

MACRO AND MICROMORPHOLOGY OF THE
LEAF, STEM AND FLOWER-HEADS OF TAGETES ERECTA L.

A.A. Ali, N.A. El-Emary & O.A.El-Toweesy
Department of Pharmacognosy, Faculty of Pharmacy, Assiut
University, Assiut, Egypt.

The macro and micromorphology of the leaves, stems and flower-heads of Tagetes erecta L. is described and illustrated for the purpose of its identification in the entire and powdered form.

The genus *Tagetes* family *Compositae*¹⁻³ constitutes about 70 species, which are mainly distributed in Mexico and was introduced to Britain over 300 years ago⁴. In Africa, it is claimed that the plant acts as fly and vermin-repellent⁵. The phytochemical study of the different organs of this plant revealed the isolation of some flavonoid aglycones, glycosides, thiophens and steroids⁷.

Material:

Samples of *Tagetes erecta* L., were obtained from the Faculty of Agriculture, University of Assiut, as well as from the Experimental Station of Medicinal Plants of the Faculty of Pharmacy, Assiut.

MACROMORPHOLOGY

Tagetes erecta L. is a green erect herb, with monopodially branched stems, and yellow radiating flower-heads.

The Leaves: (Fig. 1 A)

The leaf is compound, imparipinnate, with 15-19 leaflets, alternate and sessile. The leaflets have a dark green upper surface and a paler lower one; it is mostly ovate to lanceolate in shape, having an acute apex, serrate margin, showing transparent scattered spots due to the oil glands in the mesophyl, i.e. punctate surface and asymmetric base. The leaflet measures 2-4.5 cm long and 0.5-2cm wide, It has a pinnate-reticulate venation, the veins are prominent on the lower surface and leave the midrib at an acute angle of about 45 degree.

The rachis is green in colour, cylindrical, slightly grooved on the upper side. It measures about 5-8 cm in length and 2-3 mm in diameter. The dried leaves are brittle, with strong aromatic odour and slightly astringent, camphoraceous taste.

MICROMORPHOLOGY

The transverse section of the leaflet (Fig. 2, 3, A) shows a dorsiventral structure, the palisade being discontinuous in the midrib region. The midrib shows a vascular system of a large central crescent-shaped vascular bundle in addition to one or two smaller ones. Each vascular bundle consists of radiate xylem with a band of phloem underneath. The pericycle is formed of an upper and lower arc of pericyclic fibres. The upper epidermis (Fig. 2 C) is formed

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of polygonal, isodiametric cells measuring 48 - 50 - 55 μ in length and 18 - 20 - 25 μ in width and covered with thick striated cuticle. The glandular hairs are numerous, each being formed of uniseriate multicellular stalk and unicellular head, measuring 50 - 53 - 60 μ in length.

The lower epidermis (Fig. 2 B), is identical with the upper in shape and size, but more wavy and sinuated; stomata of anomocytic type are numerous, measuring 9 - 10 - 12 μ in diameter.

The mesophyll is heterogeneous, dorsiventral with one row of palisade, spongy tissue is narrow of 3 - 4 row of rounded to irregular parenchyma containing chloroplasts; midrib and big veins with sub-epidermal collenchyma of 2-3 rows of irregular, thick-walled, cellulosic cells; cortical region is rather wide parenchymatous cells; endodermis is indistinguishable; vascular strand with lower and upper arcs of pericycle; pericycle is formed of lignified fibres having regular or slightly irregular outline and narrow lumen with acuminate sometimes rounded tips measuring 250 - 280 - 300 μ in length, 8 - 10 - 15 μ in width. Phloem is narrow, of thin-walled shining elements; cambium is formed of few rows of cambiform cells; xylem is mostly primary of radial rows of lignified, pitted, spiral and scalariform vessels, being about 20 - 22 - 26 μ in diameter and accompanied by few pitted and spiral lignified tracheids; medullary rays is biseriate or triseriate, traversing xylem and phloem.

The transverse section of the rachis (Fig. 4 B) is subrounded to suboval in shape, with a grooved upper side

and a bulging convex lower one. The vascular system consists of three separate bundles. The lower epidermis (Fig. 4 C) is formed of polygonal, usually isodiametric cells with straight anticlinal walls, covered with thick striated cuticle and measuring 42 - 48 - 50 μ in length and 20 - 24 - 26 μ in width. The upper epidermis is identical with the lower in all respects. Glandular hairs are numerous, similar in shape and size to that of the leaflet; the cortical tissue is formed of wide parenchymatous cells; endodermis is indistinguishable; vascular strand, with lower and upper arcs of pericyclic fibres, measuring 230 - 250 - 280 μ in length and 10 - 13 - 15 μ in width. Phloem is narrow of thin-walled cells; xylem is mostly primary of radial rows of lignified, pitted and scalariform vessels, being about 20 - 24 - 30 μ in diameter.

THE POWDERED LEAF

The powdered leaves are greenish to greyish-green in colour, with characteristic aromatic odour and slightly astringent camphoraceous taste, it shows under the microscope, the following elements:

- 1- Epidermal cells with polygonal, isodiametric form and slightly sinuated anticlinal walls; anomocytic stomata are numerous on the lower epidermis.
- 2- Lignified pericyclic fibres having regular or slightly irregular outline, with narrow lumen, their tips are more or less acuminate, but sometimes rounded.
- 3- Fragments of mesophyll having dorsiventral structure and showing palisade cells and spongy parenchyma containing chloroplasts.

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- 4- Numerous spiral and scalariform lignified vessels.
- 5- Numerous glandular hairs of uniseriate, bi- or multicellular stalks and unicellular heads.
- 6- Absence of sclereids, calcium oxalate and starch granules.

MACROMORPHOLOGY OF THE STEM

The stem is erect, cylindrical, monopodially branched and attaining from 60 - 100 cm in height and about 1 - 1.5 cm in diameter with about 8 - 12 small ridges. The internodes are rather short, especially near the base, being generally from 1 - 1.5 cm long; the surface is pale green in colour.

The dry stem is tough, flexible and breaks with an incomplete hard fracture exposing a yellowish-white interior. It is tasteless with faint aromatic odour.

MICROMORPHOLOGY

The transverse section of the stem (Fig. 5 & 6), is more or less circular in outline. It shows externally an epidermis, a narrow parenchymatous cortex with outer collenchymatous groups especially in the ridges. The pericycle is represented by groups of fibres interrupted by parenchyma. The vascular tissue consists of a ring of 16 - 18 separate vascular bundles enclosing a relatively wide pith.

The epidermis (Fig. 5 C) is formed of polygonal, axially elongated cells, covered with thick smooth cuticle, measuring 60 - 65 - 80 μ in length and 26 - 28 - 30 μ in width. Stomata of anomocytic type measuring 22 - 24 - 26 μ in length and 12 - 15 - 16 μ in width and few composite glandular hairs are observed.

