



MACRO- AND MICROMORPHOLOGY OF THE LEAF, STEM, STEM BARK AND FRUIT OF *FAIDHERBIA ALBIDA* (DEL.) A. CHEV. CULTIVATED IN EGYPT

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*The trees of *Faidherbia albida* Del. are indigenous to Africa and considered a prominent feature in the flora of Nile valley and the Eastern Desert. They are known as Apple-ring trees because the pods tend to roll in to a spirals resembling dried apple peel. It is employed traditionally to treat disorders such as fever, diarrhoea, urticaria, vomiting, cough, rheumatism and haemorrhage. To our knowledge, few morphological and microscopical studies were traced concerning the plant¹, so this study aims for characterization and identification of this plant in both entire and powdered forms.*

INTRODUCTION

Acacia (Mill.) is the largest genus in the Leguminosae - Mimosoideae with approximately 1300 species distributed mainly in tropical and subtropical regions. *Acacia* trees are known as thorn trees; this is due to that the plants often bear spines, especially the species growing in arid regions^{2&3}.

It is represented in Egypt by ten species; which are widely distributed in various phytogeographical regions of Egypt, where they are immensely useful as sources of food, fodder, fire-wood and as a source of natural products such as gum exudates³.

Acacia sp. have many purposes as being valuable wood for industries, decorations, sources for gum, tannin, perfumes, ink, protein, paint and to prepare disinfectant for micro-organisms and hand washes⁴.

The universally accepted concept of *Acacia* is based on the absence of conspicuous glands on leaf-rachis and the presence of apical stalked glands on anthers. This concept led to segregate *Acacia albida* Delile into a new mono-specific genus *Faidherbia albida*. Chev.³.

The trees of *Acacia albida* Delile are indigenous to Africa, where they are widely

distributed in Senegal and Gambia⁵. In Egypt, they are considered a prominent feature in the flora of Nile valley and the Eastern Desert³.

They are known as Apple-ring trees because the pods tend to roll in to a spirals resembling dried apple peel. The word "albida" means somewhat whitish, referring to the color of the stem⁵.

It is employed traditionally to treat disorders such as fever, diarrhoea, urticaria, vomiting, cough, rheumatism and haemorrhage^{6&3}. Also it can be used in treating certain skin infections⁷.

The bark of *Acacia albida* used as ingredient in many medicinal remedies in folk medicine as^{8,9&10}.

- 1- Remedy for diarrhea among several tribes.
- 2- The bark decoction curtails nausea and for the management of the sleeping sickness and treatment of malaria.
- 3- A liniment, made by steeping the bark, is used for bathing and massage in pneumonia.
- 4- The bark infusion is used for difficult delivery.

Habitat

Faidherbia albida (Del.) A. Chev. is a large thorny tree up to 20 m in height. The bark

is nearly white on young shoots while it is dull grey and fissured when old. The tree puts out leaves during dry season and sheds them during rains. Leaves are typical of the Mimosoideae which are compound and bipinnate, paripinnate, with leaflets (pinnae) borne along the rachis. There are thorns present in pairs at the base of the leaves. The flowering season is from March to September, followed by the fruiting one from September to December. The inflorescence consists of scented and pale yellow elongated spike, about 10-12.5 cm long. Flowers are bisexual, pentamerous, sessile or with a pedicel up to 2 mm long; calyx is up to 2 mm long and petals are up to 3.5 mm long. Stamens are numerous (usually 40-50), 4-6 mm long and ovary is superior. The fruit is orange to red-brown in colour, non-splitting and has curved to twisted ends rounded pod, about 4-10 cm long. The seeds are anatropous dark brown with shiny surface. It is oval in shape, laterally compressed, measuring 6-8 mm in length, 4-5 mm in width and about 2.5-3 mm in thickness^{5&11-13}.

MATERIALS AND METHODS

The plant materials used in this study are the separated fresh and dry organs (leaves, fruits and stem barks) of *Faidherbia albida*. It was collected during the fruiting stage in the period of September to December 2013 from the fields of Kom-ombo garden of medicinal plant, Aswan, Egypt. The plant was kindly identified and authenticated by Prof. Dr. kotb Amer. Botany Department, Faculty of Science, Assiut University.

Fresh materials of the separate organs (leaves, fruits, stems and stem barks) of *Faidherbia albida* (Del.) A. Chev. as well as samples preserved in a mixture of alcohol (70%) - glycerin - water (1:1:1). The different plant organs were air-dried and separately reduced to powder of suitable particle size for microscopical examination.

RESULTS AND DISCUSSION

1- The leaf

A- Macromorphology

The leaves (Fig. 1) are compound bipinnate, pari-pinnate, alternate, stipulate and of about 10 cm long. They carry 3-12 pairs of leaflets (pinnae) which are 1.2-5.5 cm long,

oppositely arranged on the primary rachis and subdivided into 6-18 pairs of pinnula. Thorns occur in pairs at the base of the leaves and are modified, spiny stipules. They are 1- 2 cm in length, straight, thickened at the base and often orange to brown at the tip¹⁴. Both the primary and secondary rachises of the leaves are almost cylindrical, hairy and green in colour. The primary rachis measures 2-5-10 cm in length while the secondary rachis measures 1.2-3-5.5 cm in length. Each pinnula measures 1-3-6 mm in length and 1-2-3 mm in width. Pinnules are green in colour, the upper surface is darker than the lower one. They are hairy, shortly petiolated with oblong lamina, entire margin, mucronate apex except the basal pairs which are mostly rounded. They have symmetric oblique bases, the midrib isn't prominent and divides the lamina into two unequal halves. The pinnula has a faint odour and a slightly disagreeable taste. The petiole is cylindrical to subcylindrical, greenish in colour, hairy and measures 0.5-0.7-1 cm in length and 1-1.5-2 mm in diameter¹⁴⁻¹⁷.

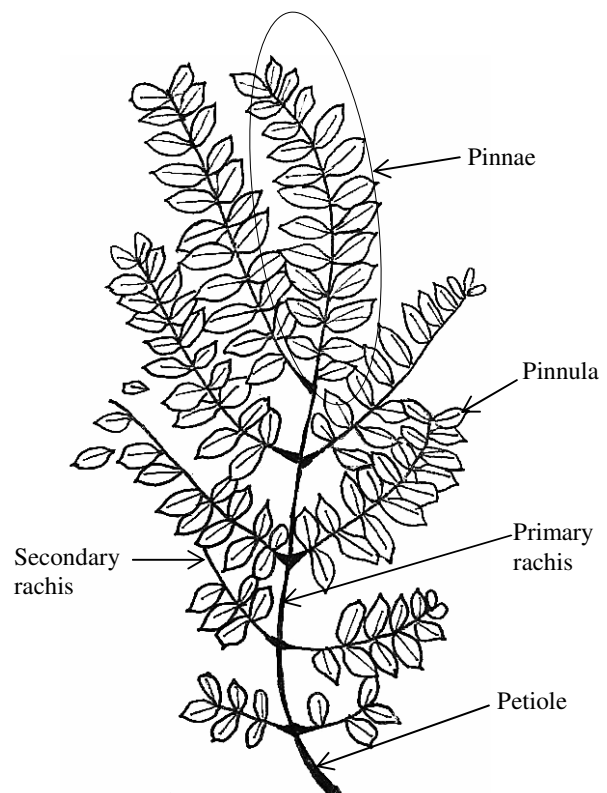


Fig. 1: Macromorphology of the leaf
x 1.625

B- Micromorphology

This study includes micromorphology of the following:

- 1- The petiole.
- 2- The pinnula.
- 3- The leaf base.
- 4- The rachis of the leaf (primary rachis).
- 5- The rachis of the pinnae (secondary rachis).

1- Micromorphology of the petiole

A transverse section in the petiole (Fig. 2) appears more or less concavo-convex in outline and prominent in the lower surface with two upper ridges. It has an outer epidermis, carrying both glandular and non-glandular hairs, followed by 3-5 rows of chlorenchymatous cells which are continuous in the upper surface only. The chlorenchymatous layer is followed by parenchymatous cortex which has scattered chlorenchymatous cells. The endodermis is indistinguishable. The vascular system is formed of a ring of vascular tissue showing xylem and phloem. It is opened in the adaxial side and laterally and is surrounded by a circle of pericyclic fibers some of parenchyma cells surrounding pericyclic fibers contain prisms of calcium oxalate. The phloem region has few scattered tannin cells that give blue colour with FeCl_3 . There are two small additional inverted bi-collateral vascular bundles under the upper ridges which have small arcs of pericyclic fibers at their upper sides. Microscopical measurements of the petiole are listed in table 1.

The outer epidermis

The epidermis (Fig. 3) is formed of one row of square to sub-rectangular cells, while in surface view (Fig. 2), they appear polygonal, usually elongated, iso-diametric with straight anticlinal walls. The cells are covered with thick smooth cuticle. It usually carries paracytic stomata that is obscured by transverse or oblique secondary division of subsidiary cells.

The epidermal cells mostly carry non-glandular hairs and few glandular ones. The non-glandular hairs are uni-cellular, erect or curved having thick walls, wide to narrow lumen and are covered with warty cuticle.

The glandular hairs have uni-cellular, bi-cellular or multi-cellular (5-10 cells) uniseriate

stalks and multicellular globular heads (7-11 cells).

The cortical tissue

The cortical tissue (Fig. 3) is formed of 3-5 layers of chlorenchymatous cells which contain chloroplasts. It is not continuous in the lower side. It is followed by a paryrenchymatous cortex, formed of 2-7 layers and contains scattered chlorenchyma cells. The cells are usually rounded with wide intercellular spaces. Throughout this layer there are some cells contain prisms of calcium oxalate others contain starch granules which are mainly simple, circular with indistinct hilum or striation.

The vascular system

The vascular system (Fig. 3) is represented by a ring of collateral vascular tissue showing xylem and phloem which is open in the adaxial side and laterally. It is surrounded by a circle of pericyclic fibers. The xylem region consists of lignified vessels regularly arranged in radial rows, wood fibers and wood parenchyma. The xylem vessels (Fig. 6) show spiral and annular thickenings. The wood fibers (Fig. 6) are elongated with thin lignified walls, wide lumen and blunt ends. The wood parenchyma are rectangular to sub-rectangular in shape. The vessels are transversed by uni- to bi-seriate polygonal to sub-rectangular non-lignified medullary rays.

The phloem (Fig. 3) consists of several rows of small thin-walled cellulosic elements which consist of sieve tubes, companion cells and phloem parenchyma. There are few scattered tannin cells throughout the phloem parenchyma that gives blue colour with FeCl_3 .

The cambium is formed of a little cambiform tissue (2-3 layers) between xylem and phloem.

The pericyclic fibers (Fig. 6) are formed of 3-5 layers surrounding the central steel. There are two types of fibers; the first type has a lignified, moderately thick pitted wall, wide lumen, blunt or pointed apices. The fibers are surrounded by parenchyma containing prisms of calcium oxalate forming crystal sheath. The second type has a lignified, thin walls and a very wide lumen which becomes narrow in the pointed ends (balloon-like fibers). The endodermis is indistinguishable.

Table 1: Microscopical measurements of the pinnula and petiole of *Faidherbia albida* (Del.) A. Chev. (in microns).

