

MACRO- AND MICROMORPHOLOGY OF THE STEM AND LEAF OF *WEDELIA PROSTRATA* HOOK. ET ARN. (HEMSL.) CULTIVATED IN EGYPT

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تم في هذا البحث دراسة الصفات العيانية والمجهرية لأوراق وسيقان نبات الوديليا بروستراتا بغرض التعرف على الخواص المميزة في حالة وجودها في صورة كاملة أو على هيئة مسحوق.

The macro- and micromorphological characters of the stems and leaves of Wedelia prostrata Hook. et Arn. (Hemsl.) cultivated in Egypt have been investigated in order to determine the diagnostic features by which each organ could be identified in both the entire and powdered forms.

INTRODUCTION

Wedelia prostrata Hook. et Arn. (Hemsl.) (Asteraceae, tribe Heliantheae)^{1,2} is cultivated in Egypt as an ornamental plant. The genus *Wedelia* comprises about 70 species natives of the warmer regions of the world.³ Economically, the plants of family Asteraceae are of considerable importance. There are numerous food and drug plants, many are ornamentals and several are noxious weeds.⁴ Some *Wedelia* species have valuable biological activities.⁵⁻⁷ The isolated kaurene diterpenes showed antibiotic activity and could justify the utilization of *Wedelia* species as an antitussive agents.⁸

The previous phytochemical studies of *W. prostrata* Hook. et Arn. (Hemsl.) have led to the isolation of eudesmanolides, chalcones, phenyl propanoids and kaurenoids.⁹⁻¹¹

Reviewing the current literature, nothing have been reported regarding the macro- and micromorphological characters of both the leaves and stems of the titled plant.

EXPERIMENTAL

Habitat

Wedelia prostrata Hook. et Arn. (Hemsl.) is a prennial prostrate herb (Figs. 1 & 2) having

long-creeping, hirsute and monopodially branched stems. The leaves are simple, shortly-petiolate, opposite and exstipulate. The heads are solitary and terminal. The corollas of the ray flowers are 1-seriate and yellow. The fruit is an achene, densely strigose and 3- or 4- angled. The plant is flowering in July-October.¹²

Plant material

The plant material used in this investigation was obtained from the plants cultivated in the Experimental Station of Medicinal Plants, Faculty of Pharmacy, Assiut University, Assiut, Egypt. The identification of the plant was confirmed by Prof. Dr. Abdel-Aziz Fayed, Prof. of Plant Taxonomy, Faculty of Science, Assiut University, Assiut, Egypt. Fresh leaves and stems as well as samples preserved in a mixture of alcohol (70%)-glycerin-water (1:1:1) were used. The different plant organs viz. stems and leaves at different stages of growth were separately air dried and reduced to fine powder.

1- The Stem

I- Macromorphology

The stem (Figs. 1 & 2) is solid, creeping, herbaceous, cylindrical, reaching about 0.25-1.2 meters in length and up to 0.3-1 cm in diameter.



Fig. 1: Photo of the plant.

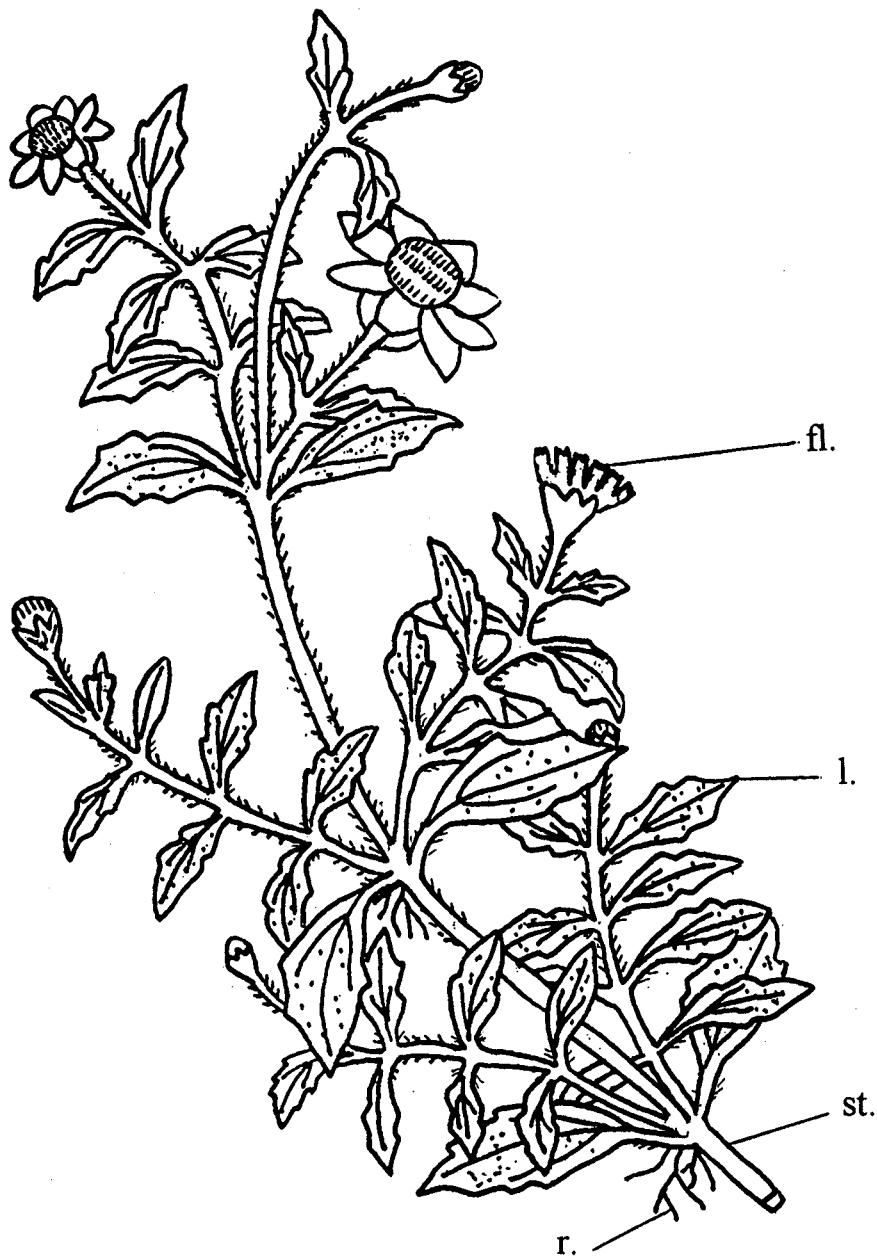


Fig. 2: Sketch of the plant

x 0.4

l., leaf; fl., flower; r., root; st., stem.

The flowering branches are ascending. The branches carry opposite and simple leaves. The lower part of the stem is nearly glabrous, green in colour, faintly longitudinally striated and carries scars of fallen leaves while the upper part is coarsely hirsute and purplish green in colour. It is rooting at the nodes, the internodes are short and measuring about 2-7 cm long. The stem is broken with fibrous fracture. It has a faint odour and a slight bitter taste.

II- Micromorphology

The transverse section in young stem (Figs. 3A & 4A) is more or less circular in outline. It shows an outer epidermis followed by a fairly wide cortex consisting of an outer zone of collenchyma and an inner zone of parenchyma. Numerous schizogenous secretory glands are scattered in the parenchymatous cortex. The endodermis and the pericycle are not well distinct. The vascular system consists of groups of open vascular bundles arranged in a single ring around the central region of pith. The vascular bundles are separated by wide primary medullary rays running between the cortex and pith. Each bundle has an outer patch of soft phloem and an inner patch of xylem separated by the intrafascicular cambium. The pith is very wide and parenchymatous.

In old stage (Figs. 3B & 4B) the parenchymatous cortex shows besides the schizogenous glands many cluster crystals of calcium oxalate. The endodermis is distinct and limits the inner side of the cortex. The pericycle consists of groups of fibres interrupted by parenchymatous cells and encircling the stele. The vascular tissue consists of a continuous ring of an outer soft phloem and inner radiating xylem which are traversed by narrow secondary medullary rays. The pith is very wide and parenchymatous with few schizogenous secretory glands and cluster crystals of calcium oxalate.

The epidermis (Figs. 5 & 6); consists of one layer of square to subrectangular cells. In surface view (Figs. 3C & 4C) the cells are polygonal, axially elongated, subrectangular, sometimes isodiametric with straight finely

beaded anticlinal walls. The cells are covered with thick smooth cuticle and measuring about 11.2-35.2 μ in length, 6.4-16 μ in width and 6.4-14.4 μ in height. Occasional stomata of cruciferous type¹³ are present, being oval in shape, measuring about 16-17.6 μ in length and 14.4-16 μ in width. Numerous covering trichomes and their cicatrices are observed. The hair is uniseriate, multicellular, usually two to eight cells long, having acute or blunty pointed apex, covered with thin smooth cuticle and measuring about 80-600 μ in length and 12-48 μ in width at the middle.

