

MACRO- AND MICROMORPHOLOGY OF THE LEAF, STEM AND STEM BARK OF *TECOMA MOLLIS* HUMB. AND BONPL. CULTIVATED IN EGYPT

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نبات التيكوما مولس همب وبونبل المنزرع في مصر هو أحد نباتات الزينة التابعة للعائلة البجنونية ، ويتأصل هذا الجنس في المنطقة الإستوائية وشبه الإستوائية مثل البرازيل والمكسيك وشيلي وبيرو ، وتشتهر أنواع كثيرة منها بأزهارها الجميلة وتستعمل أخشابها في صناعة السفن والأثاث وأيضا لغرض الزينة. كما عرف عن بعض هذه النباتات إستعمالها في علاج بعض الأمراض مثل الملاريا وعلاج بعض الفطريات وتستعمل حديثا في علاج الأورام. كما ثبت أن بعض المواد المفصولة لها تأثير على بعض أنواع البكتيريا والفيروسات وفي حالات السكر كمنظم لنسبة الجلوكوز في الدم. وباستقصاء المراجع المتوافرة لم يعثر على أى دراسة عيانية أو مجهرية لهذا النبات ذى الأهمية الطبية مما حدا بالباحثين على التفكير في هذه الدراسة والتي تشمل دراسة الصفات العيانية والمجهرية لأجزاء النبات المختلفة (الأوراق ، الساق ، قلف الساق) وذلك للتعرف عليها كاملة كانت أو على هيئة مسحوق.

*The detailed macro- and micromorphological characters of the leaf, stem and stem bark of *Tecoma mollis* Humb. and Bonpl., cultivated in Egypt have been studied in order to find out the diagnostic features which can help in the identification of these organs in both entire and powdered forms.*

INTRODUCTION

The genus *Tecoma* is typical of tropical and subtropical areas, where its timber is used in naval and building constructions, owing to the hardness and resistance of its wood.^{1,2} Genus *Tecoma* comprises about 16 species,³ they are half climbing, climbing or upright evergreen shrubs or trees. Several plants of this genus are present in central and south America.^{1,2} *Tecoma mollis* Humb. and Bonpl. is an upright shrub to a large tree attaining about 7 meters in height (Fig. 1A) belonging to the family Bignoniaceae. The species extends through Mexico into Chile and Pero.⁴

It has been introduced to Egypt as an ornamental plant for its timber and showy bell shaped flowers⁵ (Fig. 1B). Due to the quinones, irridoids and alkaloidal contents the extracts of many *Tecoma* species have been used in traditional medicine as hypoglycemic, astringent

to treat diarrhea and dysentery and in the treatment of various neoplastic and skin diseases.^{6,7} The root of *Tecoma* species ground with lemon juice or with water is an effective remedy for snake, rat bites and for scorpion sting.⁸ Ground petals of some *Tecoma* species in kerosine are used as insecticide being more potent than those of pyrethrum.⁹

The phytochemical screening of *Tecoma mollis* Humb. and Bonpl. proved the presence of saponins, flavonoidal glycosides, sterols and/or triterpenes, iridoids, quinones and traces of alkaloids.^{10,11}

Reviewing the current literature, no further information could be traced concerning the macro- and micromorphology of the different organs of the plant, as well as, phytochemical screening.

This work describes the macro- and micromorphological characters, as well as, the powders of the leaf, stem and stem bark of



A



B

Fig. 1: A- Photo of the plant
B- Photo of the leaves with the flowers

Tecoma mollis Humb. and Bonpl. cultivated in Egypt.

EXPERIMENTAL

Habitat

Tecoma mollis Humb. and Bonpl. is a garden evergreen, erect tree with monopodial branches, reaching up to 7-8 meters in height. It carries opposite decussate imparipinnate, exstipulate compound leaves and yellow bell or funnel shaped showy flowers (Fig. 1A&B). The fruit is a capsule containing numerous flattened and winged seeds. The plant prefers heavy soil and subtropical dry situation.

Plant material

The plant was cultivated in the Experimental Station of Faculty of Agriculture, Assiut University, Assiut, Egypt and was kindly identified by Prof. Dr. Gamal Taha, Departement of Horticulture, Faculty of Agriculture, Assiut University.

Fresh samples of the plant were collected in the period from January to March 2000. The samples were collected by the authors, before and during flowering and fruiting stages. Fresh leaves, stems and stem barks, as well as, samples preserved in a mixture of alcohol (70%) - glycerin - water (1:1:1) were used.

The different plant organs viz. leaves, stems and stem barks were air-dried, reduced to fine powder and stored in well closed containers.

1- The Leaf

Macromorphology of the leaf

The leaves of *Tecoma mollis* Humb. and Bonpl. (Fig. 2A) are compound leaves,¹² each leaf is usually formed of (5-9) leaflets.

The lateral leaflets are sessile while the upper ones are shortly petiolulate. The terminal leaflet has long petiolule being larger in size, oblong-ovate in shape with minutely serrate margin, acuminate apex and assymetric base. The venation is pinnate-reticulate and anastomosing near the margin. The midrib is more prominent on the lower surface.

The leaflet has a dark green upper surface and a paler lower one, measuring from 4 to 18

cm in length and from 2.5 to 8 cm in width at the widest part.

The petiole or petiolule is plano-concave, channelled on its upper surface with two lateral projections. It has a green to pale green colour and measures from 0.5-2 cm in length and 0.2 to 0.4 cm in diameter.

The rachis of the compound leaf is hairy, sub-cylindrical in outline, showing two small ridges on its upper side and a shallow groove in between. It has green colour, measuring from 3 to 10 cm in length and from 0.2-0.4 cm in diameter. The dried leaves are brittle in texture, it has bitter taste and faint odour.

Micromorphology of the leaflet

The transverse section in the leaflet (Figs. 2B&3A) is planoconvex in outline. It shows a dorsiventral structure with an upper palisade and narrow spongy tissue. The palisade layer consists of two rows of collumnar cells and interrupted in the midrib region by subepidermal mass of collenchymatous cells. Another mass of collenchyma is present on the lower part of the midrib.

The vascular system is formed of a closed vascular ring consisting of a lower larger crescent-shaped bundle, attached to an upper smaller inversed bundle forming together a complete ring with external pericycle surrounding the whole bundle and showing arms introduced in the phloem and dividing it into compartments.

The phloem forms a continuous ring surrounding the xylem which enclosed a wide central pith. Anomalous wedge shaped masses of inter-xylary phloem is present inside the xylem especially towards the upper surface.¹³ In addition to the presence of numrous scattered small vascular bundles at the periphery of pith towards the upper surface being formed of an internal pericycle, phloem and an outer xylem.

The upper epidermis

The upper epidermis consists of one row of square to subrectangular cells. In surface view (Fig. 4A&B) the cells appear polygonal usually isodiametric or slightly elongated with sinuated, beaded anticlinal walls, measuring (15-28-40) μ in length, (12-20-28) μ in width and (12-14-16) μ

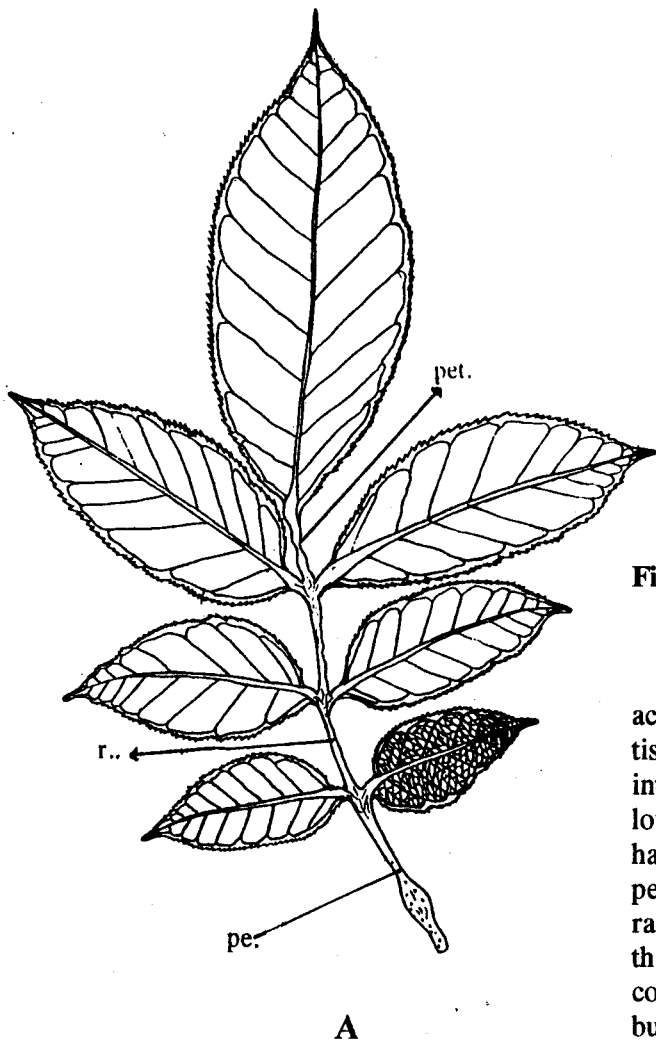
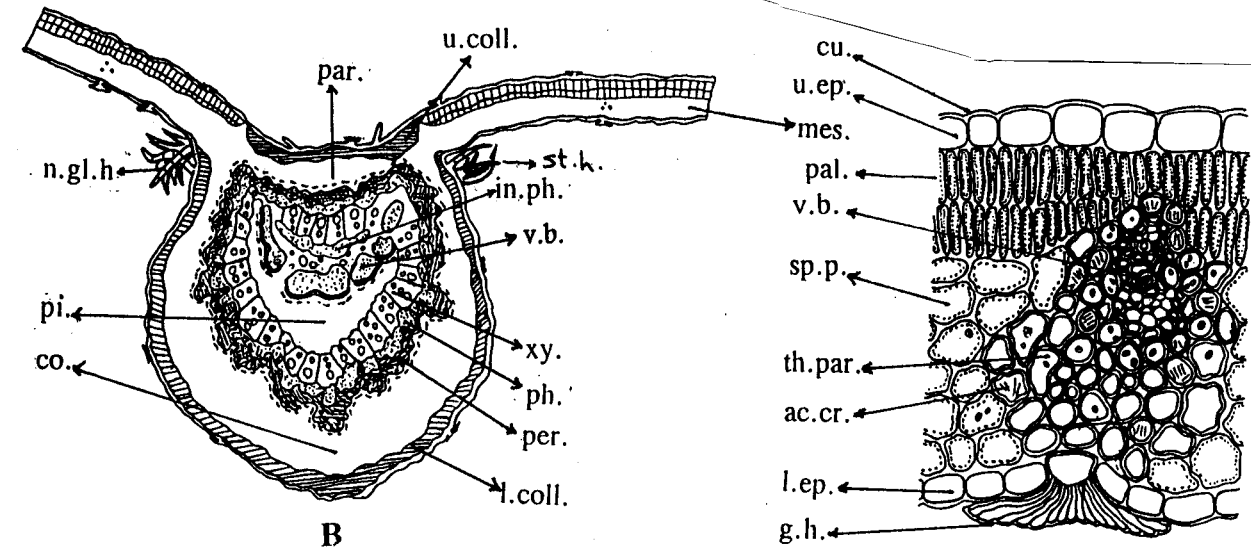
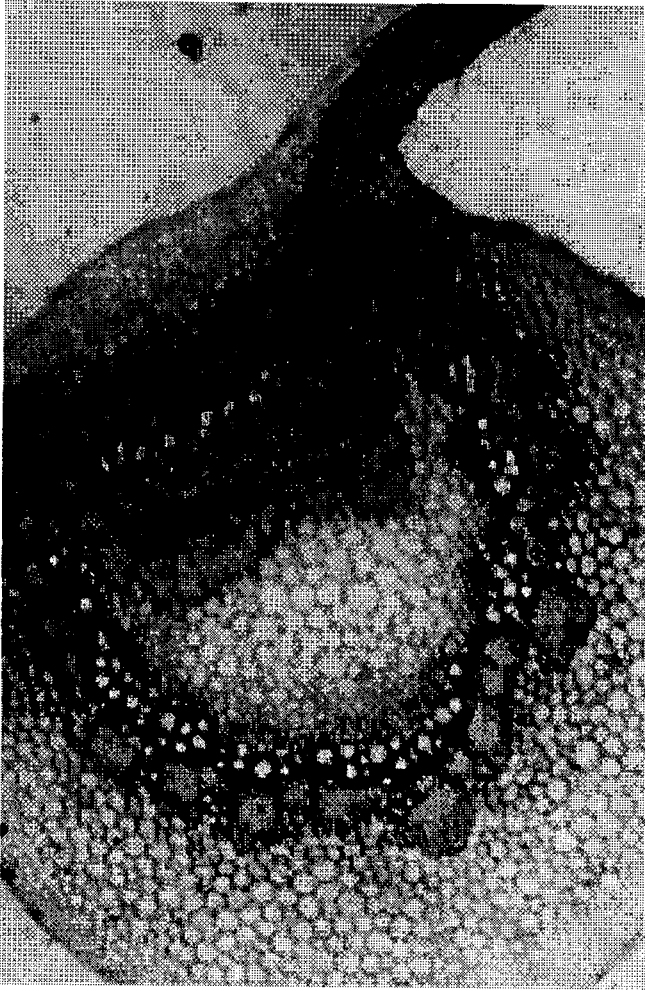


