

MACRO- AND MICROMORPHOLOGY OF THE FLOWER-HEADS AND FRUITS OF CENTAUREA ERYNGIODES LAM.

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ABSTRACT

The macro- and micromorphology of the flower heads and fruits of Centaurea eryngioides Lam. (family Compositae, tribe Cynareae) are presented with the aim of finding out the characters of these organs by which the plant could be identified, characterised and differentiated both in the entire and powdered forms.

INTRODUCTION

Centaurea eryngioides Lam. is a perennial Egyptian plant growing wildly in Saint Catherine, Sinai⁽¹⁾.

In previous publications, we reported the isolation of four sesquiterpene lactones⁽²⁾, five flavonoids and five steroidal compounds⁽³⁾, as well as the macro- and micro-morphology of the leaves, stem and root of Centaurea eryngioides Lam.⁽⁴⁾ were presented.

In the present work, we are dealing with the macro- and micro-morphology of the flower heads and fruits of the plant.

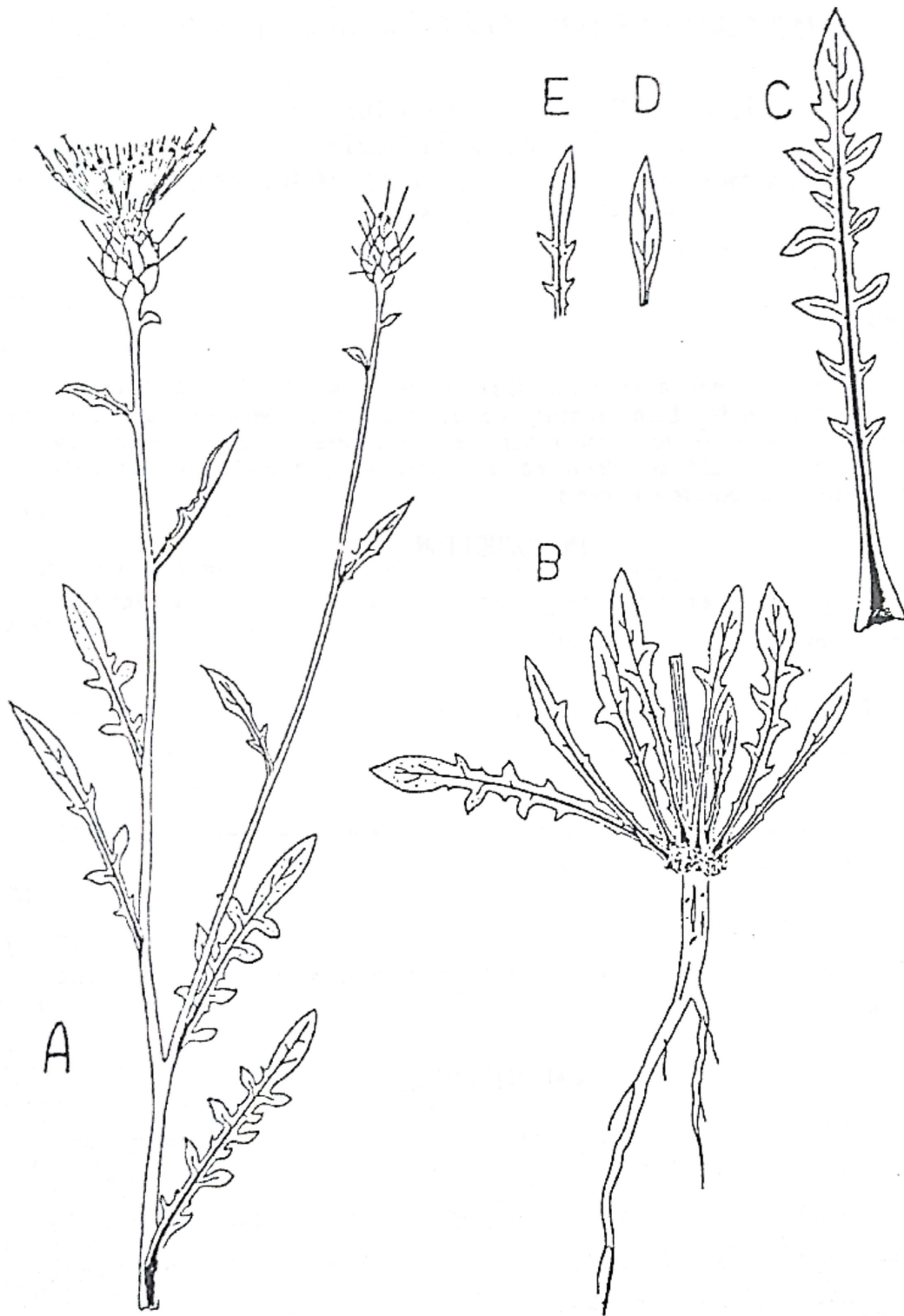
EXPERIMENTAL

Fresh samples of Centaurea eryngioides Lam. were used in this work and were collected from Saint Catherine in April 1986 and May 1987. Identification of the plant was kindly verified by Prof. Dr. N. El-Hadidi Prof. of Plant Taxonomy, Cairo University.

A- MACROMORPHOLOGY :

1. The flower-Heads :

The plant carries few terminal and axillary, hemispherical rose-coloured flower-heads (Fig. 1). Each capitulum



(Fig. 1) Sketch of *Centaurea eryngioides* lam. (All are X 0.5).
A- The stem and capitulum. B- The root and radical leaves.
C- Radical leaf, D- Upper cauline leaf. E- Lower cauline leaf.

