

MACRO- AND MICROMORPHOLOGY OF THE LEAVES, STEMS AND FLOWERS OF *CHRYSANTHEMUM CARINATUM* L.

A. A. Ali, M. A. El-Shanawani, A. A. Khalifa and M. A. Mohammad

Department of Pharmacognosy, Faculty of Pharmacy, Assiut University, Assiut, Egypt

يتبع نبات الكريزانثيموم كاريناتم إل. العائلة المركبة والتي تشمل حوالي ٢٥٠ جنساً و٢٣٠٠٠٠ نوعاً موزعة في معظم أنحاء العالم. وتنتشر زراعته في المغرب ، ووجد أن بعض أنواع نبات الكريزانثيموم تستخدم لعلاج أعراض الانفلونزا وأيضاً كمضاد للإلتهابات. وتستعمل بعض أنواع هذه العائلة تجارياً في صناعة الأصباغ ، كطارد للحشرات وكنباتات للزينة. وقد وجد انه لم يتم إجراء دراسة عقاقيرية كاملة لهذا النبات لذا أجرى هذا البحث لامكانية التعرف عليه سواء في صورة كاملة أو على هيئة مسحوق.

The genus Chrysanthemum L. is sometimes called Ismelia, it comprises about 150 species native to tropical and temperate North and South America. Chrysanthemum carinatum L. is known as Painted daisy, German flag and Tricolor Chrysanthemum. Some species of genus Chrysanthemum are used medicinally to cure influenza symptoms, liver and menstrual disorders and have anti-inflammatory and antispasmodic effects.

INTRODUCTION

Family Compositae (Aster family)¹ is a large plant family, includes about 250 genera with almost 23,000 species. The members of this family are distributed over most of the earth and in almost all habitats².

Family Compositae is of considerable importance, as the family yields economically and medicinally important members; there are edible members³, dye plants, rubber plants, weeds, insecticidal plants and ornamentals as *Dahlia* and *Chrysanthemum*^{1,4&5}.

In chinese folk medicine, the flowers of some members of the genus *Chrysanthemum* are boiled to make Chrysanthemum tea which is useful in treatment of influenza symptoms and has anti-inflammatory and antispasmodic effects.

Habitat

Chrysanthemum carinatum L. (Figs. 1A,2A) is an annual herb native to Morocco. It attains 1 meter in height. It has a monopodially branched erect stem. Leaves are alternate, exstipulate, sessile and oval to oblong in shape, deeply incised, pinnatisect in shape (Figs. 1B,2B,2C). The root system (Fig. 2A) consists of cylindrical conical tap root bearing several lateral branches, carrying wiry rootlets. The

surface is dark brown in color with fine longitudinal wrinkles and transverse cracks. The plant carries numerous terminal flower heads (Fig. 1C), which are hemispherical capitula attached to a long peduncle. The fruits are cypsela. The flowering season is from March to May^{6&7}.

Material

The plant was cultivated in the experimental station of Faculty of Pharmacy, Assiut University, Assiut, Egypt and was kindly identified by Prof. Dr. Naeem E. Keltawy Prof. of Ornamental Horticulture and Floriculture, Faculty of Agriculture, University of Assiut.

Fresh leaves and stems were preserved in mixture of alcohol- glycerin- water (1:1:1) and stored in tightly closed containers. The leaves, stems and flowers separately air-dried and reduced to fine powder.

A- The leaf

1- Macromorphology (Figs. 1B,2B,2C)

The leaves are alternate, exstipulate, sessile and oval to oblong in shape, deeply incised, pinnatisect in shape, where the lobes are further variously sected, showing about 7 lobes. The segments are acute having an entire



A



B



C

3 cm

Fig. 1: Macromorphology of *Chrysanthemum carinatum* L.

- A) Photo of the plant.
- B) Photo of the leaves.
- C) Photo of the flowers.

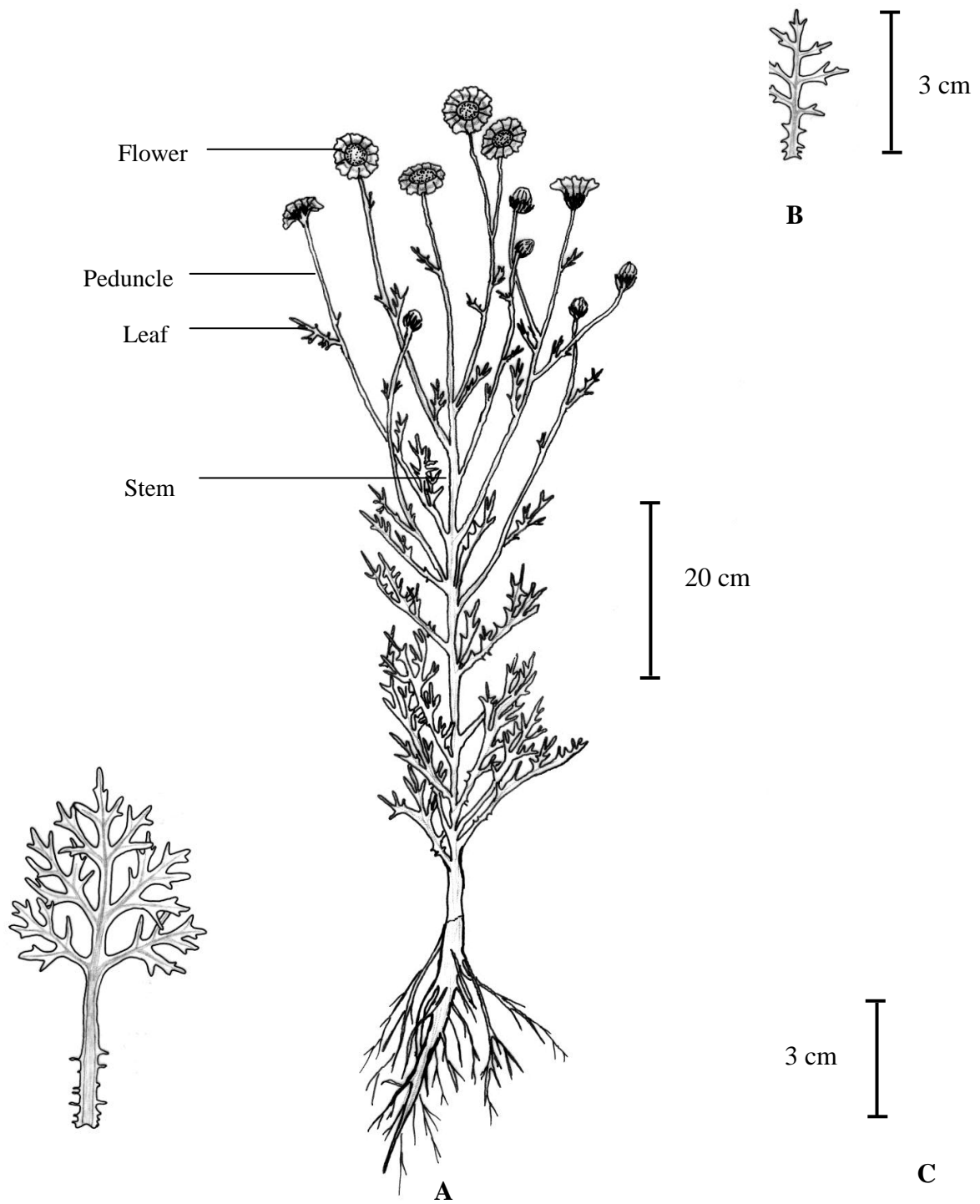


Fig. 2: Macromorphology of *Chrysanthemum carinatum* L.
 A) The whole plant.
 B) The upper leaf.
 C) The lower leaf.

margin. Leaves are pale green in colour. The upper leaves (Fig. 2B) are shorter than those of the lower leaves (Fig. 2C) being 3 cm long in the former and 9 cm long in the latter.

The leaves have broad flattened base which is almost clasping the stem.

2- Micromorphology

The transverse section in the leaf (Figs. 3D,3E,4A) is biconvex in outline. The leaf posses isobilateral structure with two rows of upper palisade cells and one row of lower one both interrupted in the midrib region by parenchymatous tissue. The vascular bundle in the midrib region is collateral with upper and lower zones of collenchymatous pericycle. The region of the spongy tissue is narrow and traversed by small vascular bundles.

The epidermis

The upper epidermis in transverse section (Fig. 4C) is formed of one row of square to sub-rectangular thin walled cellulosic cells covered with thick smooth cuticle, while in surface view they are polygonal, isodiametric to elongated in shape with sinuous wavy anticlinal walls, and covered with thick smooth cuticle.

The lower epidermal cells are polygonal with elongated more wavy anticlinal walls covered with thick smooth cuticle.

Both the upper and lower neural epidermal cells (Fig. 3C) are nearly similar in surface view are axially elongated having nearly straight anticlinal walls.

The stomata

Stomata (Fig. 3A,3B) are present on both surfaces, being more frequent on the lower epidermis and being very few in the neural region. They are oval in shape of the anomocytic type.

Non-glandular trichomes (Fig. 3D) are relatively few present in the midrib region of the upper surface.

It is uniseriate, multicellular 2-5 cells and covered with smooth cuticle.

The mesophyll

The leaf shows isobilateral structure (Figs. 3D,3E,4B,5A), with a mesophyll differentiated into palisade and spongy tissue. The upper palisade being formed of two rows of

cylindrical columnar cells with straight to slightly curved walls containing chloroplasts, the cells of the first row are longer than those of the second row. While the lower palisade is formed of only one row.

The spongy tissue is formed of 4 to 5 rows of more or less rounded or ovoid parenchymatous cells with wide intercellular spaces. The tissue is traversed by small vascular bundles.

The midrib

The cortical tissue (Figs. 4C,5B) consists of cellulosic thin walled rounded to oval parenchymatous cells, both upper and lower cortical tissue zone consist of 5 to 7 layers. The endodermis is formed of one layer of thin walled square to sub-rectangular parenchyma cells enclosing the stele, with simple spherical starch granules observed in the cells.

Schizogenous resin ducts (Figs. 4C,5B) are scattered in the midrib region.

The pericycle

The pericycle (Figs. 4C,5B) is represented by two distinct arcs of collenchyma enclosing the vascular bundle. The upper is small formed of 4 to 6 rows while the lower is large formed of 6 to 8 rows. Towards the base of the lamina the pericycle changed to lignified fibres.

These fibres (Figs. 4C,5B,6) show wide lumen and moderately to highly thickened walls and having simple pits.

The vascular tissue

The xylem (Figs. 4C,5B,6)

Consists mainly of lignified vessels radially arranged in rows of 5 to 8 vessels, separated by parenchymatous uni or bi-seriate medullary rays. The vessels are mainly of the annular, spiral and rarely pitted thickening.

The xylem parenchyma is formed of sub-rectangular axially elongated cells having thin non-lignified cellulosic walls.

The phloem (Figs. 4C,5B)

The phloem is formed of sieve tubes, companion cells and phloem parenchyma and is devoid of phloem fibers.

Powdered leaf

The leaf powder is pale green in colour has characteristic odour and salty bitter taste.