Item	Length	Width	Diameter	Height
Pinnula				
Upper epidermis	15-30-45	13-20-25		12-19-24
Lower epidermis	15-30-45	13-20-25		12-19-24
Prisms	18-30-37	15-16-17		
Starch			3.8-4-4.7	
Stomata	30-31-37		21-24-27	
Palisade cells	42-48-52	14-16-17		
Parenchyma			34-36-39	
Xylem vessels			19-22-25	
Petiole				
Epidermis	14-28-42	12-18-26		11-17-21
Stomata	29-30-32	24-26-27		
Non. Glandular Hair	130-180-241	16-20-25		
Glandular hair head	58-85-138	49-70-94		
Glandular hair stalk	44-80-100	15-15.8-16		
Prisms	18-32-36	17.5-18-19		
Starch			3.1-3.3-4	
Xylem vessels			16-25-34	
Wood fibers				
Chlorenchyma			18-21-33	
Pericyclic fibers	450-668-975		6-20-33	

200 μm

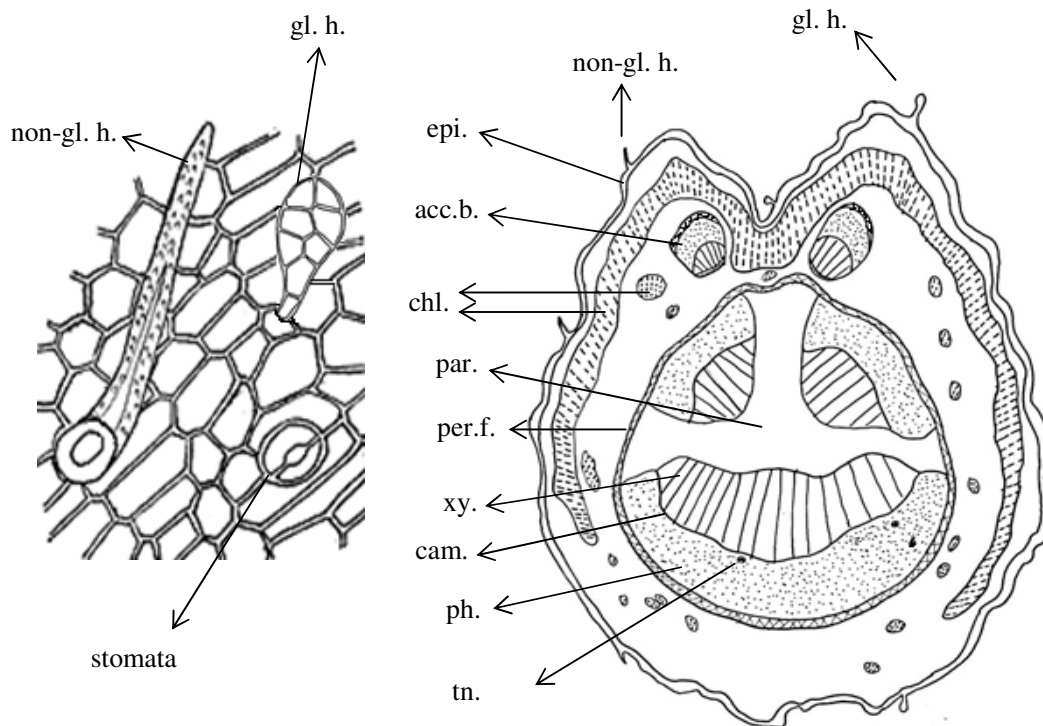


Fig. 2: A) The epidermis of the petiole.
 B) The diagrammatic T.S. in the petiole.

acc.b., accessory bundles; cam., cambium; chl., chlorenchyma; epi., epidermis; gl.h., glandular hair; non-gl. h., non-glandular hair; par., parenchyma; per.f., pericyclic fiber; ph., phloem; tn., tannin cell; xy., xylem.

20 μ m

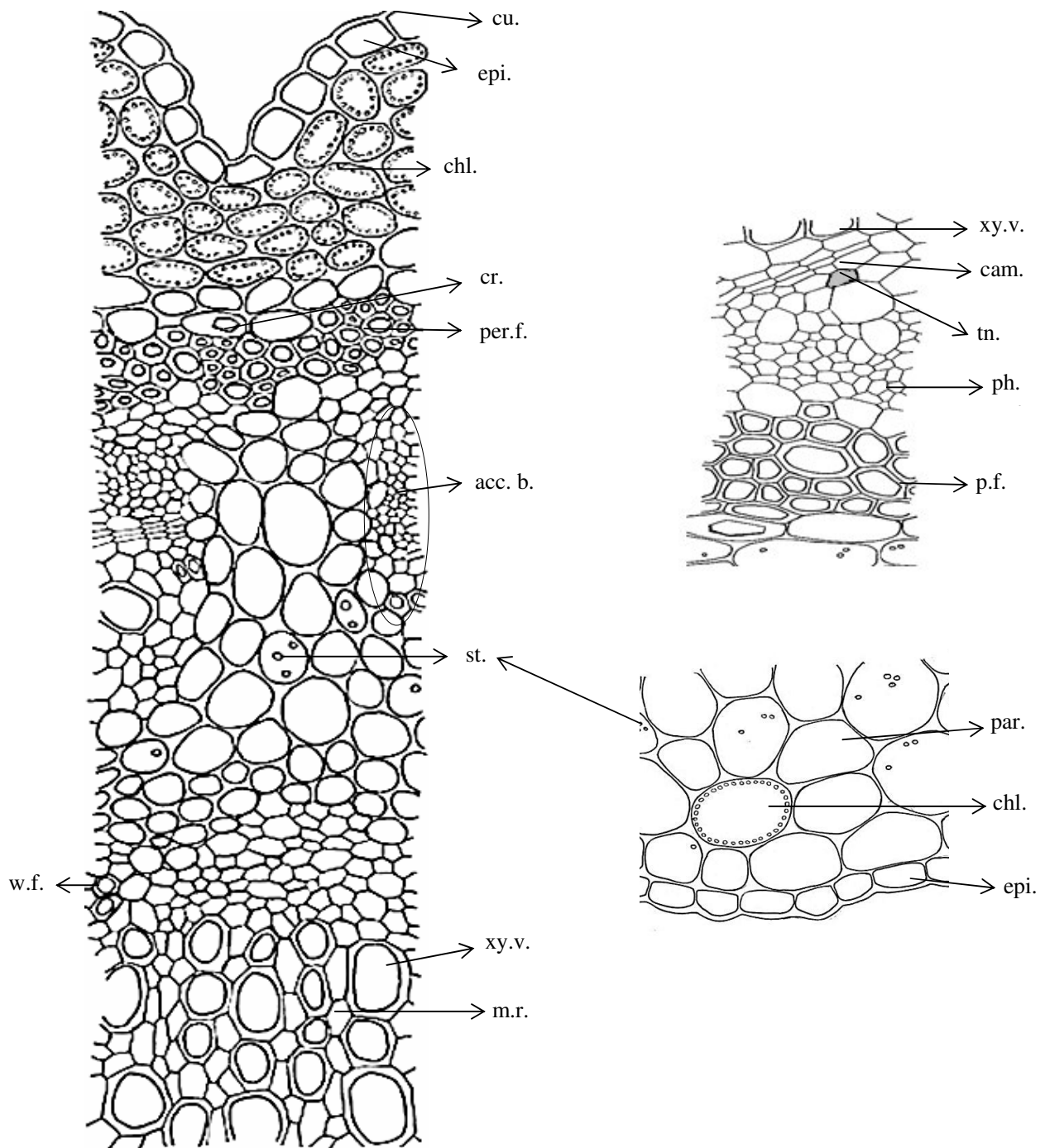


Fig. 3: The detailed T.S. in the petiole.

acc.b., accessory bundles; cam., cambium; chl., chlorenchyma; cr., prism of calcium oxalate; cu., cuticle; epi., epidermis; end., endodermis; m.r., medullary rays; par., parenchyma; per.f., pericyclic fibers; ph., phloem; st., starch; tn., tannin cell; w.f., wood fiber; xy.v., xylem vessel.

The vascular bundle is accompanied by two small additional inverted bi-collateral vascular bundles under the upper ridges which have small arcs of pericyclic fibers towards the upper side.

2- Micromorphology of the pinnula

The transverse section in the pinnula (Fig. 4A), appears more or less straight on both surfaces, sometimes the lower surface is slightly concave.

The pinnula has an isobilateral structure with two rows of palisade cells underlying the upper epidermis and one or two rows of palisade cells underlying the lower epidermis. Both the upper and lower epidermies are formed of one row of square to sub-rectangular. While in surface view (Fig. 4B and 4C) they are polygonal having straight anticlinal walls and covered with thick smooth cuticle. Hairs (Fig. 4B and 4C) and stomata are similar to those of the petiole.

The midrib region shows a main eccentric vascular bundle consisting of a radiating upper xylem and lower soft phloem. There are pericyclic fiber arcs above xylem and below phloem, some of which are surrounded by parenchyma cells containing prisms of calcium oxalate forming crystal sheath. The endodermis is formed of thin walled cellulosic parenchyma containing starch granules. Microscopical measurements of the pinnula and petiole are listed in table 1.

3- Micromorphology of the leaf base

The transverse section (Fig. 5), is rounded in outline. It has an outer epidermis, wide parenchymatous cortex and central steel, which consists of lateral phloem and central xylem with no pericyclic fibers.

4- Micromorphology of the rachis of the leaf (primary rachis)

The transverse section (Fig. 5), is similar to that of the petiole but differs in that the main vascular bundle is opened at the lateral side only and enclosing two small additional vascular bundles in its center. Also, there is one more small additional vascular bundle under each of the upper ridges.

5- Micromorphology of the rachis of the pinnae (secondary rachis)

The transverse section (Fig. 5), is similar to the rachis of the leaf but smaller in size, and contains a continuous main vascular bundle enclosing only one small additional vascular bundle in its center.

The powdered pinnula and petiole

The powdered pinnula and petiole (Fig. 6) is green in colour, with faint odour and is agreeable taste. It is characterized microscopically by the following features:

- 1- Fragments of both upper and lower epidermis of the pinnula showing polygonal cells with straight anticlinal walls and covered with thick smooth cuticle. Numerous paracytic type of stomata and occasionally anisocytic type were observed.
- 2- Fragments of parenchyma cells containing oval starch granules with indistinct hilum or striation.
- 3- Scattered prisms of calcium oxalate.
- 4- Palisade cells which are radially elongated columnar cells containing chloroplasts.
- 5- Fragments of pericyclic fibers with moderately thick, pitted, lignified walls, wide lumen and blunt or pointed apices surrounded by parenchyma cells containing prisms of calcium oxalate forming crystal sheath.
- 6- Fragments of lignified xylem vessels mainly of spiral and annular thickenings.
- 7- Fragments of epidermal cell of the petiole showing polygonal cells with straight anticlinal walls and covered with thick smooth cuticle.
- 8- Glandular trichomes with multicellular glandular heads and uni-, bi- or multicellular uniseriate stalks.
- 9- Abundant non glandular trichomes which are erect or curved having thick walls narrow to wide lumina and covered with warty cuticle.
- 10- Fragments of wood fibers which are elongated with thin lignified walls, wide lumen and blunt apices.
- 11- Fragment of pericyclic fibers showing lignified, thin walls and a very wide lumen which becomes comparatively narrow in the pointed ends (ballon-like fibers).