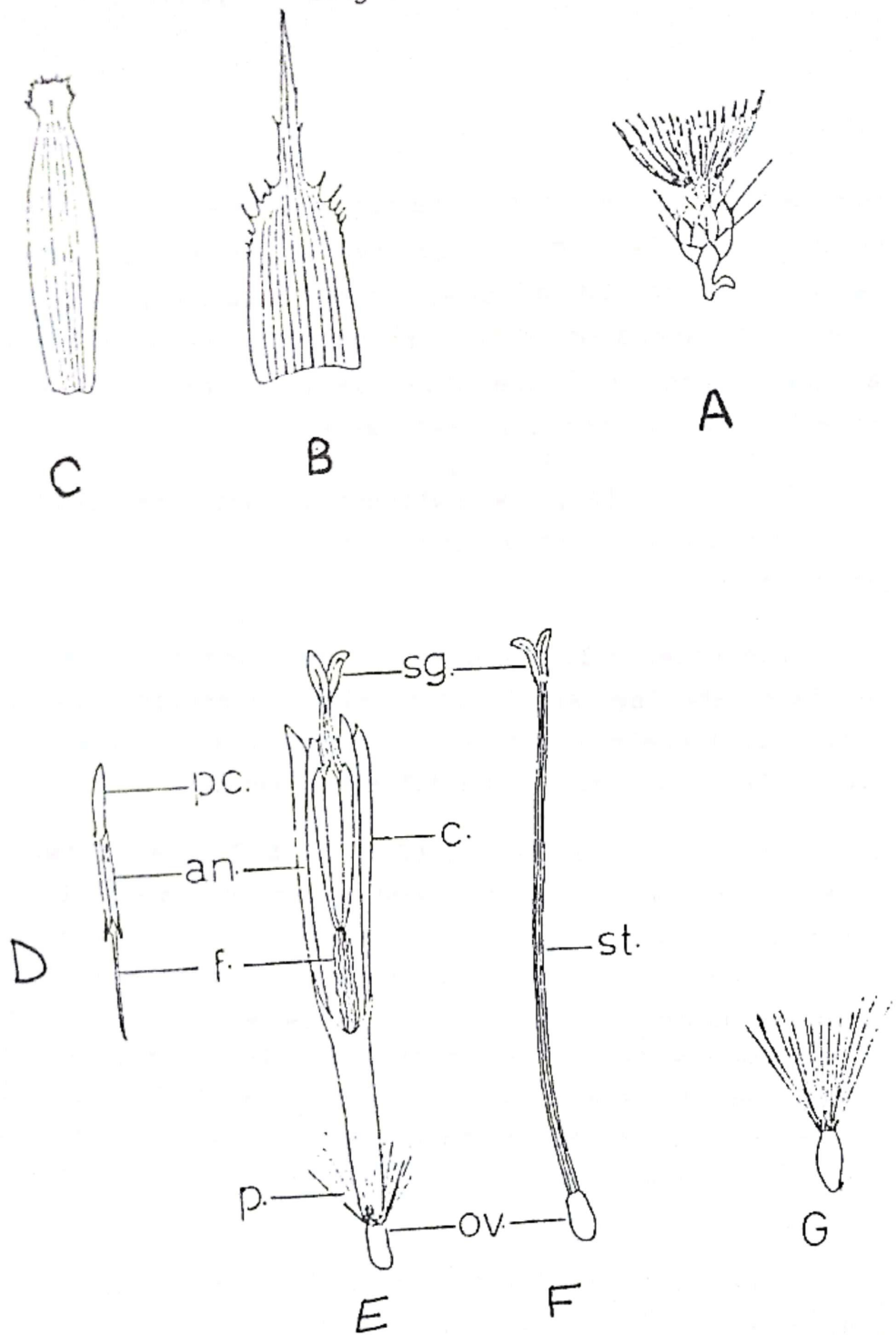
lum is born on a long peduncle and measures 2- 6 cm in height and 1.5-3 cm in diameter at its middle part. Each capitulum consists of 50-57 closely packed sessile disc florets arranged on a flat receptacle and surrounded with a cone-shaped involucre which is composed of 36-47 imbricate bracts, arranged in 6-10 whorls.

The peduncle ; is cylindrical with yellowish green glabrous surface attaining 5 cm in length and 0.4 cm in diameter.

The receptacle; is disc like, flat and solid with green surface showing small depressions corresponding to the seats of florets and numerous linear whitish scaly paleae. The paleae measures up to 1.5 cm in length.

The involucre bracts (Fig. 2B & C) are of two kinds, the outer bracts are yellowish-green, ovate-oblong, with rough, hairy outer surface, smooth inner one, entire scarious margin, symmetric base and rounded apex surmounted by numerous small spines with a central large one; they measure 1-4 cm in length and 0.3-0.9 cm in width. The inner bracts are long bottle-shaped with entire scarious margins and round serrated apices devoid of terminal spine, they measure 2-4.5 cm in length and 0.3-0.6 cm in width.

The tubular florets (Fig. 2E) are closely packed, sessile, hermaphrodite, actinomorphic and epigynous. The calyx (Fig. 2E) is epigynous and represented by white pappus. The corolla (Fig. 2E) is sympetalous consisting of 5 united petals forming a tube with five unequal triangular apical lobes. It is rose in colour and measure 3-5 cm in length and 0.16-0.25 cm in diameter. The androecium (Fig. 2D) is formed of five epipetalous stamens with equal syngenesious anthers; each stamen is formed of white



(Fig. 2) The inflorescence and the fruit. (All X 1.65) except, (A X 0.4)
 A- The capitulum. B- Outer bract. C- Inner bract.
 D- Stamen. E- Floret. F- Gynaecium. G- The fruit.
 an., anther; C., corolla; F., filament; OV., ovary; p., pappus; P.C.,
 Prolongation of connective; Sg., stigma; St., style.

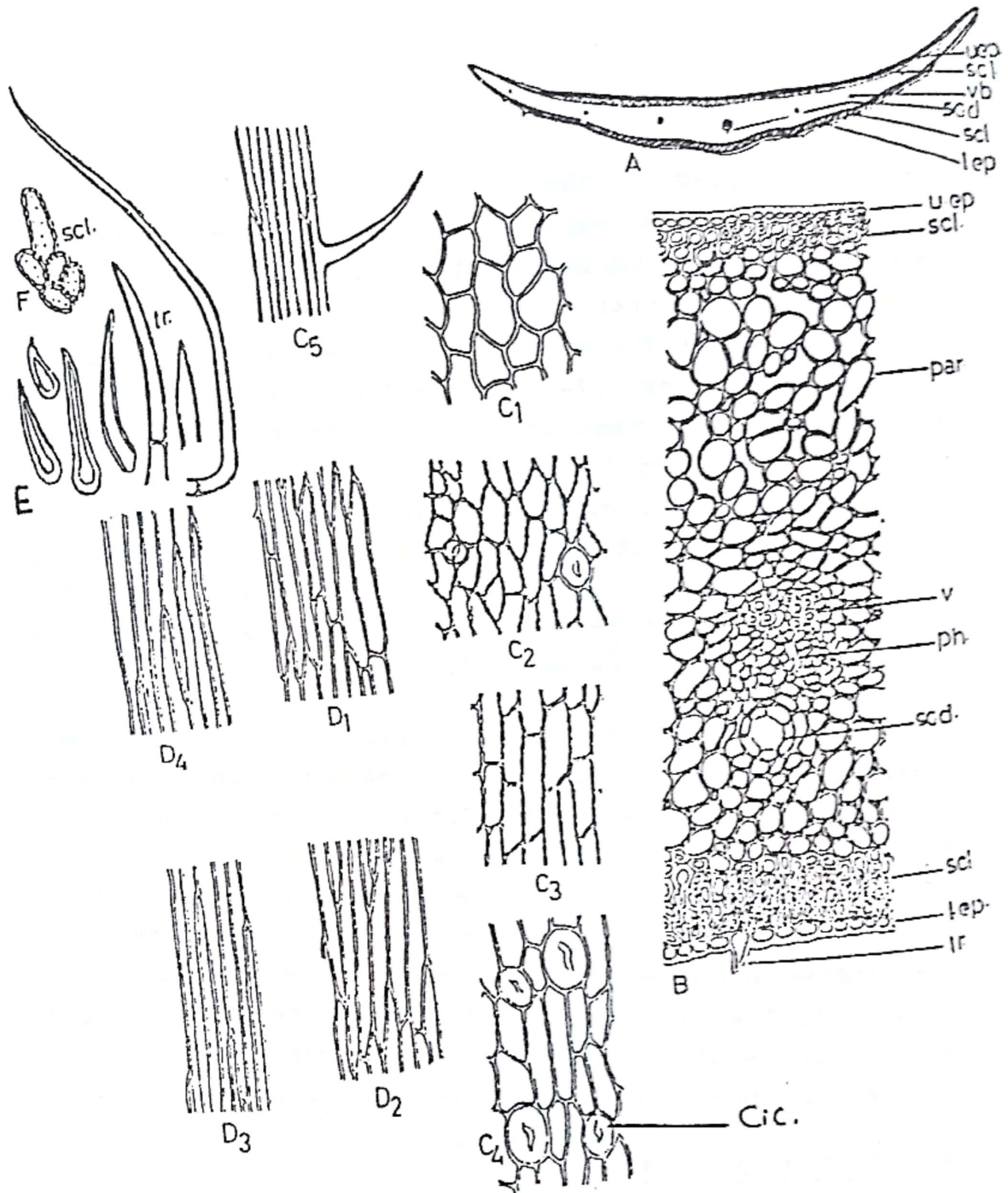
epipetalous filament and brown anther. The anther is bilobed, each with basal prolongation, the connective protrudes beyond the top of the anther lobes into a triangular projection; it measures 0.4-0.8 cm in length and about 0.2 cm in width. The filament is filiform, slender, whitish and hairy, measuring 0.7-0.9 cm in length and about 0.1 cm in diameter. The gynaecium (Fig. 2F) is bicarpellary and syncarpus. The ovary is brownish, ovoid-oblong, unilocular with a single basal ovule and hairy surface. It measures about 0.3 cm in length and up to 0.2 cm in diameter. The style is filiform, slender, yellowish and measures 2.5-5 cm in length. It terminate with bifid papillosed dark brown stigma; each lobe measures 0.2-0.3 cm in length.