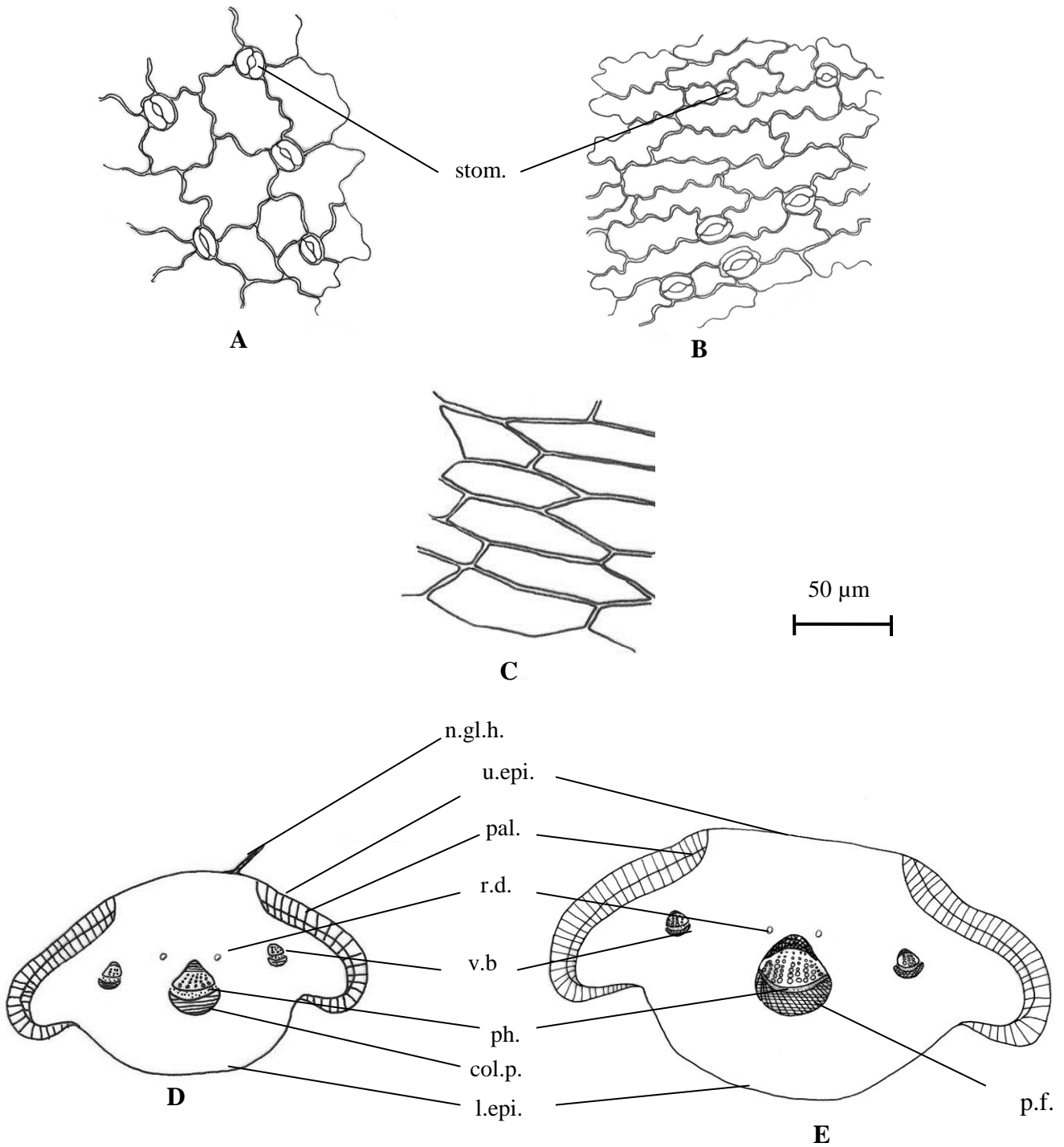


Fig. 3: Micromorphology of *Chrysanthemum carinatum* L. Leaf.

- A) Upper epidermis.
- B) Lower epidermis.
- C) Neural epidermis.
- D) Diagrammatic T.S. in the upper part of the leaf.
- E) Diagrammatic T.S. in the lower part of the leaf.

chlor., chlorenchyma; col.p., collenchymatous pericycle; end., endodermis; l.epi., lower epidermis; pal., palisade; ph., phloem; r.d., resin duct; stom., stomata; u.epi., upper epidermis; v.b., vascular bundle; x., xylem.

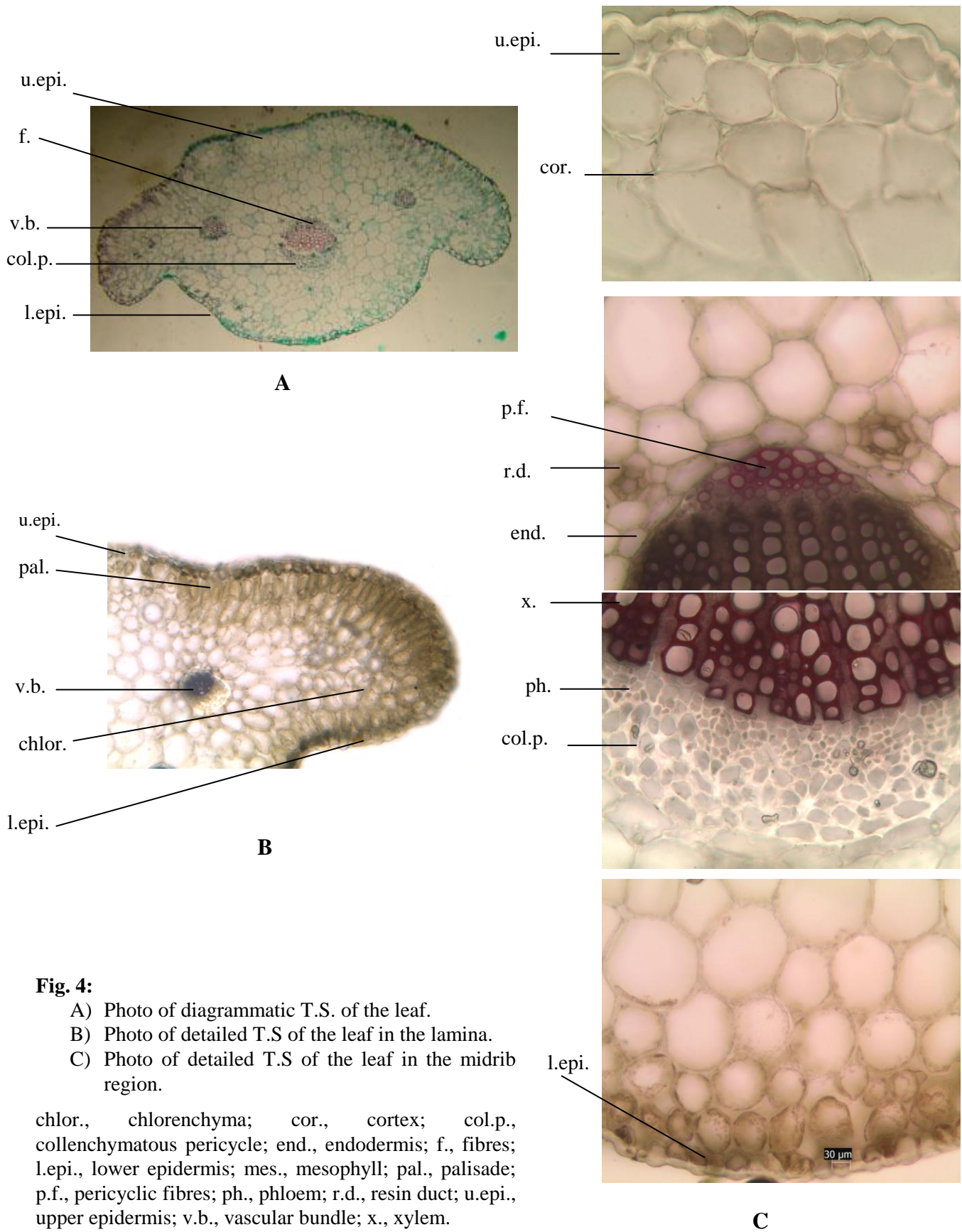


Fig. 4:
 A) Photo of diagrammatic T.S. of the leaf.
 B) Photo of detailed T.S of the leaf in the lamina.
 C) Photo of detailed T.S of the leaf in the midrib region.

chlor., chlorenchyma; cor., cortex; col.p., collenchymatous pericycle; end., endodermis; f., fibres; l.epi., lower epidermis; mes., mesophyll; pal., palisade; p.f., pericyclic fibres; ph., phloem; r.d., resin duct; u.epi., upper epidermis; v.b., vascular bundle; x., xylem.

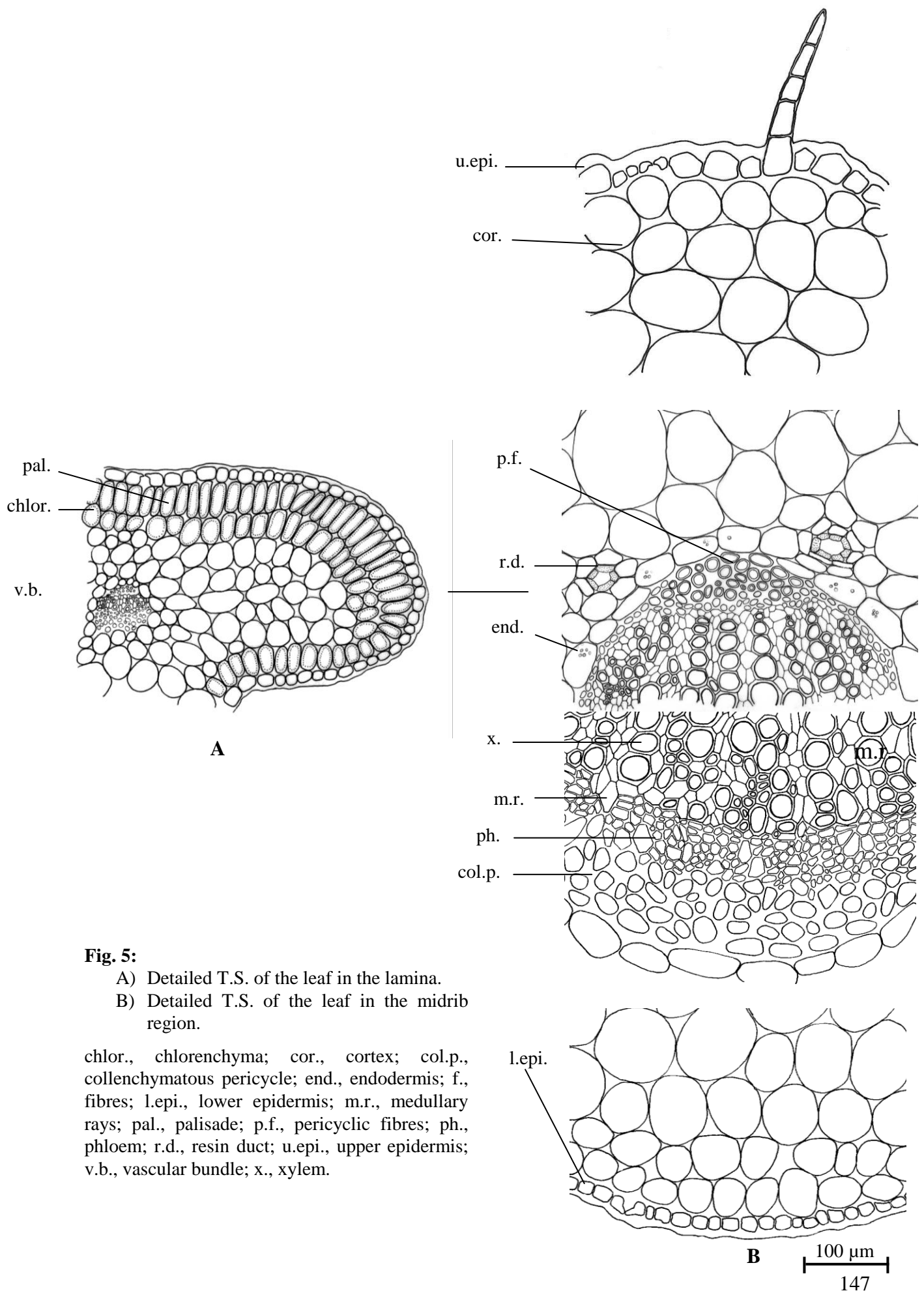


Fig. 5:

A) Detailed T.S. of the leaf in the lamina.

B) Detailed T.S. of the leaf in the midrib region.

chlor., chlorenchyma; cor., cortex; col.p., collenchymatous pericycle; end., endodermis; f., fibres; l.epi., lower epidermis; m.r., medullary rays; pal., palisade; p.f., pericyclic fibres; ph., phloem; r.d., resin duct; u.epi., upper epidermis; v.b., vascular bundle; x., xylem.

On microscopical examination it is characterized by the following (Fig. 6):

- 1- Fragments of upper and lower epidermis showing anomocytic stomata which are surrounded by 3 to 5 subsidiary cells having sinuous wavy anticlinal walls.
- 2- Fragments of neural epidermal cells which are axially elongated with straight anticlinal walls.
- 3- Few non-glandular hairs which are multicellular, uniseriate from 3-5 cells and covered with smooth cuticle.
- 4- Fragments of palisade cells and chlorenchymatous cells.
- 5- Fragments of lignified vessels showing spiral, pitted, reticulate and annular thickening.
- 6- Fragments of elongated resin ducts having thin walls and filled with brownish content.
- 7- Fragments of lignified pericyclic fibres with moderately to highly thickened walls.

B- Stem

1- Macromorphology

The stem (Fig. 2A) is erect, hollow and cylindrical, reaching up to 1 cm in diameter and 1 m in length, pale green in colour, Longitudinally striated and breaks with a short fibrous fracture exposing a white interior surface.

2- Micromorphology

A transverse section in the stem (Fig. 7A,7B) is more or less rounded in outline with 4-8 slightly raised ridges, the ridges are prominent in young and disappeared in old one.

It shows a slightly hairy epidermis (Fig. 7C), followed by relatively wide cortex consisting mainly of ordinary parenchyma but with peripheral zones of collenchyma in the ridges.

The endodermis is distinct, starchy surrounding a polyfasicular stele.

The pericycle forms upper and lower arcs of sclerenchymatous fibres enclosing the vascular bundle.