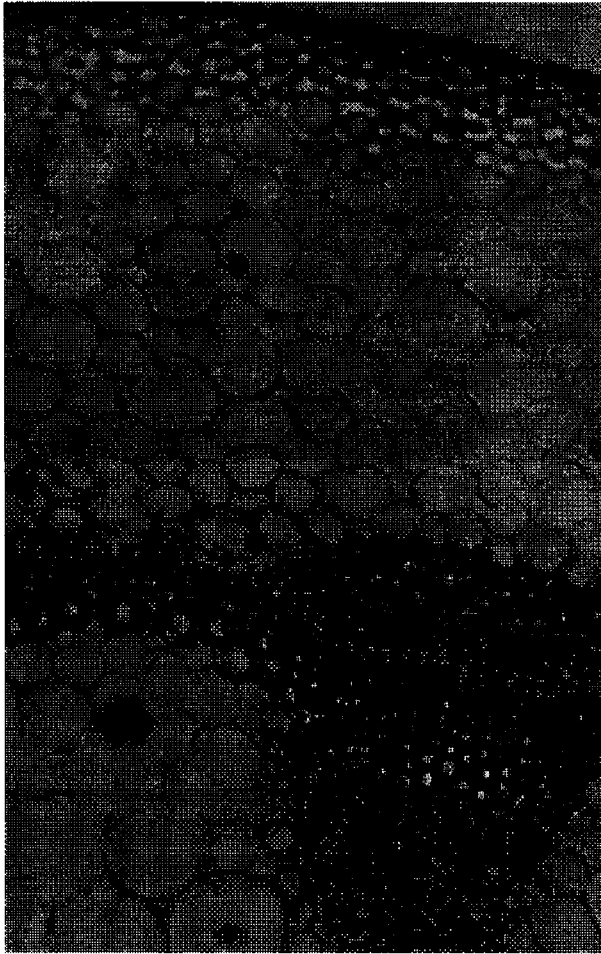
The cortex (Figs. 5 & 6); consists of an outer region of about 4-6 rows of thick-walled cellulosic collenchymatous cells being irregular in shape, followed by an inner parenchymatous region consisting of several rows of thin walled parenchyma, showing intercellular spaces and contain small cluster crystals of calcium oxalate measuring 3.2-8 μ in diameter. There are comparatively wide schizogenous secretory glands, measuring about 24.5-56 μ in width. The schizogenous cavity is lined by 4-9 secretory epithelial thin-walled cells.

The endodermis (Figs. 5 & 6); is distinct and consists of a single layer of large tabular cells having well-marked casperian strips.¹³

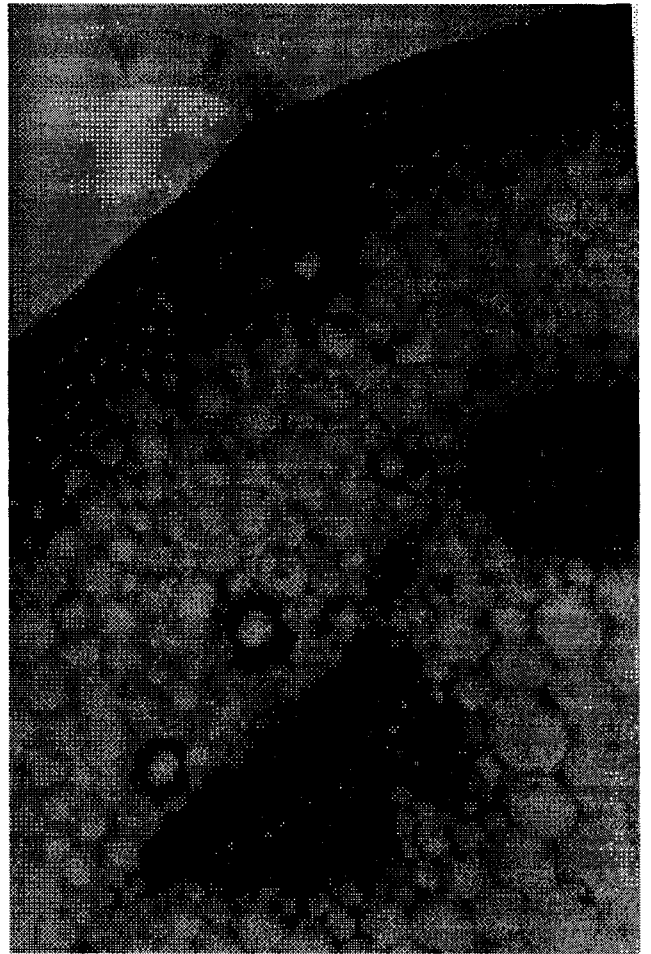
The pericycle (Figs. 5 & 6); is formed of crescent-shaped strands of pericyclic fibres over the bundles, interrupted by thin walled parenchymatous cells. The fibre (Fig. 7) is long, having slightly irregular outline, thick lignified wall, wide lumen and acute to acuminate apex, measuring about 232-400 μ in length and 6.4-12.8 μ in width.

The phloem (Fig. 5 & 6); consists of thin-walled elements, formed of sieve tubes, companion cells and phloem parenchyma.

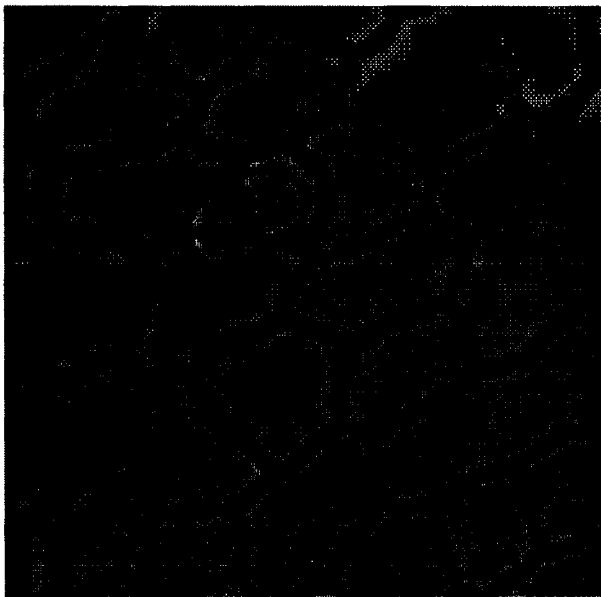
The cambium (Figs. 5 & 6); forms a narrow zone of cambiform cells consisting of few thin-walled cellulosic cells which are subrectangular tangentially elongated and radially arranged.



B

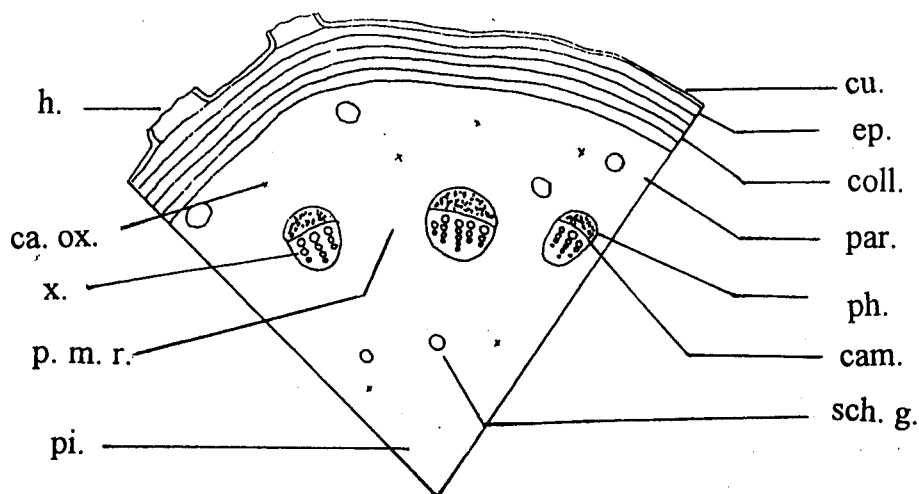


A

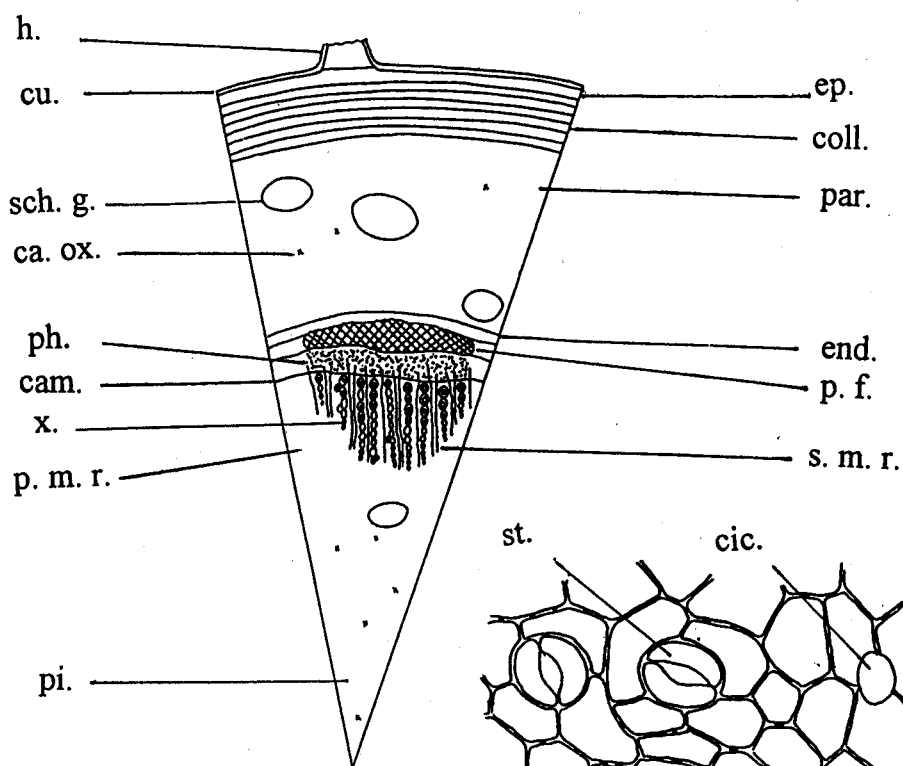


C

Fig. 3: A- Photo of T.S. of young stem
B- Photo of T.S. of old stem
C- Photo of surface preparation of stem



A



B

C

Fig. 4: A- Diagrammatic T.S. of the young stem x 112.5
 B- Diagrammatic T.S. of the old stem x 220.5
 C- Surface preparation of stem x 562.5

ca.ox., calcium oxalate; cam., cambium; cic., cicatrix; coll., collenchyma; cu., cuticle; end., endodermis; ep., epidermis; h., hair; m.r., medullary ray; p.f., pericyclic fibre; par., parenchyma; ph., phloem; pi., pith; p.m.r., primary medullary ray; sch.g., schizogen gland; s.m.r., secondary medullary ray; st., stomata; x., xylem.

