

MACRO- AND MICROMORPHOLOGY OF THE LEAF AND STEM OF *RUELLIA BRITTONIANA* LEONARD CULTIVATED IN EGYPT

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يتبع نبات الرويليا العائلة الاكانثسية والتي تشمل حوالي جنساً و نوعاً موزعة في معظم أنحاء العالم. وتنتشر زراعة نبات الرويليا في المكسيك، ووجد أن بعض أنواعه تستخدم لعلاج بعض الأمراض مثل السيلان، الزهري، التهابات العين و التهابات المجارى البولية. وتستعمل بعض انواع هذه العائلة تجارياً في صناعة الاصباغ و كنباتات للزينة. وقد وجد انه لم يتم اجراء دراسة عقاقيرية كاملة لهذا النبات لذا أجرى هذا البحث لامكانية التعرف عليه سواء في صورة كاملة أو على هيئة مسحوق.

The genus Ruellia L. is sometimes called Dipteracanthus, it comprises about 150 species native to tropical and temperate North and South America. Ruellia brittoniana Leonard is known as Britton's wild petunia, wild petunia, Mexican bluebell and Ruellia tweediana Grisebach. Some species of genus Ruellia are used medicinally to cure gonorrhoea, syphilis, eye sores and in renal infections.

INTRODUCTION

The family Acanthaceae (Acanthus family) is a large plant family, includes about 250 genera with almost 2500 species mostly found not only in hot countries, tropical and subtropical regions of the world, but also found in Mediterranean regions, Australia and USA. The main four centres for distribution of this family are Indomalay, Africa, Brazil and Central America. Six species are found in the northeastern United States¹⁻⁴.

Some species of the family Acanthaceae are used in folk medicine to treat several diseases, specially gastrointestinal ailments⁵. Some plants are used as purgative, emetic, in childbirth to relieve pain⁶, food stuff and diuretic^{2,6&7}, antidysentric, galactagogue and antidote for snake-bite⁶ while being used externally as a poultice in rheumatism^{2&6}.

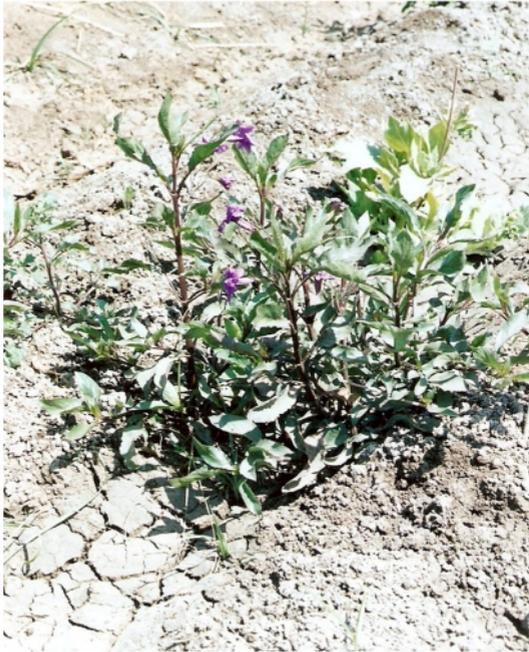
Some species of genus *Ruellia* are used medicinally to cure gonorrhoea, syphilis, eye sores and in renal infections⁷⁻⁹. Economically, many members of the family Acanthaceae are used in blue and yellow dye manufacture¹⁰. Many genera of this family are favourite ornamentals mainly green-house or hot-house plants by reason of their brightly coloured flowers¹.

HABITAT

Ruellia brittoniana Leonard (Mexican Petunia) (Fig. 1A) is a perennial herb native to Mexico. It attains 1 meter in height. Leaves (Figs. 1B and 2) are opposite decussate, exstipulate, petiolate and ovate to lanceolate in shape. Flowers (Fig. 1C) are purple in colour, arranged in dichasial cymes and tending to be monochasial. The fruits (Fig. 1C) are capsules ellipsoid in shape. The flowering season is from April to November.

MATERIAL

The plant was cultivated in the experimental station of Faculty of Pharmacy, Assiut University, Assiut, Egypt and was kindly identified by Mrs. Traes Labib, general manager and specialist of plant taxonomy in El-Orman Botanical Garden, Giza, Egypt. The plant material was collected in the period from April to June 2004 during flowering stage. Fresh leaves and stems were preserved in mixture of alcohol- glycerin- water (1:1:1) and stored in tightly closed containers. The leaves and stems were separately air-dried and reduced to fine powder.



A



B



C



D

Fig. 1: Macromorphology of *Ruellia brittoniana* Leonard.

A) Photo of the plant

x 0.13

B) Photo of a branch

x 0.78

C) Photo of the inflorescence showing mono- and dichasial cymes

x 0.75

D) Photo showing flower and fruits

x 0.75

1- The leaf

A- Macromorphology (Figs. 1B and 2)

The leaves are opposite decussate, exstipulate, petiolate and ovate to lanceolate in shape, with acute to acuminate apex. Each leaf has somewhat sinuate to crenate margin (rarely dentate), slightly decurrent base and flattened lamina. Leaves are dark green in colour with violet tinge, the upper epidermis more darker than the lower one. They measure about 2.2-5.2-8.5 cm long and 0.9-1.8-2.5 cm wide at the middle portion. The venation is pinnately reticulate, the veins being prominent in the lower surface, anastomose near the margin and leaving the midrib at an acute angle. The texture is membranous. The petiole is cylindrical to subcylindrical, has a green colour and measures about 0.5-1-2 cm in length and 0.1-0.2-0.3 cm in diameter. Hairs are abundant on the surface of the petiole. The leaf has faint odour and slightly disagreeable taste.

B- Micromorphology

The lamina

A transverse section in the lamina (Fig. 3A) shows the midrib being more prominent in the lower surface with two upper ridges, a dorsiventral structure with one layer of palisade underlying the upper epidermis; the palisade being interrupted in the midrib region by a large collenchymatus mass alternated with chlorenchyma; the midrib region showing patches of perimedullary phloem and a central arc of vascular tissue consisting of a radiating upper xylem and lower soft phloem and the endodermis present in the lower side. There are two small additional collateral vascular bundles under the two ridges. Both upper and lower epidermises show diacytic type of stomata, numerous cystoliths of calcium carbonate and carry glandular and nonglandular hairs.

The upper epidermis

The upper epidermis (Figs. 3B and 4A) consists of one row of square to subrectangular cells as seen in transverse section, while in surface view (Fig. 3B) they appear polygonal, isodiametric with slightly sinuous anticlinal walls. The cells are covered with thin smooth cuticle. Numerous diacytic type of stomata (caryophyllaceous) are present. There are numerous epidermal cells which are modified

to cystoliths containing deposits of calcium carbonate. They are simple, solitary, elongated with pointed end, irregular walls and striated surfaces. The occurrence of these cystoliths is recorded as one of the most characteristic features of family Acanthaceae¹⁰. The epidermal cells carry two types of hairs; glandular and nonglandular. The glandular hairs have unicellular stalk and bi- or multicellular globular head. The nonglandular hairs are uniseriate, multicellular with 5-8 cells and having acute to acuminate apices. Most of the hairs have collapsed cells. Some are covered with striated cuticle and others with smooth cuticle.

The lower epidermis

The lower epidermis (Figs. 3B and 4A) consists of one row of square or cubical cells as seen in transverse section, while in surface view (Fig. 3C) the cells appear polygonal, mostly isodiametric showing more sinuated anticlinal walls. The cells are covered with smooth cuticle. Stomata, cystoliths and hairs are present, being exactly identical to those of the upper epidermis.

The epidermal cells of the midrib region of both surfaces (Fig. 4B) are polygonal in surface view, usually, axially elongated with straight anticlinal walls. They carry glandular hairs and cystoliths of calcium carbonate.

The mesophyll (Figs. 3A and 4A)

The leaf is dorsiventral showing one layer of palisade underlying the upper epidermis, followed by spongy tissue with irregular cells of loosely-packed chlorenchyma with wide intercellular spaces and containing starch granules. The palisade is formed of one row of cylindrical columnar cells closely packed with distinct intercellular spaces and containing chloroplasts. They are interrupted in the midrib region by a large collenchymatus mass.

The cortical tissue (Fig. 5)

The upper epidermis is formed of one row of square to subrectangular cells showing diacytic stomata, cystoliths of calcium carbonate and carrying hairs. The epidermal cells are followed by a mass of collenchyma cells, 3-4 rows under the two ridges and 2 rows inbetween which contain few chloroplasts. They are nearly rounded, cellulosic, followed