The vascular system is formed of about 22-28 collateral vascular bundles varying in size, separated from each other by the primary medullary rays. These bundles increase in size in old stem (Fig. 7B), to form a complete ring.

The stem shows wide parenchymatous pith in the centre. The phloem and xylem are separated by a narrow zone of cambium cells and traversed radially by the secondary medullary rays.

Epidermis

The epidermis (Figs. 8,9A,9B,9C) consists of one row of rectangular to subrectangular cells, in side view.

In surface view (Fig. 7C) the cells are polygonal usually elongated with more or less straight anticlinal walls and covered with thick smooth cuticle.

The epidermis carries uniseriate multicellular non-glandular hairs.

The stomata

The stomata (Fig. 7C) are oval in shape, of the ranunculaceous (anomocytic) type.

The trichomes

Non-glandular hairs (Fig. 10), are rare especially in the old stem, the type present is uniseriate, multicellular of 3 to 4 small basal cells and an elongated apical cell and covered with smooth cuticle.

The cortex

In the young stem the cortex (Figs. 8,9A,9B,9C) is relatively wide, consisting of 4-7 rows of rounded to oval parenchymatous cells with thin cellulosic walls, but in the ridges it is formed of 5 to 7 layers of collenchyma followed by 3 to 5 layers of parenchyma.

The innermost layer of the cortex consists of the endodermis, being formed of tangentially elongated cells which are more enlarged above the vascular bundles and containing simple spherical starch granules.

Resin ducts of the schizogenous type are irregularly distributed throughout the cortex. They are formed of elongated thin-walled cells filled with amorphous brown contents and appear ovoid or rounded in shape in transverse section.

The pericycle

The pericycle (Fig. 10) consists of thin walled parenchymatous cells, interrupted by groups of pericyclic fibres 8 to 12 layers capping the primary vascular bundles.

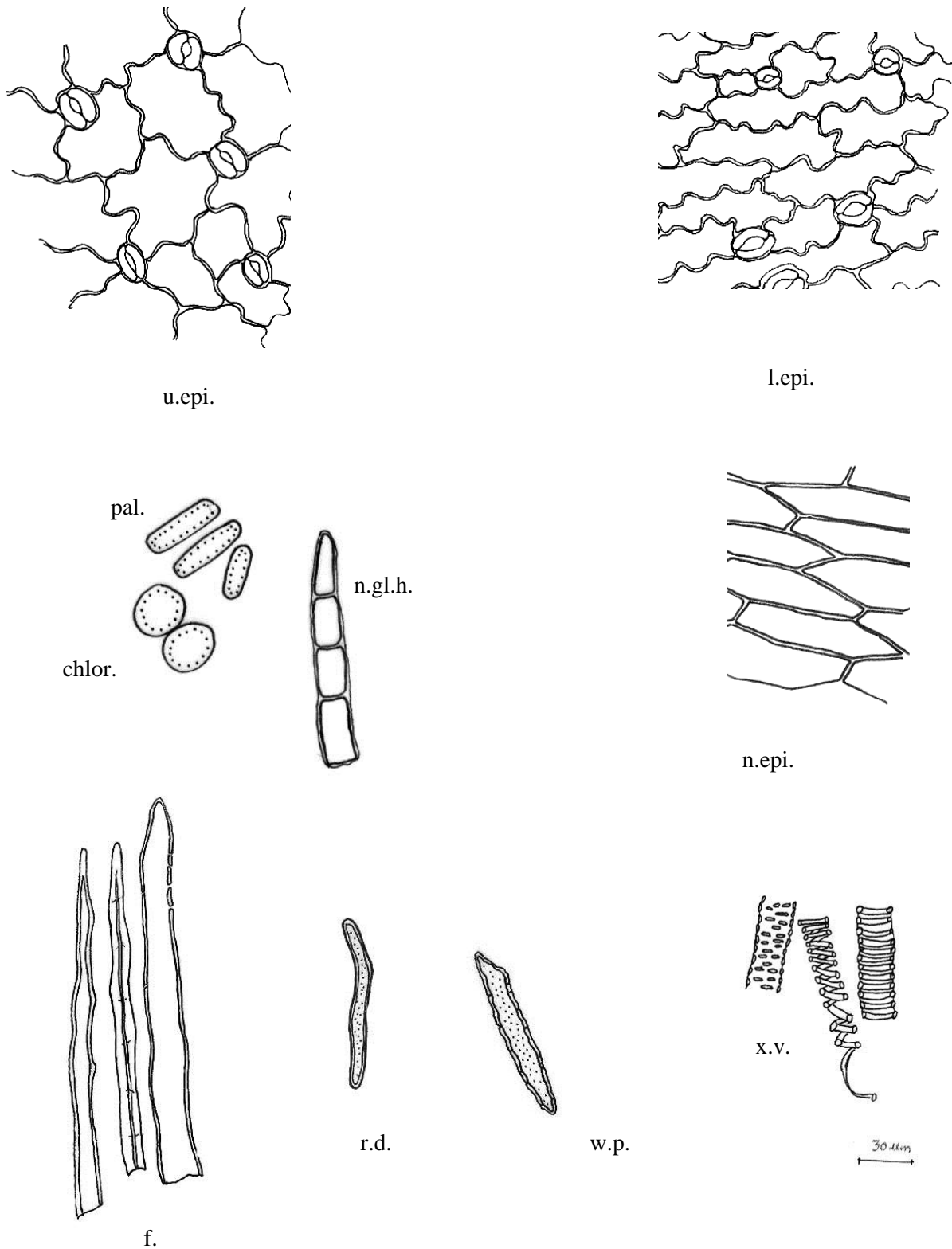


Fig. 6: Powdered elements of the leaf.

chlor., chlorenchyma; f., fibres; l.epi., lower epidermis; n.epi., neural epidermis; n.gl.h., non-glandular hair; pal., palasides; r.d., resin duct; u.epi., upper epidermis; w.p., wood parenchyma; x.v., xylem vessels.

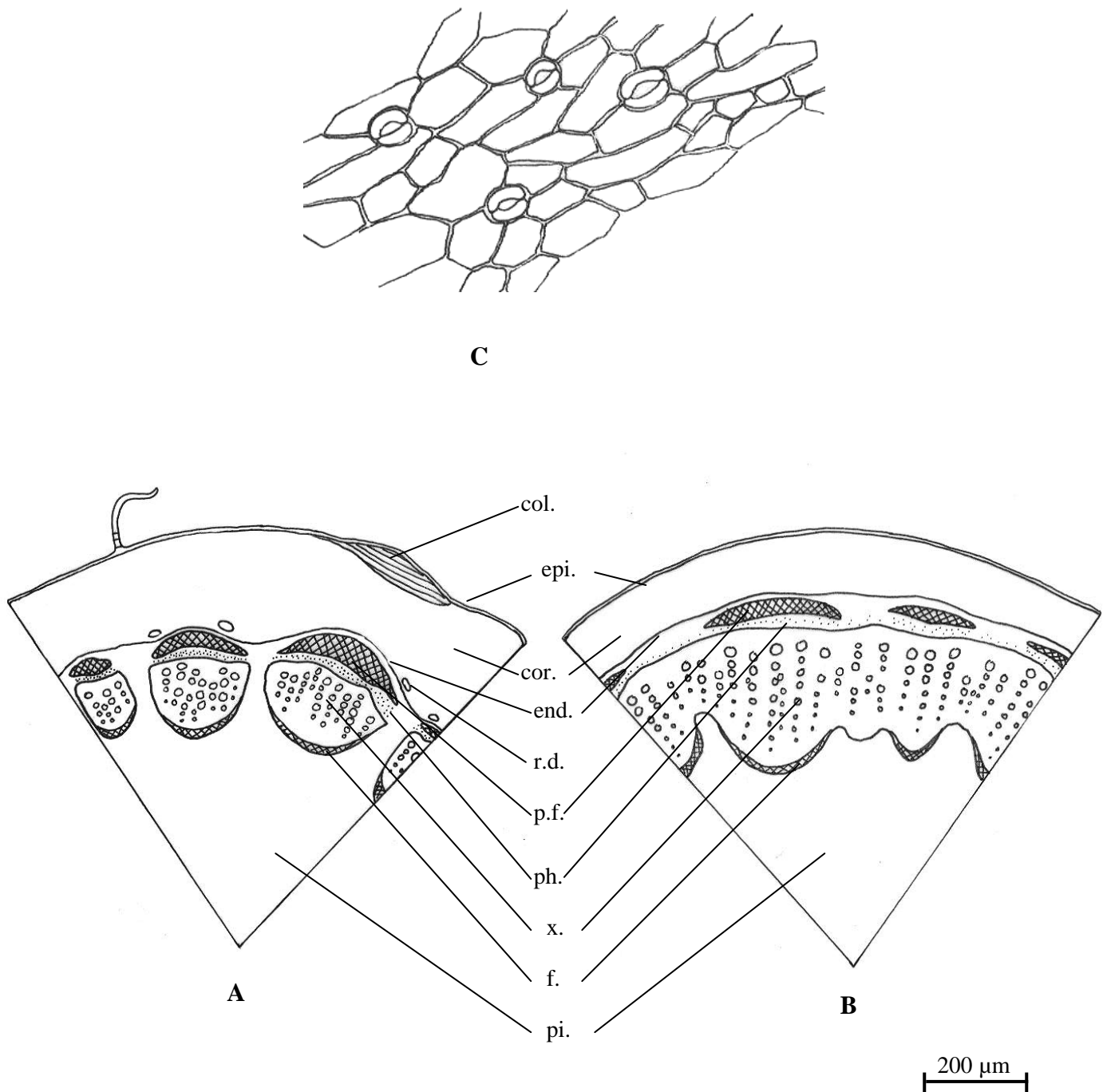


Fig. 7: Micromorphology of *Chrysanthemum carinatum* L. stem.

- A) Diagrammatic T.S. of the young stem.
- B) Diagrammatic T.S. of the old stem.
- C) Surface preparation of the stem.

cam.,cambium; col., collenchyma; cor., cortex; end., endodermis; epi., epidermis; p.f., pericyclic fibers; ph., phloem; pi., pith; r.d., resin duct; stom., stomata; w.f., wood fibers; x., xylem.

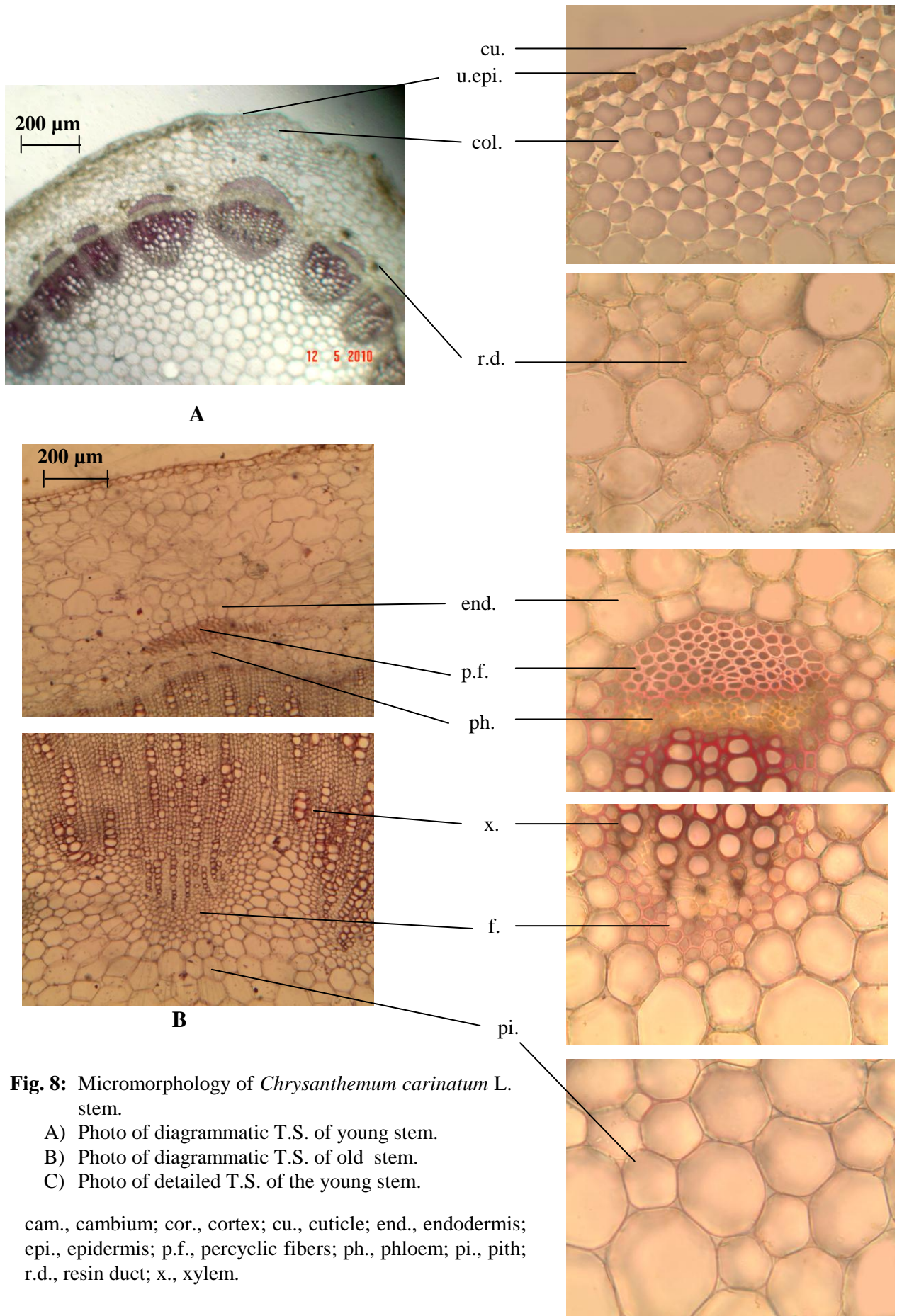


Fig. 8: Micromorphology of *Chrysanthemum carinatum* L. stem.

