

MACRO- AND MICROMORPHOLOGY OF *STERCULIA RUPESTRIS* BENTH. (LEAF AND STEM)

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نبات الاستركوليا روبسترس بنث هو أحد النباتات التابعة للعائلة الاستراكوليسية وموطنه الأصلي استراليا وقد تمت زراعته حديثا في مصر وهو ينمو في الشوارع والحدائق العامة. ولهذه العائلة عدة أجناس لها الكثير من الاستعمالات الطبية وخصوصا في بعض البلدان الإفريقية ودول غرب آسيا والصين. فبعض هذه الأجناس تستخدم كملين ومدر للبول ومضاد للفطريات وبعضها يستخدم في علاج بعض الأمراض التناسلية والبعض الآخر يستخدم في علاج الأزمات الصدرية والروماتزم وقد ثبت أن الزيوت المستخرجة من بذور بعض هذه النباتات لها تأثير فعال في إيقاف عملية التكاثر في إناث بعض أنواع الفئران.

وقد حدا هذا بالباحث إلى التعمق في دراسة هذا النبات وسوف يقوم الباحث بنشر نتائج الدراسة الكيميائية في بحث مستقل خصوصا وأن الباحث قد سبق له مع آخرين بدراسة أحد النباتات التابعة لنفس العائلة وقام بنشر عدة أبحاث في هذا الصدد. أما هذا البحث فيشمل على دراسة الصفات العيانية والمجهريّة لسيقان وأوراق هذا النبات الذي يزرع في مصر بهدف التعرف على سيقانه وأوراقه صحيحة كانت أو على هيئة مسحوق.

The macro- and micromorphology of the leaf and stem of Sterculia rupestris Benth., cultivated in Egypt have been investigated in order to determine the diagnostic feature by which each organ could be identified both in the entire and powdered forms.

INTRODUCTION

Family Sterculiaceae is of about 50 genera, 750 species, nearly all are tropical or subtropicals¹⁻³. It is present as trees, shrubs, herbs and sometimes vines.

Sterculiaceae has several economic importance as it is a source of gums, mucilage, cocoa and chocolate, in addition to its extensive ornamental uses^{1,4,5}.

The genus *Sterculia* L. comprises about 11 species of Australian trees and shrubs grown for ornament in warm climates and propagated by seeds and cuttings of ripened wood^{1,3,5,6}.

Sterculia species have condensed folk uses specially in Africa, Southern Asia and China⁷. Some species are used as purgative⁷, others have been reported to possess diuretic, diaphoretic and antiparasitic actions⁷. The oil content of some species is used as a gonorrhoeal remedy⁷. The barks of some species are used in some Asian countries as a remedy of dropsy and

rheumatism⁷. The dry leaves of some *Sterculia* species are smoked by the Zezuru to relief bronchial asthma⁷. On repeated feeding the female rats with a diet containing the oil of some species, the reproduction was completely inhibited due to the disturbance of the pituitary gonadal axis⁸.

Sterculia rupestris Benth.⁹ is an Australian plant, cultivated in Egypt in streets and public gardens. Very little was reported about its morphology, and nothing was traced concerning the detailed macro- and micromorphological study of the different organs of the plant, hence detailed study was thought to be pertinent due to important situation among other *Sterculia* species.

In previous papers, several purine bases, flavonoids, phenolic acids and other compounds have been isolated and identified from *Sterculia diversifolia* Don.¹⁰. The macro- and micromorphological characters of the previous plant were also reported^{11,12}.

In continuation of the work on *Sterculia* species cultivated in Egypt, the author reports here the macro- and micromorphology of the leaves and stems of *Sterculia rupestris* Benth. to reveal the diagnostic features by which the plant can be identified in the entire and powdered forms from other closely related species. The chemical study of this plant will be published in the near future.

Plant material

Fresh samples of the flowering *Sterculia rupestris* Benth. were collected in April 1995 from the Experimental Station of the Faculty of Agriculture, Assiut University, Assiut, Egypt. The identity of the plant was confirmed by Prof. A. Fayed, Prof. of Plant Taxonomy, Faculty of Science, Assiut University.

A voucher sample is kept in the Dept. of Pharmacognosy, Faculty of Pharmacy, Assiut University.

