

MACRO- AND MICROMORPHOLOGY OF *DALBERGIA SISSOO* ROXB. GROWING IN EGYPT. Part I: The leaf and Stem

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ABSTRACT

The macro- and micromorphological characters of the leaf and stem of *Dalbergia sissoo* Roxb. growing in Egypt have been studied in order to find out the diagnostic features which can help in the identification of this plant in both entire and powdered forms.

INTRODUCTION

As a part of our continued investigation and survey on the Egyptian medicinal plants, the species *Dalbergia sissoo* Roxb. was nominated for phytochemical and pharmacological studies.

Dalbergia sissoo Roxb. (Family Leguminosae, Fabaceae) is a plant indigenous to India and Afghanistan^(1,2). Now, it is cultivated in Egypt as a shade tree especially on the banks of irrigation canals and is known by the arabic name "Al Sarsoa".

Many *Dalbergia* plants have been reported for their medicinal uses such as antimicrobial, antitumor, smooth muscle relaxant⁽³⁻⁶⁾, emmenagogue⁽⁷⁾, antihypercholesterolemic, anticoagulant⁽⁸⁾ and antifungal agents⁽⁹⁾. They are useful in treatment of scabies⁽⁷⁾, some cardiovascular diseases, asthma and allergy, inflammation^(9,10) and abdominal complaints of newborn children⁽⁷⁾. In addition, some plants extracts from the genus have been used as poultice in varicose veins, nervous disorder and for typhoid fever⁽⁷⁾.

As a result of our phytochemical study⁽¹¹⁾ on this plant two terols, one triterpene, eight isoflavones and one flavone compound were isolated and identified. Also, pharmacological, histopathological and antimicrobial studies of *Dalbergia sissoo* Roxb. have been reported⁽¹¹⁾.

In view of the importance of this plant we decided to do a comprehensive macro- and micromorphological study of its organs. In the present study, we are dealing with the macro- and micromorphology of the leaf and stem of this plant to show the salient diagnostic characters of each organ by which one can identify it in both entire and powdered forms.

EXPERIMENTAL

Plant Material :

Fresh samples of leaves and stem of *Dalbergia sissoo* Roxb. were collected in May 1994 from plants

growing on the banks of irrigation canals in the vicinity of Zagazig (85 Km Northeastern Cairo), Egypt. The identity of the plant was kindly verified by Dr. Nabil El-Hadidi, Prof. of Plant Taxonomy, Faculty of Science, Cairo University, Egypt. A voucher sample of the flowering tops of the plant is kept in the Department of Pharmacognosy, Faculty of Pharmacy, Zagazig University, Egypt.

A- Macromorphology :

Dalbergia sissoo Roxb. is a large perennial tree attaining 8 meters high, the plant shows richly branched hard wood trunk reaches up to 340 cm in height and 35 to 145 cm in diameter. It has big branches and numerous young green branches. It carries numerous compound alternate leaves and yellowish-white papilionaceous hermaphrodite flowers arranged in terminal racemose inflorescences. The plant flowers from April to May.

i- The Leaf :

The leaves (Fig. 1) are crowded, compound alternate with 3 to 6 leaflets arranged alternately on rachis terminated by one leaflet (imparipinnate). They are cauline persistent and petiolate with exstipulate base showing pulvinus. The leaflets are shortly petiolate orbicular with dark green hairy upper surface and pale green pubescent lower one, acuminate apex, entire margins, symmetric base and measure 2.0 to 6.5 cm in length and 1.5 to 4.0 cm in width. They have pinnately reticulate venation; midrib and big veins are prominent on the lower surface and much less prominent on the upper one. They have papery texture, slight odour and mucilagenous taste.

ii- The Stem :

The main trunk is erect, cylindrical and measures up to 340 cm in height and 35 to 145 cm in diameter. It is freely monopodially branched showing greyish-brown rough surface with deep longitudinal and transverse fissures and whitish patches of lichens; cork is easily exfoliated. The big branches are dark greyish brown, rigid, solid and cylindrical, showing internodes of 3 to 14 cm in length and 0.5 to 2.9 cm in diameter. The young branches are cylindrical with green smooth hairy



Fig. (1) Sketch of *Dalbergia visaya* Roxb. : (AEX04 except C X01, EX06)
 A. The flowering branch. B. The leaf. C. The leaflet. D. The fruiting branch. E. The inflorescence.
 a. fruit in. inflorescence. b. leaflet. ca. rachis. s. scar of the fruit. sc. stem.

surface; internodes measure 1.5 to 5.0 cm in length and 0.1-5 mm in diameter. Young stem is flexible but on drying breaks with fibrous fracture exposing greenish-brown outer bark and yellowish-white center. It has slight odour and slightly bitter taste.

B. Micromorphology :

A transverse section of the leaflet (Fig. 2) shows a dorsiventral structure; palisade layer is interrupted by collenchyma in the midrib region. Both epidermis show collenchymatous hypodermis. The midrib region shows crescent-shaped vascular tissue with lower arc of pericyclic fibres surrounded with crystal sheath and small batches of perimedullary phloem above xylem.

A transverse section of the petiole (Fig. 3) is almost circular in outline with slight depression on the upper surface. It consists of an epidermis surrounding a wide parenchymatous cortex showing a complete layer of subepidermal collenchyma. The vascular system consists of a large crescent-shaped vascular tissue in addition to 2 to 3 separate vascular bundles on both sides with a lower arc of pericyclic fibres surrounded with crystal sheath and small batches of perimedullary phloem above xylem.