Fig. 2: A- Sketch of the leaf x 1/2
 B- Diagrammatic T.S. of the leaflet x 62.5
 C- Detailed T.S. of the lamina x 350

ac.cr., acicular crystals of calcium oxalate; co., cortical tissue; cu., cuticle; g.h., glandular hair; in.ph., interxylary phloem; l.coll., lower collenchyma; l.ep., lower epidermis; mes., mesophyll; n.gl.h., nonglandular hairs; pal., palisade; par., parenchyma; pe., petiole; per., pericycle; pet., petiolule; pi., pith; ph., phloem; r., rachis; sp.p., spongy parenchyma; st., stellate hair; th.par., thick walled parenchyma; u.coll., upper collenchyma; u.ep., upper epidermis; v.b., vascular bundle; xy., xylem.

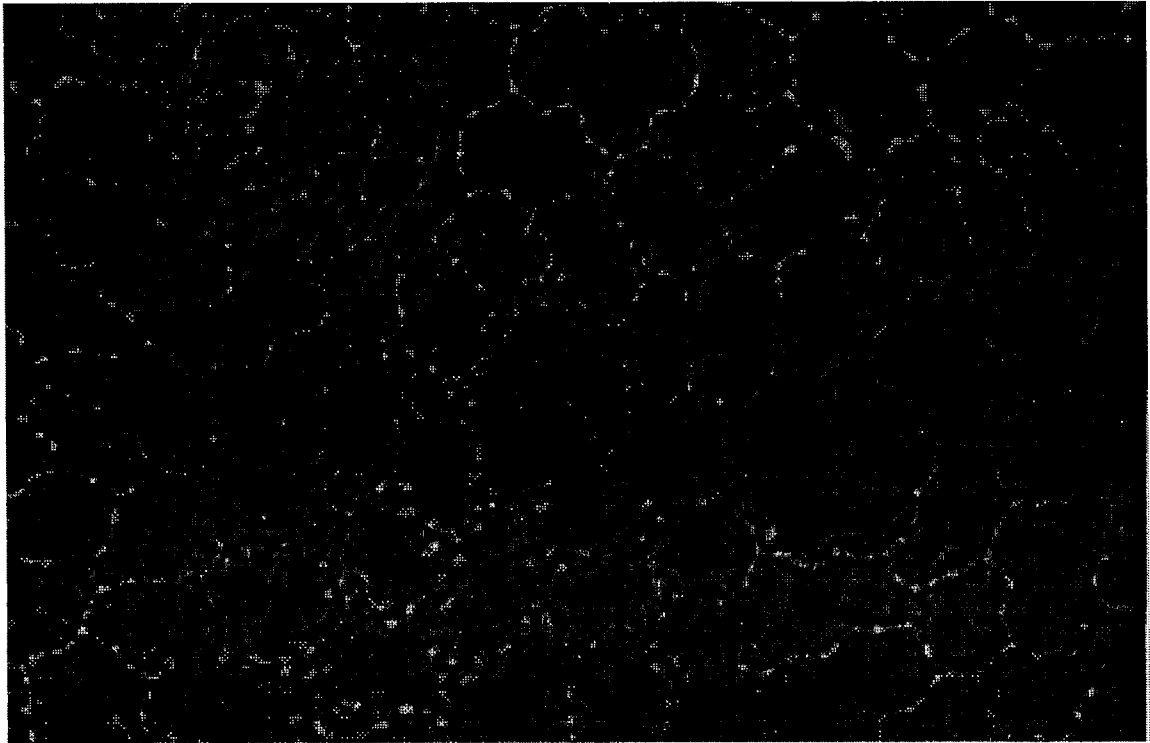


A

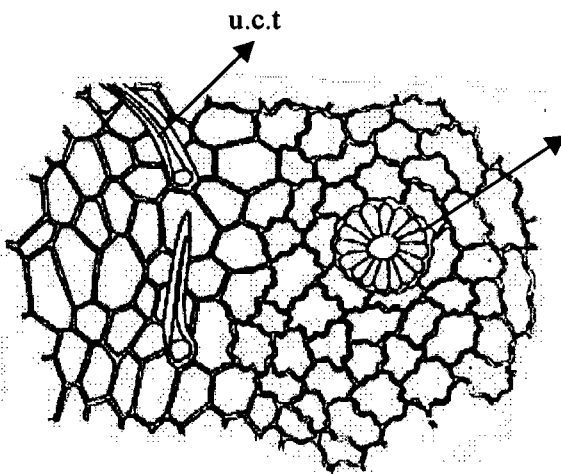


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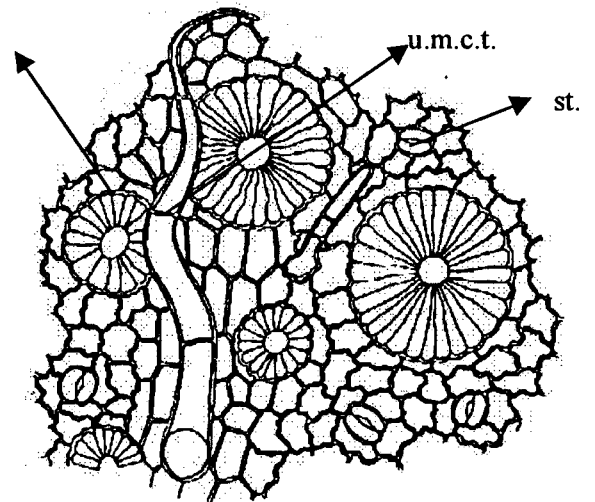
Fig. 3: A- Photo of detailed T.S. of leaf at the midrib region x 156.25
B- Photo of hairs on the lower surface x 156.25



A



B



C

Fig. 4: A- Photo of the upper surface x 775
B- Surface preparation of the upper epidermis x 350
C- Surface preparation of the lower epidermis x 350

g.h., glandular hairs; st., stomata; u.c.t., unicellular covering trichomes; u.m.c.t., uniseriate multicellular covering trichomes.

in height. The cells are covered with thin smooth cuticle. Stomata of anomocytic type are of rare occurrence. Glandular and nonglandular trichomes are present. The nonglandular trichomes are mainly of unicellular type and rarely bicellular or uniseriate multicellular. The unicellular nonglandular type are present only on the midrib region on the upper surface. It is conical in shape, slightly elongated covered with thick, smooth cuticle, measuring (40-55-70) μ in length and (10-12-14) μ in diameter.

The glandular trichomes are formed of unicellular stalk and multicellular head of peltate type having (16-17-18) radiating cells and measuring (25-40-55) μ in diameter and (14-18-20) μ in height.

The neural epidermal cells are polygonal, axially elongated rectangular with straight anticlinal walls covered with thin smooth cuticle, measuring (14-26-40) μ in length, (10-18-26) μ in width and carrying unicellular nonglandular hairs.

The lower epidermis

The lower epidermis is formed of one layer of square to subrectangular cells as seen in the transverse section (Fig. 5) being nearly similar to those of the upper epidermis. In surface view (Fig. 4C) the cells are polygonal, isodiametric somewhat elongated with more sinuated, beaded anticlinal walls. They measure (13-24-35) μ in length, (11-16-22) μ in width and (12-14-16) μ in height.

Stomata are of anomocytic type, being usually oval to rounded in shape surrounded by about (4-6) cells and measuring (11-15-20) μ in diameter. Stomata are numerous on the lower surface and rare on the upper one. Glandular and nonglandular trichomes are present. The nonglandular trichomes are of uniseriate multicellular, from (2-14) cells, covered with thin, smooth cuticle, they measure (40-190-340) μ in length and (10-20-30) μ in width. They occur only on the midrib region of the lower surface (Fig. 3B). Another type of stellate nonglandular trichomes (Fig. 9B) are present in few numbers on the lower surface only and measuring (75-105-140) μ in length. While the glandular trichomes are of two types: one with

unicellular stalk, multicellular head of peltate type formed of (16-17-18) radiating cells resembling those of the upper epidermis in shape and size, but being more numerous. The other type of glandular trichomes has a unicellular stalk and multicellular head of pateliform type¹³ (30-31-32) radiating cells and covers about 4-8 epidermal cells measuring (40-65-90) μ in diameter and (20-25-30) μ in height.

The neural epidermal cells are polygonal, axially elongated, rectangular with nearly straight anticlinal walls, covered with thin, smooth cuticle, measuring (12-25-38) μ in length and (11-18-25) μ in width.

The mesophyll

The mesophyll (Fig. 2C) is dorsiventral, being differentiated into an upper palisade and spongy tissue. The palisade is formed mostly of two rows of compact, cylindrical, columnar cells and interrupted by a mass of collenchyma cells in the midrib region. The cells of the palisade layer measure (12-20-28) μ in length and (5-9-12) μ in width. The spongy tissue consists of (6-10) rows of thin-walled, rounded or irregular parenchymatous cells with intercellular spaces. The parenchyma of the mesophyll is interrupted by small vascular bundles surrounded by pericyclic fibres.

The parenchyma neighbouring the veins show thick-walled, rounded cells, some of which contain small starch granules and fine acicular crystals of calcium oxalate.

The cortical tissues

The cortical tissue (Fig. 5) of the midrib shows an upper and lower subepidermal collenchymatous masses. The upper being formed of (2-4) rows, while the lower is formed of (3-5) rows of nearly rounded cells with no intercellular spaces. The rest of the cortical tissue above the lower collenchymatous cells as well as under the upper collenchymatous masses is formed of (5-11) rows of rounded to oval thick walled parenchyma with narrow intercellular spaces, some of these cells are pitted and containing small starch granules.