- A) Photo of diagrammatic T.S. of young stem.
- B) Photo of diagrammatic T.S. of old stem.
- C) Photo of detailed T.S. of the young stem.

cam., cambium; cor., cortex; cu., cuticle; end., endodermis; epi., epidermis; p.f., pericyclic fibers; ph., phloem; pi., pith; r.d., resin duct; x., xylem.

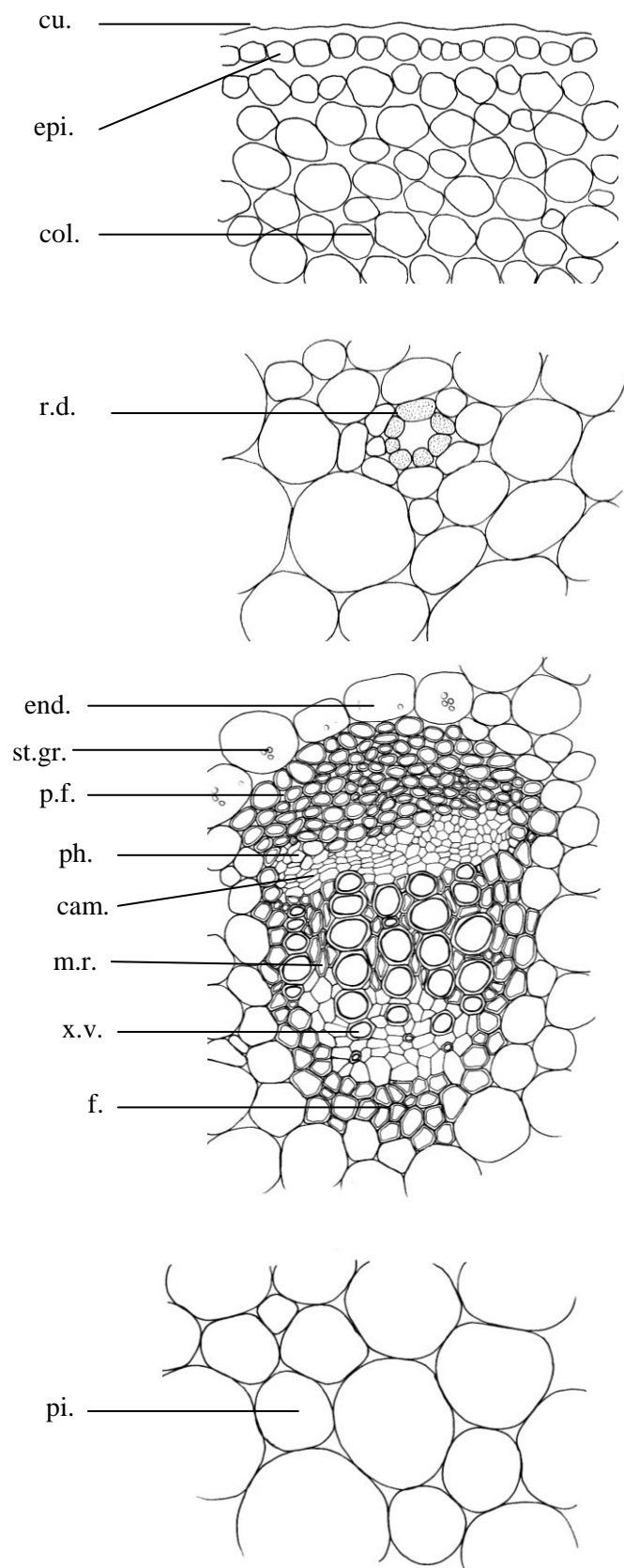


Fig. 9: Detailed T.S. of the young stem.

cam., cambium; cor., cortex; cu., cuticle; end., endodermis; epi., epidermis; p.f., pericyclic fibers; ph., phloem; pi., pith; r.d., resin duct; st.gr., starch granules; stom., stomata; x.v., xylem vessel.

The fibres (Figs. 8,9C) have moderately lignified walls, with wide lumen and with acute to acuminate apices.

The vascular system

In the young stem, the central stele is formed of about 22 to 28 collateral vascular bundles (Figs. 7A,9A) separated by medullary rays, 2 to 4 cells wide, consisting of thin walled slightly lignified rectangular parenchymatous cells.

In the old stem (Figs. 7C,9B), the central stele is formed of a continuous ring of vascular tissue separated by uni- or bi-rarely tri-seriate medullary rays formed of rectangular cells showing simple pits.

The phloem

Consists of shining thin-walled, cellulose, soft elements of sieve tubes, companion cells and phloem parenchyma and devoid of bast fibres and calcium oxalate.

The cambium

The cambial zone (Fig. 9C) is formed of 2-3 rows of thin-walled cellulose subrectangular meristematic cells, which are tangentially elongated and radially arranged.

The xylem

The xylem (Fig. 9C) is lignified and formed of vessels, tracheidal vessel, few tracheids, fibres and wood parenchyma.

The vessels are lignified found either single or in groups being spirally (single or with double helix) (Fig. 10), pitted and reticulate.

The fibres are abundant similar to those of pericycle, they have thick lignified walls which show few slit like oblique simple pits and have pointed or obtuse apices.

The wood parenchyma consists of polygonal axially elongated cells with pitted lignified walls.

The medullary rays

The medullary rays (Figs. 8,9C) are usually uniseriate, biseriate or triseriate and formed of radially elongated subrectangular cells with thin walls in the xylem region, while in the phloem region, these cells are cellulose,

thin walled and somewhat tangentially elongated.

The pith

The pith (Figs. 8,9C) is wide consisting of rounded or oval usually isodiametric paraenchymatous cells, with wide intercellular spaces having moderately thickened, slightly lignified walls showing simple pits.

The size of the cells increases towards the centre. The cells are devoid of calcium oxalate crystals and starch granules.

Powdered stem

The powdered stem is greyish green in color having a faint aromatic odour and a slight bitter taste.

It is characterized microscopically (Fig. 10) by the presence of the following:

- 1- Fragment of epidermal cells, it is more or less polygonal or elongated having straight anticlinal walls and covered by a thick cuticle. Showing ranunculaceous (anomocytic) stomata.
- 2- Non-glandular hairs which is uniseriate, multicellular of 3 to 4 small basal cells and an elongated apical cell.
- 3- Fragment of paraenchymatous cells of the cortex which are rounded or oval with thin cellulose walls.
- 4- Fragment of pericyclic and wood fibres which are lignified, with pointed rarely blunt or rounded apices, with straight moderately thickened walls showing slit-like oblique simple pits.
- 5- Fragment of lignified vessels having spiral, pitted and reticulate thickening.
- 6- Fragment of polygonal to subrectangular lignified wood parenchyma with moderately thick lignified pitted walls.
- 7- Fragment showing lignified pitted parenchyma cells and medullary rays.
- 8- Occasional fragment of tracheids or tracheidal vessels showing lignified pitted walls.

C- The inflorescence

1- Macromorphology (Figs. 1C,11A)

The inflorescence are hemispherical capitula attached to somewhat long peduncle, the opened capitulum attains about 6 cm in diameter.

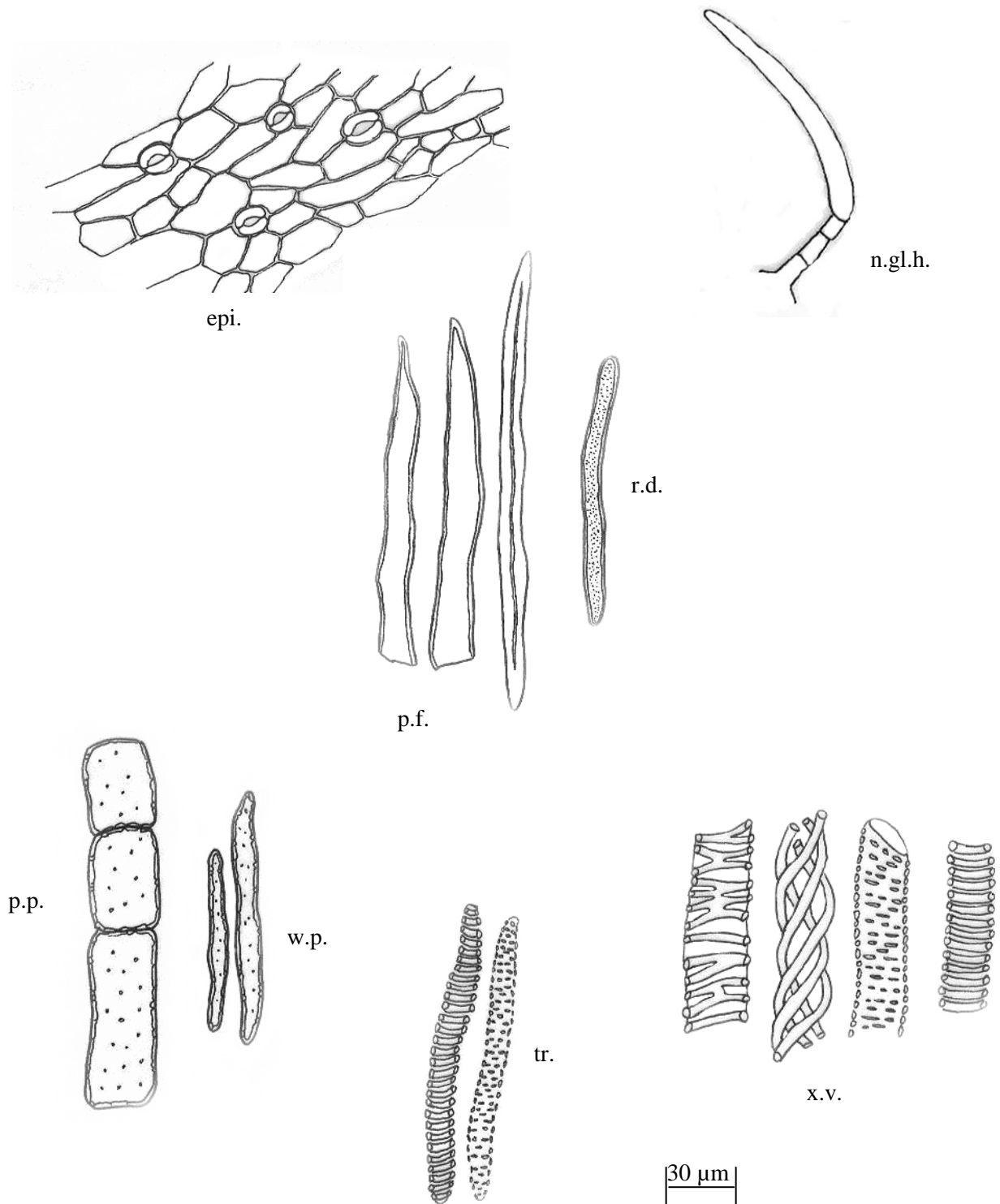


Fig. 10: Powdered elements of the stem.

epi., epidermis; n.gl.h., non-glandular hair; p.f., pericyclic fibres; p.p., pitted parenchyma; r.d., resin duct; st.gr., starch granules; tr., tracheids; w.p., wood parenchyma; x.v., xylem vessels.