A transverse section of the old stem (Fig. 4) is almost circular in outline. It shows an outer cork followed by a narrow collenchymatous phelloderm with few sclereids and a parenchymatous cortex. The pericycle shows numerous batches of lignified pericyclic fibres arranged in a ring and surrounded by crystal sheath. The vascular tissue forms a complete ring of an outer phloem and inner xylem with cambium in

between. The pith is narrow and lignified. In the young stem (Fig. 5) and the rachis (Fig. 6), they show an outer epidermis, parenchymatous cortex with subepidermal collenchyma, a ring of 13 to 15 vascular bundles and wide parenchymatous pith. The pericycle of rachis shows groups of fibres surrounded by crystal sheath while that of young stem is collenchymatous.

i- Epidermis :

Both epidermis of the lamina (Fig. 7) consist of polygonal cells with straight anticlinal walls and covered with thick smooth cuticle. The neural epidermal cells of the leaflets (Fig. 7); petiole (Fig. 3), rachis (Fig. 6) as well as young stem (Fig. 5) are axially elongated and covered with thick striated cuticle. The size of epidermal cells in microns are given in Table (1).

ii- Stomata :

They are present on both surfaces of the leaflet as well as that of the rachis (Fig. 7.6) but they are completely absent on petiole and young stem. They are of the paracytic type, oval or rounded in outline and measure 10 to 16 μ , 6 to 13 μ in length and 8 to 14 μ , 6 to 8 μ in breadth respectively.

iii- Trichomes :

They are of covering type only and present on epidermis of the leaflet, petiole, rachis and young stem (Fig. 2,7,3,6,5). Trichomes are uniseriate multicellular formed of 2 to 3 short basal cells and a long terminal one. They have thick cellulosic walls, narrow or wide lumens, acute or blunt apices, warty cuticle and

Table (1): Size of epidermal cells of the leaflet, petiole, rachis and young stem in microns.

Epidermis	Length	Breadth	Height
Upper epidermis of the lamina	10-35	6-18	8-14
Lower epidermis of the lamina	10-42	3-18	5-11
Upper neural epidermis	10-35	6-18	11-17
Lower neural epidermis	6-18	5-10	5-8
Epidermis of petiole	6-32	6-16	3-13
Epidermis of rachis	9-23	4-9	3-7
Epidermis of young stem	7-24	5-14	5-9