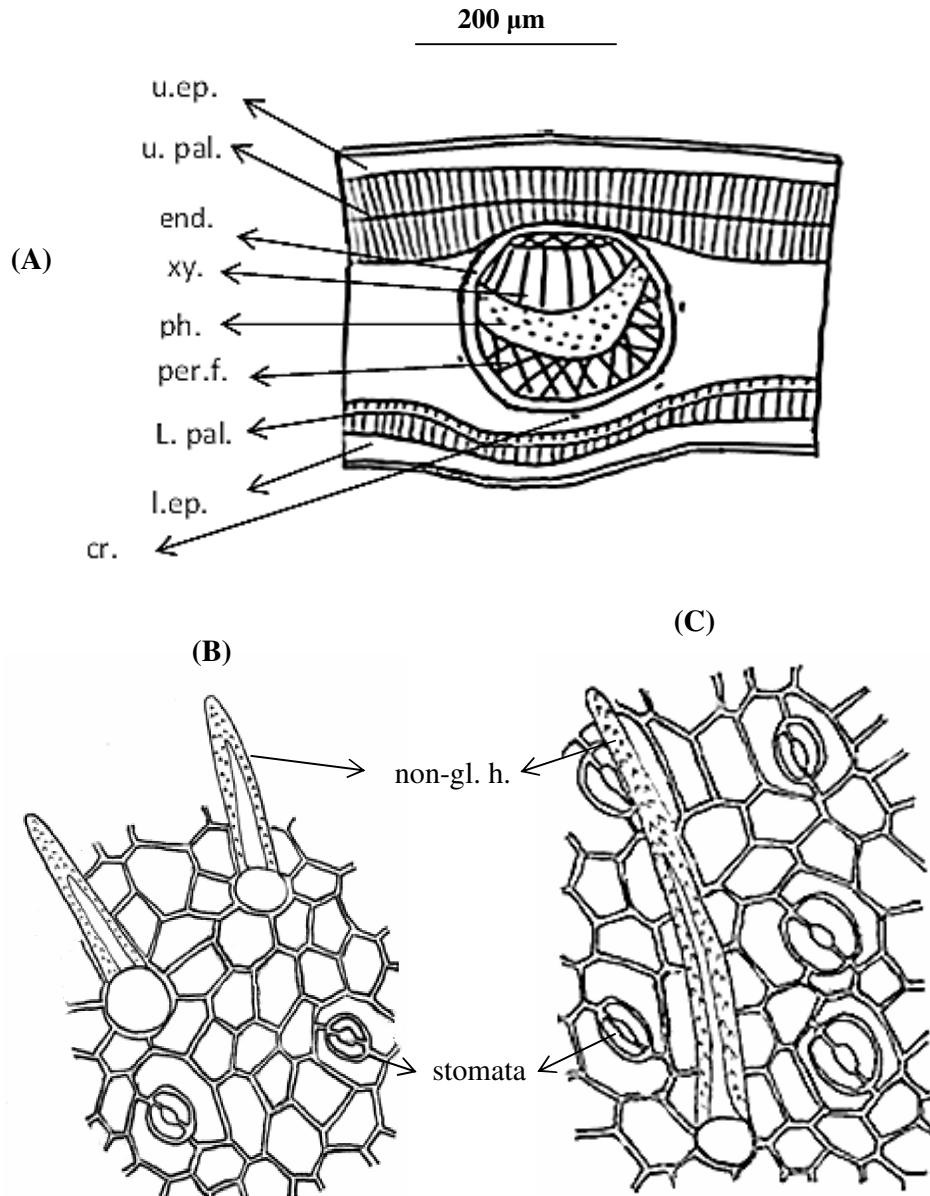


Fig. 4:

A) The diagrammatic T.S. of the leaf.

B) The upper epidermis of the leaf.

C) The lower epidermis of the leaf.

cr., prism of calcium oxalate; end., endodermis; l.ep., lower epidermis; l.pal., lower palisade; non-gl. h., non-glandular hair; per.f., pericyclic fibers; ph., phloem; u.ep., upper epidermis; u. pal., upper palisade cells; xy., xylem.

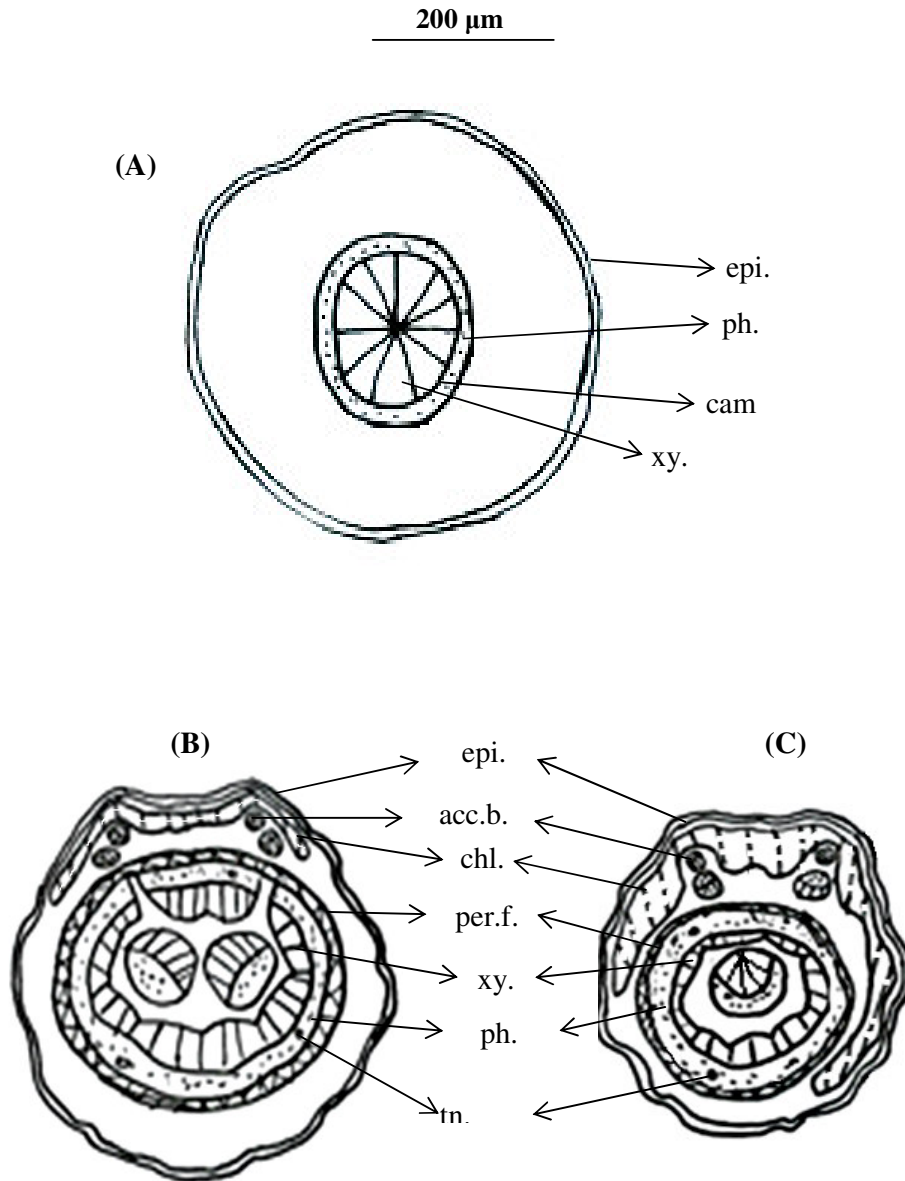


Fig. 5:

- A) The diagrammatic T.S. of the leaf base.
- B) The diagrammatic T.S. of the rachis of the pinnae.
- C) The diagrammatic T.S. of the rachis of the leaf.

acc.b., accessory bundles; cam., cambium; chl., chlorenchyma; epi., epidermis; per.f., pericyclic fiber; ph., phloem; tn., tannin cell; xy., xylem.

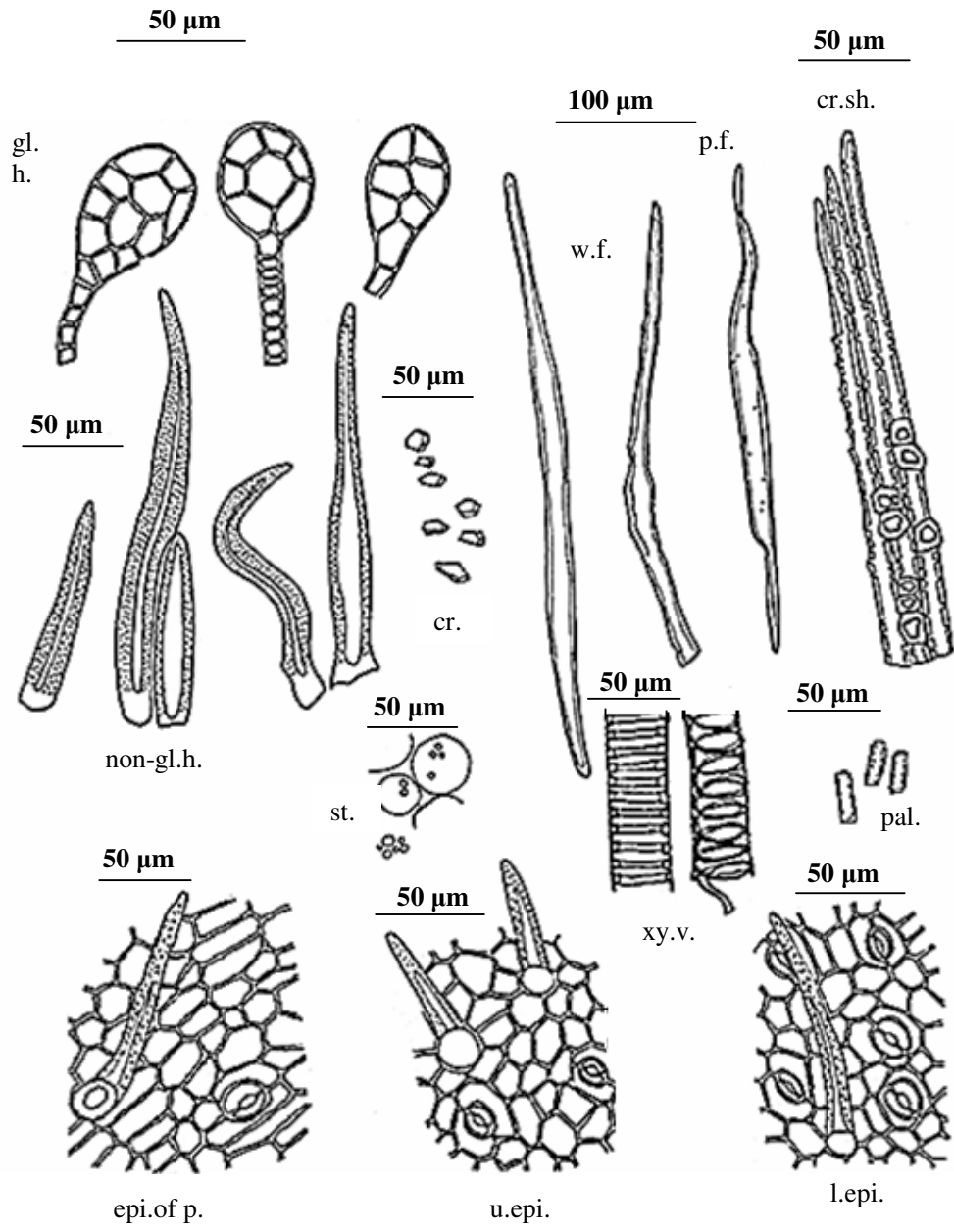


Fig. 6: Elements of the powdered pinnula and petiole.

cr., prisms of calcium oxalate; cr.sh., crystal sheath; epi.of p., epidermis of the petiole; gl.h., glandular hair; l.epi., lower epidermis; non-gl.h., non-glandular hair; pal., palisade cells; per.f., pericyclic fibers; st., starch granules; u.epi., upper epidermis; w.f., wood fibers; xy.v., xylem vessels.

2- The stem

A- Macromorphology (Fig. 7)

The stem of the plant is erect, suffruticose, rounded and monopodially branched with internodes that become short near the top. It has spines in pairs at the base of the leaves. The young part has smooth surface which is greenish grey to whitish grey in colour while the old one has a rough surface covered with brownish cork. It breaks with short fracture. It has faint odour and is tasteless.



Fig. 7:
Macromorphology
of the stem x 2

B- Micromorphology (Figs. 8B and 9)

The transverse section in both young and old stems (Figs. 8B, 10B and 11), appear more or less circular in outline. The young stem shows an outer epidermis followed by a parenchymatous cortex which contains prisms of calcium oxalate and starch granules. The endodermis is indistinguishable. The pericycle is formed of a complete ring of fibers (3-4 layers) followed by 3-4 layers of parenchyma cells surrounding the central vascular cylinder. Some of the parenchyma cells surrounding fibers contain prisms of calcium oxalate forming crystal sheath. The vascular system consists of open vascular bundle arranged in a ring surrounding a central wide pith.

The old stem shows a cork followed by a narrow parenchymatous phelloderm. The pericycle consists of arcs of fibers alternating with groups of sclerides. A collateral vascular

bundle of secondary phloem and xylem surrounding wide central pith. Microscopical measurements of young and old stem are listed in table 2.

A- Young stem

The epidermis

The epidermis in the transverse section (Figs. 8A and 9) is formed of one row of square to sub-rectangular cells. In surface view (Fig. 8A), the cells are axially elongated with straight anticlinal walls. They are covered with smooth cuticle. No hairs or stomata are observed.