2 - **The fruit** : (Fig. 2G) is sessile, unilocular and one-seeded cypsela. It is oval oblong with rough yellowish brown surface and measure 0.4-0.6 cm in length and 0.2-0.4 cm in diameter. The fruit has a persistent pappus formed of two types of bristles; the outer bristles are long, brownish, measuring 0.4-1.0 cm in length; the inner ones are shorter and more darker in colour measuring 0.1-0.4 cm in length. The pericarp is hard and leathery enclosing an anatropous, exalbuminous, basally placented seed, being longer towards the centre and often with thickened base.

B - MICROMORPHOLOGY :

The Bract :

A transverse section of the bract (Fig. 3A & B) consists of an outer and inner epidermis enclosing in between a homogenous mesophyll which is traversed by 7-8 collateral vascular bundles. Each epidermis is underlined by several rows of sclerenchyma which are not extending to the scarious margin. The outer epidermal cells of the involuclar bracts (Fig. 3C) are polygonal, with straight slightly curved, sometimes beaded anticlinal walls and covered with thin smooth cuticle. The inner epidermal



(Fig. 3) The bract: (All x 246,4 except A x 22,4)

A- Diagrammatic transverse section of the bract. B- Detailed transverse section of the bract.

C- Outer (Lower) epidermis of outer bract:
 C₁- At the apex. C₂- of the middle. C₃- of the lower part.
 C₄- Over vein. C₅- Near the margin.

D- Inner (upper) epidermis of outer bract:
 D₁- At the apex. D₂- of the middle. D₃- of the lower part. D₄- Over vein.

E- Trichomes of the outer outer bract. F- Sclereids from bract.

Col., collenchyma; L.ep., lower epidermis; par., parenchyma; ph., phloem; Sol., sclereids; Sc.d., Secretory duct; tr., trichomes; U. ep., upper epidermis; V., vessel.

cells (Fig. 3D) and those of the scarious margin are axially elongated narrower with non beaded walls. Some cells of the margin protrudes into unicellular conical projection; measuring 79-136 u in length and 11-15 u in breadth. Dimensions of the epidermal cells of the bracts are listed in table (1).

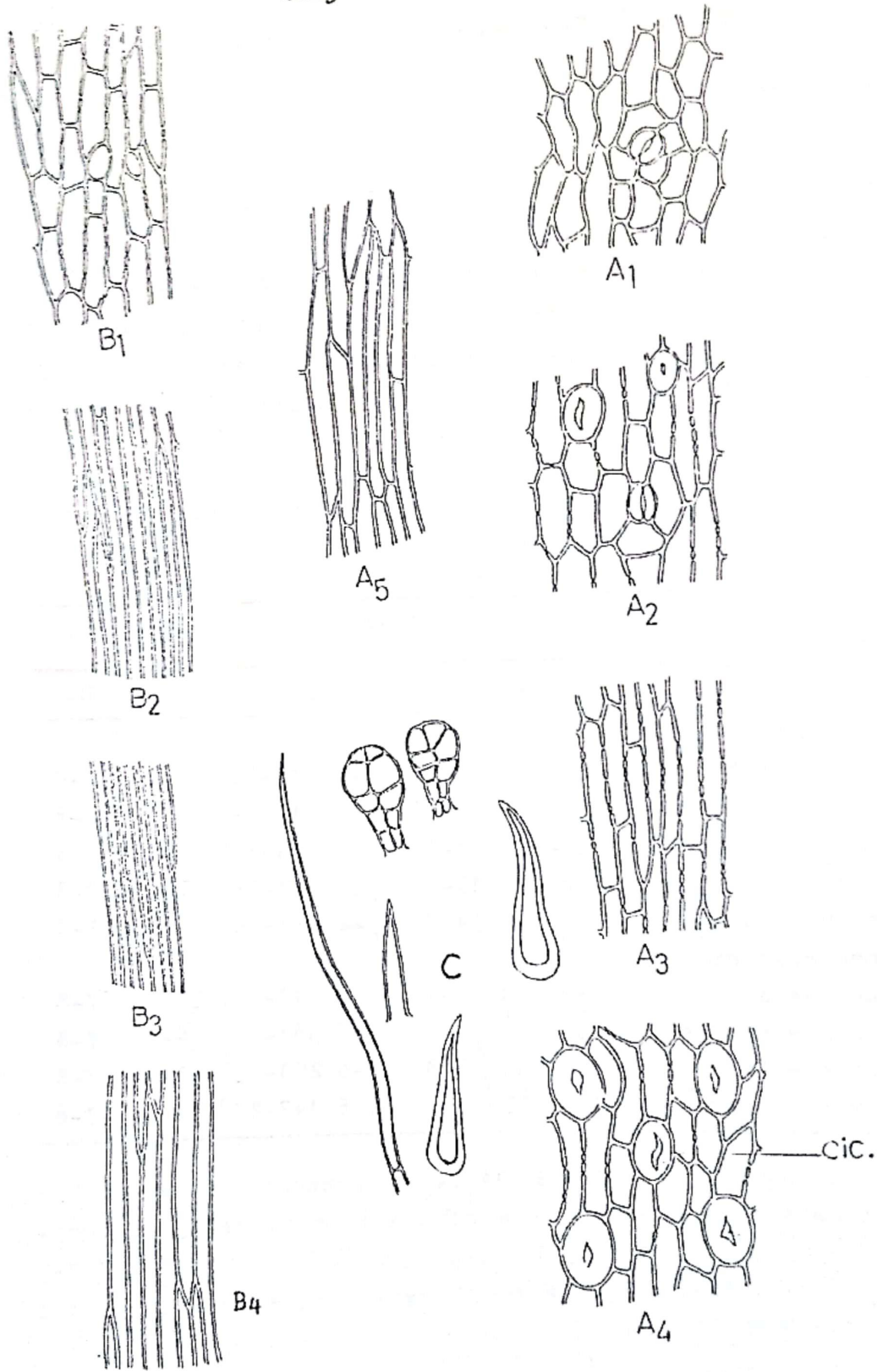
Table (1) : Dimensions of the Epidermal Cells of the Involucral Bracts (in microns).