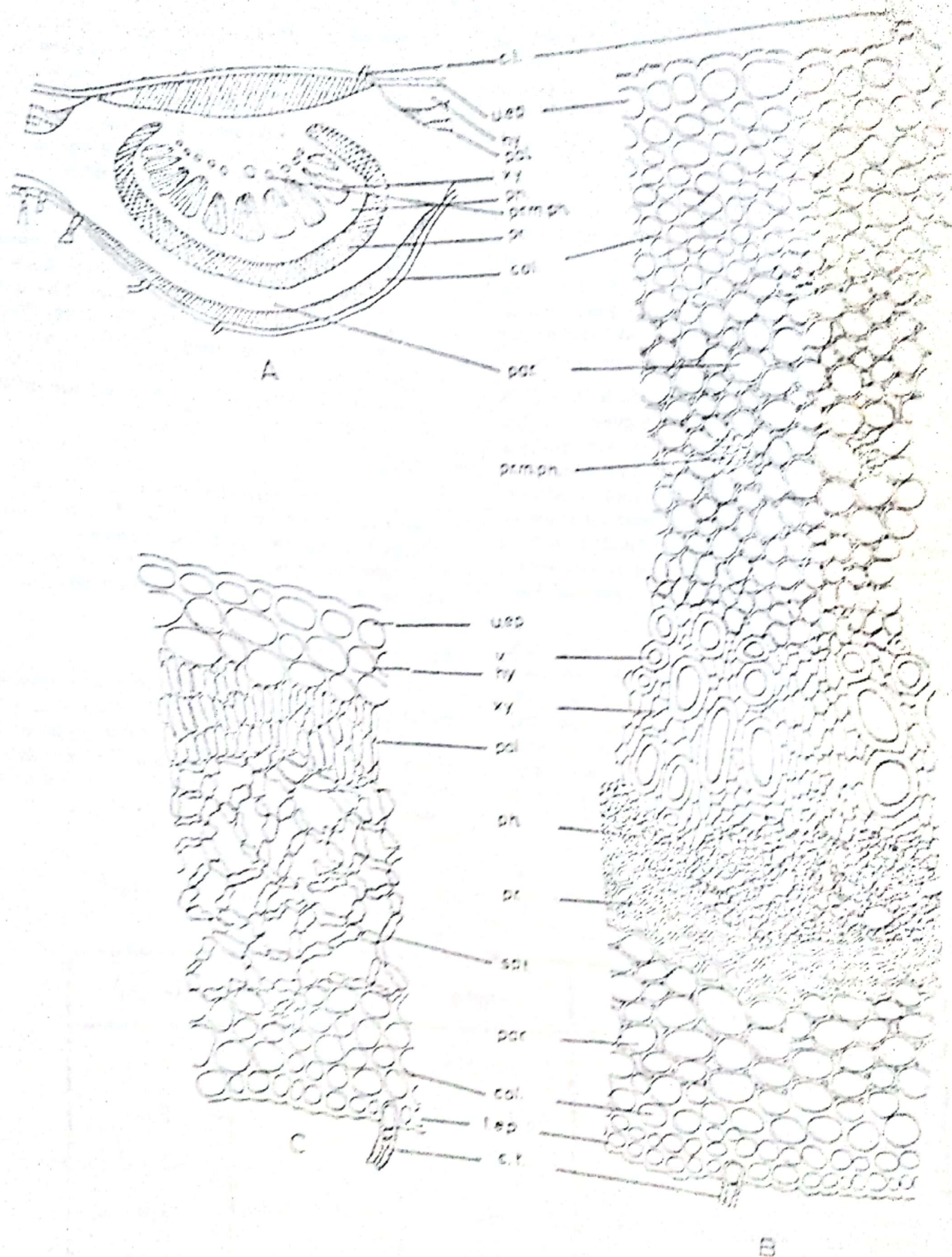


Fig. (2) The Leaflet: (All X 362, except A X 85)
 A- Diagrammatic transverse section. B- Detailed transverse section. C- Detailed transverse section of the lamina.
 col., collenchyma; hy, hypodermis; lep., lower epidermis; pal, palisade; par., parenchyma; ph, phloem; pt, pericycle; pr. m. ph., perimedullary phloem; sp., spongy tissue; u.e.p., upper epidermis; v., vessel; xy., xylem.

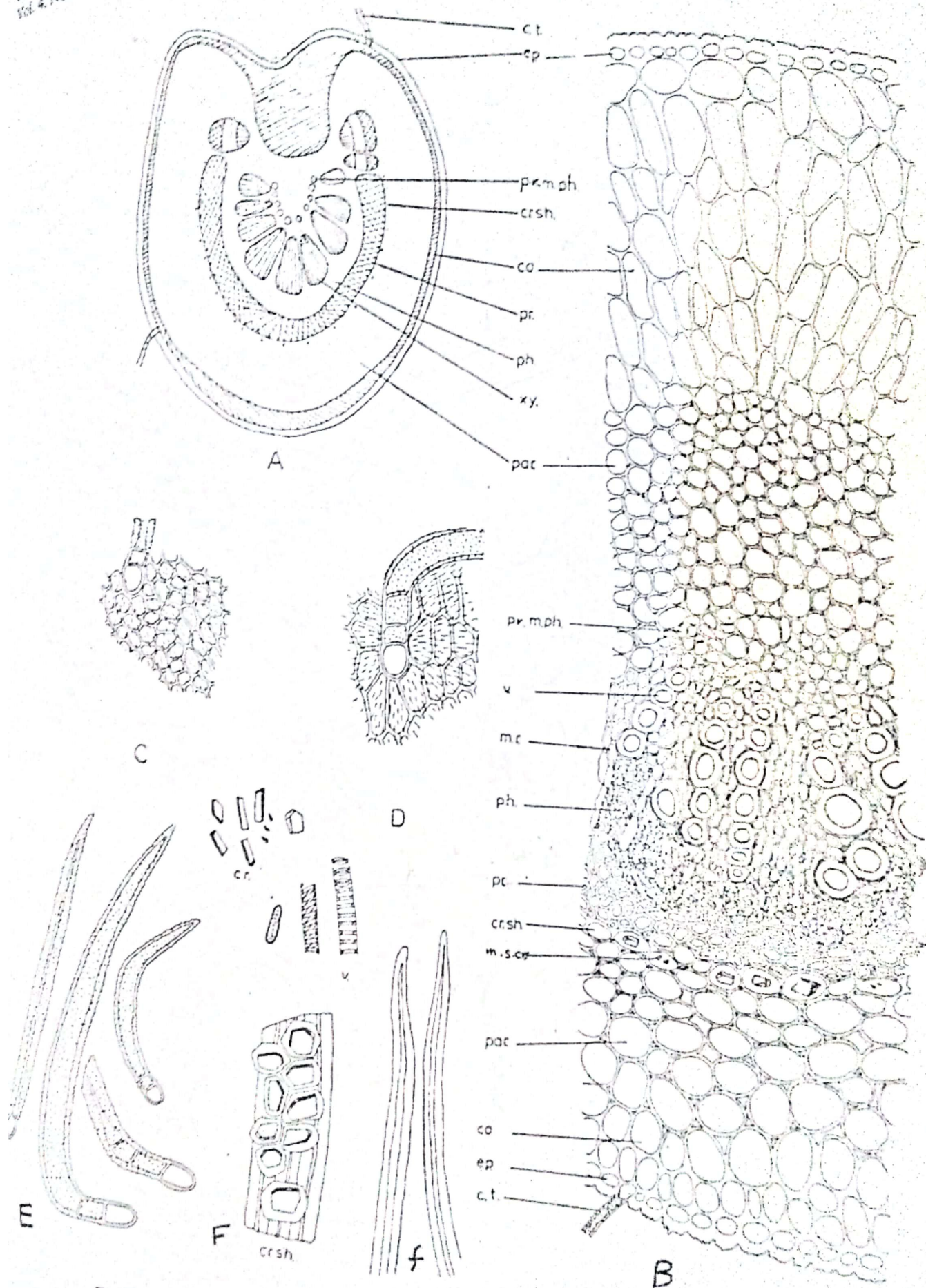


Fig. (3) The Paritole: (All X 317, except A X 92)

A- Diagrammatic transverse section

D- Lower epidermis

co- collenchyma, ct, covering trichomes, cr.sh, crystal sheath, ep, epidermis, mc, medullary ray, m.s.cr, microspineoidal crystals of calcium oxalate, pac, parichyma, ph, phloem, pc, pericycle, prm.ph, perimedullary phloem, v, vessel.