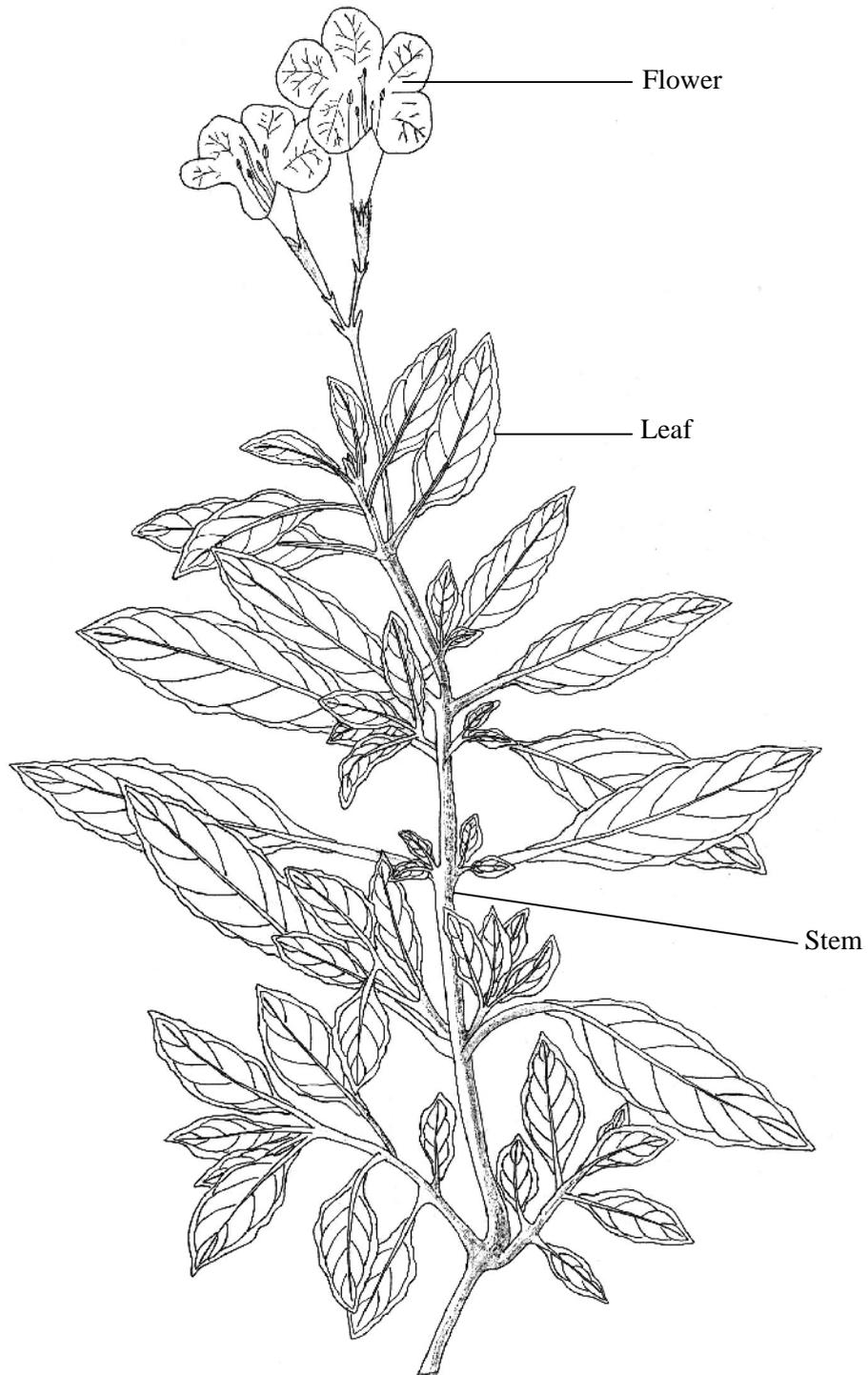


Fig. 2: Macromorphology of the aerial parts of *Ruellia brittoniana* Leonard x 0.5

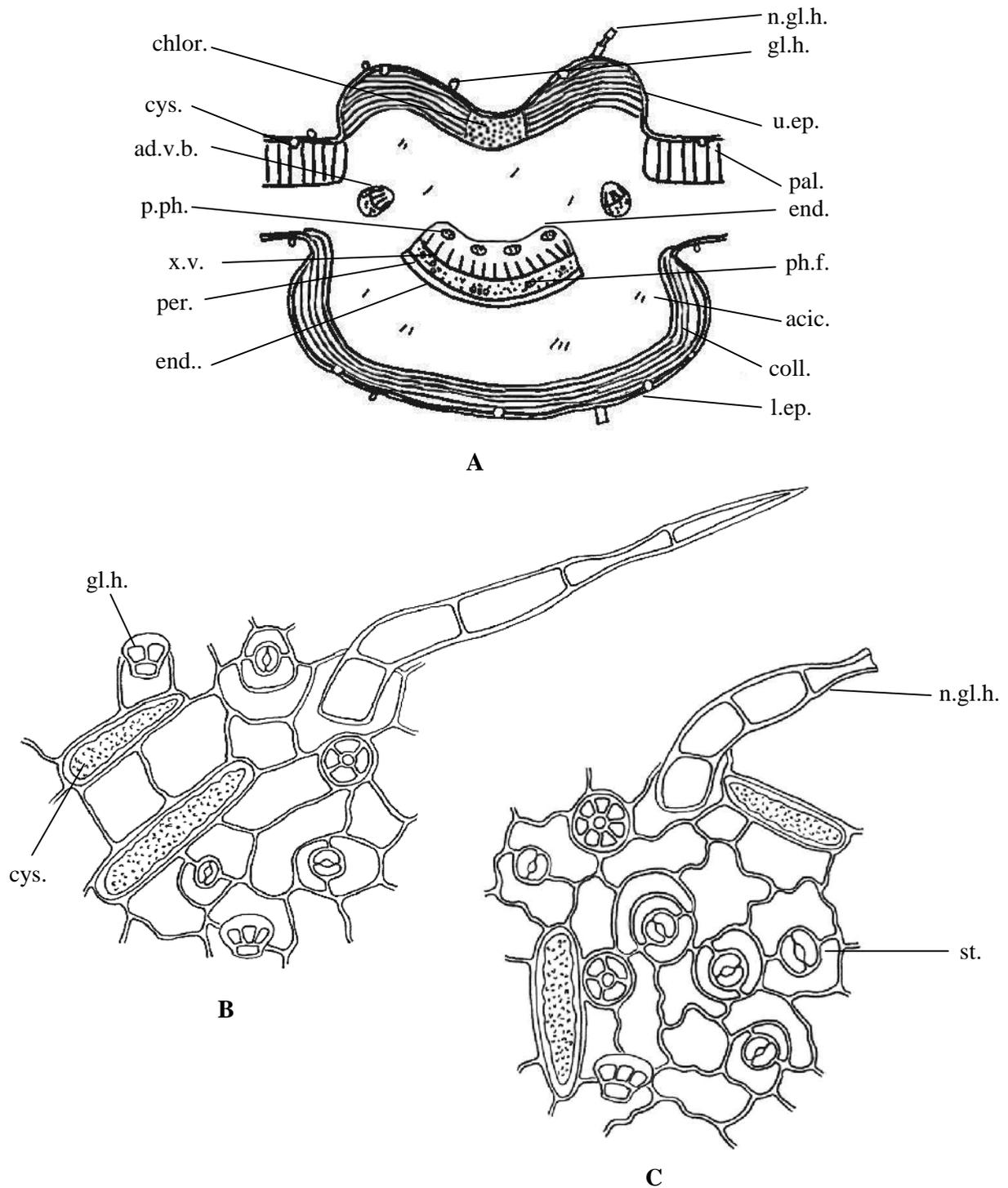


Fig. 3: Micromorphology of *Ruellia brittoniana* Leonard Leaf.

A) Diagrammatic T.S. of the leaf

x 75

B) The upper epidermal cells

x 500

C) The lower epidermal cells

x 500

acic., acicular crystals of calcium oxalate; ad.v.b., additional vascular bundle; coll., collenchyma; cys., cystoliths of calcium carbonate; end., endodermis; gl.h., glandular hair; l.ep., lower epidermis; n.gl.h., non glandular hair; per., pericycle; p.ph., perimedullary phloem; pal., palisade; ph., phloem; ph.f., phloem fibre; st., stomata; u.ep., upper epidermis; x.v., xylem vessel.

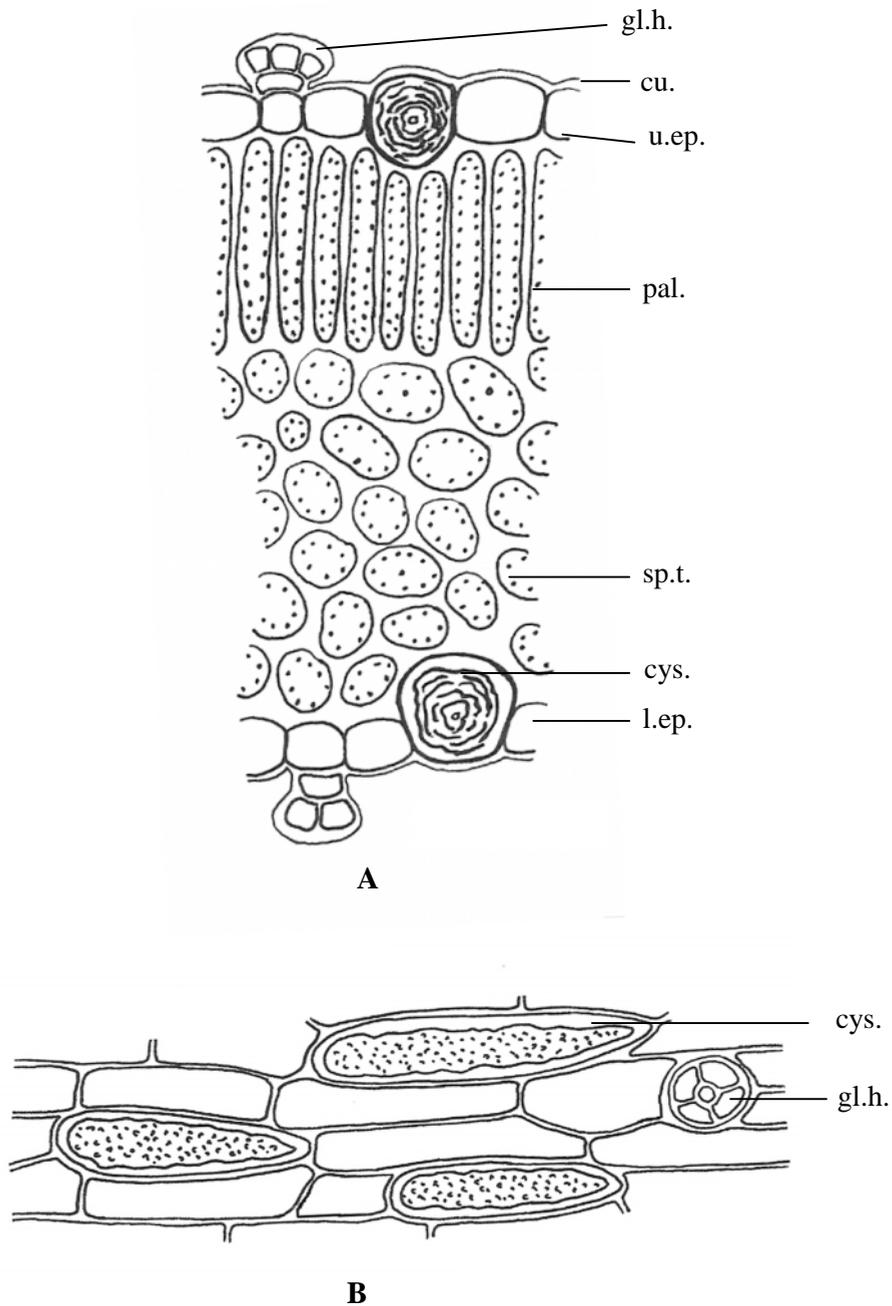


Fig. 4: A) Detailed T.S. in the lamina of the leaf x 500
B) The neural epidermis x 500

cu., cuticle; cys., cystoliths of calcium carbonate; gl.h., glandular hair; l.ep., lower epidermis; pal., palisade; sp.t., spongy tissue; u.ep., upper epidermis.