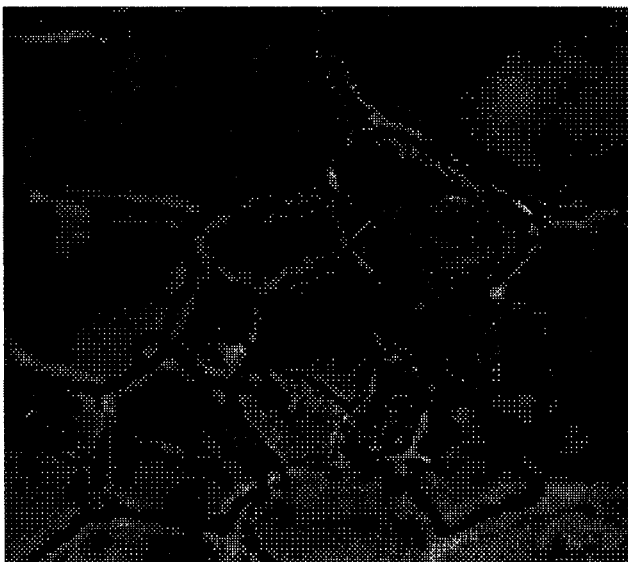
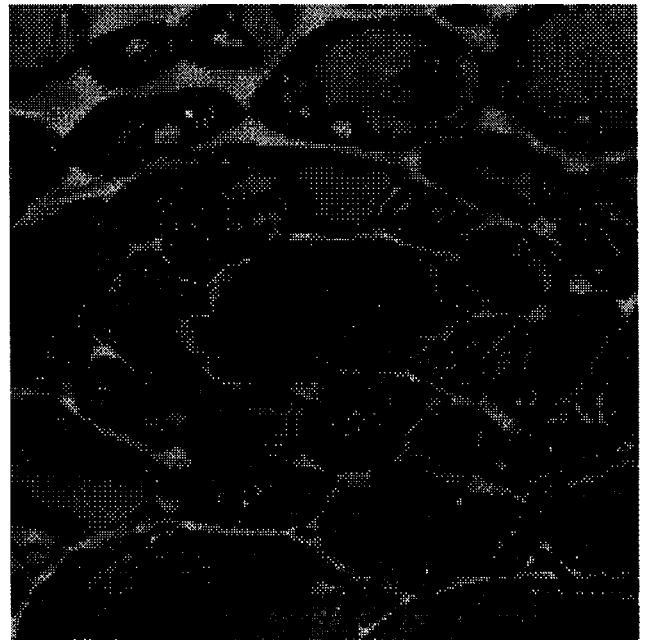
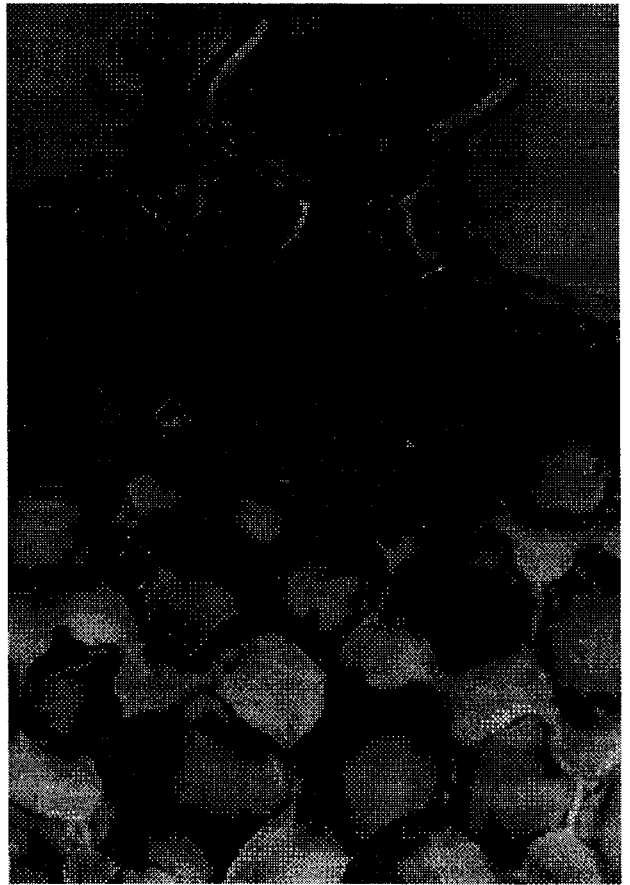
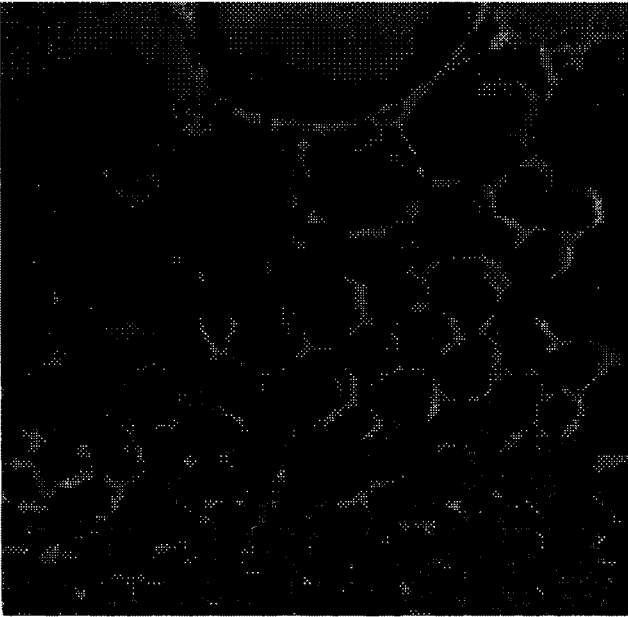


Fig. 5: Photo of detailed T.S. of old stem.

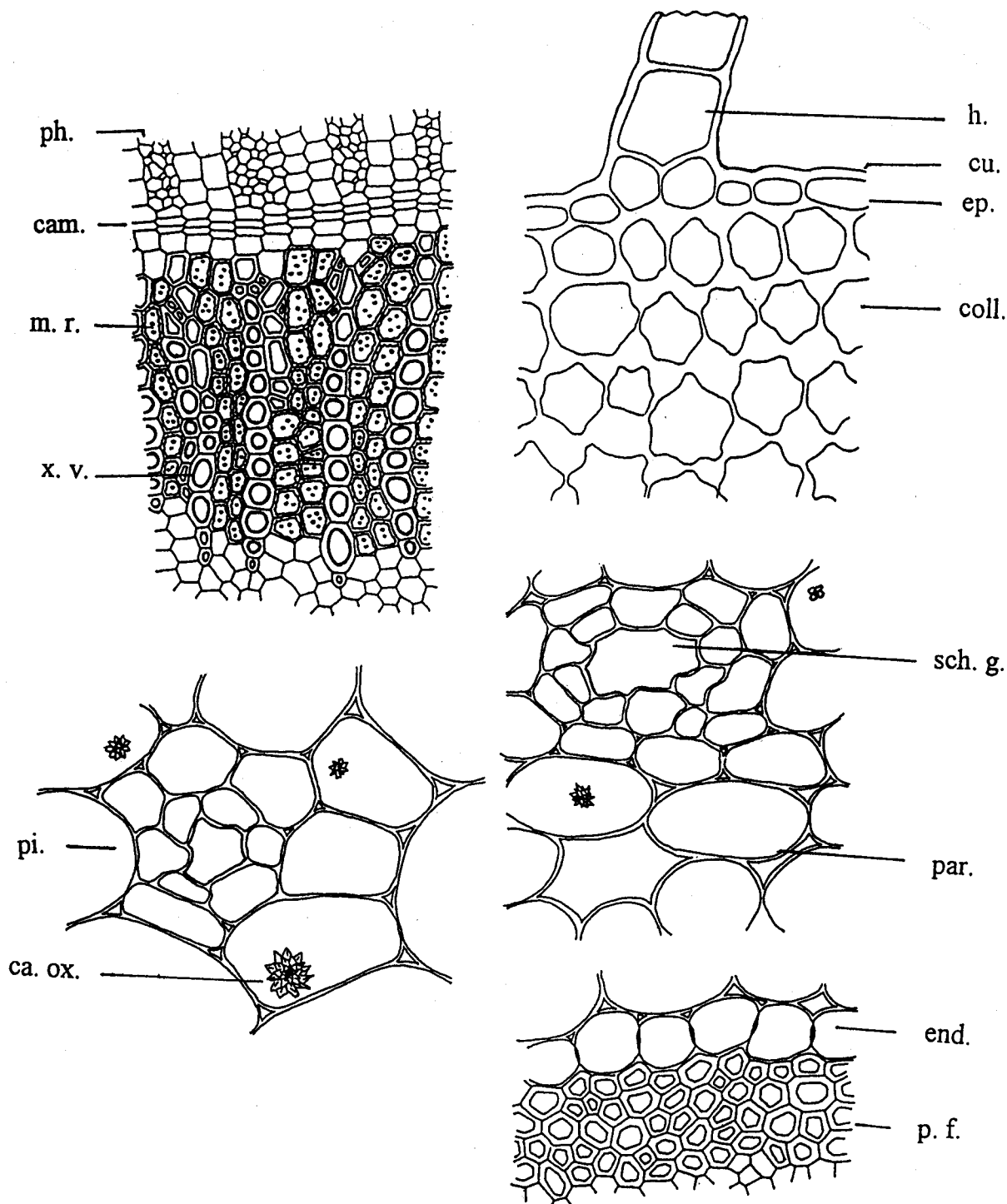


Fig. 6: Detailed T. S. of the old stem

x 562.5

ca.ox., calcium oxalate; cam., cambium; coll., collenchyma; cu., cuticle; end., endodermis; ep., epidermis; h., hair; m.r., medullary ray; p.f., pericyclic fibre; par., parenchym; ph., phloem; pi., pith; sch.g., schizogenous gland; x.v., xylem vessel.

