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BOTANICAL CHARACTERIZATION OF *PARKIA ROXBURGHII* G. DON AND *PARKIA BIGLOBOSA* (JACQ.) BENTH CULTIVATED IN EGYPT.

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ABSTRACT

The macro-and micromorphological characterizations of the stem, stem bark and leaf of *Parkia roxburghii* G.Don. and *P. biglobosa* (Jacq.) Benth cultivated in Egypt were presented, with the aim of their identification in both entire and powdered forms. Paracytic stomata of the epidermal cells, numerous non-glandular short unicellular trichomes covered with warty cuticle, prisms of calcium oxalate, crystal sheath and tannin cells were found to be the diagnostic elements of both the young stems and leaves of the two species, while thick lignified pitted-walls sclerides of variable shapes and sizes were diagnostic elements of the stem bark of the two species.

KEYWORDS: Macromorphological, micromorphological, *Parkia roxburghii G.Don.*, *Parkia biglobosa*, (Jacq.) Benth.

INTRODUCTION

Family Leguminosae comprises 642 genera and about 18000 species, they are most abundant in the tropical and subtropical regions.[1] The genus parkia has a wide distribution and comprises about 40 species. It is native to the tropical regions of Central and South America, savannah region of West Africa.[2] It were introduced to Egypt in 1890. Traditionally, both species were used as analgesic drug in dental pain.[3,4] *P. roxburghii* has been used as human food, tanning, face wash and shampoo.[5] While *P. biglobosa* was used to treat digestive

system diseases, injuries and burns, headaches, rheumatism, elephantiasis, infectious diseases as malaria, abscesses, yellow fever, scabies, measles, chicken-pox and jaundice.[6]

Chemically, flavonoids, tannins and phenolic acids are found in the legumes of *P. roxburghii* G.Don. and the bark and leaves *P.biglobosa* (Jacq.).[7-9] Lectins were isolated from *P. roxburghii.*[10] Moreover, it was reported to have a high nutritive value since it is rich in protein, essential amino acids, fat content, carbohydrates, vitamins and minerals.[5,11,12]

Concerning the biological activities, it was reported that both plants possess cytotoxic, antimicrobial[9,13,14], antidiarrheal[15,16], antidiabetes[14,17,18], and for the relief of stomach disorder and abdominal pain.[5,14,18] Howeover, *P. roxburghii* exerts insecticidal effect.[5] Meanwhile *P. biglobosa* possess immunomodulatory[18-20], antioxidant[20] and cardioprotective activities.[17,21-23]

Concerning the botanical characteristics of *P. roxburghii* G.Don and *P.biglobosa* (Jacq.) Benth, no information was found in the available literature. Therefore, the macro- and micro-morphological studies of the stem, stem bark and leaf of the two species were performed, with the aim of finding out the diagnostic characters for identification and differentiation of them in both entire and powdered forms.

MATERIALS AND METHODS

Plant material

Samples of *Parkia roxburghii* G.Don and *P. biglobosa* (Jacq.) Benth cultivated in Egypt were collected from plants growing in Orman Botanical Garden. The plant was kindly authenticated by Engineer Therease Labib, consultant in Orman Botanical Garden and National Gene Bank. Specimens were dried according to the standard herbarium techniques and voucher samples (5-3-2015 **I** & **II**) were kept at the Herbarium of the Department of Pharmacognosy, Faculty of Pharmacy, Cairo University. Fresh samples were kept in 70% alcohol containing 5% glycerol and dried powdered material were reduced to size 36. Both species do not flower in Egypt.

RESULTS

I. Macromorphology

Parkia roxburghii G.Don. (Fig.1A&C) is an evergreen tree. It attains a height of 19-25 m and having usually a comparative long trunk with a large spreading branches carrying

compound leaves. The trunk is about 2 meters in length and 0.85 meter in diameter. The trunk and the big old branches are erect, solid, hard, woody, cylindrical and covered with greyish brown cork with rough surface. *Parkia biglobosa (Jacq.)Benth* (Fig.1B & D). attains a long height of 25-34 m and has a large straight reddish brown trunk (with grey tinge) which is about 0.5 m in diameter, with very long upward branches carrying compound leaves. It has a rounded or umbrella shaped spreading crown, with drooping leaves. The thick bark is grey with a scaly texture, and has an orange coloured slash. The timber is white with a brown core, and is relatively hard, but rapidly spoiled by insects and fungi. The tree loses its old leaves at the end of winter just as the new growth is beginning. Both species show monopodial branching.

a) The lateral branches

The old branches of the two species are brown in color, hard, cylindrical, with rough surfaces. The young branches are cylindrical, green in color showing longitudinal fine striations and hairy surface. They break with fibrous fracture and show solid interiors (Fig. 1A& B). The stems possess a slight characteristic odor and a slightly bitter astringent taste. The stem barks of the two species (Fig. 1C & D) & (Fig. 2 A-D) are brown in color, hard, rough, showing longitudinal and transverse wrinkled cork with few scattered lenticels. The barks of both species are odorless and have a slightly bitter astringent taste. They break with a fibrous splintry fracture, exhibiting a pale yellow interior.

b) The Leaf

Parkia roxburghii G.Don. (Fig. 2E & G): the leaf is dark green, exstipulate alternate, compound bi-pinnate petiolate, and 30-40 cm in length, with 15-30 pairs of alternate pinnae, and each of these is further divided into 45-72 pairs of secondary leaflets or pinnules.The newly unfolding leaves are yellowish green, soon turning to dark green. The leaflets are opposite, sessile, mostly oblong with rounded obtuse apex, entire margin and symmetric base. The upper surface is dark green, the lower surface is lighter in color. They are nearly glabrous to the naked eye and the midrib is slightly prominent on the lower surface. The texture is leathery. The leaflets are 0.3-0.5 cm in length and 0.1-0.2 cm in width. The petiole is green in color, short, and cylindrical with slightly hairy base. It measures 5-10 cm in length and 0.5-1cm in diameter. The rachis is long, cylindrical and green in color measuring 30 cm-70 cm in length and 1-2.5 cm in diameter. The leaf has a faint characteristic odor when crushed and possesses an astringent taste. The leaf of *Parkia biglobosa (Jacq.)Benth.* (Fig.

2F& H). is larger than that of *P. roxburghii G.Don.* with 60-88 cm in length, with 25-40 pairs of alternate pinnae, and each of these is further divided into 80-110 pairs of secondary leaflets or pinnules. The leaflets are similar in shape but larger in size 0.5-0.8 cm in length and 0.2-0.3 cm in width. The petiole is longer10-19 cm in length and 0.7-2.8 cm in diameter as well as the rachis which reaches 50 -100 cm in length and 1.9-3.5 cm in diameter. The differences between the two leaves of the two species are recorded in table (1)

Table (1): Major macromorphological differences between *Parkia roxburghii G.Don.* *Parkia biglobosa (Jacq.) Benth.*

Organ	*Parkia roxburghii G.Don.*	*Parkia biglobosa (Jacq.) Benth.*
Leaf	30-40 cm in length 15-30 pairs alternate pinnae 45-72 pairs of secondary pinnules	60-88 cm in length 25-40 pairs alternate pinnae 80-110 pairs of secondary pinnules
petiole	5-10 cm in length 0.5-1 cm in diameter.	10-19 cm in length 0.7-2.8 cm in diameter
rachis	30 -70 cm in length 1-2.5 cm in diameter	50 -100 cm in length 1.9-3.5 cm in diameter.
leaflet	0.3-0.5 cm in length 0.1-0.2 cm in width	0.5-0.8 cm in length 0.2-0.3 cm in width

II. Micromorphology

1. Micromorphology of *Parkia roxburghii G.Don.*

The stem

a)The old stem branch

A transverse section in the old stem branch (Fig. 3A & B) is circular in outline. It consists of cork followed by a somewhat wide secondry cortex. The endodermis is distinct forming a starch sheath. The pericycle is formed of patches of lignified fibres interrupted with parenchyma cells. The vascular tissue is comparatively wide representing about 1/3 of the diameter forming a ring traversed by medullary rays. The central pith is relatively wide constituting about 1/2 of the diameter and formed of pitted parenchyma containing prisms of calcium oxalate and tannin cells.

The cork (Fig. 3B&C): It is formed of several rows (8-11) of radially arranged, tangentially elongated polygonal isodiametric cells with thin suberized walls.

The 2ry cortex (phelloderm) (Fig. 3B) is formed of 9-13 rows of thick- walled rounded parenchymatous cells containing starch grains and scattered numerous big styloid prisms of calcium oxalate. The endodermis is filled with starch granules forming starch sheath. Starch

granules are very small simple and sometimes compound with neither visible hila nor striations. Tannin cells are present characterised by their brown content (green colour with ferric chloride T.S.).

The pericycle (Figs. 3A&B) is formed of patches of lignified fibres interrupted with parenchyma cells, with scattered tannin cells. The fibres (Fig. 5) are fusiform having straight, moderately wide to narrow lumina and acute tapering apices and also, tortous with undulating walls, slightly acute to acuminate apices and with narrow lumina. The pericyclic fibers are mostly surrounded by parenchyma cells containing prisms of calcium oxalate forming crystal sheath.

The vascular tissue (Figs. 3A&B and 5) consists of a complete ring of a collateral vascular bundles traversed by uni- to biseriate medullary rays. The phloem consists of cellulosic elements with no phloem fiber. Some phloem parenchyma cells contain prisms of calcium oxalate. The cambium is formed of few rows of tangentially elongated radially arranged thin walled cellulosic cambiform cells. The xylem (Fig.5) is formed continuous ring of lignified radially arranged elements viz.: vessels, tracheids, wood fibers and wood parenchyma. The vessels are arranged in radial rows showing lignified spiral, annular and pitted thickenings. Tracheids (Fig. 5) are elongated with thin lignified pitted walls and blunt ends. Wood fiberes (Fig. 5) are moderate in length with wide lumina, straight or slightly undulating thin lignified pitted walls and acute apices. Wood parenchyma(Fig. 5) consists of rectangular cells with thick pitted walls. Medullary rays are uni- or biseriate formed of rectangular radially elongated cells, with pitted lignified walls.

The pith (Fig. 3A&B) is comparatively wide and consists of rounded thin-walled parenchymatous cells with some cells containing tannin.

b) The young stem branch

The young stem (Figs. 4 A&B) is slightly irregular and wavy in outline with two distinct projections on one side. Its structure is similar to that of the old stem branch with the following differences.

1- The epidermis(Fig. 4B-C &5) consists of polygonal axially elongated cells having slightly wavy anticlinal walls and covered with a thin smooth cuticle(sometimes striated).Stomata are mostly of paracytic and rarely of anomocytic type.

2- Trichomes are abundant (Figs. 4A &C- 5) and of non glandular type. They are unicellular short covered with faint warty or smooth cuticle, some are long and curved.
3- The pith is formed of rounded parenchyma cells having thin cellulosic walls.

The microscopical measurements of the different elements of the old and young stem branches are shown in table (2).

Powdered stem

The powder is yellowish brown in color, odorless and has an astringent taste. Microscopically (Fig.5), it is characterized by the presence of the following.

1. Fragments of cork cells which are polygonal isodiametric slightly elongated cells with thin suberized walls.
2. Fragments of polygonal axially elongated epidermal cells having slightly wavy anticlinal walls and covered with thin smooth cuticle. Stomata are mostly of the paracytic type and rarely of anomocytic type. Trichomes are abundant, they are of non glandular, unicellular, short covered with faint warty or smooth cuticle, sometimes they are long and curved.
3. Fragments of thin or thick-walled pitted parenchyma of the cortex containing prisms of calcium oxalate.
4. Fragments of lignified pericyclic fibres with straight or undulating walls showing moderately wide to narrow lumina having acute tapering apices. Tortous fibres are with undulating walls, slightly acute to acuminate apex and with narrow lumen.
5. Numerous fragments of crystal sheath where the pericyclic fibers are mostly surrounded by parenchyma cells containing prisms of calcium oxalate..
6. Lignified fragments of xylem vessels showing spiral, annular and pitted lignified thickenings, fragments of lignified pitted tracheids with blunt ends, fragments of pitted lignified walled wood parenchyma, lignified wood fibres with straight or undulating walls having wide lumina and acute tapering apices and fragments of the rectangular medullary rays with pitted and lignified walls.
7. Fragments of parenchyma of the pith having thin walls containing small simple or compound starch granules, showing neither hila nor striations.
8. Frequent elongated tannin cells are present.

2. The stem bark

A transverse section in the bark (Fig. 6A) shows the cork followed by a wide secondary cortex and a considerably wide phloem traversed by bi-triseriate medullary rays. Secondary cortex and pericycle is parenchymatous showing patches of lignified fibres.

Phloem is consisting of tangential bands of lignified bast fibres and scattered groups of sclerides. Phloem parenchyma contain numerous styloid prisms of calcium oxalate, tannin cells and starch granules.

The cork (Fig. 6A & B): The cork is consists of several rows of brown radially arranged, tangentially elongated slightly thick suberized wall with equal thickening. The cells are polygonal slightly axially elongated with straight walls.

The secondry cortex (Fig. 6A & B): It is consists of about 20 rows of thin-walled oval shaped parenchyma cells. The parenchyma cells contain simple rounded starch granules with neither visible hila nor striations, as well as styloid prisms of calcium oxalate and many tannin cells (green color with ferric chloride T.S.). this region contains lignified sclerides of different shapes and sizes.

The pericycle (Fig. 6A & B): It is formed of scattered patches of long lignified fibres interrupted with parenchyma cells and lignified sclerides. The sclerides are of different shapes and sizes and also with different thickness of lignified walls. The fibres have straight or slightly wavy thick lignified walls, narrow lumina and acute tapering apices some are accompanied with crystal sheath. The parenchyma cells contain tannin (green color with ferric chloride T.S.) and occasionally starch granules.