The cortex (Fig. 6), is formed of thin-walled parenchyma cells, with wide intercellular spaces. The endodermis, is formed of thin-walled parenchyma cells hardly differentiated from the cortical cells.

The pericycle is formed of separate groups of fibres and parenchyma; fibres (Fig. 5 D) are irregular in outline, with moderately thickened lignified walls and fairly wide lumina, and showing blunt to acute sometimes rounded apices measuring 240 - 260 - 280 μ in length and 14 - 16 - 20 μ in diameter.

The vascular bundle is formed of narrow phloem of thin-walled elements of sieve tubes, companion cells and phloem parenchyma. Cambium is formed of distinct layer of thin-walled cells arranged in radial rows. Xylem, is formed of wide lignified vessels, mostly spiral, pitted or scalariform measuring 30 - 32 - 35 μ in diameter. The wood fibres are abundant, similar to those of the pericycle but are shorter.

The medullary rays which traverse the xylem and phloem are bi- or triseriate, with pitted lignified walls.

The pith is formed of large polygonal parenchyma cells, measuring 75 - 80 - 90 μ across. The pith and cortical parenchyma are free from calcium oxalate and starch granules.

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THE POWDERED STEM

The powdered stem is greyish-green in colour, with faint odour and tasteless, characterized microscopically by the presence of the following elements:

- 1- Fragments of epidermal cells having more or less polygonal straight anticlinal walls and covered with thick, smooth cuticle with some anomocytic stomata.
- 2- Glandular trichomes of the compositous type.
- 3- Collenchyma cells with thickened cellulosic walls.
- 4- Fragments of pericyclic and wood fibres with tapering, rarely blunt apices and straight, moderately thickened lignified walls.
- 5- Lignified spiral, pitted and scalariform vessels.
- 6- Absence of calcium oxalate and starch granules or sclereids.

MACROMORPHOLOGY OF THE FLOWER HEAD

The flower heads (Fig. 7 A) occur as hemispherical capitula, attached to long peduncle. Each individual capitulum, when fresh, measure from 3 - 5 up to 6 cm in diameter. It has an aromatic odour and light yellow to deep orange colour. The peduncle is cylindrical, erect, pubescent, longitudinally wrinkled and measures from 3 - 13 cm in length and 3 - 7 mm. in width.

The receptacle is 2 - 6 cm high and 0.8 - 2.2 cm in diameter; it is obconical or dome shaped, and surrounded by involucre of one row of green bracts.

The bract (Fig. 7 B) is oblong, lanceolate, indistinctly keeled. It measures from 1.5 - 2.5 cm in length and 0.5 - 0.7 cm in breadth.

The ray floret (Fig. 7 D), each capitulum bears about 30 - 35 florets arranged in two or more outermost whorls on the receptacle. They are 3 - 4.5 cm in length, zygomorphic, sessile and pistillate; the calyx is represented by a pappus in which the scales are united forming a cup-pappus of few unequal scales, of which one or more (mostly two) are owned. The scales measure 3 - 8 mm in length and 1 - 2 mm in width. The corolla is epigynous, ligulate, pale yellow to orange colour, consists of a short tubular part 1 - 1.3 cm in length and a long strapshaped part from 1.8 - 2.5 cm in length. The gynaecium is syncarpous of 2 united carpels with inferior ovoid, black coloured ovary, measuring 3 - 10 mm in length and up to 1 mm in diameter. Style is thread-like, cylindrical and yellowish-white in colour. The stigma is bifid, with long papillae.

The disc florets (Fig. 7 C) are fertile, hermaphrodite, sessile and tubular. Each floret measures 1.5 - 2.8 cm in length and 0.8 - 2 mm in diameter. Calyx, represented by a cup pappus of few unequal scales in which one or two are owned. Corolla, sympetalous, consisting of 5 united petals forming a tube which is yellowish orange in colour with acute apex; it measures from 12 - 20 mm in length and 0.2-4 mm in width. Androecium, consists of 5 epipetalous, synergensious stamens, alternating with the corolla lobes.

Each stamen is formed of a yellow anther and thin colourless free filament.

Gynaecium, consists of an inferior, bicarpellary, unilocular ovoid ovary. It measures from 0.8 - 10 mm in length and 1 - 1.5 mm in diameter. The style is filiform, orange in colour and with a bifid stigma.

MICROMORPHOLOGY OF THE FLOWER HEAD

The bract (Fig. 8), the epidermis of the bract appears in surface view polygonal, mostly isodiametric, with straight anticlinal walls. The cells measure 40 - 50 - 60 μ in length and 16 - 20 - 25 μ in width. Stomata are numerous of the anomocytic type measuring 26 - 30 - 33 μ in length and 13 - 15 - 18 μ in width.

The mesophyll showed sclerenchymatous hypodermis, followed by one to three layers of thin walled parenchymatous cells. The hypodermal cells (Fig. 8 D) have lignified pitted walls, narrow lumen and measure 30 - 40 - 50 μ in length and 16 18 - 20 μ in diameter.

The vascular bundles are small, formed of thin-walled phloem tissue and delicate vessels which are 8 - 15 - 20 μ in diameter, with spiral and reticulate thickenings.

The calyx (Fig. 9) on both the ray and disc florets is represented by pappus which possesses a multicellular axis and unicellular conical, thick-walled branches, measuring 50 - 60 - 65 μ in length and 20 - 22 - 25 μ in width and having acute apices.

The corolla: The epidermal cells of the corolla in the ray florets (Fig. 9 A, B, C) are polygonal, axially elongated with sinuous anticlinal walls and are covered with thin striated cuticle, they measure 42 - 45 - 50 μ in length and 25 - 26 - 28 μ in width. The cells become narrower and less sinuous towards the base of the corolla.

The inner epidermal cells (Fig. 9 D, E) have slightly wavy anticlinal walls and covered with thin smooth cuticle. They measure 20 - 22 - 26 μ in length and 16 - 18 - 20 μ in breadth. Arising from each cell is a dome-shaped papillae which measures 20 - 23 - 25 μ in diameter and are covered with thin smooth cuticle.

The outer epidermal cells in the disc florets corolla (Fig. 9 G, H), are axially elongated with straight anticlinal walls and are covered with thin striated cuticle. They measure 95 - 100 - 110 μ in length and 22 - 26 - 30 μ in width. The inner epidermal cells of the upper part (Fig. 9 F) shows rounded papillae in each cell, measuring 25 - 30 - 35 μ in diameter. Both epidermises are devoid of stomata; glandular and non-glandular trichomes are present on the outer epidermis only. The glandular trichomes having unicellular head, bi-or tricellular stalk and covered with warty cuticle. The non-glandular trichomes are uniseriate, multicellular and covered with thin striated cuticle and measure 40 - 50 - 65 μ in length.