MACROMORPHOLOGY

Habitat

Sterculia rupestris Benth. (Fig. 1) is a perennial shrub cultivated in Egypt. It attains a height of about 4-6 meters. It shows a monopodial branching and carries obovate, entire, acuminate, alternate leaves. The plant bears unisexual and hermaphrodite, pinkish-white flowers, arranged in axial panicles. The corolla is absent and the calyx is corolla-like having bell-shape. The fruit is a woody follicle, tardely dehisces. The shrub shows a big root system of main tap root and lateral branches.

The flowering period is April to May, while the fruiting season is summer.

The leaf (Fig. 1)

It is dark green in colour, slightly bitter in taste and odourless. It is obovate in shape, simple, alternate, entire with acuminate apex, smooth (showing reticulations) surface. It measures 5-8 cm in length and 3-5 cm in width.

The leaves are exstipulate. It is petiolated with a long petiole which is smooth, cylindrical, solid, somewhat swollen at the basal part, bright

green in colour measuring 2-7 cm in length and 0.5-1.2 mm in width.

The stem (Fig. 1)

The old stem is woody, erect, cylindrical, solid, reaching about 3-4 meters in height, 20-30 cm in diameter in the middle part and 2-5 cm at higher levels. It is monopodially branched and the small branches possess internodes, measuring from 3-7 cm in length. The young stem is yellowish-green in colour and bearing the scars of fallen leaves.

The stem bark is hardly separated from the wood. It is thick, soft, with an outer dark brown longitudinally striated surface. The stem is odourless and with a slight bitter taste.

MICROMORPHOLOGY

The leaf (Fig. 2,A)

A transverse section through the lamina is biconvex in outline, possesses a dorsiventral structure with an upper palisade of mainly two rows. The palisade is interrupted in the middle region by a mass of hypodermal collenchyma. Another mass of collenchyma is situated beneath the lower epidermis. The upper epidermis is accompanied by a hypodermis of one row of large parenchyma cells. The vascular system is represented by a large crescent-shaped collateral vascular bundle with an upper arc of radiating xylem elements and a lower arc of soft phloem elements. Other additive two inverted bundles are situated at the upper part of the main bundle. The whole system is surrounded by a pericycle of alternated groups of lignified fibers and parenchyma.

A large mucilage cavity is present at the upper side of the vascular system and numerous schizogenous glands containing mucilage (which stains red with Ruthenium red), forming an arc beneath in the cortex.

The upper epidermis (Fig. 2,C): It is formed of a single mucillagenous layer of quadrangular cells as seen in the transverse section. In surface view (Fig. 2,C), the cells are polygonal, isodiametric and have straight anticlinal walls.



Fig. 1: Sketch of *Sterculia rupestris* Benth.

(x 0.70)