The phloem (Fig. 6A & B): It is composed of soft tissues showing mainly thin walled parenchymatous cells, sieve tubes and companion cells and interrupted with several tangential bands of phloem fibers and scattered groups of lignified sclerides. Bast fibers are similar in shape to those of the pericycle. Sclerides are of different shapes and sizes, some are slightly elongated with thick pitted lignified walls and narrow lumen which has brown content, others are isodiametric with thin lignified walls and very wide lumen.

Some phloem parenchyma cells contain tannin cells (green color with ferric chloride T.S.), styloid prisms of calcium oxalate and starch granules. The phloem tissue is traversed by uni-,

bi, or triseriate medullary rays which are formed of rectangular radially elongated cells having lignified pitted walls containing starch granules**. (Fig. 6B).**

Powdered stem bark

The powder is brown in color, odorless and has an astringent taste. Microscopically, it is characterized by the presence of (Fig. 6B)**.**

1. Fragments of brown, polygonal cork cells with slightly thick suberized walls.
2. Fragments of lignified pericyclic and phloem fibres with straight or slightly wavy thick walls having narrow or wide lumina and acute tapering apices.
3. Fragments of polygonal elongated medullary ray cells showing pitted lignified walls and containing styloid prisms of calcium oxalate or starch granules.
4. Large scattered styloid prisms of calcium oxalate.
5. Frequent fragments of tannin cells.
6. Numerous fragments of sclerides which are of different shapes and sizes. They are polygonal axially elongated or isodiametric. The elongated sclerides are with thick pitted lignified walls and narrow lumen with brown content, but the isodiametric ones are with thin lignified walls and very wide lumen.

The Leaf

A transverse section in the leaflet (Fig. 7 and 10) shows upper and lower epidermises enclosing a dorsiventral mesophyll and palisade is continuous in the midrib region. The midrib appeared equally slightly prominent on both surfaces having no cortical parenchyma below the palisade and narrow peripheral parenchyma abutting the lower palisade. It shows a cresent-shaped collateral vascular bundle which is surrounded by a continous ring of lignified pericyclic fibres. The epidermis (Fig.7&10) of both surfaces are nearly similar in shape. They are polygonal slightly axially elongated cells with slightly wavy anticlinal walls. The lower epidermal cells being more wavy and covered with thick smooth cuticle. Stomata are present on both surfaces and are mostly of paracytic and rarely anomocytic type and nearly of the same number on both surfaces. The neural epidermis (Figs. 7B, C and 10) of the upper and lower surfaces are polygonal isodiametric, having straight thick walls, covered with thick smooth cuticle and devoid of stomata. Trichomes (Figs. 10) are of non glandular type, resembling those of young stem but differ in size.

The mesophyll (Fig. 7A-C) is heterogeneous dorsiventral with continuous palisade in the midrib region. It is formed of one row of columnar, straight, thin-walled closely packed cells

containing green chloroplasts. The spongy tissue is formed of irregular shaped parenchyma cells (2-5 rows) with wide intercellular spaces containing scattered prisms of calcium oxalate. Small vascular bundles of the lateral veins are embedded within the spongy tissue.

The midrib: (Fig. 7C) The upper cortical tissue of the midrib consists of one row of palisade cells, while the lower cortical tissue consists of 1or2 rows of parenchyma cells showing narrow intercellular spaces and containing scattered calcium oxalate prisms and some tannins cells. The endodermis is indistinct.

The pericycle (Fig. 7C) is formed of an almost continuous ring of lignified pericyclic fibres. The pericyclic fibres (Fig.10) are fusiform with straight or tortuous lignified walls, narrow or wide lumina and tapering apices sometimes appeared forked. The pericyclic fibres are surrounded by thin walled parenchyma cells containing prisms of calcium oxalate forming a crystal sheath.

The vascular tissue (Figs. 7C and 10) consists of crescent-shaped collateral vascular bundle. It shows xylem towards the upper side and phloem towards the lower one. The xylem is wholly lignified composed of vessels and wood parenchyma traversed by uniseriate medullary rays. The xylem vessels are lignified with spiral and annular thickenings. The wood parenchyma cells are rectangular in shape having pitted lignified walls.The phloem consists of delicate thin walled cellulosic elements containing prisms of calcium oxalate and tannin cells. The microscopical measurements of the different elements present in the leaf are represented in table (2).

The petiole

A transverse section in the petiole (Fig. 8A & B) is circular to oval in outline with two slightly rounded lateral projections. It is formed of an epidermis followed by narrow cortex. The inner most layer of the cortex is distinct and differentiated into starch sheath. The vascular system shows a circular vascular bundle and surrounded by continous ring of lignified pericyclic fibres which is surrounded by crystal sheath. The epidermis (Fig. 10) consists of polygonal, axially elongated cells with straight thick anticlinal walls and covered with thick smooth cuticle, stomata are absent. Nonglandular trichomes, similar to those of lamina, are abundant on the lower side. The cortex (Fig. 8B) is formed of about 7-9 rows of rounded or oval parenchymatous cells with narrow intercellular spaces containing prisms of calcium oxalate as well as tannin (green color with ferric chloride T.S.).The endodermis is

distinct forming a starch sheath. The pericycle (Fig. 8B) is formed of continous ring (2-3 rows) of pericyclic fibers . The fibres are elongated, fusiform with straight, moderately thick lignified walls, wide lumina and pointed apices. Those fibers are surrounded by parenchyma cells containing prismatic crystals of calcium oxalate forming crystal sheathes. The vascular tissue (Fig. 8B) consists of a wide circular vascular bundle occupying about 1/2 of the diameter. They are separated by di ,tri and tetraseriate medullary rays which consist of lignified polygonal slightly elongated cells. The phloem consists of sieve elements and phloem parenchyma containing calcium oxalate prisms and starch granules. The xylem is formed of xylem vessels, wood parenchyma and wood fibres. The xylem vessels are radially arranged showing lignified spiral.and annular thickenings. Wood fibres are short to moderate in length with wide lumina, straight or slightly undulating thin lignified walls and tapering apices. Wood parenchyma is rectangular in shape having pitted lignified walls. The pith consists of thin-walled parenchymatous cells.The microscopical measurements of the different elements present in the petiole are recorded in table (2).

The rachis (Fig. 9& 10) differs from the petiole in the following.

1. The outline of the rachis is more rounded to rhomboidal with two slightly rounded lateral projections. It consists of an epidermis, followed by a narrow cortex about (1/7 of the diameter), the innermost layer (endodermis) is distinct as starch sheath. The vascular system consists of a large central vascular bundle surrounding a central non lignified pith, in addition to two small inverted vascular bundles above the large one.
2. The epidermis is the same as petiole but the trichomes are more abundant.
3. The cortex is formed of 9-11 layers of parenchymatous cells.
4. The tannin cells are more abundant in the cortex.
5. The pericycle consists of 5-7 rows of continuous ring of fibers surrounding the large vascular bundle and 2-3 rows rings continuously surrounding the two small bundles.
6. The vascular bundle is wider than that of the petiole (about 3/5 of the diameter).
7. The medullary rays and pith parenchyma contain tannin cells.

Powdered leaf

The powdered leaf is green in color with faint characteristic odour and an astringent taste. Microscopically (Fig. 10),it is characterized by the following elements:

1- Fragments of the upper and lower epidermes of the leaflet showing polygonal slightly axially elongated cells with thin wavy anticlinal walls, covered with a smooth cuticle. The

lower one shows more wavy anticlinal walls. Stomata are on both surfaces and are mostly of paracytic type and rarely of anomocytic one.

2- Fragments of the neural polygonal isodiametric epidermal cells, having thick straight anticlinal walls and covered with a smooth cuticle and devoid of stomata.

3- Fragments of the epidermal cells of the petiole and rachis showing polygonal axially elongated cells, having straight thick anticlinal walls and covered with smooth cuticle and devoid of stomata.

4- Fragments of columnar, thin-walled palisade cells containing green chloroplasts.

5- Fragments of lignified pericyclic fibres, fusiform having straight or tortuous walls, narrow or wide lumina and tapering apices also forked pericyclic fibers are found. They are mostly surrounded by parenchyma cells containing prisms of calcium oxalate forming crystal sheath.

9. Fragments of lignified xylem vessels showing spiral, annular and pitted lignified thickening, fragments of pitted lignified walled wood parenchyma, fragments of lignified wood fibres with straight or undulating walls having wide lumina and acute tapering apices and fragments of the rectangular medullary rays showing pitted and lignified walls.

6- Scattered prisms of calcium oxalate.

7- Frequent short and elongated tannin cells are present.

8- Numerous non glandular trichomes which are unicellular straight or curved and covered with smooth (sometimes warty) cuticle.

2. Micromorphology of *Parkia biglobosa (Jacq. Benth)*

The microscopical structures of the stem, stem bark and leaf *Parkia biglobosa (Jacq. Benth)* could be differentiated and characterized from *Parkia roxburghii G.Don.* by the following.

The stem (Fig. 11- 14)

1. Old stem (Fig. 11 & 13)

- The cork is narrower and cortex is wider.
- The vascular bundle region is wider occupying about 2/3 of the diameter.
- Tannin cells are more.

2. Young stem (Fig. 12 & 13)

- The outline is nearly circular or oval in outline and more hairy.
- The cortex is wider.

- Tannin cells are less.

In the powdered stem, tannin cells are more elongated.

The stem bark (Fig. 14)

- Cork region is narrower and have cells with more brown content.
- Sclerides are less abundant in the phloem region.
- Tannin cells are more.
- Calcium oxalate prisms are not styloid ones as in *Parkia roxburghii G.Don.*

The leaf (Fig. 15-18)

- The midrib of the leaflet is slightly more prominent on the upper and lower surfaces.
- The upper epidermal cells of the leaflet have slightly wavy anticlinal walls.
- The lower epidermal cells of the leaflet have more wavy anticlinal walls with a number of stomata is more than in case of *Parkia roxburghii G.Don.*
- Neural epidermal cells are more axially elongated and less thick, on the other hand epidermal cells of the petiole are polygonal isodiametric.
- The palisade is two rows, the upper row is longer than the lower one.
- Calcium oxalate prisms are less abundant in the mesophyll.
- Tannin cells are more abundant in the leaflet and also more in the cortex of the petiole.
- Petiole has two lateral projections which are more prominent.
- The two inverted vascular bundles in the rachis are more distinct and present in a long apical projection.
- The pericyclic fibres are shorter and have wider lumina.
- The forked fibers are not detected in the powdered leaves although they were detected in powdered leaves of *Parkia roxburghii G.Don.*

  The dimensions of the different elements differ from the respective ones of *Parkia roxburghii G.Don.* These are recorded in table (2).

Table (2): Dimensions (in microns) of the elements of the stems and leaves of *Parkia roxburghii G.Don.* and *Parkia biglobosa (Jacq.) Benth* :

Element	*Parkia roxburghii G.Don.*				*Parkia biglobosa (Jacq.) Benth*			
	Length	Width	Height	Diameter	Length	Width	Height	Diameter
Lateral branch								
Cork cells	40-54-64	28-32-41	7-11-13	-	49-68-87	32-52-55	8-13-17	-
Epidermal cells	32-34-37	8-9-11	-	-	25-27-30	5-7-11	5-7-9	-
Non glandular hair	191-211-236	6-9-14	-	-	54-95-136	3-6-8	-	-
Prisms of ca. ox.	11-23-33	5-8-13	-	-	13-17-22	9-13-17	-	-
Medullary rays	63-68-75	20-23-25	-	-	47-49-56	23-26-29	-	-
Pitted parenchyma	73-79-83	40-48-50	-	-	68-114-125	36-43-50	-	-
Pericyclic fibres	540-690-780	6-12-15	-	-	438-500-621	6-19-25	-	-
Tracheids	35-52-73	4-6-12	-	-	131-150-199	34-45-53	-	-
Wood fibres	260-280-480	2-4-6	-	-	420-570-630	12-15-21	-	
Wood parenchyma	107-133-160	17-20-24	-	-	90-126-141	15-18-21	-	-
Vessels	-	-	-	31-34-37	-	-	-	10-15-23
Tannin cell	186-271-300	-	-	29-50-64	264-293	-	-	15-18
Sclerides	67-43-24	36-29-24	-	-	32-47-53	13-22-28	-	-
Leaf								
Upper epidermis	40-49-60	13-18-20	10-11-13	-	29-38-45	9-17-23	20-22-25	-
Lower epidermis	38-42-50	20-24-30	9-10-11	-	26-30-33	9-11-15	17-20-23	-
Neural epidermis	13-14-15-	6-9-13	20-23-26	-	26-28-49	9-11-13	20-22-25	-

Cont. Table (2): Dimensions (in microns) of the elements of the stems and leaves of *Parkia roxburghii G.Don.* and *Parkia biglobosa (Jacq.) Benth* continued:

Element	*Parkia roxburghii G.Don.*				*Parkia biglobosa (Jacq.) Benth*			
	Length	Width	Height	Diameter	Length	Width	Height	Diameter
Petiole epidermis	53-71-88	21-28-32	4-5-7	-	12-13-16	10-12-16	1.6-2.5-3	-
Palisade cells	33-42-45	5-7-10	-	-	46-53	12-14	-	-
Stomata	20-28-32	13-14-16	-	-	20-23-29	12-15-17	-	-
Non glandular hair	138-143-204	6-9-12	-	-	161-180-210	4-10-14	-	-
Prisms of ca. ox.	5-10-13	5-8-10	-	-	21-28-30	16-18-19	-	-
Medullary rays	50-60-143	17-33-43	-	-	50-61-84	10-12-18	-	-
Pericyclic fibres	200-250-300	5-7-10	-	-	366-455-720	15-17-20	-	-
Wood fibers	521-550-600	8-10-15	-	-	221-293-311	2-5-7	-	-
Wood parenchyma	50-59-67	5-7-8	-	-	23-33-48	5-8-10	-	-
Vessels	-	-	-	19-21-30	-	-	-	11-20-33