The endodermis is formed of one row of thick walled, elongated parenchyma cells

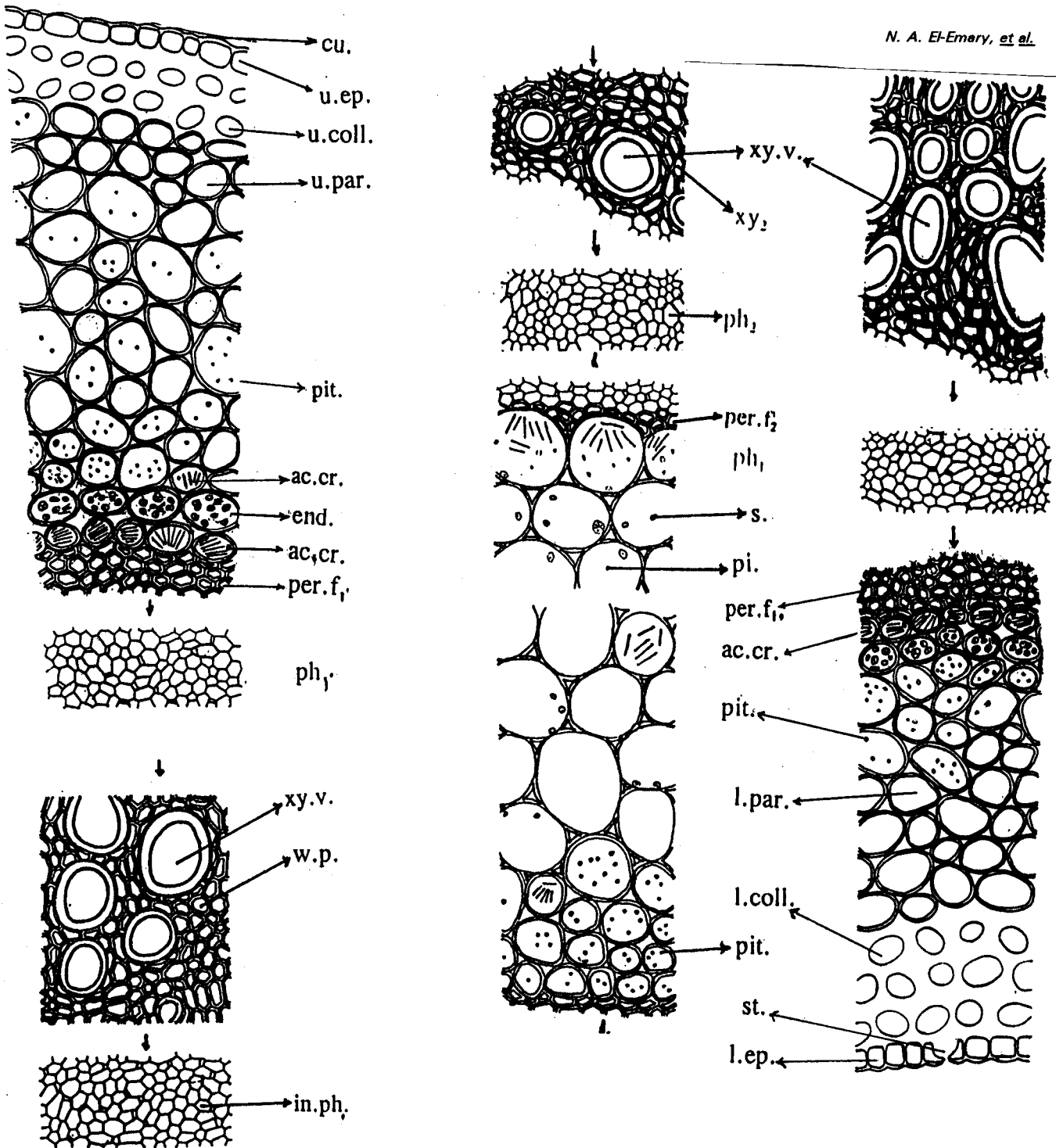


Fig. 5: Detailed T.S. of the midrib x 250

ac.cr., acicular crystals of calcium oxalate; cu., cuticle; end., endodermis; in.ph., interxylary phloem; l.coll., lower collenchyma; l.ep., lower epidermis; l.par., lower parenchyma; per.f₁, pericyclic fibres; per.f₂, pericyclic fibres of scattered vascular bundle; ph₁, phloem; ph₂, phloem of scattered vascular bundle; pi., pith parenchyma; pit., pits; s., starch granules; st., stomata; u.coll., upper collenchyma; u.ep., upper epidermis; u.par., upper parenchyma; w.p., wood parenchyma; xy.v., xylem vessels; xy₂, xylem of scattered vascular bundles.

containing small starch granules and acicular crystals of calcium oxalate.

The vascular tissues

The vascular system in the midrib (Figs. 2B&3A) is represented by a closed vascular ring consisting of a lower large crescent-shaped bundle, attached to an upper smaller inverted one, forming together a complete ring with external pericycle surrounding the whole bundle and showing arms introduced in the phloem and dividing it into compartments.

In transverse section, the pericyclic fibres (Fig. 5) appear polygonal with wide lumina and lignified walls. The fibres (Fig. 9) are elongated with dentate margins and acute apices. They measure (200-340-450) μ in length and (10-14-18) μ in diameter. The parenchymatous cells surrounding the pericyclic fibres contain acicular crystals of calcium oxalate giving a crystal sheath-like appearance.

The Phloem

The phloem (Figs. 2B&5) forms a continuous ring surrounding the xylem and separated from it by a narrow collapsed indistinct cambial zone. The phloem is formed mainly of phloem parenchyma and soft elements of sieve tubes and companion cells. Phloem fibres are absent, so that the phloem region is free from any lignified elements.

The xylem

The xylem zone (Fig. 5) is formed of lignified vessels, tracheids, wood fibres and wood parenchyma.

The vessels are lignified, arranged in radial rows mainly having spiral, annular and few pitted thickenings and measuring (15-50-85) μ in diameter. The tracheids have tapering to blunt pointed ends and lignified pitted thickening measuring (55-90-125) μ in length and (12-17-22) μ in diameter.

Wood fibres are lignified having wide lumina and acute to rounded apices, measuring (10-15-20) μ in width and (200-260-320) μ in length.

The wood parenchyma is formed of subrectangular cells with thick lignified pitted walls. The medullary rays are usually uniseriate

or biseriate, each row consists of radially elongated subrectangular lignified parenchyma.

Anomalous wedge-shaped masses of interxylary phloem are observed inside the xylem (Fig. 2B), usually formed of soft elements. In addition to the presence of scattered small vascular bundles at the periphery of pith towards the upper surface and formed of an internal pericycle, phloem and an outer xylem.

The pith

There is a crescent shaped pith (Figs. 2B&5) consists of polygonal to rounded wide parenchymatous cells with intercellular spaces, some of them containing minute starch granules. The cells towards the xylem are thickened, pitted and slightly lignified, measuring (20-55-90) μ in diameter.

2- The Petiolule

A transverse section in the petiolule (Fig. 6A&B) appears more or less rounded in outline, showing two small ridges on its upper side with a shallow groove in between.

It shows an epidermis and a cortical tissue formed of an outer collenchymatous zone and an inner parenchymatous one.

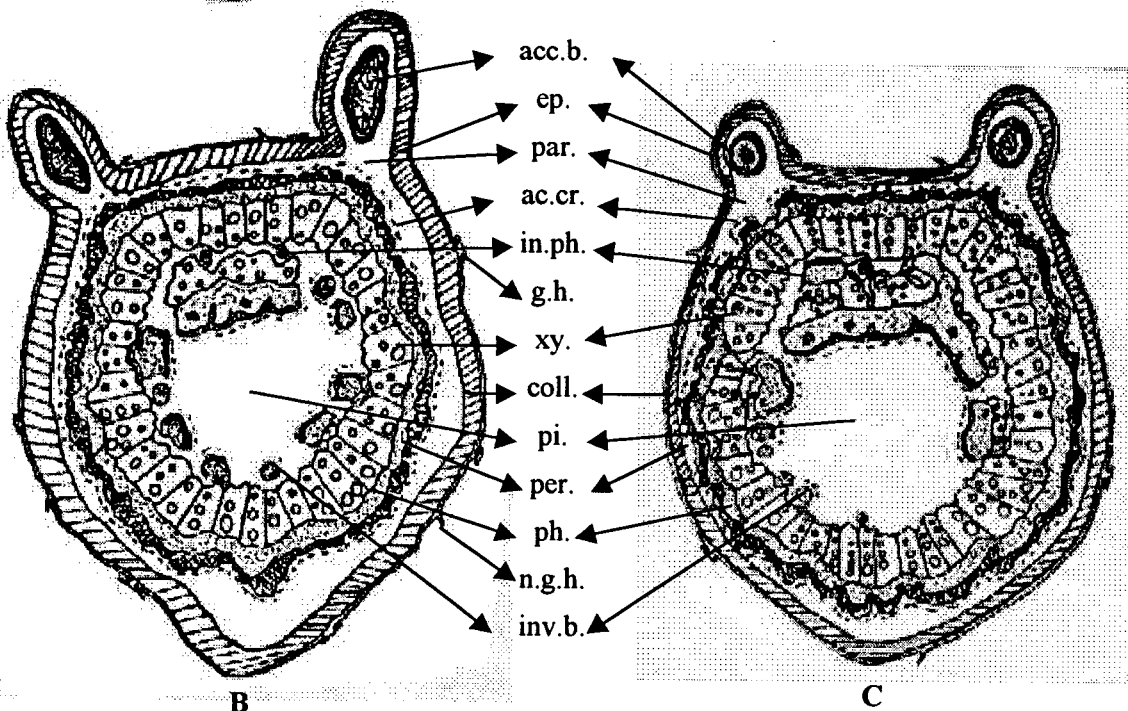
The vascular system of the petiolule shows certain resemblance to that of the midrib of the leaflet in structure. It consists of a complete ring of xylem surrounded by phloem with external pericycle surrounding the hole bundle. In addition to the presence of numerous inversely oriented bundles at the periphery of pith. These bundles are separated towards the lower side and are formed of an inner pericycle, phloem and an outer xylem, but towards the upper portion, they are close together and appear as a single band (Fig. 6A&B). Small groups of hardly distinct interxylary phloem are observed inside the xylem. Two subsidiary small lateral vascular bundles are present corresponding to the two ridges, each bundle consists of a complete ring of xylem surrounded by a phloem and pericycle and enclosing a small central pith. Abundant glandular trichomes are observed on the epidermal cells resembling those of the leaflet.



Fig. 6: A- Photo of diagrammatic T.S. of the petiolule x 125
 B- Diagrammatic T.S. of the petiolule x 62.5
 C- Diagrammatic T.S. of the rachis & petiole of the leaf x 25

acc.b., accessory bundle; ac.cr., acicular crystals; coll., collenchyma; ep., epidermis; g.h., glandular hair; inv.b., inversely oriented bundle; in.ph., interxylary phloem; n.g.h., nonglandular hair; par., parenchyma; per., pericycle; ph., phloem; pi., pith; xy., xylem.

A



3- The Rachis and Petiole

A transverse section in the rachis and petiole (Fig. 6C) is identical to that of the petiolule, but the vascular system shows large additive inter-xylary phloem embedded in the xylem of the upper part and partially or completely surrounded by fibres. Also, two subsidiary small vascular bundles are present corresponding to the two ridges.

The upper epidermis

The upper epidermis (Fig. 8) is formed of one layer of subrectangular cells as seen in transverse section.

In surface view (Figs. 9&10B) the cells appear polygonal, mostly subrectangular, axially elongated with almost straight anticlinal walls. They measure (15-29-40) μ in length, (12-18-25) μ in width and (10-14-18) μ in height.

The epidermis is covered with thin smooth cuticle, stomata are of rare occurrence. Glandular trichomes are present of unicellular stalk, multicellular head of (16-17-18) radiating cells measuring (25-40-55) μ in diameter, similar to those of the leaf in size and shape.

The lower epidermis

The lower epidermis is closely identical to the upper epidermis in shape and size.

The cortical tissue

The cortical tissue (Figs. 7A&8) of the rachis is formed of an outer collenchymatous zone and an inner parenchymatous one. The collenchymatous zone is formed of 4-6 rows of cells which vary in size and shape, being rounded, oval or ovoid in shape.

The parenchymatous zone is formed of 5-7 rows of thick walled parenchyma cells with narrow intercellular spaces. They are rounded in outline, sometimes containing fine acicular crystals of calcium oxalate and minute starch granules. The endodermis is formed of one row of thick walled parenchymatous cells containing starch granules and acicular crystals of calcium oxalate. Starch granules are simple or compound of 2-3 components. The simple granules are oval in shape, sometimes show point central hilum and measuring (2-4-6) μ in diameter.

The pericycle

The pericycle (Figs. 7A&8) is formed of groups of pericyclic fibres forming a complete ring surrounding the phloem, sometimes the fibres alternating with small groups of parenchyma cells.

In transverse section (Fig. 8), the fibres appear somewhat polygonal in outline with lignified walls and wide lumena. The fibres are elongated somewhat with dentate margins and tapering to rounded ends. They measure (200-340-450) μ in length and (12-16-20) μ in diameter. The pericyclic fibres are surrounded by parenchymatous cells containing fine acicular crystals of calcium oxalate giving crystal sheath-like appearance (Figs. 8&9A).

