

COMPARATIVE MACRO- AND MICROMORPHOLOGY OF *HIBISCUS CANNABINUS* L. AND *H. ROSA-SINENSIS* L. PART II: THE FLOWER

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تناول هذا البحث مقارنة للصفات العيانية والمجهريّة لزهور نباتيّ التيل ووردة الصين .. اللذان ينموان في مصر .. والتي أدت إلى إمكانية التعرف عليهما سواء كانت أي منهما كاملة أو على هيئة مسحوق.

The macro- and micromorphological characters of the flowers of *Hibiscus cannabinus* L. and *H. rosa-sinensis* L. growing in Egypt are studied for the sake of their identification in both entire and powdered forms.

INTRODUCTION

In previous publications,¹⁻³ chemical study of *Hibiscus cannabinus* L. and *H. rosa-sinensis* L., as well as the comparative macro- and micromorphological characters of their roots, stems and leaves⁴ are given.

The oral administration of benzene extract of the flowers of *Hibiscus rosa-sinensis* L. was found to have significant anti-implantation and abortifacient activities while no effect on pregnancy was noticed.⁵⁻⁸ The flowers of different *Hibiscus* species showed high carotenoid content (pro-vitamin A).⁹ Awang DV (1994)¹⁰ isolated and identified phospholipids from *H. cannabinus* L. which may be used as lipotropic agent in the treatment of fatty liver.

Reviewing the current literature, nothing was found concerning the macro- and micromorphology of the flowers of both plants. So, it was found of interest to carry out such study.

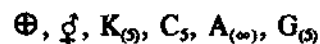
MATERIAL

Fresh samples of flowering plants of *H. cannabinus* L. were collected from plants growing around cotton field at Mansoura in May to July while those of *H. rosa-sinensis* L. were

collected from flowering plants (one year old) cultivated in the Experimental Station, Faculty of Agriculture, Mansoura Univ. Both plants were identified by Dr. N. El-Hadidy (Prof. of Taxonomy, Faculty of Science, Cairo Univ.)

MACROMORPHOLOGY

The flowers (Fig. 1, A & B) of both plants are solitary, terminal or in the axils of the upper leaves. They are pedicillate, hermaphrodite, actinomorphic and having an outer whorl of bracts called epicalyx. The floral formula is represented by:



The main macro- and micromorphological characters of the flowers of *Hibiscus cannabinus* L. and *H. rosa-sinensis* L. are presented in tables 1 and 2 respectively.

Powdered flower

A- *H. cannabinus* L. (Fig. 3-10) is yellowish-brown in colour, odourless and with mucilaginous taste. It is characterised by:

1. Fragments of the epidermal cells from different parts.
2. Fragments of the papillose stigma.
3. Numerous large spiny pollen grains.

4. Fragments of the fibrous layer of the anther showing polygonal cells with lignified beaded anticlinal walls.
5. Numerous glandular and non glandular trichomes.
6. Fragments of lignified fibres from the pedicel as well as spiral vessels.
7. Numerous cluster crystals of calcium oxalate.

b- *H. rosa-sinensis* L. powder is reddish-brown in colour, odourless and with mucilaginous taste. Its microscopical characters are similar to that of *H. cannabinus* L. except:

1. Cluster crystals of calcium oxalate are not observed in the epidermal cells of different parts.
2. Fragments of stigma shows no glandular trichomes.
3. Non glandular stellate hairs of 4-8 unicellular components, similar to those of the stem and leaf,³ are the main type of non glandular trichomes.

Table 1: Macromorphological characters of the flowers of *Hibiscus cannabinus* L. and *H. rosa-sinensis* L.

Organ	Species	
	<i>Hibiscus cannabinus</i> L.	<i>Hibiscus rosa-sinensis</i> L.
Pedicle	(Fig. 2Ab) erect, cylindrical, solid, pubescent with occasional spines. Yellowish-green, L. 0.02-0.4 cm, D. 0.1-0.2 cm.	(Fig. 2Bb) the same but longer, L. 8.0-9.0 cm.
Epicalyx	(Fig. 2Ac) 5-8 linear bracteoles, L. 1.5-2.0 cm, W. 2.0-4.0 mm.	(Fig. 2Bc) the same but somewhat shorter L. 1.3-1.85 cm, W. 2.0-4.0 mm.
Calyx	(Fig. 2Ad) persistent, five united sepals; lanceolate, with acute apices, entire margins and symmetric base, showing prominent big veins, spiny outer surface, smooth inner one, green in colour; L. 2.5-3.0 cm, W. 1.5-2.0 cm.	(Fig. 2Bd) the same but the big veins are less prominent, less spiny outer surface, measuring L. 2.5-3.0 cm, W. 1.5-2.2 cm.
Corolla	(Fig. 2Ae) five free, thin, convoluted petals, Yellow with crimson basal part; spatulate, with obtuse apex L. 7.0-8.0 cm, W. 2.5-3.0 cm.	(Fig. 2Be) the same but red in colour, L. 8.0-9.0 cm, W. 3.0-4.0 cm.
Androecium	(Fig. 2Ab) the lower parts of the filaments are united forming the staminal tube L. 4.5-5.0 cm, while the upper parts of the filaments are free; small, yellow, one-lobed anthers.	(Fig. 2Bb) the same but staminal tube is longer, L. 10.0-11.0 cm, filaments are longer, stamens are condensed upon the upper third of the staminal tube.
Gynaecium	(Fig. 2Ab) superior ovary, 5 united carpels with 5 locules, 3-5 ovules on axile placenta. Hairy ovary, L. 0.8-1.0 cm, W. 0.5-0.7 cm; long style; 5 dark red stigmas. The style and stigma, L. 4.0-4.5 cm, D. 2-3 mm.	(Fig. 2Bb) the same but style is longer and the ovules are only two.

Table 2: Micromorphological characters of the flowers of *Hibiscus cannabinus* L. and *H. rosa-sinensis* L.

Organ	Species	
	<i>Hibiscus cannabinus</i> L.	<i>Hibiscus rosa-sinensis</i> L.
Pedicle	<p>(Fig. 3A) T.S is nearly circular in outline.</p> <p><u>Epidermis:</u> (Fig. 3B) polygonal tabular, slightly thick, straight anticlinal walls, L. 25-36-45 μ, W. 18-27-35 μ, H. 12-18-23 μ, covered with striated cuticle; some cells contain cluster crystals of calcium oxalate (D. 12-19-29 μ). Stomata, covering and glandular trichomes are similar to those of the stem.³</p> <p><u>Cortex:</u> Collenchyma of 6-8 rows (D. 24-32-42 μ), followed by parenchyma of 7-9 rows (D. 50-63-75 μ) containing cluster crystals of calcium oxalate (D. 12-19-30 μ).</p> <p><u>Stele and Pith:</u> are similar to those of the stem but the xylem vessels are narrower (D. 10-12-16 μ) and pith parenchymatous cells are smaller (D. 38-55-75 μ). No starch granules are observed.</p>	<p>The same but covering trichomes are stellate of 4-8 unicellular components, similar to those of the leaf and stem,³ and no cluster crystals of calcium oxalate.</p> <p>The same but large cells containing mucilage, similar to those of the stem,³ are present (D. 100-118-130 μ) in the parenchymatous region.</p> <p>The same</p>
Epicalyx	<p>(Fig. 4A) T.S. is biconvex in outline.</p> <p><u>Upper epidermis:</u> (Fig. 5A-C) polygonal, isodiametric, tabular, straight anticlinal walls; L. 45-58-70 μ, W. 15-21-28 μ and H. 10-13-17 μ, covered with striated cuticle, some cells contain cluster crystals of calcium oxalate (D. 15-18-22 μ).</p> <p>Glandular hairs are similar to those of the leaf and stem.³</p> <p>Non glandular trichomes: vary in shape and size, some of them are conical, unicellular, thick-walled with acute apices; L. 460-495-535 μ, W. 75-95-110 μ; others are stellate of 2-6 unicellular hairs, thin-walled with acute apices, L. 310-350-385 μ and W. 20-25-31 μ.</p>	<ul style="list-style-type: none"> - Both epidermises have beaded anticlinal walls. - No cluster crystals of calcium oxalate in the epidermal cells. - Upper epidermis shows unicellular conical, non glandular trichomes.