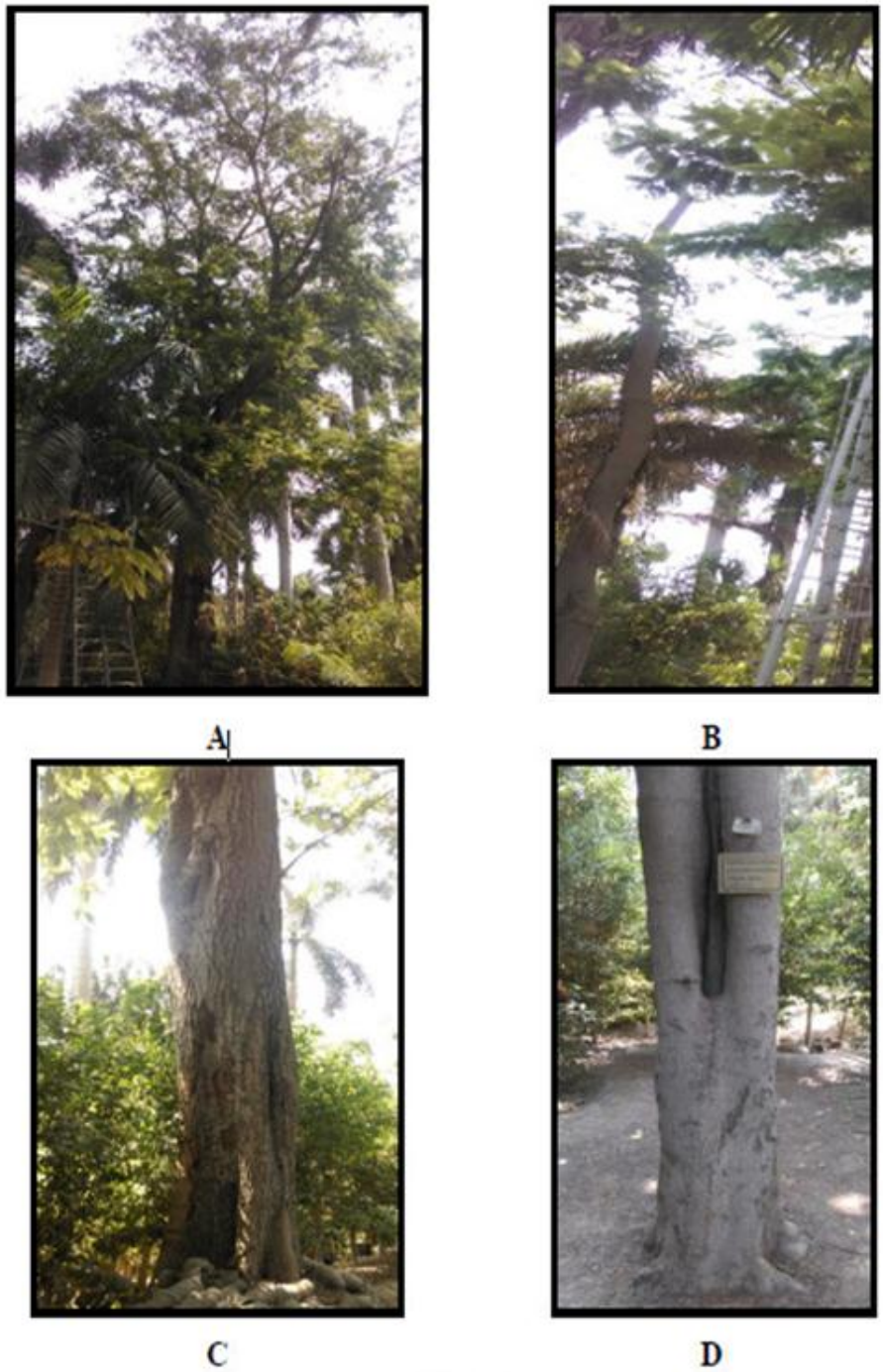


Fig. 1

Fig. (1): Photographs of the tree and trunk of *P. roxburghii* G.Don. and *P.biglobosa* (Jacq.) Benth

A) *P. roxburghii* G.Don. tree in summer (X=0.006)
B) *P. biglobosa* (Jacq.) *Benth* tree in summer (X=0.004)
C) Trunk of P. roxburghii G.Don. tree. (X=0.05)
D) Trunk of P. biglobosa (Jacq.) *Benth* tree. (X=0.06)

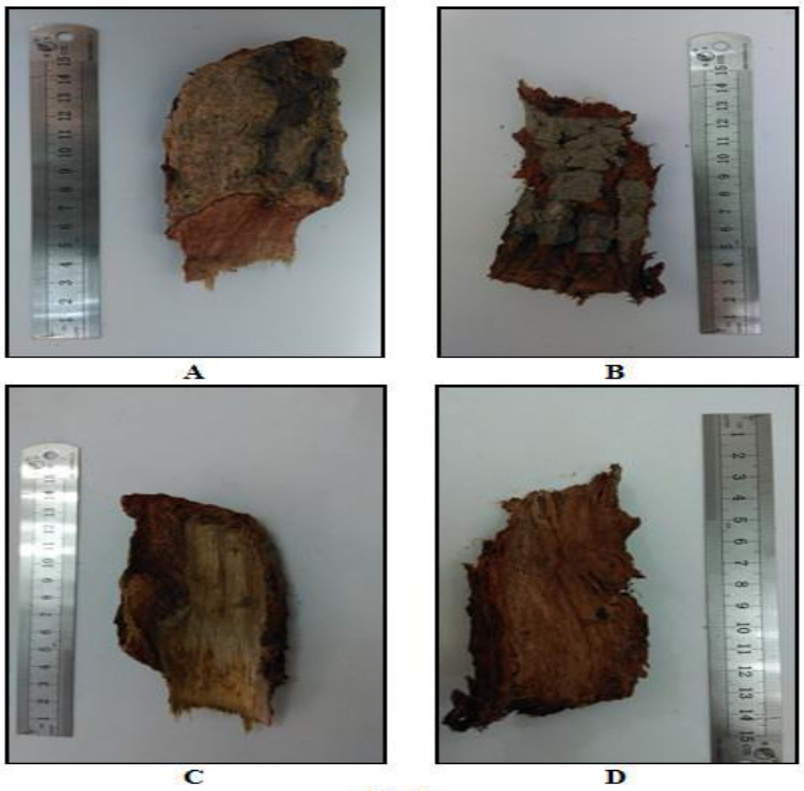
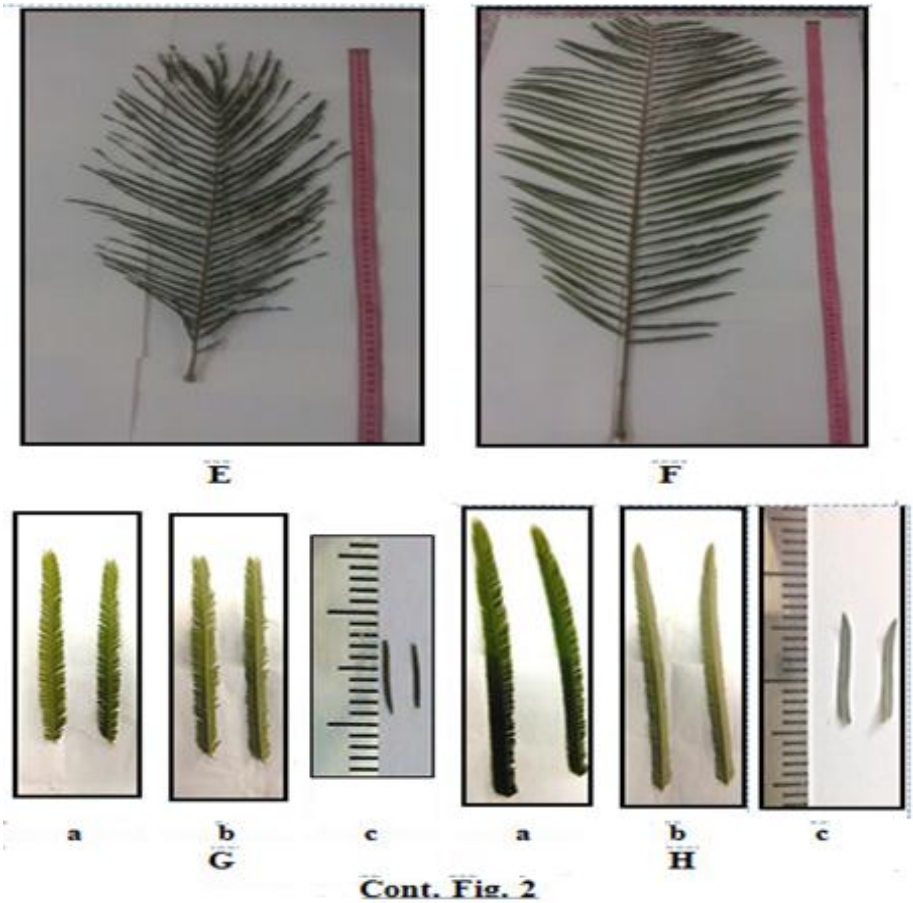


Fig.2

Fig. (2): Photographs of the bark of *P. roxburghii G.Don.* and *Parkia biglobosa (Jacq.) Benth*

A) Outer surface of stem bark *P.roxburghii G.Don.* (X=0.577)
B) Outer surface of stem bark of *P. biglobosa (Jacq.)Benth* (X=0.533)
C) Inner surface of stem bark of *P.roxburghii G.Don.* (X=0.571)
D) Inner surface of stem bark of *P. biglobosa (Jacq.) Benth* (X=0.600)



Cont. Fig. 2

Cont. Fig. (2): Photographs of the leaves of *Parkia roxburghii G.Don.* and *Parkia biglobosa (Jacq.) Benth*

A) *P.roxburghii G.Don.* leaf (X=0.153)
B) *P. biglobosa (Jacq.)* leaf (X=0.112)
C) a= The upper surface, b=lower surface and c=leaflet of *P.roxburghii G.Don.* (X=0.26)
D) a=The upper surface, b=lower surfaces and c=leaflet of *P. biglobosa (Jacq.) Benth* (X=0.21)

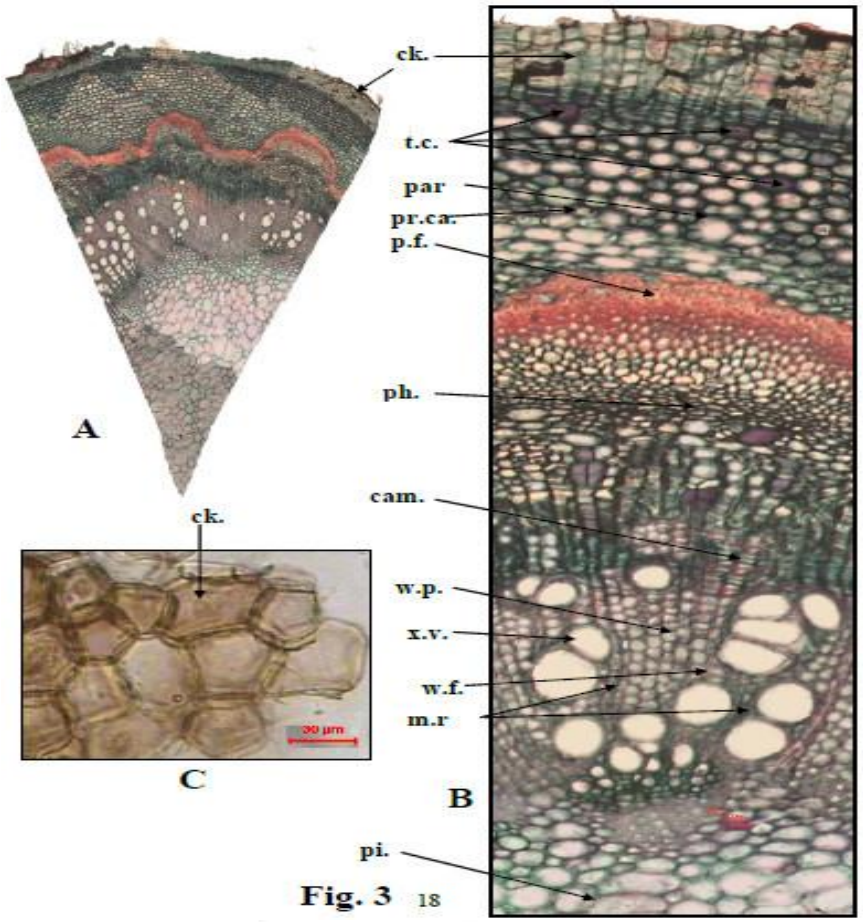


Fig. 3 18

Fig. (3): Micromorphology of the old stem of *P. roxburghii G.Don.*

A) Low power view of T.S. in the old stem (X=40)

B) High power view of T.S. in the old stem (X=180)

C) Surface view of the cork (X=400)

cam., cambium; ck., cork; m.r., medullary ray; p.f., pericyclic fibres; par., parenchyma; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; w.f., wood fiber; w.p., wood parenchyma; x.v.,