The xylem (Figs. 5 & 6); consists of narrow vessels, tracheids, fibres and wood parenchyma. The vessels (Fig. 7) having spiral, scalariform and pitted thickenings with lignified walls and measuring about 3.2-16 μ in diameter. The wood fibre has thick lignified wall, wide lumen and acute to blunt apex, with small simple pits¹³ and measuring about 49.6-232 μ in length and 4.8-14.4 μ in width. The vessels are accompanied by lignified tracheidal vessels and tracheids having thick lignified pitted walls, measuring about 35.2-83.2 μ in length and 8-14.4 μ in width. The wood parenchyma consists of square or elongated subrectangular cells with thick lignified pitted walls. The primary xylem is formed of lignified spiral, scalariform and pitted vessels and thin-walled wood parenchyma.

The medullary rays (Figs. 5 & 6); the secondary medullary rays are usually uni- to biseriate in the transverse section, but the primary medullary rays are polyseriate. The cells are square to subrectangular with thick lignified pitted walls in the xylem region but in the phloem region they are cellulose and thin walled.

The pith (Figs. 5 & 6); is formed of rounded to polygonal parenchymatous cells with wide intercellular spaces and contain cluster crystals of calcium oxalate measuring about 4.8-12.8 μ in diameter. There are small schizogenous secretory glands, measuring about 24.5-41.6 μ in diameter. The schizogenous cavity is lined by (4-6) secretory epithelial thin-walled cells.

Characters of the powdered stem

It is green in colour, with a faint odour and a slight bitter taste. It is characterized microscopically by the following (Fig. 7):

- 1- Fragments of epidermal cells which are polygonal in surface view, axially elongated, sometimes isodiametric with straight finely beaded anticlinal walls. They are covered with thick smooth cuticle and show occasional stomata of cruciferous type. Some fragments show trichomes and their cicatrices in the center of a single cell or over the junction of two or more epidermal cells.

- 2- The trichomes are uniseriate, multicellular, usually 2-8 cells long, with acute or blunt pointed apices and covered with thin smooth cuticle.
- 3- Fragments of lignified pericyclic fibres, slightly irregular in outline with thick lignified walls, wide lumina and acute or blunt apices.
- 4- Fragments of lignified spiral, scalariform and pitted vessels.
- 5- Fragments of tracheidal vessels and tracheids with pitted lignified walls.
- 6- Fragments of lignified wood fibres with thick walls, wide lumina and acute or blunt apices and show small simple pits.
- 7- Fragments of wood parenchyma and medullary ray cells with thick pitted and lignified walls.
- 8- Fragments of thin walled parenchymatous cells from the cortex and pith regions.
- 9- Cluster crystals of calcium oxalate.

2- The Leaf

I- Macromorphology

The leaves (Figs. 1 & 2) are simple and have short petioles. The leaf is oblong, sometimes ovate to lanceolate with acute apex, loosely dentate margin and cuneate at the base. It has thick-coriaceous texture and 3-nerved. The leaves measure about 2.5-8 cm in length and 1-3.5 cm in width. The upper surface is dark green while the lower one is lighter, both surfaces are coarsely strigose. The midrib is more prominent on the lower surface. The petiole is short, nearly cylindrical, green, hirsute, measures 2-8 mm in diameter. The leaf has a faint odour and a bitter taste.

II- Micromorphology

a- The lamina

A transverse section through the lamina in the midrib region (Figs. 8A & 9A) appears biconvex in outline being more prominent on the lower surface in the midrib region. It shows a dorsiventral structure enclosing a heterogeneous mesophyll. There is an upper palisade interrupted in the midrib region by a mass of hypodermal collenchyma. The midrib shows a comparatively large crescent-shaped collateral