The vascular system

The main vascular bundle of the rachis (Figs. 6C&7A) carries certain resemblance to those of the leaflet and petiolule in addition to the presence of large groups of inter-xylary phloem embedded in the xylem of the upper part.

The phloem

The phloem (Figs. 6C&8) is formed of somewhat continuous ring surrounding the xylem. It is formed of small, thin walled shinning cellulosic elements of sieve tubes, companion cells and phloem parenchyma but phloem fibres are indistinguishable.

The xylem

The xylem (Figs. 6C&8) region is formed of lignified vessels, tracheids, fibres and wood parenchyma traversed by the medullary rays.

The xylem vessels are lignified, radially arranged with mainly pitted annular and rarely spiral thickenings measuring (20-60-100) μ in diameter. The wood fibres are the main constituents of wood, each fibre is elongated showing comparatively wide lumen and lignified straight or slightly irregular wall, measuring (10-15-20) μ in diameter and (180-260-340) μ in length. The wood parenchyma are subrectangular, with lignified pitted walls. The tracheids have tapering to blunt pointed ends and lignified pitted thickenings, measuring (60-95-120) μ in length and (13-17-20) μ in diameter.

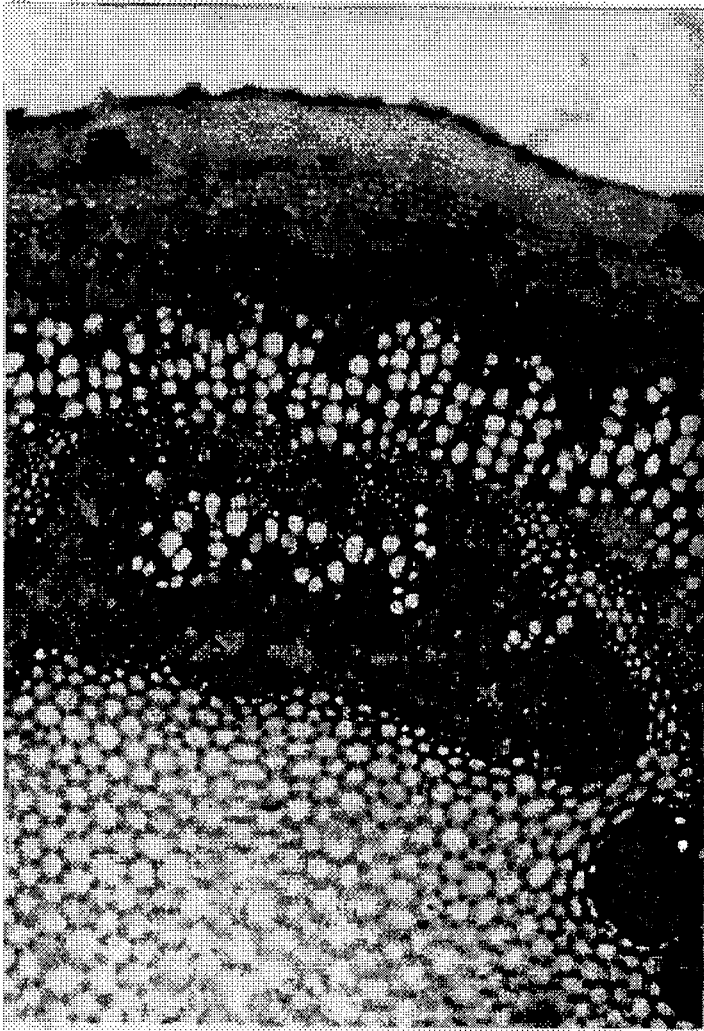
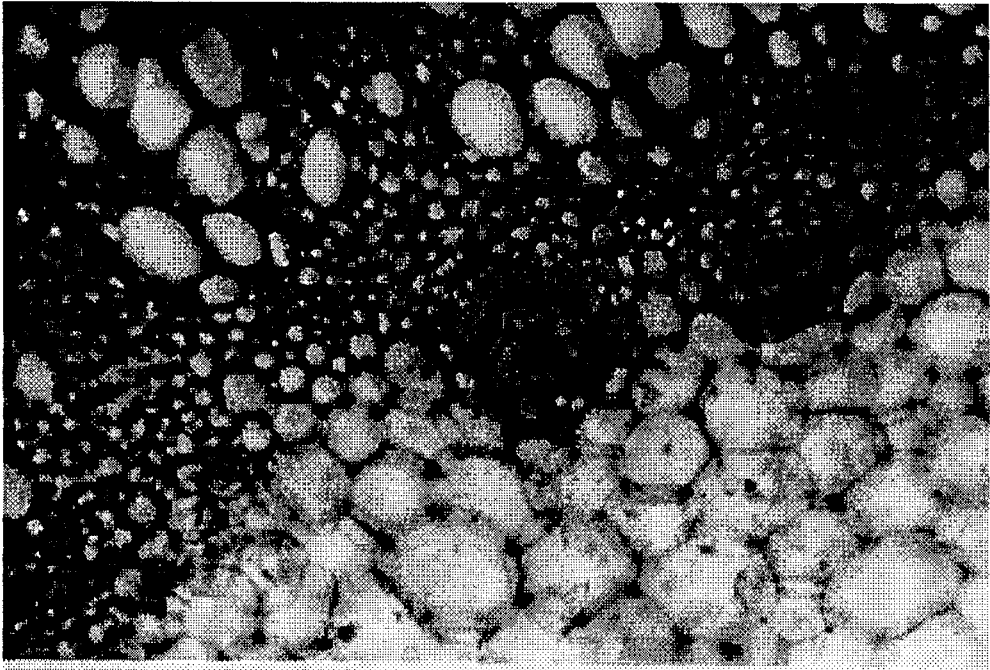


Fig. 7: A,B- Photos of detailed T.S of the rachis of the leaf x 500

A



B

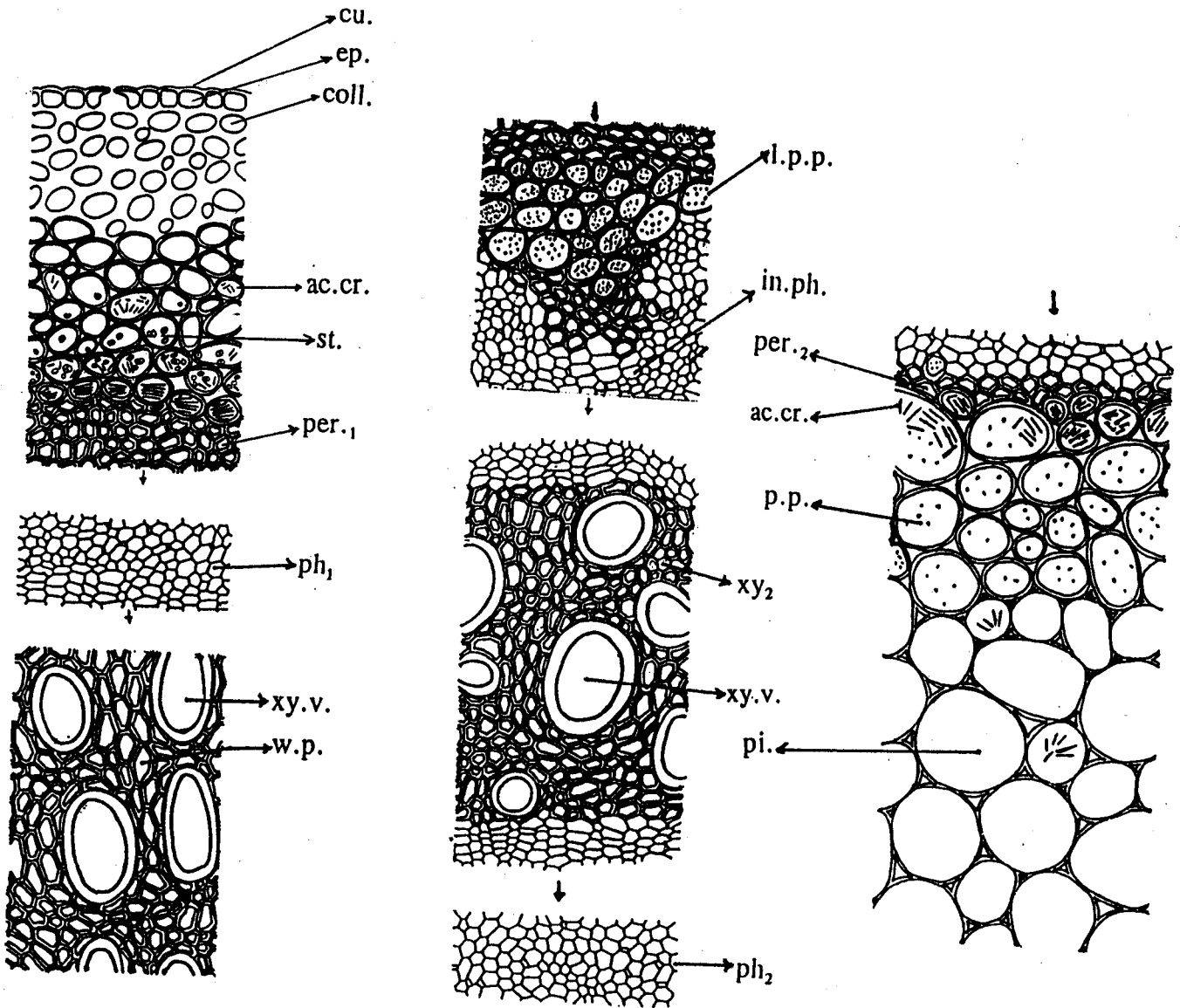


Fig. 8: Detailed T.S. of the rachis

x 200

ac.cr., acicular crystals of calcium oxalate; coll., collenchyma; cu., cuticle; ep., epidermis; in.ph., interxylary phloem; l.p.p., lignified pitted parenchyma; per.f₁, pericyclic fibre; per.f₂, pericyclic fibre of inverted vascular bundle; ph₁, phloem; ph₂, phloem of inverted vascular bundle; pi., pith parenchyma; p.p., pitted thick walled parenchyma; s., starch granules; w.p., wood parenchyma; xy.v., xylem vessels; xy₂, xylem of inverted vascular bundles.