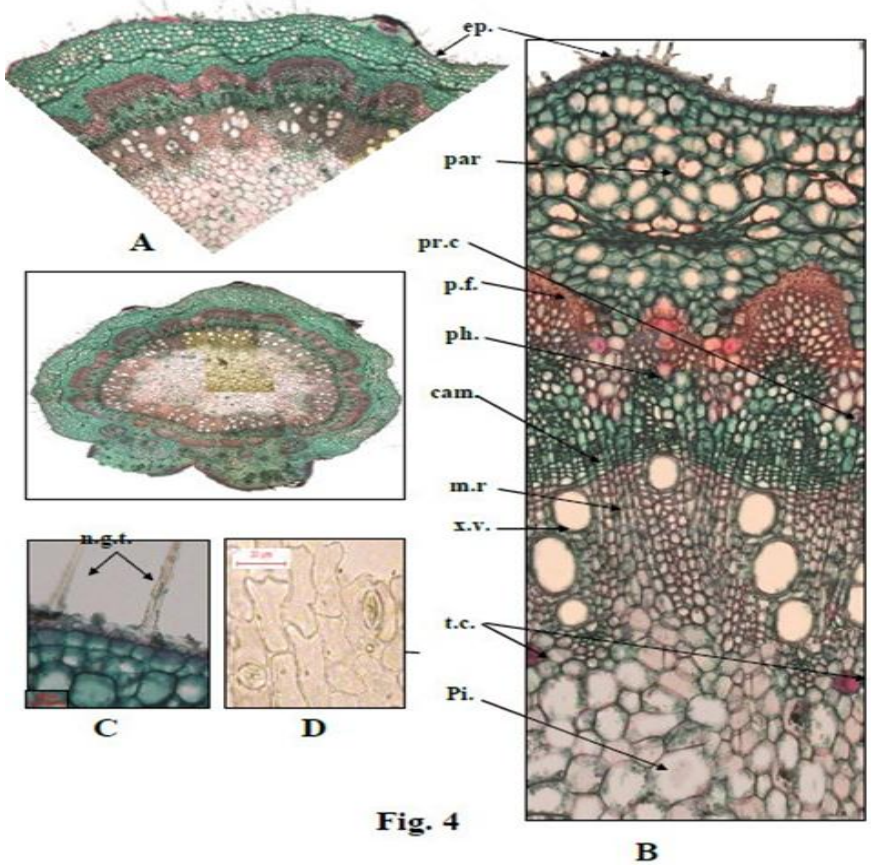


Fig. 4

Fig. (4): Micromorphology of the young stem branch of *P. roxburghii G.Don.*

A) Low power view of T.S. in t young stem (X=50)

B) High power view of T.S. in the young stem (X=190)

C) Part of the lamina showing non-glandular trichomes (X=238)

D) Surface preparation in the young stem (X=500)

cam., cambium; ep., epidermis; m.r., medullary rays; n.g.t., nonglandular trichomes; p.f., pericyclic fibres; par., parenchyma; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; x.v., xylem vessel.

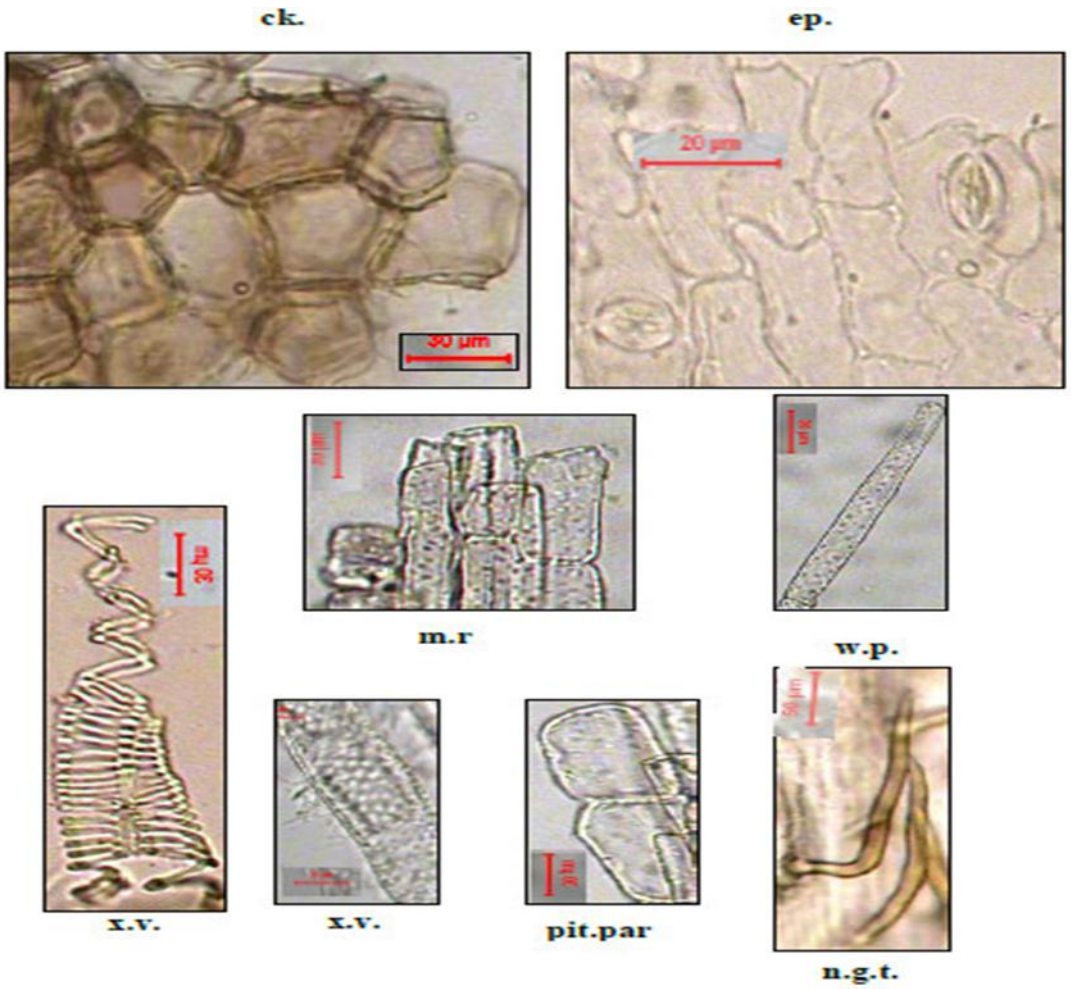
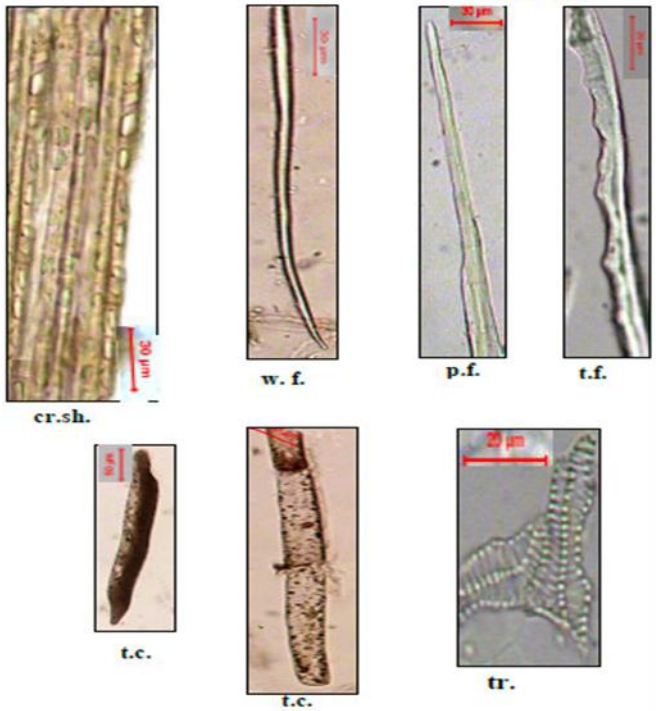


Fig. 5



Cont. Fig. 5

Fig. (5): Powdered stem of *P. roxburghii G.Don.*

ck., cork (X=466); cr.sh., crystal sheath (X=588); ep., epidermis(950); m.r., medullary rays (X=400); n.g.t., nonglandular trichomes; p.f., pericyclic fibres (X=370); pit.par., pitted parenchyma (X=303); t.c., tannin cells (X=140); t.f., tortous fiber (X=700); tr., tracheid (X=333); w.f., wood fibre (X=513); w.p., wood parenchyma (X=303); x.v., xylem vessel (X=345).

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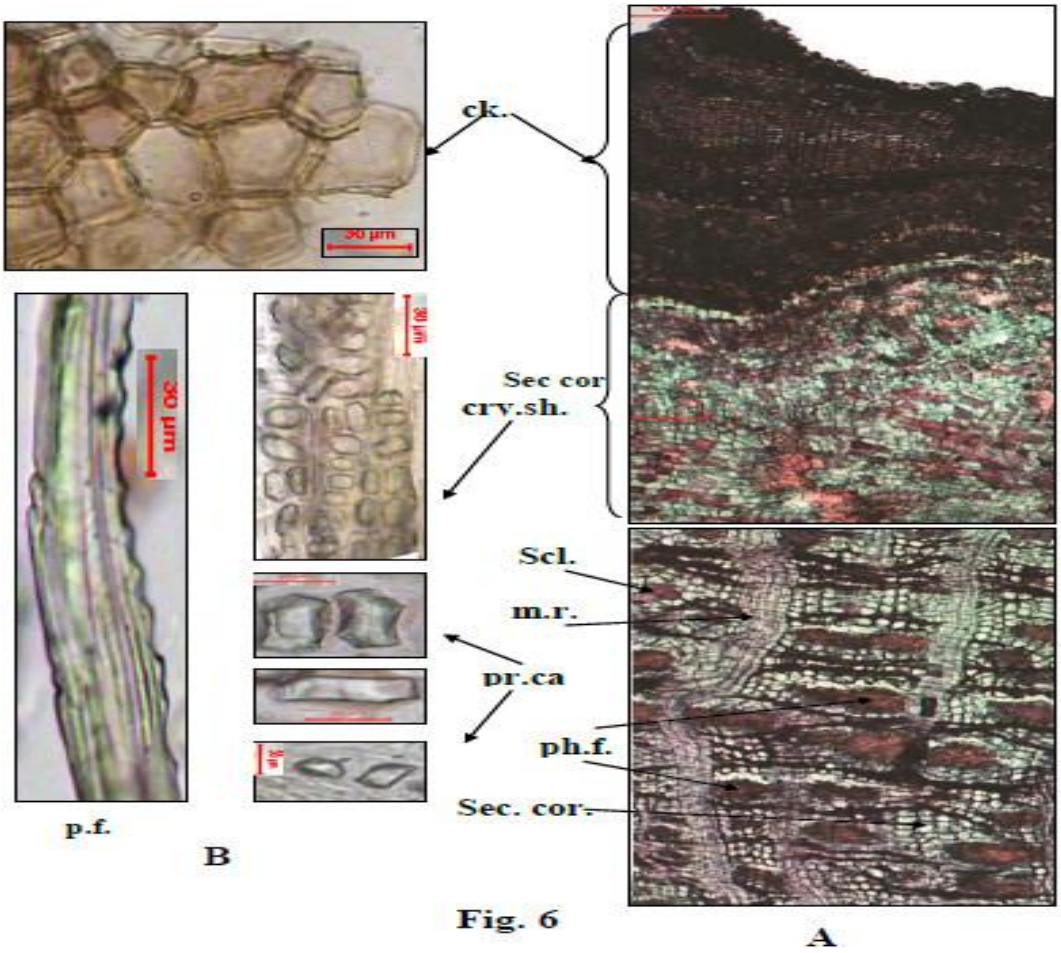
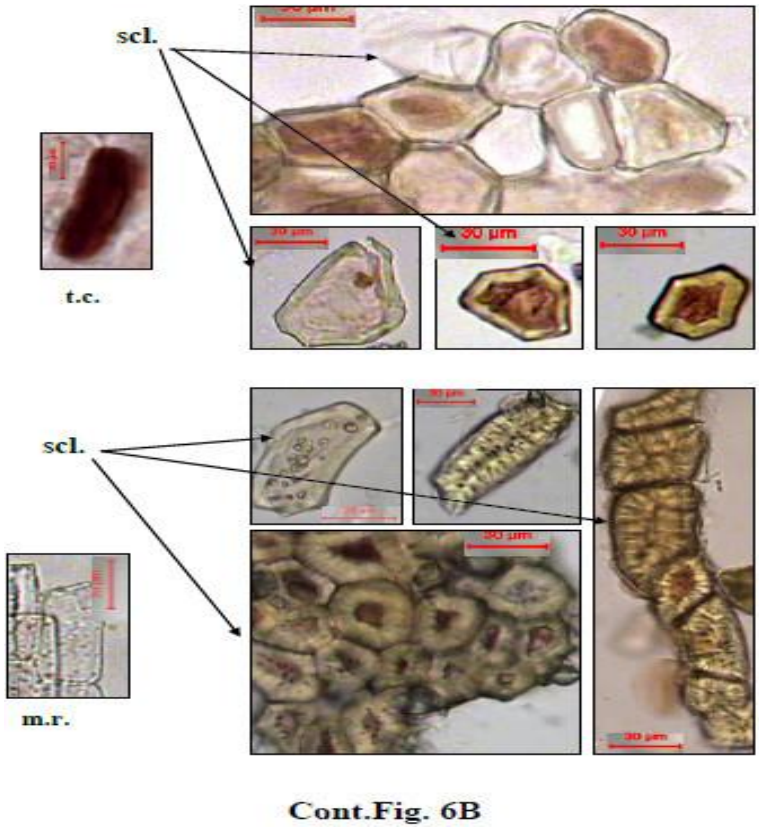


Fig. 6



Cont.Fig. 6B

Fig. (6): Micromorphology of the stem bark of *P. roxburghii G.Don.*

A) High power view of the stem bark (X=75)

B) Powdered stem bark

ck., cork (X=400); cr.sh., crystal sheath; m.r., medullary ray (X=400); p.f., pericyclic fibres (X=1000); ph.f., phloem fibres; ph.par., phloem parenchyma; pr.ca., prism of calcium oxalate (X=238); Scl.,sclereids (X=416, 466 and 533 for thin walled and 333, 416 and 450); t.c. tannin cells (X=303); sec. cor., secondary cortex.