B- Detailed transverse section

E- Covering trichomes

C- Upper epidermis

F- Isolated elements

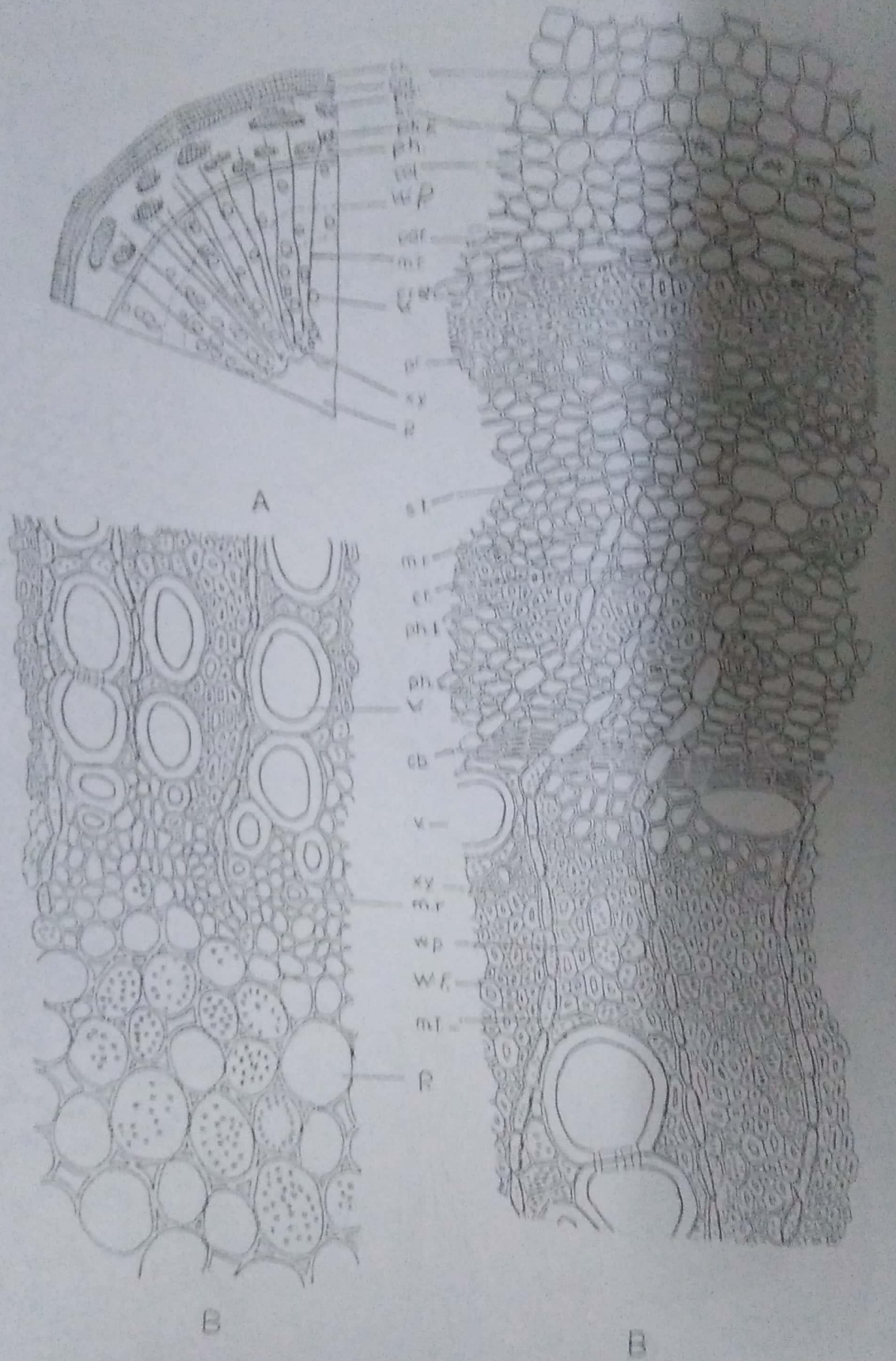


Fig. 14: The old stem - (A) X 80, except B X 175.

A. Diagrammatic transverse section.

B. Detailed transverse section.

ep - epidermis, ct - cork, cb - cambium, phl - phloem fibers, ph - phloem, v - vascular bundle, xy - xylem, mr - metaxylem, wp - wood parenchyma, wf - wood fibers, mt - metaxylem, R - ray.