The cortex

The cortex (Fig. 9) is formed of 5-7 layers of parenchymatous cells decreasing gradually in size towards the center; some of them contain prisms of calcium oxalate others contain starch granules. The starch granules are mostly simple, spherical and with indistinct hilum or striation. The endodermis is indistinguishable.

The pericycle

The pericycle (Fig. 9) separates the central stele from the cortex. It consists of a complete ring of lignified fibers (3-4 layers) followed by 3-4 layers of parenchyma cells surrounding the central vascular cylinder. The fibers are of two types; the first type has moderately thick, lignified walls with wide lumen and blunt apex. They are surrounded by parenchyma cells which contain prisms of calcium oxalate forming crystal sheath. The second type has moderately thick lignified walls, narrow lumen with one or two balloon like enlargements near the ends whereas the lumen is very wide.

The vascular system

The vascular system (Fig. 9) consists of large collateral vascular strand. The phloem (Fig. 9) consists of thin-walled cellulosic elements mainly composed of sieve tubes, companion cells and phloem parenchyma. There are few scattered tannin cells throughout the phloem parenchyma that gives blue colour with FeCl_3 .

The cambium (Fig. 9) is formed of (6-8 rows) of thin-walled, sub-rectangular, tangentially elongated and radially arranged cellulosic cells.

Table 2: Microscopical measurements of young and old stems of *Faidherbia albida* (Del.) A. Chev. (in microns).

Item	Length	Width	Diameter	Height
Young stem				
Epidermal cells	9-15-25	7-10-19		6-8-10
Prisms	20-24-30	18-18.5-20		
Starch			3.1-3.5-4.2	
Parenchyma			15-24-38	
Pericyclic fibers	790-850-900	20-23-28		
Xylem vessels			11-18-30	
Medullary rays	20-29-33			
Old stem				
Cork cells	15-23-35	7-14-22		8-12-19
Phelloderm			13-25-29	
Parenchyma			16-34-48	
Prisms	12-15-16	6-9-11		
Xylem vessels			27-48-81	
Wood fibers	350-490-530		6-17-28	
Phloem fibers	785-800-810	10-14-18		
Pericyclic fibers	390-733-917		11-14-22	
Tracheids	300-370-416	24-26-27		
Sclerides	57-74-84	29-48-52		
Medullary rays	23-36-77	8-10-11		

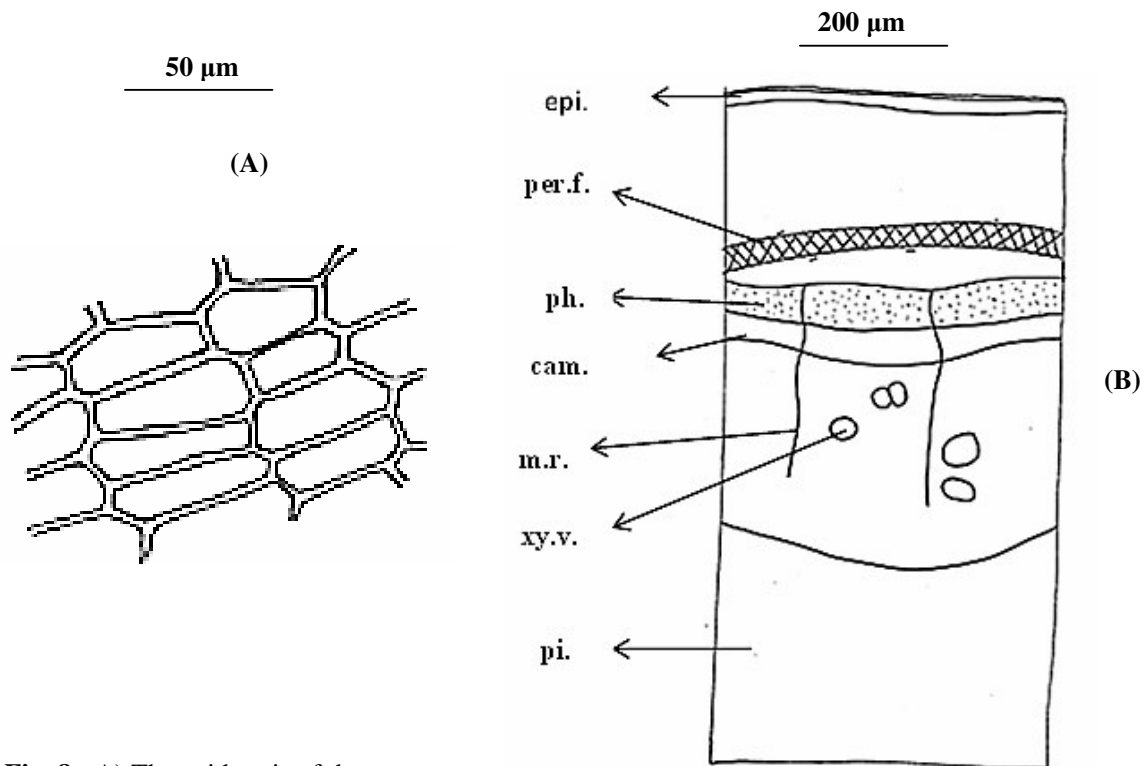


Fig. 8: A) The epidermis of the young stem.
B) The diagrammatic T.S. of the young stem.

epi., epidermis; cam., cambium; par., parenchyma; per., pericycle; per.f., pericyclic fibers; ph., phloem; pi., pith; m.r., medullary rays; xy.v., xylem vessels.

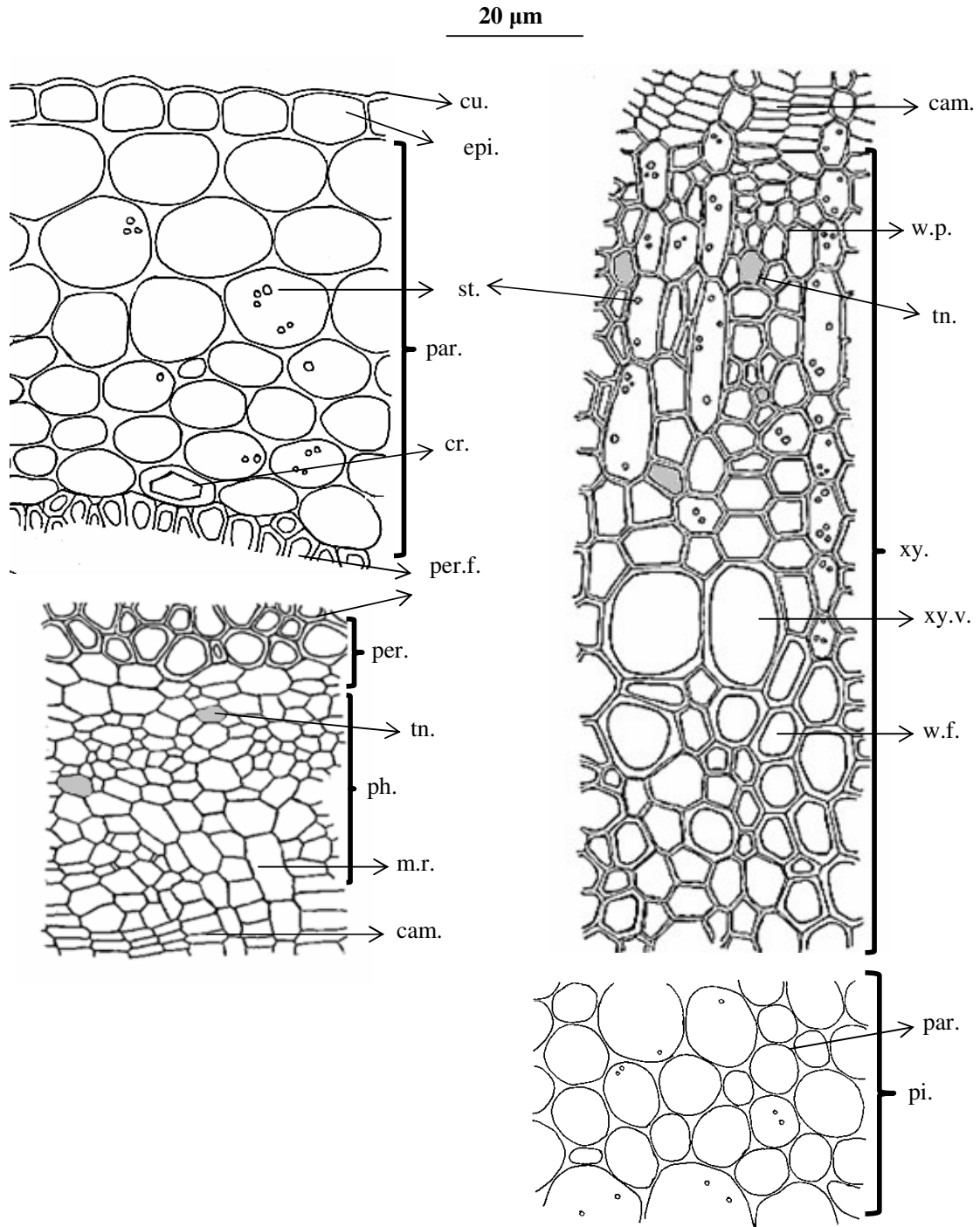


Fig. 9: The detailed T.S. of the young stem.

epi., epidermis; cam., cambium; cr., prism of calcium oxalate; cu., cuticle; m.r., medullary rays; par., parenchyma; per., pericycle; per.f., pericyclic fibers; ph., phloem; pi., pith; st., starch; w.f., wood fibers; w.p., wood parenchyma; xy., xylem; xy.v., xylem vessel.

The xylem region (Fig. 9) consists of lignified elements including xylem vessels, wood fibers and wood parenchyma. The vessels may be solitary or multiples of 2-5. They are arranged in radial rows showing spiral, annular and pitted thickenings. The wood fibers (Fig. 9) are elongated with thin lignified walls, wide lumen and blunt ends. The wood parenchyma are rectangular to sub-rectangular in shape, some of them contain starch granules similar to that of the cortex. There are few scattered tannin cells throughout the parenchyma that gives blue colour with FeCl_3 .

The medullary rays are usually uni-seriate formed of radially elongated sub-rectangular cells with moderately thin; lignified walls contain starch granules in the xylem region, while in the phloem region they appear as thin walled cellulosic cells.

The pith

The pith (Fig. 9) consists of a wide central zone of rounded parenchymatous cells some of them contain starch granules similar to that of the cortex.

B- Old stem

The cork

The cork in transverse section (Fig. 11) consists of few rows (3-5) of sub-rectangular tangentially elongated and radially arranged cells, arising lately in old stem in the inner part of cortex. In surface view (Fig. 10A), they appear polygonal usually iso-diametric cells containing a dark brown content which gives dark green colour with FeCl_3 .

The phellogen (cork cambium)

One row of thin-walled cellulosic sub-rectangular tangentially elongated and radially arranged cells.

The phelloderm (secondary cortex)

The phelloderm (Fig. 11) is narrow of 4-6 layers of parenchymatous cells some of them contain starch granules which are oval with indistinct hilum and striations.

The endodermis

The endodermis is indistinguishable.

The vascular system

The central stele (Fig. 11) is formed of a continuous ring of vascular tissue separated mainly by uni-seriate, bi-seriate or tri-seriate

medullary rays surrounded by a continuous ring of pericyclic fibers alternating with sclereides.

The pericycle is formed of a nearly continuous ring of fibers alternating with sclereides. Some of parenchyma cells surrounding them contain prisms of calcium oxalate. The fibers (Fig. 12) are similar to those of young stem. The sclereids (Figs. 11 and 12) are densely packed of various sizes and shapes; with wide lumen and thick, pitted and lignified walls.

The phloem (Fig. 11) is formed of complete ring of secondary phloem surrounding the xylem and accompanied by compressed groups of primary phloem elements at the periphery. The secondary phloem consists of thin-walled soft cellulosic elements of sieve tubes, companion cells, phloem parenchyma and phloem fibers. Some of the phloem parenchyma near fibers contains prism of calcium oxalates. The phloem fibers have moderately thick, lignified walls, narrow lumen and acute ends. There are few scattered tannin cells throughout the phloem parenchyma that gives blue colour with FeCl_3 .