Regions of the	Outer Bract			Inner Bract		
	L.	B.	H.	L.	B.	H.
Outer epidermis :						
At the apex	23-52	15-22	7-8	11-68	7-16	7-8
At the middle	20-62	8-18	7-8	17-79	8-28	7-8
At the lower	36-72	8-17	7-8	59-106	9-13	7-8
over the vein	28-80	10-23	7-8	33-73	5-17	7-8
At the margin	176-193	4-7	7-8	91-158	6-13	7-8
Inner epidermis :						
At the apex	33-159	7-11	2-8	17-57	8-15	7-8
At the middle	157-216	8-11	2-6	361-402	4-6	7-8
At the lower	204-341	2-8	2-6	250-388	3-6	7-8
over the vein	125-227	3-11	2-6	147-277	6-9	7-8

Stomata (Fig. 3C₂ & 4A₁, A₂), present on the outer epidermis of the keel region of the bracts, being anomocytic, rarely of anisocytic type, each surrounded by 3-5 epidermal cells; they are oval, measuring 15-23 u in length and 12-19 u in breadth.

Trichomes :

Glandular trichomes (Fig. 4C) are confined to the outer epidermis of the inner bracts. They are of the compositae type and measure 34-40 u in diameter.



(Fig. 4) The inner bract: (All X 275)

- A- Outer (lower) epidermis of the inner bract. A₁-At the apex.
 A₂- of the middle part. A₃- Of the lower part.
 A₄- Over vein. A₅- Near the margin.
 B- Inner (Upper) epidermis of the inner bract: B₁- At the apex.
 B₂- of the middle middle part. B₃- of the lower part. B₄-Over vein.
 C- Trichomes of the inner bract.

Covering trichomes (Fig. 3E & 4C) are present on the outer epidermis of the bracts. They are of two types; unicellular, conical trichomes with thick lignified walls, moderately wide lumen, acute apices and smooth cuticle; they measure 99-335 u in length and up to 47 u in diameter and bicellular uniseriate trichomes with short basal cell and long terminal one. They have thin walls, acute apex, smooth cuticle and measure 159-375 u in length and 9-11 u in diameter.

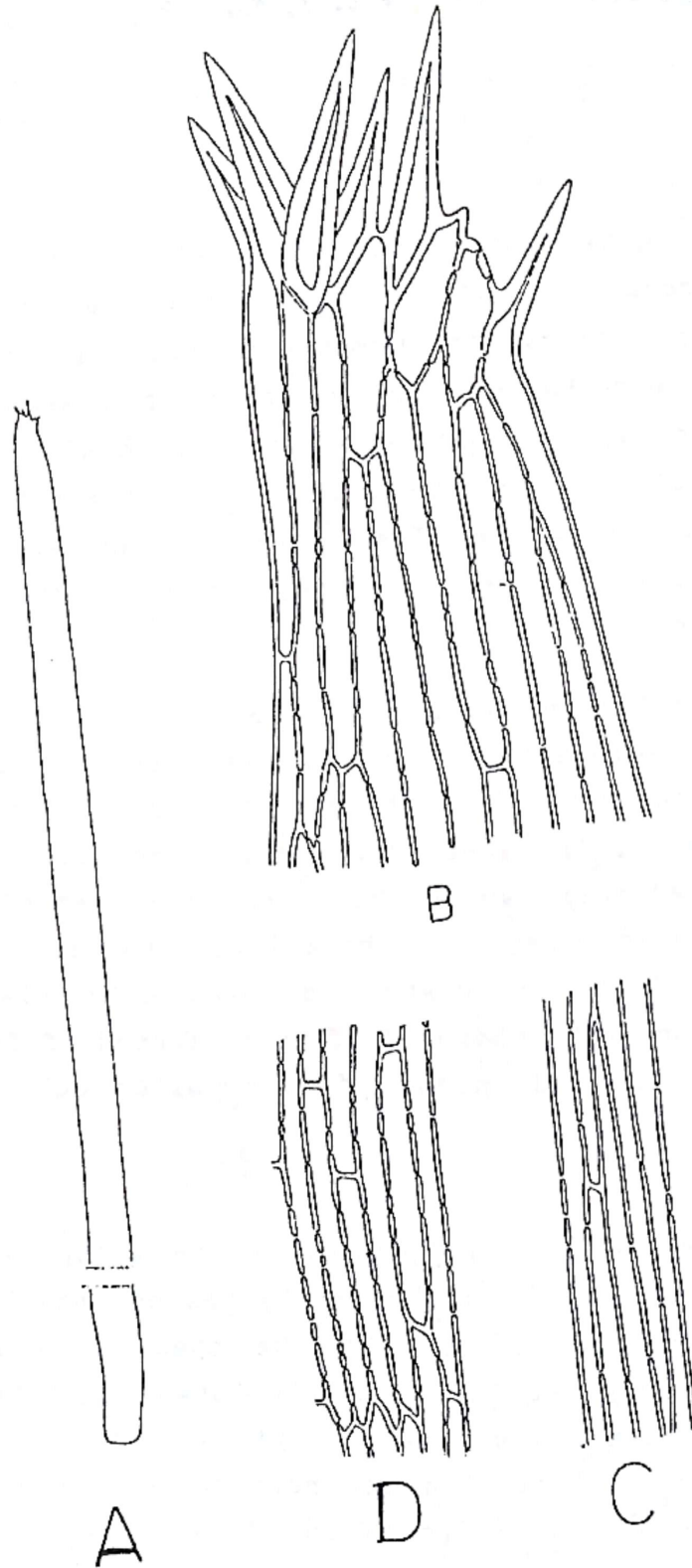
Mesophyll : The mesophyll (Fig. 3B) is parenchymatous with hypodermal sclerenchyma and is traversed longitudinally by 7-8 vascular bundles, the central one has a schizogenous duct below it. The lower hypodermis consists of 5-10 rows of lignified cells while the upper is formed of 2-5 rows; the cells have moderately thick lignified pitted walls and measure 13-75 u in length and 14-20 u in diameter. The vascular bundle is composed of xylem formed of few delicate spiral vessels and phloem of thin-walled cellulosic elements.