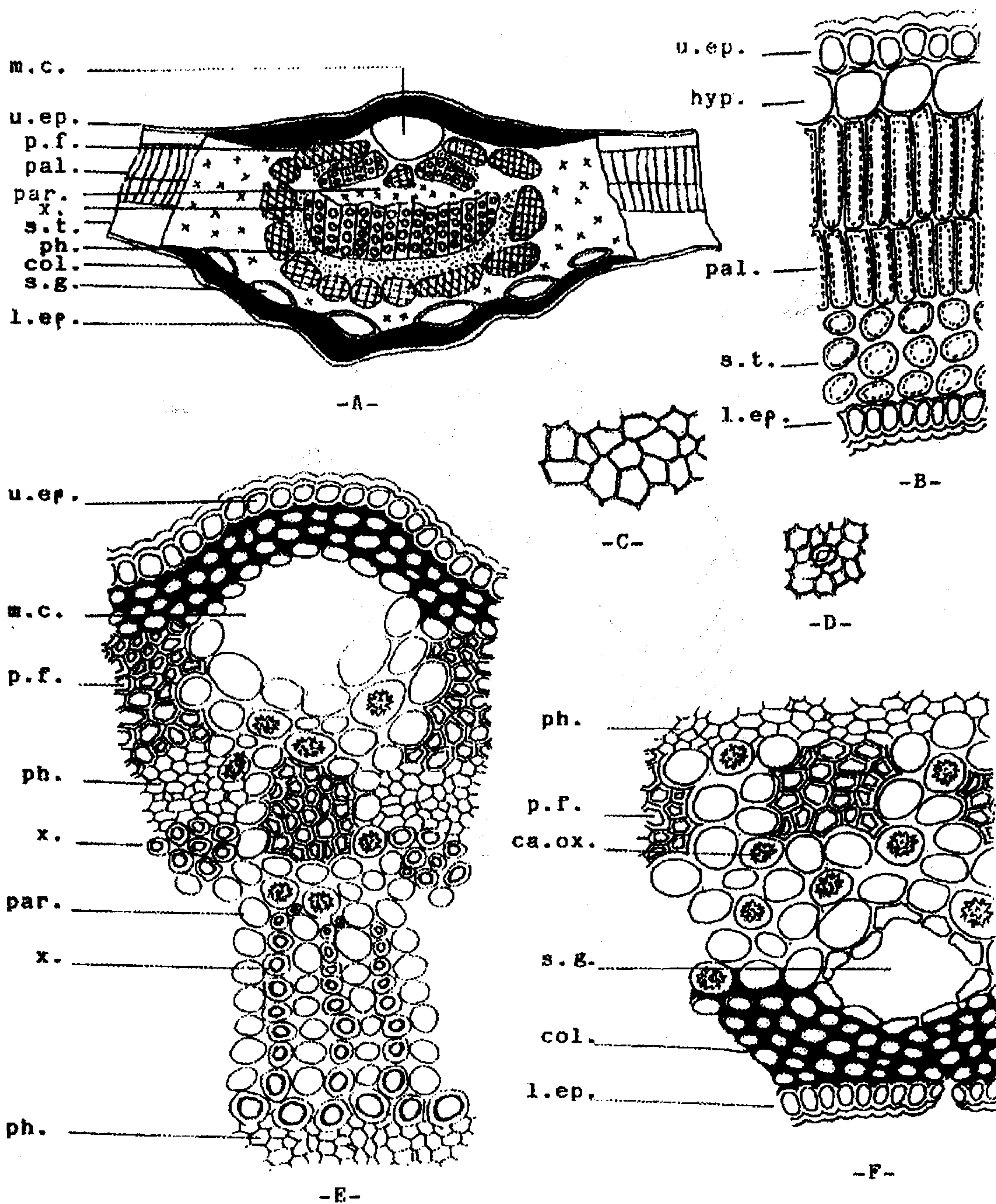


Fig. 2: The leaf:

- A- Diagrammatic T.S. of the leaf (x 43)
- B- Detailed T.S. of lamina (x 170)
- C- Upper epidermis of lamina (x 193)
- D- Lower epidermis of lamina (x 193)
- E.F.- Detailed T.S. of midrib (x 170)

ca.ox., calcium oxalate; col., collenchyma; hyp., hypodermis; l.ep., lower epidermis; m.c., mucilage cavity; par., parenchyma; p.f., pericyclic fibers; ph., phloem; s.g., schizogenous gland; s.t., spongy tissue; u.ep., upper epidermis; v., vessels; x., xylem.

They are covered with thick smooth cuticle. They measure 12 to 18 μ in width, 11 to 15 μ in length and 10 to 13 μ in height. Stomata and hairs are absent.

The lower epidermis (Fig. 2,D): It is formed of one layer of mucillagenous cells, which are similar to those of the upper, but smaller in size, being from 7 to 9 μ in width, 7 to 9 μ in length and 9 to 11 μ in height. Stomata are present which are of ranunculaceous type, measuring from 8 to 10 μ in length, 5 to 7 μ in width and each stomata is surrounded by 5 to 6 epidermal cells. Hairs are absent.

The mesophyll (Fig. 2,B): The hypodermis shows one layer of large parenchyma cells measuring from 19 to 22 μ in diameter.

The upper row of palisade is longer, measuring from 35 to 38 μ in length and from 6 to 8 μ in width. The lower row shows cells measuring from 23 to 27 μ in length and from 6 to 8 μ in width.

The spongy tissue is formed of thin-walled rounded or slightly irregular parenchyma cells with intercellular spaces and contain chloroplasts.

The cortical tissue: It consists of rounded parenchyma cells with small intercellular spaces and contain cluster crystals of calcium oxalate of a diameter of 7-9 μ .

The pericyclic fibers (Fig. 3,D): These are straight, showing pointed or acute apices, wide lumen and thin, lignified walls and measure from 125 to 175 μ in length and from 6 to 8 μ in width.