The cambial zone (Fig. 11) is formed of 6-8 rows of thin-walled cellulosic sub-rectangular tangentially elongated and radially arranged cells.

The xylem (Fig. 11) is formed of wide zone of lignified radiating elements of large vessels, wood fibers, tracheids, and wood parenchyma. The wood fibers (8-10 layers) form alternating bands with parenchyma and vessels. Vessels may be solitary or multiples of 2-5. They have thick walls with spiral, annular and pitted thickenings (Fig. 12). There are few scattered tannin cells throughout the parenchyma that gives blue colour with FeCl_3 .

Wood fibers have moderately thick walls with wide lumen and acute tapering ends (Fig. 12).

The medullary rays are usually uni- to tri-seriate formed of radially elongated sub-rectangular cells with moderately thin, lignified walls in the xylem region, while in the phloem region they appear as thin walled cellulosic cells.

The pith

The pith (Fig. 11) is wide, consisting of rounded to polygonal parenchymatous cells some of them containing starch granules similar to those of the cortex.

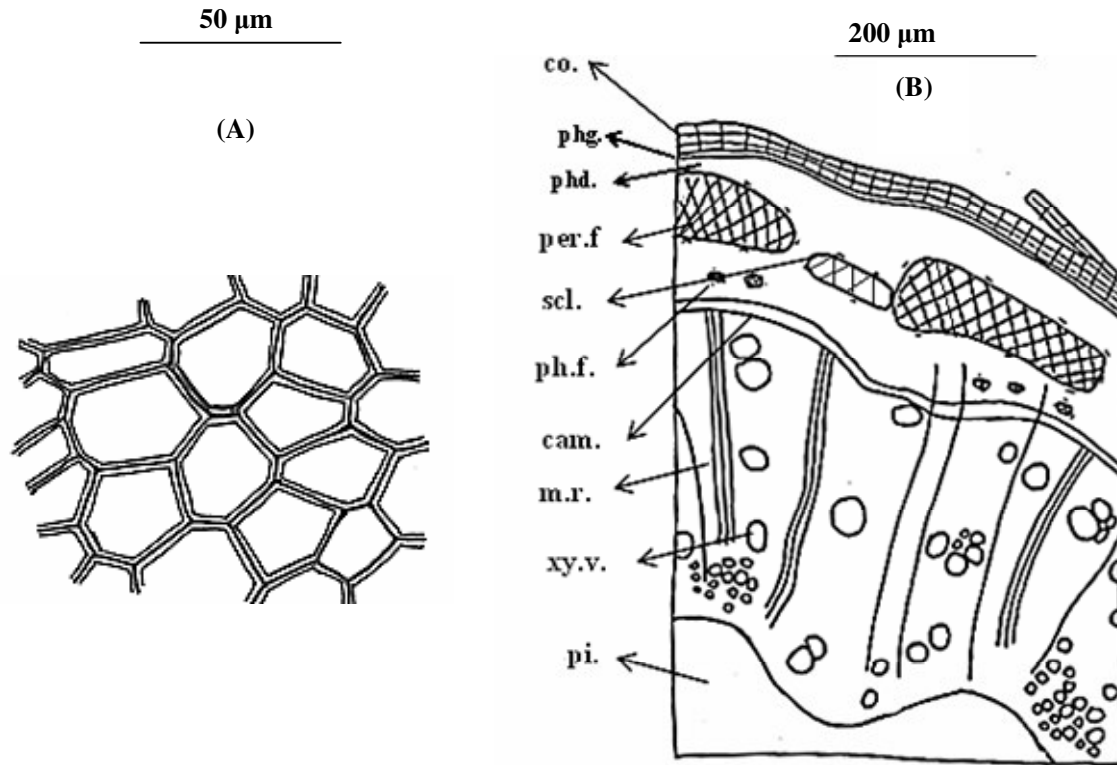


Fig. 10:

A) The cork of the old stem.

B) The diagrammatic T.S. of the old stem.

cam., cambium; co., cork; m.r., medullary rays; par., parenchyma; per.f., pericyclic fibers; phd., phelloderm; ph.f., phloem fibers; phg., phellogen; pi., pith; scl., sclerides; xy.v., xylem vessels.

20 μm

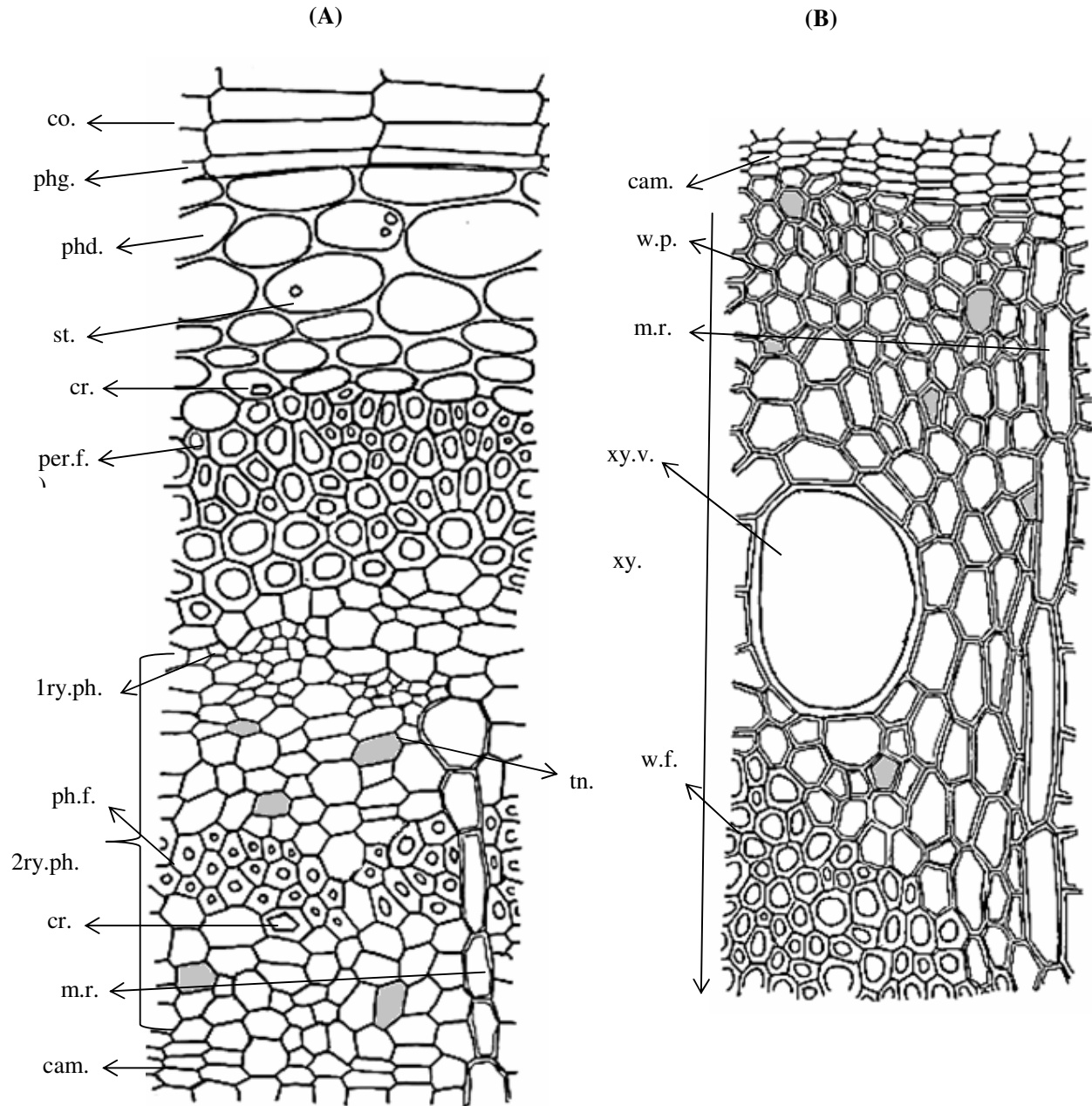


Fig. 11: A,B. The detailed T.S. of the old stem.

cam., cambium; co., cork; cr., prism of calcium oxalate; m.r., medullary rays; par., parenchyma; phd., phellogen; phg., phelogen; ph., phloem; ph.f., phloem fibers; per., pericycle; per.f., pericyclic fibers; pi., pith; scl., sclereids; st., starch; w.f., wood fibers; w.p., wood parenchyma; xy., xylem; xy.v., xylem vessel.

20 μm

(C)

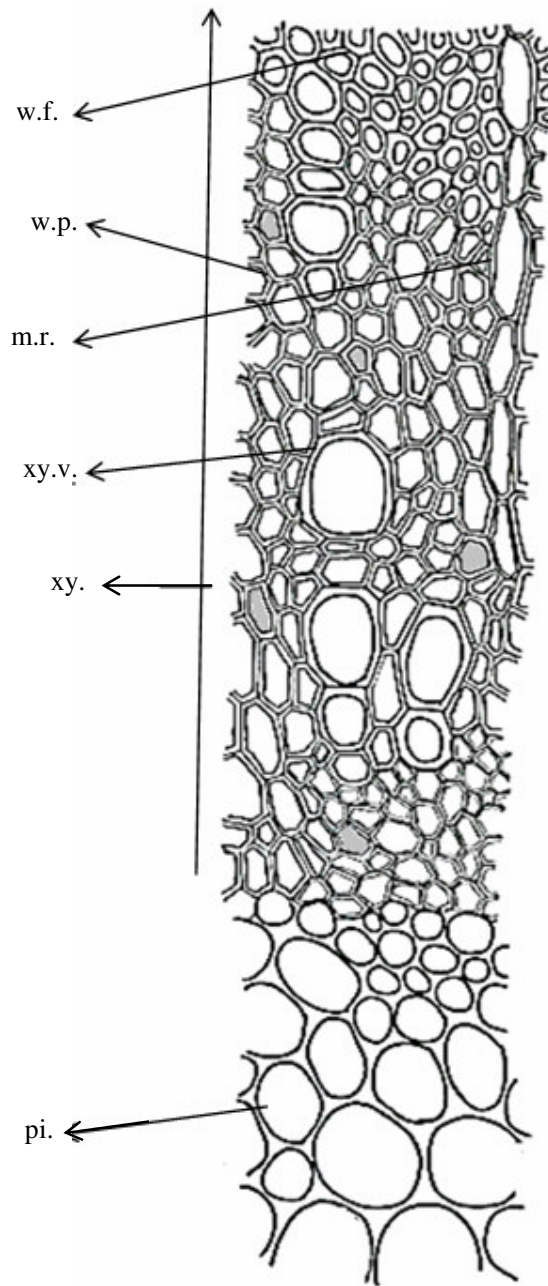


Fig. 11 Continued: C. The detailed T.S. of the old stem.

The powdered stem

The powdered stem (Fig. 12) is greyish green in colour with faint odour and tasteless. It is characterized microscopically by the following features:

- 1- Scattered prisms of calcium oxalate.
- 2- Fragments of polygonal to sub-rectangular epidermal cells of young stem having straight, moderately thick walls and covered with smooth cuticle.
- 3- Fragments of xylem vessels of spiral, annular and pitted lignifications.
- 4- Fragments of lignified, pitted tracheids.
- 5- Fragments of lignified elongated wood fibers which are lignified, with moderately wide lumen and acute tapering ends.
- 6- Scattered starch granules which are mostly simple and spherical with indistinct hilum or striation.
- 7- Fragments of pericyclic fibers has moderately thick, lignified walls with wide lumen and blunt apex. and form crystal sheath.
- 8- Fragments of pericyclic fibers has moderately thick walls, narrow lumen with one or two balloon like enlargements near the ends whereas the lumen is very wide.
- 9- Fragments of phloem fibers from the old stem which have moderately thick, lignified walls with narrow lumen and acute end.
- 10- Fragments of cork cells from the old stem which are polygonal usually iso-diametric cells containing dark brown contents.
- 11- Fragment of sclerides from the old stem of various sizes and shapes; with very wide lumen and thick, pitted and lignified walls surrounded by calcium oxalate prisms.
- 12- Fragment of wood parenchyma from the old stem with very wide lumen and thick, pitted and lignified walls.