The Palcae :

The epidermal cells (Fig. 5) are polygonal, axially elongated with straight, slightly beaded anticlinal walls and thin smooth cuticle. At the apex, they have thick walls, narrow lumen and protrude outwards in the form of conical projections with acute apices. They measure 57-204 u in length and 11-17 u in breadth. In the middle, they measure 210-454 u in length and 8-10 u in breadth. Near the base the cells are more beaded, markedly short and measuring 32-160 u in length and 7-11 u in breadth.

The floret :

The calyx (Fig. 6E,F) is represented by white sessile pappus, each bristle is multicellular, multiseriate. The



(Fig. 5) The paleae: (All are X 368, except A X 33).
A- The paleae. B- The epidermal cells of the paleae at the apex.
C- The epidermal cells of the paleae at the middle part.
D- The epidermal cells of the paleae at the lower part.

upper and lateral cells protrude outwards into conical projections forming minute denticulations. The cells measure 390 to 510 u in length and 12 to 16 u in breadth.

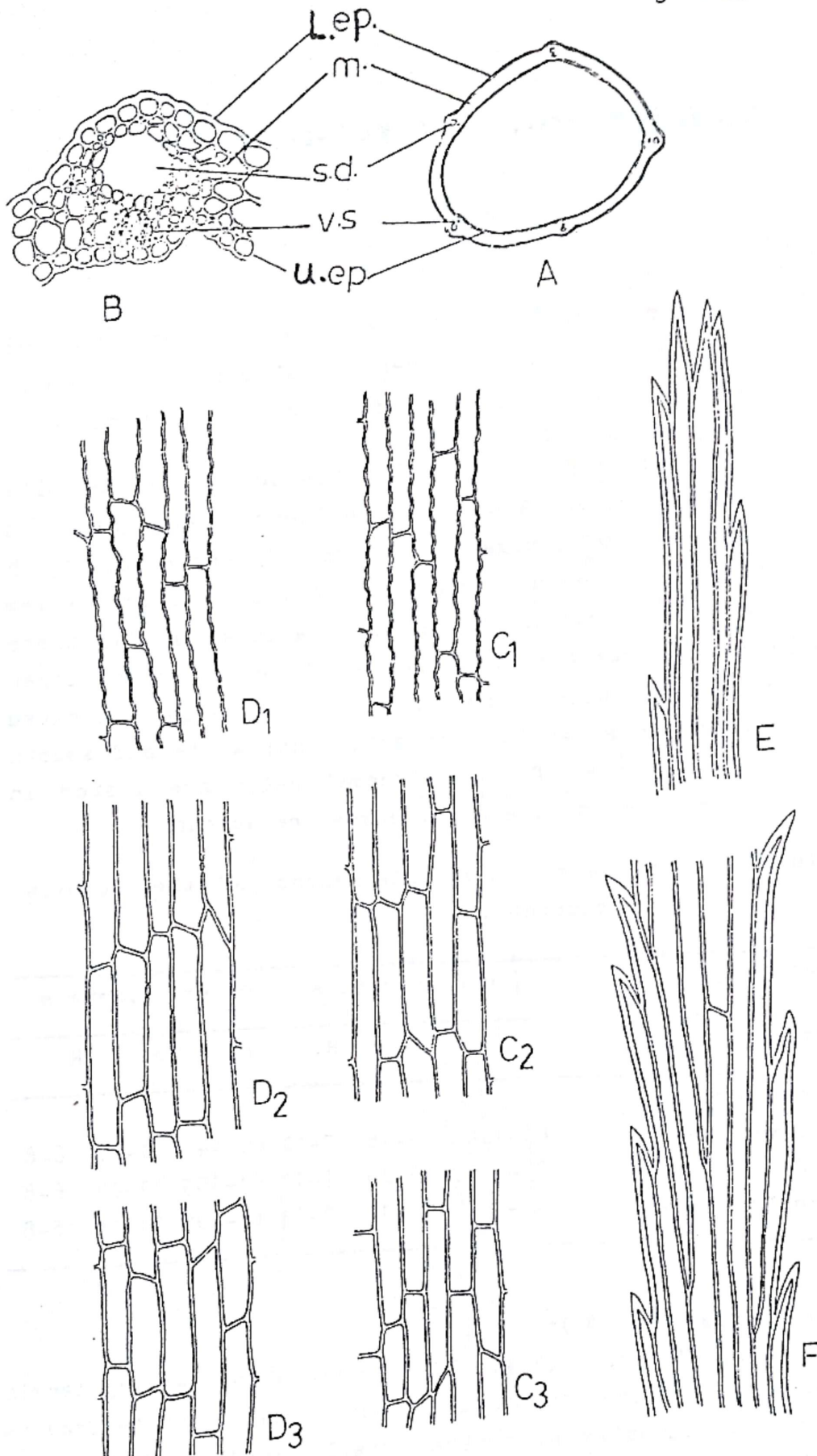
The corolla (Fig. 6A,B) : The tissues of the corolla are formed of outer and inner epidermis enclosing in between a narrow homogenous mesophyll traversed by 5 vascular strands, each formed of delicate spiral xylem vessels and soft phloem. Above each vascular strand there is a large schizogenous duct. Cells of the outer and inner epidermis (Fig. 6C,D) are polygonal, axially elongated with straight or slightly wavy anticlinal walls and smooth cuticle. Dimensions of the epidermal cells are listed in table (2). Both stomata and trichomes are absent.

Table (2) : Epidermal Cell Dimensions of the Corolla.
(in microns).

Regions of the corolla	Inner epidermis			Outer epidermis		
	L.	B.	H.	L.	B.	H.
Corolla tube :						
Lower part	40-104	10-16	7-10	60-94	11-17	6-8
Upper part	85-125	11-20	7-10	81-159	11-20	6-8
Corolla lobes	42-108	10-17	7-11	61-105	11-16	6-8

Androecium (Fig. 7) :

The filament (Fig. 7G) consists of an epidermis surrounding a parenchymatous ground tissue which is traversed longitudinally by central small vascular strand. The epidermal cells (Fig. 7H,J,I) are rectangular or polygonal, axially elongated with straight or slightly wavy anticlinal walls and covered with thin smooth cuticle. In the upper



