Figure 9B) are isodiametric with slightly wavy anticlinal walls, showing short conical-shaped papillae and most of them contain mucilage. The neural epidermal cells (Figures 9C and D) are polygonal axially elongated cells containing mucilage and have thin straight anticlinal walls and moderately thick smooth cuticle on the upper surface. The lower neural epidermal cells have moderately thick beaded anticlinal walls. Stomata of paracytic type (Figure 9B) are present on the lower surface only, absent on neural regions. Trichomes are absent.

The mesophyll (Figures 8A and B) is dorsiventral, formed of one row of palisade cells abutting the upper epidermis, followed by spongy tissue. The palisade cells are columnar with thin straight radial walls. The spongy tissue is formed of few rows of more or less polygonal parenchyma with thin walls and wide intercellular spaces showing few irregular lignified idioblast (Figure 9G).

In the midrib region, the cortex (Figures 8A and C) is parenchymatous with two collenchymatous hypodermal bands, one row below each epidermis. The collenchyma consists of one row of thick-walled cellulose cells. The parenchyma is formed of more or less rounded, isodiametric, thin-walled cellulose cells with narrow intercellular spaces.

The pericycle (Figures 8A and C) is collenchymatous present as an arc below and hemispherical group above the vascular bundle. The cells are isodiametric with moderately thick cellulose walls.

The vascular bundle (Figures 8C and 9G) consists of cellulose phloem thin-walled elements and xylem formed of lignified spiral and annular vessels, and cellulose wood parenchyma. The medullary rays (Figure 8C) are uni- to biseriate, moderately thin-walled cellulose cells. Numerous cluster crystals and very few prisms of calcium oxalate are observed in mesophyll.

The stipule:

The upper epidermis of stipule (Figure 9E) is formed of polygonal papillose axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle. The lower epidermal cells (Figure 9F) are polygonal isodiametric with thin straight anticlinal walls with paracytic stomata.

• The petiole

A transverse section of the petiole (Figures 10A and B) is semicircular in outline. It shows an epidermis surrounding a wide parenchymatous cortex with sub-epidermal collenchyma.

The vascular system consists of a large crescent-shaped vascular bundle, consists of a radiated xylem with phloem underneath, and a collenchymatous pericycle.

The epidermal cells (Figure 10C) are axially elongated with straight thick beaded anticlinal walls, thick smooth cuticle and contain mucilage; the adaxial cells (Figures 10B and D) are isodiametric. Stomata and trichomes are absent on both epidermis.

The cortex (Figures 10A and B) is formed of 6 to 8 rows of rounded or elongated parenchyma. The subepidermal collenchyma is formed of 2 to 4 rows of moderately thick-walled, oval or polyhedral cells. The endodermis is indistinct. Scattered cluster crystals of calcium oxalate and starch granules are found in the cortical tissue.

The pericycle is formed of 4 to 6 rows of thick-walled polygonal collenchymatous cells. The vascular tissue (Figures 10A and B) is formed of polygonal, moderately thin-walled cellulose phloem and radiating xylem (Figure 10B) showing polygonal cellulose wood parenchyma and lignified spiral and annular vessels.

Powdered leaf:

The powdered leaf (Figures 9 and 10) is yellowish-green in colour with slight characteristic odour and slightly bitter taste. It is characterized microscopically by the following features:

1. Fragments of the upper epidermis of the lamina formed of polygonal occasionally papillose cells with thin straight anticlinal walls and thin smooth cuticle.
Fragments of the lower epidermis of the lamina; the cells are polygonal with thin slightly wavy anticlinal walls and thin smooth cuticle showing paracytic stomata and many cells have short conical-shaped papillae.
2. Fragments of the neural epidermis; the cells are axially elongated with thin straight anticlinal walls and covered with thin smooth cuticle showing no stomata; the lower cells have beaded walls.
3. Fragments of the epidermis of the petiole; the cells are isodiametric or axially elongated with thick straight beaded or thin straight anticlinal walls and covered with thick smooth cuticle showing no stomata.
4. Fragments of lignified spiral and annular vessels.
5. Numerous cluster crystals and very few prisms of calcium oxalate free or inside mesophyll or cortical cells.
6. Few fragments of the lamina showing lignified irregular idioblasts with very thick walls.
7. Fragments of the upper epidermis of the stipule; the cells are papillose, polygonal axially elongated with straight anticlinal walls and covered with thin smooth cuticle showing no stomata.
8. Fragments of the lower epidermis of the stipule; the cells are polygonal isodiametric with thin straight anticlinal walls and covered with thin smooth cuticle showing paracytic stomata.