The stamens (Fig. 10 A): The epidermal cells of the filament are formed of rectangular, axially elongated cells, having straight anticlinal walls covered with thin smooth cuticle. They measure 30 - 32 - 35 μ in length and 16 - 18 - 20 μ in width. The epidermal cells of the anther lobes are

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similar to those of the filament, but measure 26 - 30 - 32 μ in length and 6 - 8 - 10 μ in width. The fibrous layer is formed of one row of lignified isodiametric cells, showing bar-like thickenings and measuring 10 - 12 - 15 μ in diameter.

The pollen grains (Fig. 10 D), are spherical, 30 - 32 - 35 μ in diameter, having 3 germinal pores and 3 germinal furrows and shows a spiny exine.

The gynaecium (Fig. 10 J): A transverse section in the ovary is more or less rounded in outline. The ovary wall consists of an outer and an inner epidermises enclosing a parenchymatous ground tissue transversed by small vascular strands.

The outer epidermis (Fig. 10 K) consists of polygonal cells with straight anticlinal walls and covered with thin smooth cuticle. They measure 42 - 45 - 50 μ in length and 18 - 20 - 24 μ in breadth.

Trichomes, of glandular compositous type are present on the outer epidermis, but stomata are absent. The epidermal cells of the style are rectangular, axially elongated with straight anticlinal walls and are covered with thin smooth cuticle. They measure 55 - 58 - 60 μ in length and 18 - 20 - 23 μ in width.

The stigmatic surface is papillosed, showing club-shaped papillae measuring 30 - 32 - 36 μ in length and 6 - 8 - 10 μ in width.

The stalk (Fig. 11 A, B): A transverse section in the peduncle is more or less rounded in outline. It is composed of an epidermis, followed by a comparatively narrow cortex, a sclerenchymatous pericycle capping about 12 - 14 vascular bundles and a parenchymatous pith.

THE POWDERED FLOWER HEADS

The powdered flower heads is yellowish orange in colour having a characteristic aromatic odour and tasteless. It is characterized microscopically by the following:

- 1- Numerous spiny pollen grains.
- 2- Epidermal cells showing compositous glandular hairs in side and in top views.
- 3- Fragments of the stigma showing its papillosed surface.
- 4- Fragments of non-glandular, uniseriate, multice-llular trichomes.
- 5- Fragments of the epidermal cells of the corolla with straight or slightly sinuated anticlinal walls.
- 6- Fragments of the fibrous layer of the anther with polygonal, isodiametric cells, having beaded, ligni-fied walls.



F. 1: Sketch of *Tagetes erecta* L.
A. The leaf
B. The stem

X 1.5
X 1

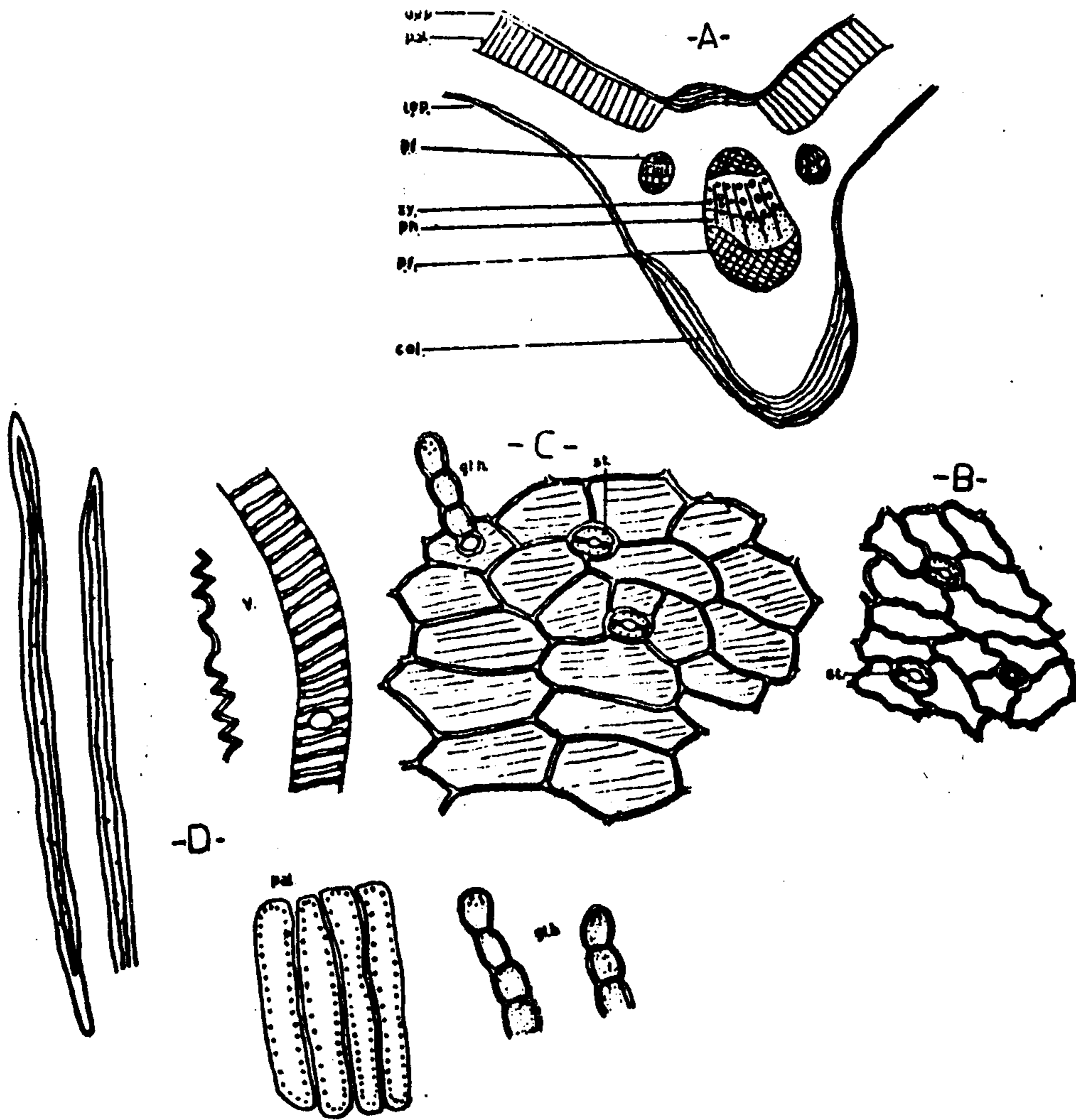


Fig. 2: The leaflet.

- | | |
|---|-------|
| A. Diagrammatic T.S. in the leaflet | X 12 |
| B. Surface preparation of the lower epidermis of the leaflet. | X 135 |
| C. Surface preparation of the upper epidermis of the leaflet | X 135 |
| D. Isolated elements of the leaflet | X 135 |

Col., collenchyma; f., fibre; gl., glandular hair; L.ep., lower epidermis; pal., palisade; p.f., pericyclic fibre; ph., phloem; st., stomata; u.ep., upper epidermis; v., vessels; xy., xylem.