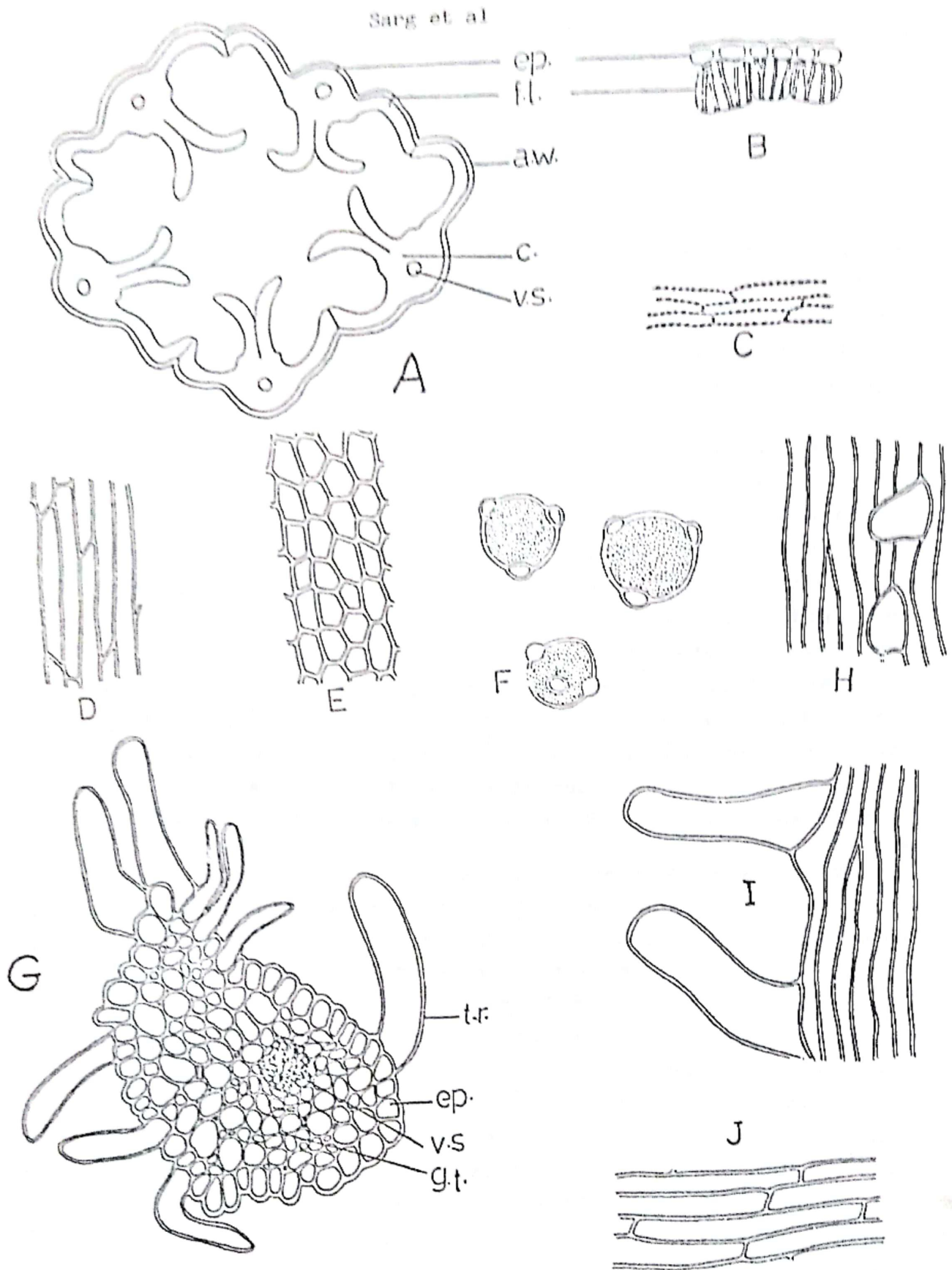
(Fig. 6) The Calyx and Corolla: (All X 300, except A X 20).

- A- Diagrammatic transverse section of the corolla.
 B- Detailed transverse section of the corolla.
 C- Inner (upper) epidermis of the corolla.
 C₁- At the lobe. C₂- At the middle of corolla tube.
 C₃- At the base of corolla tube.
 D- Outer (lower) epidermis of corolla: D₁- At the lobe.
 D₂- At the middle of corolla tube. D₃- At the base of corolla tube.
 E- The bristle of the pappus at the apex.
 F- The bristle of the pappus at the lower part.
 M., mesophylle; L.ep., lower epidermis; s.d., secretory duct.; U.ep., upper epidermis; V.S., Vascular strand.

are prolonged into long conical papillae with acute apices up to 74 u in length. The cells measure 25-45 u in length. The ground tissue is collenchymatous on one side with highly thickened, cellulosic walls and parenchymatous on the other enclosing the small vascular strand.

The style (Fig. 8 E,F) is formed of an epidermis surrounding a ground tissue consisting of an outer parenchyma and central collenchyma, it is traversed longitudinally by 2 narrow vascular strands and two large schizogenous ducts with reddish brown contents on both side. The epidermal cells of the style (Fig. & I,G,H) are polygonal, axially elongated with thin straight anticlinal wall and thin smooth cuticle. At the apex, (Fig. 8 G.) it measures 68 to 160 u in length, 7-15 u in breadth. At the middle, the cells measure 136 to 206 u in length and 8-14 u in breadth. The basal epidermal cells of the style are short beaded and measure 47-93 u in length and 8-13 u in breadth.

The ovary, A transverse section of the ovary (Fig. 8 A,B) is ovoid and composed of an outer and inner epidermis with parenchymatous mesophyll in between traversed longitudinally by 4 small vascular strands. The outer epidermal cells (Fig. 8 D) are rectangular, or polygonal with straight anticlinal walls and thin smooth cuticle. The cells measure 28-64 u in length, 7-10 u in breadth and 3-5 u in height. Glandular covering trichomes are present on the outer epidermis of the ovary. These trichomes are of compositae type and measure 95-100 u in length and 25-34 u in diameter. Covering trichomes are unicellular with thin walls, wide lumen, acute apices and measure 85-164 u in length and about 7 u in diameter. Few unicellular covering trichomes are present at the basal part of the ovary having thick walls, narrow lumina and measure 590-648 u in length and about 11 u in diameter.



(Fig. 7) the androecium: (All X 308) except A and G (X 28).
 A- Transverse section of anthers. B- Detailed transverse section of anther-wall.
 C- Fibrous layer in surface view. D- Epidermis of the connective
 E- Epidermis of the anther. F- Pollen grains.
 G- Detailed transverse section of the filament.
 H- Epidermis of the filament at the apex.
 I- Epidermis of the filament at the middle.
 J- Epidermis of the filament at the base.
 a.w., anther-wall; C., connective; ep., epidermis; f.l., Fibrous layer;
 g.t., ground tissue; V.S., vascular strand.

and middle part, some epidermal cells protrude into cylindrical unicellular trichomes with round apices and smooth cuticle. The cells measure 131-170 u in length, 9-11 u in breadth and 8-17 u in height. Hairs measure 25-113 u in length and 16-32 u in diameter. Stomata are absent.