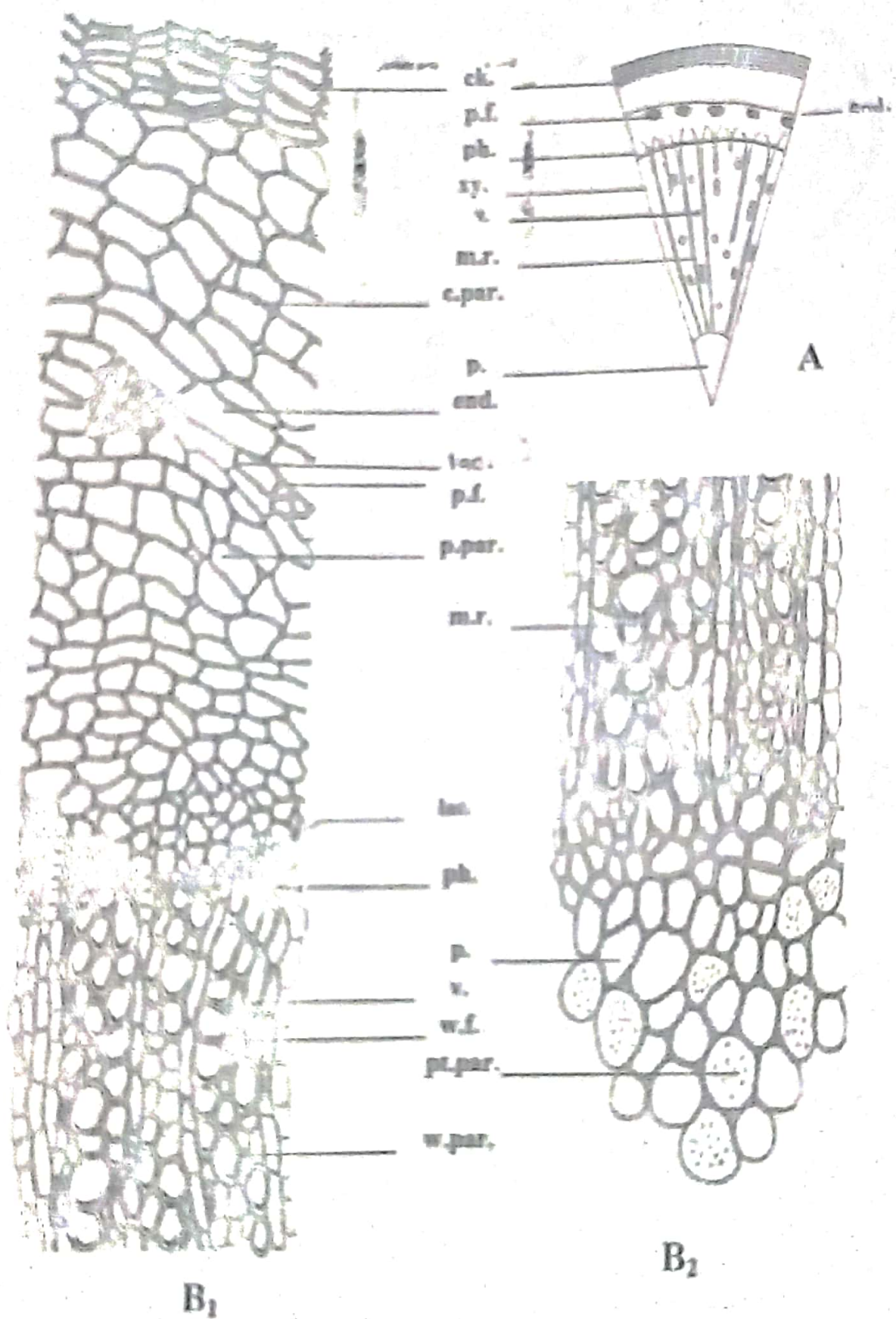


Fig (4) The old stem of *Piptocarpha argenteopurpurea* Boj

A Diagrammatic transverse section. (x 23.8)

B₁ and B₂ Detailed transverse sections. (B₁ x 236.25 and B₂ x 251.7)

v.p., vertical parenchyma; ch., cork; end., endodermis; lac., lacuna; m.r., medullary ray; p., pith; p.f., pericycle fibre; p.par., paracyclic parenchyma; ph., phloem; pt.par., pitted parenchyma; v., vessel; w.f., wood fibre; w.p., wood parenchyma; xy., xylem

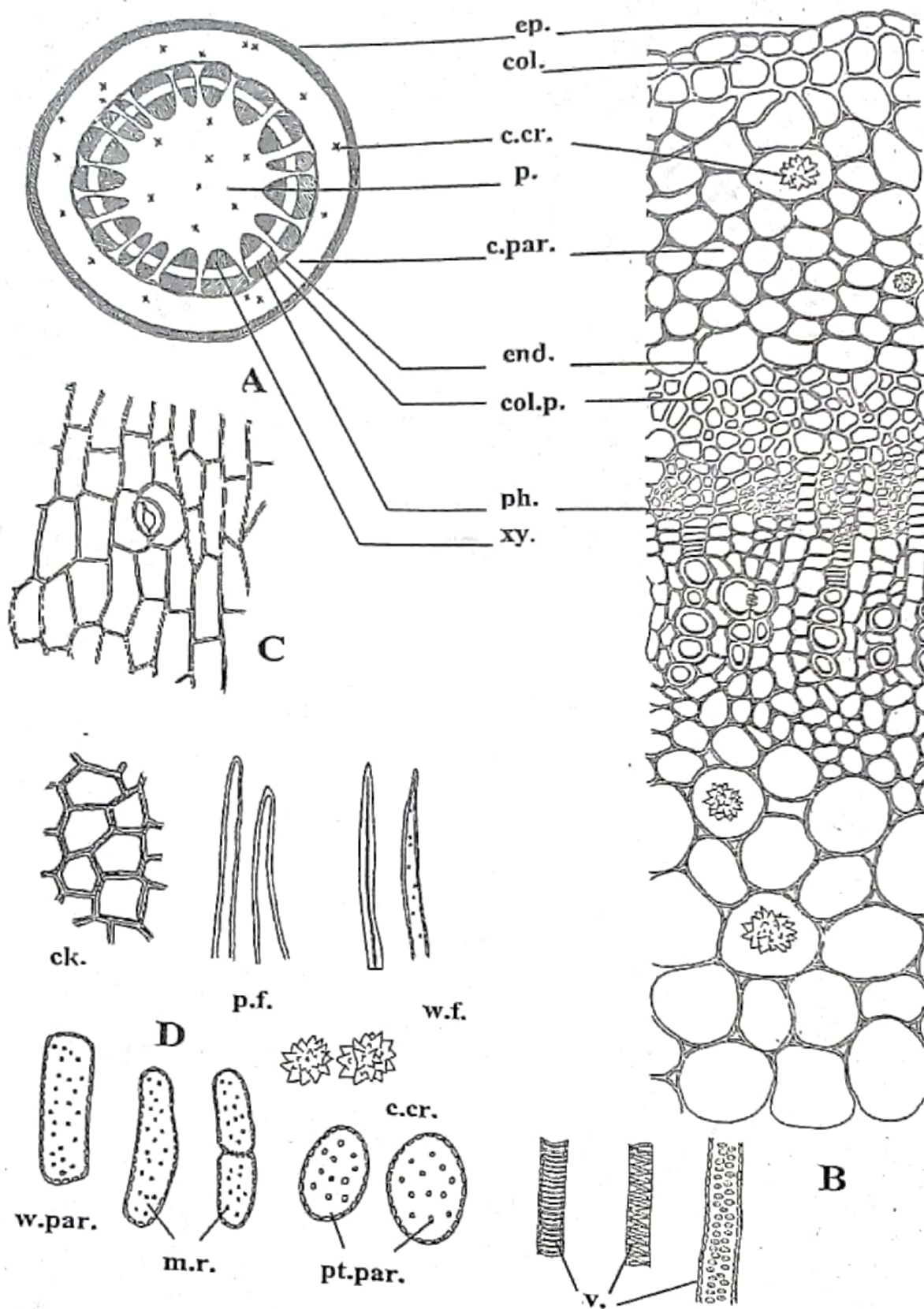


Fig. (7): The young stem of *Phyllanthus atropurpureus* Boj.
 A. Diagrammatic transverse section. (x 55)

C. Epidermal cells. (x 337.5)

D. Some elements of the old stem. (ck. x 245, p.f. and w.f. x 148, c.cr. x 369, w.par., m.r. and v. x 322.5)

B. Detailed transverse section. (x 279)

c.cr, cluster crystal of calcium oxalate; ck., cork; p.f., pericyclic fibre; pt. par., pitted parenchyma; v., vessels; w.f., wood fibre; w. par., wood parenchyma.