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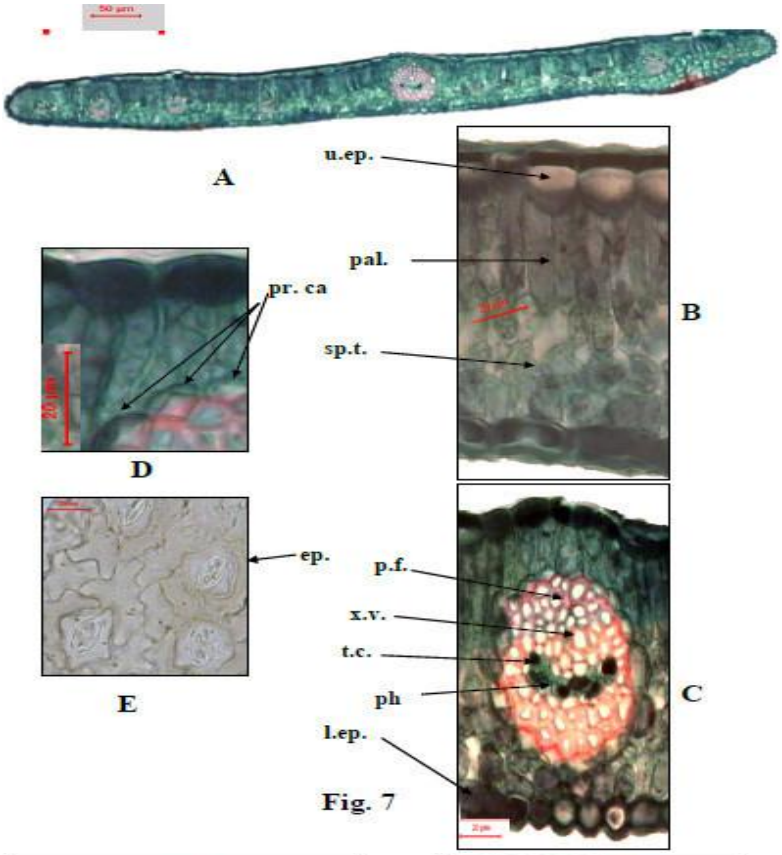


Fig. 7

Fig. (7): Micromorphology of the leaflet of *Parkia roxburghii G. Don.*

A) Low power view of T.S. in the leaflet (X=200)
B) High power view of T.S. in the lamina (X=700)
C) High power view of T.S. in the midrib (X=400)
D) Part of the lamina showing prisms of ca-oxalate (X=1250)
E) Lower surface preparation in the leaflet (X=400)

l.ep., lower epidermis; p.f., pericyclic fibres; pal., palisade; ph., phloem; pr.ca., prism of calcium oxalate; sp.t., spongy tissue; t.c., tannin cells; u.ep., upper epidermis; x.v., xylem vessels.

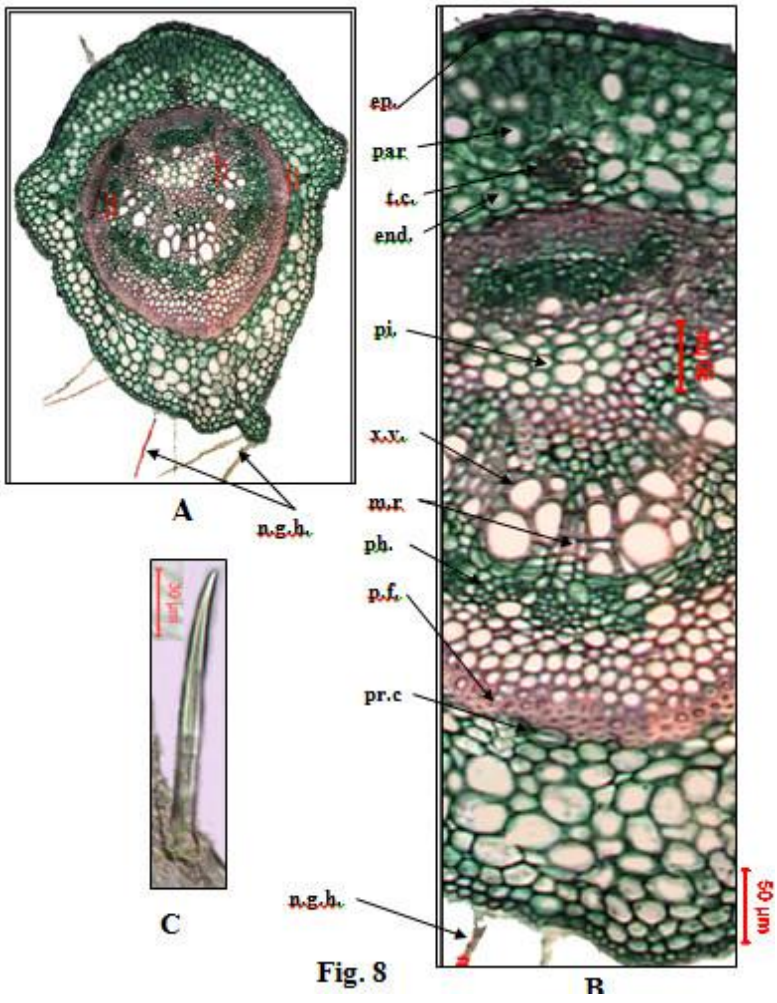


Fig. 8

Fig.(8): Micromorphology of the petiole of *Parkia roxburghii G.Don.*

A) Low power view of T.S. in the petiole (X=140)
B) High power view of T.S. in the petiole (X=280)
C) Non glandular trichome (X=500)

end., endosperm; ep., epidermis; m.r., medullary rays; n.g.t.; non-gladular trichome; p.f., pericyclic fibres; par., parenchyma cells; ph., phloem; pa., parenchyma cells; pr.ca.; prism of calcium oxalate; t.c., tannin cells; x.v.,

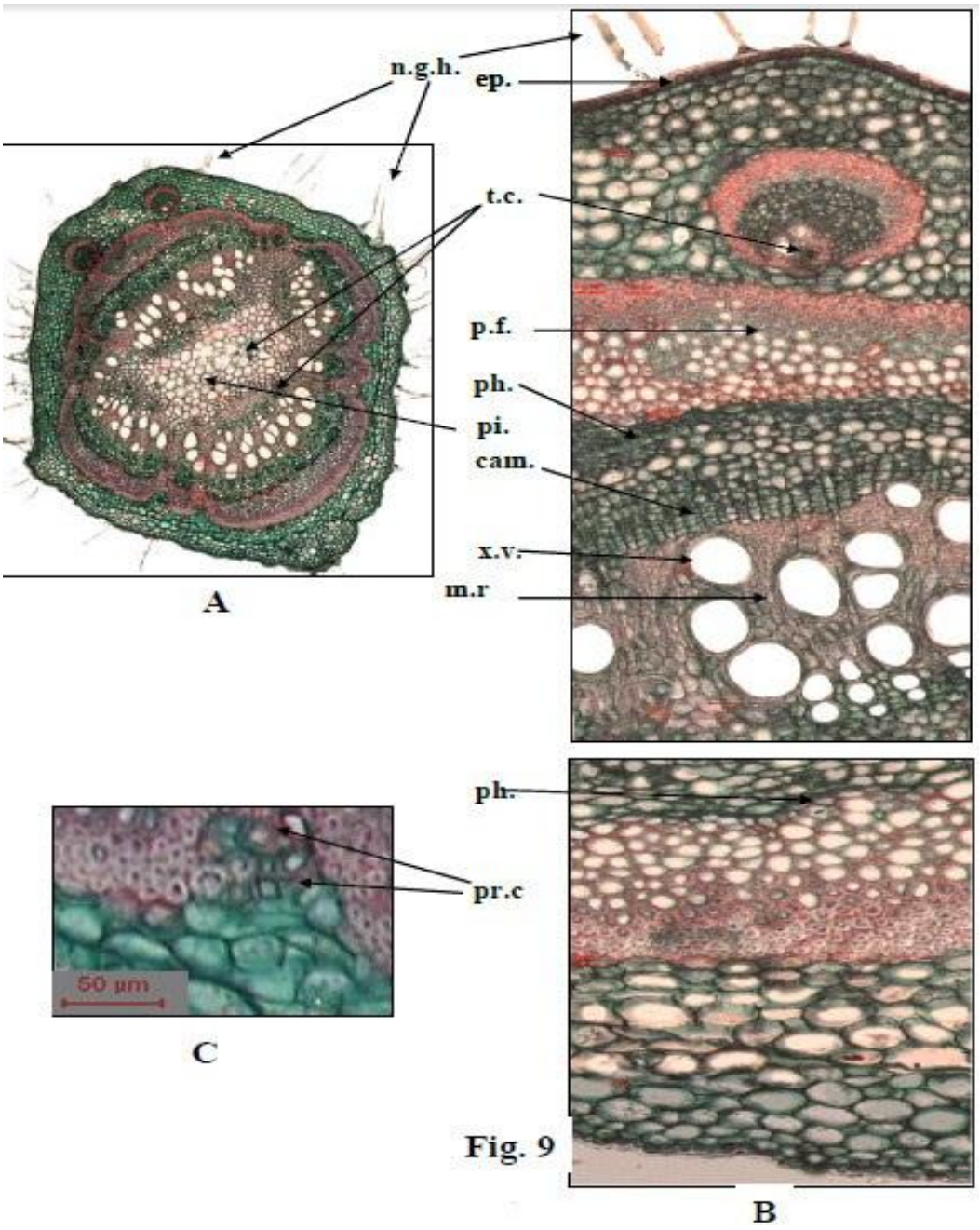


Fig. (9): Micro morphology of the rachis of *Parkia roxburghii G.Don.*

A) Low power view of T.S. in the rachis (X=40)

B) High power view of T.S. in the rachis (X=100)

C) Part of the sector showing prisms of ca-ox (X=320)

ep., epidermis; m.r., medullary rays; n.g.t.; non-gladular trichome; p.f., pericyclic fibres; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; x.v., xylem vessel.

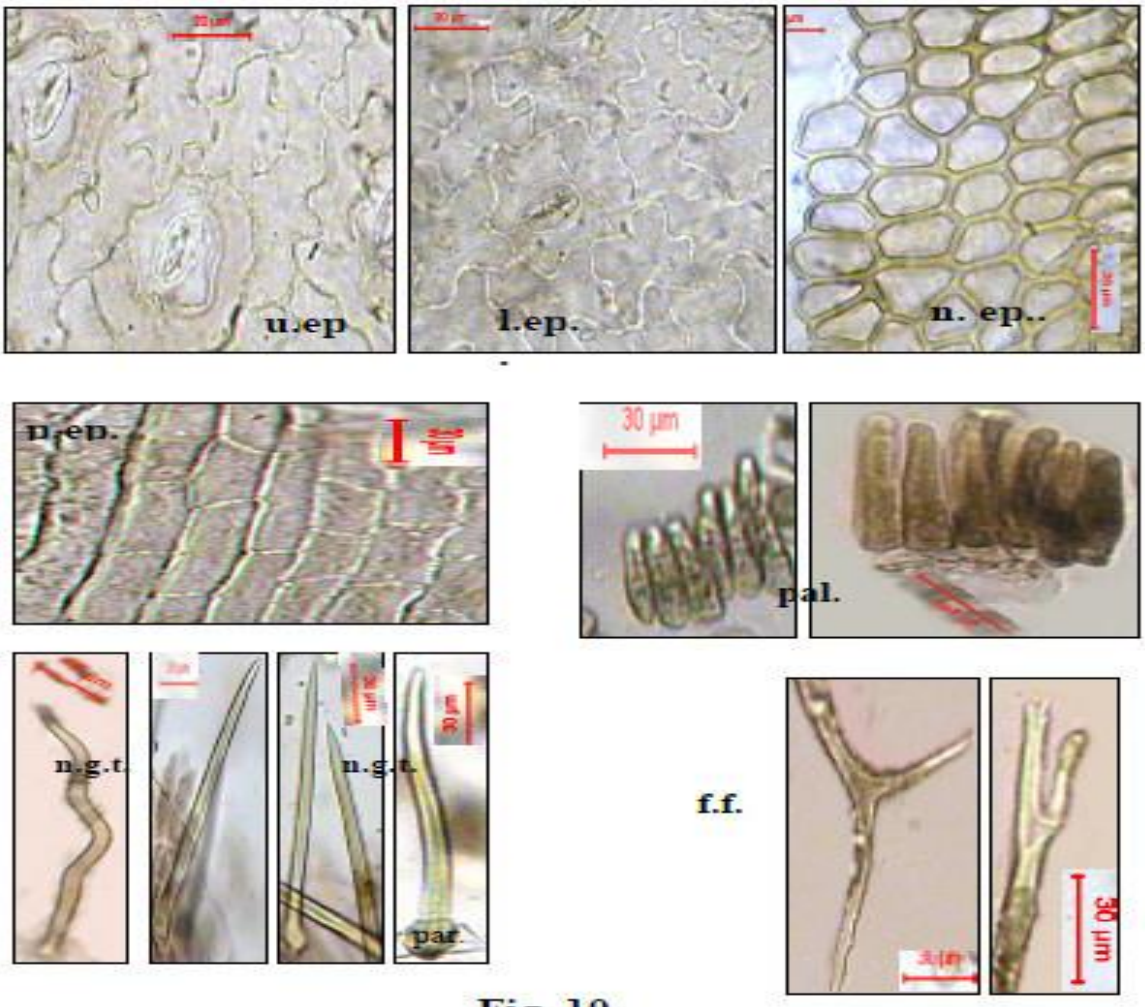
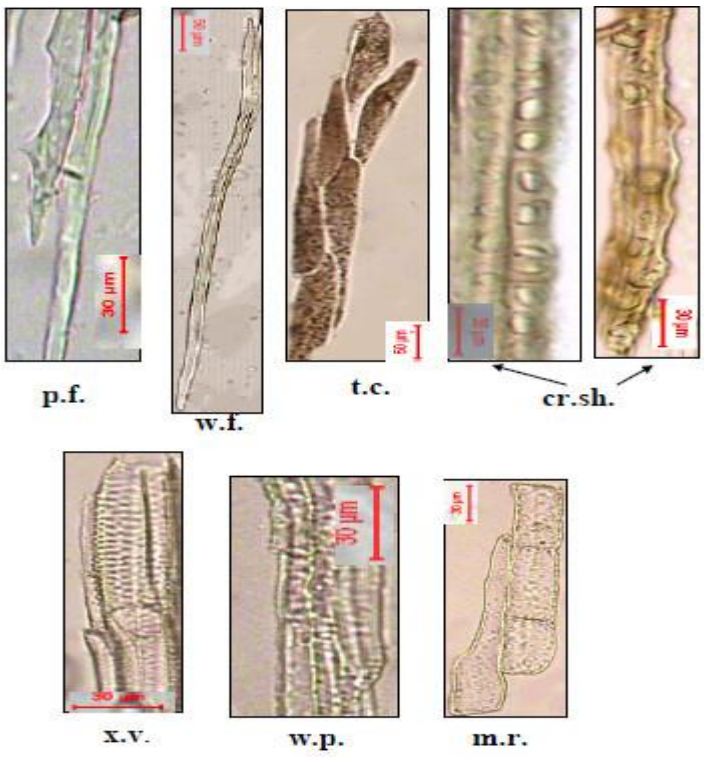