Table 2: Continued

Organ	Species	
	<i>Hibiscus cannabinus</i> L.	<i>Hibiscus rosa-sinensis</i> L.
	<p>Lower epidermis: (Fig. 5D, E). Similar to the upper epidermis but the anticlinal walls are beaded, L. 32-38-45 μ, W. 13-20-25 μ and H. 11-15-17 μ.</p> <p>Cortex: (Fig. 4B) 2-4 layers of collenchyma (D. 17-20-25 μ), 2-3 layers of parenchyma (D. 22-32-45 μ); cluster crystals of calcium oxalate are scattered in the cortex.</p> <p>Vascular tissue: (Fig. 4B) Small collateral vascular bundles (7-12) arranged alongside the central aerenchymatous region; phloem, soft shining tissue; xylem, small spiral vessels.</p> <p>Central aerenchyma: (Fig. 4B) network structure, uniseriate, elongated thin parenchyma enclosing air cavities; some cells contain cluster crystals of calcium oxalate (D. 15-20-24 μ).</p>	<p>Lower epidermis shows stellate hairs of 4-6 components.</p> <p>The same.</p> <p>Vascular bundles are 2 to 5 in number.</p> <p>No aerenchyma but large cells containing mucilage (red with ruthenium red), similar to those of the pedicel and stem³ are present.</p>
Calyx	<p>(Fig. 6A) T.S. in the sepals shows three neural parts connected together with thin interneural regions.</p> <p>Upper epidermis: (Fig. 7A, B) Polygonal, tabular, axially elongated with beaded anticlinal walls; L. 20-32-41 μ, W. 15-20-27 μ and H. 10-13-15 μ; covered with smooth cuticle.</p> <p>Stomata: Only in the basal part, anisocytic, oval, L. 25-27-30 μ and W. 15-18-20 μ.</p> <p>Glandular trichomes: 2 type, some are similar to those of the leaf and stem,³ others with unicellular stalk, multicellular (16-18 cells), biseriate elongated head, L. 185-195-205 μ and W. 47-50-55 μ.</p> <p>Non glandular trichomes are either single or stellate of 2-4 unicellular trichomes, thin walled, wide lumen, acute apices, L. 235-265-305 μ and W. 40-42-45 μ.</p>	<p>Upper, epidermal cells have beaded, anticlinal walls; covered with smooth cuticle except the neural part which is covered with striated cuticle. They measure L. 28-33-40, W. 20-23-26 μ and H. 10-12-15 μ.</p> <p>No stomata are observed.</p> <p>The glandular trichomes are biseriate, multicellular (8-12 cells) head and unicellular stalk, L. 110-120-130 μ and W. 37-40-42 μ.</p> <p>Non glandular trichomes are single or stellate (2-6 components) of unicellular type conical with acute apices and thick cellulosic walls, L. 260-305-340 μ and W. 13-16-20 μ.</p>

Table 2: Continued

Organ	Species	
	<i>Hibiscus cannabinus</i> L.	<i>Hibiscus rosa-sinensis</i> L.
	<p>Lower epidermis: (Fig. 7C-F), tabular, beaded anticlinal walls, L. 33-50-65 μ, W. 12-17-21 μ and H. 12-15-18 μ, covered with striated cuticle except in the neural part which shows smooth cuticle, some cells contain cluster crystals of calcium oxalate.</p> <p>The anisocytic stomata and glandular trichomes, are similar to those of the upper epidermis. Non glandular trichomes are either large conical or octopus-stellate hairs of 4-7 unicellular units.</p> <p>Cortical tissue: (Fig. 6B) 2-3, 3-5 layers of collenchyma abutting the lower and upper epidermis respectively (D. 12-18-23 μ), followed by few layers of polygonal isodiametric parenchymatous cells (D. 31-35-40 μ), shows large mucilagenous cells (ruthenium red) D. 63-70-76 μ and cluster crystals of calcium oxalate.</p> <p>Vascular tissue (Fig. 6A, B) numerous vascular bundles, show xylem towards the upper epidermis and phloem towards the lower one.</p>	<p>Lower epidermis have beaded anticlinal walls; carries stellate hairs of 4-8 unicellular components; glandular trichomes are similar to those of the stem; leaf and epicalyx.</p> <p>Stomata are anisocytic, L. 40-43-45 μ and W. 23-25-27 μ.</p> <p>Cortical tissue is parenchymatous in nature and shows cluster crystals of calcium oxalate.</p> <p>Vascular bundles are similar to those of <i>H. cannabinus</i></p>
Corolla	<p>Upper surface of the petals:</p> <p>Apical and basal parts: (Fig. 8A), polygonal, isodiametric, straight anticlinal walls; stomata and trichomes are absent. They measure L. 45-56-70 μ, W. 36-42-50 μ.</p> <p>Middle part: (Fig. 8B) The cells measure L. 50-68-82 μ and W. 38-45-53 μ. Numerous glandular trichomes, unicellular stalk, triseriate, multicellular (15-18 cells) clup-shaped head, L. 132-138-145 μ and W. 54-59-65 μ.</p> <p>Lower surface of the petals:</p> <p>Apical and middle parts: (Fig. 8D) polygonal isodiametric, covered with smooth cuticle; L. 38-49-62 μ and W. 24-27-30 μ, no Stomata.</p>	<p>All parts of the upper surface shows no variation in shape and size. The cells are polygonal, isodiametric, L. 75-90-100 μ and W. 22-25-28 μ. Stomata are absent.</p> <p>The same but the cells are somewhat larger, L. 42-53-70 μ and W. 30-34-40 μ. Stomata of anisocytic type are present, L. 38-40-42 μ and W. 30-34-40 μ.</p>

Table 2: Continued

Organ	Species	
	<i>Hibiscus cannabinus</i> L.	<i>Hibiscus rosa-sinensis</i> L.
	<p>Glandular trichomes: unicellular stalk, biseriate multicellular (12-20- cells) elongated head, L. 130-140-150 μ and W. 30-34-38 μ.</p> <p>Covering trichomes: single or stellate of 2-4 unicellular hairs; slightly thick walls, wide lumen, acute apices; L. 340-380-440 μ and W. 20-24-28 μ.</p> <p>Basal part: (Fig. 8C) The cells are larger, L. 91-110-414 μ and W. 37-42-52 μ, only glandular trichomes are present.</p> <p>Androecium: Staminal tube.</p> <p>Epidermis: (Fig. 9A) polygonal, axially elongated with straight anticlinal walls and covered with smooth cuticle, L. 87-94-103 μ and W. 18-25-38 μ, papillosed; few oval anisocytic stomata are present.</p> <p>Glandular trichomes: bicellular uniseriate stalk, multicellular (15-17 cells) triseriate clup-shaped head, L. 173-190-205 μ and W. 85-90-95 μ.</p> <p>Filament epidermis: (Fig. 9B) similar to the staminal tube epidermis but stomata are absent.</p> <p>Anther:</p> <p>Epidermis: (Fig. 9D) polygonal, axillay elongated with straight anticlinal walls and smooth cuticle, L. 35-42-50 μ and W. 10-15-21 μ.</p> <p>Fibrous layer: (Fig. 9C) polygonal, axially elongated with lignified, bar-like thickening having straight beaded anticlinal walls, L. 13-18-23 and W. 8-13-17 μ.</p> <p>Pollen grains: (Fig. 9F) brownich-yellow, spherical, having 3 germinal pores, 3 germinal furrows and spiny exine, D. 112-120-132 μ.</p>	<p>Unicellular or stellate of 4-8 unicellular trichomes similar to those of the calyx and epicalyx.</p> <p>Resembles the apical and middle parts.</p> <p>The same but is devoid of papillae, stomata and glandular trichomes. The cells measure L. 90-100-115 μ and W. 23-30-35 μ.</p> <p>Similar to the staminal tube.</p> <p>The same</p> <p>The same</p> <p>The same shape but larger in size, D. 175-200-230 μ.</p>