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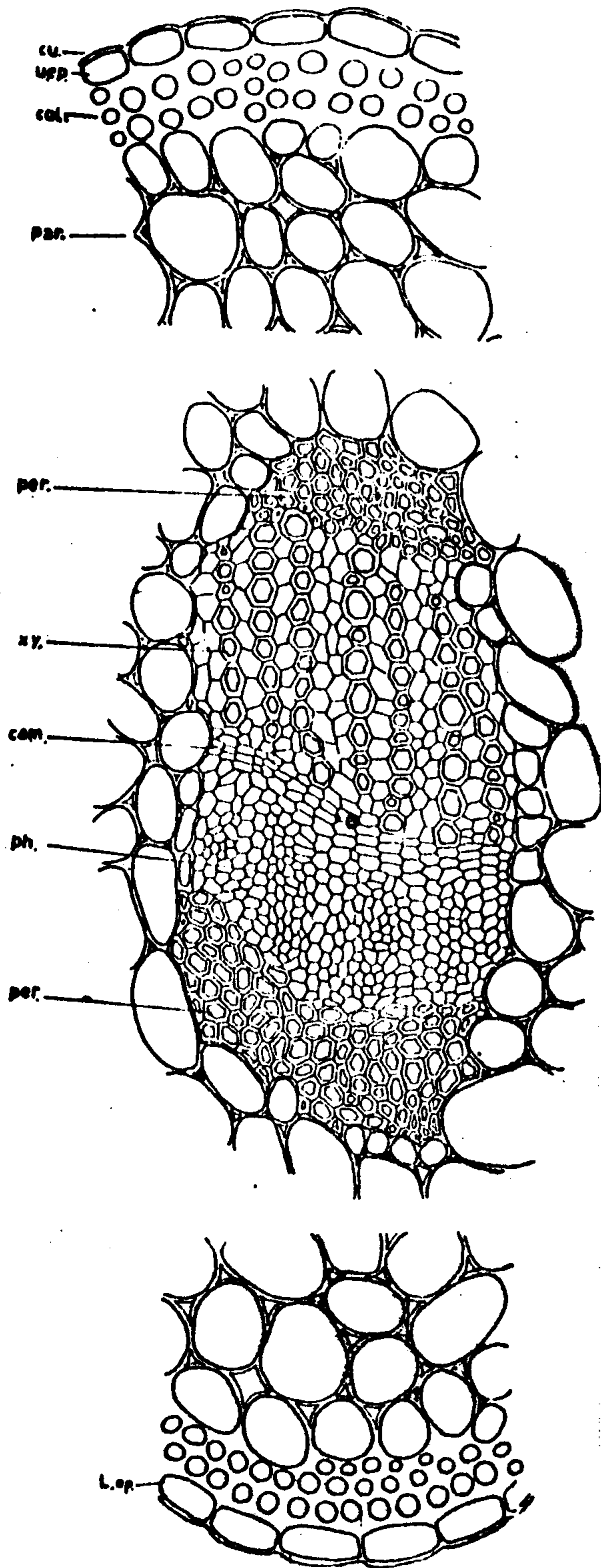


Fig. 3: Detailed T.S. in the leaflet

X 135

camb., cambium; col., collenchyma; cu., cuticle; l.ep., lower epidermis; per., pericycle; par., parenchyma; ph., phloem; u.ep., upper epidermis; xy., xylem.

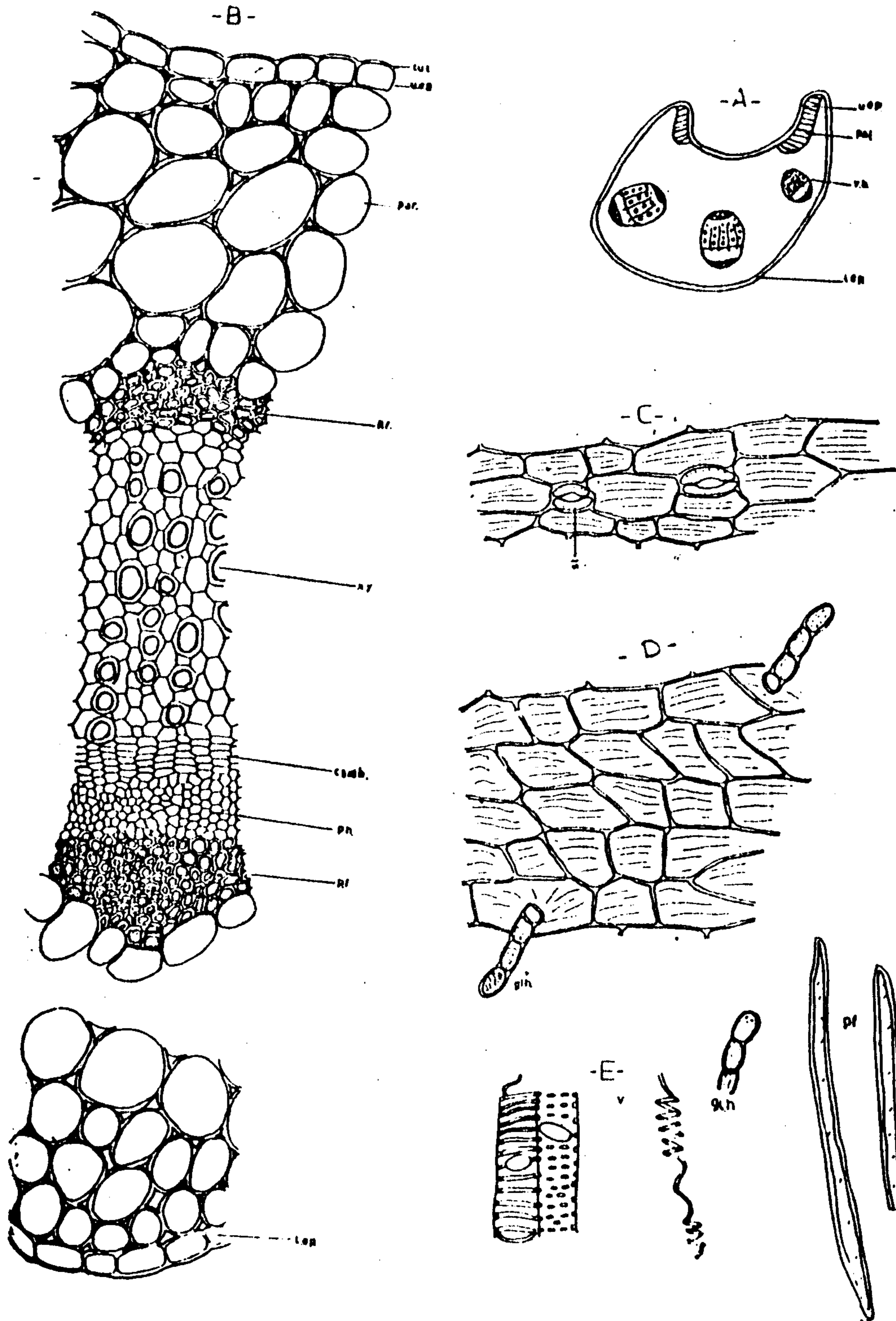


Fig. 4: The Rachis.