3- The stem bark

A- Macromorphology (Fig. 13)

The inner surface of the bark has a reddish brown to yellowish brown colour and is longitudinally striated. The external surface is whitish grey to yellowish grey in colour and rough due to presence of wrinkles or fissures. Pieces of the bark are curved and some are channeled, about (7-10 cm) in length, (3-6 cm)

in width and (3-5 mm) in thickness. The fracture is short in the outer part and fibrous in the phloem region. The bark has a faint odour and tasteless¹⁴.

B- Micromorphology

The transverse section of the stem bark shows (Fig. 14), outer cork cells, which are arranged in radial and tangential rows followed by phellogen then a narrow parenchymatous phelloderm followed by wide primary cortex.

The pericycle is composed of groups of lignified sclereids alternating with the pericyclic fibers. The phloem is wide and traversed by medullary rays. Microscopical measurements of the stem bark are listed in table 3.

The cork

The cork region in transverse section (Fig. 15) is formed of 4-5 rows of radially arranged and tangentially elongated cells with thin walls. In top view (Fig. 16), they appear polygonal in shape, having thin anticlinal walls.

The phellogen

The phellogen (Fig. 15) consists of one row of thin-walled tangentially elongated and radially arranged cellulosic sub-rectangular cells.

The phelloderm

The phelloderm (Fig. 15) is formed of few rows (3-4) of tangentially elongated parenchymatous cells.

The primary cortex

The primary cortex (Fig. 15) is formed of several rows (18-21) of rounded parenchyma some of them contain starch granules and others contain prisms of calcium oxalate.

The pericycle

The pericycle is composed of alternating bands of pericyclic fibers and densely packed lignified sclereids. The pericyclic fibers (Fig. 16) have thickened, lignified walls and narrow lumen. The sclereids (Figs. 15 and 16) have different shapes and sizes. They may be polygonal or iso-diametric, having thick lignified pitted walls and moderately narrow to wide lumen. Some of parenchyma cells surrounding the fibers and sclerides contain prisms of calcium oxalate.

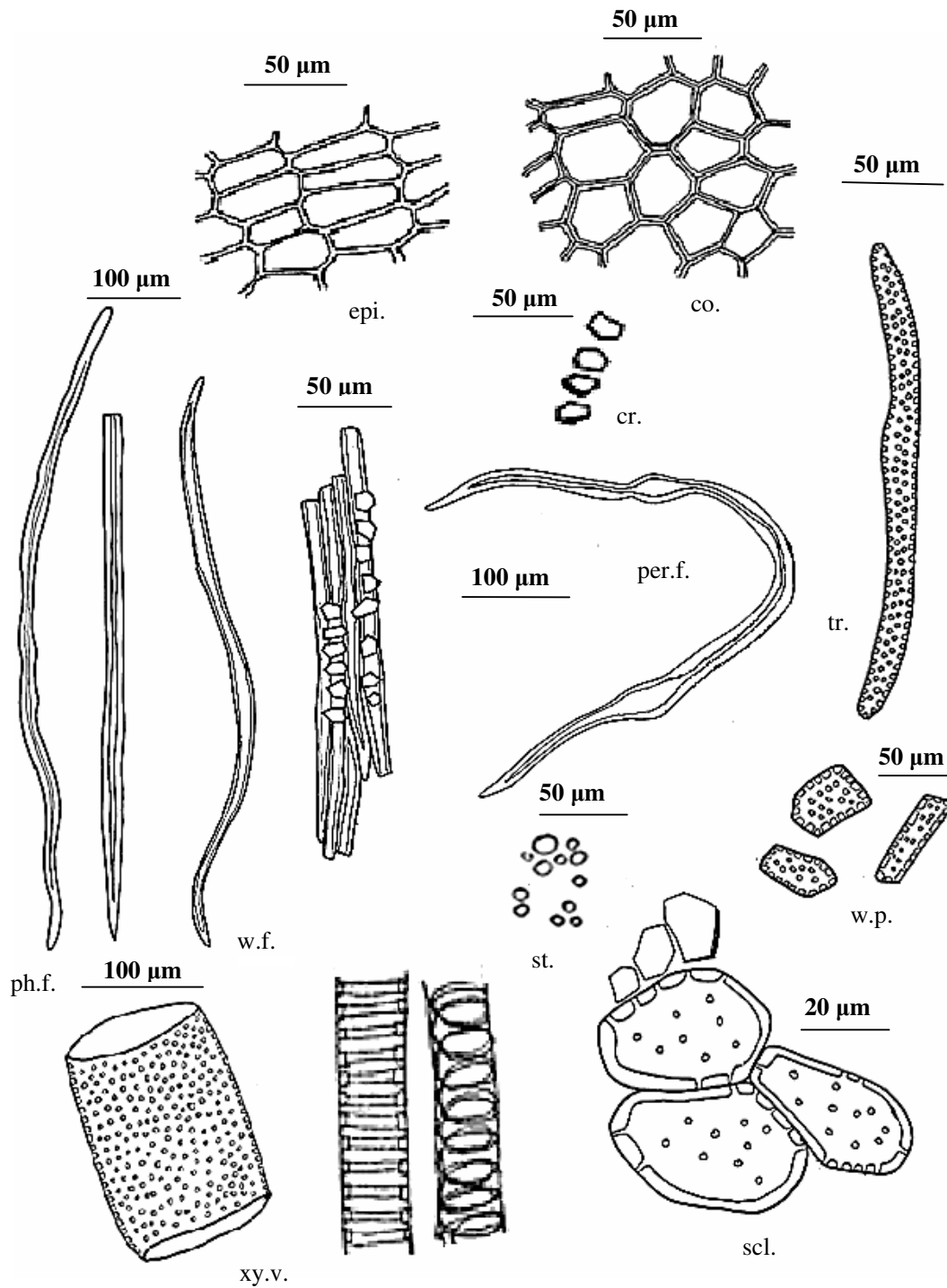


Fig. 12: Elements of the powdered stem.

co., cork; cr., prisms of calcium oxalate; cr.sh., crystal sheath; epi., epidermis; per.f. pericyclic fibers; ph.f., phloem fibers; scl. sclereids; st., starch; tr., tracheids; w.f., wood fibers; w.p., wood parenchyma; xy.v., xylem vessels.

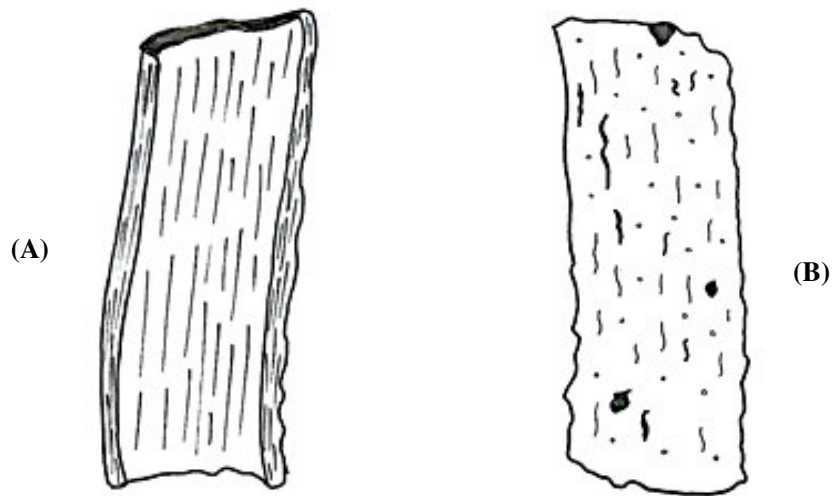


Fig. 13: x 1.677
 A) Macromorphology of the outer surface of the stem bark.
 B) Macromorphology of the inner surface of the stem bark.

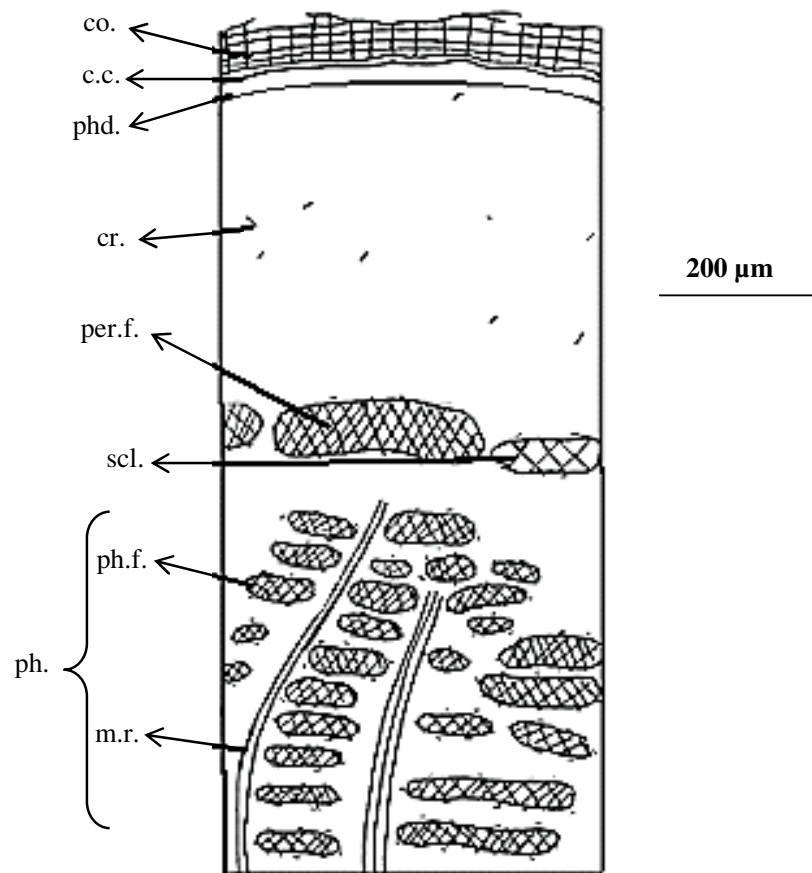


Fig. 14: The diagrammatic T.S of the stem bark.
 c.c., cork cambium; co., cork cells; cr., prisms of calcium oxalate; m.r., medullary rays; phd., phelloderm; ph., phloem; ph.f., phloem fiber; scl., sclereids.