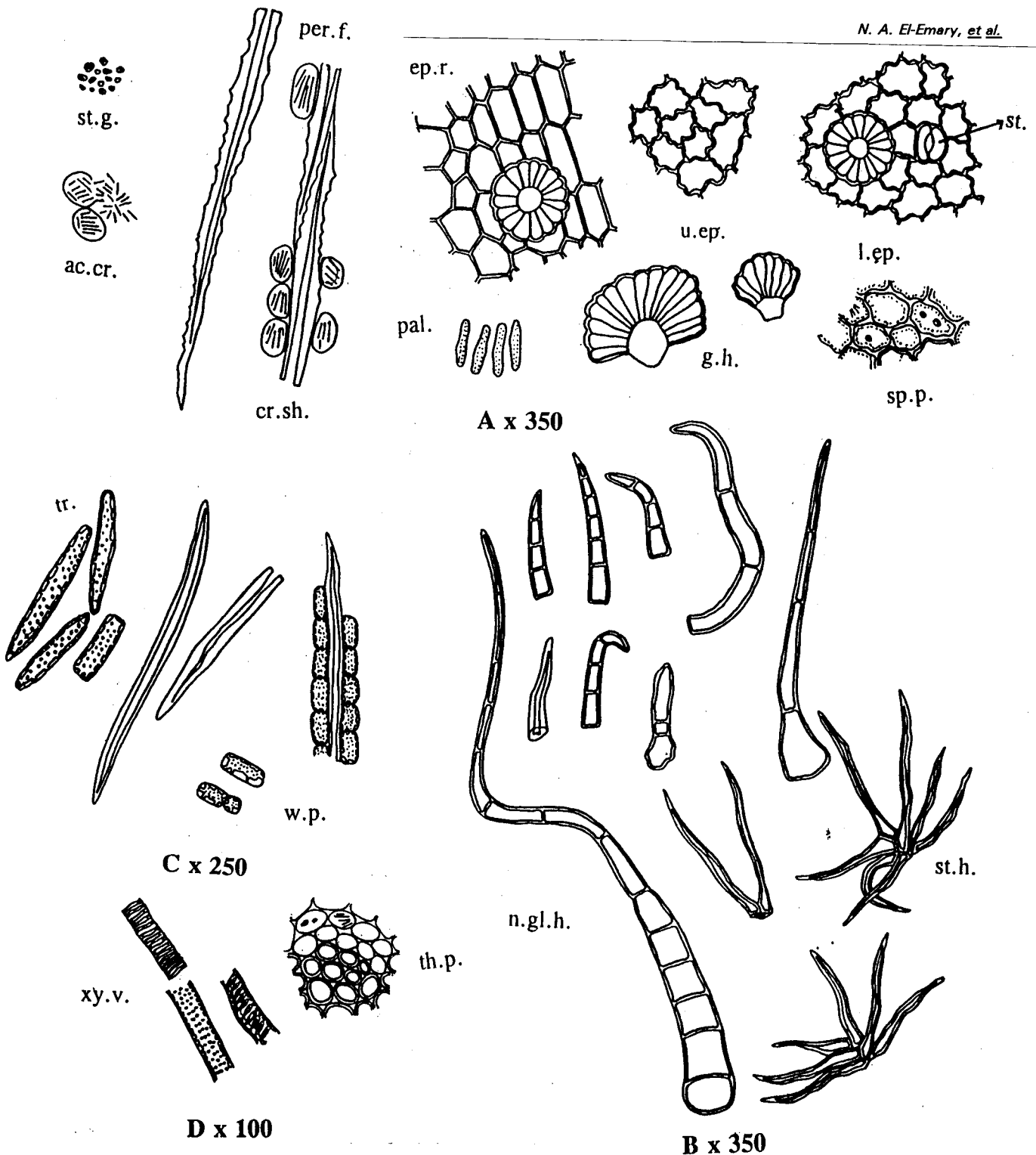
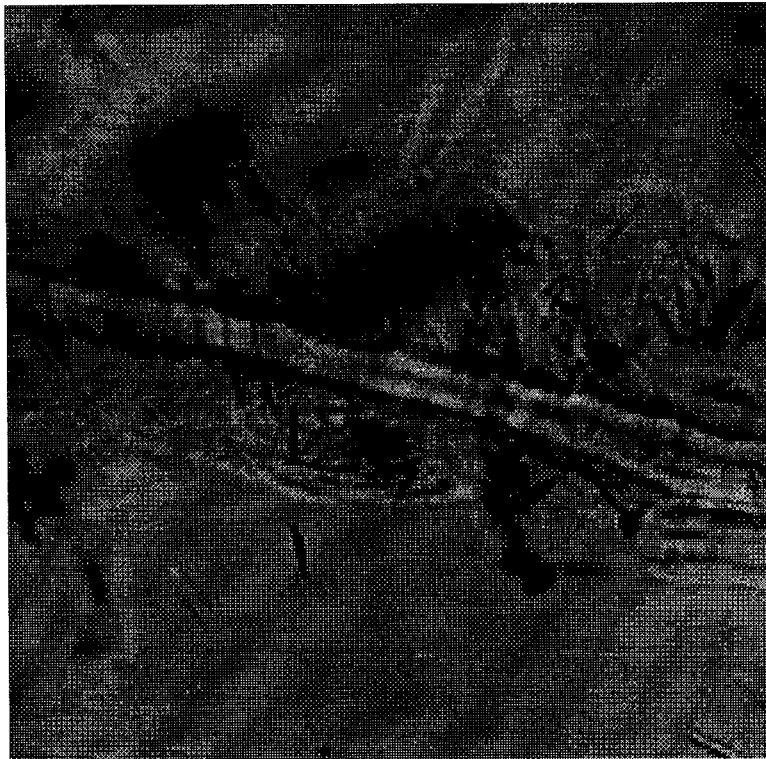
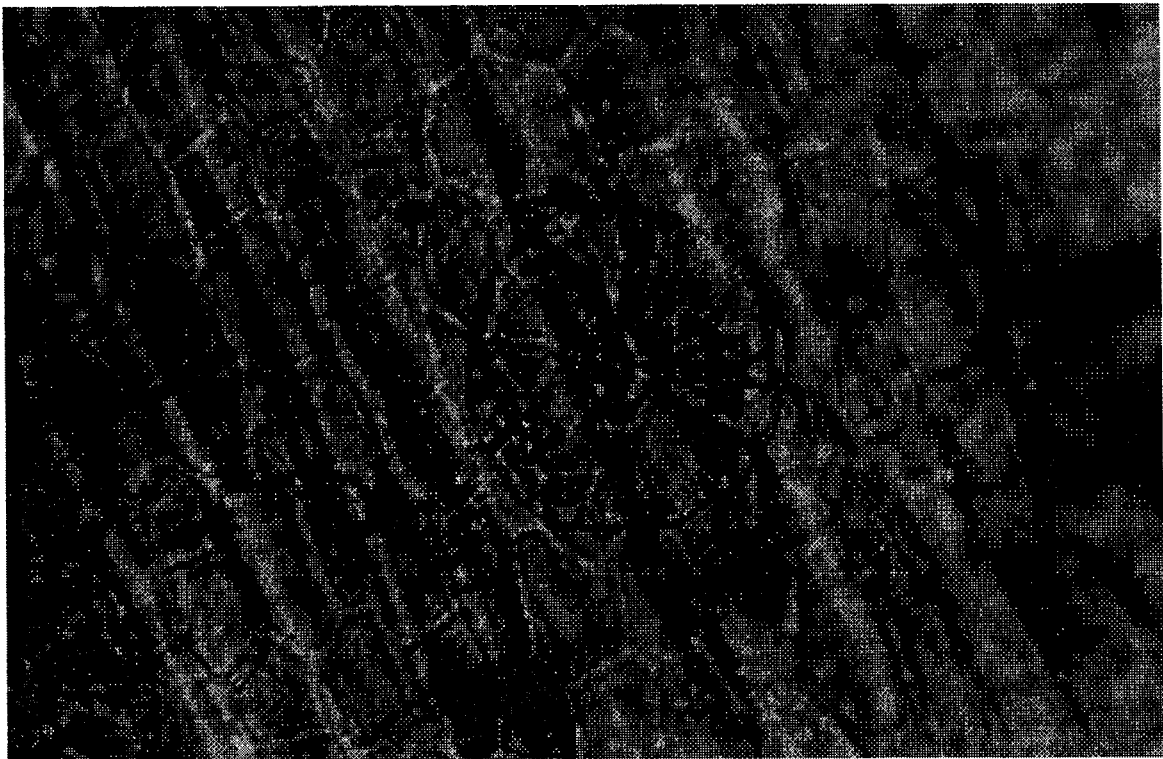


Fig. 9: A,B,C&D- Isolated elements of the leaf

ac.cr., acicular crystals of calcium oxalate; cr.sh., crystal sheath; ep.r., epidermis of rachis; g.h., glandular hairs; l.ep., lower epidermis; n.gl.h., nonglandular hairs; pal., palisade cells; per.f., pericyclic fibres; sp.p., spongy parenchyma; st.g., starch granules; st.h., stellate hair; st., stomata; th.p., thick walled parenchyma; tr., tracheids; u.ep., upper epidermis; w.f., wood fibres; w.p., wood parenchyma; xy.v., xylem vessels.



A



B

Fig. 10: A- Photo of crystal sheath x 450
B- Photo of epidermal cells of rachis x 850

The pith

The pith (Figs. 6C,7A&8) is a comparatively wide zone, formed of wide parenchymatous cells. The cells in the outer region are pitted, having thick walls. The pith parenchyma are rounded or oval in shape, some of them contain acicular crystals of calcium oxalate and small starch granules.

The periphery of pith showing inversely oriented vascular bundles, each one is formed of internal pericycle, outside to it phloem is present followed by xylem (Figs. 6C,7A&B).

The phloem and xylem of inversely oriented vascular bundles show the same structure of the phloem and xylem of the main vascular ring, while the pericycle is formed mainly of fibres with little parenchyma. The fibres are lignified with wide lumena, dentate margins and acute to acuminate apices and surrounded by parenchyma cells of the pith that contain acicular crystals of calcium oxalate to form crystal sheath-like appearance.

In the upper portion, the inversely oriented bundles are close to each other and appear as a single band. Additive inter-xylary phloem is found embedded in the xylem of the upper part.

Two subsidiary small lateral vascular bundles are present corresponding to the two ridges, each bundle consists of complete ring of xylem surrounded by phloem and pericycle enclosing a small central pith.

The powdered leaf (Fig. 9)

The powdered leaf is dark green in colour with faint odour and a slightly bitter taste.

It is characterized microscopically by the following:

- 1- Fragments of the upper epidermis of leaflet showing polygonal, isodiametric slightly elongated cells with wavy anticlinal beaded walls and covered with thin, smooth cuticle.
- 2- Fragments of the lower epidermis showing polygonal cells, somewhat elongated with sinuous beaded anticlinal walls, covered with thin, smooth cuticle and showing stomata of anomocytic type.

Both epidermises carry nonglandular trichomes ranged from unicellular type on the upper epidermis to uniseriate multicellular of 2-14 cells on the lower one, as well as glandular trichomes of unicellular stalk, multicellular head of the peltate type showing (16-18) radiating cells and pateliform hairs of (30-32) radiating cells. Non glandular stellate hairs are present only on the lower surface and in few numbers.

- 3- Fragments of heterogeneous mesophyll showing palisade cells and spongy parenchymatous cells containing chloroplasts, acicular crystals of calcium oxalate and few, oval, simple starch granules.
- 4- Fragments of the parenchyma of the cortical tissue showing small starch granules and acicular crystals of calcium oxalate.
- 5- Fragments of the vascular tissue consisting of lignified, spiral, annular and pitted xylem vessels as well as pitted lignified tracheids.
- 6- Fragments of thin walled phloem elements and medullary rays.
- 7- Fragments of the epidermis of the rachis consisting of polygonal, axially elongated cells with straight anticlinal walls.
- 8- Fragments of the pericyclic fibres which are elongated with tapering to rounded ends, dentate margins and somewhat wide lumena surrounded by parenchymatous cells containing acicular crystals of calcium oxalate to form crystal sheath-like structure.
- 9- Fragments of wood fibres which are elongated with tapering to rounded ends and wide lumena.
- 10- Fragments of lignified, pitted wood parenchyma associated with wood fibres.
- 11- Small starch granules are scattered in the field.
- 12- Numerous acicular crystals of calcium oxalate are present free in the field.

4- The Stem

Macromorphology of the stem

The main trunk of the plant (Fig. 1A) is erect, woody, cylindrical to sub-cylindrical reaching about 3 meters in height. It carries numerous cylindrical alternate branches. The young branches are green to yellowish-green in colour with smooth surface and show internodes measuring about 5-10 cm in length. The lower older ones are brown to brownish green in colour with rough surface due to the presence of brownish cork. Towards the basal part of the trunk the surface showing dark spots and fine longitudinal striations (Fig. 11A). The stem breaks with fibrous fracture and bearing scars of the fallen leaves. Internally, it is generally solid. It has a faint characteristic odour and a slight bitter, astringent taste.

Micromorphology of the stem

A transverse section in the stem (Fig. 11B) appears more or less rounded in outline showing a hairy epidermis, followed by a comparatively narrow cortex then a pericycle surrounding a continuous ring of vascular tissue and a wide parenchymatous central pith. In very old stage the stem (Fig. 11C) shows the same fundamental structure in addition to the formation of cork and the secondary cortex (phelloderm) as well as a large zone of secondary phloem and xylem tissues with more fibres.