Table 2: Continued

Organ	Species	
	<i>Hibiscus cannabinus</i> L.	<i>Hibiscus rosa-sinensis</i> L.
	<p>Gynaecium:</p> <p>a) Ovary: <u>Epidermis:</u> (Fig. 10B) formed of polygonal cells with straight anticlinal walls and smooth cuticle, L. 22-27-33 μ and W. 13-16-20 μ. Some cells contain cluster crystals of calcium oxalate. Stomata and trichomes resembling those of the calyx.</p> <p>b) Style: <u>Epidermal cells:</u> (Fig. 10E): polygonal, axially elongated with straight anticlinal walls and smooth cuticle, L. 78-108-143 μ and W. 32-45-52 μ. Stomata are anisocytic.</p> <p>c) Stigma: <u>Epidermal cells of the apical part:</u> (Fig. 10C): are polygonal, isodiametric with straight anticlinal walls and smooth cuticle, D. 20-29-40 μ, having dense long papillae, L. 285-305-320 μ, W. 10-14-18 μ. <u>Epidermal cells of lower part:</u> (Fig. 10D) are polygonal, axially elongated with straight anticlinal walls and smooth cuticle, L. 72-98-123 μ and W. 20-29-40 μ. Stomata are anisocytic. Glandular trichomes are similar to these of the staminal tube.</p>	<p>The same, but stomata, covering trichomes and cluster crystals of calcium oxalate are absent.</p> <p>The same.</p> <p>The same but glandular trichomes are absent.</p>

D. : Diameter

H. : Height

L. : Length

W. : Width

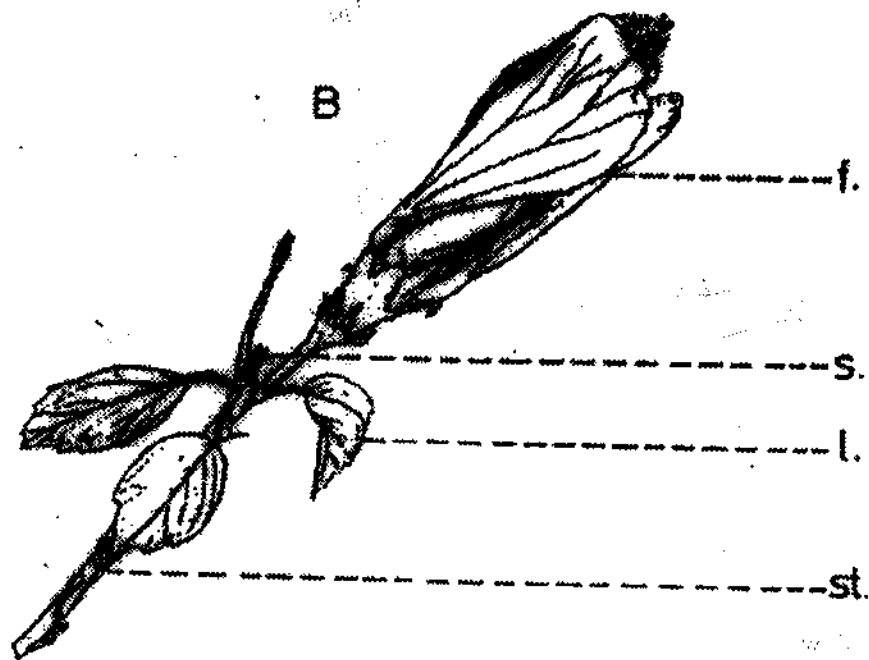


Fig. 1: Flowering branch

A- *Hibiscus cannabinus* L. (x 0.7)

B- *Hibiscus rosa-sinensis* L. (x 0.7)

f., flower; l. leaf; pet., petiole; s., stipule; st., stem.

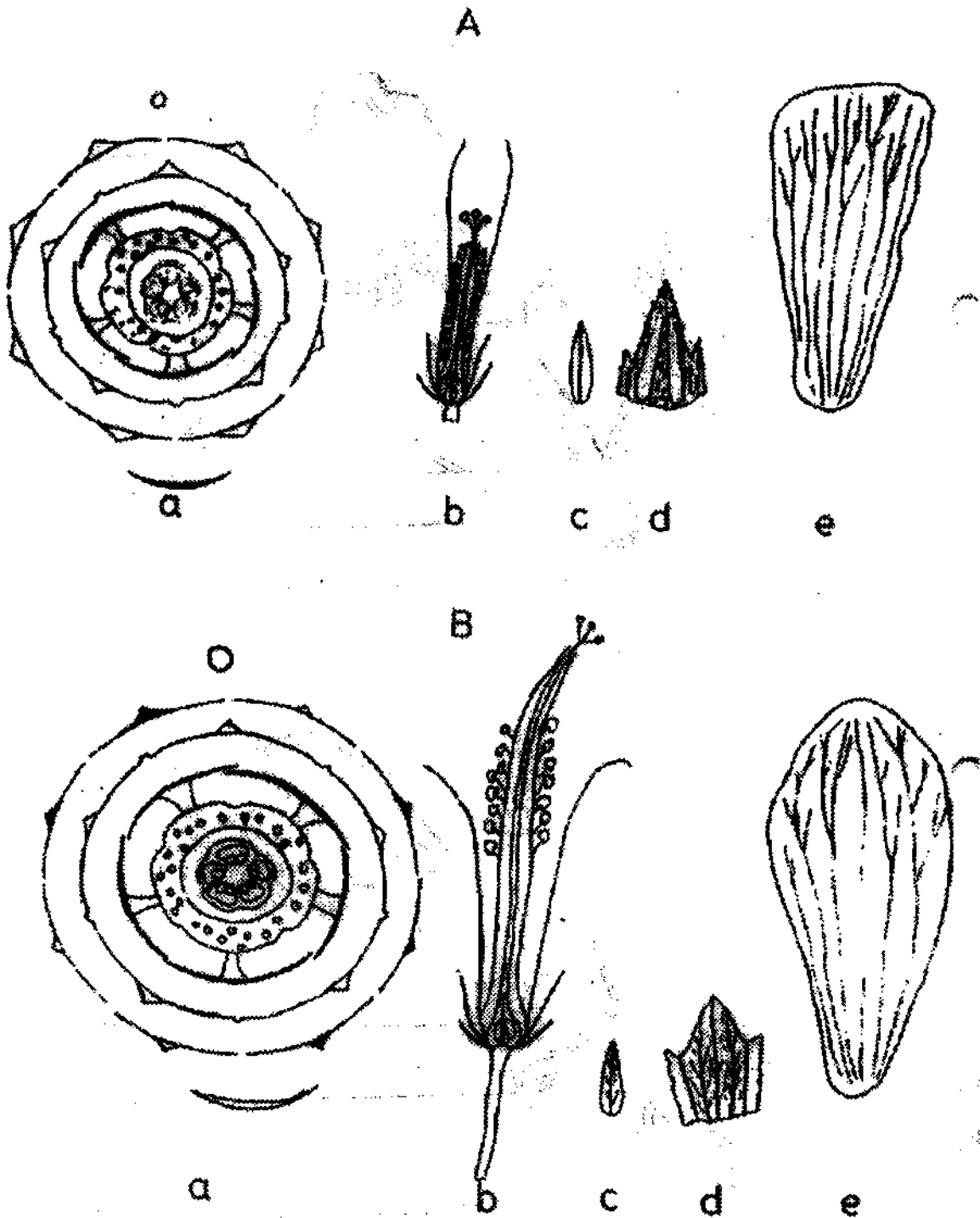


Fig. 2: The flower

A- *Hibiscus cannabinus* L.