The xylem (Fig. 3,D): It shows lignified vessels, arranged in radial rows, mainly pitted, spiral and annular, measuring from 6 to 12 μ in diameter.

The phloem (Fig. 2,E): It is formed of small, thin-walled, shining cellulosic elements.

The medullary rays (Fig. 2,E): These are mainly uni- or biseriate thin-walled cells. Some of which contain cluster crystals of calcium

oxalate measuring about 9 μ in diameter.

The pith: It is formed of parenchymatous cells with moderate intercellular spaces, some of which contain cluster crystals of calcium oxalate measuring about 8-9 microns in diameter.

The petiole (Fig. 3,A)

A transverse section through the petiole (Fig. 3,A) is nearly circular in outline. It is formed of an epidermis enclosing a moderately wide cortex. The outer zone of the cortex is formed of 5-6 rows of collenchyma cells followed internally by 3-6 rows of rounded parenchymatous cells. Several mucilage glands arranged in a circle are present in the cortex.

The pericycle is formed of a complete ring of alternating groups of pericyclic fibers and parenchyma. There is another pericyclic ring composed of fibers, continuously arranged and situated between the vascular system and the central pith. The vascular system is represented by an outer ring of phloem followed by a continuous ring of radiating xylem elements. There are 4-6 accessory medullary bundles arranged at the periphery of the narrow central pith, each is composed of an outer arc of xylem elements and an inner batch of pericyclic fibers, and in between there is a narrow phloem. The pith is narrow and parenchymatous.

The epidermis (Fig. 3,C): It is formed of a single mucilagenous layer of square to quadrangular cells, in T.S. (Fig. 3,B). The cells are polygonal, isodiametric and have straight anticlinal walls. They are covered with thick smooth cuticle. They measure 9 to 11 μ in width, 8 to 11 μ in length and 8 to 10 μ in height. Stomata and hairs are absent.

The cortical tissue

The hypodermis (Fig. 3,C): The collenchyma layer is composed of rounded to oval cells. The parenchyma consists of rounded thin-walled cells, some of them contain cluster crystals of calcium oxalate measuring about 10 μ in diameter.

The pericycle (Fig. 3,D): The fibers are long, having regular outlines, with thin lignified walls,