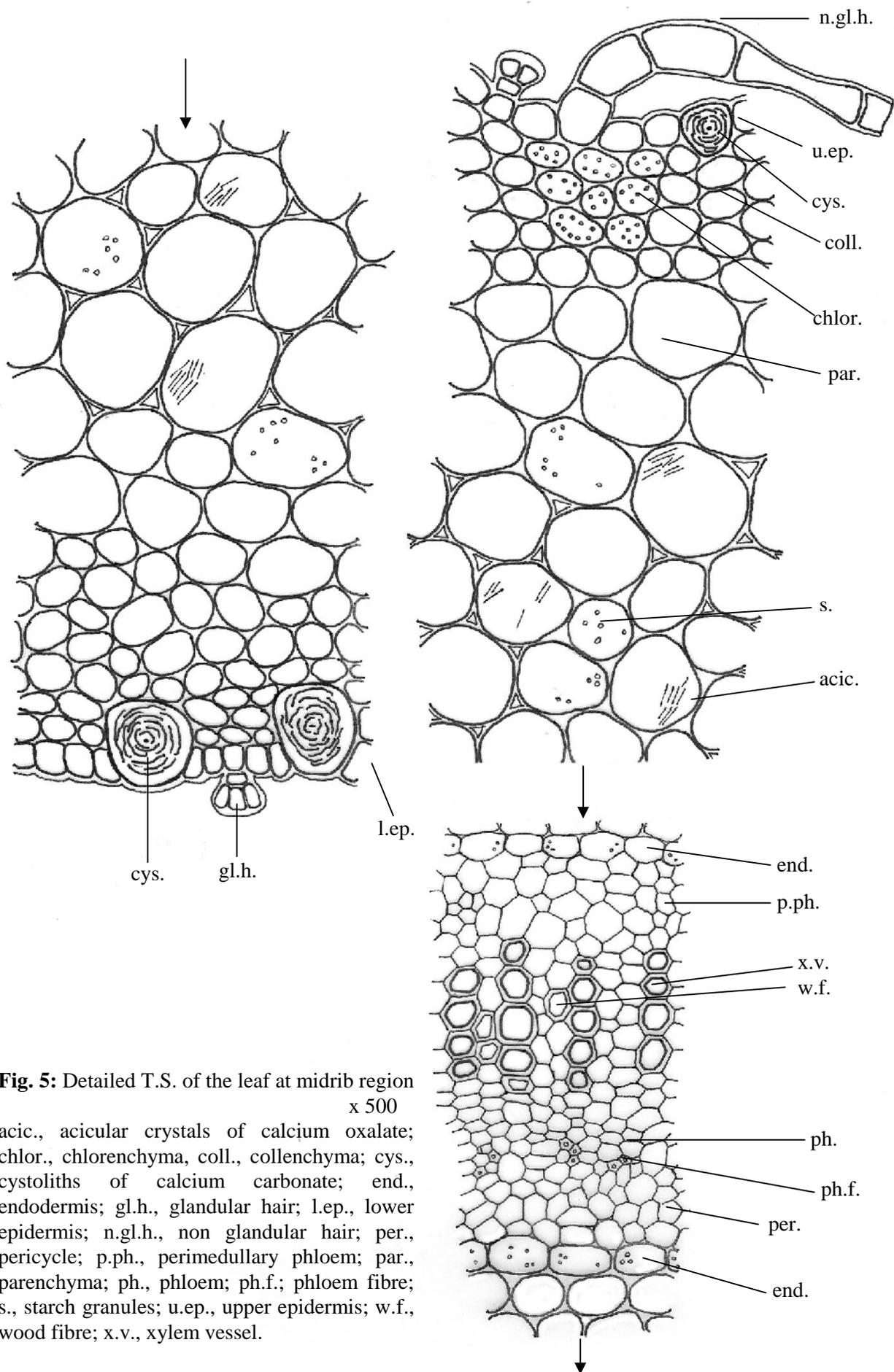


Fig. 5: Detailed T.S. of the leaf at midrib region
x 500

acic., acicular crystals of calcium oxalate; chlor., chlorenchyma, coll., collenchyma; cys., cystoliths of calcium carbonate; end., endodermis; gl.h., glandular hair; l.ep., lower epidermis; n.gl.h., non glandular hair; per., pericycle; p.ph., perimedullary phloem; par., parenchyma; ph., phloem; ph.f.; phloem fibre; s., starch granules; u.ep., upper epidermis; w.f., wood fibre; x.v., xylem vessel.

by a mass of parenchyma cells of about 7-9 rows. Some of these cells contain acicular crystals of calcium oxalate, while others contain rounded starch granules.

The perimedullary phloem (Fig. 5)

There are patches of "perimedullary or intraxillary phloem" present in the cortical tissue adjacent to protoxylem, which is considered as an abnormal secondary thickening¹⁰.

The vascular system (Fig. 5)

It is represented in the midrib region by an arc of vascular tissue showing xylem and phloem. Also there are two small additional collateral vascular bundles present under the two ridges.

The xylem region consists of radial rows of lignified vessels, fibres and wood parenchyma. The xylem vessels (Fig. 6) show spiral, annular, pitted and reticulate thickening. The wood fibres (Fig. 6) are elongated with lignified, septate walls showing wide lumen and with acute ends. The wood parenchyma (Fig. 6) consists of rectangular to subrectangular cells. The xylem vessels are traversed by uni-, bi-, and triseriate rectangular cellulosic medullary rays (Fig. 5).

The phloem (Fig. 5) forms a narrow zone of soft elements below the xylem. It is formed of small, thin-walled and cellulosic elements. It is interrupted by groups of acicular non-lignified fibres (Fig. 6).

The cambium is hardly distinguishable, but represented by a little cambiform tissue between the xylem and the phloem.

The pericycle is formed of thin-walled parenchyma cells below the vascular bundle.

The endodermis present below the vascular bundle. It consists of one row of tabular elongated cells which contain rounded starch granules. The endodermis is followed by 6-8 rows of parenchyma cells containing acicular crystals of calcium oxalate, while others contain rounded starch granules. The parenchyma cells are followed by 2-3 rows of lower collenchyma.

The lower epidermis consists of one row of square cells showing cystoliths of calcium carbonate and glandular hairs.

The petiole

A transverse section in the petiole, (Fig. 7A) shows that the epidermal cells at the position of the midrib are sunken, giving the T.S. a kidney-like shape with projection in the lower surface. It has an outer epidermis covered with thin smooth cuticle carrying both glandular and nonglandular hairs and followed by a comparatively wide parenchyma. The vascular system is formed of an arc of vascular tissue showing xylem and phloem, accompanied with patches of perimedullary phloem; the endodermis being below the vascular bundle. Two additional small collateral vascular bundles are present on both sides of the transverse section. Abundant cystoliths of calcium carbonate are observed in the epidermal cells, resembling those of the leaf in size and shape.

The epidermis

The upper epidermis (Fig. 8) consists of one row of square to subrectangular cells as seen in transverse section, while in surface view (Fig. 7B) they appear polygonal, isodiametric with straight anticlinal walls. The cells are covered with thin smooth cuticle. Cystoliths of calcium carbonate, glandular and nonglandular hairs are also present (Fig. 6C), resembling those of the leaf. Stomata are not observed.

The cortical tissue

The cortical tissue (Fig. 8) of the petiole is formed of 2 layers of collenchymatous cells, alternating with chlorenchymatous ones which contain chloroplasts. They are followed by a wide parenchymatous layer of about 7-8 rows. Some of these cells contain acicular crystals of calcium oxalate, while others contain rounded starch granules.