B- *Hibiscus rosa-sinensis* L.

a- Floral diagram

b- L. cut in the flower

c- Epicalyx

d- Sepal

e- Petal

(x 0.7)

(x 0.7)

(x 0.7)

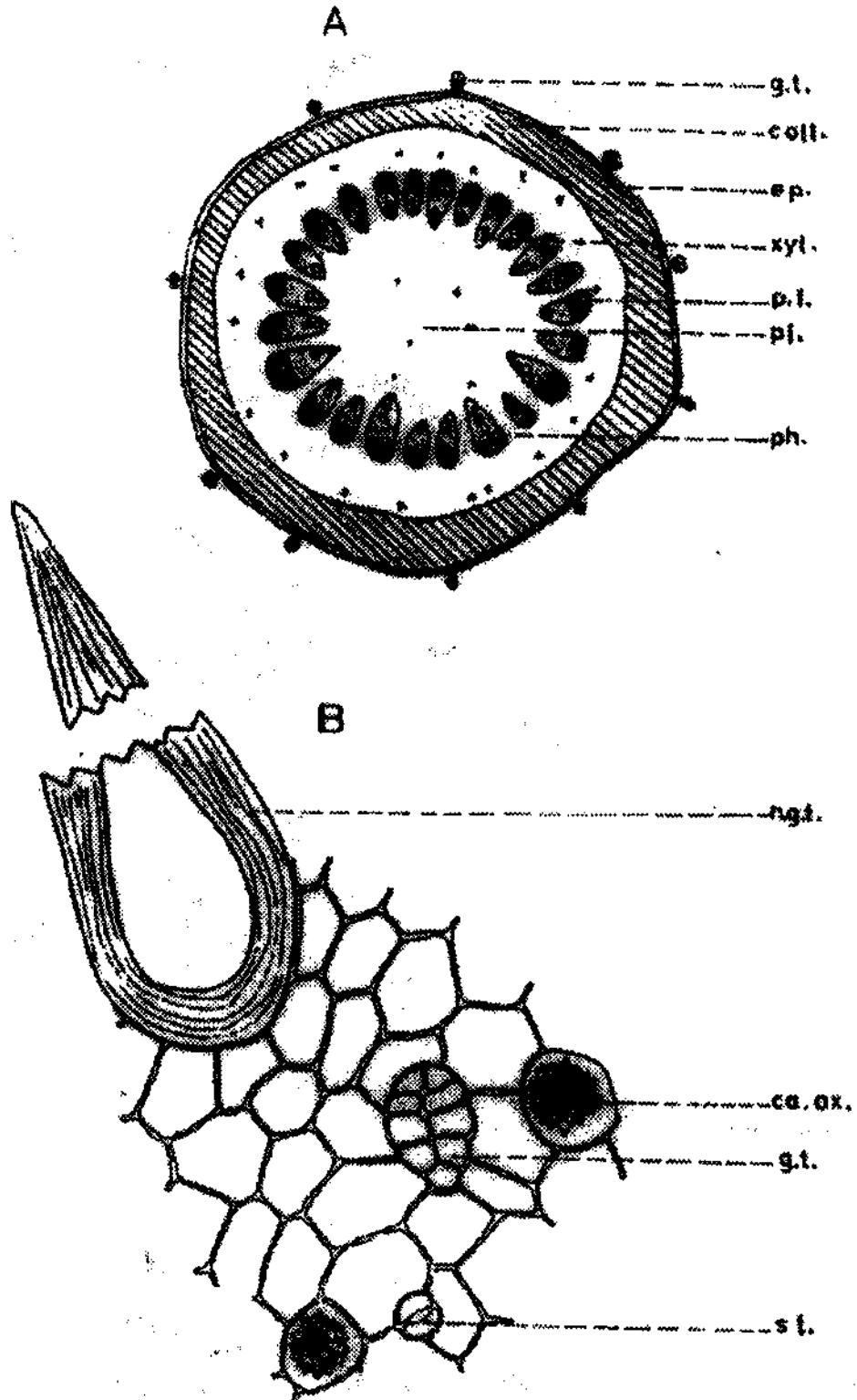


Fig. 3: The pedicel of the flower of *Hibiscus cannabinus* L.
 A- Diagrammatic transverse section (x 50)
 B- Surface preparation (x 250)
 ca.ox., calcium oxalate; coll., collenchyma; ep., epidermis; g.t., glandular trichomes;
 n.g.t., non glandular trichome; p.f., pericyclic fiber; ph., phloem; pi., pith; st., stomata;
 xyl., xylem.

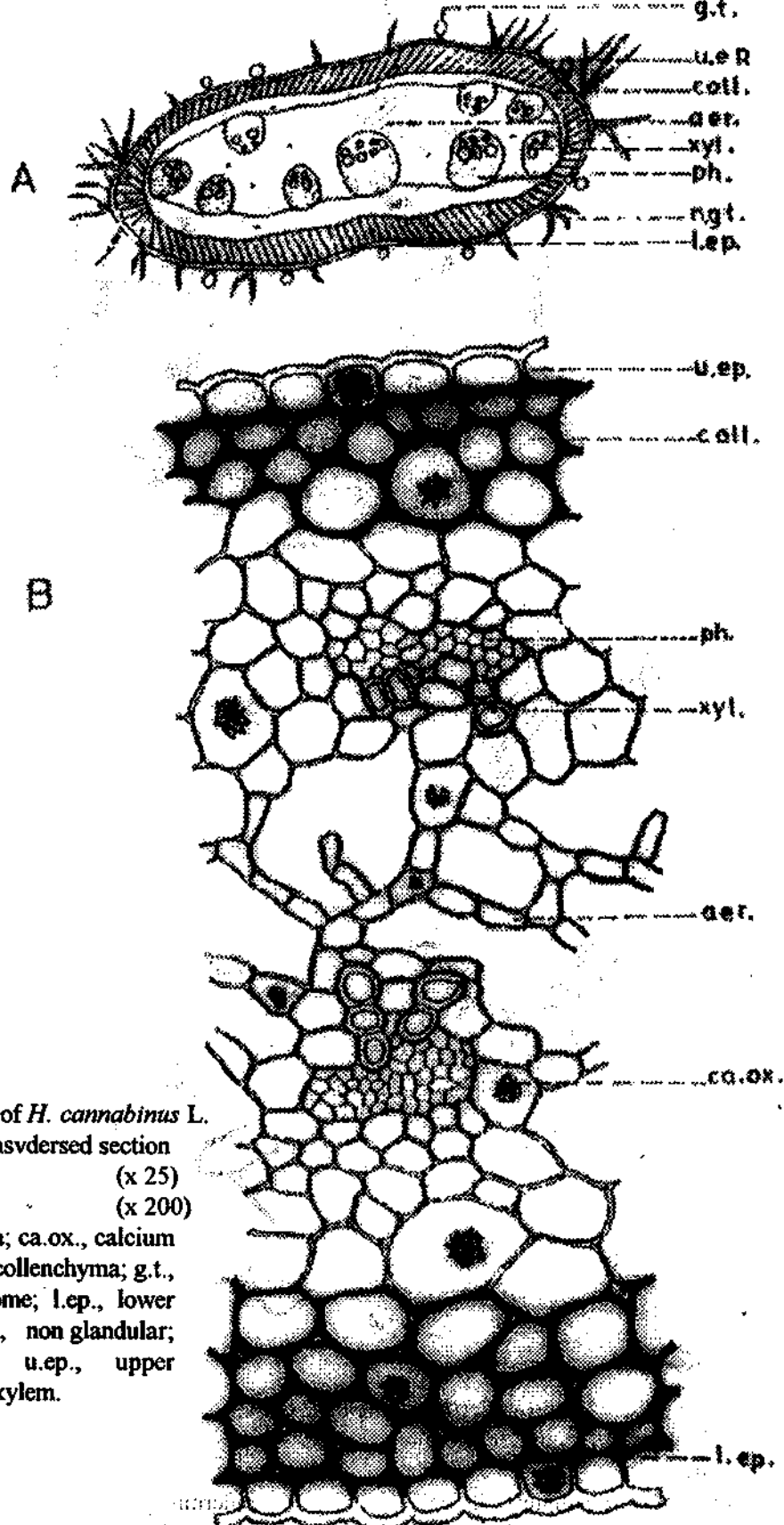


Fig. 4: The epicalyx of *H. cannabinus* L.