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|---|-------|
| A. Diagrammatic T.S. in the rachis | C 12 |
| B. Detailed T.S. in the rachis | X 135 |
| C. Surface preparation of the lower epidermis of the rachis | X 135 |
| D. Surface preparation of the upper epidermis | X 135 |
| E. Isolated elements of the rachis | X 135 |

camb., cambium; cut., cuticle; gl.h., glandular hair; L.ep., lower epidermis; pal., palisade; par., parenchyma; p.f., pericyclic fibre; ph., phloem; st., stomata; u.ep., upper epidermis; v., vessels; xy., xylem.

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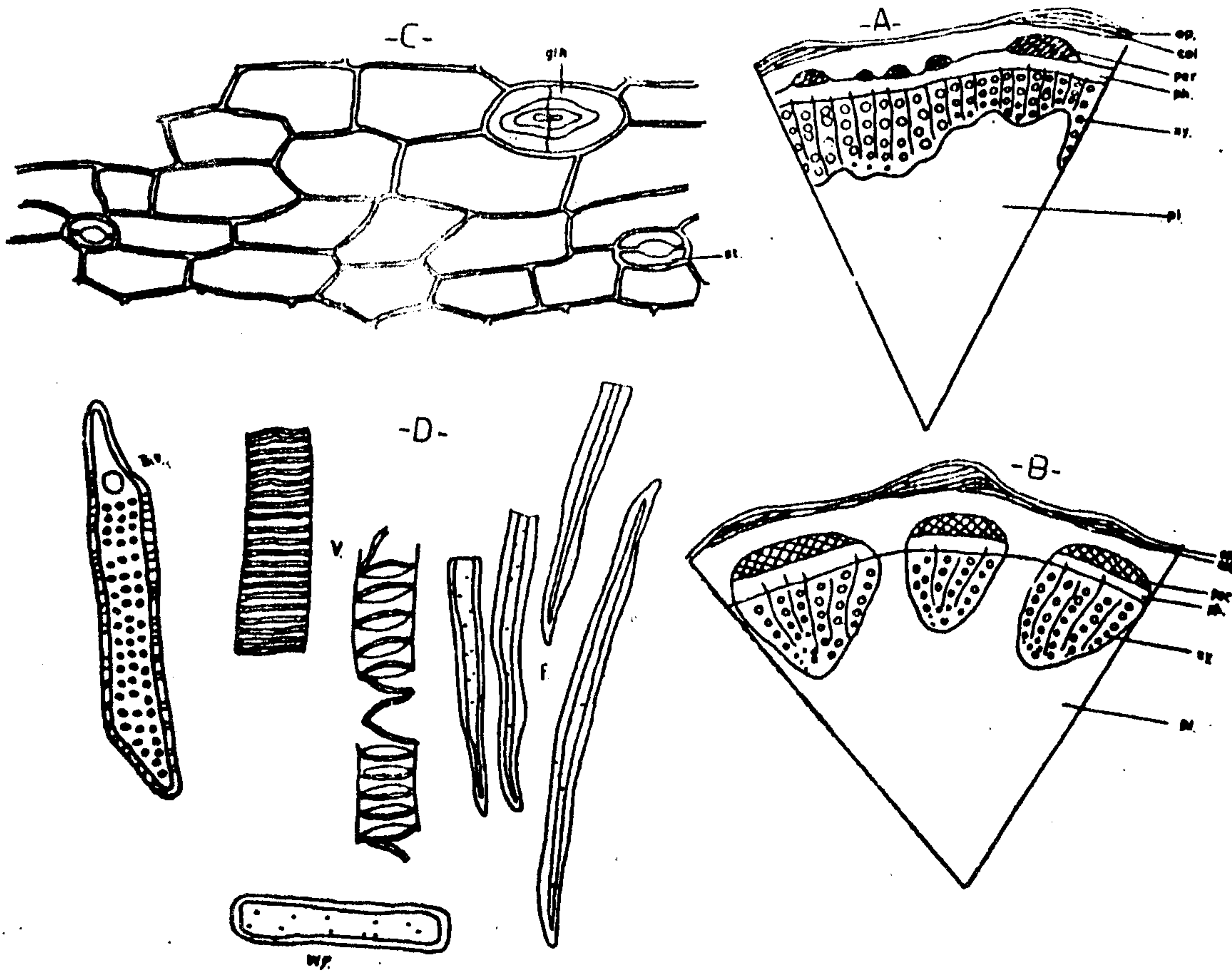


Fig. 5: The stem

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|--|-------|
| A. Diagrammatic T.S. in the old stem | X 12 |
| B. Diagrammatic T.S. in the young stem | X 12 |
| C. Surface preparation of the stem | X 135 |
| D. Isolated elements of the stem | X 135 |

Col., collenchyma; ep., epidermis; f., fibre; gl.h., glandular hair; per., pericycle; ph., phloem; pi., pith; st., stomata; tr.v., tracheidal vessel; v., vessels; w.par., wood parenchyma; xy., xylem.