The primary phloem shows few keratenchyma and small groups of lignified fibres take their position in the newly formed secondary phloem. The cambium forms a cambial zone between the phloem and the xylem. The wood cylinder becomes more dense, distinctly radiating and occupying about half the diameter of the stem. Numerous secondary lignified medullary rays traverse the secondary vascular elements. Cork (Figs. 11C&12B) arises in the very old stem being, usually situated in the first few layers replacing the epidermis and the outer zone of primary cortex and consisting of several rows of lignified, thick walled parenchyma cells. The primary cortex becomes somewhat collapsed towards the pericycle and the primary phloem becomes nearly collapsed (keratenchyma). The secondary phloem shows

numerous large groups of fibres which extends tangentially and alternating with the soft elements.

The epidermis

The epidermis (Fig. 12A) consists of one row of square to slightly rectangular cells covered with thin, smooth cuticle. In surface view (Fig. 12C), the epidermal cells are polygonal, subrectangular usually axially elongated sometimes isodiametric with straight anticlinal walls, they measure (13-25-36) μ in length, (10-16-22) μ in width and (10-13-16) μ in height. Non glandular trichomes of unicellular type is present being conical in shape, slightly elongated covered with thick, smooth cuticle and measuring (50-65-80) μ in length and (10-13-16) μ in diameter, as well as peltate glandular trichomes of unicellular stalk and multicellular head of (16-17-18) radiating cells, measuring (30-57-85) μ in diameter. Stomata are rarely observed.

In the old stem cork replaces the epidermis and the outer zone of primary cortex, the cork is situated in the outer layers of the cortex where the phellogen originate. In transverse section, the cork (Fig. 12B) is formed of several rows of subrectangular radially arranged, and tangentially elongated cells. The cells have thick lignified walls and contain yellowish brown pigments. In surface view (Fig. 12D) the cork cells are polygonal, usually isodiametric, lignified cells measuring (16-26-35) μ in length, (10-15-20) μ in width and (8-11-14) μ in height.

The cortex

The primary cortex (Fig. 12A) is comparatively narrow, being formed of an outer continuous zone of thick walled, cellulosic collenchymatous cells being rounded to ovoid in shape, formed of 4-6 rows, followed by 3-4 rows of rounded thick walled parenchyma cells with narrow intercellular spaces. Some parenchyma cells contain small starch granules and very fine acicular crystals of calcium oxalate.

The secondary cortex (phelloderm) (Fig. 12B) appears only in old stem after cork formation just above the remaining of the

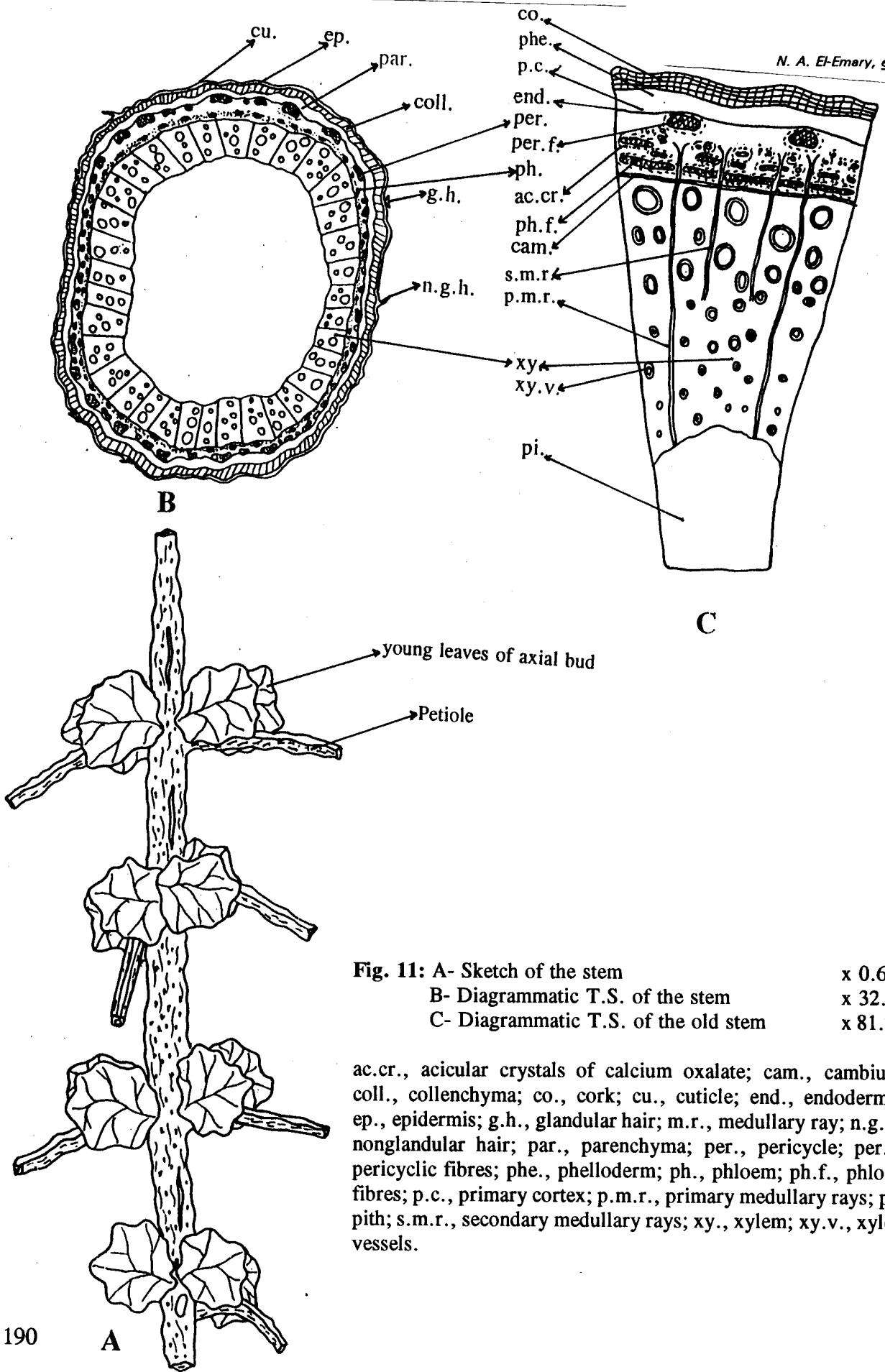


Fig. 11: A- Sketch of the stem x 0.65
 B- Diagrammatic T.S. of the stem x 32.5
 C- Diagrammatic T.S. of the old stem x 81.25

ac.cr., acicular crystals of calcium oxalate; cam., cambium; coll., collenchyma; co., cork; cu., cuticle; end., endodermis; ep., epidermis; g.h., glandular hair; m.r., medullary ray; n.g.h., nonglandular hair; par., parenchyma; per., pericycle; per.f., pericyclic fibres; phe., phelloderm; ph., phloem; ph.f., phloem fibres; p.c., primary cortex; p.m.r., primary medullary rays; pi., pith; s.m.r., secondary medullary rays; xy., xylem; xy.v., xylem vessels.

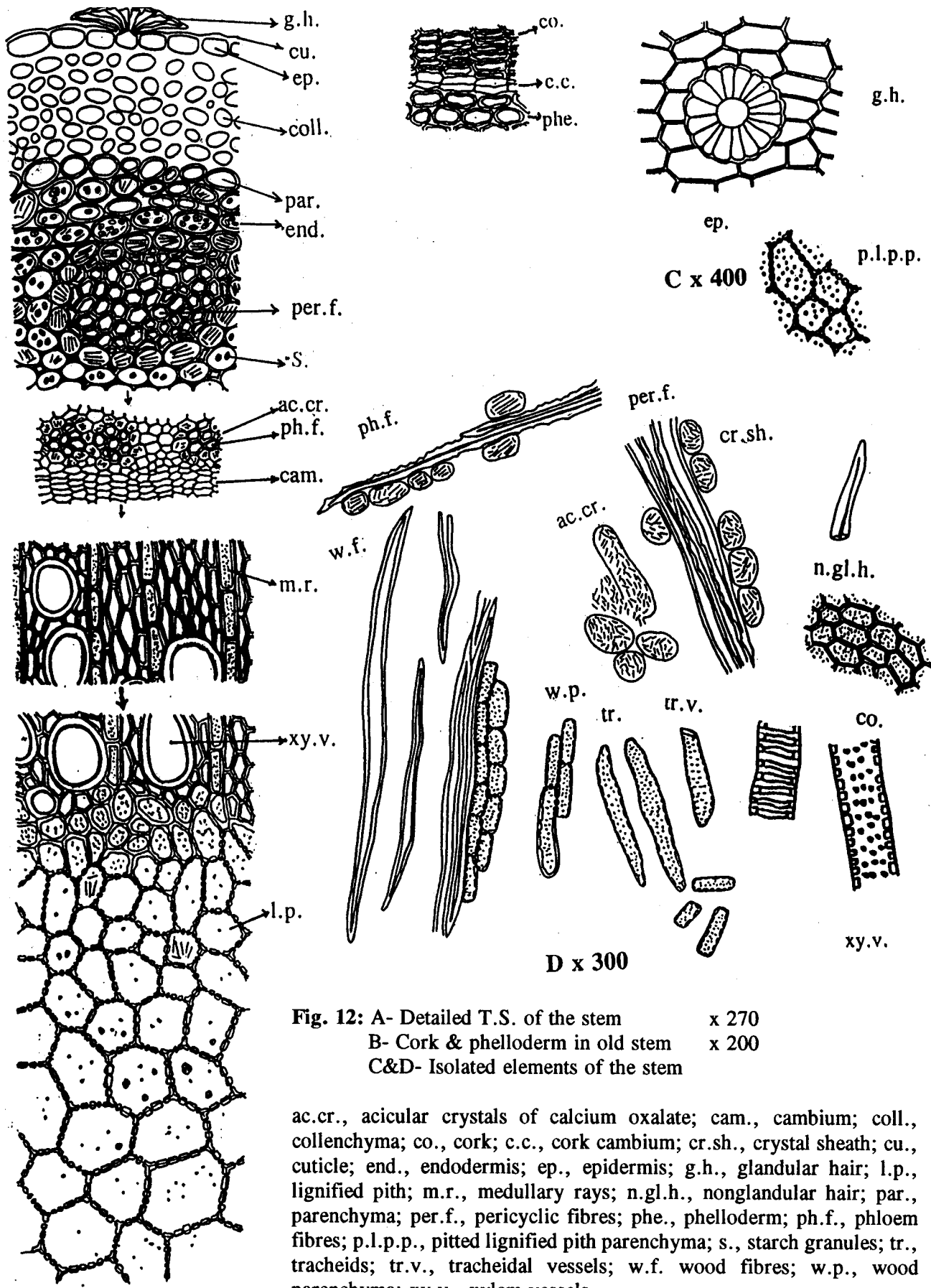


Fig. 12: A- Detailed T.S. of the stem x 270
 B- Cork & phelloderm in old stem x 200
 C&D- Isolated elements of the stem

ac.cr., acicular crystals of calcium oxalate; cam., cambium; coll., collenchyma; co., cork; c.c., cork cambium; cr.sh., crystal sheath; cu., cuticle; end., endodermis; ep., epidermis; g.h., glandular hair; l.p., lignified pith; m.r., medullary rays; n.gl.h., nonglandular hair; par., parenchyma; per.f., pericyclic fibres; phe., phelloderm; ph.f., phloem fibres; p.l.p.p., pitted lignified pith parenchyma; s., starch granules; tr., tracheids; tr.v., tracheidal vessels; w.f. wood fibres; w.p., wood parenchyma; xy.v., xylem vessels.

primary cortex. It consist of few layers 2-3 of thick walled, cellulosic parenchymatous cells followed by the remaining of primary cortex containing acicular crystals of calcium oxalate and small starch granules.

The endodermis is formed of one row of thick walled elongated parenchyma cells containing small starch granules and acicular crystals of calcium oxalate.

The pericycle

The pericycle (Fig. 12A&D) is formed of groups of fibres interrupted by parenchyma cells.

The fibres are lignified with wide lumena, dentate margins and acute to acuminate apices, measuring (10-16-20) μ in diameter and (250-320-480) μ in length.

The parenchyma cells surrounding the fibres contain acicular crystals of calcium oxalate forming a crystal sheath-like appearance.

The vascular system

The phloem

Consists of shining, thin walled, cellulosic soft elements of sieve tubes, companion cells and phloem parenchyma. Some of which contain fine acicular crystals of calcium oxalate.