The vascular system

The vascular system (Fig. 8) is formed of a large collateral vascular strand accompanied with patches of perimedullary phloem. The xylem region consists of radial rows of lignified spiral, annular, pitted and reticulate vessels, fibres and wood parenchyma. The phloem forms a narrow zone of soft elements below the xylem. It is formed of small, thin-walled and cellulosic elements, interrupted by groups of nonlignified fibres. The cambium is

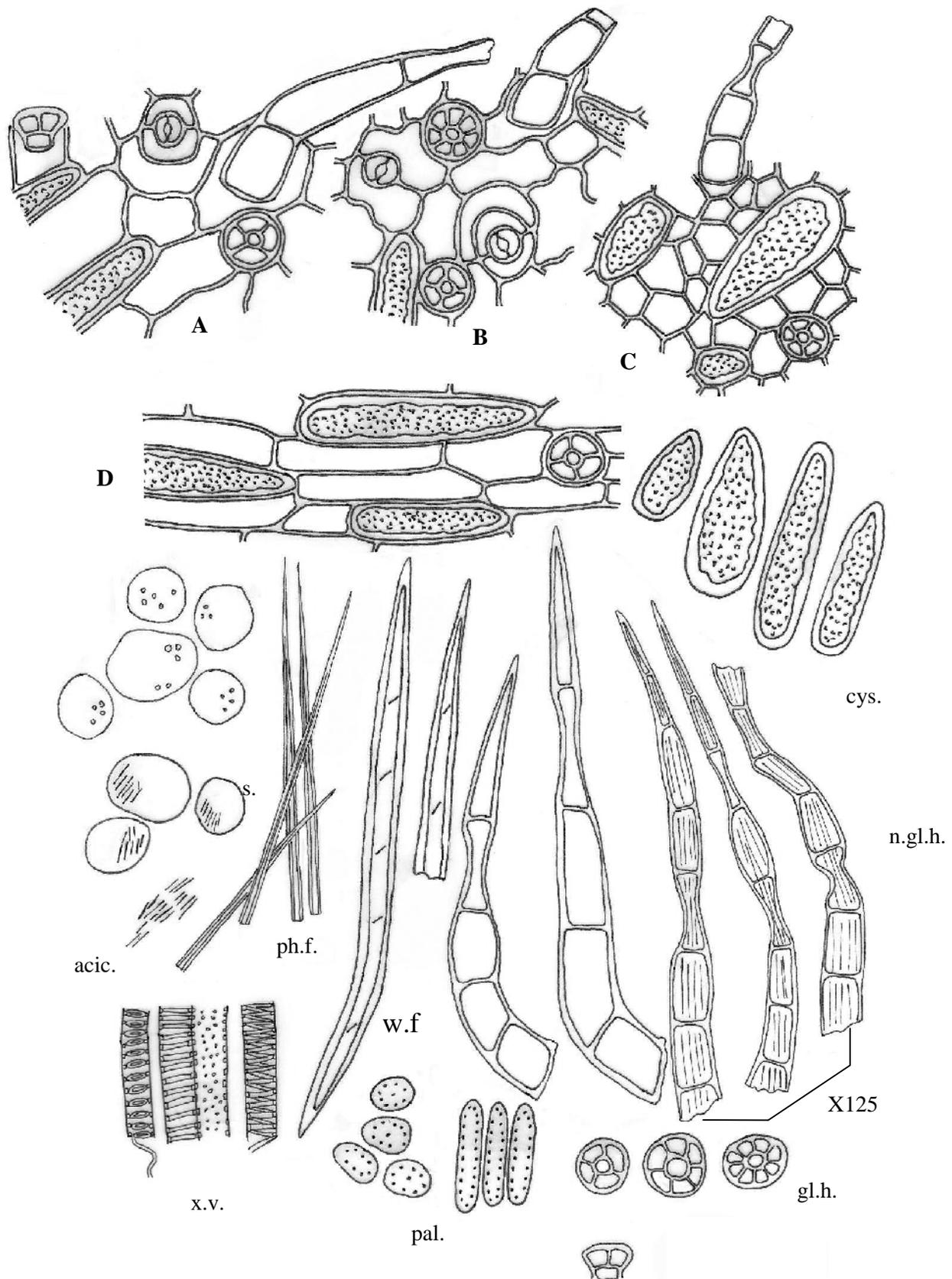
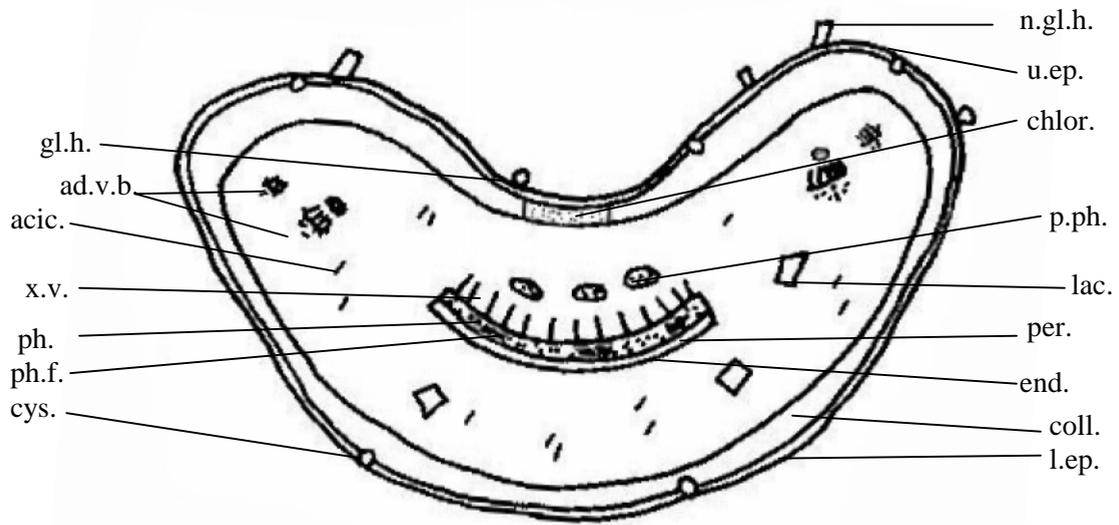


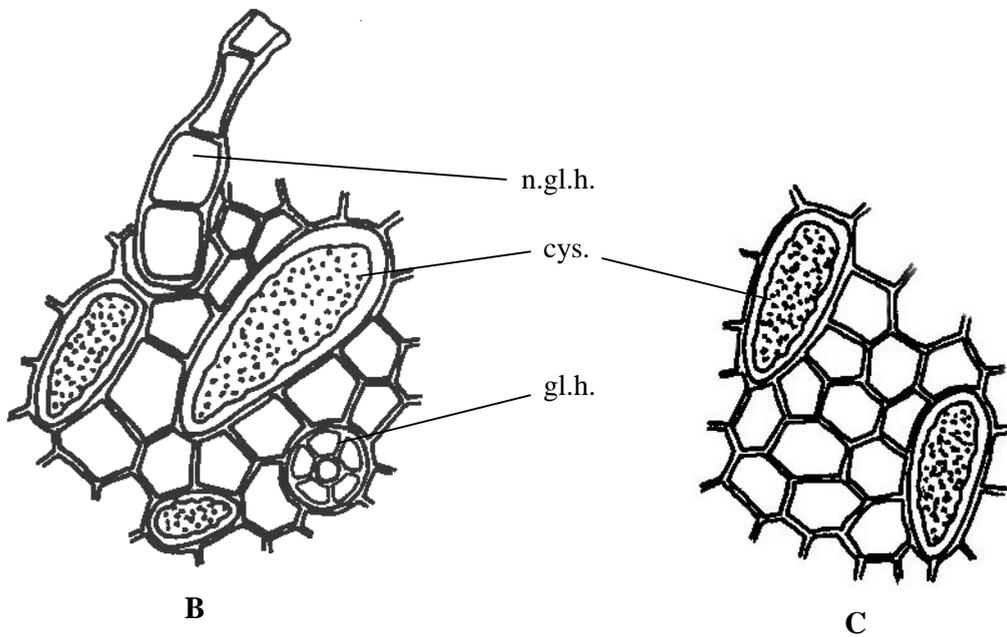
Fig. 6: Powdered elements of the leaf and the petiole x 500

- A)** Upper epidermis of the leaf **B)** Lower epidermis of the leaf
C) Epidermis of the petiole **D)** Neural epidermis

acic., acicular crystals of calcium oxalate; cys., cystoliths of calcium carbonate; gl.h., glandular hair; n.gl.h., non glandular hair; pal., palisade; ph.f., phloem fibre; s., starch granules; w.f., wood fibre; x.v., xylem vessel.



A



B

C

Fig. 7: A) Diagrammatic T.S. of the petiole

B) The upper epidermal cells

C) The lower epidermal cells

x 60

x 500

x 500

acic., acicular crystals of calcium oxalate; ad.v.b., additional vascular bundle; chlor., chlorenchyma; coll., collenchyma; cys., cystoliths of calcium carbonate; end., endodermis; gl.h., glandular hair; l.ep., lower epidermis; n.gl.h., non glandular hair; per., pericycle; p.ph., perimedullary phloem; ph., phloem; ph.f.; phloem fibre, s., starch granules; u.ep., upper epidermis; x.v., xylem vessel.