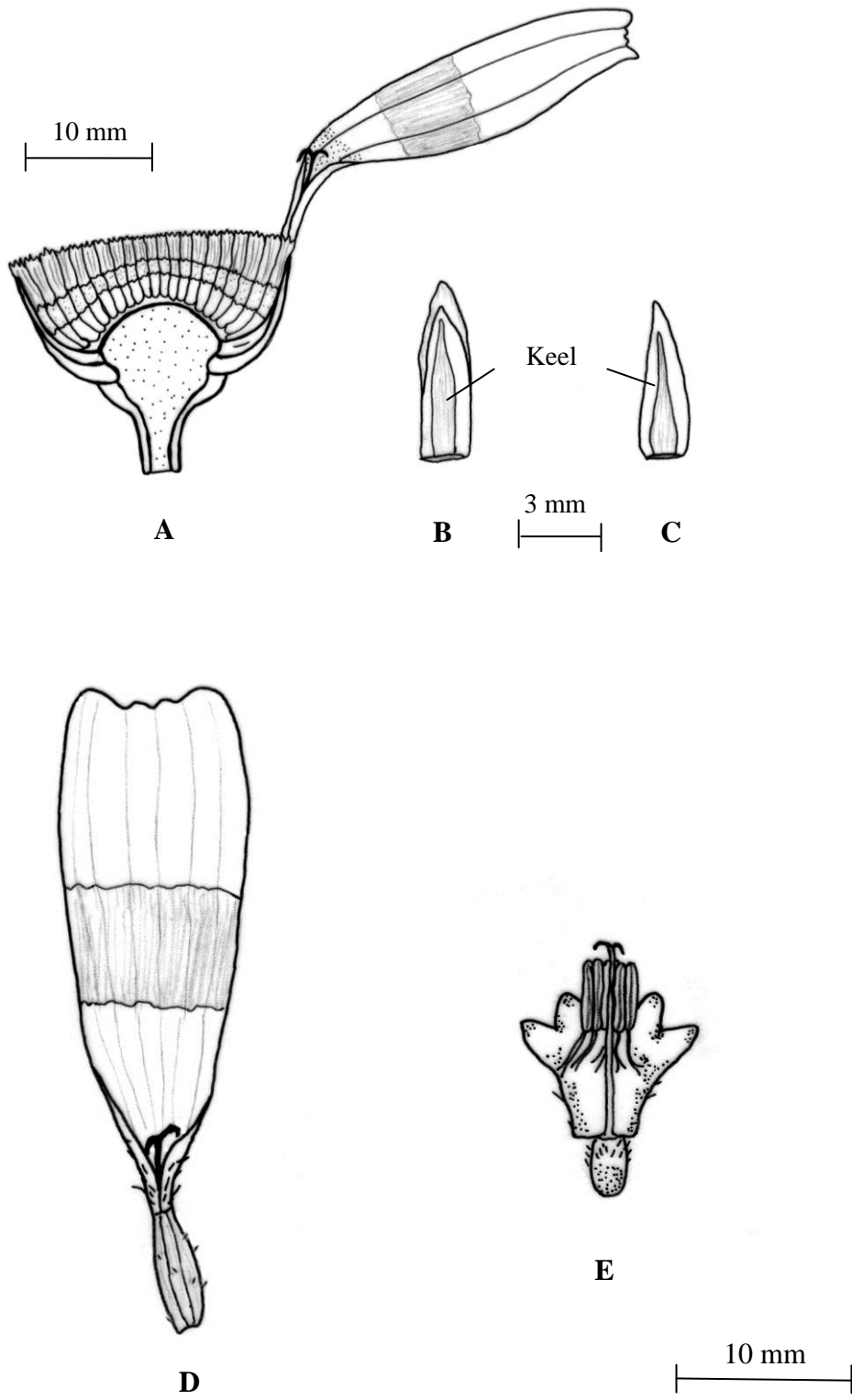


Fig. 11: Macromorphology of *Chrysanthemum carinatum* L. flower head.

- A) Longitudinal cut in the flower head.
- B) Inner bract.
- C) Outer bract.
- D) Ray floret.
- E) Disc floret.

The peduncle

Cylindrical erect, pale green in color, it measures from 10 to 15 cm in length and 5 to 7 mm in diameter.

The receptacle

It is hemispherical in shape, it measures from 1-1.5 cm in diameter and up to 1 cm in height, surrounded by an involucre of 2 rows of bracts.

The bracts

The outer bracts (Fig. 11C) are oval to oval lanceolate, they are keeled thick opaque in the central region but gradually become thinner and membranous towards the tips and margins, forming transparent wings. It measures about 7 mm in length and 4 mm in width.

The inner bracts (Fig. 11B) having similar color and characters of the outer, but differs in being longer and thinner about 1 cm in length and 2-3 mm in width.

The ray florets

The ray florets (Fig. 11D) are arranged in a single rarely 2 diffused whorls of about 19 to 25 in number.

The ray florets are sessile, zygomorphic, pistillate and measure from 1 to 2 cm in length and 0.7 to 1 cm in width at the middle of its corolla.

Each ray floret has a strap-like or legulate corolla which is formed of 2 to 3 colors and with velvety smooth touch, terminates 4 rounded apical teeth, the central ones being smaller, and has 6 to 8 principal veins which unite by arches near the apex.

Near the base of the corolla, the margins fold together to form a tubular structure from which protrudes the style and a brown bifid stigma.

The calyx is tubular cup-shaped membranous 1 to 2 mm in length and 1 to 1.5 mm in diameter, with inconspicuous 5 irregular rounded teeth, having transparent white color.

Gynaecium is syncarpous and having an inferior unilocular ovary, containing one ovule which is anatropous, basally placented.

The style is filiform brown in color, ending with a bifid papillosed brown stigma.

The disc florets

The disc florets (Fig. 11E) are numerous being about 250 to 300 in number occupying all the central area of the receptacle and arranged spirally in many whorls, they are sessile, hermaphrodite and actinomorphic.

The corolla is epigenous and consists of 5 purplish membranous petals which are shorter than that of ray florets and they are united together for about four fifths of their length forming a tubular corolla.

It shows 5 apical acute teeth which are dark purple in color and this is the main taxonomic feature of the species, it measures from 1 to 2 mm in length and about 0.5 to 1 mm in diameter.

The andraecium consists of 5 epipetalous syngenesious stamens, with short filaments and somewhat large oblong yellow anthers.

The gynaecium is unilocular formed of two united carpels encloses one basally placented ovule, the style is relatively long, and the bifid stigma protrudes beyond the corolla tube. The calyx is similar to that of the ray florets⁸.

2- Micromorphology**The peduncle** (stalk of the capitulum)

A transverse section in the peduncle (Figs. 12A,13A) is more or less circular, slightly irregular in outline showing 8 to 10 prominent ridges. It has an epidermis carrying non-glandular hairs followed by narrow parenchymatous cortex which shows outer collenchymatous groups under the ridges followed by a distinct endodermis. The pericycle is formed of ring of fibers surrounding the vascular bundles.

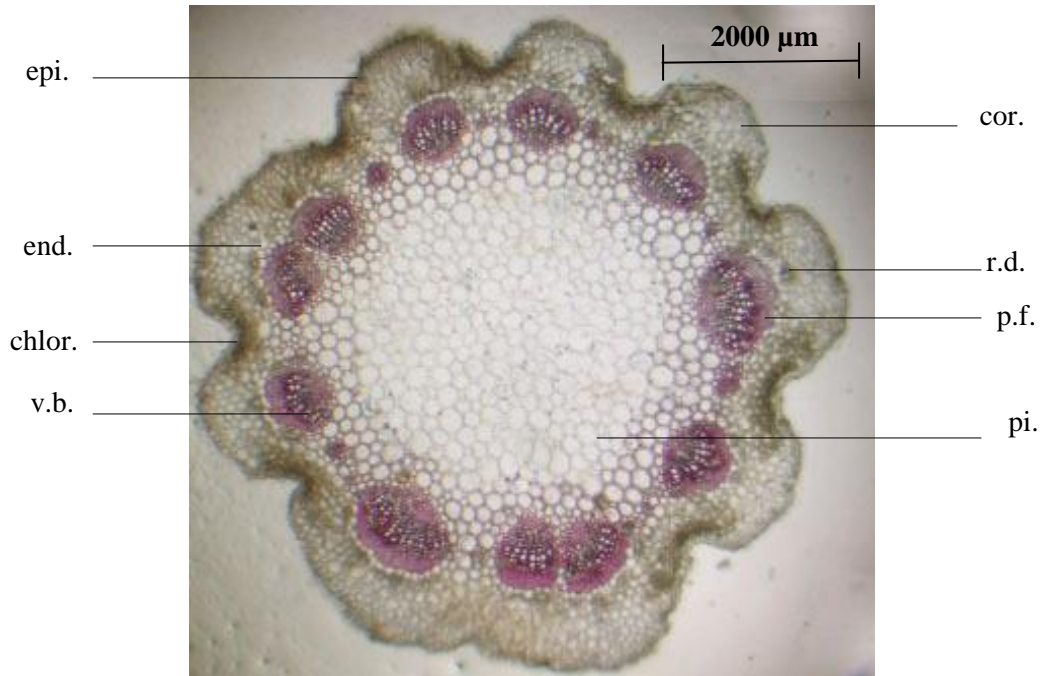
The vascular system is formed of 12 to 15 separate bundles enclosing wide parenchymatous pith.

The epidermis

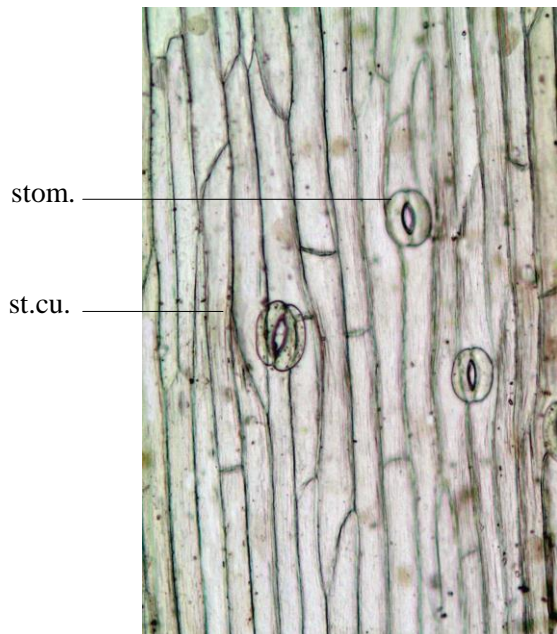
Epidermis (Figs. 14B,15B) is formed of tabular usually elongated cells. In surface view the cells are polygonal with straight anticlinal walls. The epidermal cells are covered with thick stratified cuticle.

The stomata

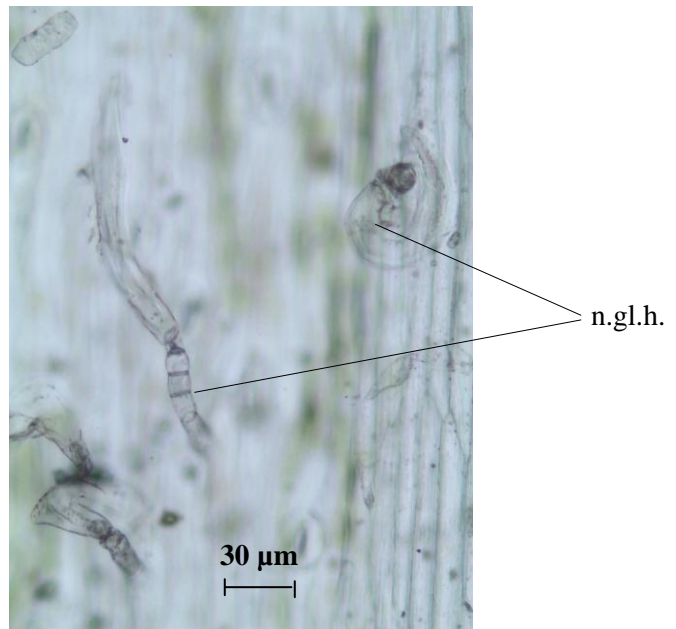
The stomata (Figs. 12B,13B) are of the ranunculaceous (anomocytic) type.



A



B



C

Fig. 12:

- A) Photo of diagrammatic T.S. of the peduncle.
- B) Photo of surface preparation of the peduncle.
- C) Photo of non-glandular hairs.

chlor., chlorenchyma; col., collenchyma; epi., epidermis; n.gl.h., non-glandular hair; p.f., pericyclic fibres; pi., pith; r.d., resin duct; stom., stomata; st.cu., striated cuticle; v.b., vascular bundle.