A- Diagrammatic transversed section (x 25)

B- Detailed sector (x 200)

aer., aerenchyma; ca.ox., calcium oxalate; coll., collenchyma; g.t., glandular trichome; l.ep., lower epidermis; n.g.t., non glandular; ph., phloem; u.ep., upper epidermis; xyl., xylem.

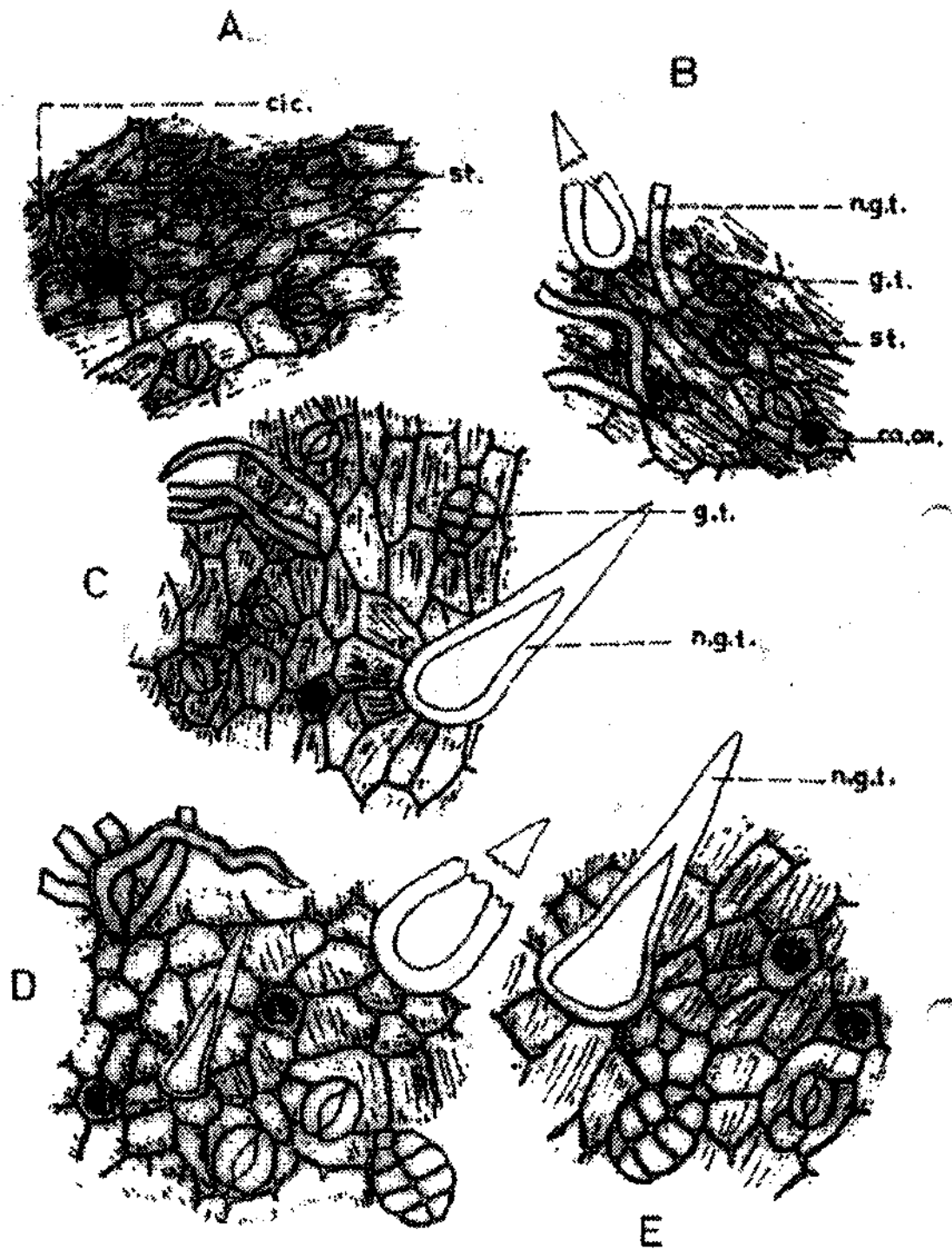


Fig. 5: The epicalyx of *H. cannabinus* L.

- A- Upper surface preparation in the apical region (x 140)
- B- Upper surface preparation in the basal region (x 140)
- C- Upper surface preparation in the middle region (x 190)
- D- Lower surface preparation in the basal region (x 400)
- E- Lower surface preparation in the apical and middle regions (x 400)

ca.ox., calcium oxalate; cic., cicatrix; g.t., glandular trichome; n.g.t., non glandular trichome; st., stomata.