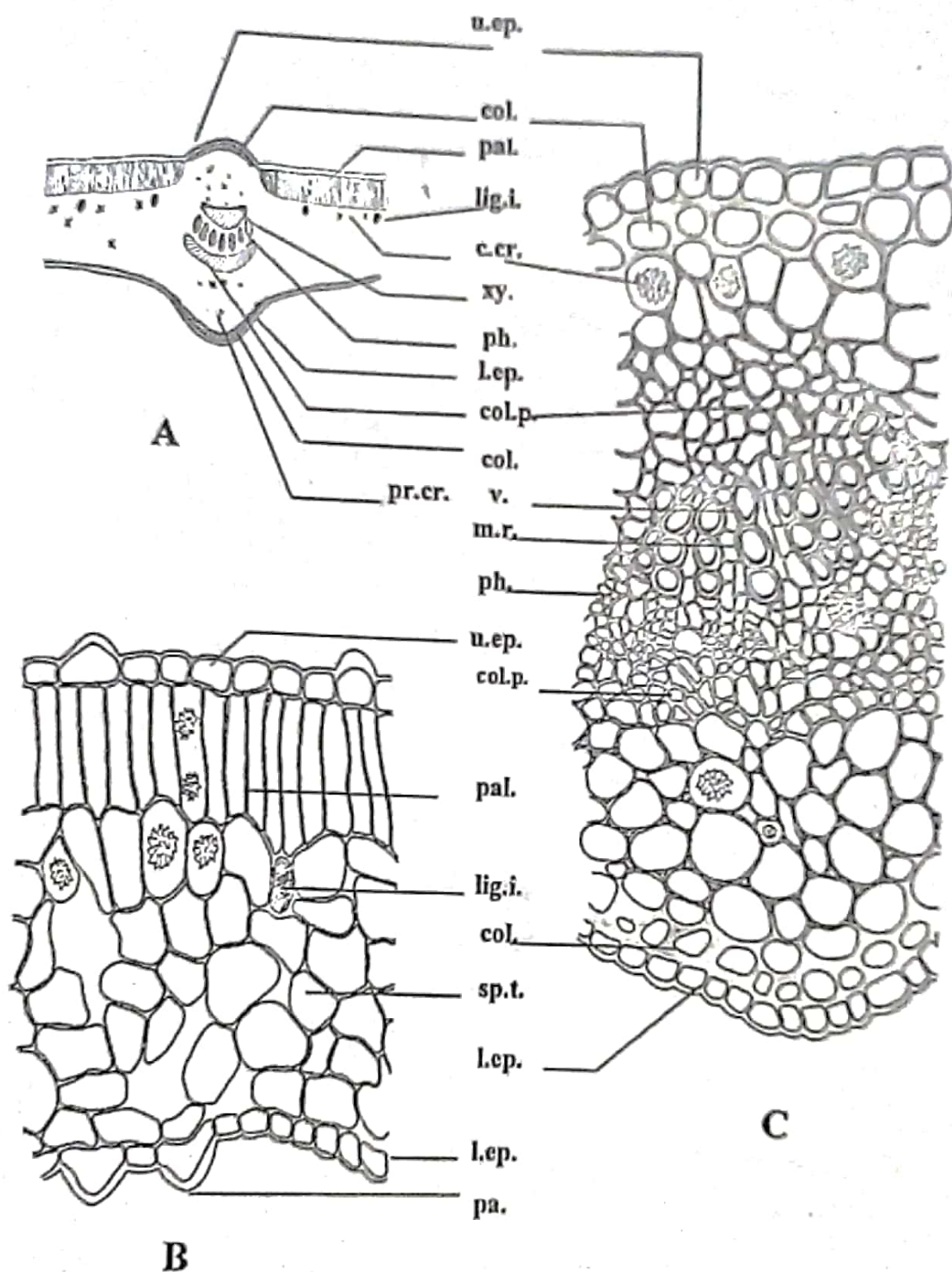


Fig. (8): The Leaf of *Phyllanthus atropurpureus* Boj.

- A. Diagrammatic transverse section. (x 73)
- B. Detailed transverse section of the lamina. (x 348.1)
- C. Detailed transverse section of the midrib. (x 210.65)

C.cr., cluster crystal of calcium oxalate; col., collenchyma; col.p., collenchymatous pericycle; Lep., lower epidermis; lig.i., lignified idioblast; m.r., medullary ray; pa., papilla; pal., palisade; ph., phloem; pr.cr., prismatic crystal of calcium oxalate; sp.t., spongy tissue; u.ep., upper epidermis; v., vessels; xy., xylem.

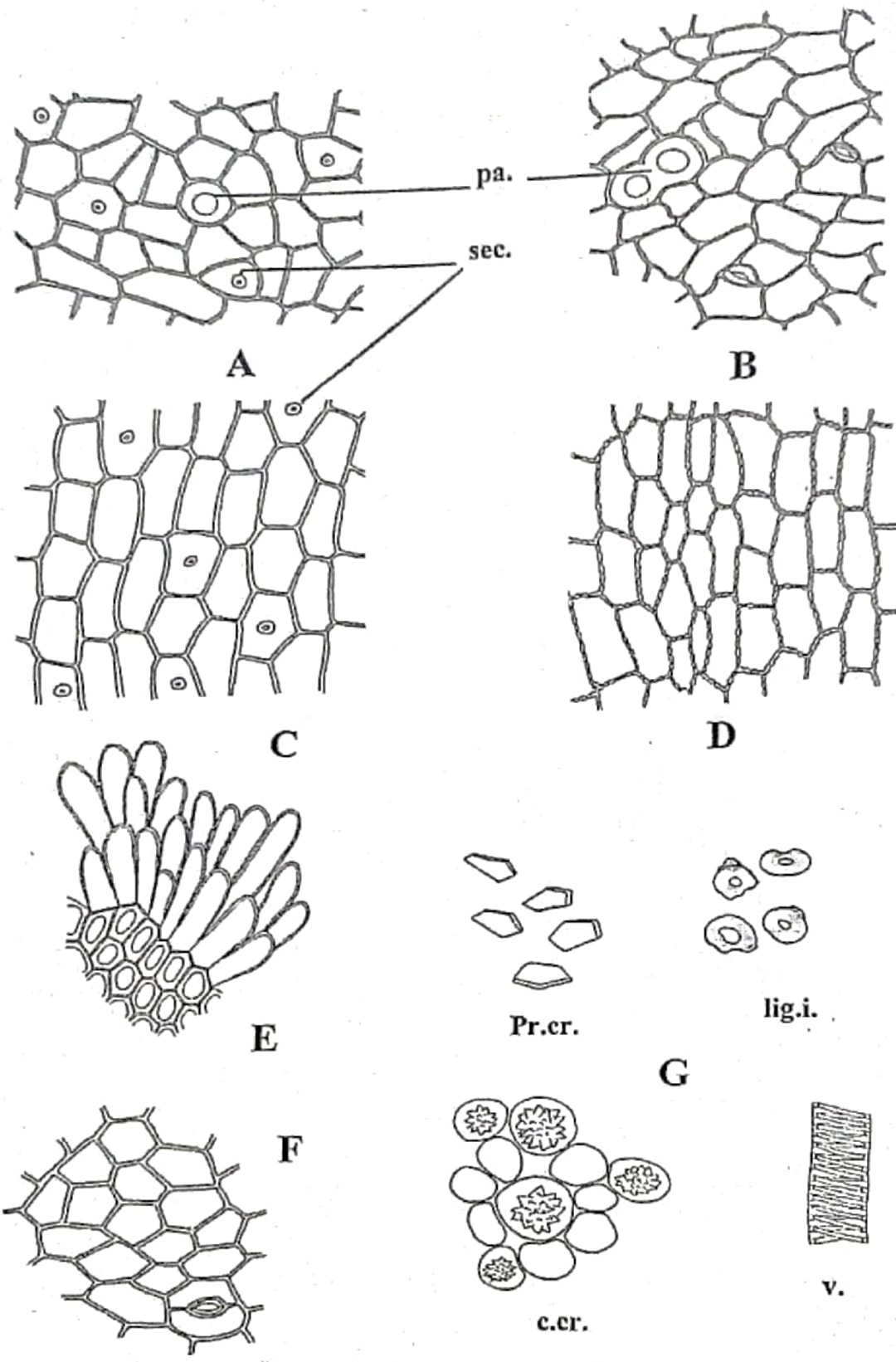


Fig. (9): The epidermal cells and some elements of the Leaf of *Phyllanthus atropurpureus* Boj.
 A. Upper epidermal cells of the lamina. (x 180.7) B. Lower epidermal cells of the lamina. (x 205.1)
 C. Upper neural epidermal cells. (x 175) D. Lower neural epidermal cells. (x 177.1)
 E. Upper epidermal cells of the stipule. (x 238.7) F. Lower epidermal cells of the stipule. (x 365.32)
 G. Some elements of the leaf. (pr.cr. x 215, lig.i. x 221.3, c.cr. and v. x 219.46)