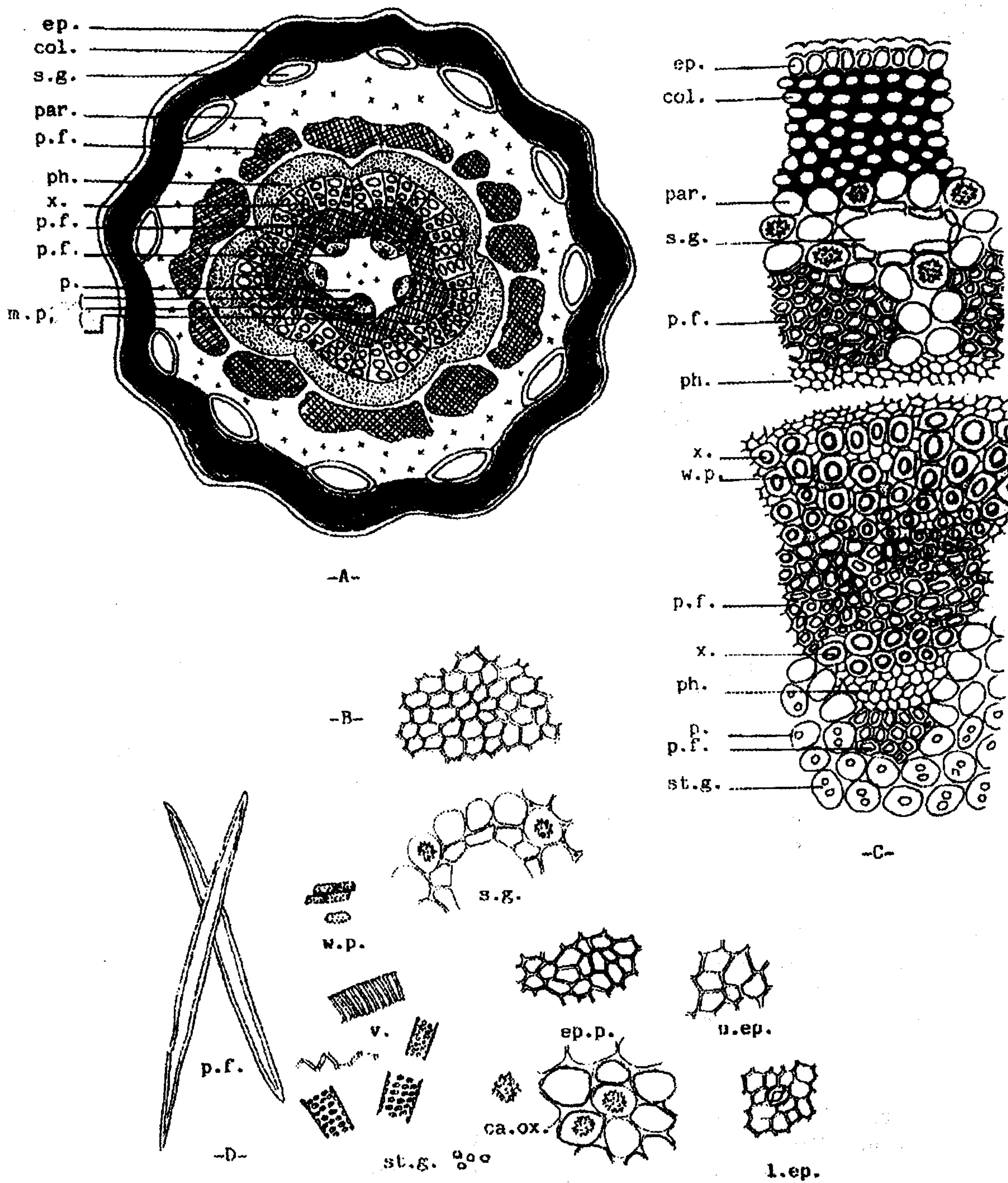


Fig. 3: The leaf:

- A- Diagrammatic T.S. of the petiole (x 42)
 - B- Epidermis of the petiole (x 188)
 - C- Detailed T.S. of the petiole (x 166)
 - D- Isolated elements of the leaf (x 188)
- ca.ox., calcium oxalate; col., collenchyma; ep., epidermis; l.ep., lower epidermis of leaf; par., parenchyma; p.f., pericyclic fibers; ph., phloem; s.g., schizogenous gland; st.g., starch granules; u.ep., upper epidermis of leaf; v., vessels; w.p., wood parenchyma; x., xylem; m.p., medullary bundle.

wide lumena, acute apices and measure from 125 to 175 μ in length and 6 to 8 μ in diameter.

The phloem: It consists of shining thin-walled soft cellulosic elements of sieve tubes, companion cells and phloem parenchyma.

The xylem: It is formed of lignified vessels having pitted, spiral and annular thickenings and measuring from 6 to 12 μ in diameter. They are accompanied by scattered wood parenchyma having lignified pitted walls showing simple pits and measuring 3 to 5 in length and 8 to 10 μ in width, in addition to xylem parenchyma which are thin-walled non-lignified cellulosic cells.

The pith: It is formed of a central narrow zone of polygonal to rounded isodiametric cells with intercellular spaces. Starch granules are abundant in pith, each granule has an oval shape and measures 2 to 3 μ in diameter.

Conclusion

The characteristic elements in the powdered form can be identified as follow:

- 1- Fragments of the upper and lower epidermises, which are (mucilagenous), quadrangular, isodiametric polygonal with straight anticlinal walls and covered with thick smooth cuticle. The lower epidermal cells are smaller in size and bear ranunculaceous stomata. Hairs are absent.
- 2- Fragments of the epidermis of petiole, which are mucilagenous polygonal, isodiametric, having straight anticlinal walls and covered with smooth and thick cuticle. These cells bear no hairs.
- 3- Fragments of schizogenous glands containing mucilage.
- 4- Fragments of pericyclic fibers, which are long, having regular outlines, with thin lignified walls, wide lumena and acute apices and wood parenchyma which have lignified pitted walls showing simple pits.
- 5- Fragments of lignified pitted, annular and spiral xylem vessels of lamina and petiole.
- 6- Fragments of the cortical parenchyma containing cluster crystals of calcium oxalate.
- 7- Numerous starch granules either free or

enclosed in the parenchymatous cells of the pith.