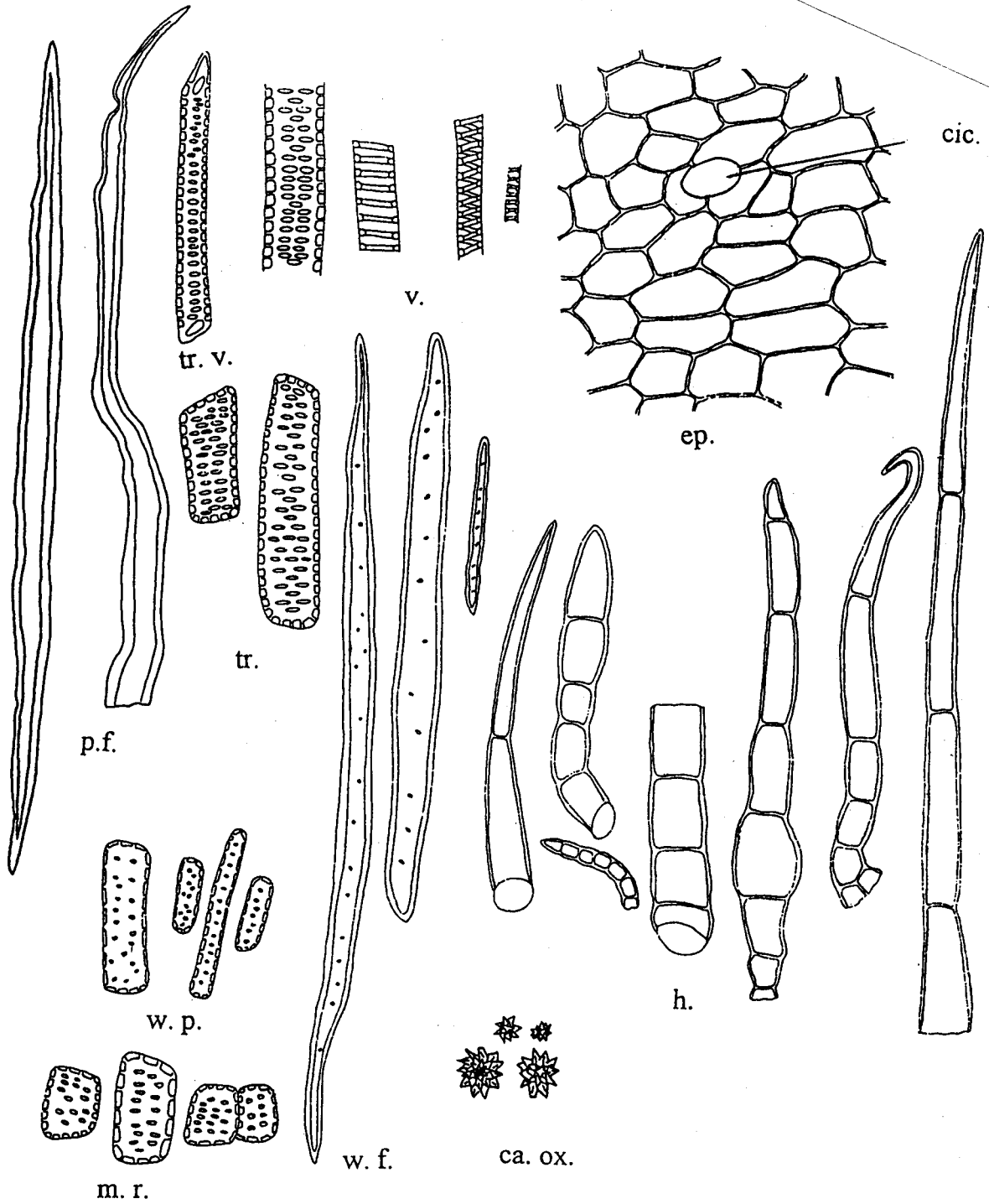


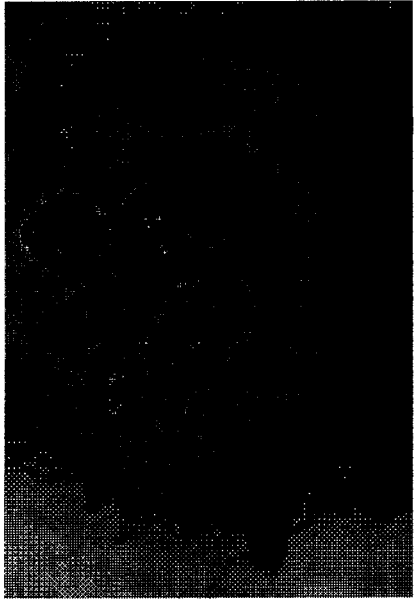
Fig. 7: Isolated elements of the stem

Hairs

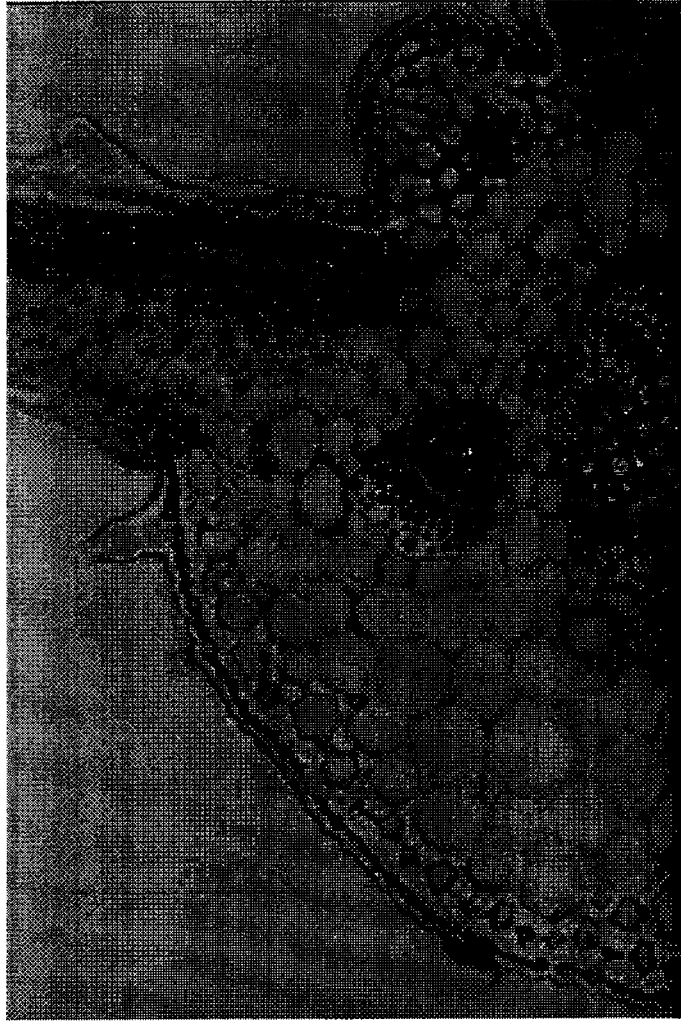
x 562.5

x 225

Ca.ox., calcium oxalate; cic., cicatrix; ep., epidermis; h., hair; m.r., medullary ray; p.f., pericyclic fibre; tr., tracheid; v., vessel; w.f., wood fibre; w.p., wood parenchyma.



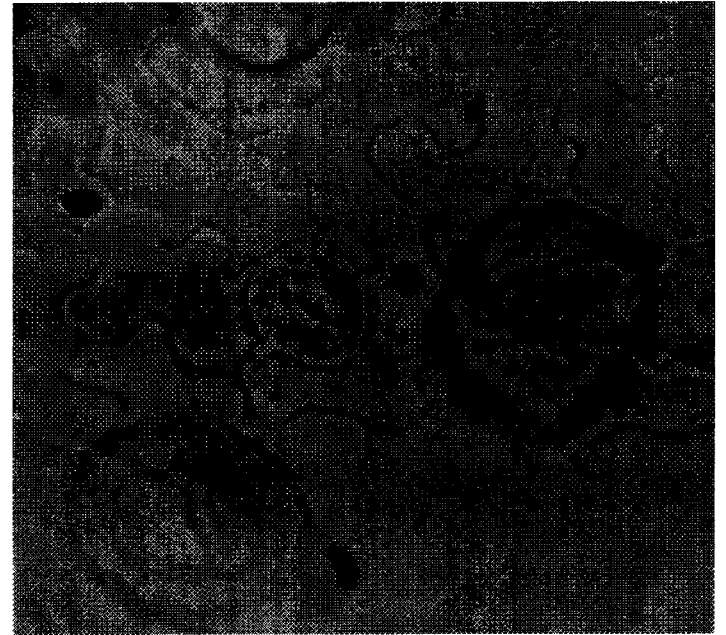
D



A



B



C

Fig. 8: A- Photo of T.S. of the leaf
B- Photo of surface preparation of the upper epidermis
C- Photo of surface preparation of the lower epidermis
D- Photo of non glandular trichome

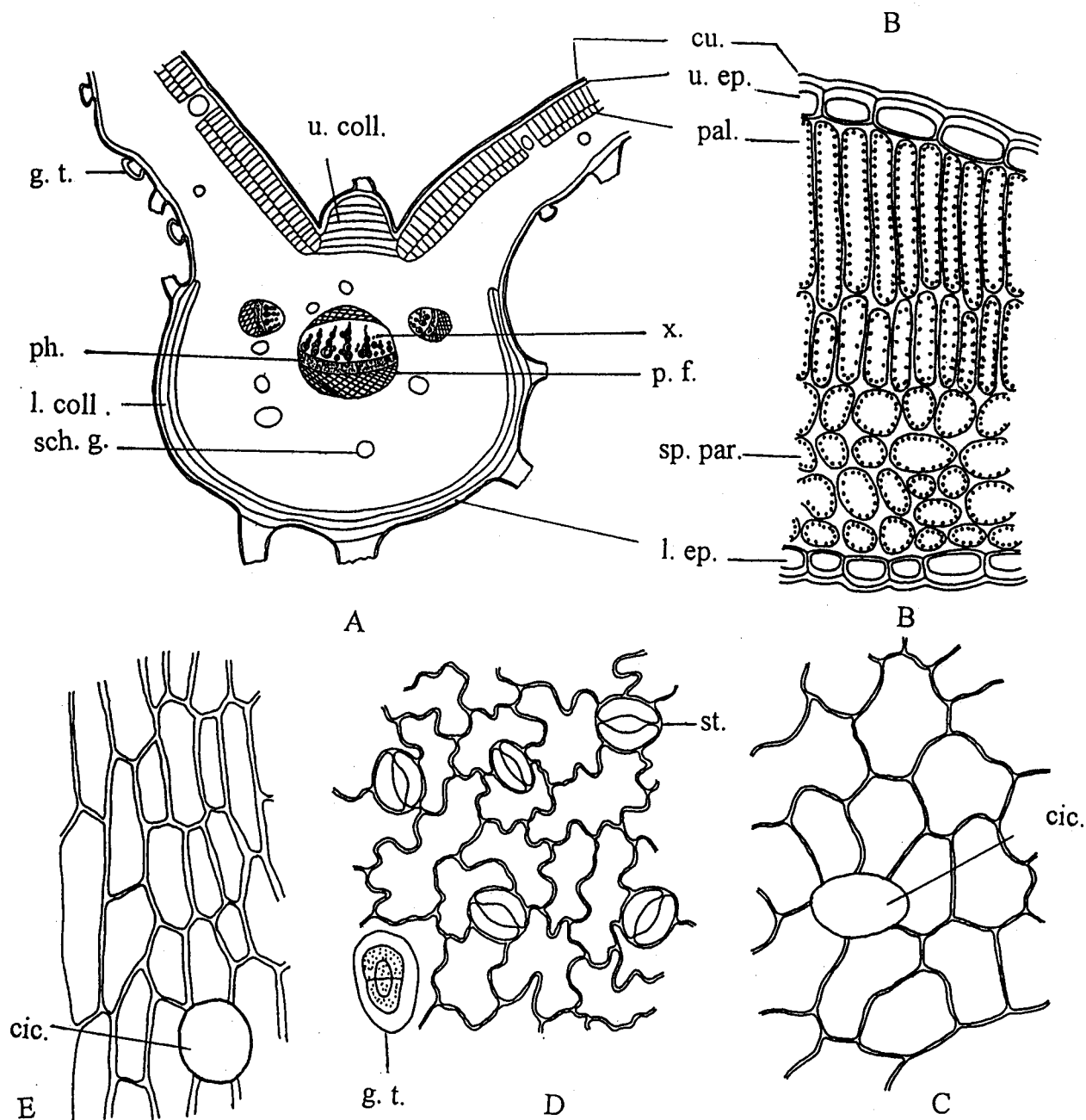


Fig. 9: A- Diagrammatic T.S. of the leaf x 112.5
 B- Detailed T.S. of the lamina x 562.5
 C- Surface preparation of the leaf (upper epidermis) x 562.5
 D- Surface preparation of the leaf (lower epidermis) x 562.5
 E- Surface preparation of the leaf (midrib region) x 450

cic, cicatrix; c.t., covering trichome; cu., cuticle; g.t., glandular trichome; l.coll., lower collenchyma; l.ep., lower epidermis; p.f., pericyclic fibre; pal., palisade; ph., phloem; sch.g., schizogenous gland; sp.par., spongy parenchyma; st., stomata; u.coll., upper collenchyma; u.ep., upper epidermis; x., xylem.

vascular bundle consisting of a radiating upper xylem and a lower soft phloem and provided by a pericycle formed of an upper and a lower arcs. Subepidermal collenchyma is present on both the upper and lower epidermises of the midrib. Numerous small schizogenous secretory glands are observed in the cortical parenchyma of the midrib and the mesophyll of the lamina. The upper and lower epidermises carry covering trichomes while the glandular trichomes are carried only on the lower epidermis.

The upper epidermis (Figs. 8A, 9B & 10); consists of one row of square to subrectangular cells with thick outer tangential and radial walls as seen in the transverse section. In surface view (Figs. 8B & 9C) the cells appear polygonal, usually elongated, sometimes isodiametric with thin wavy anticlinal walls. They are covered with thick smooth cuticle, measuring about 25.1-40 μ in length, 12.8-29.7 μ in width and 8-12.8 μ in height. Stomata are absent. Few covering trichomes are present. The hair (Fig. 8D) is uniseriate, multicellular, usually 2-6 cells long, having acute or bluntly pointed apex, covered with thin smooth cuticle and measures about 60-308 μ in length and 12-20 μ in width at the middle. Some epidermal cells show cicatrices which occur in the center of a single cell or over the junction of two or more epidermal cells.

The lower epidermis (Figs. 8A, 9B & 10); consists of one row of square to subrectangular cells with thick outer tangential and radial walls as seen in the transverse section. In surface view (Figs. 8C & 9D) the cells appear polygonal, usually elongated, sometimes isodiametric with thin sinuous anticlinal walls. They are covered with thick smooth cuticle and measuring about 19.2-49.6 μ in length, 8-27.2 μ in width and 8-16 μ in height. Numerous stomata of cruciferous type are present, being usually oval and measuring 14.4-17.6 μ in length and 9.6-14.4 μ in width. Numerous covering trichomes and cicatrices being exactly identical to those of the upper epidermis are present. Glandular trichomes are found; they have short biseriate two-celled stalks and biseriate heads with two or four cells; around each head the cuticle is raised to form a bladder-like covering. They measure

about 27.2-52 μ in length and 16-28 μ in width.