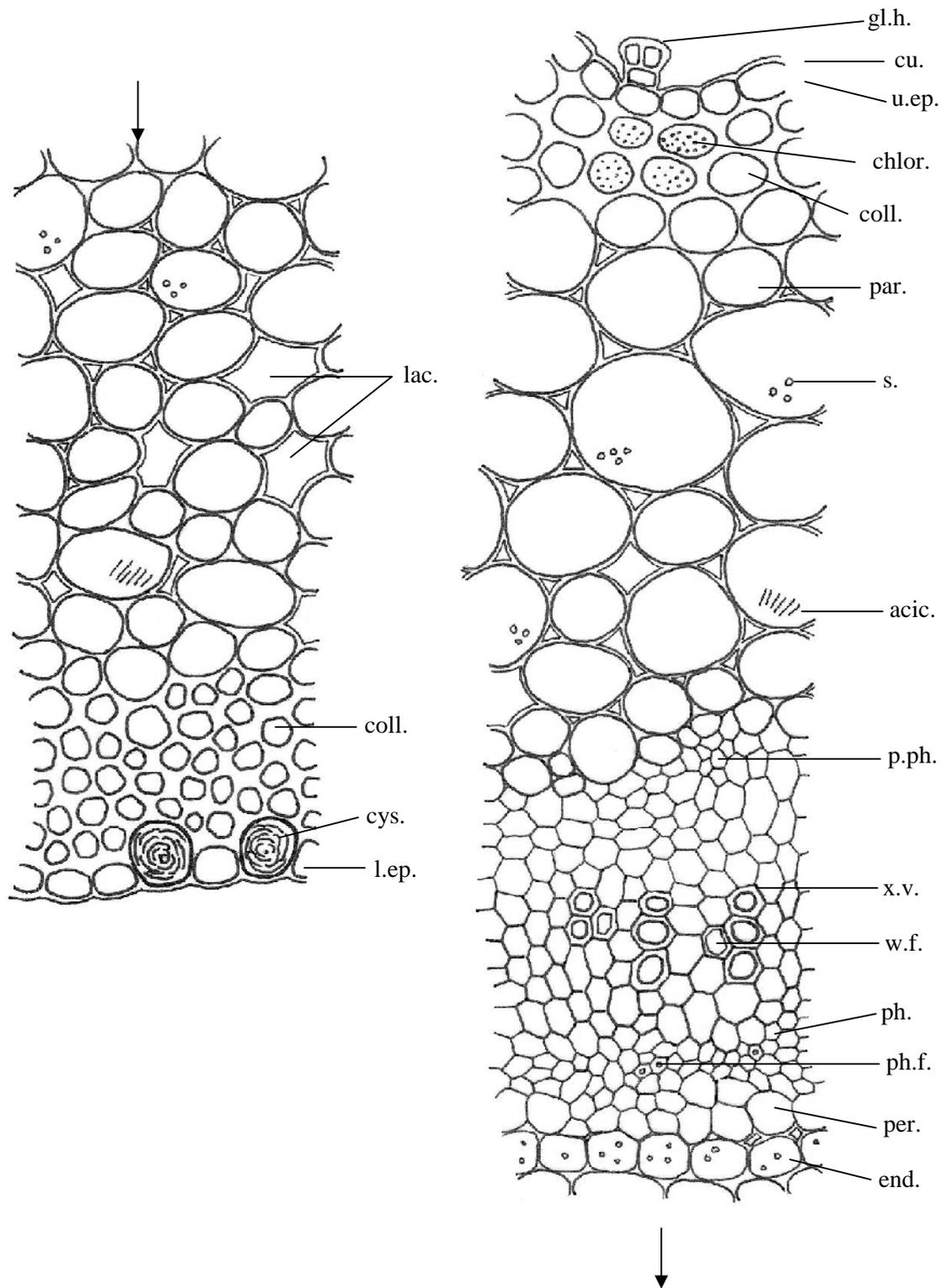


Fig. 8: Detailed T.S. of the petiole

x 450

acic., acicular crystals of calcium oxalate; chlor., chlorenchyma; coll., collenchyma; cu., cuticle; cys., cystoliths of calcium carbonate; end., endodermis; gl.h., glandular hair; l.ep., lower epidermis; lac., lacunae; n.gl.h., non glandular hair; per., pericycle; p.ph., perimedullary phloem; par., parenchyma; ph., phloem; ph.f.; phloem fibre; s., starch granules; u.ep., upper epidermis; w.f., wood fibre; x.v., xylem vessel.

hardly distinguishable. The pericycle is formed of thin-walled parenchyma cells, formed of 2 rows and followed by the endodermis which consists of one row of tabular elongated cells containing rounded starch granules. The endodermis is followed by 6-8 rows of parenchyma cells, containing acicular crystals of calcium oxalate, while others contain rounded starch granules. The parenchyma cells are followed by 4-5 rows of lower collenchyma cells.

The two additional vascular bundles are collateral consisting of xylem and phloem.

The lower epidermal cells (Figs. 7C and 8) resemble the upper ones but the glandular and nonglandular hairs are hardly observed.

The powdered leaf and petiole

The powder of leaf and petiole is dark green in colour, with faint odour and slightly disagreeable taste. It is characterized microscopically (Fig. 6) by the following:

- 1- Fragments of upper epidermal cells of the lamina being polygonal, isodiametric with slightly sinuated anticlinal walls. The cells are covered with thin smooth cuticle. They show numerous cystoliths of calcium carbonate, diacytic type of stomata (caryophyllaceous) and nonglandular hairs which are uniseriate, multicellular with 5-8 cells and having acute to acuminate apices. Most of the hairs have collapsed cells. Some are covered with striated cuticle and others with smooth one with fragments of glandular hairs with unicellular stalk and bi- or multicellular globular head.
- 2- Fragments of lower epidermal cells of the lamina being polygonal, mostly isodiametric with more sinuated anticlinal walls. The cells are covered with thin smooth cuticle and showing cystoliths of calcium carbonate, diacytic type of stomata, as well as covering trichomes and glandular ones similar to those of the upper epidermal cells in all aspects.
- 3- Fragments of epidermal cells of both surfaces of the midrib region, polygonal in surface view, usually, axially elongated with straight anticlinal walls. They carry glandular hairs and cystoliths of calcium carbonate (Fig. 6D).

- 4- Fragments of mesophyll cells showing columnar palisade cells and spongy chlorenchyma.
- 5- Fragments of vascular bundles showing lignified xylem vessels with spiral, annular, pitted and reticulate thickening.
- 6- Scattered acicular crystals of calcium oxalate, either free or embedded in parenchyma cells of the cortical tissue.
- 7- Fragments of parenchyma cells containing rounded starch granules.
- 8- Numerous scattered cystoliths of calcium carbonate, which are solitary, elongated with pointed end, irregular walls and striated surfaces. These cystoliths dissolved and disappeared on addition of dilute HCl.
- 9- Fragments of epidermal cells from the petiole showing small polygonal isodiametric cells with straight anticlinal walls, carrying glandular and nonglandular hairs (Fig. 6C).
- 10- Fragments of phloem fibres, non-lignified and acicular in shape.
- 11- Fragments of wood fibres, elongated with lignified walls, septate, showing wide lumen and acute ends.

2- The stem

A- Macromorphology (Fig. 9A and B)

The main trunk of the plant is erect, suffruticose, perennial, quadrangular in its upper part and cylindrical in its lower one, reaching about 1 meter in height and 24 mm in diameter. It is monopodially branched carrying numerous branches and showing more or less long internodes, up to 9 cm in the lower parts and shorter in the upper ones. The young upper part has smooth surface except at internodes which carry hairs and has purplish green colour, while the old one has rough surface covered with brownish cork. The stem is broken with complete fracture in its upper part and with fibrous fracture in its lower one. It has faint odour and slightly disagreeable taste.

B- Micromorphology

A transverse section in young stem (Fig. 10) is quadrangular in outline. It shows an outer epidermis carrying glandular and few nonglandular hairs and showing cystoliths of



A



B

Fig. 9: A) Photo of the plant

B) Photo showing the nodes and the internodes

x 0.45

x 0.89

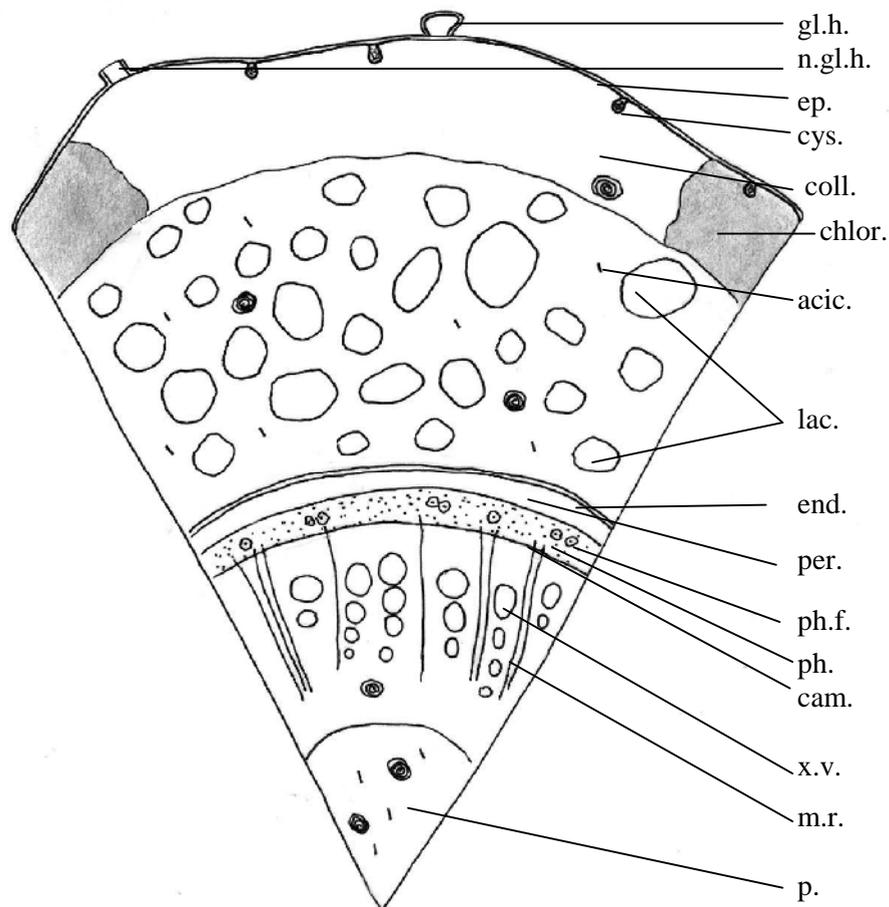


Fig. 10: Diagrammatic T.S. of the young stem

x 190

acic., acicular crystals of calcium oxalate; cam., cambium; chlor., chlorenchyma; coll., collenchyma; cys., cystoliths of calcium carbonate; end., endodermis; ep., epidermis; gl.h., glandular hair; lac., lacunae; m.r., medullary ray; n.gl.h., non glandular hair; per., pericycle; ph., phloem; ph.f.; phloem fibre, pi., pith; x.v., xylem vessel.

calcium carbonate. The outer epidermis is followed by a nearly wide cortex consisting of collenchyma groups alternating with chlorenchyma ones, which are slightly elongated containing chloroplasts (Fig. 11), followed by parenchyma cells interrupted by wide air cavities (lacunae) which is considered as one of the most characteristic features of family Acanthaceae¹⁰. The parenchyma cells contain acicular crystals of calcium oxalate and starch granules. The endodermis is distinct. The pericycle is formed of a complete ring of 1-2 layers of parenchyma cells surrounding the central vascular cylinder which consists of open vascular bundles, arranged in a ring surrounding wide region of pith.