C.cr., cluster crystal of calcium oxalate; lig.i., lignified idioblast; pa., papilla; pr.cr., prismatic crystal of calcium oxalate; sec., secretion; v., vessel.

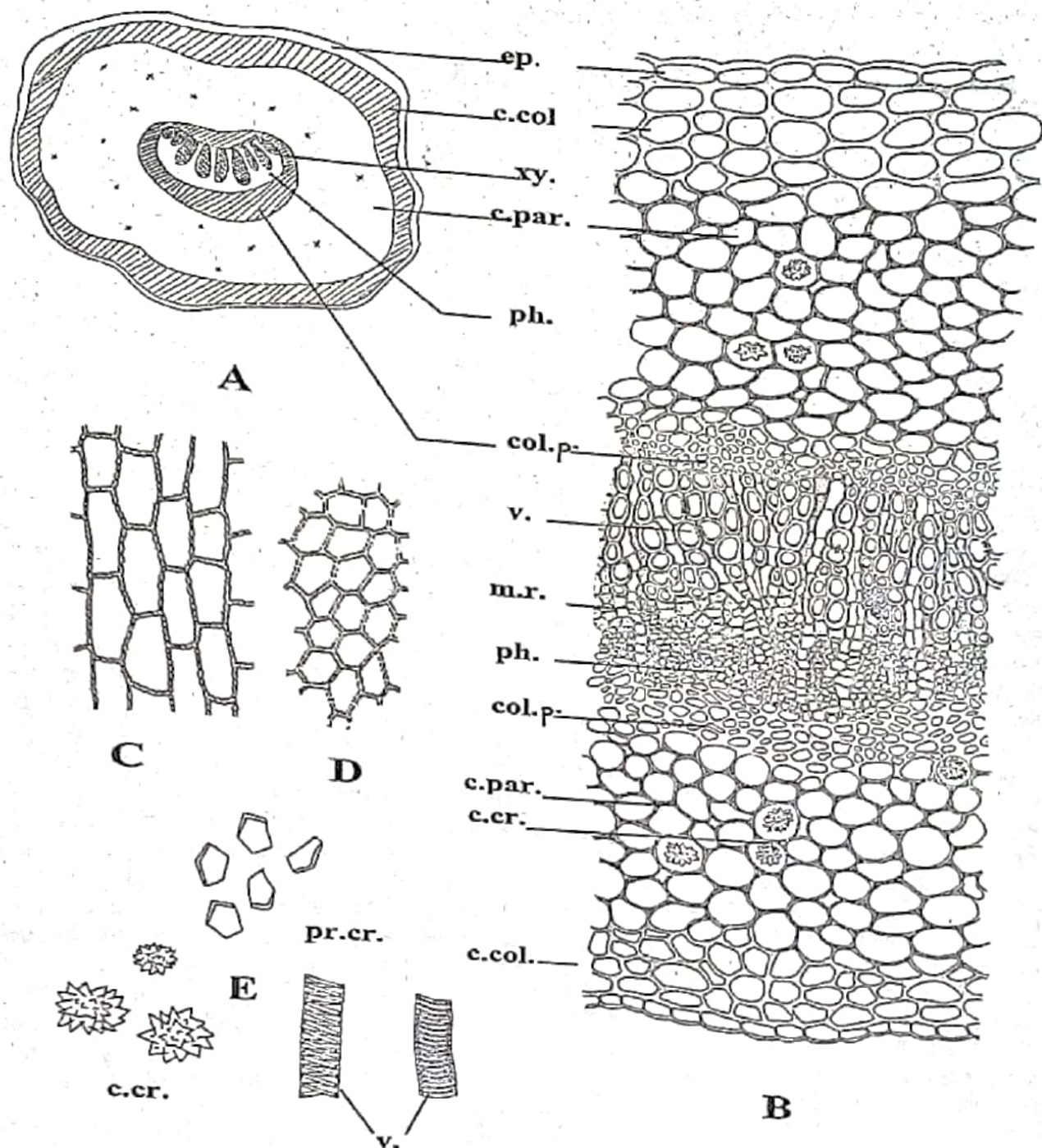


Fig. (10): The petiole of *Phyllanthus atropurpureus* Boj.

- A. Diagrammatic transverse section. (x 66.7) B. Detailed transverse section. (x 209)
 C. Upper epidermal cells. (260.35) D. Lower epidermal cells (x 365.8)
 E. Some elements of the petiole. (x 245.4)

C.col., cortical collenchyma; c.cr.; cluster crystal of calcium oxalate; c.par., cortical parenchyma; col.p., collenchymatous pericycle; ep., epidermis; m.r., medullary rays; ph., phloem; pr.cr., prismatic crystal of calcium oxalate; v., vessels; xy., xylem.

The microscopical numerical values of the leaf are summarized in Table 1.

Table 1: Microscopical numerical values of the leaf of *Phyllanthus atropurpureus* Boj.

The numerical value	Recorded value
Stomatal index of the lower epidermis	6.4-8.6
Palisade ratio	3.0-3.8
Vein-islet number	3.63
Veinlet-termination Number	4.86

The flower:

The pedicel:

The transverse section of the flower stalk (Figure 11) is circular in outline. It shows close similarity to young stem except the vascular tissue is formed of a ring of 8 to 12 separated collateral vascular bundles.

The perianth:

A transverse section of the perianth segment (Figures 12A and B) shows an outer and inner epidermis enclosing a parenchymatous mesophyll with one row of a hypodermal collenchyma below

both epidermises. It is traversed longitudinally by few vascular bundles; red contents are present, localized mainly in outer epidermis and the hypodermal layer.

The epidermises of perianth (Figures 12C and D) consist either of straight occasionally beaded thin anticlinal-walled polygonal cells covered with thin smooth cuticle or thick straight anticlinal-walled axially elongated cells (Figure 12E). Stomata of paracytic type (Figure 12C) are observed only on the outer epidermis; some cells show papilla. Cluster crystals of calcium oxalate and other cell contents which are not affected by strong alkalis or acids are observed in the inner epidermis.

The mesophyll (Figure 12B) consists of one row of outer hypodermal layer consisting of rectangular collenchymatous cells. The rest of the mesophyll is formed of almost rounded parenchyma showing cluster crystals of calcium oxalate and small intercellular spaces.