The epidermal cells of the midrib region of both surfaces (Fig. 9E) are polygonal in surface view, axially elongated with straight anticlinal walls.

The mesophyll (Figs. 8A & 9B); is heterogeneous, discontinuous at the midrib region, dorsiventral with numerous small schizogenous secretory glands. The palisade (Figs. 8A & 9B) is present on the upper surface and is formed of two rows of cylindrical columnar cells, having thin walls, filled with chloroplasts and measure about 24-44.8 μ in length and 4.8-12 μ in width. The spongy tissue (Figs. 8A & 9B) consists of 4-6 rows of somewhat rounded or oval shaped chlorenchymatous cells with comparatively wide intercellular spaces.

The cortical tissue (Figs. 8A & 10); of the midrib region consists of few layers of more or less rounded thin-walled parenchyma above and below the bundle with numerous small schizogenous secretory glands, measuring about 20-40 μ in diameter. The schizogenous cavity is lined by 4-6 secretory epithelial thin-walled cells. Abutting on both epidermises a hypodermal zone formed of few rows of thick-walled cellulosic collenchymatous cells being irregular in shape. The upper collenchymatous layer is formed of 4-7 rows, while that of the lower one is formed of 1-2 rows. The endodermis is indistinguishable.

The vascular system (Figs. 8A & 10); is represented by a large crescent shaped collateral vascular bundle, consisting of a radiating upper xylem region and a lower region of phloem. It is provided by a pericycle formed of upper and lower arcs.

The pericycle (Figs. 8A & 10) is formed of groups of pericyclic fibres. The fibre (Fig. 14) has thick non lignified wall, a wide lumen and a blunt apex. It is slightly irregular in outline and measures about 51.2-192 μ in length and 3.2-11.2 μ in width.

The xylem zone (Figs. 8A & 10) consists of vessels and wood parenchyma and it is traversed by narrow medullary rays. The xylem

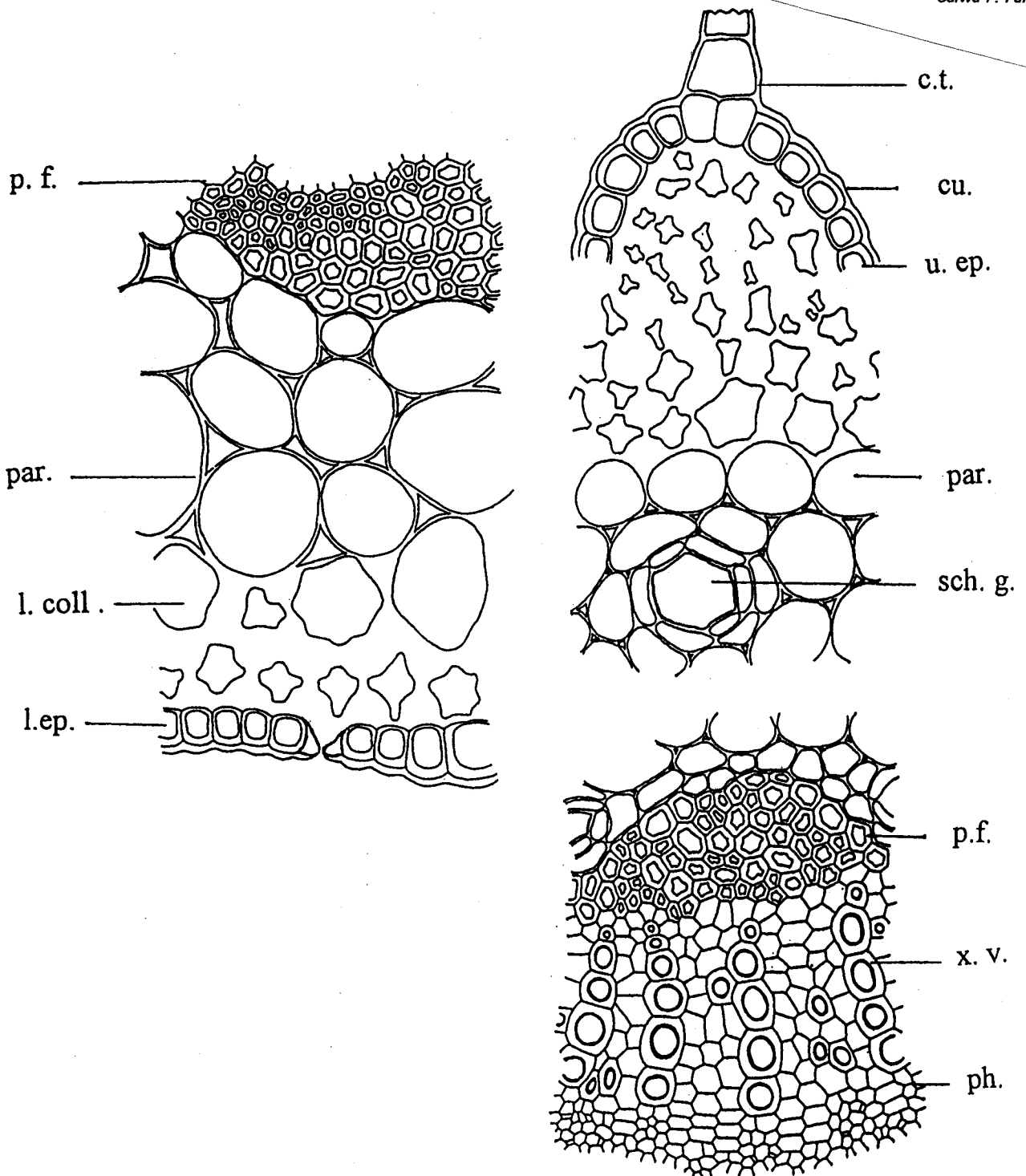


Fig. 10: Detailed T.S. of the midrib region

x 625

c.t., covering trichome; cu., cuticle; l.coll., lower collenchyma; l.ep., lower epidermis; par., parenchyma; p.f., pericyclic fibre; ph., phloem; sch.g., schizogenous gland; u.coll., upper collenchyma; u.ep., upper epidermis; x.v., xylem vessel.

vessels (Fig. 14) are lignified with spiral, scalariform and pitted thickenings and measuring about 3.2-12.8 μ in diameter. The wood parenchyma is formed of subrectangular, elongated cells having thin cellulosic walls.

The medullary ray cells (Figs. 8A & 10) are uni- or biseriate, traversing the xylem and the phloem regions. They are subrectangular and having thin cellulosic walls.

b- The petiole

A transverse section in the petiole (Figs. 11A&B) is nearly concavoconvex in outline. It has an outer epidermis with numerous covering trichomes, followed by a comparatively wide parenchymatous cortical tissue with an outer layer of collenchymatous cells. The endodermis is indistinguishable. The vascular system is represented by separate strands of bundles traversing the cortical region. The vascular bundle consists of a radiating upper xylem and a lower soft phloem. Each bundle is provided by a pericycle formed of an upper and a lower arcs of fibres. Many small schizogenous secretory glands are scattered in the parenchymatous cortical tissue.

The epidermis (Fig. 12 & 13); consists of one layer of square to subrectangular cells in the transverse section, but in surface view (Figs. 11C & 14) the cells are polygonal, axially elongated, sometimes isodiametric with straight finely beaded anticlinal walls. The cells are covered with thick smooth cuticle and measuring about 11.2-28.8 μ in length, 6.4-19.2 μ in width and 8-20.8 μ in height. Occasional stomata of cruciferous type are present, being rounded and measuring about 14.4-17.6 μ in diameter. Numerous covering trichomes (Fig. 14) are observed. The hair is uniseriate, multicellular, usually 5 to 9 cells long, having acute or bluntly pointed apex, covered with thin smooth cuticle and measures about 440-640 μ in length and 20-48 μ in width at the middle. Some epidermal cells show cicatrices (Figs. 11C & 14).

The cortical tissue (Figs. 12 & 13); is formed of an outer collenchymatous zone and an inner parenchymatous one. The collenchymatous zone is formed of about 2-3 rows (being up to 6 rows

at the narrow sides of the petiole) of thick-walled cellulosic collenchymatous cells of irregular shape. The parenchymatous zone is composed of rounded or oval thin walled parenchymatous cells showing intercellular spaces and contain few cluster crystals of calcium oxalate, measuring 3.2-8.0 μ in diameter. Numerous schizogenous secretory glands are present being exactly identical to those of the leaf. The endodermis is indistinguishable.

The vascular bundle (Figs. 12 & 13); is formed of a radiating upper xylem region and a lower region of phloem and is provided by a pericycle formed of an upper and a lower arcs of fibres.

The pericyclic fibre (Fig. 14) has thick non lignified wall, a wide lumen, acute or blunt apex and it is slightly irregular in outline, measures about 51.2-192 μ in length and 4.8-16 μ in width.

The xylem zone (Figs. 12 & 13) is formed of lignified vessels, wood parenchyma and is traversed by medullary rays. The xylem vessels (Fig. 14) are lignified with spiral, scalariform and pitted thickenings and measuring about 3.2-9.6 μ in diameter. The wood parenchyma are rounded to subrectangular in shape with thin cellulosic walls.