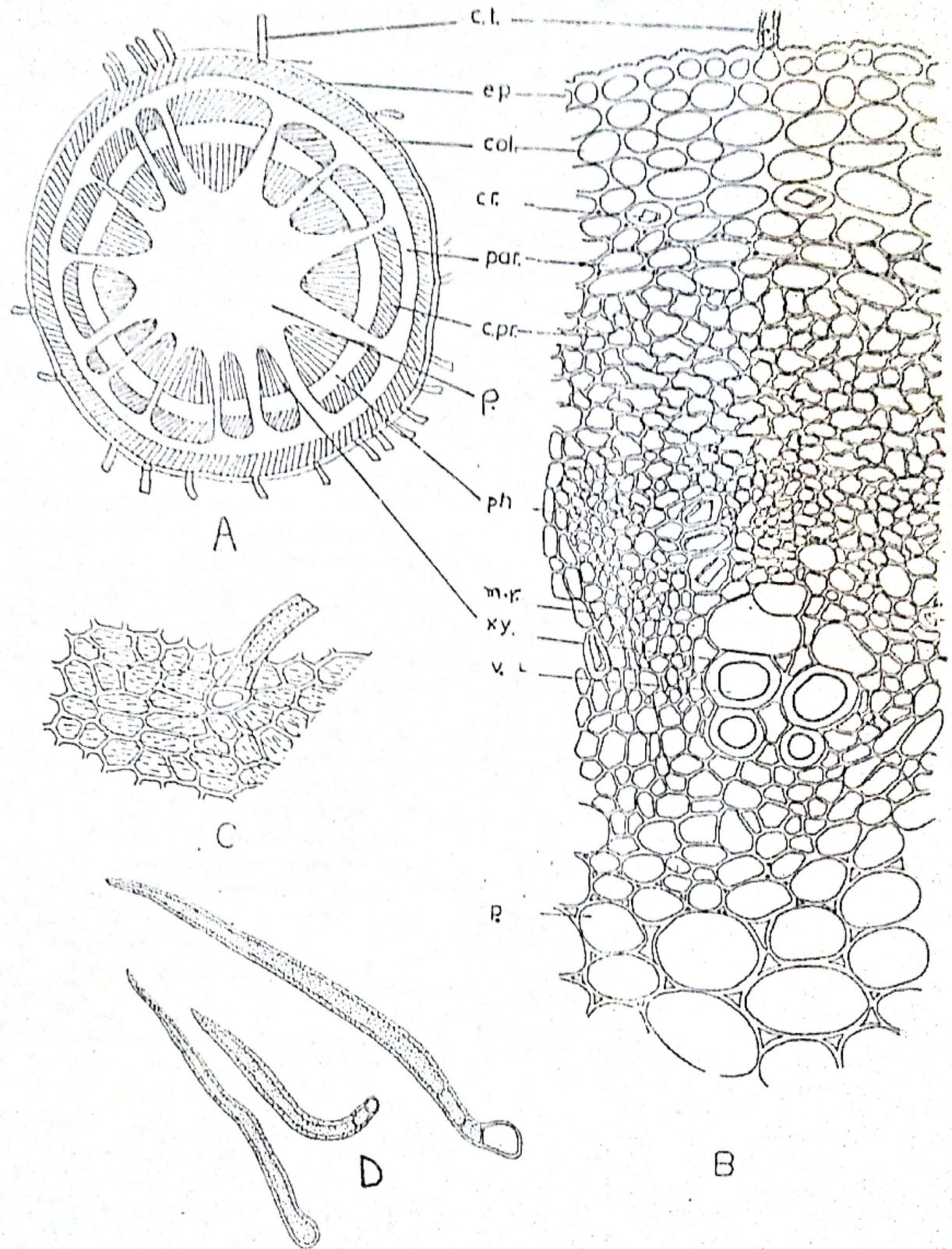


Fig. (5) The Young Stem: (All X 380, except A X 80)
 A- Diagrammatic transverse section. B- Detailed transverse section. C- Epidermal cells. D- Covering trichomes.
 col., collenchyma; c.pr., collenchymatous pericycle; cr., prismatic crystal of calcium oxalate; c.t., covering trichomes; ep., epidermis; m.r., medullary ray; p., pith; par., parenchyma; ph., phloem; v., vessel; xy., xylem.