Fig. 10



Cont. Fig. 10

Fig. (10): Powdered leaf of *Parkia roxburghii G.Don.*

f.f., forked fiber (333-733); l.ep., lower epidermis of the leaflet (X=500);
m.r., medullary rays (X=267); n.ep., neural epidermis (X=800); n.g.t., non-glandular trichomes (X=166,230,400 and 433); p.ep., petiole epidermis (X=283); p.f., pericyclic fibres (X=433-600); pal., palisade (X=416-600);
t.c., tannin cells (X=160); u.ep., upper epidermis of the leaflet (X=550); w.p., wood parenchyma (X=600); x.v., xylem vessel (X=566).

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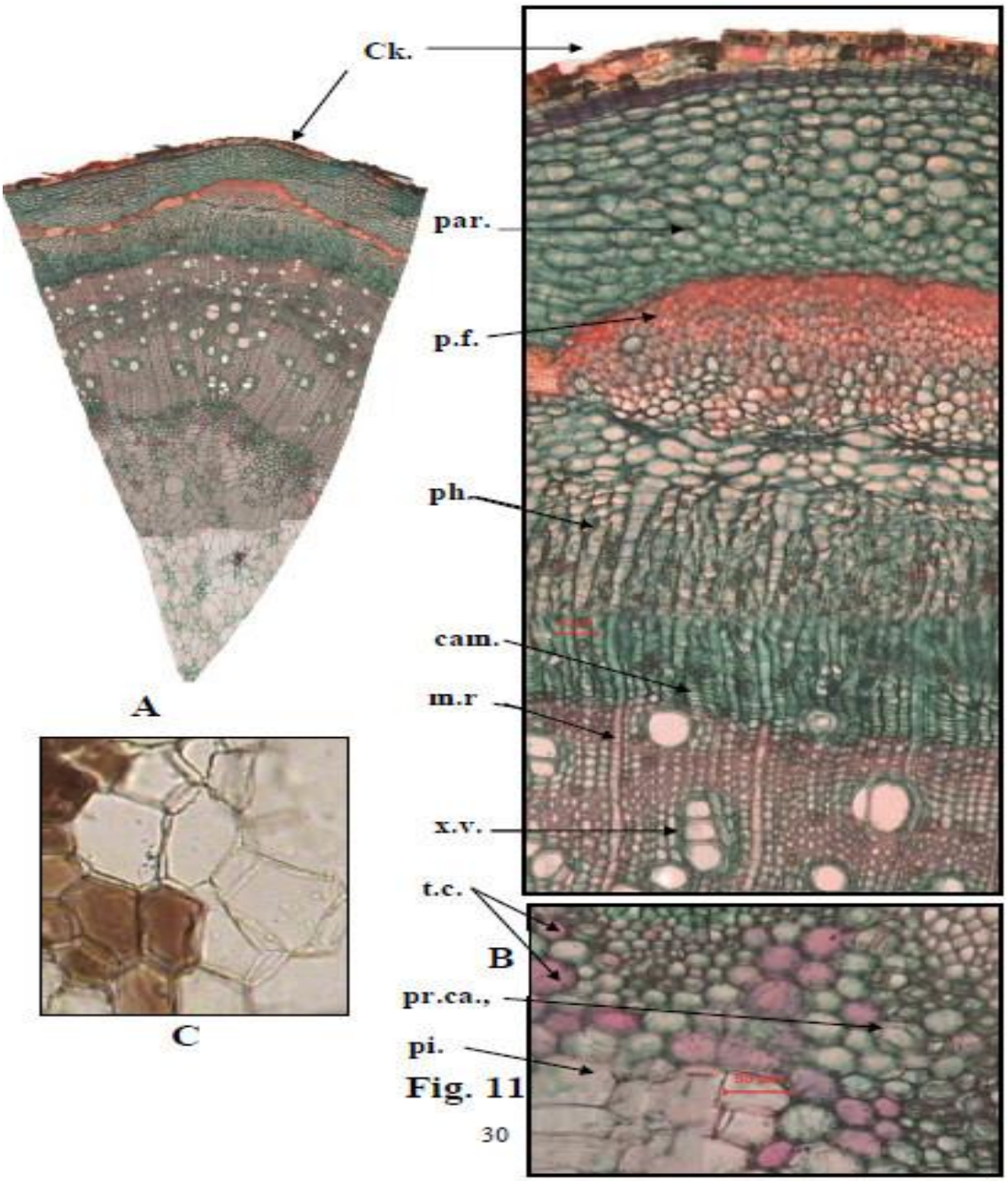


Fig. (11): Micromorphology of the old stem branch of *Parkia biglobosa (Jacq.) Benth*

A) Low power view of T.S. in the old branch (X=30)
B) High power view of T.S. in the old branch (X=130)
Surface view of the cork (X=366)

cam., cambium; ck., cork; m.r., medullary ray; p.f., pericyclic fibres; par. Parenchyma; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; x.v., xylem vessel.

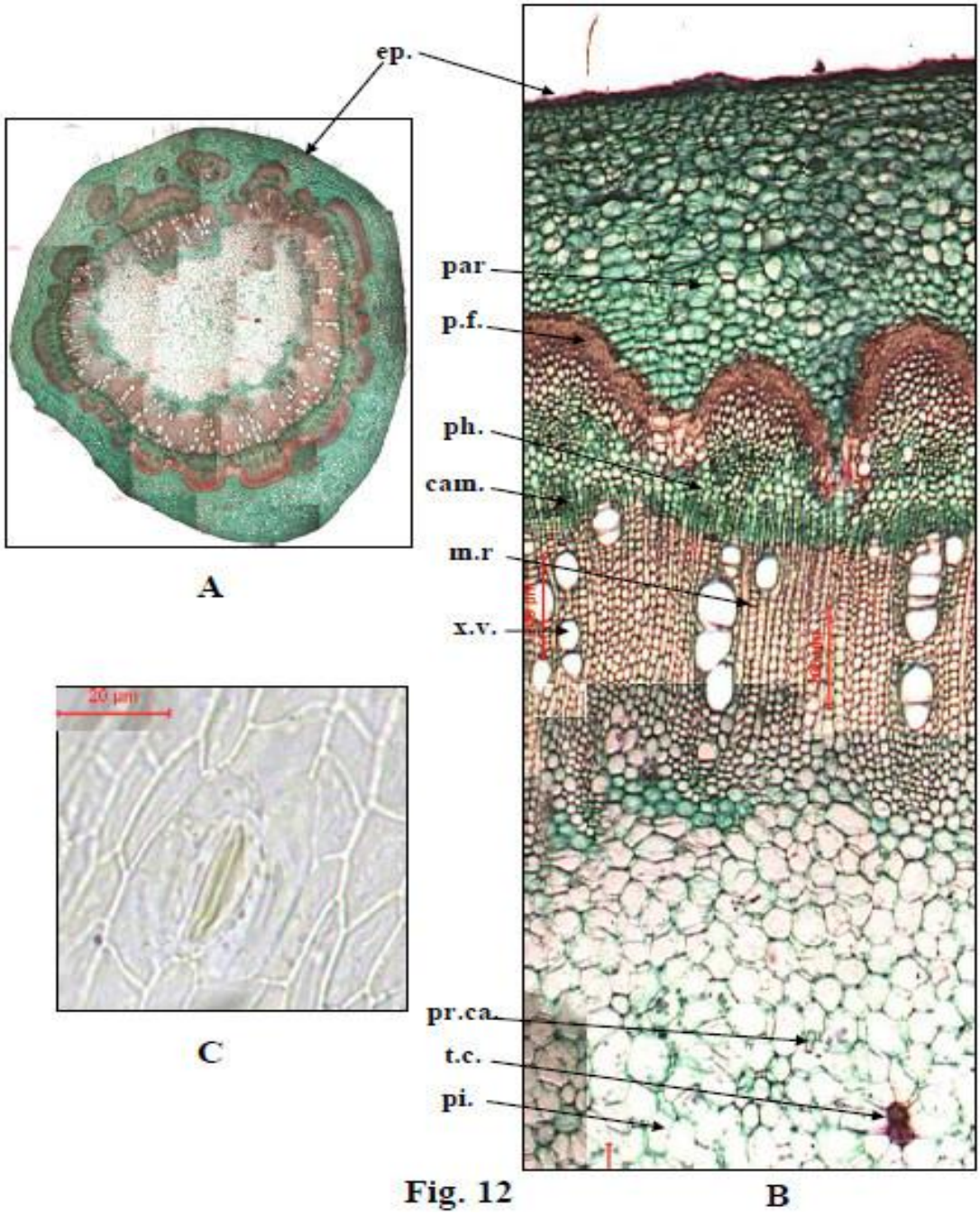


Fig. (12): Micromorphology of the young stem branch of *Parkia biglobosa (Jacq.) Benth*

A) Low power view of T.S. in the young branch (X12.5)
B) High power view of T.S. in the young branch (X=100)
C) Surface preparation in the young branch (X=700)

cam., cambium; ep., epidermis; m.r., medullary rays; p.f., pericyclic fibres; par., parenchyma; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; x.v., xylem vessel.

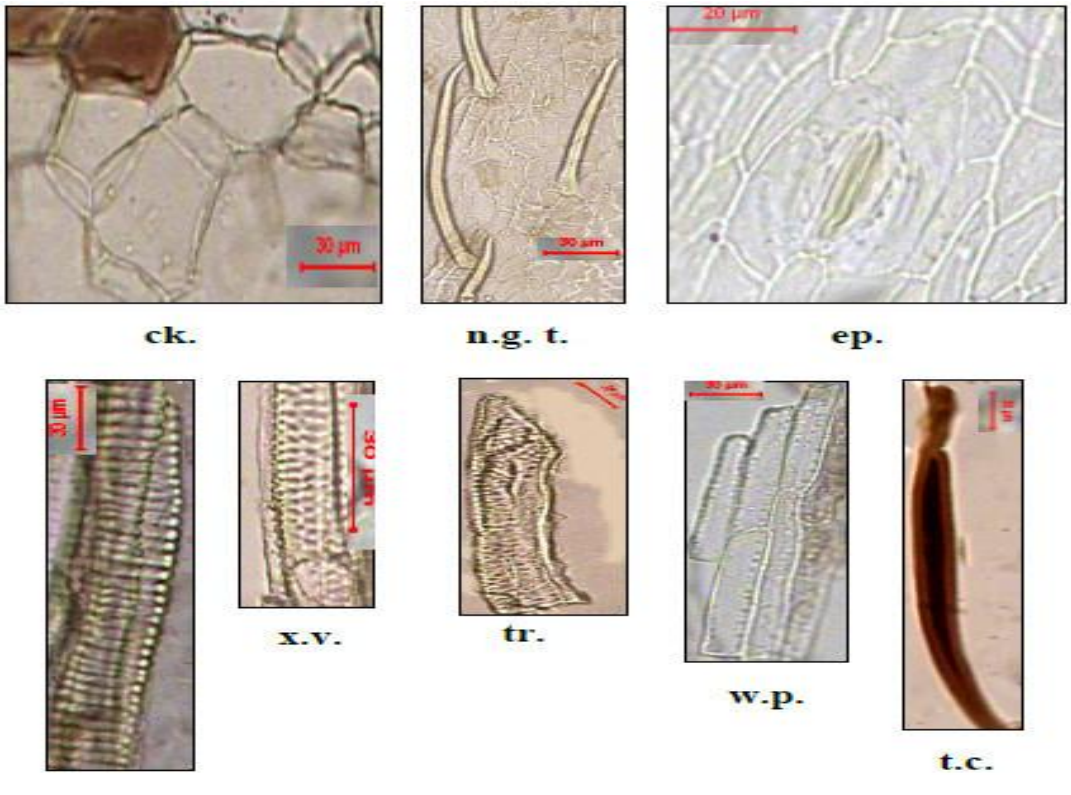
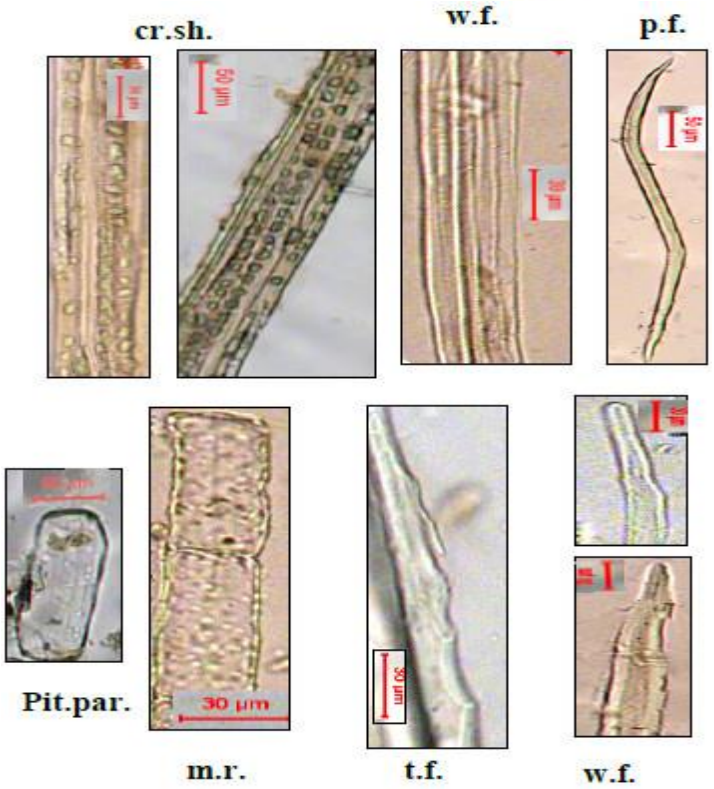