The pericycle is not differentiated and the vascular bundles are fifteen to eighteen, each consists of an inner xylem showing lignified spiral vessels and an outer phloem formed of moderately thick-walled cellulosic elements.

The androecium:

A transverse section in the anther region of the androecium (Figure 13A) shows six bilobed anthers attached by the connective; each lobe consists of one pollen sac. The anther wall (Figure 13B) is thin and formed of an outer epidermis followed by a single row of lignified fibrous layer cells and the remains of tapetum. The epidermal cells of the anther lobe (Figure 13B) are barrel-shaped with straight anticlinal walls and covered with thin smooth cuticle. The fibrous layer of the anther (Figure 13B) is formed of one row of polygonal axially elongated cells with straight and beaded anticlinal walls. The pollen grains (Figure 13 F) are spherical with finely granular exine, three germ pores, and three germinal furrows. A transverse section of the staminal column (filaments) (Figure 13C) is nearly circular in outline showing an outer epidermis surrounding a parenchymatous ground tissue with one or two rows of subepidermal moderately thick-walled rectangular collenchyma. It is traversed longitudinally by three small central vascular bundles. Each vascular strand is formed of few delicate spiral vessels and cellulosic elements of the phloem. Few cluster crystals of calcium oxalate and many reddish contents are present in the ground tissue parenchyma.

The epidermal cells of staminal column (Figures 13G and H) are polygonal, isodiametric to rectangular axially elongated cells with straight thin anticlinal walls and thin smooth cuticle.

The gynaecium:

The ovary wall (Figures 14A and B) is composed of outer and inner epidermises enclosing a

parenchymatous mesophyll bordered from the outer side by one row of collenchymatous cells.

Many cluster crystals of calcium oxalate are scattered in the mesophyll cells. The outer epidermis (Figures 14B, C and D) consists of thin-walled, polygonal, axially elongated cells with straight occasionally beaded anticlinal walls and covered with smooth cuticle, being less elongated at the base. Red contents are present in outer epidermal cells.

A transverse section of the style (Figures 14E and F) is nearly lenticular in outline with a notch on the middle of the inner side and formed of an epidermis surrounding a parenchymatous ground tissue traversed longitudinally by one vascular strand. The epidermis of the style (Figure 14G) is formed of polygonal isodiametric cells with straight moderately thick anticlinal walls and thin smooth cuticle. Some epidermal cells contain transparent secretions which appear as transparent dots. The epidermis of the stigma (Figure 14H) is formed of polygonal axially elongated, papillose cells with straight anticlinal walls and smooth cuticle. Stomata and trichomes are completely absent.

Powdered flower:

The powdered flower is reddish-brown in colour, having a faint odour and slightly bitter taste. It is characterized microscopically by:

1. Numerous cluster crystals of calcium oxalate free or in parenchymatous cells.
2. Fragments of the epidermal cells of the pedicel.
3. Fragments of the epidermal cells of perianth segments.
4. Fragments from the fibrous layer of the anther.
5. Fragments of the epidermis of the staminal column and anther
6. Numerous spherical pollen grains with finely granular exine, three germ pores and three germinal furrows.
7. Fragments of the epidermal cells of the ovary and the style.
8. Fragments of papillose stigma.
9. Fragments of parenchymatous cells of perianth, staminal column, ovary and style containing reddish contents or cluster crystals of calcium oxalate.

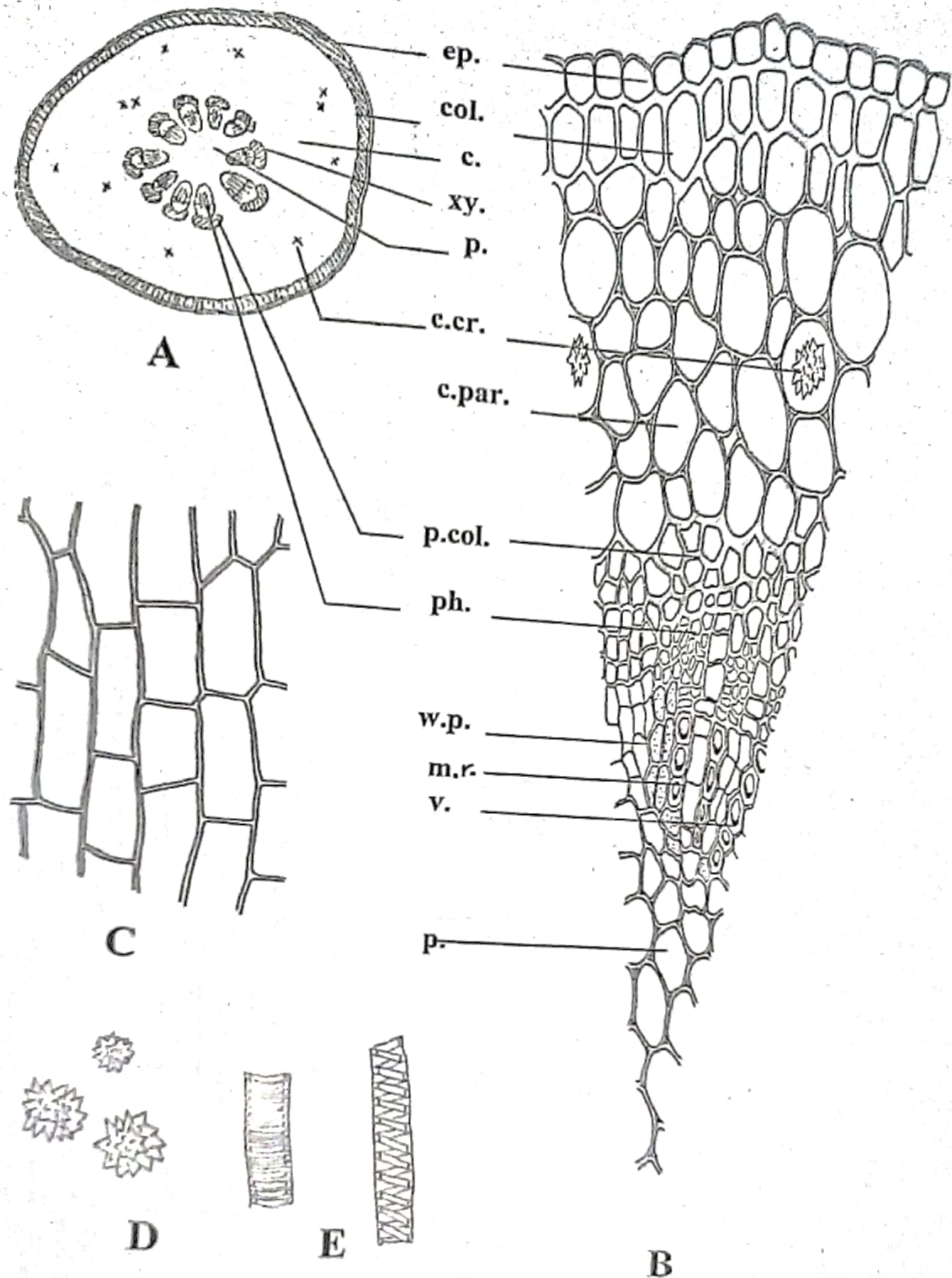


Fig (11): The Pedicel of *Phyllanthus atropurpureus* Boj.