- 8- Fragments of the hypodermal parenchymatous cells of lamina which are large in size.
- 9- Fragments of the mesophyll of lamina, showing spongy parenchyma and palisade cells.

The stem (Fig. 4,A)

A transverse section in the young stem is nearly circular in outline. It is formed of an epidermis carrying stellate hairs, followed by hypodermis consisting of 6-9 rows of collenchyma cells. The cortex is parenchymatous, lined internally by a well-defined endodermis. Throughout the cortex there are several schizogenous glands containing mucilage, arranged in a circle. The pericycle is formed of alternated groups of parenchyma and fibers. The phloem is narrow and the xylem is diffused and wide. The xylem is separated from the phloem by a well-defined cambium. The central cylinder is formed of a ring which is opened by the medullary rays. The central zone of the pith shows a well-defined schizogenous gland containing mucilage.

The epidermis (Fig. 4,C): It is composed of a single layer of quadrangular cells containing mucilage as seen in transverse section. In surface view (Fig. 4,B), the cells are polygonal isodiametric with straight anticlinal walls and covered with thick smooth cuticle. They measure from 8 to 10 μ in width, 8 to 11 μ in length and 9 to 11 μ in height. The epidermis is covered with stellate hairs, each hair consists of 10 to 15 cells, each cell has an acute apex, thick wall and comparatively narrow lumen. Stomata are absent.

The cortical tissue (Fig. 4,C): The hypodermis is formed of 6-9 rows of collenchyma cells without intercellular spaces and contain chloroplasts. The parenchyma are rounded to oval in shape with intercellular spaces, some of which contains cluster crystals of calcium oxalate measuring 11 to 13 μ in diameter.

The mucilage glands are oval in shape, each is lined with a layer of small lining cells and its