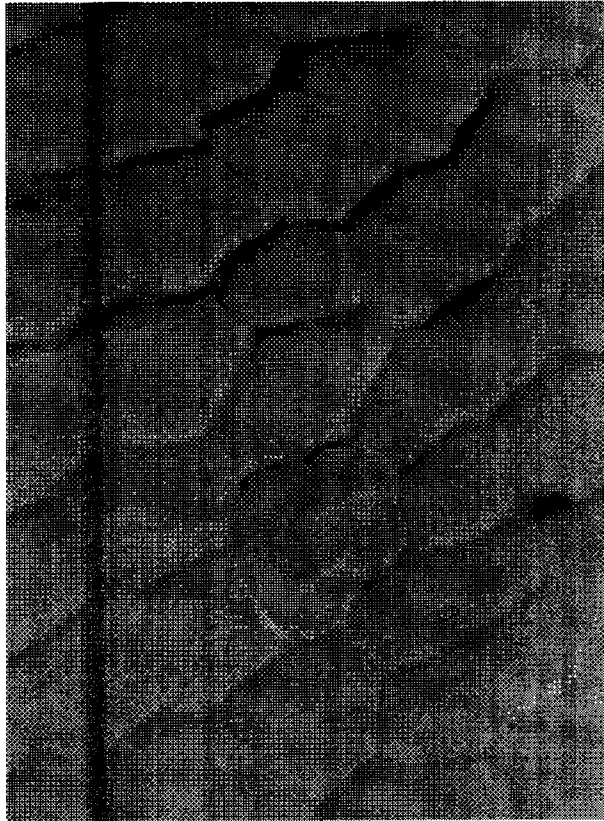
The phloem (Figs. 12 & 13) consists of soft elements of sieve tubes and phloem parenchyma.

The medullary rays (Figs. 12 & 13) are uni- or bi-seriate and traversing the xylem and phloem regions. The cells are oval to subrectangular and having thin cellulosic walls.

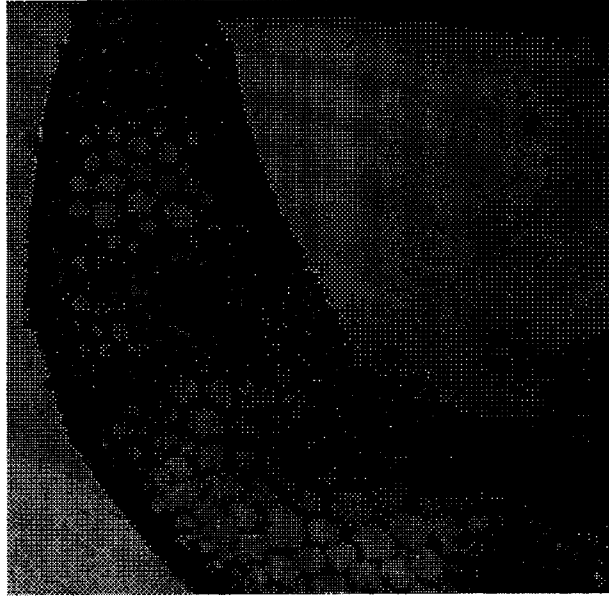
Characters of the powdered leaf

The powdered leaf is green in colour, possessing a faint odour and a bitter taste. It is characterized microscopically by the following features (Fig. 14):

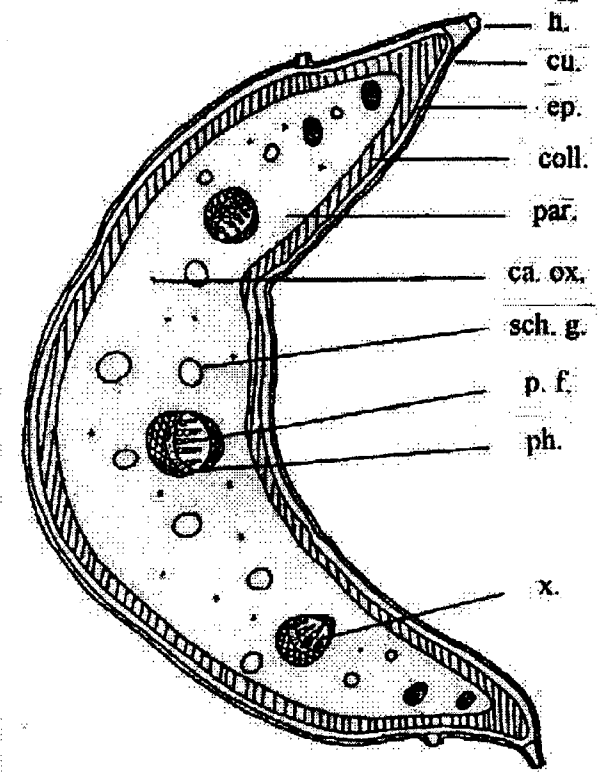
- 1- Fragments of upper epidermal cells of the lamina being polygonal in surface view, with wavy anticlinal walls. They are subrectangular and covered with thick smooth cuticle. Stomata are absent. Some fragments have cicatrices where covering trichomes were attached. The trichome is uniseriate, multicellular, usually 2-6 cells



C



B



A

Fig. 11: A- Diagrammatic T.S. of the petiole x 87.5
 B- Photo of T.S. of the petiole
 C- Photo of the petiole epidermis

Ca.ox.; calcium oxalate, coll.; collenchyma, cu.; cuticle, ep.; epidermis, h.; hair, p.f.; pericyclic fibre, par.; parenchyma, ph.; phloem, sch.g.; schizogenous gland, x.; xylem.

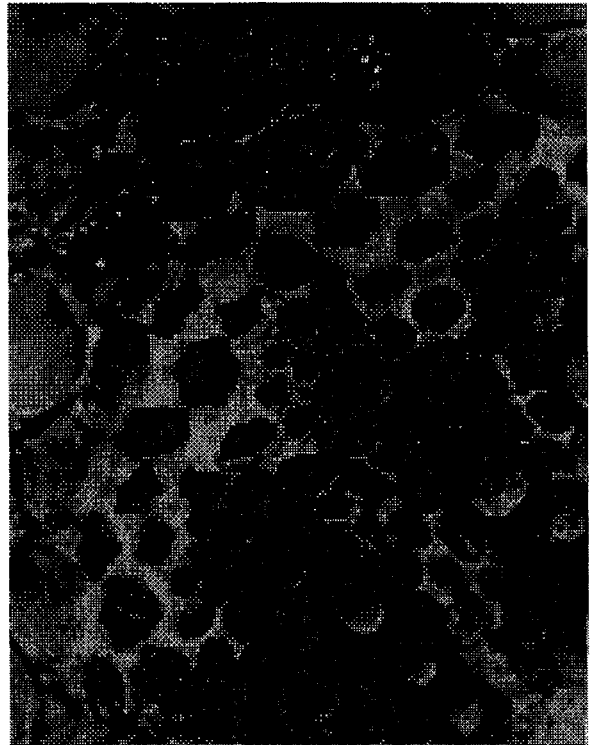
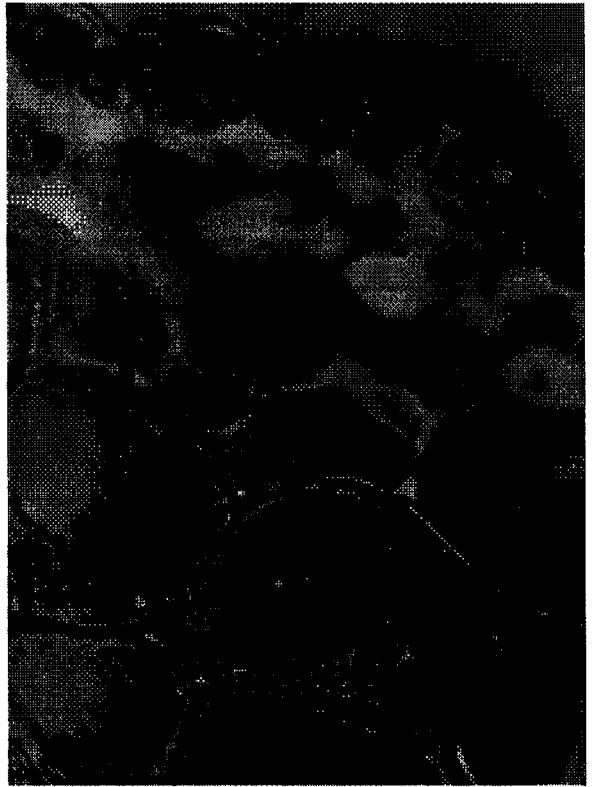
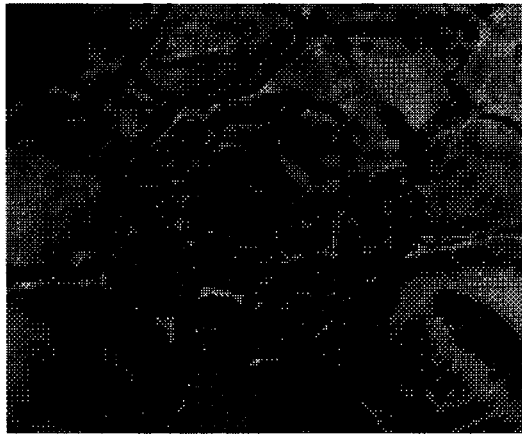
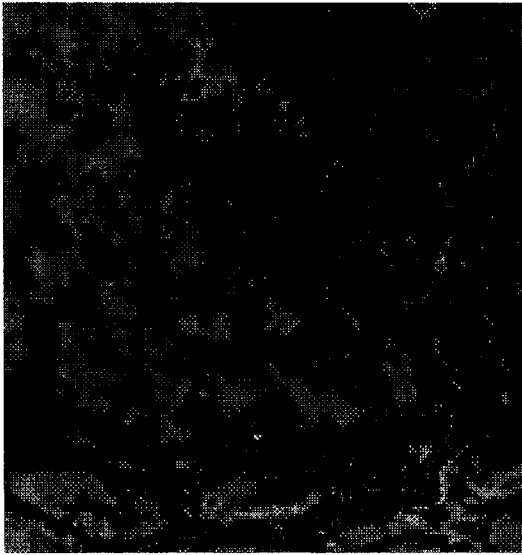


Fig. 12: Photo of detailed T.S. of the petiole.