C, cortex; c.cr, cluster crystals of calcium oxalate; c.par., cortical parenchyma; col., collenchyma; ep., epidermis; m.r., medullary rays; p., pith; p.col., pericyclic collenchyma; ph., phloem; v., vessel; w.p., wood parenchyma; xy., xylem.

A. Diagrammatic transverse section.

(x 77.2)

B. Detailed transverse section.

(x 581.6)

C. Epidermal cells.

(x394.4)

D. Cluster crystals of calcium oxalate.

(x 263.86)

E. Xylem vessels.

(x 365)

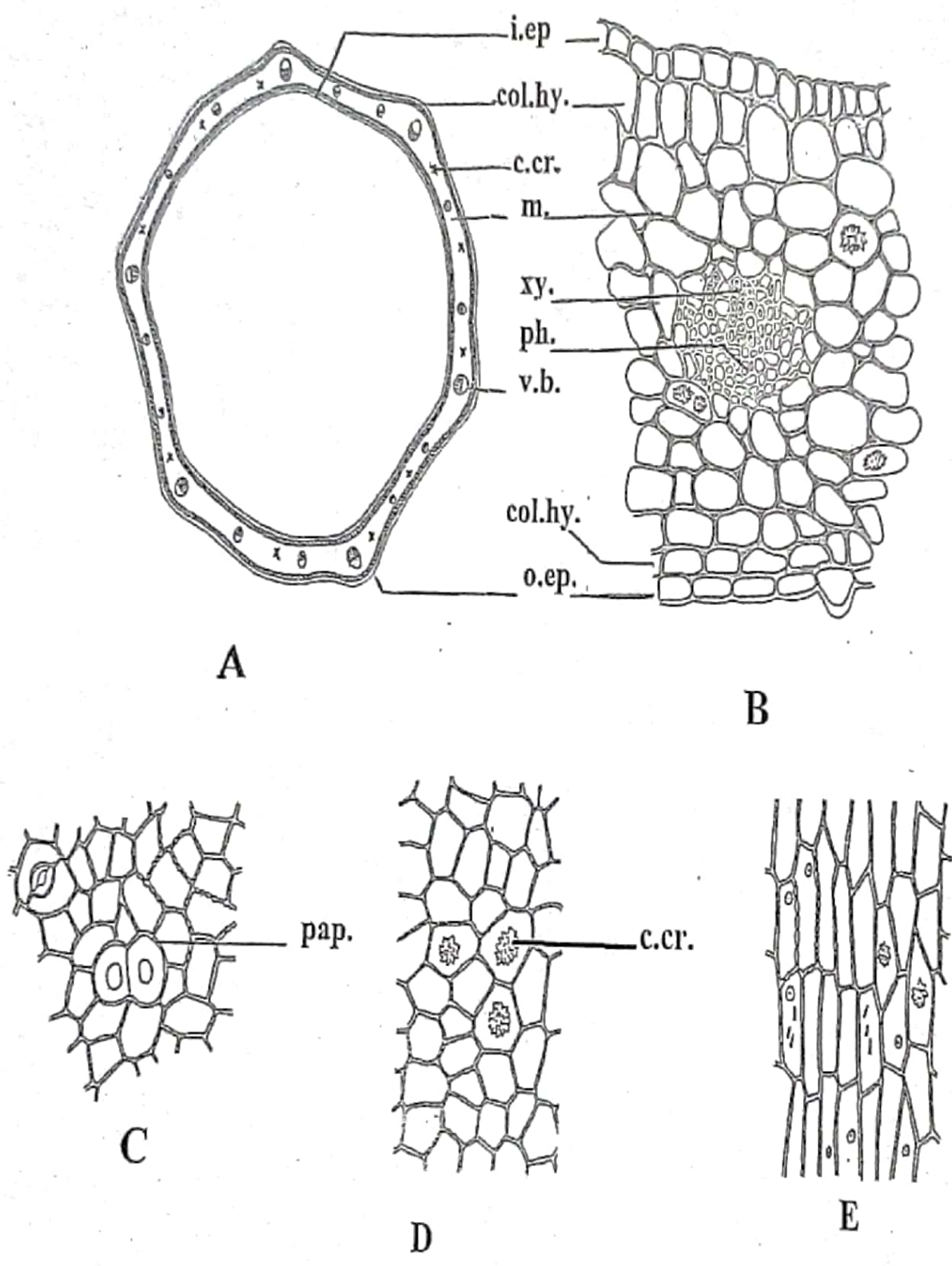


Fig. (12): The perianth of *Phyllanthus atropurpureus* Boj.
 A. Diagrammatic transverse section. (x 75.6) B. Detailed transverse section. (x 254)
 C. Outer epidermis of perianth- lobe. (x 231.8) D. Inner epidermis of perianth - lobe. (x 207.7)
 E. epidermis of perianth- lobe over the vein. (x 207.7)

C.cr, cluster crystal of calcium oxalate; col.hy., collenchymatous hypodermis; i.ep., inner epidermis; m., mesophyll; o.ep., outer epidermis; pap., papilla; ph., phloem; v.b., vascular bundle; xy., xylem.