Fig. 13



Cont. Fig. 13

Fig. (13): Powdered stem of *Parkia biglobosa (Jacq.) Benth* **ck., cork (X=366); cr sh.,crystal sheath (X=230); ep., epidermis; m.r., medullary rays (X=700); n.g.t., non-glandular trichomes; p.f., pericyclic fibres (X=160); pit. par., pitted parenchyma; t.c., tannin cell (X=300); tr., tracheid; w.f., wood fibre (X=333); w.p., wood parenchyma (X=300); x.v., xylem vessel (X=516&1000).**

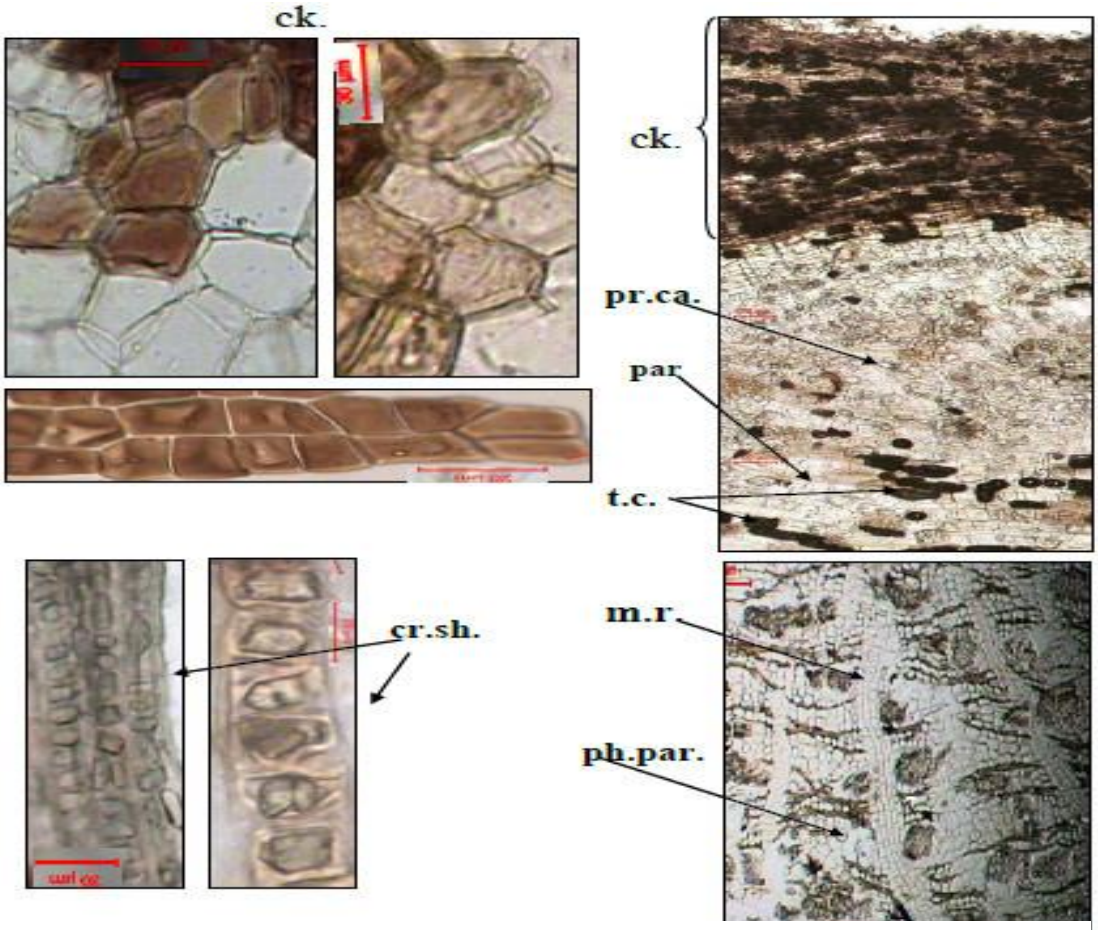
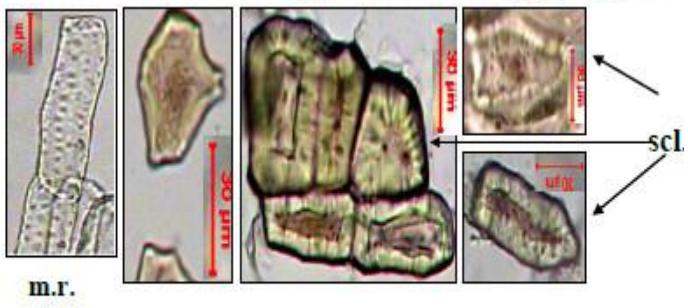


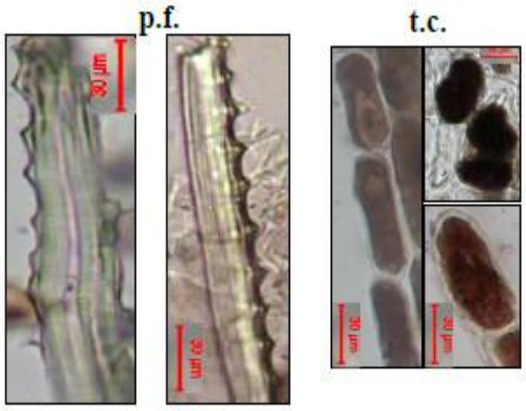
Fig.(14): Micromorphology of the stem bark of *Parkia biglobosa (Jacq.) Benth*

A) High power view of T.S. in the stem bark (X=125)

B) Powdered stem bark

ck., cork (X=366,500 and 900); cr.sh.,crystal sheath (X=263); m.r., medullary ray (X=333); p.f., pericyclic fibre (X=476-500); ph.par., phloem parenchyma (X=300); pr.ca., prism of calcium oxalate (X=714); scl., sclerides (X=300, 433,600 and 800); t.c., tannin cells (X=333); w.p., wood parenchyma (X=466).





Cont. Fig. 14 B

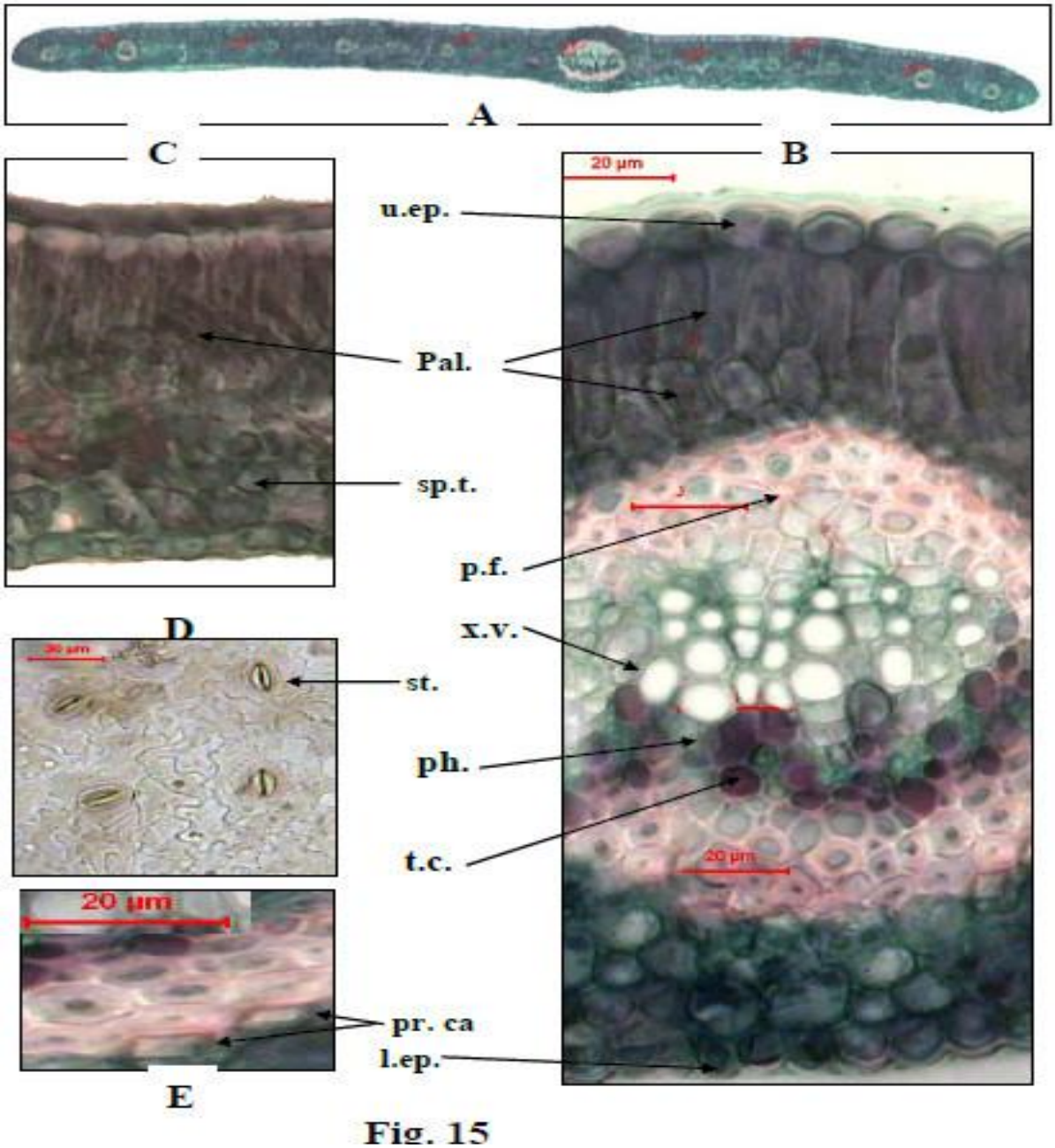


Fig. 15

Fig. (15): Micromorphology of the leaflet of *Parkia biglobosa (Jacq.) Benth*

A) Low power view of T.S. in the leaflet (X=80)
B) High power view of T.S. in the midrib (X=833)
C) High power view of T.S. in the lamina (X=410)
D) Lower surface preparation in the leaflet (X=370)
E)Part of the sector showing calcium oxalate prisms (X=1428)

l.ep., lower epidermis; m.r., medullary rays; p.f., pericyclic fibres; pal., palisade; ph., phloem; pr.ca., prisms of calcium oxalate; sp.t., spongy tissue; t.c., tannin; u.ep., upper epidermis; x.v., xylem vessels.