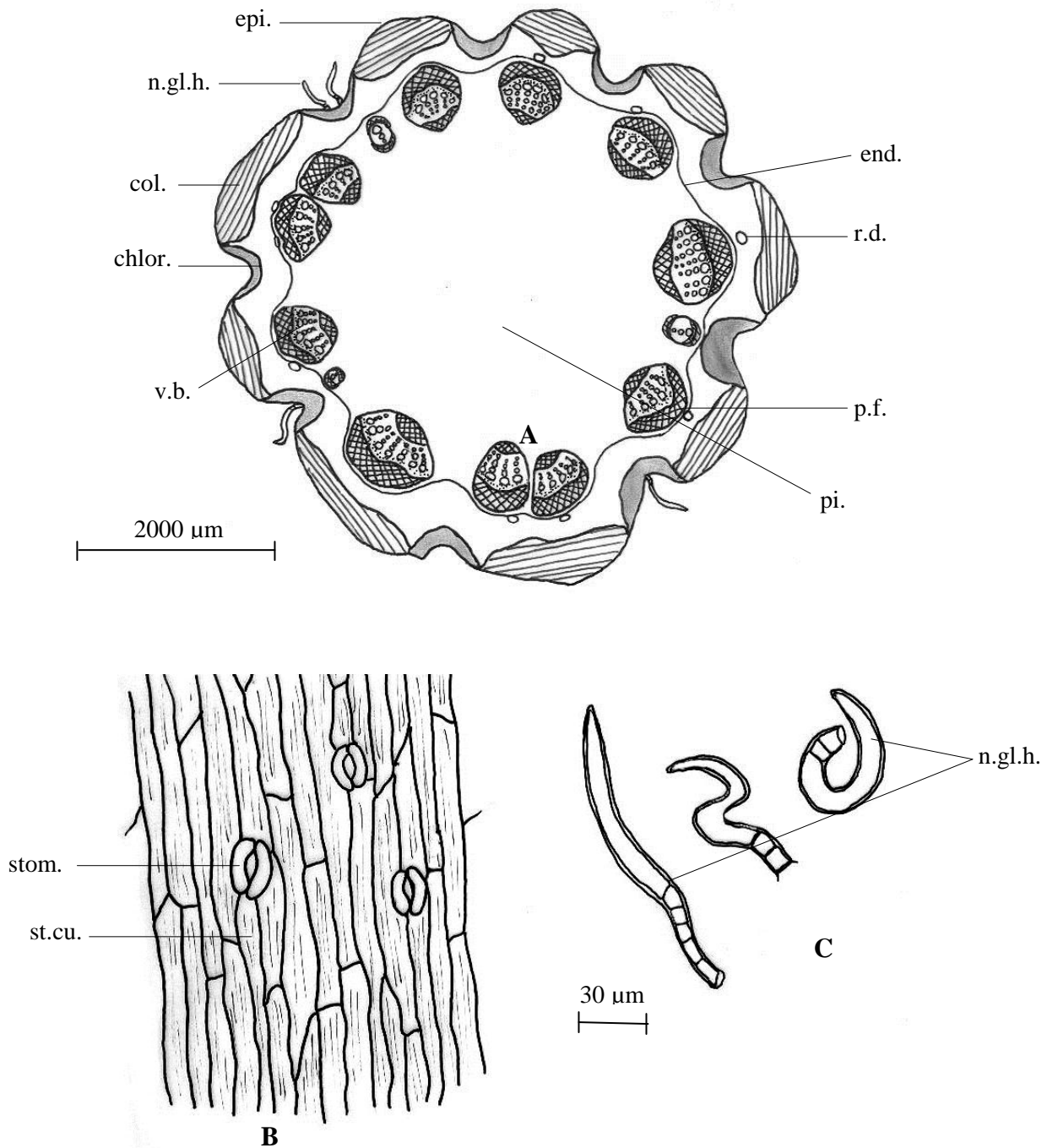


Fig. 13: Micromorphology of the peduncle.

A) Diagrammatic T.S. of the peduncle.

B) Surface preparation of the peduncle.

C) Surface preparation of the peduncle showing non-glandular hairs.

chlor., chlorenchyma; col., collenchyma; epi., epidermis; n.gl.h., non-glandular hair; p.f., pericyclic fibres; pi., pith; r.d., resin duct; stom., stomata; st.cu., striated cuticle; v.b., vascular bundle.

The trichomes

Trichomes (Figs. 12C,13C) are commonly present especially on the epidermal cells of the furrows. They are of the non-glandular type, uniseriate multicellular from 4 to 6 cells, with 3 to 4 small basal cells and an elongated apical one and usually covered with smooth cuticle.

The cortex

The cortex (Figs. 14B,15B) is composed of 4 to 6 layers of collenchymatous cells followed by 5 to 7 layers of parenchyma cells alternating with groups of chlorenchymatous cells under the furrows (Figs. 14A,15A). Resin ducts (Fig. 15B) of the schizogenous type are present.

The pericycle

The pericycle (Figs. 14B,15B) is composed of 2 to 5 layers of parenchymatous cells, interrupted by groups of pericyclic fibres surrounding the vascular bundles.

The fibres are lignified with moderately thick walls, showing few slit-like oblique simple pits, wide lumen and pointed ends.

The vascular system

It is represented by about 12 to 15 collateral vascular bundles surrounding the central pith.

The phloem consists of thin walled sieve tubes and phloem parenchyma. Cambium formed of thin walled compact parenchymatous cells.

The xylem is formed of lignified vessels and wood parenchyma.

The pith

The pith (Figs. 13A,15B) is wide and composed of rounded or oval usually isodiametric parenchymatous cells, the cells near to the vascular bundles are lignified and show few simple pits.

2- Micromorphology

A- The bract

The transverse sections in the outer and the inner bracts (Figs. 16A,17A) are nearly similar being plano-convex to concavo-convex in outline. The midrib projects in the outer surface and is traversed by a vascular strand formed of collateral vascular bundles, while the

lamina on both sides of the midrib is traversed by bands of sclerenchymatous fibres.

The epidermis

The cells of the inner epidermis (upper) of the bract (Fig. 17A) in the surface view are formed of polygonal cells having straight anticlinal walls covered with smooth cuticle.

The cells of the outer epidermis (lower) (Fig. 17A) are polygonal to sub-rectangular in shape and they are covered with striated cuticle.

The cells of the inner epidermis are longer and narrower than those of the outer epidermis.

The stomata

The stomata (Fig. 17B) are present in the outer epidermis only. They are numerous, of the ranunculaceous (anomocytic) type.

The trichomes

Trichomes (Fig. 16A,16B) are present on the outer surface only, they are non glandular uniseriate multicellular formed of 4 to 6 cells, 3 to 4 small basal cells and an elongated apical one and covered with smooth cuticle.

The mesophyll

The mesophyll (Figs. 16A,17A) is traversed by a continuous band of sclerenchymatous fibres.

The fibres have thick lignified pitted walls and slightly pointed to rounded ends.

The sclerenchymatous fibres (Figs. 16B,7B) are separated from the inner epidermis by 2 to 3 layers of rounded to ovoid spongy parenchyma with wide intercellular spaces and from the outer epidermis by 3 to 4 layers of the similar cells.

The number of rows of the spongy parenchyma decreases towards the margin, where the mesophyll consists mainly of sclerenchymatous fibres.

The midrib

The cortical tissue (Fig. 17A) of the midrib is formed of rounded to oval parenchymatous cells showing wide intercellular cells.

Resin duct of schizogenous type is present in the parenchymatous tissue facing the inner epidermis.

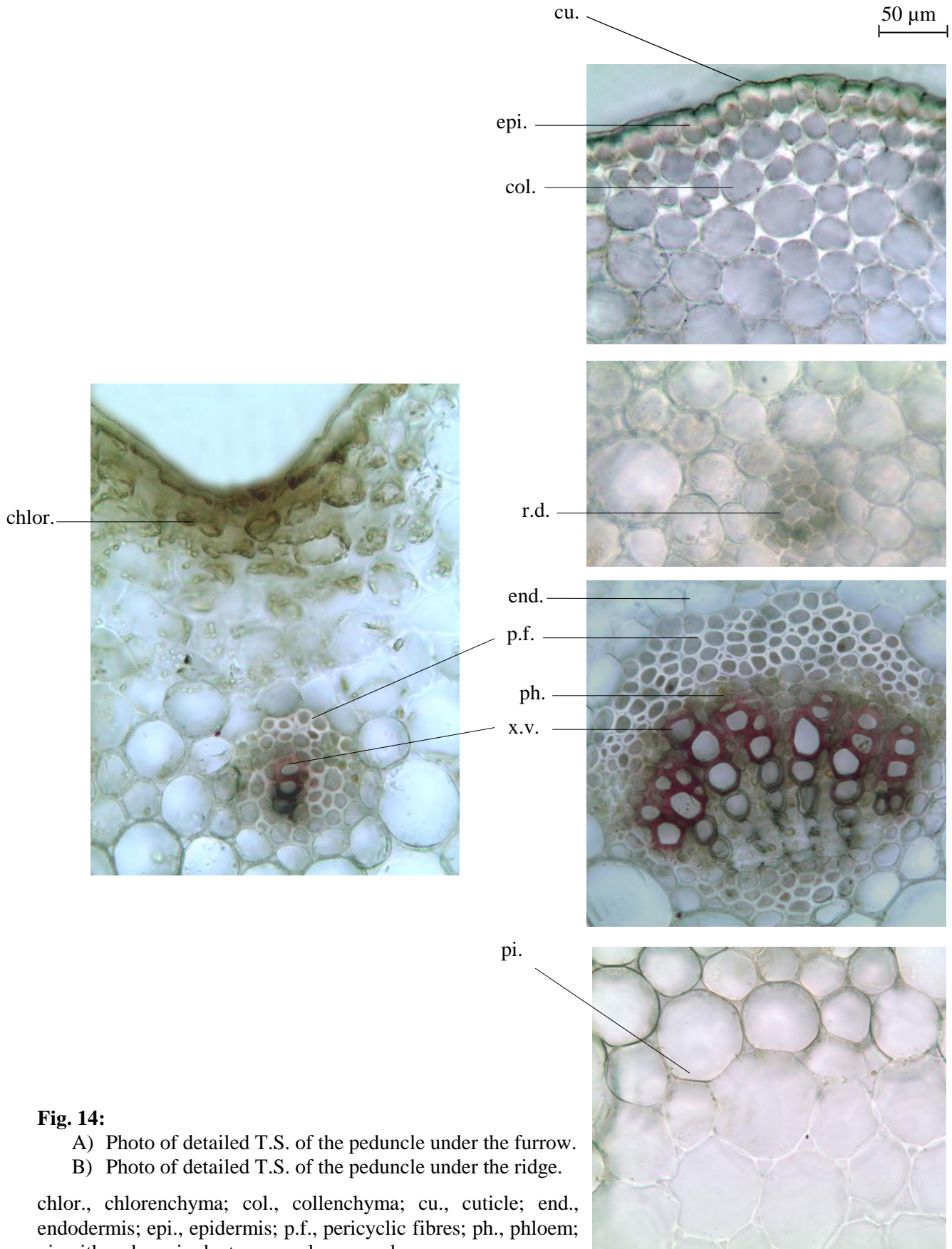


Fig. 14:

A) Photo of detailed T.S. of the peduncle under the furrow.

B) Photo of detailed T.S. of the peduncle under the ridge.

chlor., chlorenchyma; col., collenchyma; cu., cuticle; end., endodermis; epi., epidermis; p.f., pericyclic fibres; ph., phloem; pi., pith; r.d., resin duct; x.v., xylem vessel.