The epidermis (Fig. 11)

The epidermis in the transverse section of young stem consists of one layer of square to subrectangular cells, but in surface view (Fig. 12) the cells are polygonal, usually isodiametric, sometimes axially elongated with more or less straight anticlinal walls. The cells are covered with thin smooth cuticle. Diacytic type of stomata is present. Some cells show cystoliths of calcium carbonate. Glandular and few nonglandular hairs are observed. The glandular hairs have unicellular stalk and bi- to multicellular globular head. The nonglandular hairs are uniseriate multicellular, 3-5 cells having acute to acuminate apices. Most of the hairs have collapsed cells and are covered with smooth cuticle.

The cortex (Fig. 11)

The cortex consists of about 5-6 rows of thick-walled cellulose collenchymatous cells being rounded to angular in shape, alternating with chlorenchymatous cells followed by a parenchymatous region consisting of 4-6 layers, interrupted by wide lacunae. Numerous scattered cystoliths of calcium carbonate are also present. Some cells contain acicular crystals of calcium oxalate and starch granules.

The innermost layer of the cortex is the endodermis, distinct and formed of a single layer of tangentially elongated parenchyma cells containing starch granules.

The pericycle (Fig. 11)

The pericycle separates the central stele from the cortex and consists of 2-4 layers of

thin-walled, nonlignified parenchyma cells with narrow intercellular spaces.

The phloem (Fig. 11)

The phloem consists of cellulosic elements of sieve tubes, companion cells, phloem parenchyma and phloem fibres. The phloem fibres are nonlignified and polygonal in shape.

The cambium (Fig. 11)

The cambium is formed of a band of cambiform cells consisting of 1-3 rows of thin-walled cellulosic cells; subrectangular tangentially elongated and radially arranged.

The xylem (Fig. 11)

The xylem consists of lignified, comparatively wide zone of distinctly radiating elements of vessels, fibres and wood parenchyma. The vessels are radially arranged and showing spiral and annular thickening (Fig. 12). The fibres have thick lignified walls, moderately wide lumen and acute to acuminate apices. Septate fibres are also present. The wood parenchyma consists of subrectangular cells with thick lignified pitted walls.

The medullary rays (Fig. 11)

The medullary rays are usually uniseriate or biseriate formed of cellulosic elongated cells with thin walls.

The pith (Fig. 11)

The pith is formed of wide central zone of rounded to oval parenchymatous cells showing scattered acicular crystals of calcium oxalate, cystoliths of calcium carbonate and starch granules.

A transverse section in the old stem (Figs. 13 and 14) is more or less circular in outline, showing several rows of subrectangular, radially arranged and tangentially elongated cork cells. They appear in surface view (Fig. 15) as polygonal, usually isodiametric cells containing dark brown contents giving dark green colour with FeCl_3 . The cortex consists of an outer zone of phelloderm and collenchyma in 5-6 rows, followed by 6-8 rows of parenchyma cells interrupted by wide lacunae. The parenchyma cells are slightly polygonal in outline, some of which showing cellulosic septa and others containing acicular crystals of

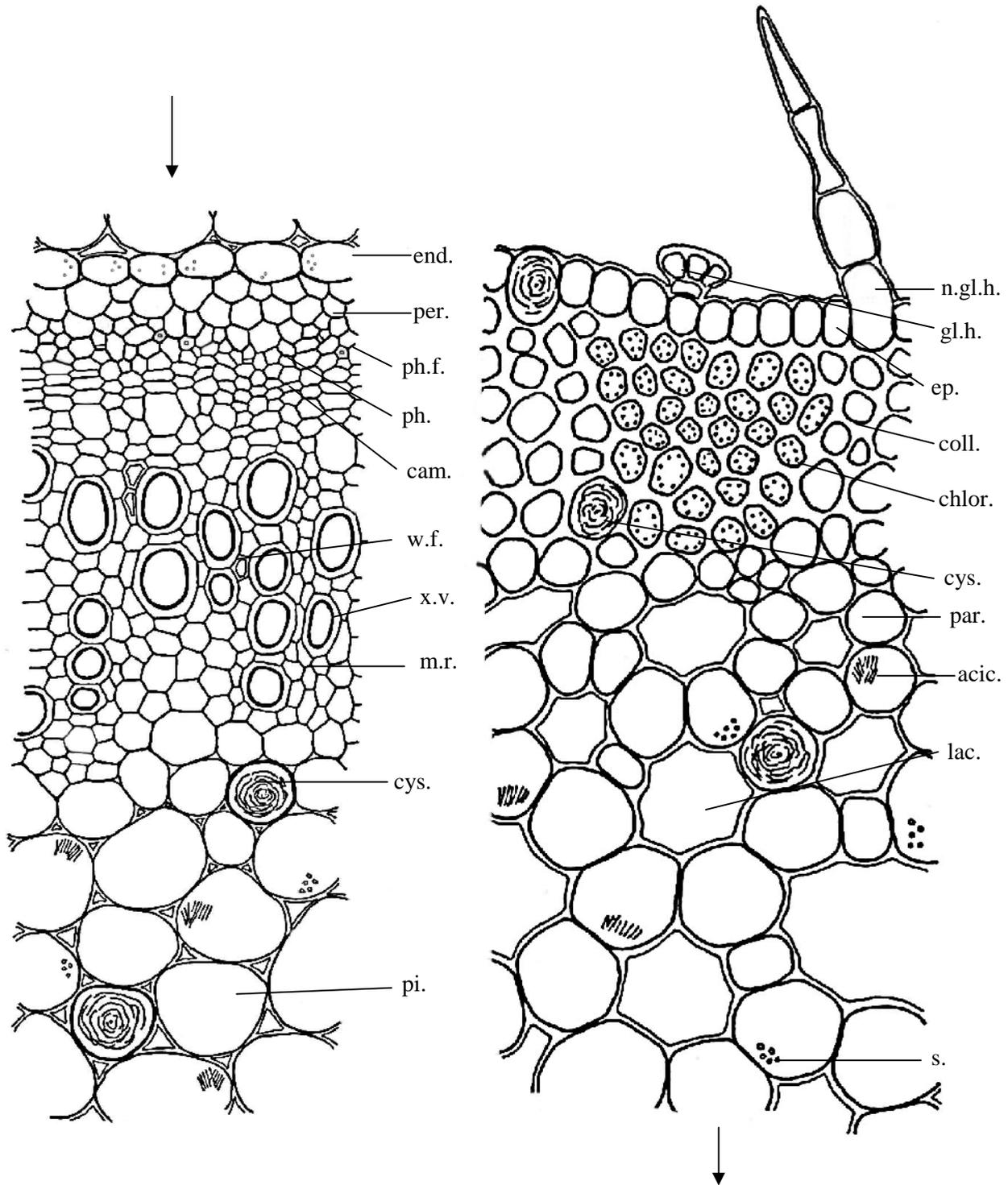


Fig. 11: Detailed T.S. of the young stem

x 500

acic., acicular crystals of calcium oxalate; cam., cambium; chlor., chlorenchyma; coll., collenchyma; cys., cystoliths of calcium carbonate; ep., epidermis; gl.h., glandular hair; lac., lacunae; n.gl.h; non glandular hair; m.r., medullary ray; per., pericycle; par., parenchyma; ph., phloem; ph.f.; phloem fibre, pi., pith; s., starch granules; x.v., xylem vessel.