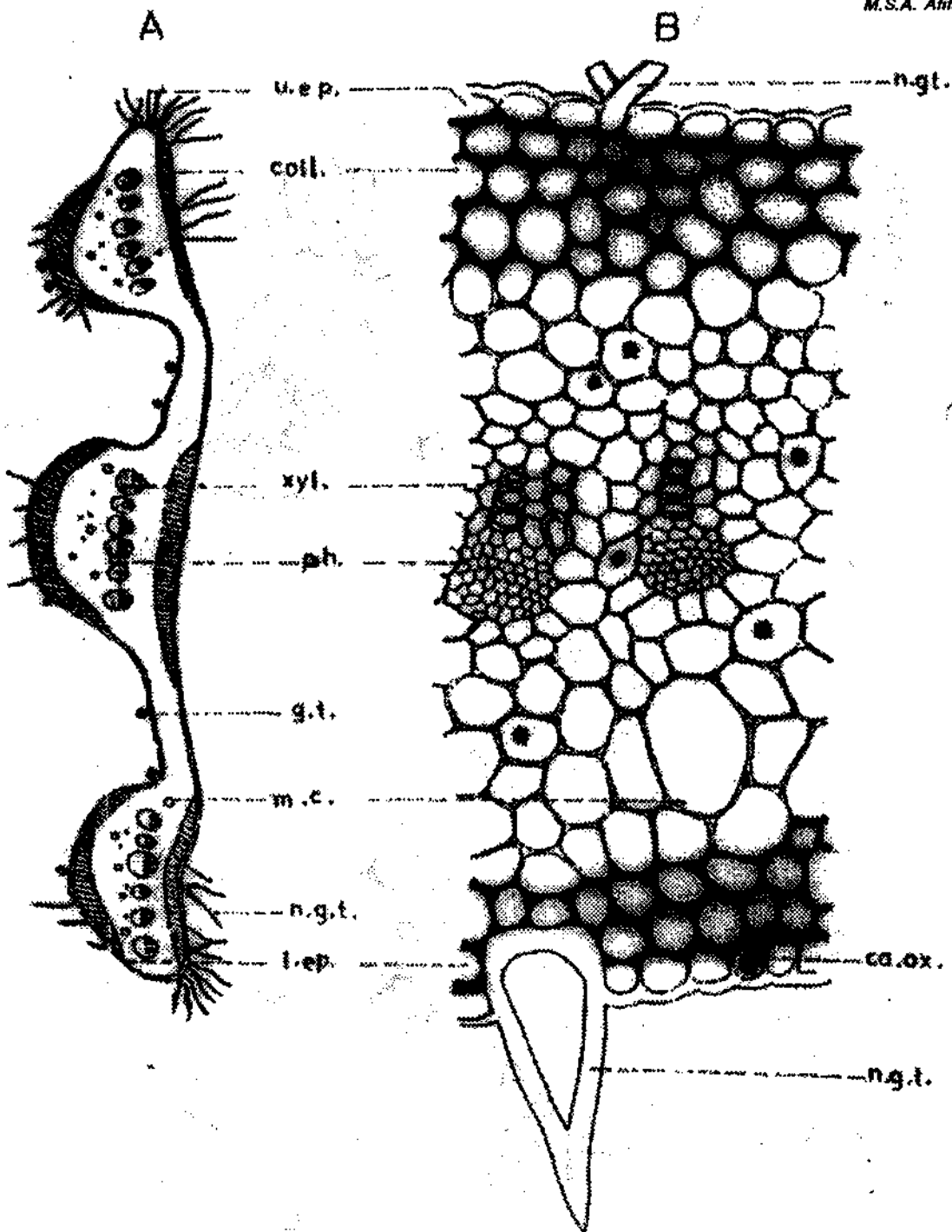


Fig. 6: The calyx of *H. cannabinus* L.

A- Diagrammatic transverse section (x 20)

B- Detailed sector (x 200)

ca.ox., calcium oxalate; coll., collenchyma; g.t., glandular trichome; l.ep., lower epidermis; m.c., mucilagenous cell; n.g.t., non glandular trichome; ph., phloem; u.ep., upper epidermis; xyl., xylem.

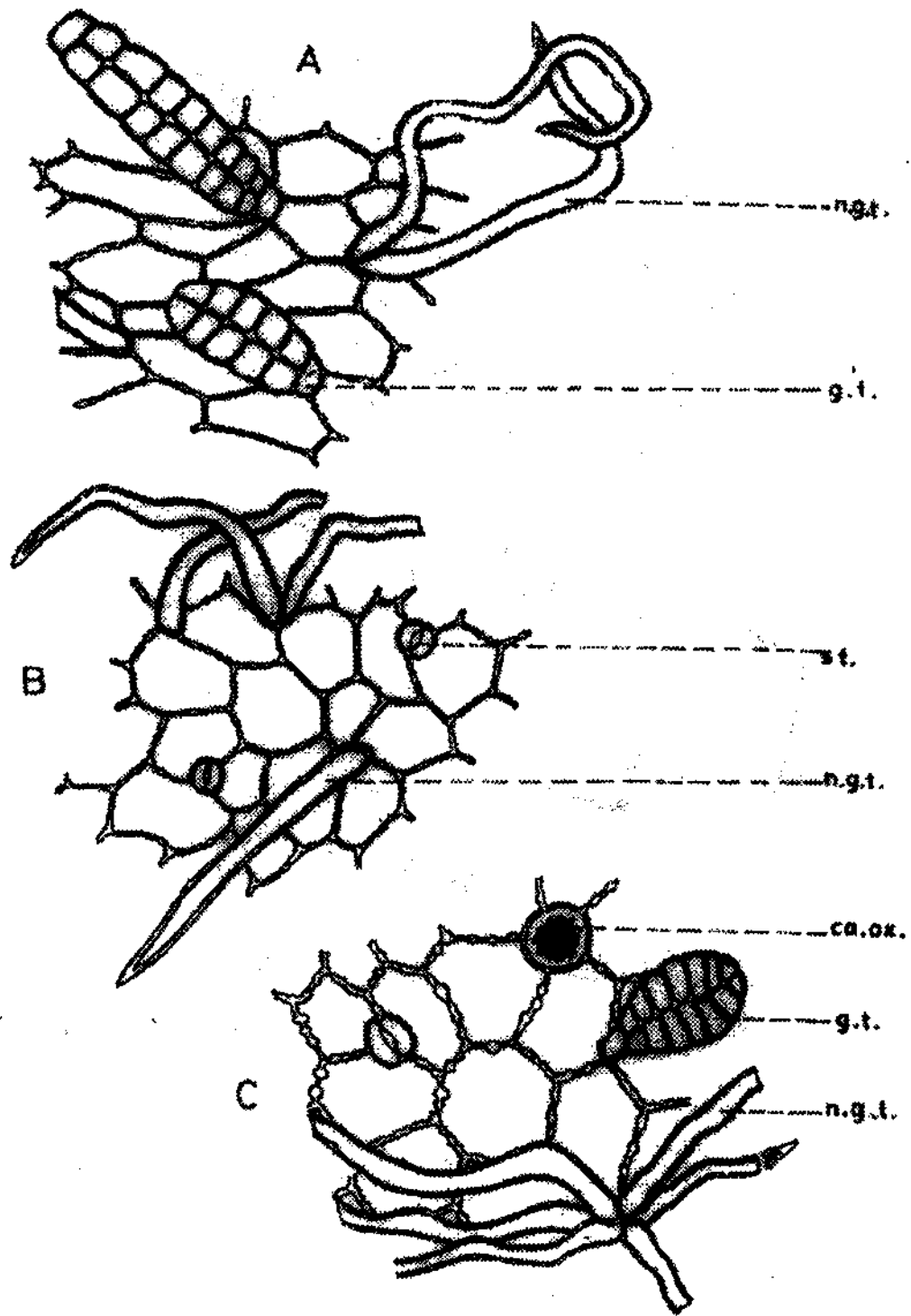


Fig. 7: The calyx of *H. cannabinus* L.
 A- Upper surface preparation in the apical and middle regions (x 400)
 B- Upper surface preparation in the basal region (x 400)
 C- Lower surface preparation in the interneural part (x 400)
 ca.ox., calcium oxalate; g.t., glandular trichome; n.g.t., non glandular trichome; st., stomata.