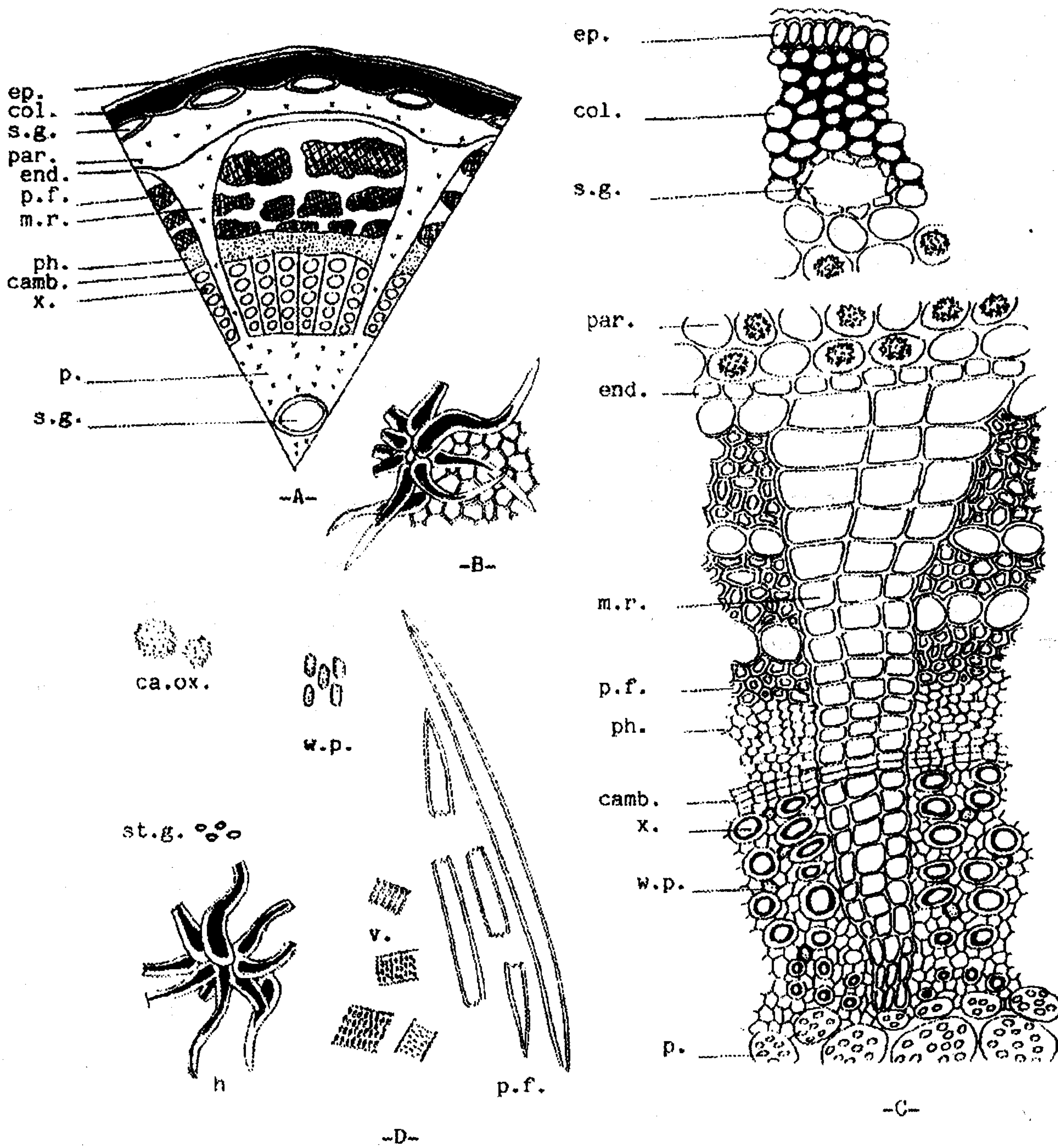


Fig. 4: The stem:

- A- Diagrammatic T.S. of stem (x 40)
- B- Epidermis of stem (x 177)
- C- Detailed T.S. of stem (x 158)
- D- Isolated elements of stem (x 177)

ca.ox., calcium oxalate; camb., cambium; col., collenchyma; end., endodermis; ep., epidermis; h., hair; m.r., medullary rays; par., parenchyma; p.f., pericyclic fibers; ph., phloem; p., pith; s.g., schizogenous gland; st.g., starch granules; v., vessels; w.p., wood parenchyma; x., xylem; m.p., medullary bundle.

content stains red with ruthenium red.

The endodermis is formed of one layer of somewhat tangentially elongated quadrangular cells containing no starch.

The pericycle (Fig. 4,D): The fibers are long, having straight lignified walls, acute apices and comparatively wide lumina. They measure from 195 to 250 μ in length and 8 to 10 μ in diameter.

The vascular system (Fig. 4,C)

The phloem: It is composed of sieve tubes, companion cells and thin-walled phloem parenchyma.

The cambium: The cambial zone is represented by 3-4 rows of cellulosic, thin-walled cells.

The xylem: It consists of lignified vessels having pitted and annular thickenings and measuring 11 to 20 μ in diameter. They are accompanied with scattered wood parenchyma having lignified pitted walls showing simple pits, quadrangular in shape and measuring 3 to 4 μ in length and 8 to 10 μ in width. The xylem parenchyma are thin-walled non-lignified cellulosic cells.

The medullary rays (Fig. 4,C): They are tri- or tetraseriate and traverse the stele to the cortex, the cells are tangentially elongated in the pericycle and phloem and radially elongated in the xylem, thin-walled, cellulosic and free from contents.

The pith: It forms a comparatively narrow central zone of ordinary parenchyma which are thin-walled, rounded to oval cells containing abundant starch granules which are oval in shape and measuring 3 to 4 μ in diameter.

Conclusion

From the previous study of the stem of *Sterculia rupestris* Benth. the characteristic elements in the powdered form can be identified as follow:

1- Fragments of epidermal cells which are quadrangular, isodiametric polygonal with straight anticlinal walls, contain mucilage

and covered with smooth thick cuticle. The epidermis bears numerous stellate hairs, each one consists of 10 to 15 cells, the individual cell possesses a blunt to rounded base and acute apex, thick wall and comparatively narrow lumen. No stomata are present in the epidermis.

- 2- Fragments of oval schizogenous glands containing mucilage.
- 3- Fragments of pericyclic fibers and wood parenchyma.
- 4- Fragments of the cortical parenchyma, some contain cluster crystals of calcium oxalate.
- 5- Fragments of lignified pitted and annular xylem vessels.
- 6- Numerous oval starch granules either free or enclosed in the parenchyma cells of pith.

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