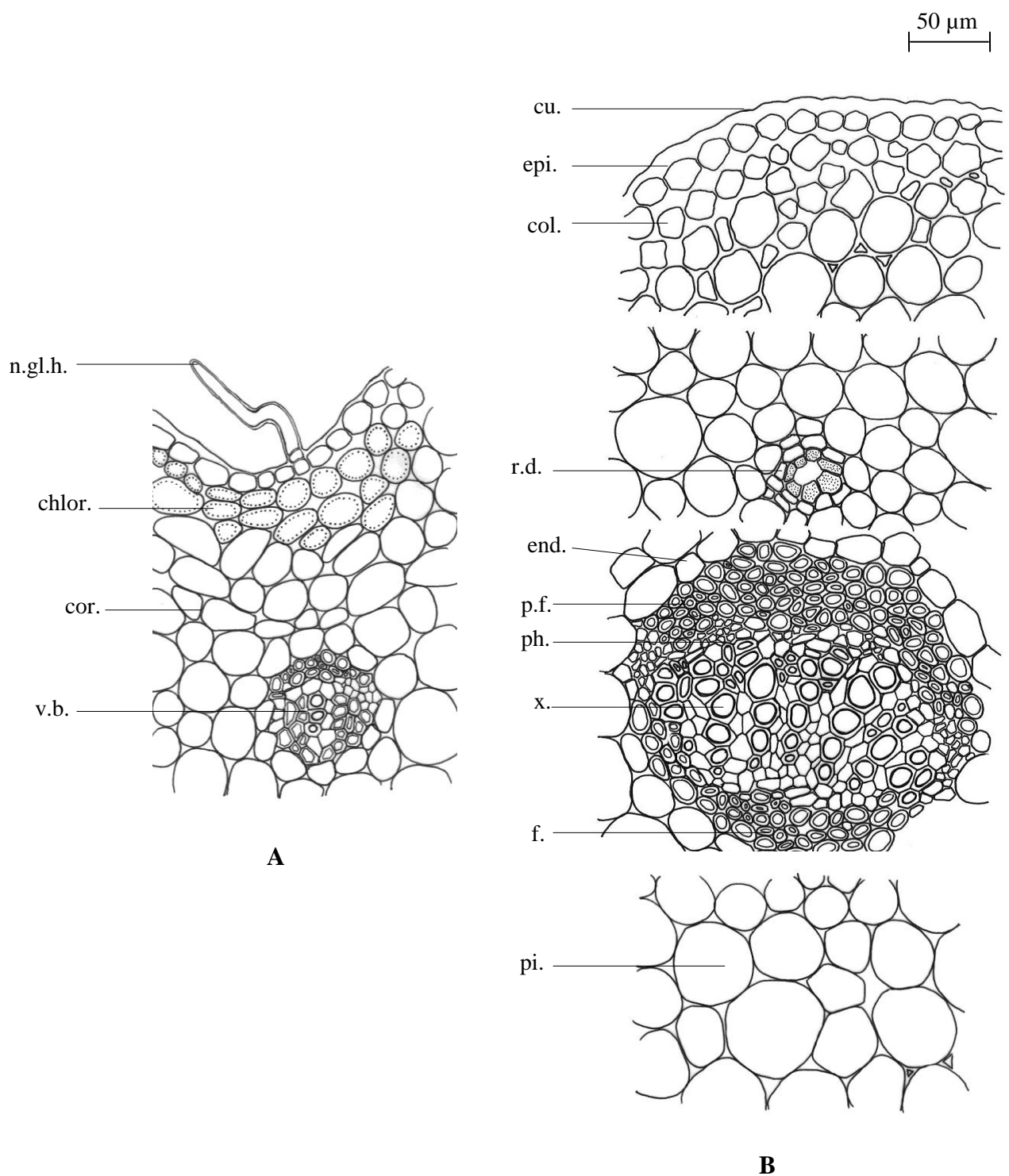


Fig. 15: Micromorphology of the peduncle.

A) Detailed T.S. of the peduncle under the furrow.

B) Detailed T.S. of the peduncle under the ridge.

col., collenchyma; cor., cortex; cu., cuticle; end., endodermis; epi., epidermis; f., fibres; n.gl.h., non-glandular hair; p.f., pericyclic fibres; ph., phloem; pi., pith; r.d., resin duct; v.b., vascular bundle; x., xylem.

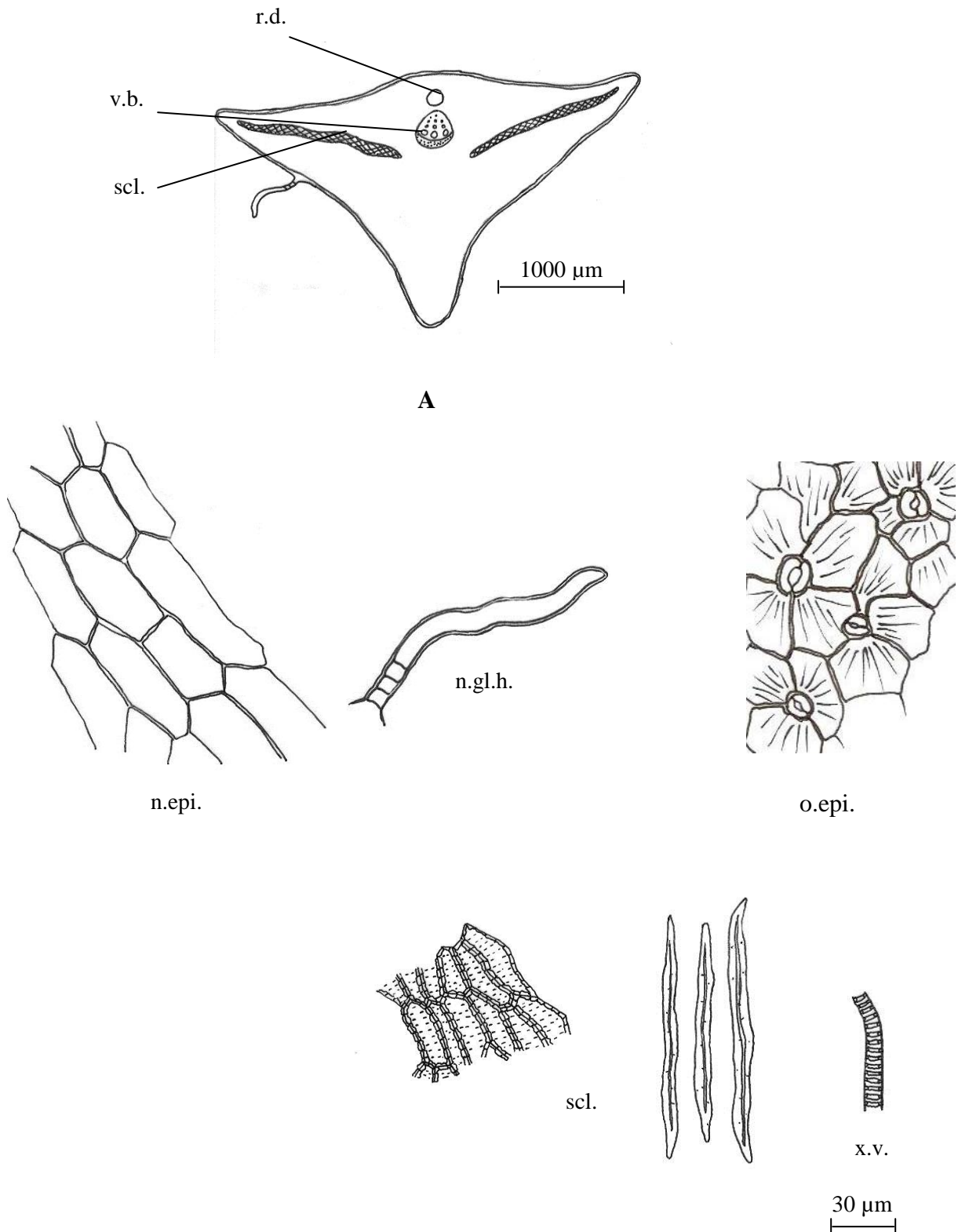
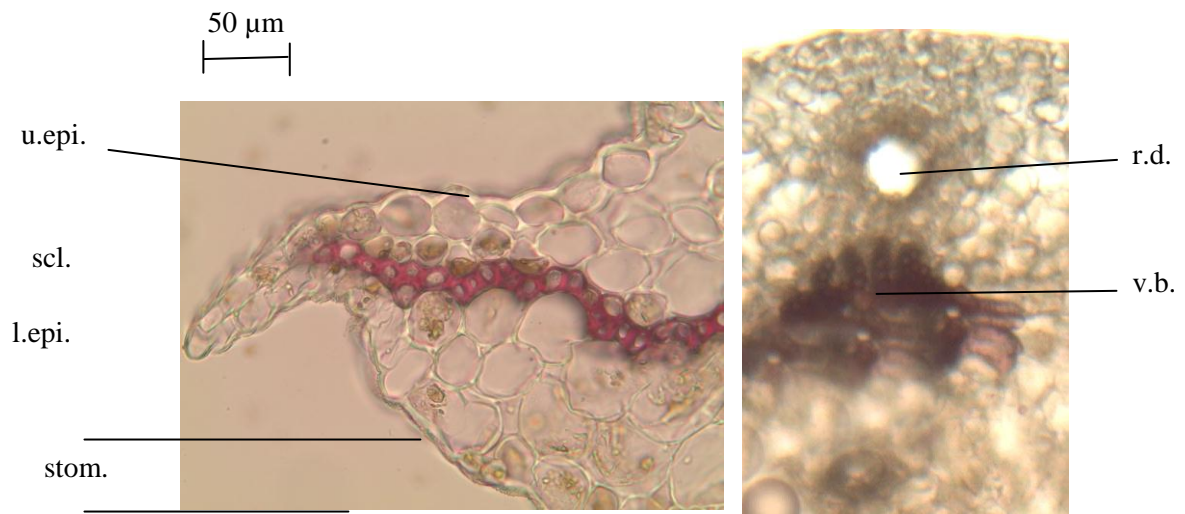


Fig. 16: Micromorphology of the bract.

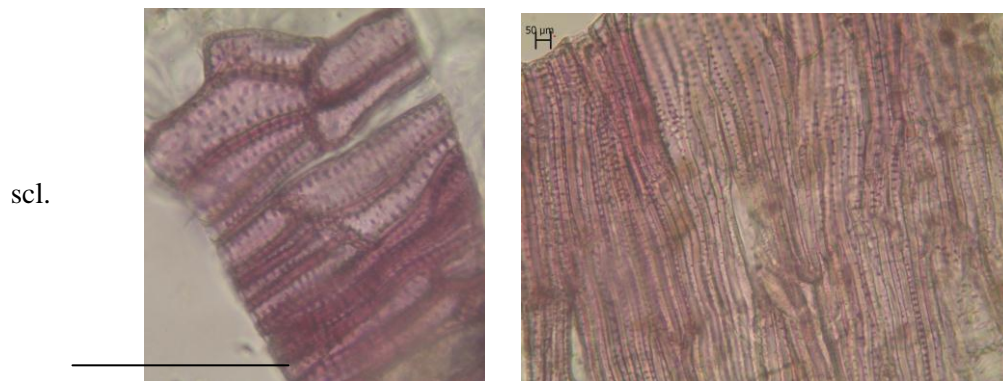
A) Diagrammatic T.S. of the bract.

B) Powdered elements of the bract.

n.epi., neural epidermis; n.gl.h., non-glandular hair; o.epi., outer epidermis; r.d., resin duct; scl., sclerenchyma; v.b., vascular bundle; x.v., xylem vessel.



A



B

Fig. 17: Micromorphology of the bract.

A) Photo of detailed T.S. of the bract.

B) Photo showing sclerenchyma of the bract.

l.epi., lower epidermis; r.d., resin duct; scl., sclerenchyma; stom., stomata; u.epi., upper epidermis; v.b., vascular bundle.

The vascular bundles (Figs. 16A,17A) are separated by uni- or bi-serriate medullary rays, collateral, 3 to 5 in number and capped by an arc of pericyclic fibres.

The xylem consists of delicate vessels and few tracheids, the vessels show annular and spiral thickening. The tracheids are lignified with pitted or reticulate thickening.

The phloem consists of thin walled cellulosic phloem parenchyma, companion cells and sieve tissue. The pericyclic fibres are lignified having thick walls that show few simple oblique slit-like pits and pointed ends.

B- Ray florets and disc florets

Corolla of the ray florets (marginal florets) (Fig. 19A,19B,19C)

A transverse section (Fig. 18C) in the ray floret shows an upper and lower epidermises enclosing in between a homogeneous mesophyll which is traversed by small vascular bundles.

The upper epidermis (inner surface)

The upper epidermis shows slight variations in shape and size of the cells in the different parts of the surface. In surface view, the cells of apical region are polygonal, usually subrectangular in shape with more or less straight anticlinal walls. Towards the middle region the cells become axially elongated with straight anticlinal walls. Towards the basal region, the cells become gradually smaller in size being slightly axially elongated with slightly straight anticlinal walls. The cells are covered with faint striated cuticle.

Numerous glandular trichomes (Fig. 19J) are present especially on the basal epidermal cells. They are formed of bicellular stalk and a biserriate multicellular head 6-8 cells. Stomata are not observed.

The lower epidermis (outer surface)

The lower epidermal (Fig. 18C) cells are identical to those of the upper surface in all respects.

Corolla of the disc florets (Fig. 19D,19E,19F)

The upper epidermis (inner surface)

The upper epidermis shows slight variations in size and shape of the cells in the different parts of the surface.

In surface view, the cells of the apical region are polygonal, usually isodiametric, with straight anticlinal walls. Towards the middle region, the cells become axially elongated with more or less straight anticlinal walls. Towards the basal region the cells become shorter in length, being less, axially elongated with slightly straight anticlinal walls.

The epidermal cells are covered with faint striated cuticle. Stomata of the anomocytic type are observed. Glandular trichomes as those on the epidermal cells of the corolla of the marginal florets are also present.

The lower epidermis (outer surface)

The lower epidermal cells are exactly identical to those of the upper surface in all respects.

Androecium

The filament

The epidermis of the filament (Fig. 19L) is formed of polygonal cells in surface view, almost axially elongated, having straight or slightly wavy anticlinal walls, covered with smooth cuticle.

The stomata and trichomes are not observed.

The anther

The epidermis of the anther lobes consists of polygonal, isodiametric cells, covered with a thin smooth cuticle but no stomata or trichomes are observed.

The fibrous layer of anther (Fig. 19N) appears in surface view as polygonal cells with lignified bar-like thickenings, and beaded walls.