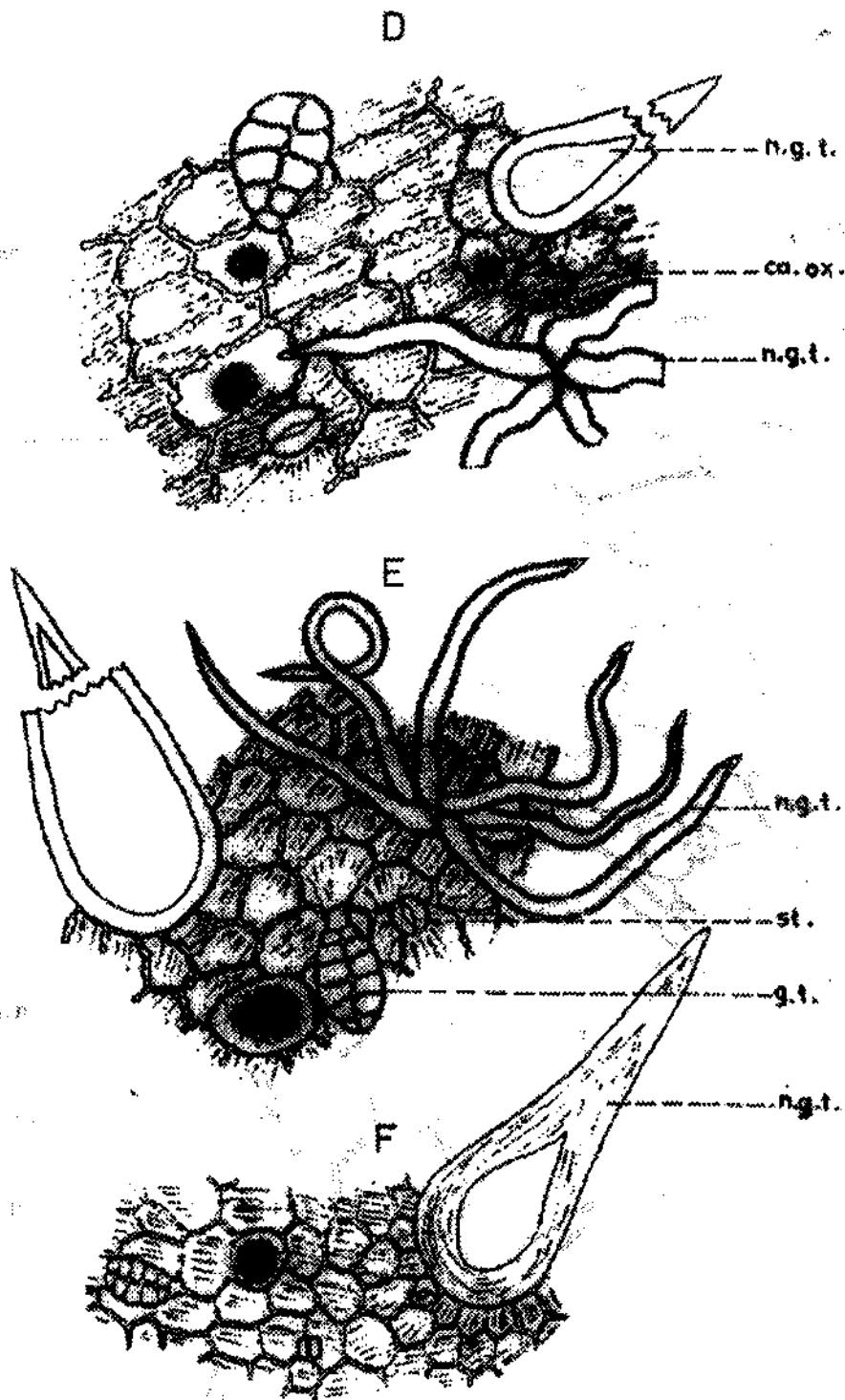


Fig. 7: Continued

D- Lower surface preparation in the middle part

E- Lower surface preparation in the basal part

F- Lower surface preparation in the apical part

ca.ox., calcium oxalate; g.t., glandular trichome; n.g.t., non glandular trichome; st., stomata.

(x 250)

(x 100)

(x 100)

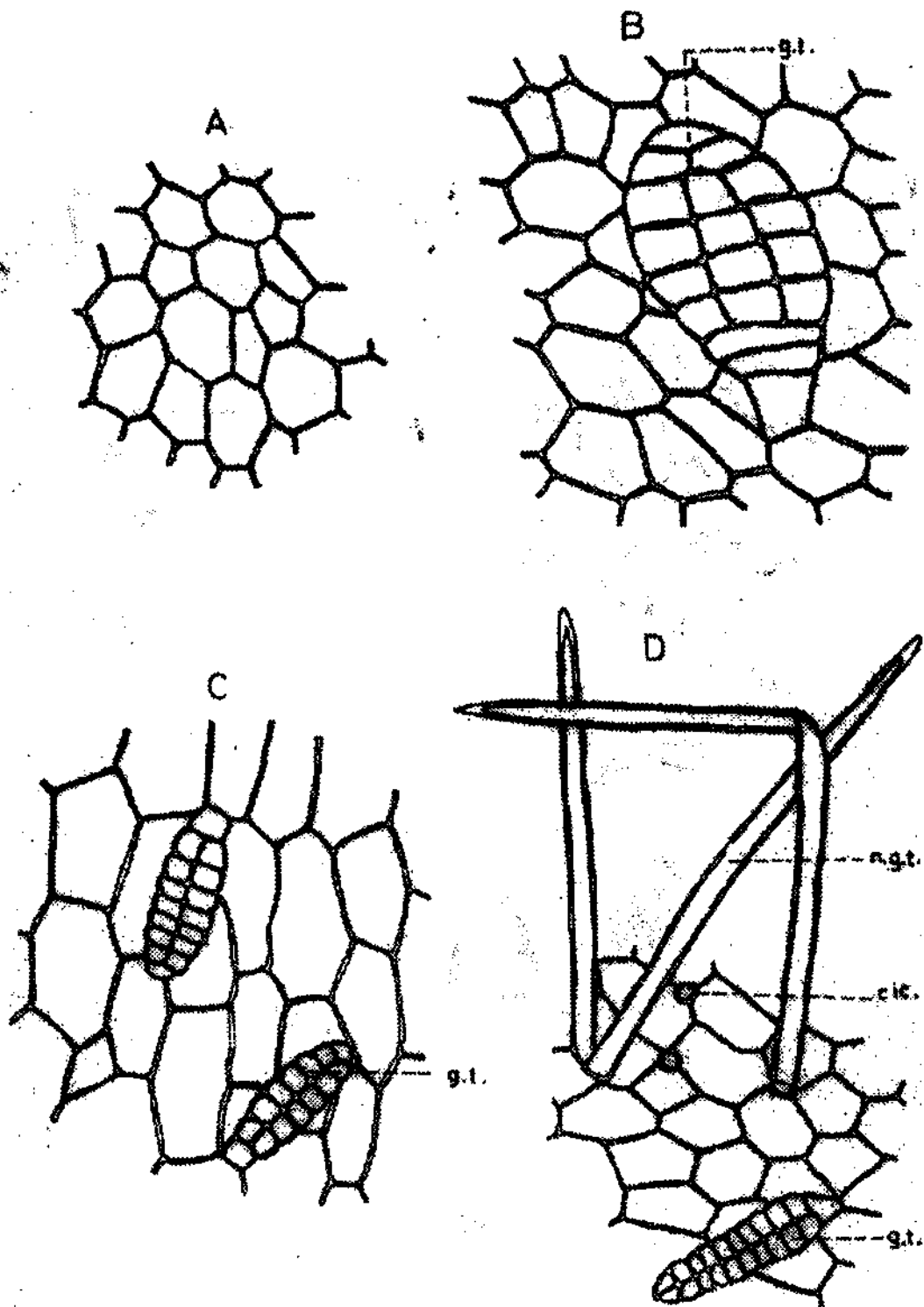


Fig. 8: The corolla of *H. cannabinus* L.

- A- Upper surface preparation in the apical and basal parts (x 400)
 B- Upper surface preparation in the middle part (x 400)
 C- Lower surface preparation in the basal part (x 250)
 D- Lower surface preparation in the apical and middle parts (x 400)
 cic., cicatrix; g.t., glandular trichome; n.g.t., non glandular trichome.