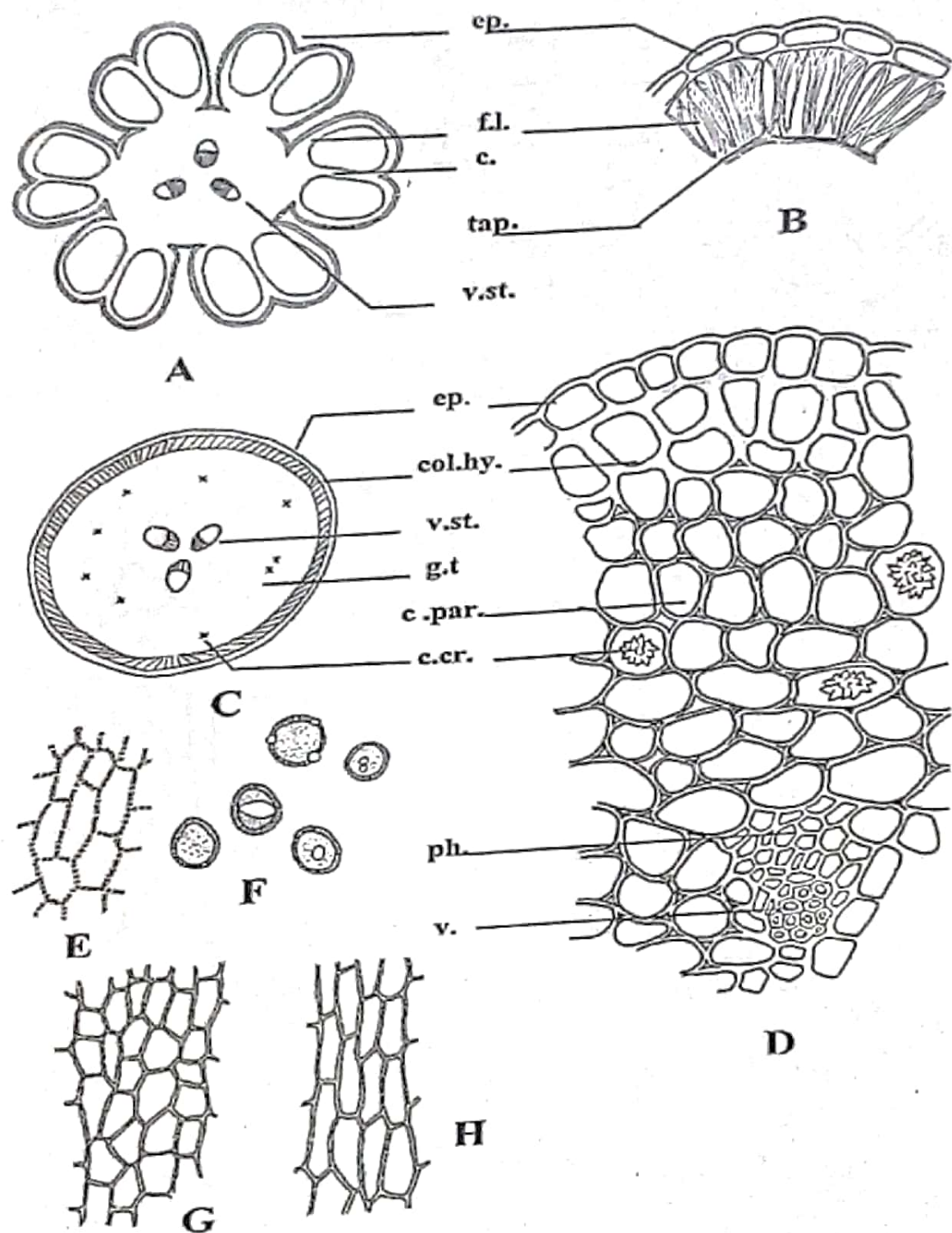


Fig. (13): The Androecium of *Phyllanthus atropurpureus* Boj.

- | | |
|--|-----------|
| A. Diagrammatic transverse section of the anther. | (x 78) |
| B. Detailed transverse section in the anther wall. | (x 345.2) |
| C. Diagrammatic transverse section of the staminal column below the anthers. | (x 89.9) |
| D. Detailed transverse section of the staminal column below the anthers. | (x 440) |
| E. The fibrous layer of the anther. | (x 183.6) |
| F. Pollen grains. | (x 305.6) |
| G. Epidermis of the staminal column at apex. | (x 250) |
| H. Epidermis of the staminal column at base. | (x 180) |

C., connective; c.cr., cluster crystals of calcium oxalate; col.hy., collenchymatous hypodermis; c.par., cortical parenchyma; ep., epidermis; f.l., fibrous layer; g.t., ground tissue; ph., phloem; tap., tapetum; v., vessels; v.st., vascular strand.

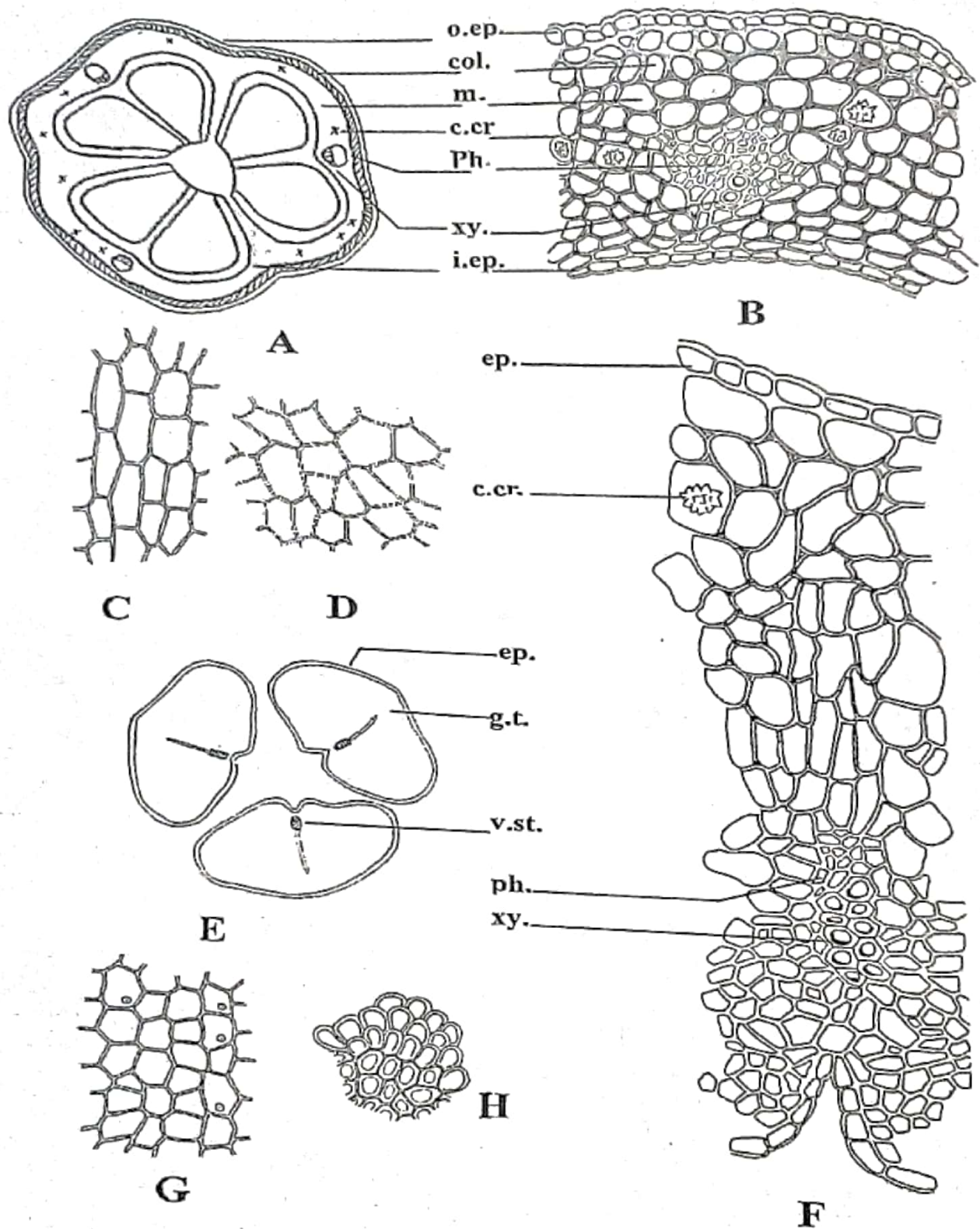


Fig. (14): The gynaecium of *Phyllanthus atropurpureus* Boj.

A. Diagrammatic transverse section in the ovary (x 58)

C. Outer epidermis of the ovary wall at the (x209.2)

E. Diagrammatic transverse section of the style. (x 58.5)

G. Epidermis of the style. (x 220)

B. Detailed transverse section in ovary (x 295)

D. Outer epidermis of the ovary wall at the (x 200)

F. Detailed transverse section of the style. (x 380)

H. Epidermis of the stigma. (x 266)

C.cr, cluster crystal of calcium oxalate; col., collenchyma; ep., epidermis; g.t., ground tissue; i.ep., inner epidermis; m., mesophyll; o.ep, outer epidermis; ph., phloem; v.st., vascular strand; xy., xylem.