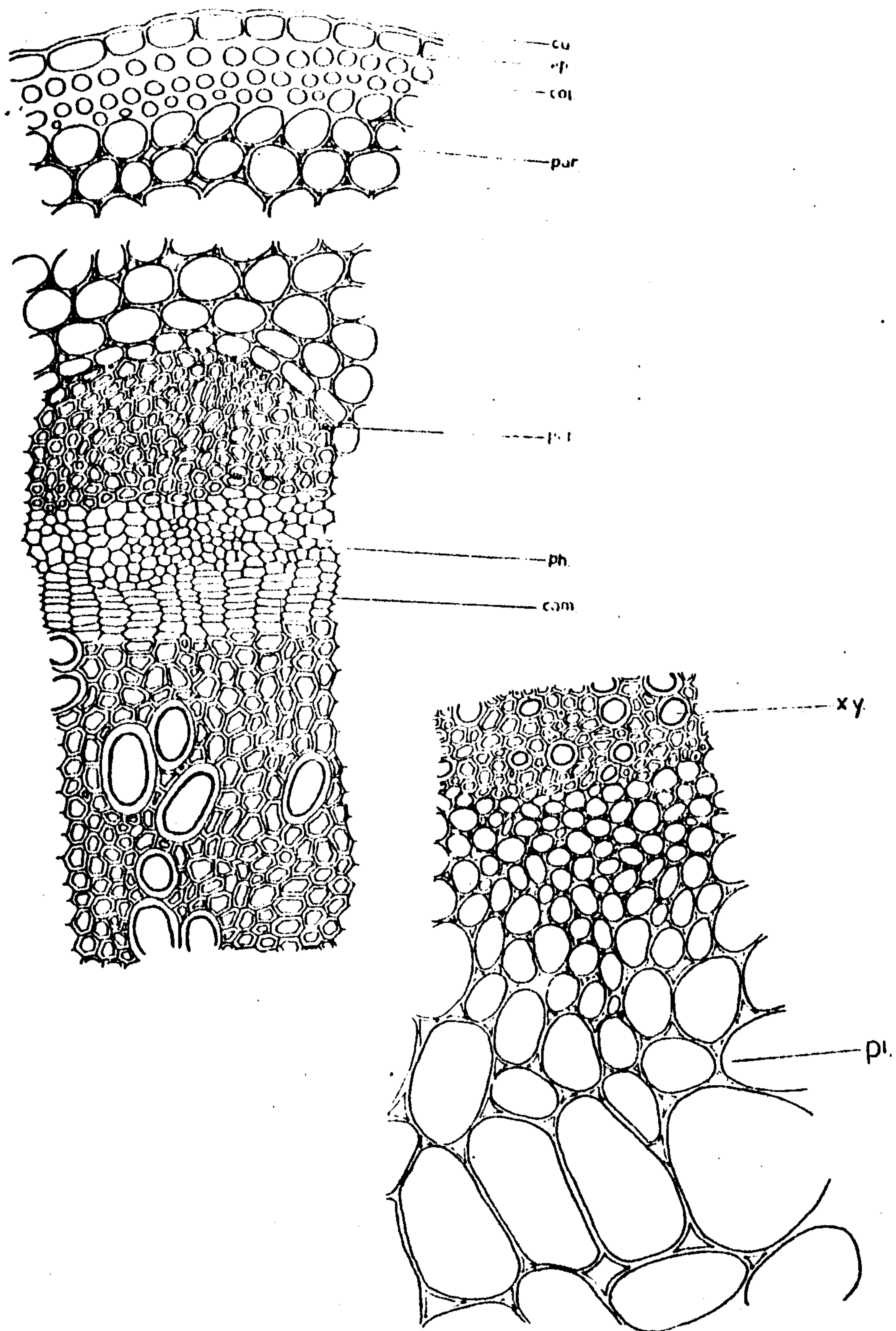


Fig. 6: Detailed T.S. in the Stem

X 135

Camb., cambium; col., collenchyma; cut., cuticle; ep., epidermis; par., parenchyma; per., pericycle; ph., phloem; pi., pith; xy., xylem.

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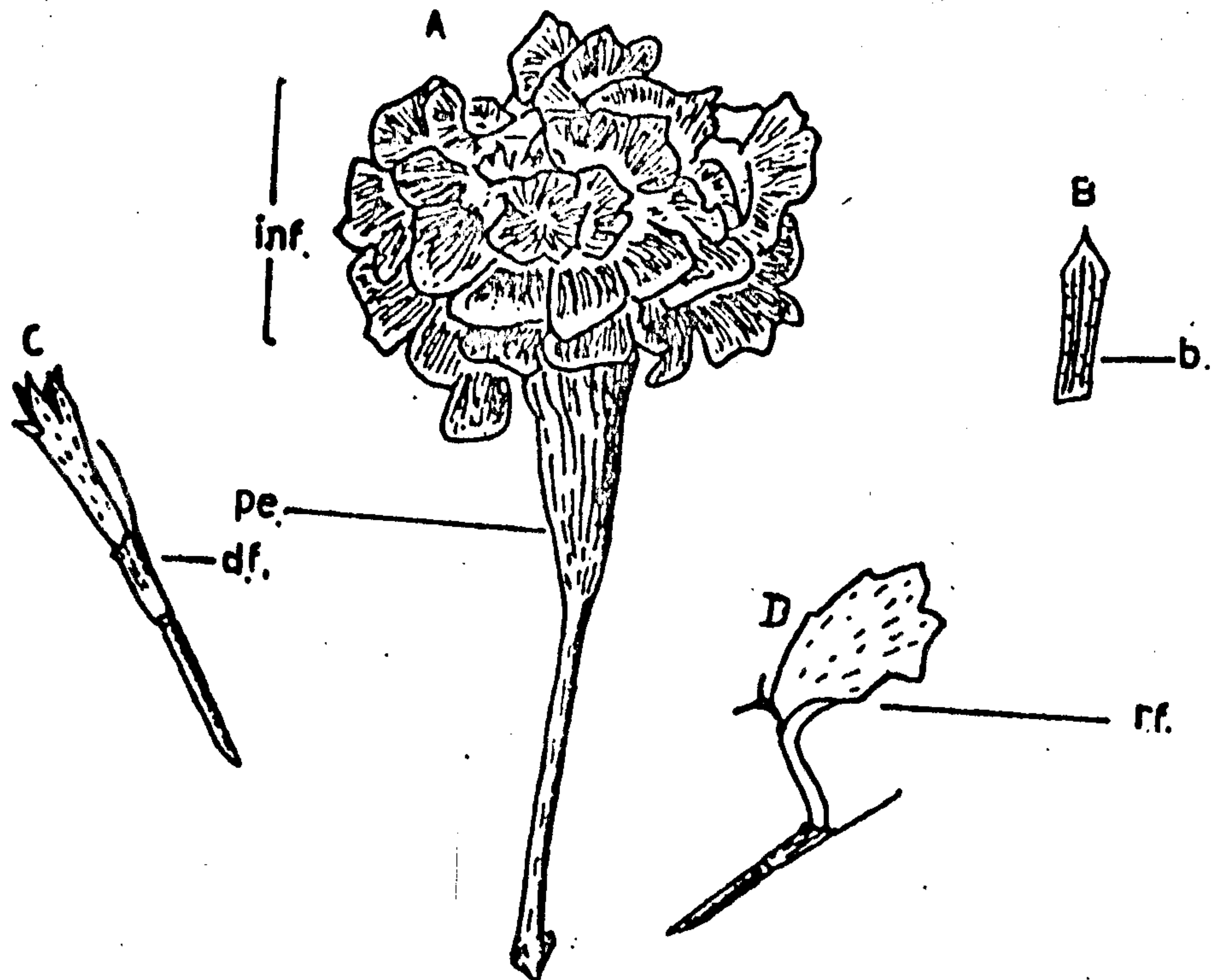


Fig. 7: Sketch of *Tagetes erecta* L.

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|----|-----------------|-------|
| A. | The flower-head | X 3/4 |
| B. | The bract | X 1/2 |
| C. | The disc floret | X 1 |
| D. | The ray floret | X 1 |

B., bract; d.f., disc floret; inf., inflorescence; pe., peduncle; r.f., ray floret; pet., petiole; s., stem.