The phloem tissue is interrupted by small groups of lignified bast fibres, having tapering to rounded apices with thick lignified walls and narrow lumena, measuring (200-280-330) μ in length and (8-11-13) μ in diameter. In very old stem, the primary phloem shows collapsed cells forming ceratenchyma or keratenchyma, while the secondary phloem have large groups of lignified fibres extending tangentially and alternating with bands of soft phloem. Generally the phloem fibres are surrounded by parenchyma cells containing fine acicular crystals of calcium oxalate to form crystal sheath-like appearance. The phloem is generally traversed by primary and secondary medullary rays.

The cambium

The cambium forms a cambial zone of several layers of thin walled, subrectangular, tangentially elongated and radially arranged

cellulosic cells.

The xylem

The xylem (Fig. 12A) consists of wide zone of lignified thick walled, radially arranged elements traversed by uniseriate to triseriate lignified medullary rays. The xylem elements include vessels, fibres, tracheids and wood parenchyma. The vessels are arranged in radial rows, showing annular and pitted thickenings, measuring (30-60-90) μ in diameter. The tracheids have tapering to blunt pointed ends and lignified pitted thickening (Fig. 12D) and measuring (60-100-140) μ in length and (10-16-20) μ in diameter.

The wood fibres are abundant (Fig. 12D), each fibre is elongated showing comparatively wide lumen and lignified straight or slightly irregular wall measuring (10-15-20) μ in diameter and (190-260-340) μ in length.

The wood parenchyma consists of elongated rectangular or subrectangular cells with pitted lignified walls measuring (20-50-80) μ in length and (10-18-25) μ in width.

The medullary rays are usually uniseriate to triseriate, formed of elongated subrectangular cells with thick lignified pitted walls in xylem region but in phloem region the medullary ray cells are cellulosic and thin walled.

The pith

The pith (Fig. 12A) is formed of a wide zone of rounded parenchymatous cells having thick, pitted and lignified walls.

The parenchyma of pith increase in size towards the centre, some of these contain starch granules and fine acicular crystals of calcium oxalate. The starch granules are mainly simple and some are compound of (2-3) components. The simple granules are oval in shape, sometimes show point central hilum, measuring 2 to 6 μ in diameter.

The powdered stem (Fig. 12B,C&D)

The powdered stem is yellowish green in colour with bitter taste and faint odour, it is characterised microscopically by the following features:

- 1- Fragments of polygonal, usually axially elongated epidermal cells, having straight anticlinal walls and covered with thin smooth cuticle. Stomata are rarely observed.
- 2- Unicellular, nonglandular, slightly elongated hairs covered with thick smooth cuticle as well as peltate hairs of unicellular stalk multicellular head of (16-18) radiating cells.
- 3- Fragments of lignified cork cells from old stem which are polygonal in surface view having thick, lignified walls containing yellowish-brown contents. In side view, the cells occur in tabular layers, frequently associated with parenchyma of the phelloderm.
- 4- Fragments of thick-walled parenchymatous cells of the cortex which are rounded or oval in shape containing small starch granules and acicular crystals of calcium oxalate.
- 5- Fragments of lignified pericyclic fibres surrounded by parenchymatous cells containing acicular crystals of calcium oxalate forming crystal sheath-like appearance.
- 6- Scattered simple or compound starch granules. The simple granules are oval in shape, sometimes show point centric hilum.
- 7- Numerous acicular crystals of calcium oxalate are scattered.
- 8- Xylem fragments showing pitted lignified wide vessels as well as pitted tracheids accompanied by lignified wood fibres with acute to rounded apices and wide lumena.
- 9- Fragments of lignified pitted wood parenchyma and medullary rays.
- 10- Fragments of large, polygonal, thick, pitted and lignified walled parenchyma from the pith, sometimes containing acicular crystals of calcium oxalate as well as starch granules.

5- The Stem Bark

Macromorphology of the stem bark

The stem bark

The stem bark of *Tecoma mollis* Humb. and Bonpl. (Fig. 13A) occurs as flat pieces,

channelled, single quills or double quills. It measures 0.2-0.4-0.8 cm in thickness, 2-3-5 cm in width and from 10-35 cm in length.

The outer surface is greenish-brown to light brown in colour with numerous lenticels and irregular longitudinal striations while the inner surface has a yellowish-brown colour and finely longitudinal striated occasionally with yellowish pieces of wood.

It has a fibrous fracture, a faint characteristic odour and a slight bitter, astringent taste.

Micromorphology of the stem bark

A transverse and longitudinal sections in the stem bark (Figs. 13B,C,14&15) show three distinct regions, the cork, the secondary cortex (phelloderm) and the phloem region.

The cork consists of several rows of radially, elongated thick walled lignified cells. The phelloderm is comparatively narrow, formed of 4-6 rows of thick walled parenchyma cells containing both starch granules and acicular crystals of calcium oxalate.

Groups of lignified pericyclic fibres are scattered in the innermost layer of the cortex.

The phloem region appears as a wide zone, traversed by uniseriate to triseriate medullary rays.

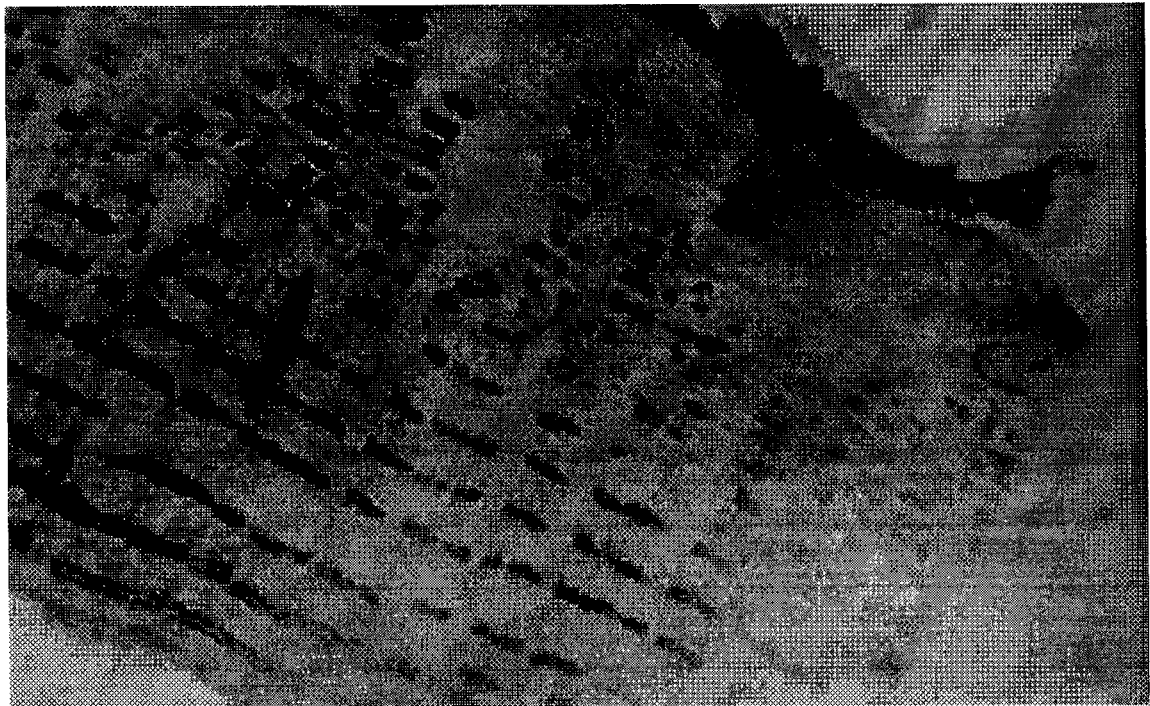
The cork

In side view, the cork region (Fig. 14) is formed of several rows 4-10 of radially and tangentially arranged cells which are tabular with thick, lignified walls. In top view (Fig. 16A) they appear polyhedral in shape, having straight anticlinal walls containing yellowish-brown contents measuring from (20-30-40) μ in length, (14-18-24) μ in width and (9-12-14) μ in height.

The cortex

Phellogen consists of 1-3 rows of thin-walled tangentially elongated or rectangular cells below the cork cells. A well marked phelloderm (Fig. 14) is formed of several rows 4-6 of thick walled parenchyma cells contain starch granules and acicular crystals of calcium oxalate.

Starch granules are mainly simple and some are compound of (2-3) components. The simple



B

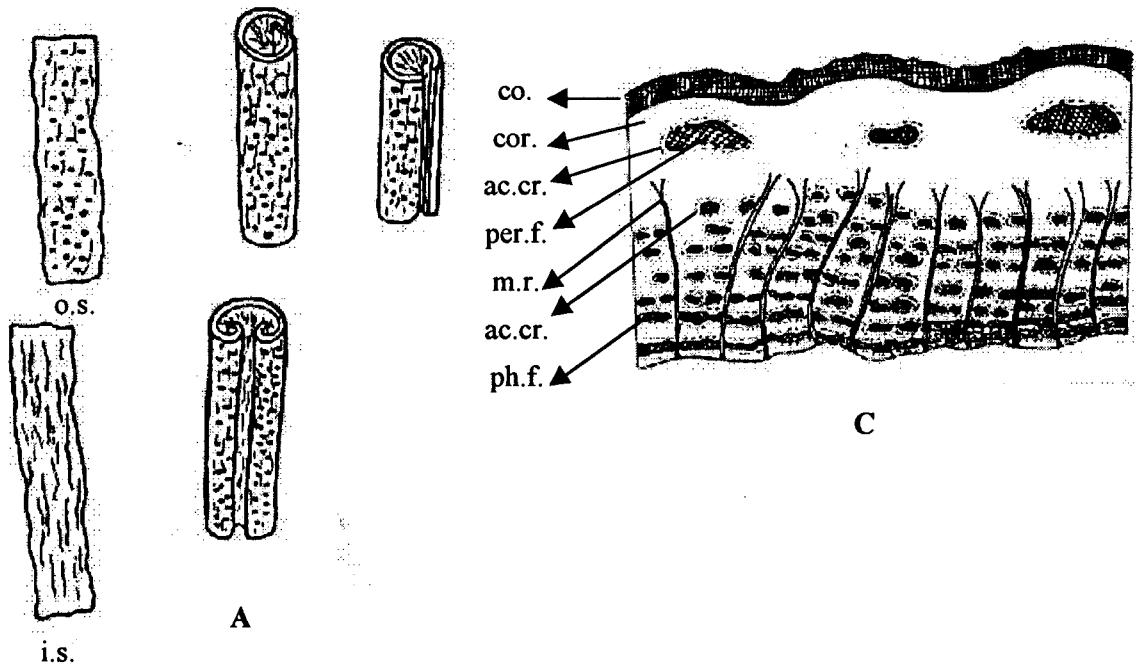


Fig. 13: A- Sketch of the stem bark x 1/2
 B- Photo of diagrammatic T.S. of stem bark x 175
 C- Diagrammatic T.S. of stem bark x 62.5

ac.cr., acicular crystals of calcium oxalate; co., cork; cor., cortex; i.s., inner surface; m.r., medullary ray; o.s., outer surface; per.f., pericyclic fibres; ph.f., phloem fibres.