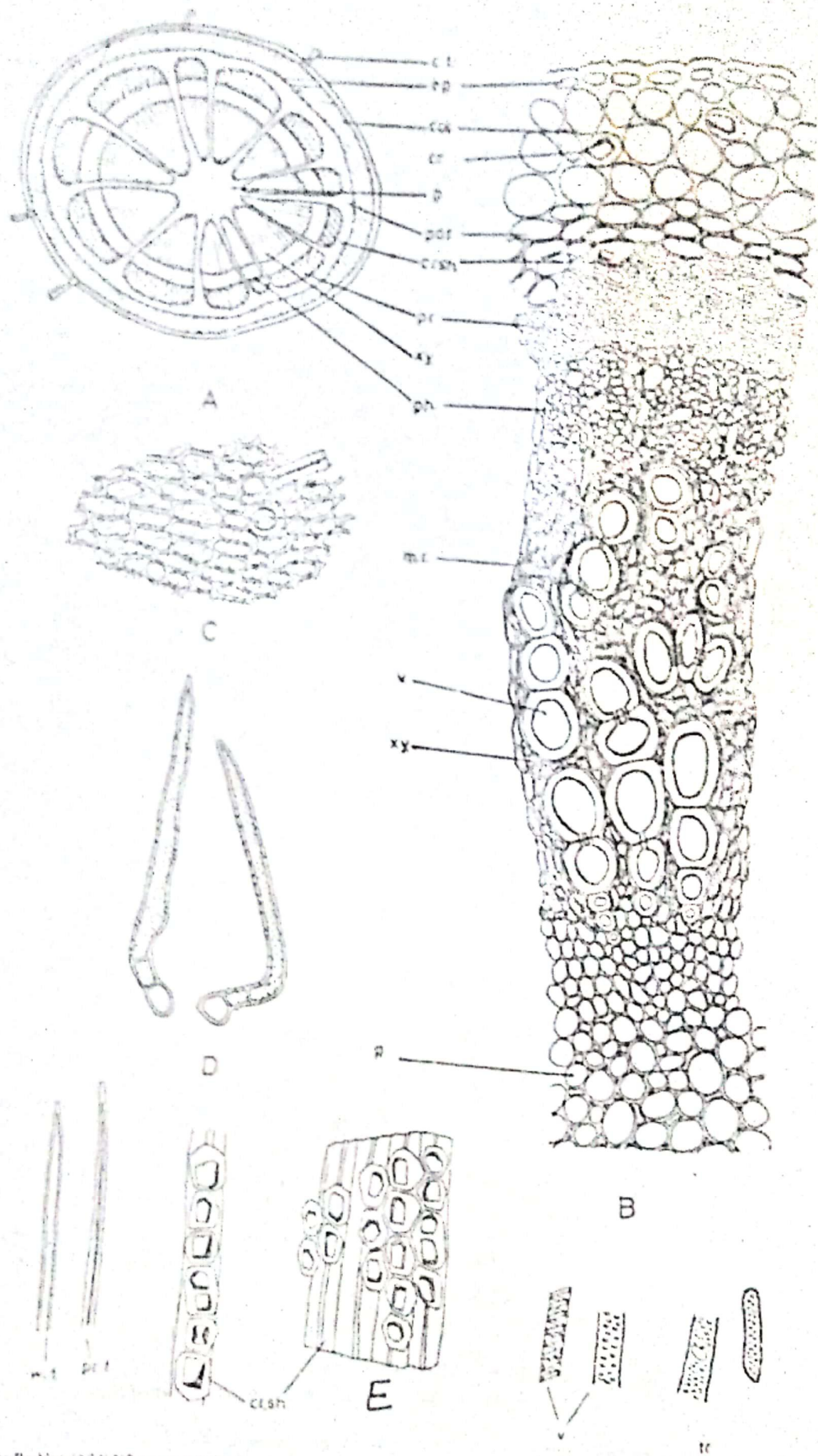


Fig. (6) The Rachis (Ad X 317, except A X 60)

A. Diagrammatic transverse section

D. Covering trichomes

col., collet; cut., cuticle; st., stoma; st.c., stoma cell; sc, subsidiary cell; cc, cork cell; cc.sh., cork sheath; cc.f., cork fibre; cc.w., cork wall; cc.v., cork vein; cc.c., cork cell; cc.s., cork sheath

B. Detailed transverse section

E. Isolated elements

mod., modular ray; p., pericycle; par., parenchyma; ph., phloem; pr., pericycle fibre; tr., tracheids; v., tracheidal vessel; w.f., wood fiber; w.p., wood parenchyma; xy., xylem

C. Epidermal cells

measure 90 μ to 270 μ in length and 7 to 22 μ in diameter. The epidermis of young stem shows also unicellular trichomes (Fig. 5), they are long conical with thin to moderately thick cellulosic walls, wide lumen, blunt apices and covered with warty cuticle. They measure 81 to 140 μ in length and 5 to 11 μ in diameter.

iv- Hypodermis :

Both epidermis of the lamina (Fig. 2) show hypodermal layer formed of 2 to 5 rows of polygonal axially elongated collenchymatous cells with thick cellulosic walls. They measure 13 to 45 μ in length, 5 to 17 μ in height and 10 to 24 μ in width.

v- Cortex :

The cortex of the midrib (Fig. 2), petiole (Fig. 3) rachis (Fig. 6) and young stem (Fig. 5) are parenchymatous with subepidermal collenchyma. The parenchymatous cells are more or less rounded with thick cellulosic walls and wide intercellular spaces. The collenchyma are 2 to 7 rows of cellulosic thick-walled cells. The cortex of the old stem (Fig. 4) is formed of tangentially elongated, more or less rounded parenchymatous cells.

vi- The Pericycle :

The pericycle of the midrib (Fig. 2), petiole (Fig. 3), rachis (Fig. 6), consists of an arc of 4 to 5 rows of pericyclic fibres surrounded with crystal sheath, while that of the old stem (Fig. 4) is formed of an interrupted ring of large groups of 6 to 9 rows of pericyclic fibres surrounded with crystal sheath. Pericyclic fibres (Fig. 3,6,7,8) are spindle-shaped with thick lignified walls, wide or narrow-lumen, blunt apices and measure 130 to 400 μ in length and 5 to 18 μ in diameter. The pericycle of young stem (Fig. 5) is formed of 7 to 11 rows of irregular collenchyma.

vii- Vascular tissue :

The vascular tissue of the leaflet (Fig. 2), petiole (Fig. 3), rachis (Fig. 6), old stem (Fig. 4) and young stem (Fig. 5) are formed of a radiating xylem and cellulosic phloem; numerous groups of perimedullary phloem are present above xylem of leaflet and petiole.

The phloem (Fig. 2,3,4,5,6) consists of moderately thick cellulosic elements but in old stem it shows group of fibres surrounded with crystal sheath. The fibres (Fig. 8) are spindle-shaped with moderately thick lignified pitted walls, blunt apices, dentate surface and measure 140 to 300 μ in length and 5 to 18 μ in diameter.

The xylem (Fig. 2,3,4,5,6) is lignified and formed of lignified spiral, annular and pitted vessels, few tracheids and tracheidal vessels as well as wood parenchyma being cellulosic in leaflets and petiole. Tracheids (Fig. 3,6,7,8) have thick lignified walls, showing oval bordered pits. The wood fibres (Fig. 6,8)

have lignified thick pitted walls, narrow or wide lumen and blunt apices. The wood parenchyma (Fig. 4,8) are diffuse, paratracheal or metatracheal, formed of axially elongated cells with thick lignified pitted walls.

The medullary rays of rachis and old stem (Fig. 4,6) are mostly uniseriate formed of rectangular radially elongated cells with thick pitted walls in the xylem region and cellulosic in the phloem. The medullary rays of the young stem (Fig. 5) are cellulosic. The measurements of xylem elements of leaflet, petiole, rachis and stem are represented in Table (2).