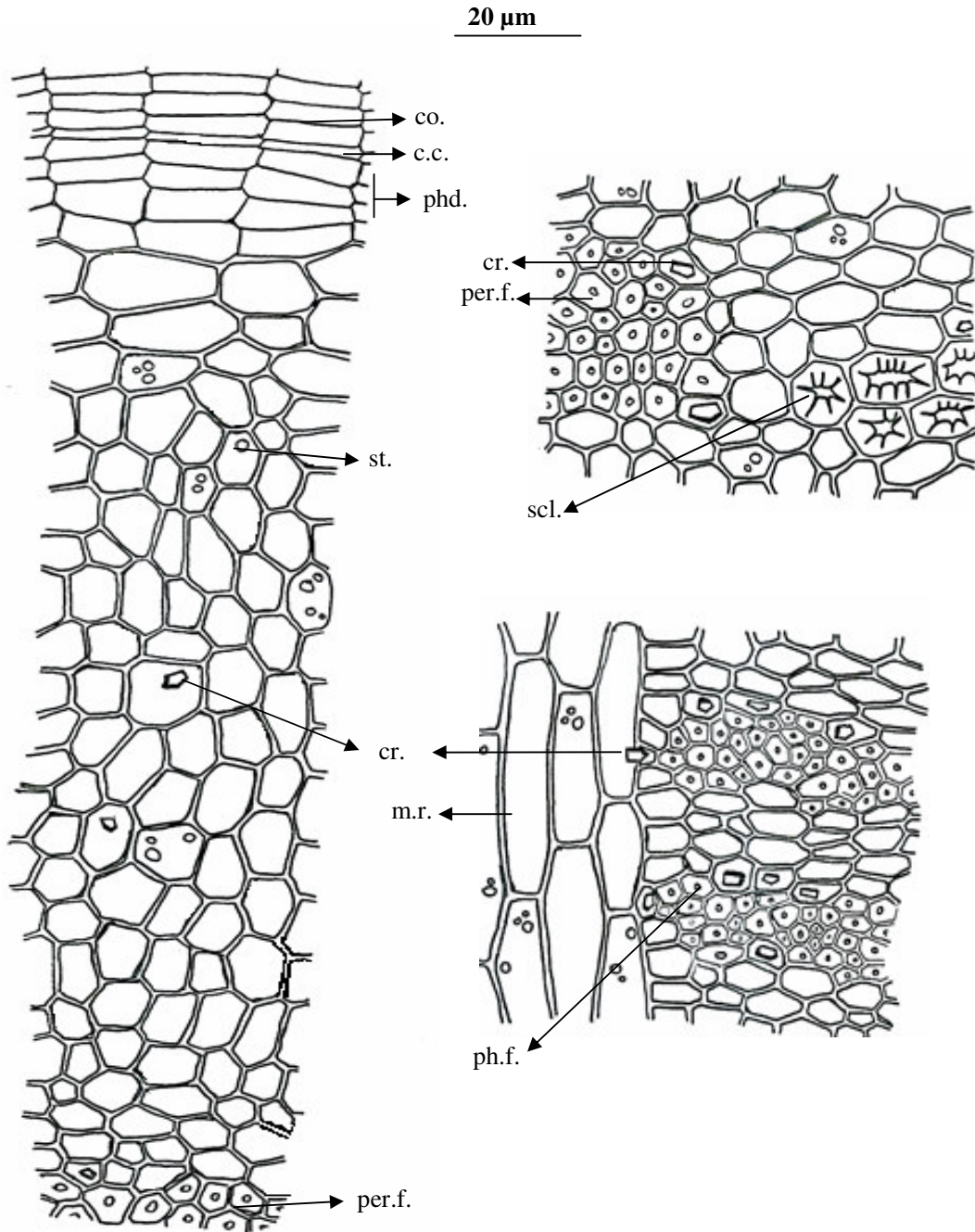


Fig. 15: The detailed T.S. in the stem bark.

c.c., cork cambium; co., cork cells; cr., prisms of calcium oxalate; m.r., medullary rays; per.f., pericyclic fiber; ph.f., phloem fiber; phd., phelloderm; scl., sclereids; st., starch granules.

Table 3: Microscopical measurements of the stem bark of *Faidherbia albida* (Del.) A. Chev. (in microns).

Item	Length	Width	Diameter	Height
Cork cells	13-17-29	11-18-26	10-13-16	
Pericyclic fiber	390-710-977		14-23-35	
Phloem fibers	310-416-533		9-20-25	
Sclerides	14-37-47	12-24-30		
Medullary rays	33-47-55	16-19-23		
Starch			3-7-10	
Prisms			4-9-14	

The phloem

The phloem (Fig. 15) is formed of sieve tubes, companion cells, phloem parenchyma and phloem fibers and traversed by medullary rays.

The phloem parenchyma are present in tangential bands alternating with sieve tubes and phloem fibers. Some of them contain prisms of calcium oxalate near the fibers.

The phloem fibers (Fig. 16) are present in groups. Each fiber has a thickened, lignified wall with one slightly dentate side and possesses narrow lumen.

The medullary rays are bi- to multi-seriate. They are somewhat tangentially elongated to sub-rectangular non-lignified thin-walled cells.

The powdered stem bark

The powdered stem bark (Fig. 16) has a reddish brown colour with faint characteristic odour and tasteless. It is characterized by the following features:

- 1- Fragments of cork cells which are polygonal with thin anticlinal walls.
- 2- Fragments of phloem fibers which are large, lignified, with thick walls, having narrow lumen, blunt ends and one slightly dentate side; either single or in groups surrounded by parenchyma containing prisms of calcium oxalate.
- 3- Scattered sclereids having different shapes and sizes. They may be polygonal or isodiametric. They have thick lignified pitted walls and narrow to wide lumen.
- 4- Scattered starch granules either free or in parenchyma cells.
- 5- Fragment of pericyclic fibers having thickened, lignified walls and possess narrow lumen.

- 6- Scattered prisms of calcium oxalate.

3- The fruit

A- Macromorphology (Fig. 17)

The fruit is indehiscent, shortly stalked (0.4-1.3 cm) pod, bright orange to yellow in colour, glabrous, twisted as the fleshy mesocarp lignifies and it tends to roll in to a spiral resembling dried apple peel, hence the common name "apple ring acacia". It measures 4-10 cm in length and 1.3-2 cm in width. It has a rounded apex and a rounded base with acute tip. The surface of the pods is prominently veined and shows elevated areas over the position of the seeds. Each pod contains 5-30 seeds with different stages of maturity. It has a characteristic odour and an aromatic slightly bitter taste.

The seeds are anatropous, dark brown with shiny surface. It is oval in shape, laterally compressed, measuring 6-8 mm in length, 4-5 mm in width and about 2.5-3 mm in thickness.

The seed coat is tough, water-proof and leathery. Hilum and micropyl are present in a shallow depression at the top of the seed^{14&15}.

B- Micromorphology

A) The pericarp

A transverse section (Figs. 18 and 19), in the pericarp shows an outer epicarp and an inner endocarp enclosing a moderately wide mesocarp. Microscopical measurements of the fruit and pedicle are listed in table 4.

The mesocarp is differentiated into two regions; the outer one is mostly parenchymatous transversed by numerous fibrovascular bundles, while the inner one is sclerenchymatous.

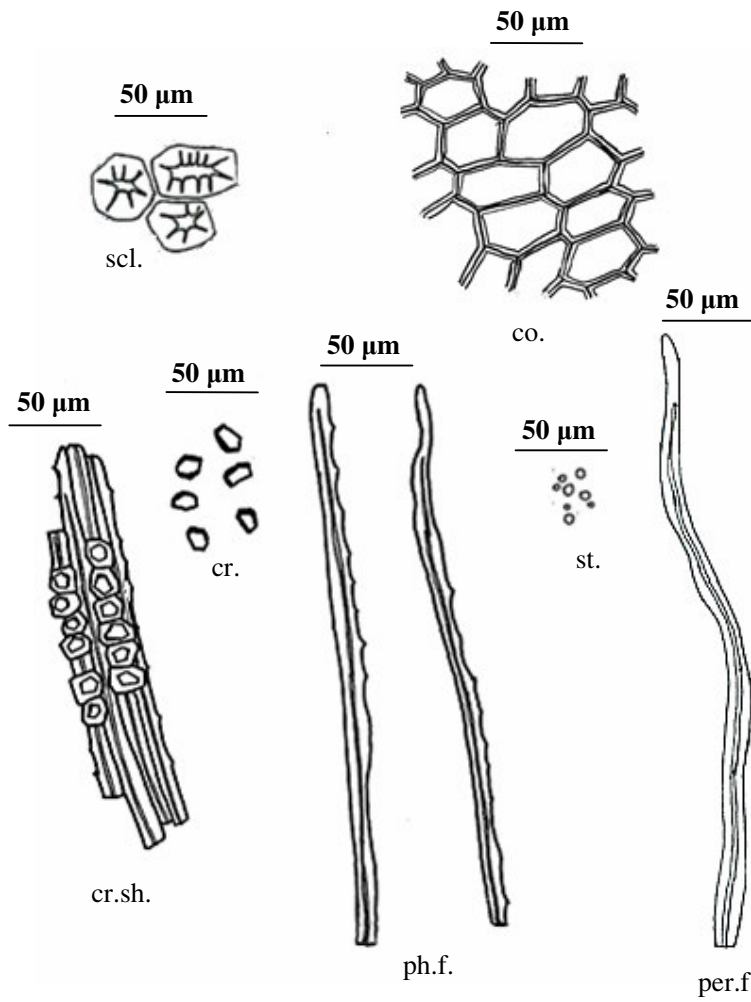


Fig. 16: Elements of the powdered stem bark.

co., cork cells; cr., prisms of calcium oxalate; cr.sh., crystal sheath; per.f. pericyclic fiber; ph.f., phloem fiber; sc., sclereids; st., starch granules.



Fig. 17: Macromorphology of the fruit.

x 1.53

Table 4: Microscopical measurements of the fruit and pedicle of *Faidherbia albida*(Del.) A. Chev. (in microns).

Item	Length	Width	Diameter	Height
Fruit				
Epicarp	6-13-21	5-10-20		6-9-11
Collenchyma			5-10-15	
Sclerides	13-35-52	10-19-27		
Pericyclic fiber	394-520-680		12-19-30	
Tangential fibers	730-920-1130		15-21-34	
Prisms			4-9-14	
Xylem vessels			17-29-38	
Pedicle				
Cork	11-13-19	9-12-14		6-9-11
Wood parenchyma	45-65-90	12-33-40		
Pericyclic fiber	490-725-995		13-26-37	
Phloem fibers	290-450-633		10-21-25	
Wood fibers	132-260-470		5-12-18	

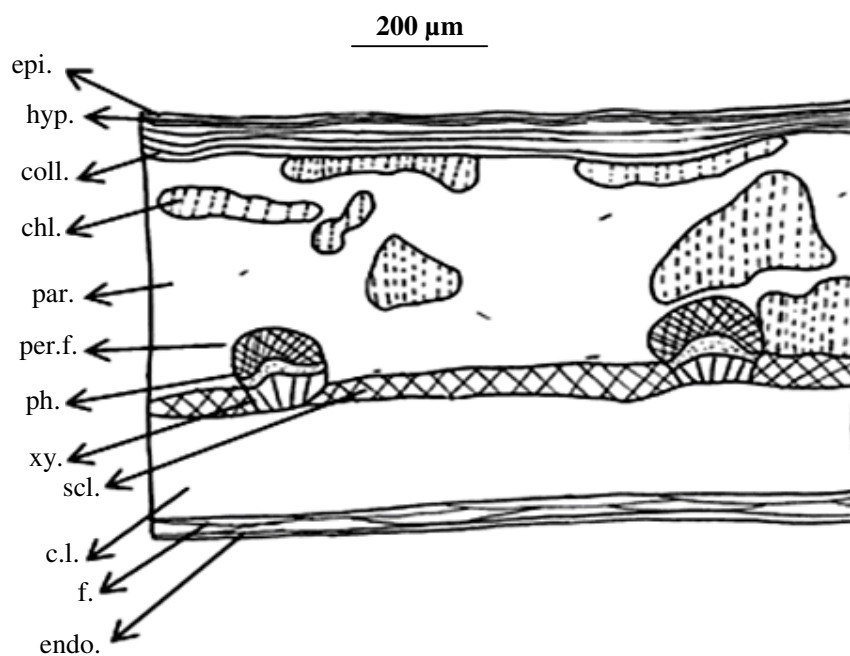


Fig. 18: The diagrammatic T.S. of the fruit.

c.l., collapsed layer; chl., chloroplast; coll., collenchyma; epi., epidermis; endo., endocarp; f., fiber; hyp., hypodermis; par., parenchyma; per.f., pericyclic fibers; ph., phloem; scl., sclereids; xy., xylem.