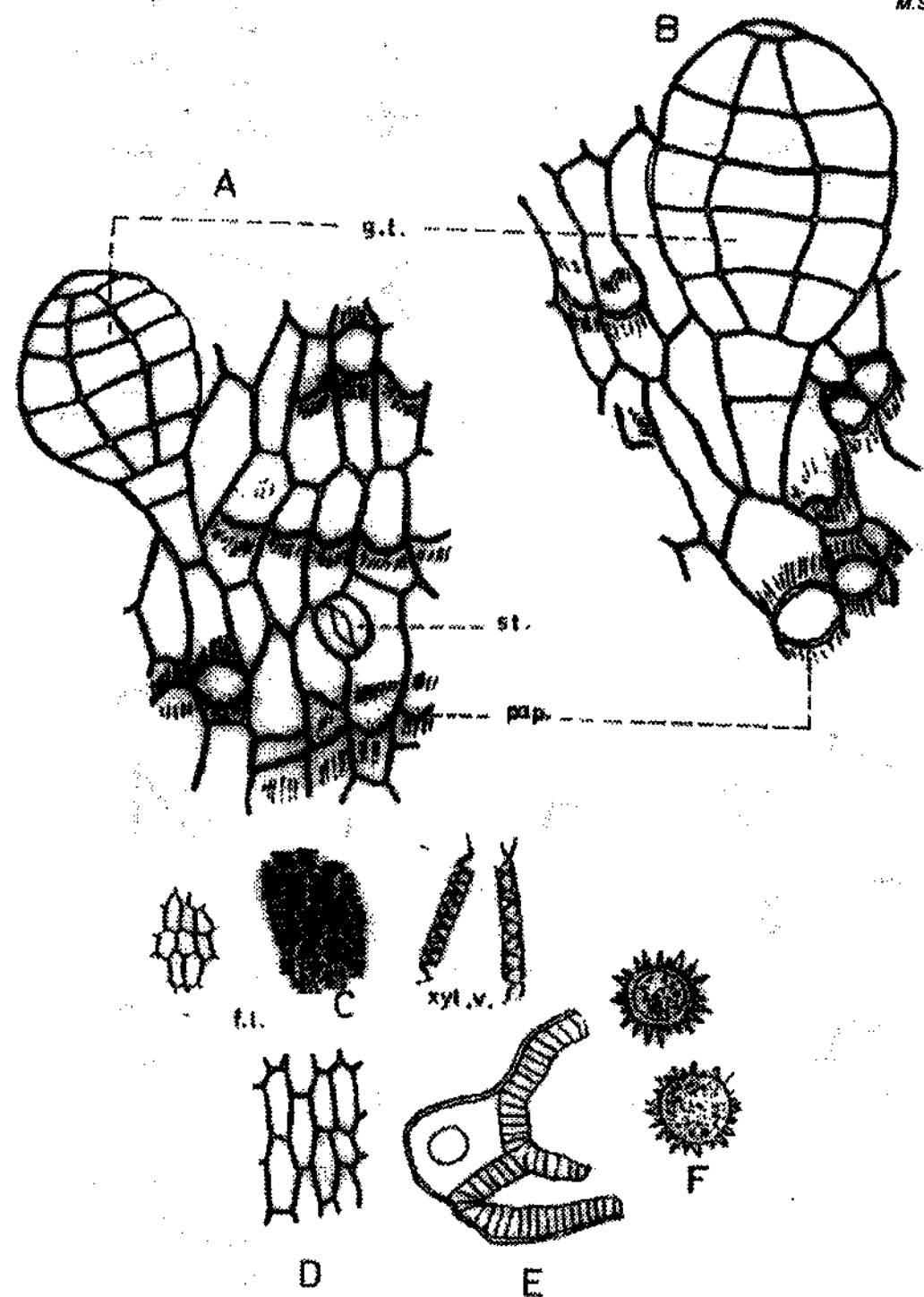


Fig. 9: The androecium of *H. cannabinus* L.

- A- Surface preparation in the staminal tube (x 250)
- B- Surface preparation in the filament (x 400)
- C- Isolated elements of the flower (x 250)
- D- Surface preparation in the anther lobe (x 250)
- E- Transverse cut in the anther lobe (x 25)
- F- Pollen grains (x 50)

f.l., fibrous layer; g.t., glandular trichome; pap., papillae; st., stomata; xyl.v., xylem vessel.

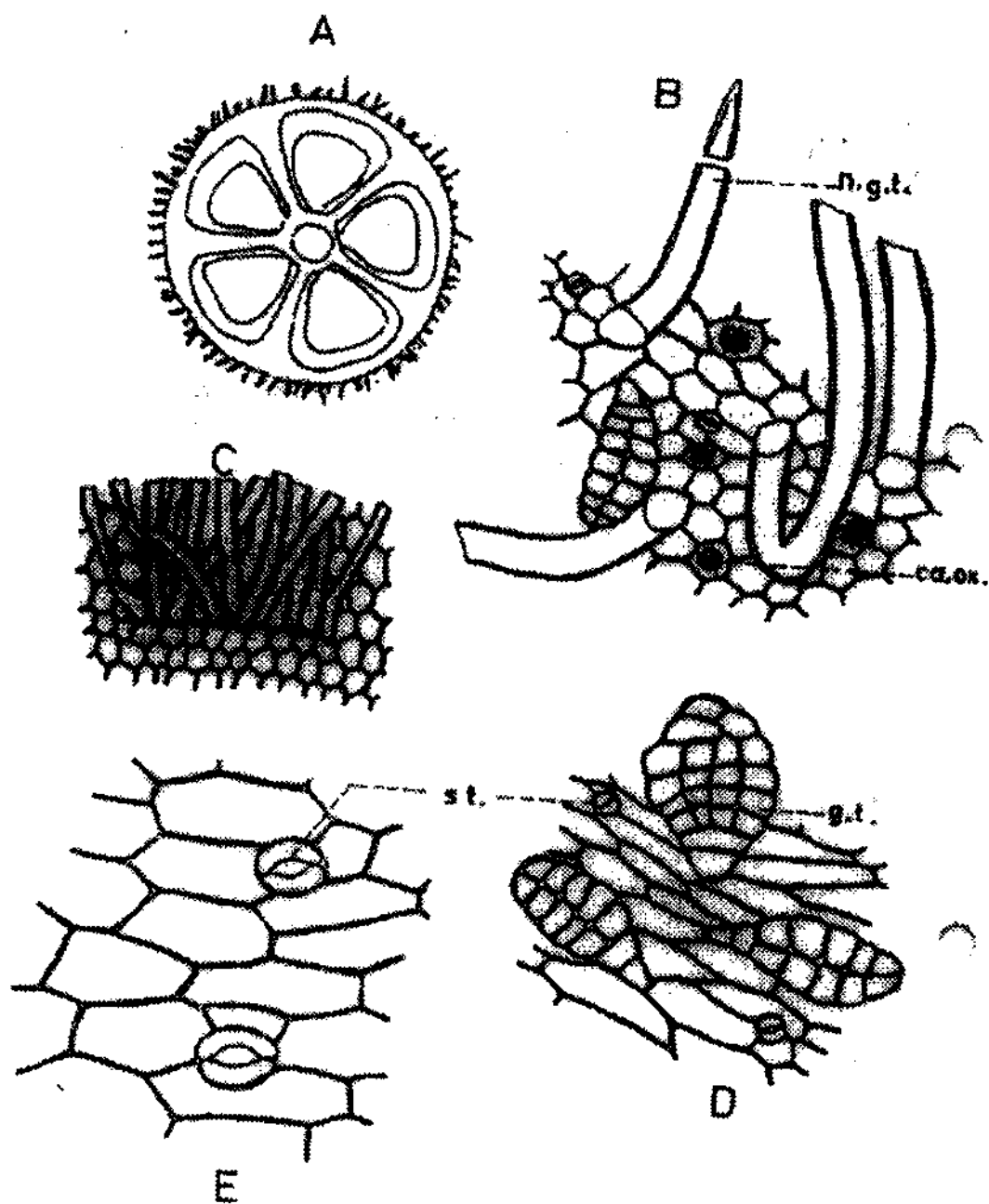


Fig. 10: The gynaeceum of *H. cannabinus* L.

- A- Transverse cut in the ovary (x 10)
- B- Surface preparation in the ovary (x 250)
- C- Papillosed stigma (apical part) (x 150)
- D- Surface preparation in the stigma (lower part) (x 250)
- E- Surface preparation in the style (x 200)

ca.ox., calcium oxalate; g.t., glandular trichome; n.g.t., non glandular trichome; st., stomata.

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