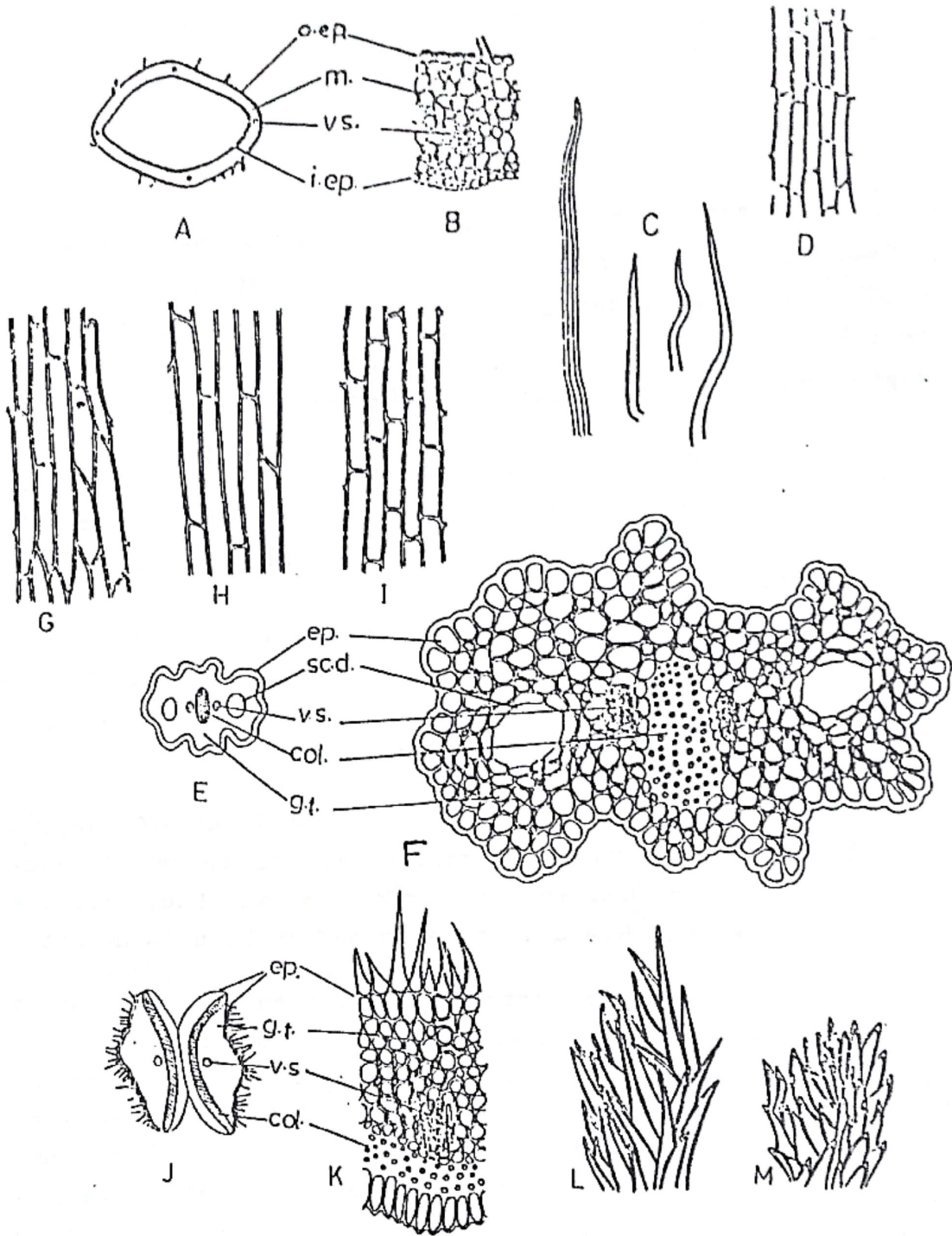
The anther (Fig. 7A) consists of two lobes each enclosing pollen sac and separated by a connective. The anther-wall (Fig. 7B) is formed of an epidermis underlined by a fibrous layer. The epidermis (Fig. 7E) is composed of rectangular or polygonal cells with thick straight anticlinal walls and smooth cuticle. They measure 11 to 27 u in length, 9-27 u in breadth and 7-8 u in height. The epidermis of anther shows neither stomata nor trichomes.

The fibrous layer (Fig. 7B,C) is made up of one row of polygonal cells having lignified spiral bands of thickening appearing beaded in surface view; they measure 22-38 u in length, 5-9 u in breadth and 15-22 u in height.

The connective projects beyond the anther lobes as a membranous appendage. The epidermal cells of the connective (Fig. 7D) are polygonal, axially elongated with straight anticlinal walls, and thin smooth cuticle. They measure 81-148 u in length, 8-10 u in breadth and 3-5 u in height. The pollen grains (Fig. 7F) are spherical yellow with 3 germ pores, 3 germinal furrows and granular exine, they measure 35 to 51 u in diameter.

The Gynaecium (Fig.8) :

The stigma lobe (Fig.8J,K) is formed of papillosed epidermis enclosing a ground tissue which is traversed longitudinally by a small vascular strand. The epidermis of the stigmatic surface is formed of polygonal, papillosed axially elongated cells with straight anticlinal walls and thin smooth cuticle. The outer epidermal cells (Fig.8L,M)



(All x 216 except A,E & J x52)

(Fig. 8) The gynaecium:
 A- Diagrammatic transverse section of ovary wall.
 B- Detailed transverse section of ovary wall.
 C- Trichomes of the ovary. D- Outer epidermis of ovary wall.
 E- Diagrammatic transverse section of the style.
 F- Detailed transverse section of the style.
 G- The epidermis of the upper part of the style.
 H- The epidermis of the middle part of the style.
 I- The epidermis of the lower part of the style.
 J- Diagrammatic transverse section of the stigma.
 K- Detailed transverse section of the stigma.
 L- The epidermis of the stigma at the lower part.
 M- The epidermis of the stigma at the upper part.
 Col.; collenchyma; ep., epidermis; g.t., ground tissue; M., mesophyll;
 O. ep., outer epidermis; i.ep., inner epidermis; Sc.d., secretory
 duct; V.S., vascular strand.

The fruit :

A transverse section of the pericarp (Fig. 9 A,B) consists of an epicarp, sclerenchymatous mesocarp and an endocarp.