The cambium (Fig. 4) is formed of 5 to 6 rows of thin-walled tangentially elongated more or less flattened flattened cellulosic meristematic cells.

viii- The Pith :

The pith of rachis and young stem (Fig. 5,6) is formed of rounded parenchymatous cells; they measure 6 to 53 μ in diameter. In the old stem (Fig. 4,8) the pith is narrow, composed of rounded cells with moderately thick lignified pitted walls and wide intercellular spaces. They measure 10 to 43 μ in diameter.

ix- The Periderm :

It is present in old stem only, the cork (Fig. 4,8) is formed of 5 to 8 rows of polygonal to rectangular cells with moderately thick suberized walls and mucilagenous contents. They measure 11 to 33 μ in length, 9 to 24 μ in width and 3 to 22 μ in height. The phellogen arises in the cortex and is not distinguished in the old stem, the phelloderm (Fig. 4) is formed of 3 to 5 rows of more or less rounded collenchymatous cells. It shows few sclereids which are polygonal with thick lignified pitted walls and narrow lumen. They measure 10 to 32 μ in length and 8 to 24 μ in width.

x- Cell Contents :

Simple more or less rounded starch granules with distinct hilum measuring 2 to 4 μ in diameter are present in the pith of rachis and young stem. The epidermal cells of the leaflet, petiole, rachis and young stem, cork cells of the old stem and the terminal cell of the covering trichomes contain mucilage. Also numerous prismatic crystals and few microsphenoidal crystals of calcium oxalate are present in the spongy tissue of the leaflet near the veins and in the phloem parenchyma of the old stem around phloem fibres forming crystal sheath. Also, they are present in the parenchymatous cells around pericyclic fibres of leaflet, petiole, rachis, young and old stem forming crystal sheath.

Powdered leaf and stem:

The powdered leaf and stem is greenish-brown in colour with characteristic odour and slightly bitter taste. It is characterised microscopically by :

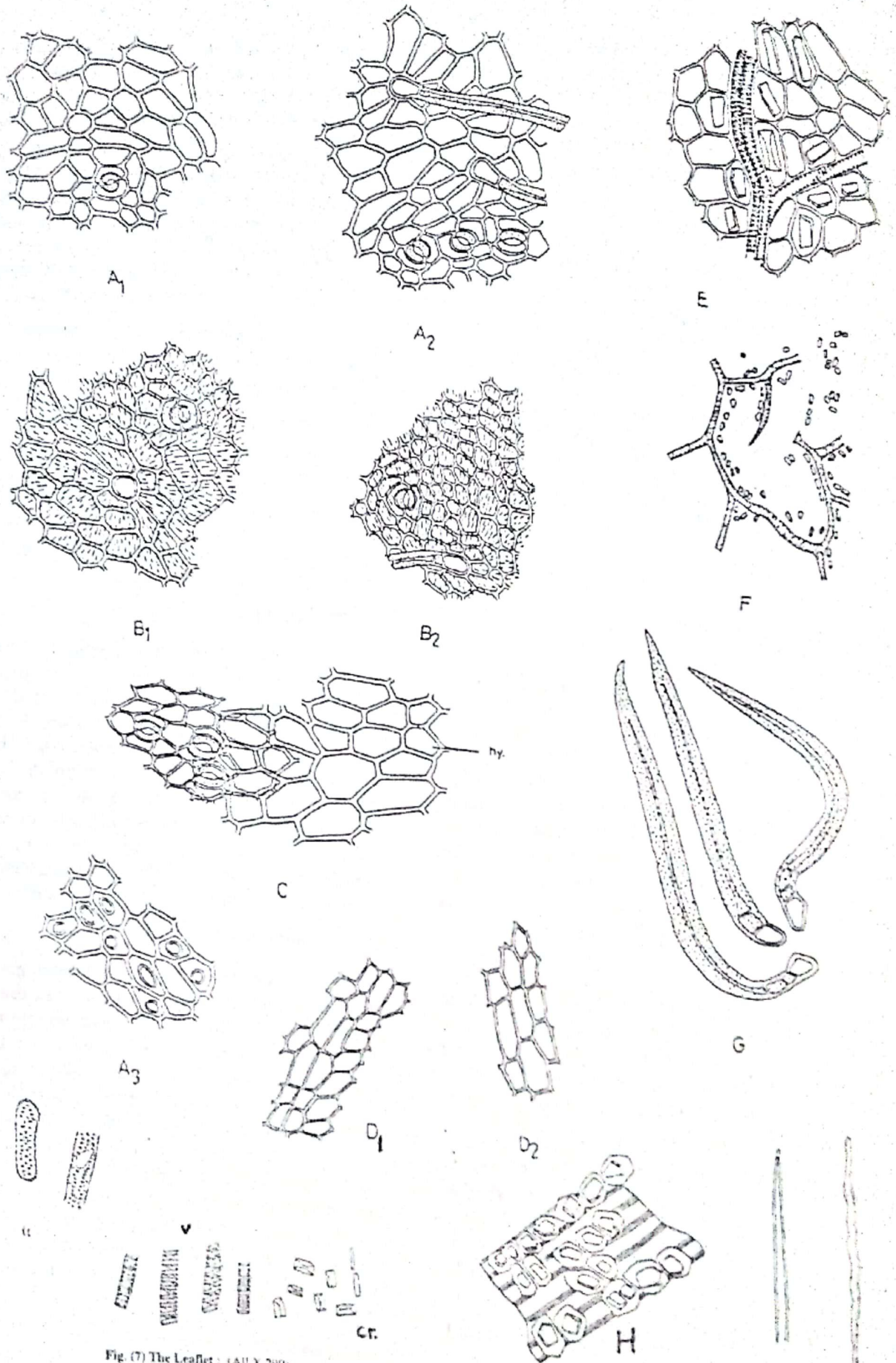


Fig. (7) The Leaflet : (All X 290)

A₁ - Upper epidermal cells of the lamina.