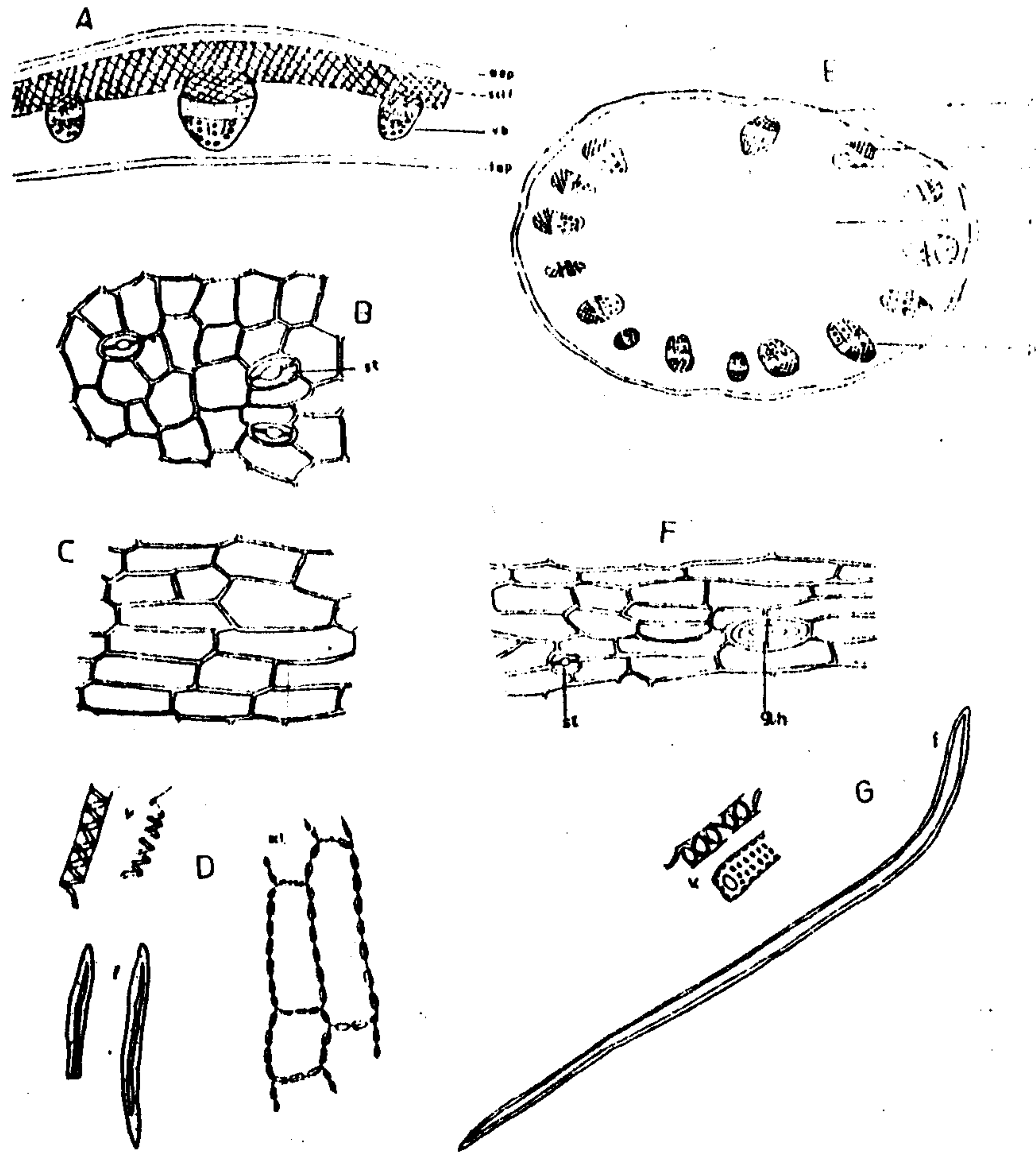


Fig. 8: The Flower-head

A. Diagrammatic T.S. in the bract	X 12
B. Surface preparation in the outer epidermis of bract	X 135
C. Surface preparation in the inner epidermis of bract	X 135
D. Isolated elements of the bract	X 135
E. Diagrammatic T.S. of the peduncle	X 135
F. Surface preparation of the epidermis of the peduncle	X 135
G. Isolated elements of the peduncle	X 135

ep., epidermis; f., fibre; gl.h., glandular hair; i.ep., inner epidermis; o.ep., outer epidermis; per., pericycle; ph., phloem; pi., pith; scl., sclereids; st., stomata; v. b., vascular bundle; v., vessels; xy., xylem.

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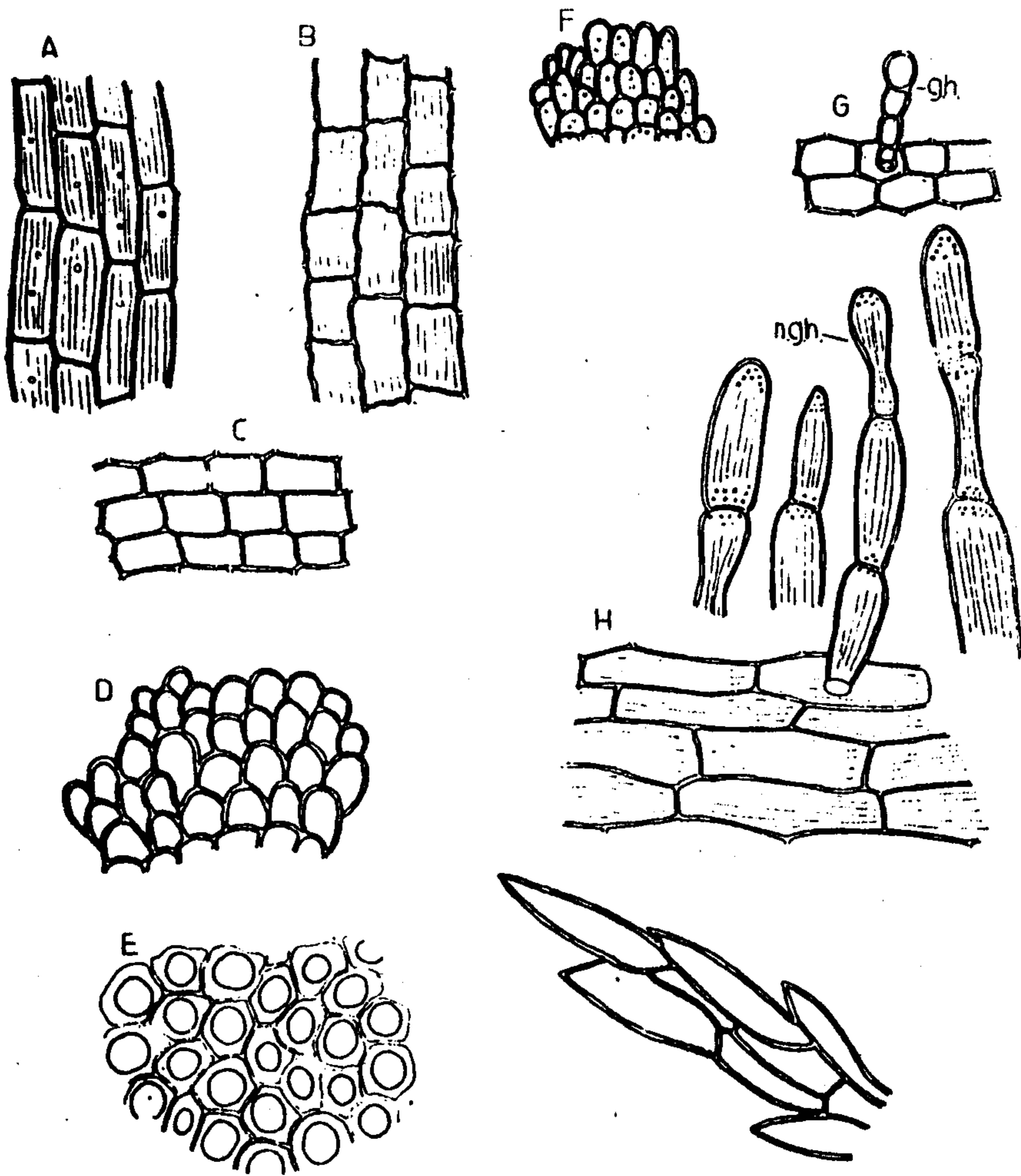