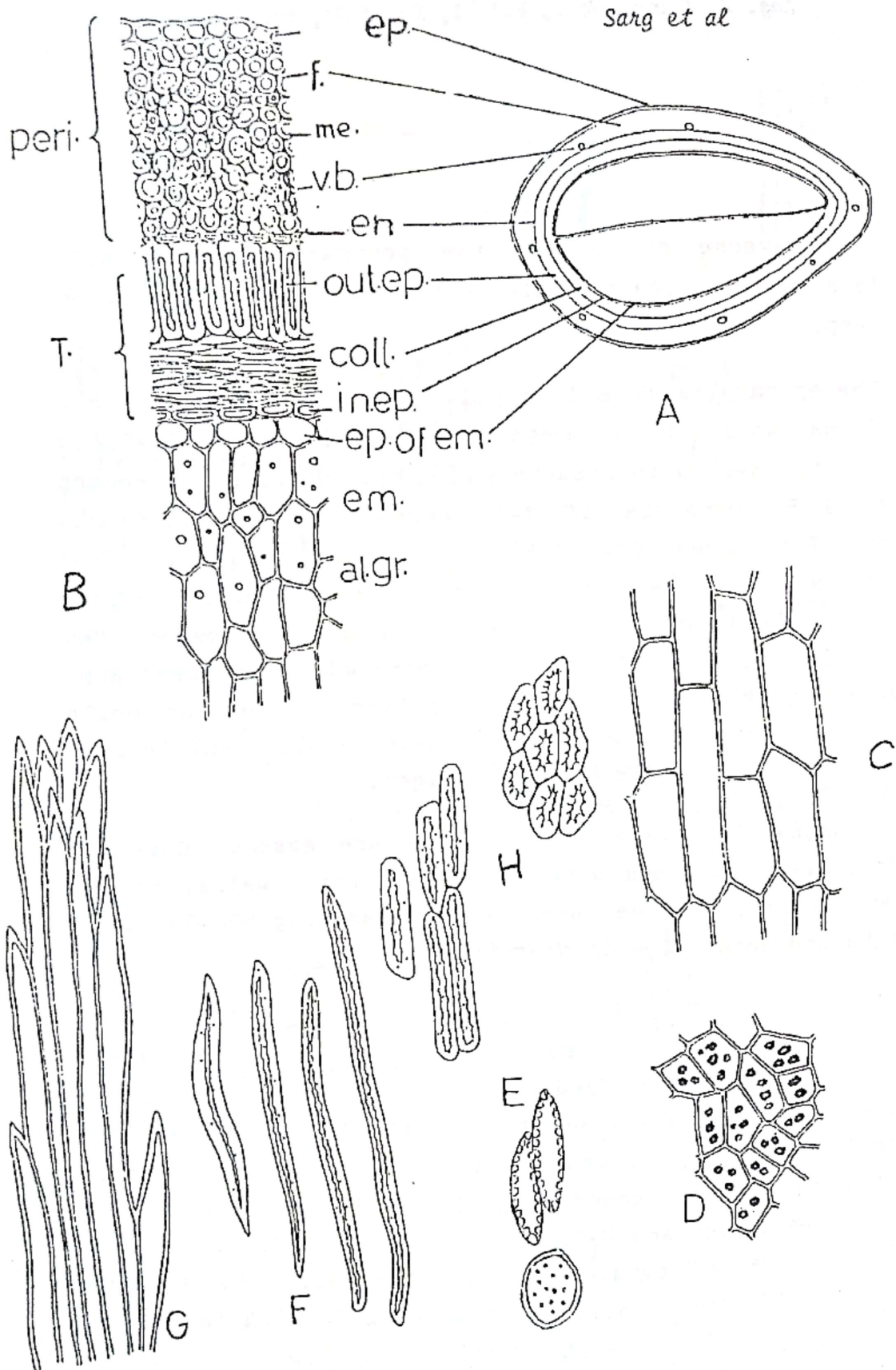
The epicarp is formed of polygonal cells with straight anticlinal walls, thin smooth cuticle and measure 53-102 u in length, 13-23 u in breadth and 6-7 u in height. **Mesocarp** (Fig. 9 B) consists of 7-12 rows of sclerenchymatous fibres. The fibres (Fig. 9 F) have thick, pitted lignified walls, narrow lumen and acute or blunt apices; they measure 122-204 u in length and 9-13 u in diameter. Few small fibro-vascular bundle are scattered in the mesocarp. **Endocarp** (Fig. 9 B) consists of polygonal, tubular cells with thick lignified walls and measure 40-73 u in length, 11-16 u in breadth and 2-5 u in height.

Stomata and glandular trichomes are absent. Covering unicellular trichomes with thick cellulosic walls, narrow lumen and acute apices are present measuring 500-710 u in length and about 10 u in diameter.

Seed :

The **testa** (Fig. 9 B) consists of outer and inner epidermis with a collapsed nutritive layer in between. The outer epidermis is formed of palisade-shaped, pitted, lignified sclerenchymatous cells with narrow lumen, and mostly equally thickened wall (Fig. 9 B); they measure 40-79 u in height and 8-13 u in breadth. The inner epidermis is formed of tabular, rectangular cells, having thin straight anticlinal walls and measuring 16-32 u in length, 6-9 u in breadth and 3-5 u in height.

The **embryo** : (Fig. 9 B) the tissue of the embryo consists of polyhedral cellulosic, thin-walled cells containing fixed oil globules and aleurone grains containing



(Fig. 9) The fruit: (All X 368, except A X33).
 A- Diagrammatic transverse section of the fruit.
 B- Detailed transverse section of the fruit.
 C- Epicarp in surface view. D- Fragment of endosperm.
 E- Isolated sclereids of endocarp.
 F- Isolated sclerenchymatous fibres of mesocarp.
 G- Pappus. H- Outer epidermis of testa.
 I- Collapsed nutritive layer; em., embryo; en. endocarp; ep. epicarp, ep. of en. epidermis of embryo; al.gr., aleurone grains; coll., collapsed nutritive layer; in.ep. inner epidermis; me. mesocarp; out.ep., outer epidermis; peri., pericarp; t. testa; v.b., vascular bundle.

globoids only.

The pappus : (Fig. 9G), which is multicellular, multi-seriate shows upper and terminal cells protrude outwards into conical projection.

CONCLUSION

From the previous study, one can conclude that the most diagnostic features are :

1. Capitulae are axillary or terminal showing rose coloured tubular disc florets arranged on a flat solid receptacle. Bracts of the involucre imbricate in several rows, the outer ones ending with a spine.
2. Pollen grains are spherical with 3 germ pores, 3 germinal furrows and granular exine.
3. Large schizogenous ducts are present in the ground tissues of the style, corolla and bracts.
4. Basal appendage of anthers and of the connective.
5. The covering trichomes : are unicellular , conical in shape, with thick lignified walls, which are present in the bracts and at the basal part of the ovary wall.
6. The fruit is cypsela, sessile, unilocular, one seeded. The pericarp shows lignified epicarp, sclerenchymatous mesocarp formed of thick, lignified pitted fibres with acute or round apices. Endocarp shows one row of lignified thin walled cells.
7. The flower-heads and fruits are completely free of starch granules and calcium oxalate crystals.

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دراسة عيانية ومجهرية لزهور (هامات)

نبات سنتاوريا ايرينجويدز لام

طه مصطفى سرج - ماهر محمد الدمياطي

عبد المنعم محمد عطية - سميح إبراهيم الدهمى

وعاصم محمد الشاذلى

قسم العقاقير- كلية الصيدلة - جامعة الزقازيق

سبق أن قام الباحثون بدراسة محتويات النبات الكيميائية وكذلك الصفات العيانية والمجهرية للأوراق وساق وجذر النبات .
وفى هذا البحث قام المؤلفون بدراسة الأزهار (هامات) لنفس النبات فى صورة ظاهرية ومجهرية وعلى هيئة مسحوق لإمكانية التعرف على النبات .