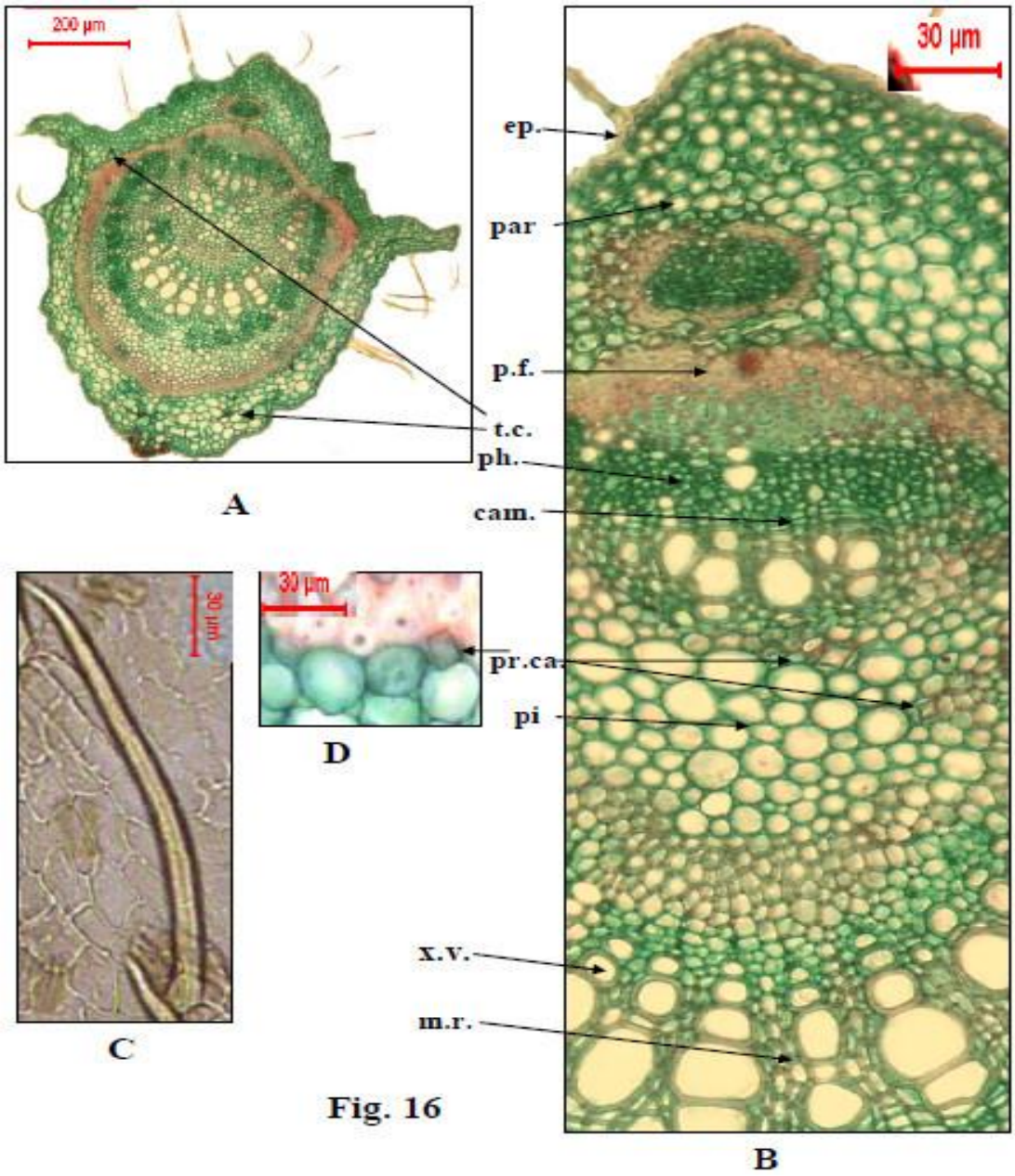


Fig. (16): Micromorphology of the petiole of *Parkia biglobosa (Jacq.) Benth*

A) Low power view of T.S. in the petiole (X=80)
B) High power view of T.S. in the petiole (X=588)
C) Surface preparation in the petiole (X=500)
D) Part of the sector showing calcium oxalate prism (X=435)

cam., cambium; ep., epidermis; m.r., medullary rays; p.f., pericyclic fibres; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; x.v., xylem vessel; cry sh., crystal sheath.

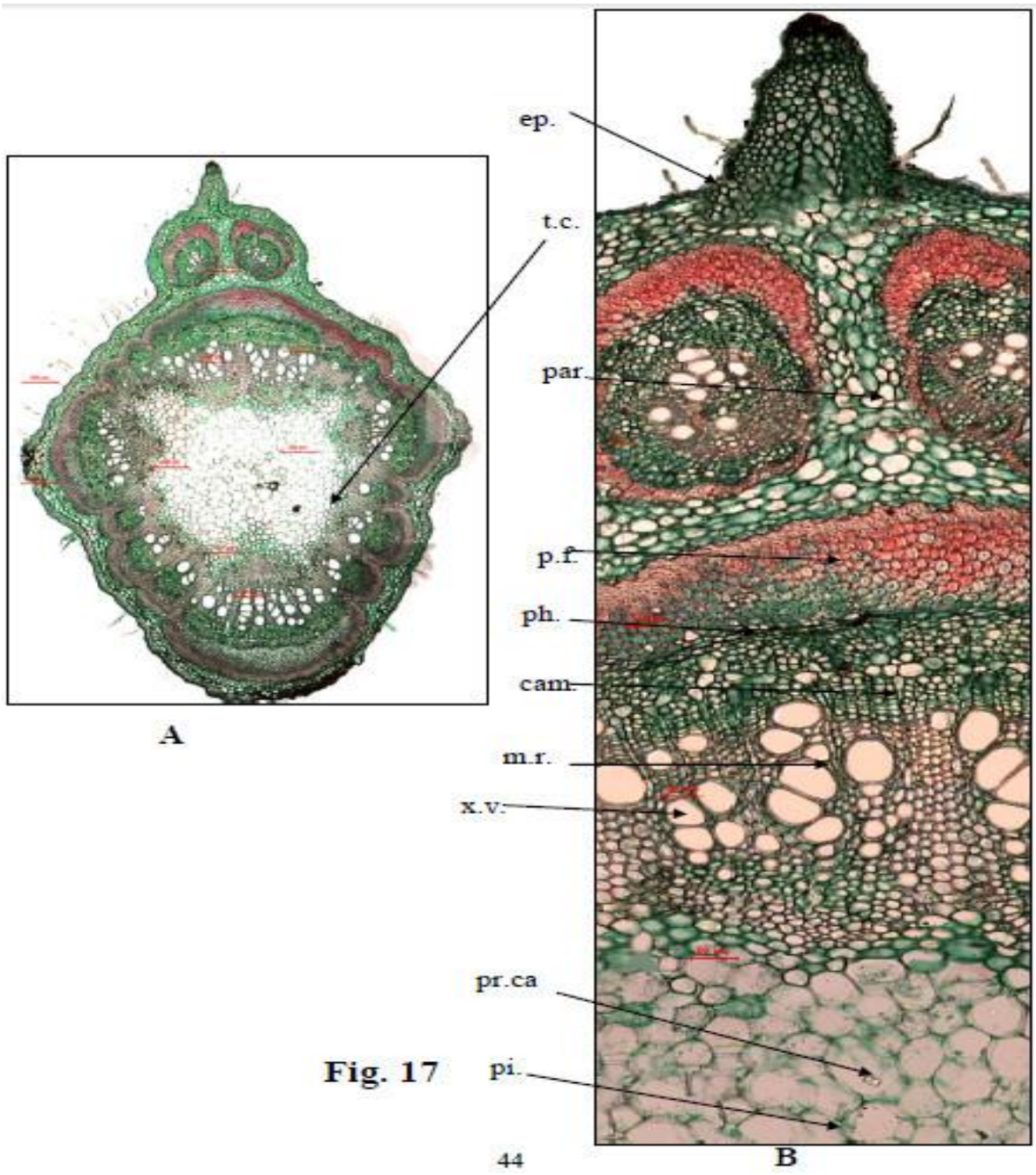


Fig. (17): Micromorphology of the rachis of *Parkia biglobosa (Jacq.) Benth*

A) Low power view of T.S. in the rachis (X=30)

B) High power view of T.S. in the rachis (X=140)

cam., cambium; ep., epidermis; m.r., medullary rays; par., parenchyma; p.f., pericyclic fibres; ph., phloem; pi., pith; pr.ca., prism of calcium oxalate; t.c., tannin cells; x.v., xylem vessel.

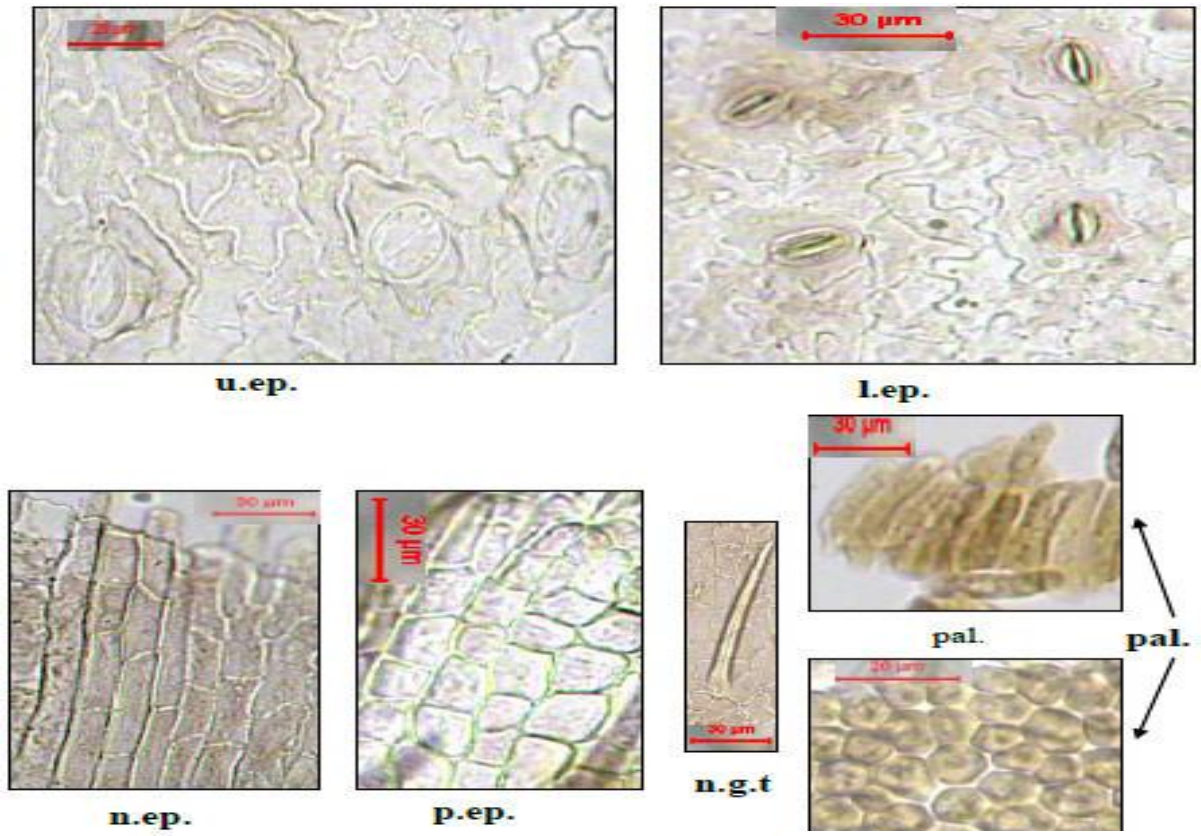
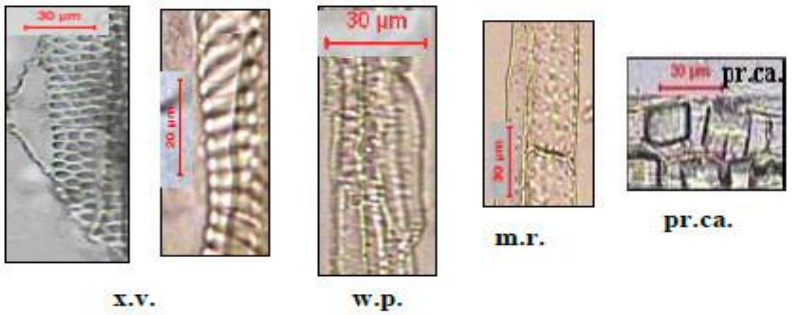
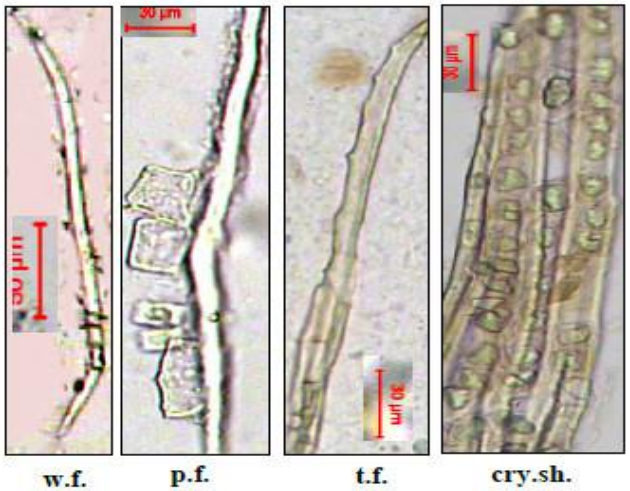


Fig. 18





Cont. Fig. 18

Fig. (18): Powdered leaf of *Parkia biglobosa (Jacq.) Benth*

cr.sh.,crystal sheath (X=417); l.ep., lower epidermis of the leaflet (X=667);

m.r., medullary rays (X= 500); n.ep., neural epidermis (X=466); n.g.t., non-glandular trichome; p.ep., petiole epidermis (X=600); p.f., pericyclic fibres (X=500) ; pr.ca., prism of calcium oxalate (X=433); t.f., tortous fibre; u.ep., upper epidermis of the leaflet (X=650); u.pal., palisade (X=850); w.f., wood fibre; w.p., wood parenchyma (X= 666); x.v., xylem vessel (X=105 and 450).

CONCLUSION

The macro- and micromorphological characteristics of the stem, stem bark and leaves of *Parkia biglobosa* (Jacq.) Benth and *Parkia roxburghii* G.Don. cultivated in Egypt are presented, with the aim of finding out the diagnostic characters for identification and differentiation of this species in both entire or powdered forms. Paracytic stomata, numerous non-glandular short unicellular trichomes covered with warty cuticle, prisms of calcium oxalate, crystal sheath and tannin cells were found to be the diagnostic elements of both the stem and leaf of the two species, while thick lignified pitted-walls sclerides of variable shapes and sizes were found abundant in the stem bark of the two species.

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