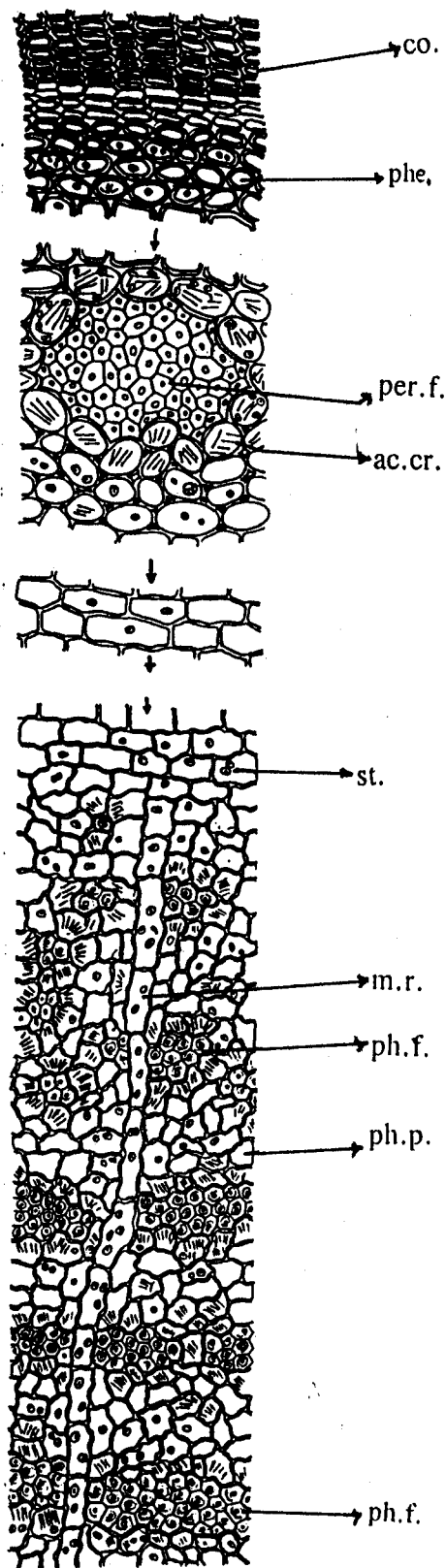


Fig. 14: Detailed T.S. of the stem bark

x 200

ac.cr., acicular crystals of calcium oxalate; co., cork cells; cor., cortex; m.r., medullary ray; per.f., pericyclic fibres; phe., phelloderm; ph.f., phloem fibres; ph.p., phloem parenchyma; st., starch granules.

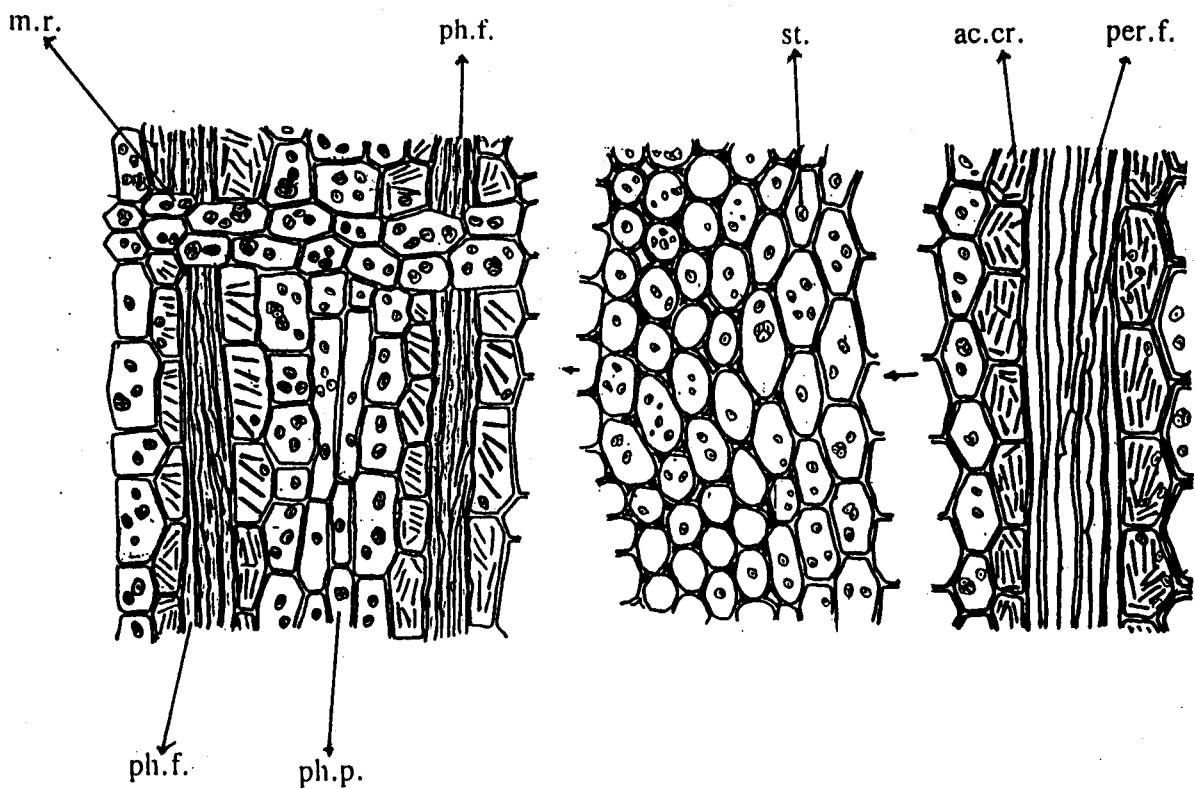
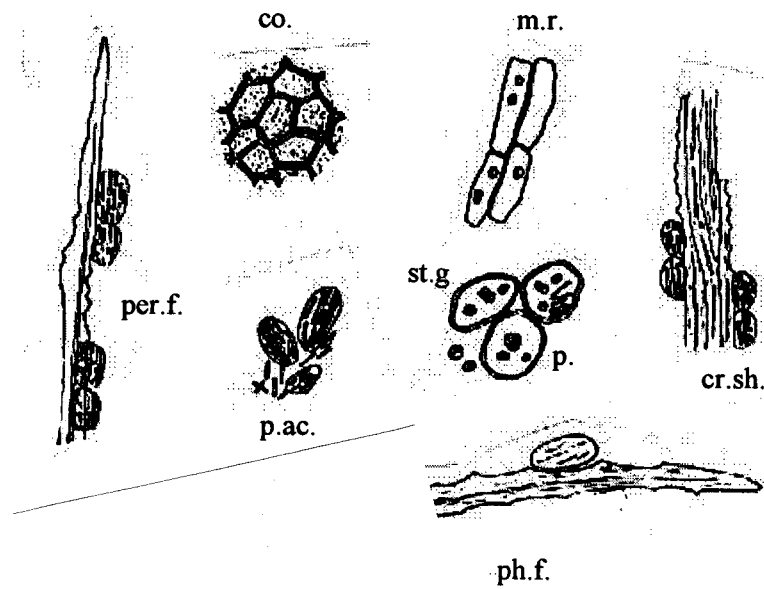


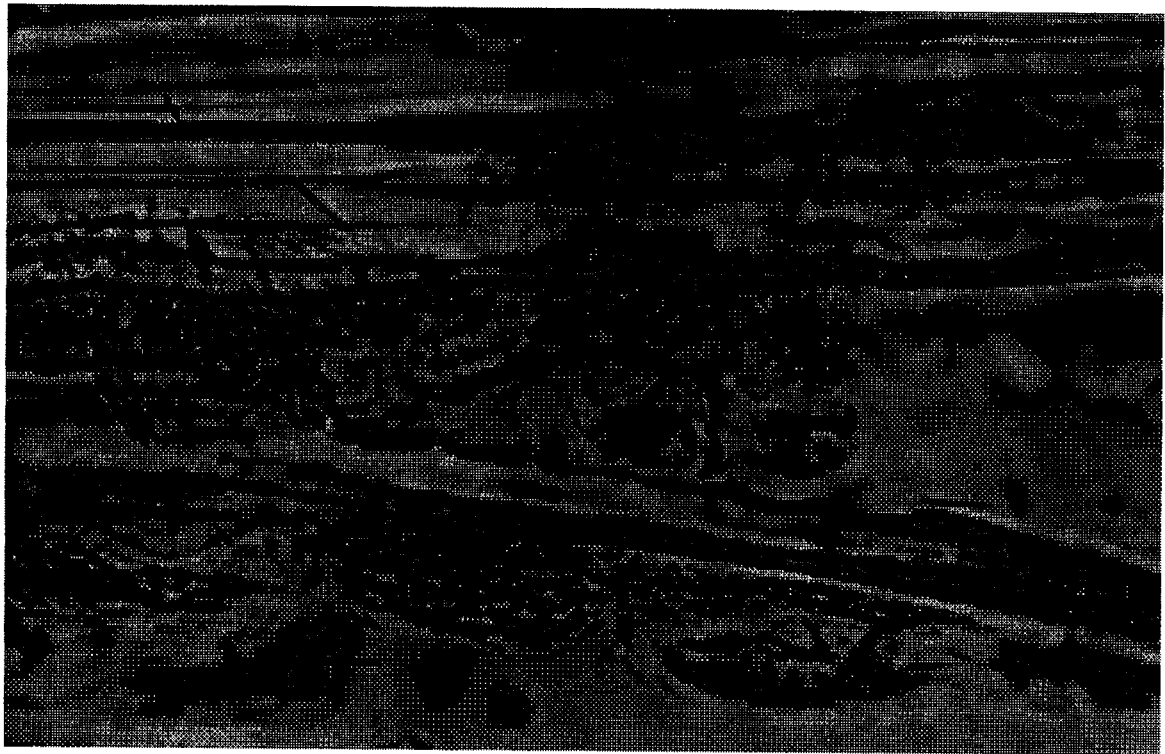
Fig. 15: Detailed L.S. of the stem bark (Radially)

x 330

ac.cr., acicular crystals of calcium oxalate; m.r., medullary ray; per.f., pericyclic fibres; ph.f., phloem fibres; ph.p., phloem parenchyma; st., starch granules.



A



B

Fig. 16: A- Isolated elements of the stem bark x 200
 B- Photo of crystal sheath x 850

co., cork cells; cr.sh., crystal sheath; m.r., medullary rays; p., parenchyma of the cortex; p.ac., parenchyma containing acicular crystals of calcium oxalate; per.f., pericyclic fibres; ph.f., phloem fibres; st.g., starch granules.

granules are oval in shape with central point hilum measuring (2-4-6) μ in diameter.

The pericycle shows groups of lignified pericyclic fibres (Fig. 14) separated by parenchyma cells. Individual fibre has thick lignified wall, narrow lumen, dentate margin with acute to acuminate apex measuring (300-400-500) μ in length and (12-16-20) μ in diameter. The parenchymatous cells surrounding the pericyclic fibres (Fig. 15) contain acicular crystals of calcium oxalate giving crystal sheath-like appearance.

The phloem

It represent the major constituent of the bark. The phloem zone (Figs. 14&15) is formed of phloem parenchyma, phloem fibres and sieve elements (sieve tubes and companion cells) which are tangentially alternated.

The phloem parenchyma have thin walls being rounded to irregular in shape and are smaller in size than the cortical parenchyma. They contain both starch granules and acicular crystals of calcium oxalate exactly identical to those of the cortical parenchyma and the sieve elements are indistinguishable.

The phloem fibres are present in groups, each fibre has thick, lignified finely striated wall, narrow lumen, dentate margin with acute to acuminate apex and measuring (8-12-16) μ in diameter and (250-350-450) μ in length.

The fibres are surrounded by parenchymatous cells containing acicular crystals of calcium oxalate giving crystal sheath-like appearance (Figs. 14&15).

The medullary rays are uniseriate to triseriate. Their cells are radially elongated subrectangular parenchymatous filled with starch granules and acicular crystals of calcium oxalate.

The powdered bark (Fig. 16A)

The powdered bark has yellowish brown to greenish-brown colour with faint characteristic odour and bitter astringent taste. The powder is characterised by the following microscopical characters:

- 1- Fragments of cork cells appearing in surface view polygonal with thick, lignified walls and contain yellowish-brown contents.
- 2- Fragments of the cortex showing oval or elongated thick walled parenchyma cells containing both starch granules and acicular crystals of calcium oxalate.
- 3- Fragments of lignified pericyclic fibres which have thick, lignified walls, narrow lumina and acute to acuminate apices.
- 4- Fragments of lignified phloem fibres which have thick lignified finely striated walls, narrow lumina and acute to acuminate apices.
Both phloem and pericyclic fibres have dentate margin and associated with parenchyma containing acicular crystals of calcium oxalate to form crystal sheath-like appearance.
- 5- Starch granules which are simple or compound from (2-3) components. The simple granules are oval in shape, sometimes show point centric hilum.
- 6- Acicular crystals of calcium oxalate are scattered.

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