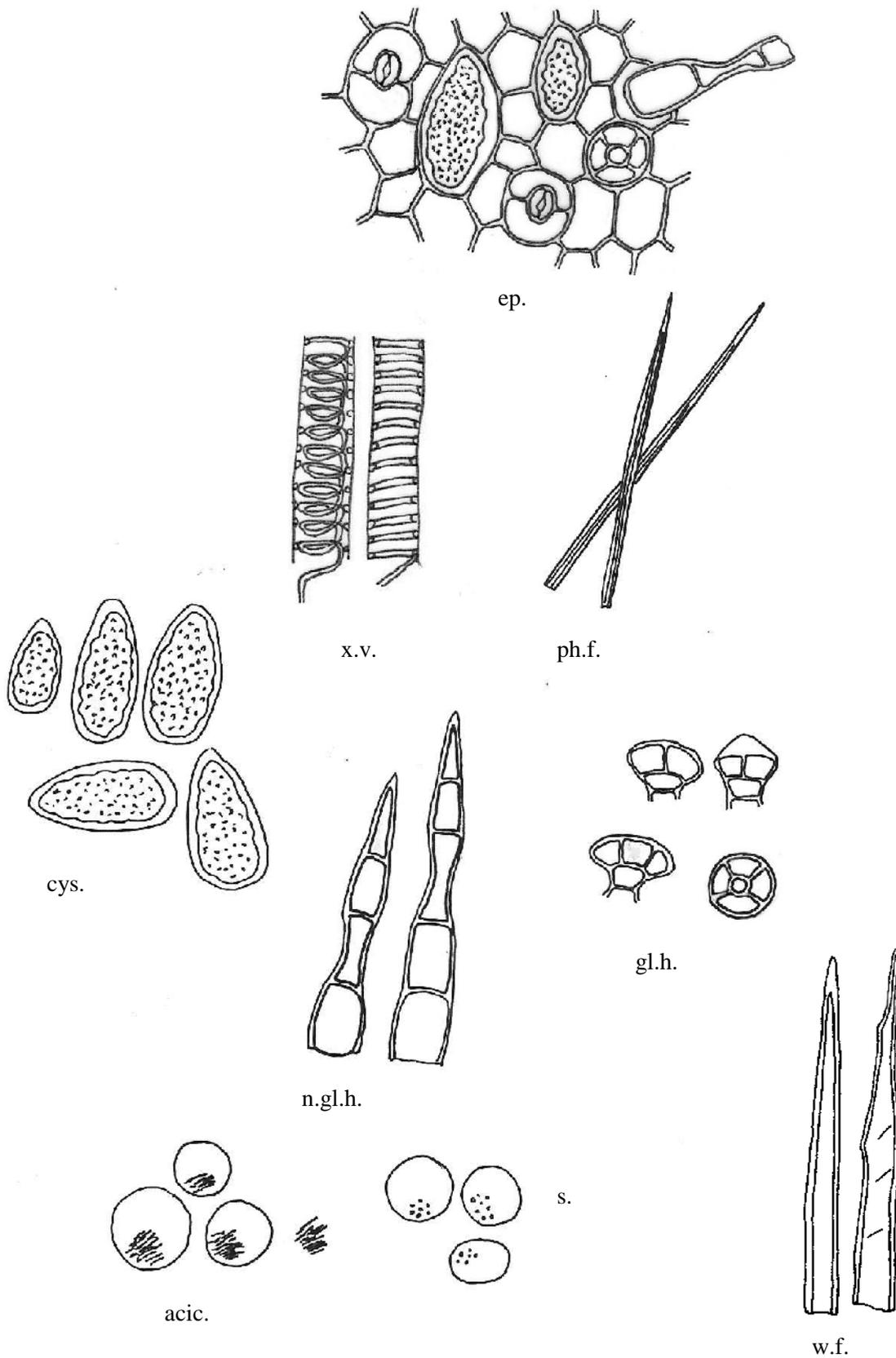


Fig. 12 : Powdered elements of the young stem

x 500

acic., acicular crystals of calcium oxalate; cys., cystoliths of calcium carbonate; ep., epidermis; gl.h., glandular hair; n.gl.h., non glandular hair; ph.f., phloem fibre; s., starch granules; x.v., xylem vessel.

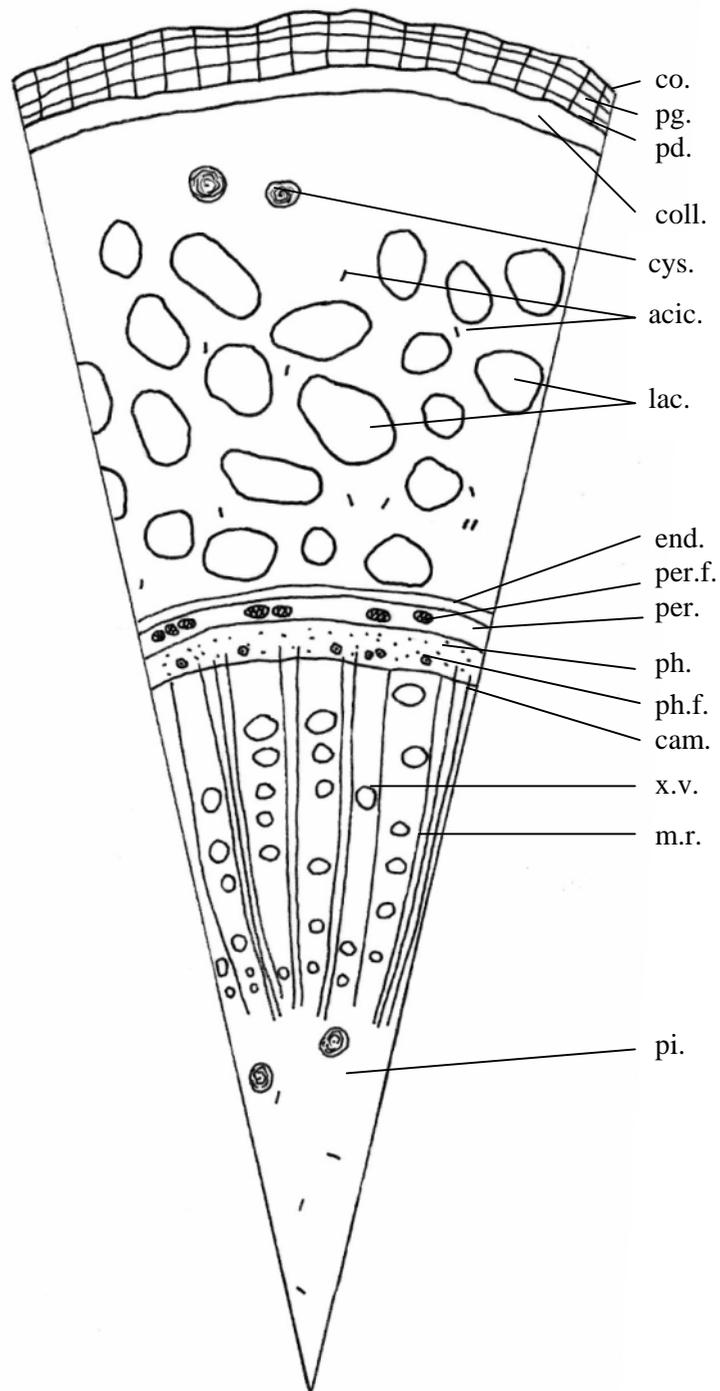


Fig. 13 : Diagrammatic T.S. of the old stem

x 126

acic., acicular crystals of calcium oxalate; cam., cambium; coll., collenchyma; cor., cork; cys., cystoliths of calcium carbonate; end., endodermis; lac., lacunae; m.r., medullary ray; per., pericycle; pd., phelloderm; pg., phellogen; ph., phloem; ph.f.; phloem fibre, pi., pith; x.v., xylem vessel.

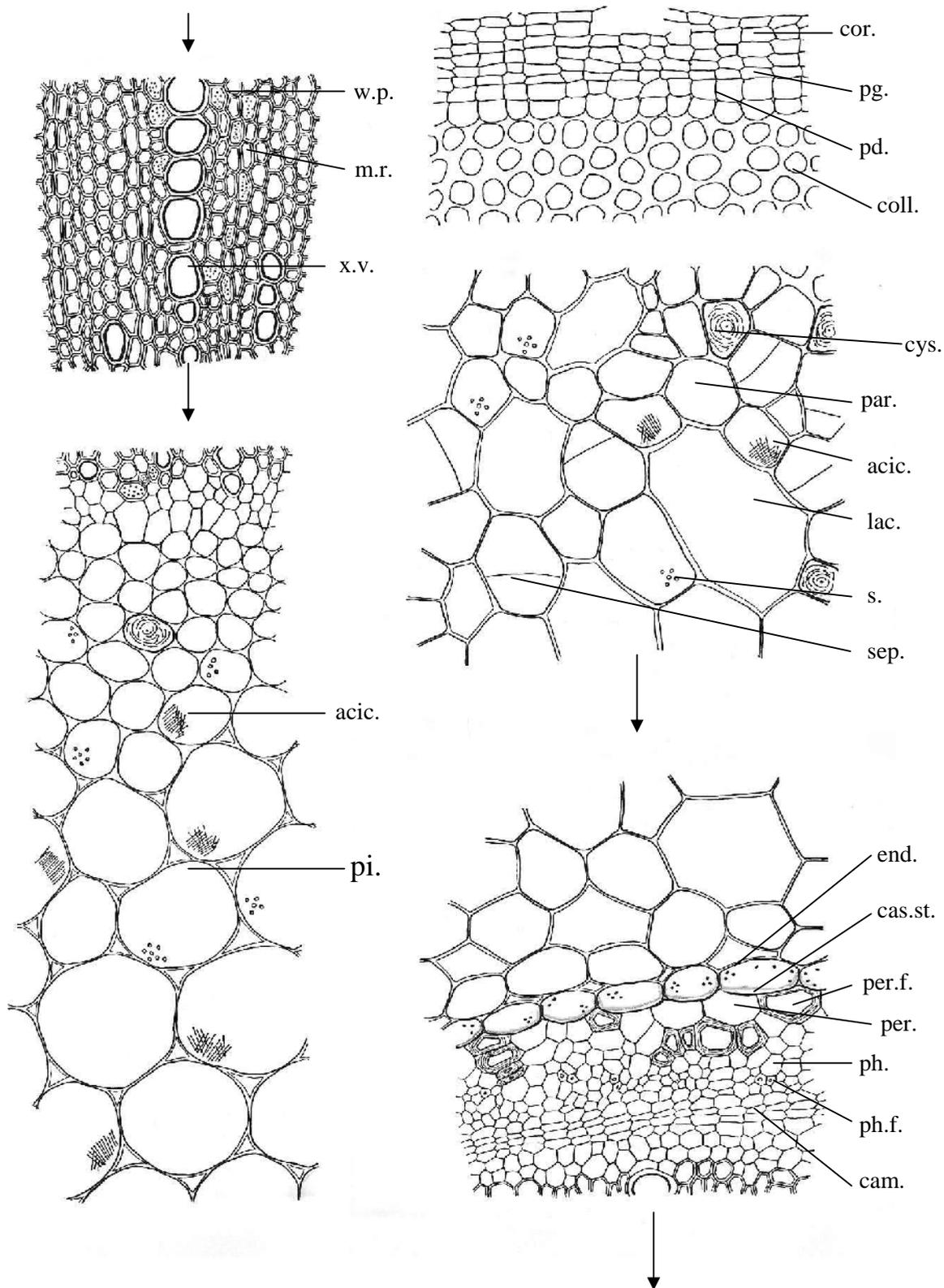


Fig. 14 : Detailed T.S. of the old stem

x 320

acic., acicular crystals of calcium oxalate; cam., cambium; cas.st., casparian strips; coll., collenchyma; cor., cork; cys., cystoliths of calcium carbonate; end., endodermis; lac., lacunae; m.r., medullary ray; per., pericycle; par., parenchyma; pd., phelloderm; pg., phellogen; ph., phloem; ph.f.; phloem fibre, pi., pith; s., starch granules; sep., septa; w.p., wood parenchyma; x.v., xylem vessel.

calcium oxalate and starch granules. The innermost layer of the cortex is the endodermis which is distinct and showing casparian strips. The pericycle consists of 2-3 rows of parenchyma cells interrupted by lignified fibres. The fibre (Fig. 15) has thick, lignified, striated wall with wide lumen and acute to acuminate apex. The phloem consists of cellulosic elements of sieve tubes, companion cells, phloem parenchyma and phloem fibres. The xylem consists of large vessels, fibres, tracheids, tracheidial vessels and wood parenchyma. Some of these fibres are slightly tortuous with swellings, while others are septate. The pith consists of parenchyma cells containing acicular crystals of calcium oxalate, cystoliths of calcium carbonate and starch granules.