The pollen grains

The pollen grains (Fig. 19H) are yellowish brown in colour, sub-spherical in shape and with spiny exine, some of the mature grains show three germinal pores.

Gynaecium

The ovary

The ovary is unilocular enclosing a single basally placented ovule.

A transverse section in the ovary (Fig. 18A,18B) is more or less polygonal in outline. It consists of an outer and an inner epidermises

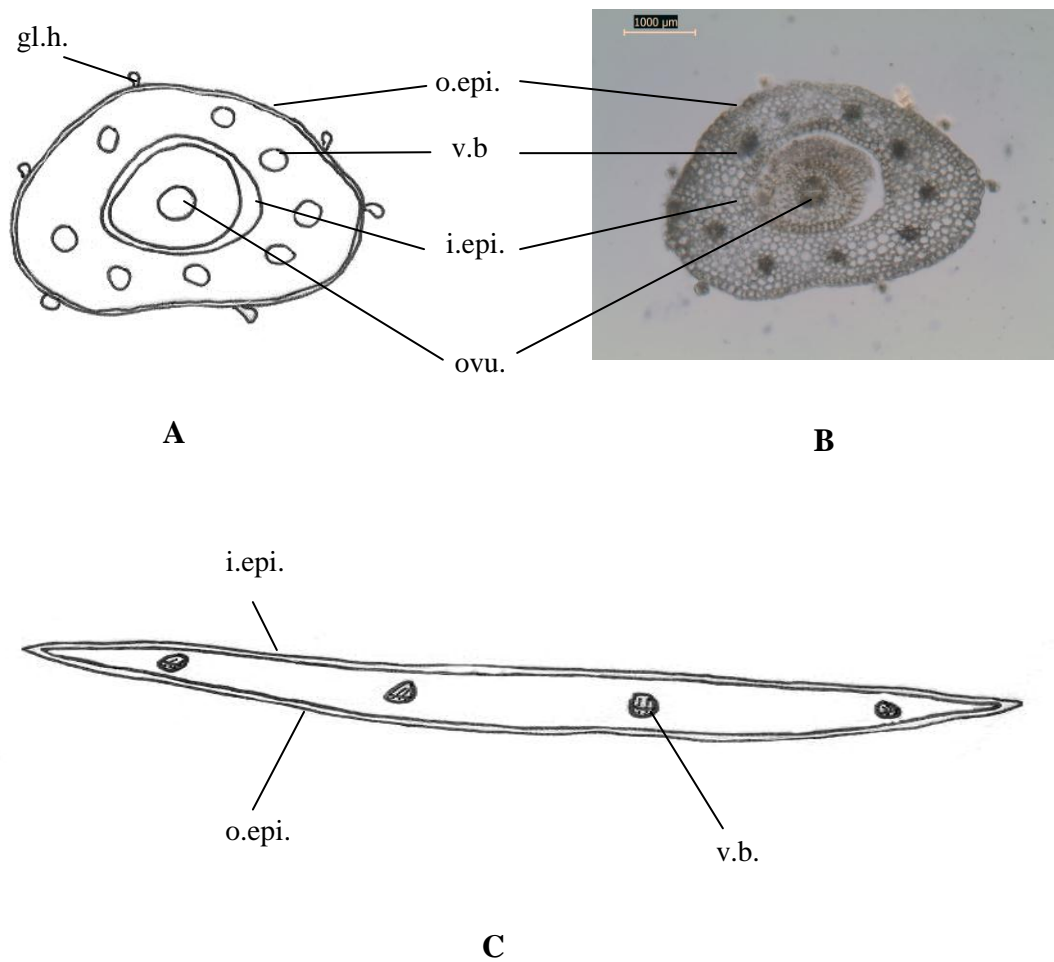


Fig. 18: Micromorphology of the ray floret.

- A) Diagrammatic T.S. in the ovary.
- B) Photo of diagrammatic T.S. in the ovary.
- C) Diagrammatic T.S. in the corolla of the ray floret.

gl.h., glandular hair; i.epi., inner epidermis; o.epi., outer epidermis; ovu., ovule; v.b., vascular bundle.

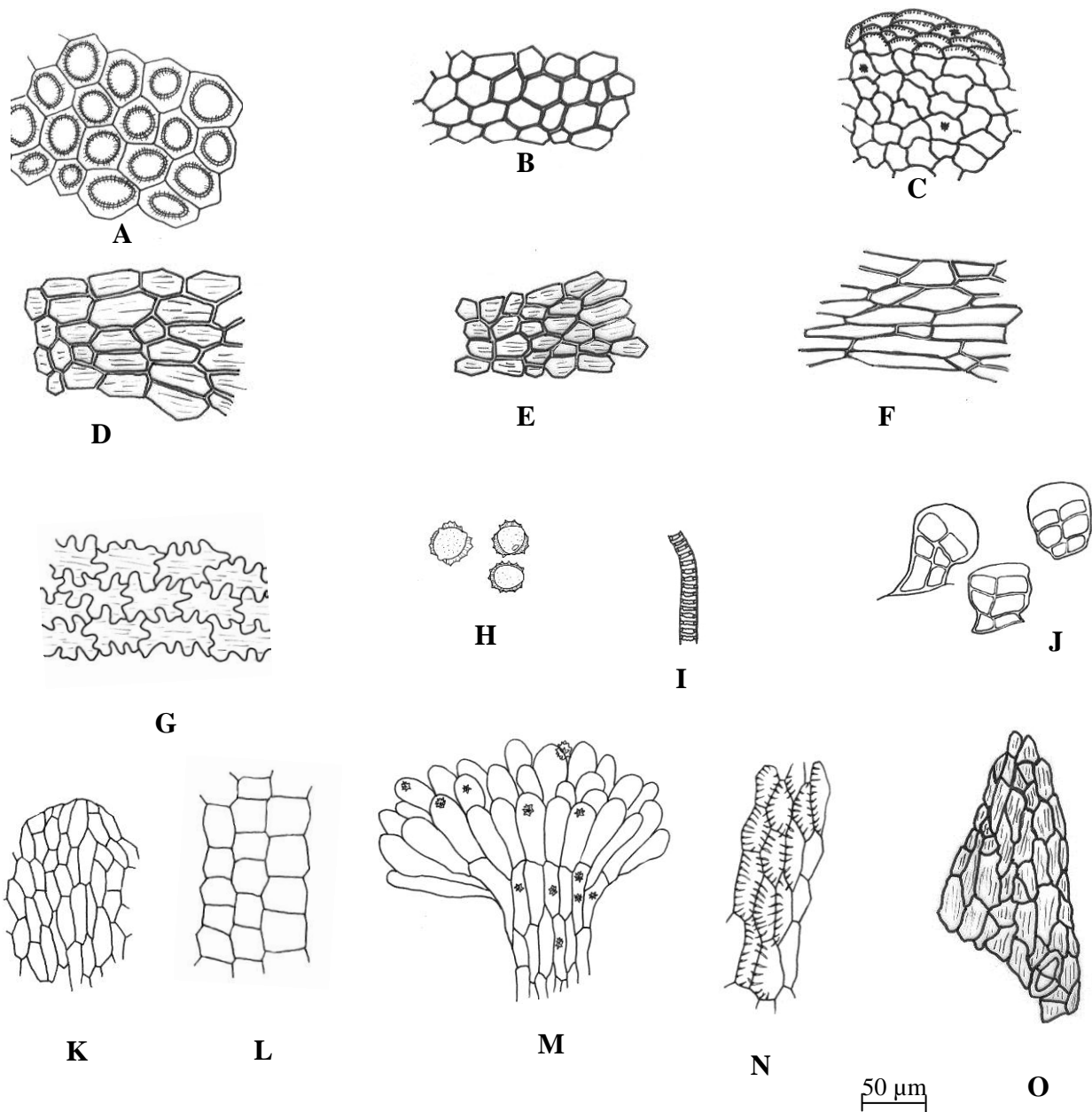


Fig. 19: Powdered elements of the flower heads.

- A) Inner epidermis of ray floret corolla.
- B) Inner epidermis of ray floret corolla at the base.
- C) Inner epidermis of ray floret corolla at the top.
- D) Inner epidermis of disc floret corolla at the top.
- E) Inner epidermis of disc floret corolla at the base.
- F) Outer epidermis of disc floret corolla at the margin.
- G) Outer epidermis of ray floret corolla.
- H) Pollen grains.
- I) Xylem vessel.
- J) Compositae hairs.
- K) Epidermis of the apical part of the anther lobe.
- L) Epidermis of the filament.
- M) Papillosed stigma.
- N) Fibrous layer of anther.
- O) Inner epidermis of disc floret corolla at the margin.

enclosing a parenchymatous ground tissue, which shows several vascular strands.

The outer epidermis (Fig. 18B) consists of polygonal cells with thin straight anticlinal walls and are covered with smooth cuticle.

The inner epidermis (Fig. 18B) consists of polygonal cells resembling those of the outer epidermis, but are somewhat elongated and have slightly wavy anticlinal walls.

The trichomes (Fig. 18A,18B) are very numerous on the outer epidermis. They are of the glandular type similar to those of the ray and disc florets. Stomata are absent on both epidermises. The ground tissue consists of several rows of parenchymatous cells, the cells below the epicarp, being somewhat compact radially elongated and having straight anticlinal walls. The remaining cells are ovoid or rounded parenchyma with wide intercellular spaces.

The vascular bundle

The vascular bundle (Fig. 18A,18B) xylem consists of few narrow spiral and annular vessels, and a small patch of phloem tissue either on both sides of the xylem or below it.

The style

The epidermal cells of the style are polygonal, axially elongated with slightly wavy anticlinal walls, covered with thin smooth cuticle.

The stigma

The stigma (Fig. 19M) is papillosed showing dome shaped papillae protruding from the cells of the epidermis, the papillae are covered with smooth cuticle, the cells contain numerous calcium oxalate clusters.

Table of measurements of *Chrysanthemum carinatum* L. in microns.

Item	L	W	H	D
Leaf				
Upper epidermis	40- <u>45</u> -55	35- <u>40</u> -45	20- <u>22</u> -24	
Lower epidermis	44- <u>50</u> -60	30- <u>36</u> -40	18- <u>20</u> -22	
Palaside cells	60- <u>65</u> -75	34- <u>36</u> -38		
Pericyclic fibres	115- <u>120</u> -135			68- <u>72</u> -75
Xylem vessels				16- <u>20</u> -25
Wood parenchyma	18- <u>20</u> -24	14- <u>16</u> -18		
Stomatal index	Upper epidermis 0.08-0.09-0.1		Lower epidermis	0.08-0.09-0.1
Stomatal number	Upper epidermis 28- <u>30</u> -32		Lower epidermis	46- <u>48</u> -50
Palaside ratio	2- <u>2.5</u> -3		Vein islet no.	18- <u>20</u> -22
Stem				
Epidermis	44- <u>50</u> -58	24- <u>27</u> -30	20-22-26	
Trichomes	116- <u>120</u> -132			4- <u>6</u> -8
Pericyclic fibres	115- <u>120</u> -135			15- <u>25</u> - 35
Xylem vessels (Metaxylem) (Protoxylem)				25- <u>32</u> -42 13- <u>15</u> -19
Wood fibres				15- <u>18</u> -20
Tracheids				
Resin duct	13- <u>14</u> -15	10- <u>12</u> -14	10- <u>11</u> -12	
Starch granules				3- <u>5</u> -7
Peduncle				
Epidermis				24- <u>28</u> -34
Pericyclic fibres	100- <u>110</u> -120			8- <u>10</u> -12
Xylem vessels				10- <u>12</u> -15
Resin duct	14- <u>16</u> -22	13- <u>15</u> -18	7- <u>10</u> -12	
Trichomes	116- <u>120</u> -132			4- <u>6</u> -8

Item	L	W	H	D
Flower				
The bract				
Inner epidermis	65- <u>70</u> -77	30- <u>33</u> -36	26- <u>28</u> -34	
Outer epidermis	70- <u>75</u> -80	26- <u>28</u> -30	22- <u>24</u> -26	
Sclerenchyma	58- <u>65</u> -80			12-16-22
Xylem vessels				9- <u>11</u> -14
Ray floret				
Inner epidermis	47- <u>53</u> -63	36- <u>43</u> -47		
Outer epidermis	75- <u>84</u> -95	32- <u>37</u> -45		
Epidermis of ovary		32- <u>35</u> -38		25- <u>32</u> -35
Calcium oxalate clusters				10- <u>11</u> -13
Glandular hairs	74- <u>76</u> -80			66- <u>70</u> -74
Disc floret				
Inner epidermis	66- <u>69</u> -73	35- <u>40</u> -48	24- <u>28</u> -30	
Outer epidermis	55- <u>60</u> -68	25- <u>28</u> -35	22- <u>25</u> -28	
Pollen grains				23- <u>25</u> -26

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