Fig. 9: The Flower head

- A. Epidermis from the apical and middle region over the vein of the ray-floret corolla.
- B. Epidermis from the apical and middle regions of the ray floret corolla.
- C. Inner epidermis from the middle and lower regions of the ray floret corolla.
- D. Inner epidermis from the apical region of the lobe of the ray floret corolla.
- E. Papillosed epidermal cells of the ray floret corolla.
- F. Inner epidermis from the apical region of the disc floret corolla.
- G. Epidermis of the basal region of the disc floret corolla.
- H. Outer epidermis of the disc floret corolla.
- I. Surface of pappus.

All X 135.

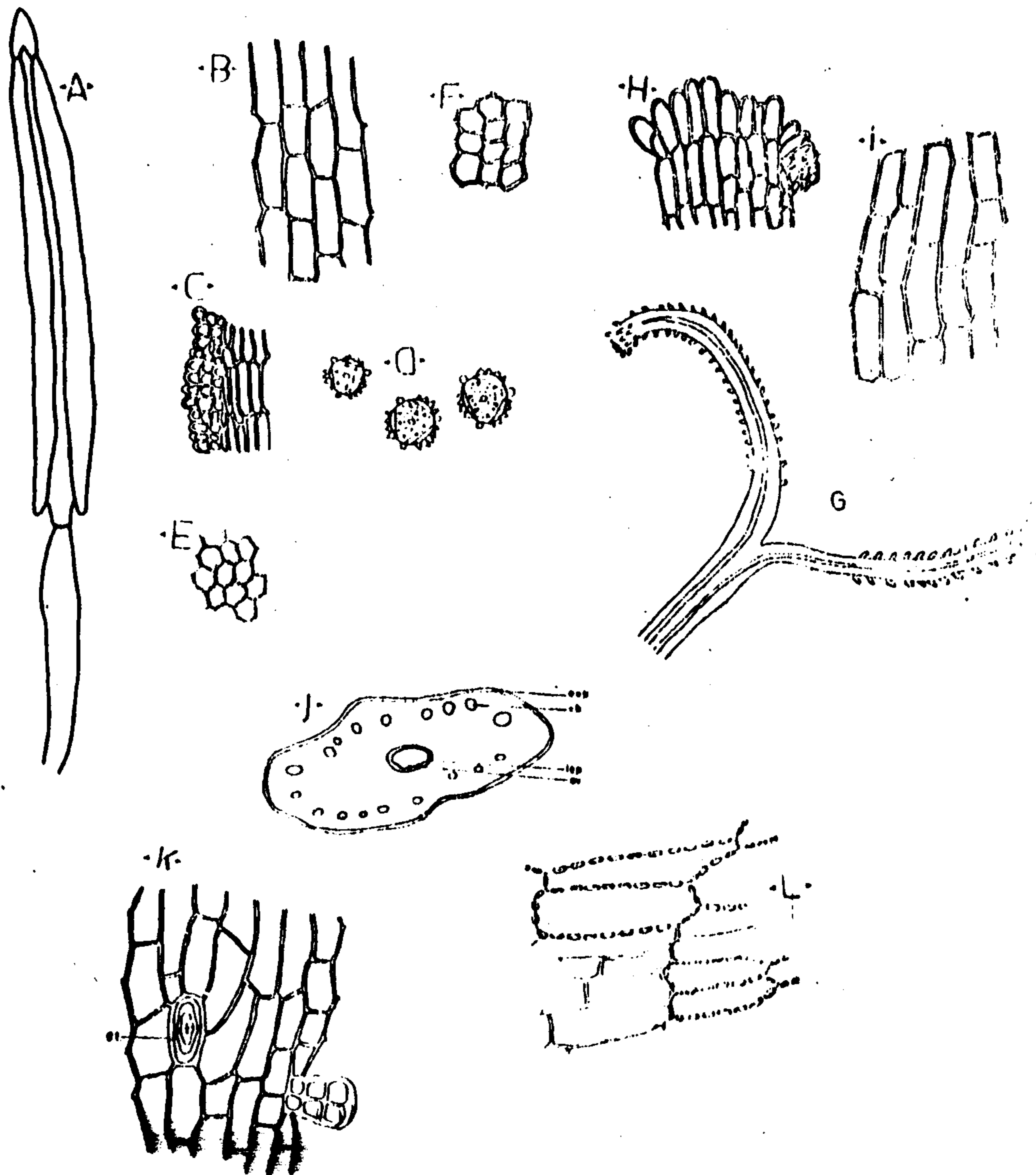


Fig. 10: The Flower-head

- A. The stamen
- B. Surface preparation in the free part of the filament
- C. Surface preparation in the anther lobe
- D. Pollen grains
- E. Surface preparation of the fibrous layer of the anther
- F. Surface preparation of the connective
- G. The stigma
- H. Surface preparation of the apical part of the stigma
- I. Surface preparation of the style
- J. Diagrammatic T.S. in the ovary
- K. Surface preparation in the outer epidermis of the ovary
- L. Sclereids from the base of the ovary

X 8

All X 95

i.ep., inner epidermis; o.ep., outer epidermis; ov., ovule;
v.b., vascular bundle.

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الصفات العيانية والمجهرية لأوراق وسيقان
ونورات تاجيتيس اريكتا لينيه الذى ينمو فى مصر
احمد عبدالرحمن على - نصر احمد العمري - عمر محمود الطويسى
قسم العقاقير - كلية الصيدلة جامعة اسيوط

تم فى هذا البحث دراسة الصفات العيانية والمجهرية
لسيقان وأوراق ونورات النبات بهدف التعرف عليها
سواء كاملة أو على هيئة مسحوق.

recieved in 14/10/1982 & accepted in 20/2/1983