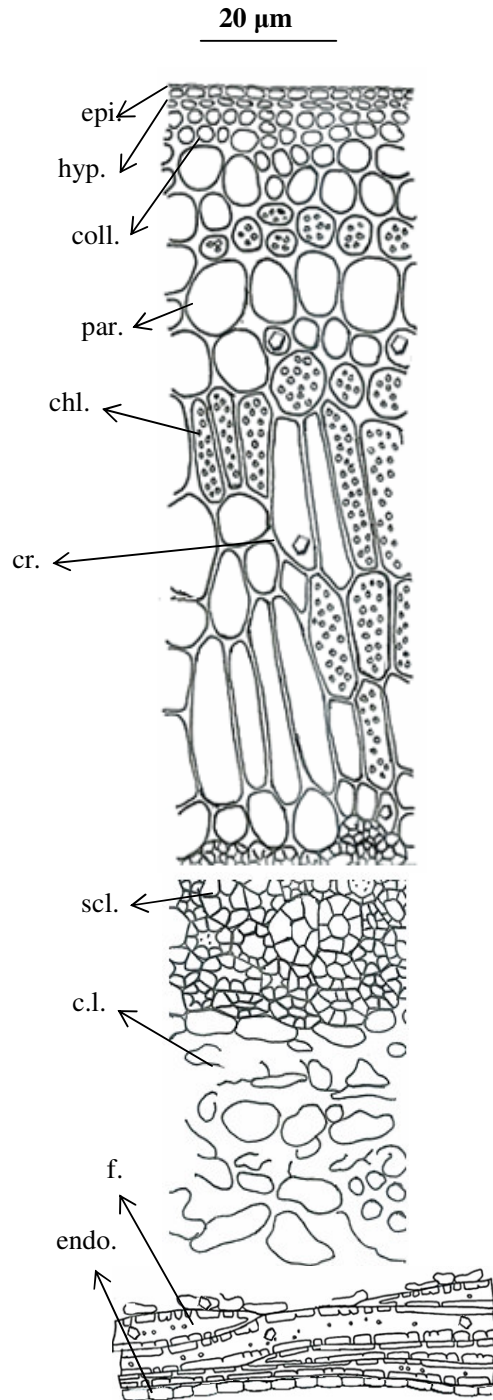


Fig. 19: The detailed T.S. of the fruit.

c.l., collapsed layer; chl., chloroplast; coll., collenchyma; c.r., prism of calcium oxalate; epi., epidermis; endo., endocarp; f., fiber; hyp., hypodermis; par., parenchyma; scl., sclerides.

The epicarp

The epicarp is formed of one row of epidermal cells followed by one row of hypodermal cells.

The epidermal cells in transverse section (Fig. 19), appear as tabular and tangentially elongated cells. In surface view (Fig. 21), the epidermal cells are somewhat polygonal, isodiametric with straight anticlinal walls, covered with thin smooth cuticle and showing few paracytic stomata.

The hypodermal cells appear as thin walled tabular tangentially elongated cells.

The mesocarp

The mesocarp (Fig. 19), is formed of two regions; the outer one is formed of 2-3 rows of collenchymatous cells then a large parenchymatous zone of 7-9 rows. The parenchymatous zone is formed of 5-6 rows of rounded parenchymatous cells and followed by 2-3 rows of columnar parenchymatous cells, some of which contain chloroplast while others contain prisms of calcium oxalate. These columnar parenchyma cells are interrupted by numerous fibrovascular bundles formed of primary phloem and xylem with pitted vessel with 2-3 layers of cambium in between and an arc of pericyclic fibers at the upper side, the fibers (Fig. 21), have moderately thick, pitted, lignified walls with wide lumen and blunt apex.

The inner region is formed of 4-5 rows of thick, pitted, lignified sclerides which are rounded, elongated or polygonal in shape. Some of these sclerides have wide lumen while others have narrow lumen. Prisms of calcium oxalates are present in some of the parenchyma cells surrounding the sclerides.

The sclerides region is followed by a moderately wide zone of indistinguishable collapsed cells.

The inner most layers (Figs. 19 and 21), are formed of 3-4 layers of transverse fibers which have thick, pitted, lignified walls with wide lumen and acute tapering ends. There are two groups of longitudinal fibers situated near the dorsal and ventral sutures of the fruit which are perpendicular on the tangential fibers forming a mat-shape like structure. Prisms of calcium oxalates are present in some of the parenchyma cells surrounding the fibers.

The endocarp

The endocarp (Fig. 19), is formed of a single row of thin walled tabular cells.

B) The pedicel

A transverse section in the pedicel (Fig. 20) is circular in outline, showing an outer layer of rhytidoma followed by cork and a parenchymatous phelloderm. The pericycle consists of arcs of fibers alternating with groups of sclerides. A collateral vascular bundle of secondary phloem and xylem which is transversed by medullary rays and surrounding a central pith which composed of peripheral columenar parenchyma cells and central rounded parenchyma cells.

The powdered fruit and pedicle

The powdered fruit (Fig. 21) has a characteristic odour and an aromatic slightly bitter taste. It is characterized microscopically by the following features:

- 1- Scattered prisms of calcium oxalate.
- 2- Fragments of polygonal, isodiametric epidermal cells of the epicarp cells, having straight, anticlinal walls, covered with smooth cuticle and showing few paracytic stomata.
- 3- Fragments of xylem vessels of pitted and spiral lignifications.
- 4- Fragments of cross linked lignified fusiform fibers from the mesocarp which are lignified, with moderately wide lumen and acute tapering ends forming mat-like structure.
- 5- Fragments of pericyclic fibers from vascular bundles having moderately thick, pitted, lignified walls with wide lumen and blunt apex.
- 6- Fragments of thick, pitted, lignified sclerides which are rounded, polygonal or elongated in shape with wide or narrow lumen.
- 7- Scattered columnar parenchymatous cells containing chloroplast.
- 8- Fragments of phloem, pericyclia and wood fibers of the pedicle.
- 9- Fragments of wood parenchyma of the pedicle.
- 10- Fragments of cork cell of the pedicle.

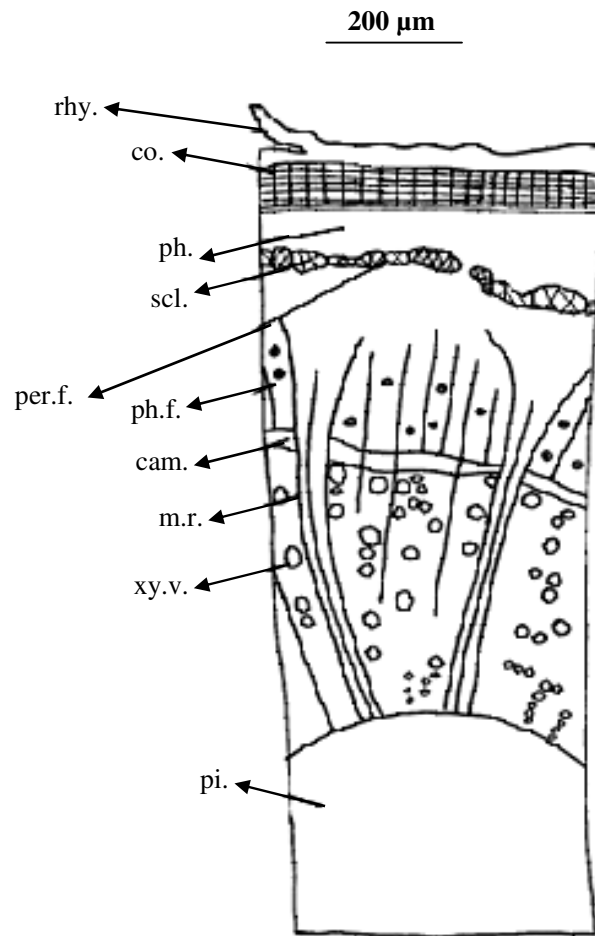


Fig. 20: The diagrammatic T.S. of the pedicle.

cam., cambium; co., cork; m.r., medullary rays; per., pericycle; per.f., pericyclic fibers; ph.f., phloem fibers; phd., phelloderm; phg., phelogen; pi., pith; rhy., rhytidoma; scl., sclereids; xy.v., xylem vessel.

50 μ m

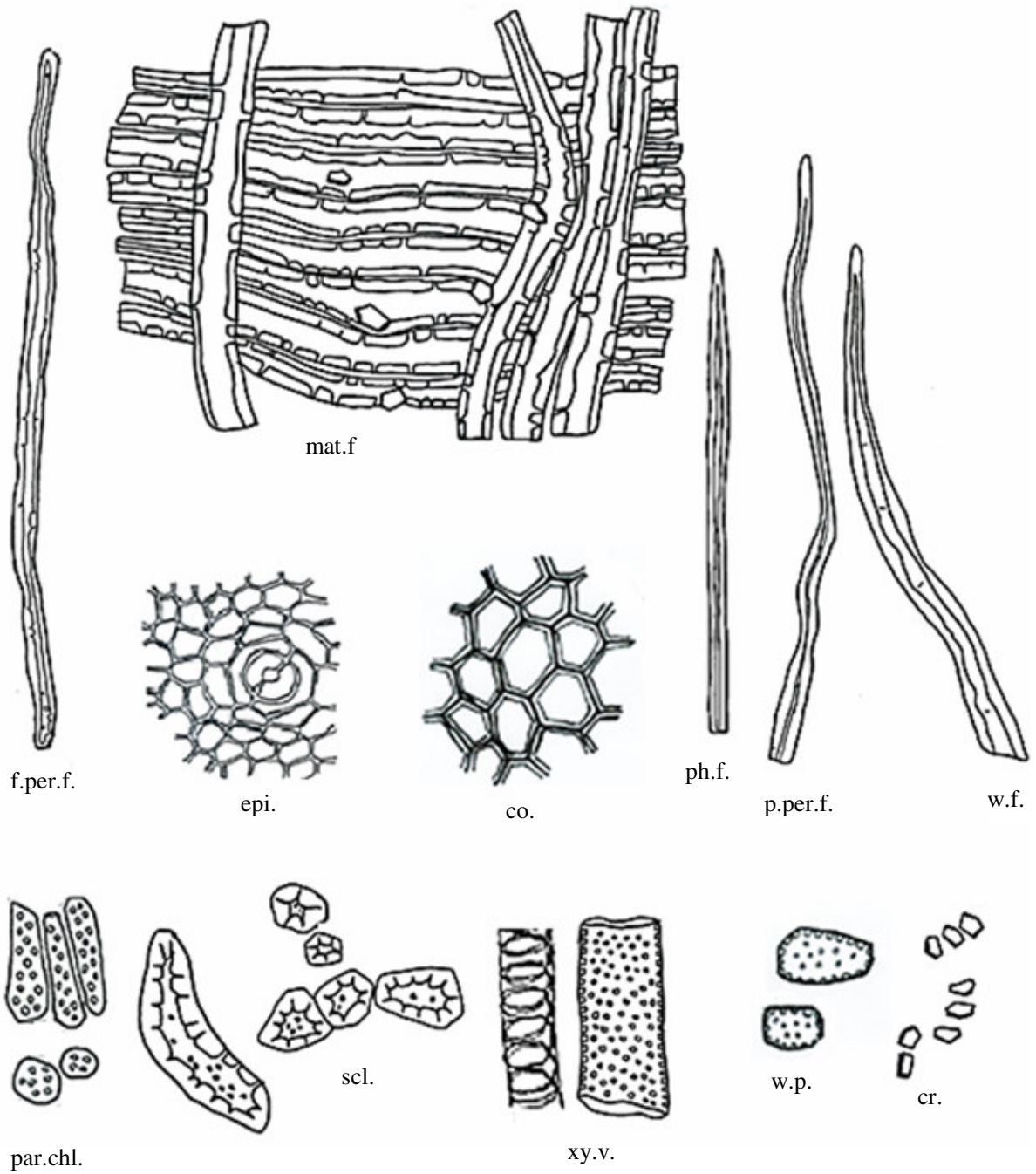


Fig. 21: Elements of the powdered fruit and pedicle.

co., cork; cr., prisms of calcium oxalate; epi., epidermis; f.per.f., fruit pericyclic fibers; mat.f., mat like fibers; par.chl., parenchyma containing chloroplast; p.per.f., pedicle pericyclic fibers; ph.f., phloem fibers; scl. sclereids; w.f., wood fibers; w.p., wood parenchyma; xy.v., xylem vessels.

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نشرة العلوم الصيدلانية جامعة أسيوط



دراسة الصفات العينية والمجهرية لأوراق وسيقان وثمار وقلف ساق نبات الفايدهيربيا البيدا المنتمي للعائلة القرنية المنزرع في مصر

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قسم العقاقير ، كلية الصيدلة ، جامعة أسيوط ، أسيوط ، مصر

يعتبر نبات الفايدهيربيا البيدا التابع للعائلة القرنية من النباتات النفضية وهو عبارة عن شجرة لا يتعدى طولها عشرون متراً وتتمو وتنتشر في إفريقيا كما أنها توجد علي ضفاف وادي النيل والصحراء الشرقية. وبإستقصاء المراجع تبين وجود عدد قليل من التقارير الخاصة بالدراسة النباتية لهذا النبات ، لذلك فقد رؤى إنه من المفيد إجراء دراسة لتوصيف والتعرف علي هذا النبات في كل من الصورة الكاملة والمسحوق.