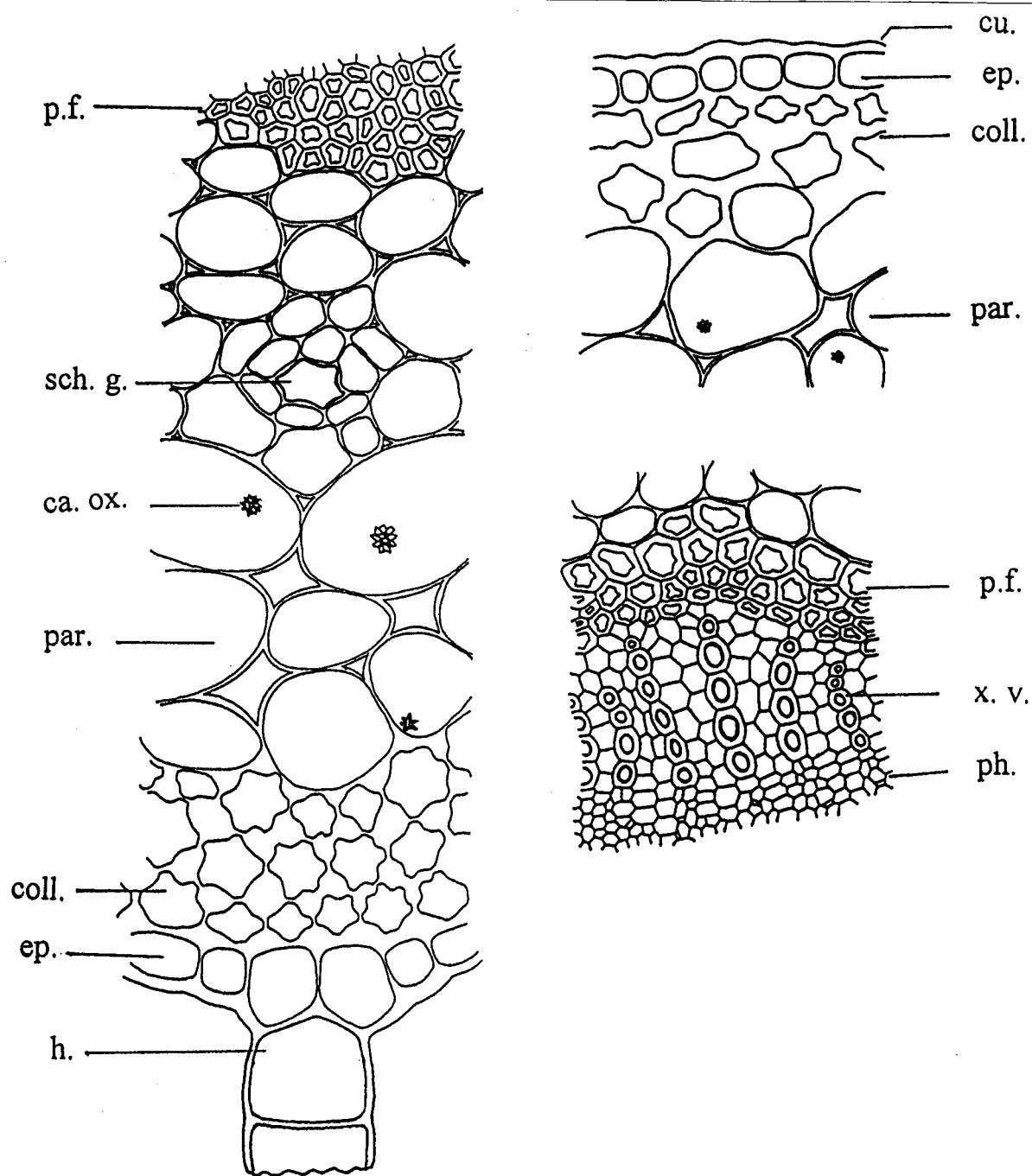


Fig. 13: Detailed T. S. of the petiole

x 625

ca.ox., calcium oxalate; coll., collenchyma; cu., cuticle; ep., epidermis; h., hair; p.f., pericyclic fibre; par., parenchyma; ph., phloem; sch.g., schizogenous gland; x.v, xylem vessel.

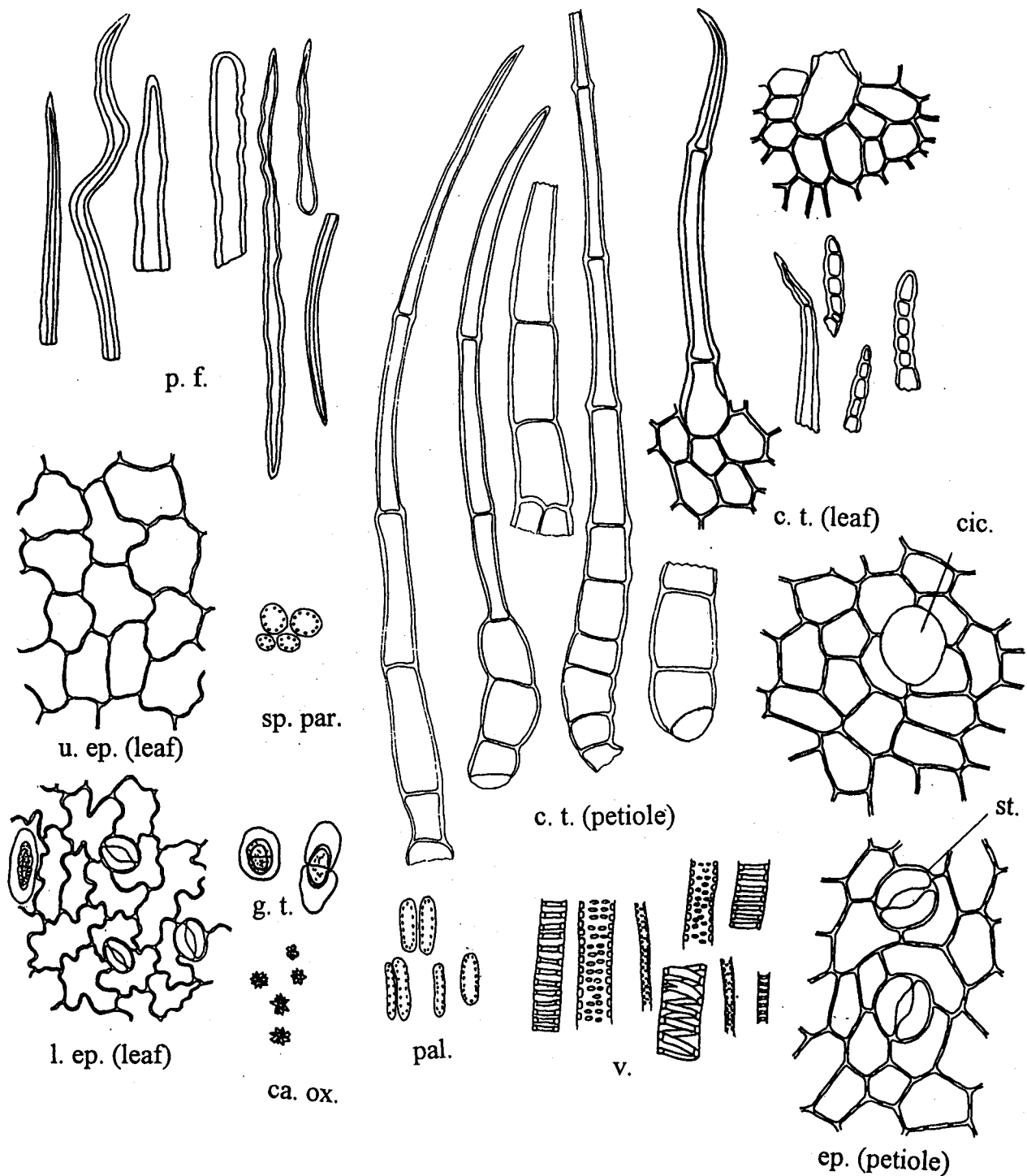


Fig. 14: Isolated elements of the leaf
 Hairs and palisade
 Epidermis of leaf

x 562.5
 x 225
 x 393.8

ca.ox., calcium oxalate; cic., cicatrix; c.t., covering trichome; g.t., glandular trichome; l.ep., lower epidermis; p.f., pericyclic fibre; pal., palisade; sp.par., spongy parenchyma; st., stomata; u.ep., upper epidermis; v., vessel.

- long, having acute or blunty pointed apex and covered with thin smooth cuticle.
- 2- Fragments of lower epidermal cells of the lamina being polygonal, subrectangular, with sinuous anticlinal walls. The cells are covered with thick smooth cuticle and showing stomata of cruciferous type. Trichomes, both covering and glandular types are present, the covering trichomes are very numerous and exactly similar to those of the upper epidermis. The glandular trichome has a short biseriate two-celled stalk and a biseriate head with two or four cells; around each head the cuticle is raised to form a bladder-like covering.
 - 3- Fragments of the epidermal cells of the petiole being polygonal in surface view, subrectangular sometimes isodiametric with straight finely beaded anticlinal walls. The cells are covered with thick smooth cuticle, showing few cruciferous type of stomata, cicatrices and numerous covering trichomes. The hair is uniseriate, multicellular, usually 5 to 9 cells long, having acute to blunty pointed apex and covered with thin smooth cuticle.
 - 4- Fragments of the mesophyll showing numerous spongy parenchyma and palisade cells.
 - 5- Fragments of pericyclic fibres from the lamina and the petiole having thick non lignified walls, wide lumena and acute or blunt apices and of slightly irregular outline.
 - 6- Fragments of lignified xylem vessels with spiral, scalariform and pitted thickenings.
 - 7- Cluster crystals of calcium oxalate from the cortical parenchyma of the petiole.

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