The old stem differs from the young stem in the presence of the cork cells and wide cortex containing larger lacunae. Also, the parenchyma of the cortex in the old stem show clear cellulosic septa. Casparian strips is also present. The pericycle in the old stem consists of groups of lignified pericyclic fibres alternating with groups of parenchyma cells, while consisting of parenchyma cells only in the young stem. The xylem vessels are more in number and wider. The medullary rays and wood parenchyma are lignified and pitted. The pith in the old stem is more wider than that of the young stem; showing the same contents (acicular crystals of calcium oxalate, cystoliths of calcium carbonate and starch granules).

The powdered stem

Powder of stem is yellowish green in colour, has faint odour and slightly disagreeable taste and characterized microscopically (Figs. 12 and 15) by the following:

- 1- Fragments of epidermal cells of young stem showing diacytic stomata. The cells are polygonal, usually isodiametric, sometimes axially elongated with more or less straight anticlinal walls. The cells are covered with thin smooth cuticle. Some cells show cystoliths of calcium carbonate. Some fragments carry glandular hairs which have unicellular stalk and bi- to multicellular head and also carry few nonglandular hairs which are uniseriate, multicellular 5-7 cells having acute to acuminate apex with collapsed cells and covered with smooth cuticle.
- 2- Numerous scattered cystoliths of calcium carbonate.
- 3- Fragments of phloem fibres, nonlignified and acicular in shape.
- 4- Fragments of pericyclic fibres, lignified, thick striated walls, wide lumen and acute to acuminate apex (from the old stem).
- 5- Fragments of wood fibres with thick lignified walls, moderately wide lumen and acute to acuminate apices. Some of these fibres are slightly tortuous with swellings (from the old stem) and others are septate.
- 6- Fragments of lignified spiral, annular and reticulate xylem vessels.
- 7- Fragments of tracheids and tracheidial vessels with lignified pitted walls (from the old stem).
- 8- Fragments of wood parenchyma cells with thick pitted and lignified walls (from the old stem).
- 9- Fragments of parenchyma cells showing scattered acicular crystals of calcium oxalate, cystoliths of calcium carbonate and starch granules.
- 10- Numerous scattered acicular crystals of calcium oxalate.
- 11- Fragments of polygonal cork cells with brownish contents (from the old stem).

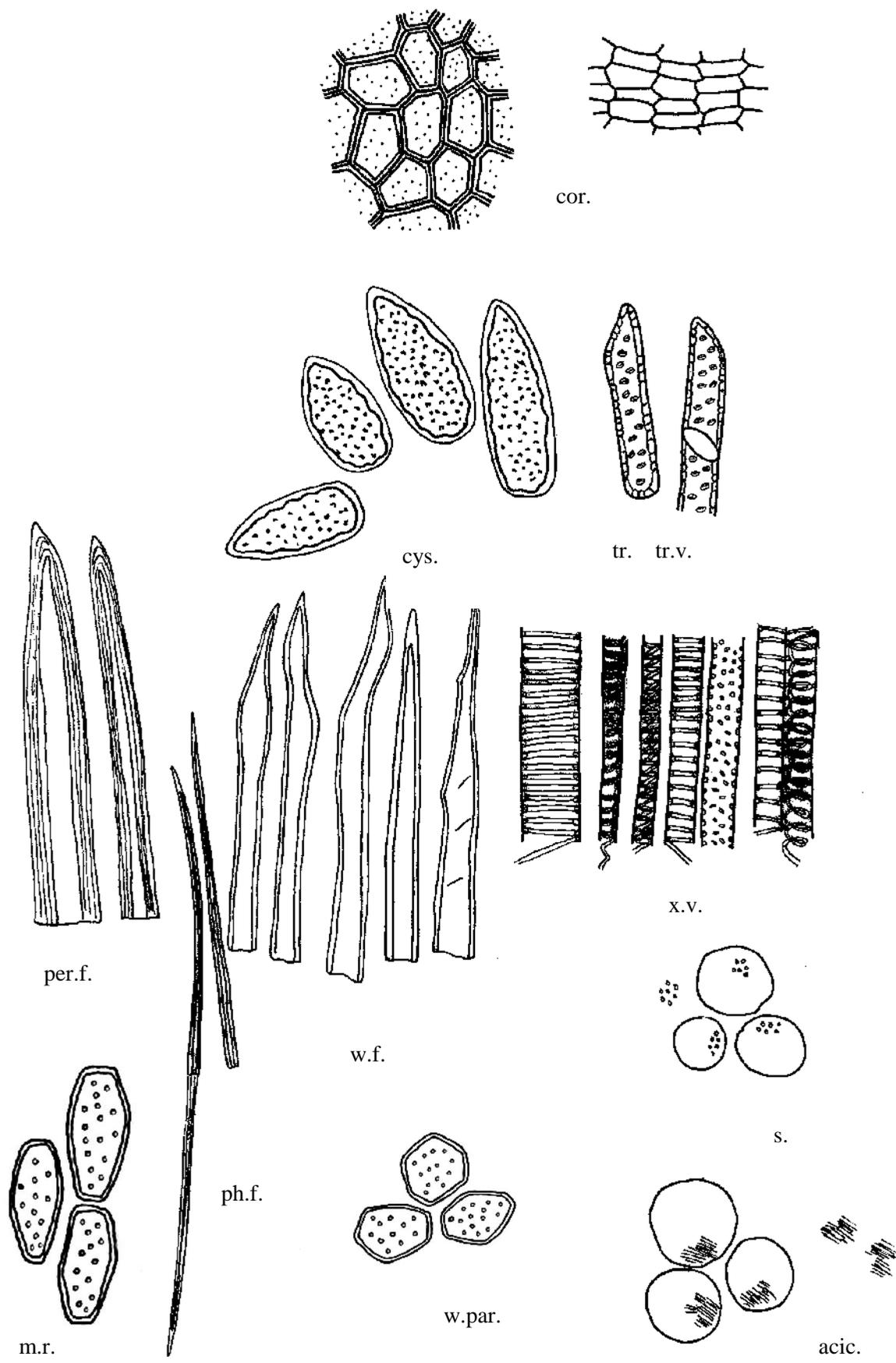


Fig. 15: Powdered elements of the old stem

x 500

acic., acicular crystals of calcium oxalate; cor., cork; cys., cystoliths of calcium carbonate; m.r., medullary ray; per.f., pericyclic fibre; ph.f., phloem fibre; s., starch granules; tr., tracheids; tr.v., tracheidal vessels; w.f., wood fibre; w.p., wood parenchyma; x.v., xylem vessel.

Microscopical measurements of the different organs of *Ruellia brittoniana* Leonard (in micron)

Item	Length	Width	Height	Diameter
Leaf				
Upper epidermis	20- <u>46</u> -60	16- <u>20</u> -30	10- <u>11</u> -12	
Lower epidermis	16- <u>36</u> -50	6- <u>8</u> -24	14- <u>16</u> -20	
Diacytic stomata	10- <u>12</u> -14			8- <u>10</u> -12
Cystoliths	64- <u>77</u> -90	14- <u>17</u> -20		
Palisade cells	46- <u>48</u> -50	6- <u>7</u> -8		
Xylem vessels				30- <u>32</u> -34
Wood fibres				30- <u>32</u> -34
Wood parenchyma	8- <u>10</u> -12	4- <u>6</u> -8		
Phloem fibres				3- <u>4</u> -5
Stomatal index	Upper epidermis 0.08- <u>0.09</u> -0.1		Lower epidermis 0.08- <u>0.09</u> -0.1	
Stomatal number	Upper epidermis 28- <u>30</u> -32		Lower epidermis 46- <u>48</u> -50	
Palisade ratio	2- <u>2.5</u> -3	Vein islet no.	18- <u>20</u> -22	
Stem				
Epidermis		8- <u>9</u> -10	12- <u>14</u> -16	
Diacytic stomata	4- <u>4.5</u> -5			
Cork	18- <u>20</u> -24	12- <u>16</u> -18	5- <u>7</u> -8	
Pericyclic fibres				12- <u>22</u> -31
Phloem fibres				3- <u>4</u> -5
Xylem vessels				12- <u>22</u> -26
Wood fibres				8- <u>10</u> -12
Tracheids and tracheidal vessels	40- <u>52</u> -68			12- <u>13</u> -14
Wood parenchyma	24- <u>25</u> -26	18- <u>20</u> -22		

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