Fragments of the epidermal cells of the ovary and the style.

Table 2: Cell dimensions of the different tissues of the root, stem, leaf and flower of *Phyllanthus atropurpureus* Boj.

Organ	Tissue	Dimension (μ)
Root and rhizome	Cork	L=17-40, W=13-32, H=7-13
	Calcium oxalate clusters	D=11-20
	Wood fibres	L=236-268, D=6-24
	vessels	H=10-39
	Tracheides	L=102-111, W=14-25
	Wood parenchyma	L=31-51, W=13-20
	Starch grain	D=4-14
Old stem	Cork	L=38-42, W=32-36, H=6-8
	Cortical parenchyma	L=14-25, W=13-44
	Lacuna	L=16-21, W=16-23
	Endodermis	L=14-16, W=50-53
	Pericyclic fibre	L=385-395, D=18-21
	Lacuna in pericycle	L=11-14, W=28-31
	Wood fibre	L=19-22, D=10-13
	Wood parenchyma	L=27-31, D=14-18
Young stem	Epidermal cells	L=29-50, H=5-7
	Stomata	L=14-20, W=17-21
	Vessels	D=10-19
	Calcium oxalate clusters	D=19-33
Leaf blade	Upper epidermis	L=11-25, W=11-31, H=8-13
	Papillae	H=14-17
	Lower epidermis	L=12-30, W=7-30, H=6-10
	Upper neural epidermis	L=21-40, W=6-9, H=8-10
	Lower neural epidermis	L=19-41, W=7-16, H=10-14
	Stomata	L=14-25, W=7-14
	The palisade	L=38-57, D=6-13
	Calcium oxalate clusters in spongy tissue	D=13-17
	Lignified idioblast	L=7-17, W=9-11
	Calcium oxalate clusters in midrib	D=6-17
	Vessels	D=8-15

Organ	Tissue	Dimension (μ)
Stipule	Upper epidermis	L=20-34, W= 8-13
	Lower epidermis paracytic stomata	L=7-14, W= 7-18 L=6-9, W= 3-4
Petiole	Upper epidermis	L=23-45, W= 15-23, H= 8-13
	Lower epidermis Calcium oxalate clusters Vessels	L= 9-16, W=5-13, H= 8-19 D= 2-3 D= 5-20
	Epidermal cells Calcium oxalate clusters Xylem vessels	L= 25-51, W= 15-23, H=5-10 D=19-38 D= 13-16
Flower Perianth	Outer epidermis: At the lobe and at the tube Inner epidermis: a) At the lobe b) Of the tubular part c) Over the veins of the lobe d) Over the veins at the tubular part Calcium oxalate clusters	L=6-18, W= 4-24, H= 5-7 L= 7-18, W= 9-18 L=17-28, W= 10-17 L=19-32, W= 7-12 L=13-25, W=7-12 D= 6-12
Androecium	Epidermis of the anther	L=7-10, W= 12-16, H=4-7
	Fibrous layer of the anther Pollen grains	L= 7-12, W=22-29, H= 24-27 D= 13-16
	Epidermis of the staminal column at the apex	L= 10-16, W= 8-11, H= 5-8
	Epidermis of the staminal column at the base	L= 22-31, W= 5-12, H= 5-9
	Calcium oxalate clusters	D=5-11

Organ	Tissue	Dimension (μ)
Gynaecium	Outer epidermis of ovary wall at the apex	L=19-31, W=9-13, H=4-7
	Epidermis of the ovary wall at the base	L=16-25, W=7-16, H=3-6
	Epidermis of the style	L=7-12, W=7-13
	Epidermis of style over the vein	L=7-15, W=8-11
	Calcium oxalate clusters in style	D=8-10
	Epidermis of the stigma	L=7-12, W=6-10

D= diameter; H= height; L= length; W= width.

REFERENCES

- Sharma O. P., "Plant Taxonomy", Tata McGraw-Hill publishing Co., LTD., New Delhi, 377, (1993).
- Wurdack K.J., Hoffmann P., Samuel R., Bruijn A.D., Bank M.V.D., Chase M.W., *Am. J. Bot.*, 91, 1882, (2004).
- Kathriarachchi H., Hoffmann P., Samuel R., Wurdack K.J., Chase M.W., *Mol. Phylogenet. Evol.*, 36, 112, (2005).
- Kathriarachchi H., Samuel R., Hoffmann P., Mlinarec J., Wurdack J., Ralimanana H., Stuessy T.F. Chase M.W., *Am. J. Bot.*, 93, 637, (2006).
- Suresh V., Asha V.V., *J. Ethnopharmacol.*, 116, 447, (2008).
- Sabir S.M., Rocha J.B.T., *Food Chem.*, 111, 845, (2008).
- Kumar S., Sachdeva N., Amir M., Kumar A., Singh S.K., *SPJ.*, 15, 55, (2007).
- Aswatha R.H.N., Shreedhara C.S., Falguni G.P., Sachin Z.B., *Pharmacologyonline.*, 2, 440, (2008).
- Chidi U., Linus A.N., Cosmas O.U., *African J. Biotechnol.*, 6, 728, (2007).
- Sailaja R., Setty O.H., *J. Ethnopharmacol.*, 105, 201, (2006).
- Chatterjee M., Sil P.C., *Indian J. Clin. Biochem.*, 22, 109, (2007).
- Pramyothin P., Ngamtin C., Pongshompoo S., Chaichantipyuth C., *J. Ethnopharmacol.*, 114, 169, (2007).
- Wongnawa M., Thaina P., Bumrungwong N., Rattanapirun P., Nitiruangjaras A., Muso A. Prasarthong V., *Songklanakarinn J. Sci. Technol.*, 28, 551, (2006).
- Islam A., Selvan T., Mazumder U.K., Gupta M., Ghosal S., *Pharmacologyonline.*, 2, 796, (2008).
- Ali H., Houghton P.J., Soumyanath A., *J. Ethnopharmacol.*, 107, 449, (2006).
- Nwanjo H.U., *Internet J. Lab. Med.*, 2, (2007).
- Sarg T., Abdel-Ghani A., Zayed R., El-Sayed M., Submitted for publication; *J. Nat. Prod.*
- Sarg T., Abdel-Ghani A., Zayed R., El-Sayed M., Submitted for publication; *J. Pharmacogn. Phytother.*

Received: 23/03/2011

Accepted: 12/06/2011

دراسة عيانية و مجهرية لنبات فيلاتشوس التروبيربوس بوج من العائلة اللبئية و المنزرع في مصر

طه مصطفى مرج- عفاف السيد عبد القوي- رابوة عبد الهادي زايد- مي أحمد السيد
قسم العظير - كلية الصيدلة - جامعة الزقازيق - الزقازيق - مصر

أجريت في هذا البحث دراسة عيانية و مجهرية لأوراق و ساق و زهرة و جدر نبات فيلاتشوس التروبيربوس بوج (العائلة اللبئية) لتعرف على النبات في حالته الصحيحة أو مسحوقاً.