B₁ - Upper epidermal cells of the leaflet over vein.

C - Upper epidermal cells accompanied with hypodermis.

D₁ - Lower epidermal cells at the margin.

G - Covering trichomes.

H - Crystal sheath

cr. - prismatic crystals of calcium oxalate, hy. - hypodermis, tr. - tracheids, v. - vessels

A₂, A₃ - Lower epidermal cells of the lamina.

B₂ - Lower epidermal cells over vein.

D₂ - Upper epidermal cells at the margin.

E, F - Arrangement of crystals around vessel.

I - Wood fibre.

J - Vascular tissue

Table (2): The measurements of xylem elements of leaflets, petiole, rachis and stem in microns.

Xylem element	Length	Breadth	Diameter
1- Vessels :			5-40
a- Leaflet			9-28
b- Petiole			6-34
c- Rachis			8-51
d- Stem			
2- Tracheids :			11-14
a- Leaflet	31-45		6-10
b- Petiole	15-29		6-10
c- Rachis	25-48		8-20
d- Stem	32-60		
3- Wood parenchyma :			
a- Stem	44-65	15-20	
4- Wood fibres :			
a- Rachis	157-253		6-12
b- Stem	239-330		8-20
Medullary ray cells :			
a- Stem	20-60	9-18	

Table (3): Numerical values of the leaf.

Value	Number
1- Stomatal Index	
a- Upper epidermis	4.0-5.0
b- Lower epidermis	9.1-14.2
2- Vein-Islet Number	10.0-15.
3- Veinlet-Termination Number	4.0-5.0
4- Palisade Ratio	3.0-7.0

1- Fragments of epidermal cells of lamina; the cells are polygonal slightly elongated with straight anticlinal walls, thick smooth cuticle showing paracytic stomata and covering trichomes or their scars.

2- Fragments of the epidermal cells of the midrib, petiole, rachis and young stem; the cells are polygonal axially elongated with straight anticlinal walls and striated cuticle. The cells show covering trichomes or their scars. The epidermal cells of midrib and rachis show paracytic stomata.

3- Fragments of cork cells of old stem; they are polygonal with moderately thick suberized walls.

4- Fragments of lamina showing dorsiventral structure with 2 to 3 layers of palisade and collenchymatous hypodermis.

5- Fragments of lamina showing vein-islet with characteristic arrangement of prisms of calcium oxalate near veins.

6- Fragments of lignified pericyclic or phloem fibres surrounded by crystal sheath.

- 7- Numerous covering trichomes which are uniseriate, multicellular with one to three short basal cells and a long terminal one and covered with warty cuticle. Few unicellular covering trichomes; they are conical, sometimes curved near the base with blunt apices and covered with warty cuticle.
- 8- Fragments of lignified spiral, annular and pitted vessels.
- 9- Fragments of lignified pitted cells of the old stem pith.
- 10- Numerous prisms of calcium oxalate are present free or in parenchymatous or collenchymatous cells.
- 11- Numerous simple more or less rounded starch granules with indistinct hilum.

CONCLUSION

From the previously mentioned study, one can conclude that, the characteristic features of the plant are the following:

- 1- The plant is a large perennial tree with richly branched hard woody stem, young green branches and carries yellowish-white papilionaceous flowers.
- 2- The leaf is compound imparipinnate with 3 to 6 leaflets; the leaflet is orbicular with acuminate apex, entire margin and hairy surfaces.
- 3- The epidermis of the leaflet and rachis is formed of polygonal cells with paracytic stomata, thick smooth or striated cuticle and containing mucilage.
- 4- Numerous covering trichomes which are uniseriate multicellular with one to three short basal cells and a long terminal one and covered with warty cuticle.
- 5- Numerous small batches of perimedullary phloem are present above xylem region of the leaflet and petiole.

- 6- The pericycle of the leaflet, petiole, rachis and old stem is formed of fibres surrounded by crystal sheath, while that of young stem is collenchymatous.
- 7- The phloem of the old stem shows batches of lignified fibres surrounded by crystal sheath.
- 8- The cork cells of the old stem are polygonal with moderately thick suberized walls.

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الدراسة العيانية والمجهريّة لنبات *دالبرجيا سيسو* روكسب (السرسوع) المنزوع في مصر الجزء الأول : الأوراق والساق

ظه مصطفى سرح - عبد المنعم محمد عطيه - عفاف السيد عبد الغنى و فاء حسن بدر

قسم العقاقير - كلية الصيدلة - جامعة الزقازيق - مصر

سبق أن قام الباحثون بدراسة كيميائية لنبات *دالبرجيا سيسو* روكسب المشهور باسم السرسوع والمنزوع في مصر وقد أمكن فصل ثلاث مركبات استرولية وتريينية وثمانية مركبات أيزوفلافونية ومركب فلافوني، أيضا تمت الدراسة الفارماكولوجية وكمضاد للبكتريا، لذا فقد رؤى أن يتم دراسة الصفات العيانية والمجهريّة لهذا النبات حتى يسهل التعرف عليه سواء في حالته الصحيحة أو على هيئة مسحوق، تتضمن هذه الدراسة الفحص العياني والمجهري لأوراق وساق هذا النبات.