

## MACRO- AND MICROMORPHOLOGY OF *ATRIPLEX INFLATA* F. MUELL.

Abdel-Monem M. Ateya, Azza M. El-Shafae, Assem M. El-Shazly and Dalia E. Hamdan  
Department of Pharmacognosy, Faculty of Pharmacy, Zagazig University, Zagazig 44519, Egypt.

### ABSTRACT

The macro- and micromorphological characters of the root, stem, leaf, flower and fruit of *Atriplex inflata* F. Muell. growing in Egypt have been studied in order to find out the diagnostic features that can help in the identification of the plant in both entire and powdered forms.

### INTRODUCTION

The genus *Atriplex* (family Chenopodiaceae) comprises about 120 species mainly in desert, saline and arid land<sup>(1)</sup>. In Egypt, the genus is represented by about 15 species<sup>(2,3)</sup>; the most economically important members of them are *A. canescens* James, *A. semibaccata* R.Br., *A. nummularia* Lindley, *A. inflata* F. Muell. and *A. spongiosa* F.B.

*Atriplex inflata* F. Muell. is a wild plant indigenous to Egypt. Recently, the plant was investigated by the authors and as a result 20-hydroxyecdysone, lupeol,  $\beta$ -sitosterol, stigmasterol,  $\beta$ -sitosterol-O-glucoside and three flavonoidal compounds were isolated from the powdered whole plant<sup>(4)</sup>.

Preliminary biological testing of the plant extracts, indicated some valuable effects including anti-inflammatory, liver protection and anti-microbial activities<sup>(4)</sup>.

Meanwhile, there is no report on the botanical study of this plant except a brief taxonomic description reported in some floras<sup>(2,3)</sup>. Therefore, it was deemed necessary to carry out a comprehensive macro- and micromorphological study of the root, stem, leaf, flower and fruit to help identification of the plant either in the entire or powdered forms.

### EXPERIMENTAL

#### Plant Material

Samples of *A. inflata* F. Muell. [Syn. *Blackiella inflata* (F. Muell.) Aellen; *Atriplex Lindleyi* Mog. spp. *inflata* (F. Muell. P.G. Wilson)]<sup>(2,3)</sup> family Chenopodiaceae were collected in the flowering and early fruiting stages in December 1997 from the vicinity of Belbis-Cairo road. The identity of the plant was kindly verified by Dr. Nabil El-Hadidi Prof. of Plant Taxonomy, Faculty of Science, Cairo University, Egypt. A voucher specimens are deposited at the Herbarium of the Department of Pharmacognosy, Faculty of Pharmacy, Zagazig University, Egypt. Fresh materials and samples kept in 70% glycerol in alcohol were used for this study.

#### A. Macromorphology

*A. inflata* F. Muell. (Fig. 1A) is a prostrate or decumbent annual herb. The plant is monoecious and reaches from 15-40 cm in height. The plant bears alternate, more or less rhombic leaves with elongated cuneate bases and few marginal teeth. Flowers exist in

small clusters, the male flowers are terminal and the female ones are auxiliary. The plant flowers from October to November. The fruit is achene included in a small hanging basket-like body situated in the upper part of yellowish-green spongy winged perianth and appear from October to December.

#### The root

The root (Fig. 1B) has a tap-root system almost cylindrical, thick, hard and woody. The main root measures 14 to 16 cm in length and 0.5 to 1 cm in diameter. It has brownish colour, covered with cork, which shows longitudinal wrinkled surface. It gives lateral rootlets. The outer surface shows numerous scars of rootlets. It has fibrous fracture exposing a very narrow bark, surrounding a wide yellowish brown stele. The root has faint odour and salty taste.

#### The stem

The main stem (Fig. 1A) is short, cylindrical, woody, solid, dark yellow to brown in colour and measures about 8 to 10 cm in length and 0.4 to 0.5 cm in diameter. The lower branches are woody, dark yellow in colour and measure 11 to 15 cm in length and 0.2 to 0.3 cm in diameter. The upper branches are green, cylindrical, rigid, hairy and measuring 10 to 13 cm in length and 0.1 to 0.2 cm in diameter. They have more or less short internodes and break with short fibrous fracture.

#### The leaves

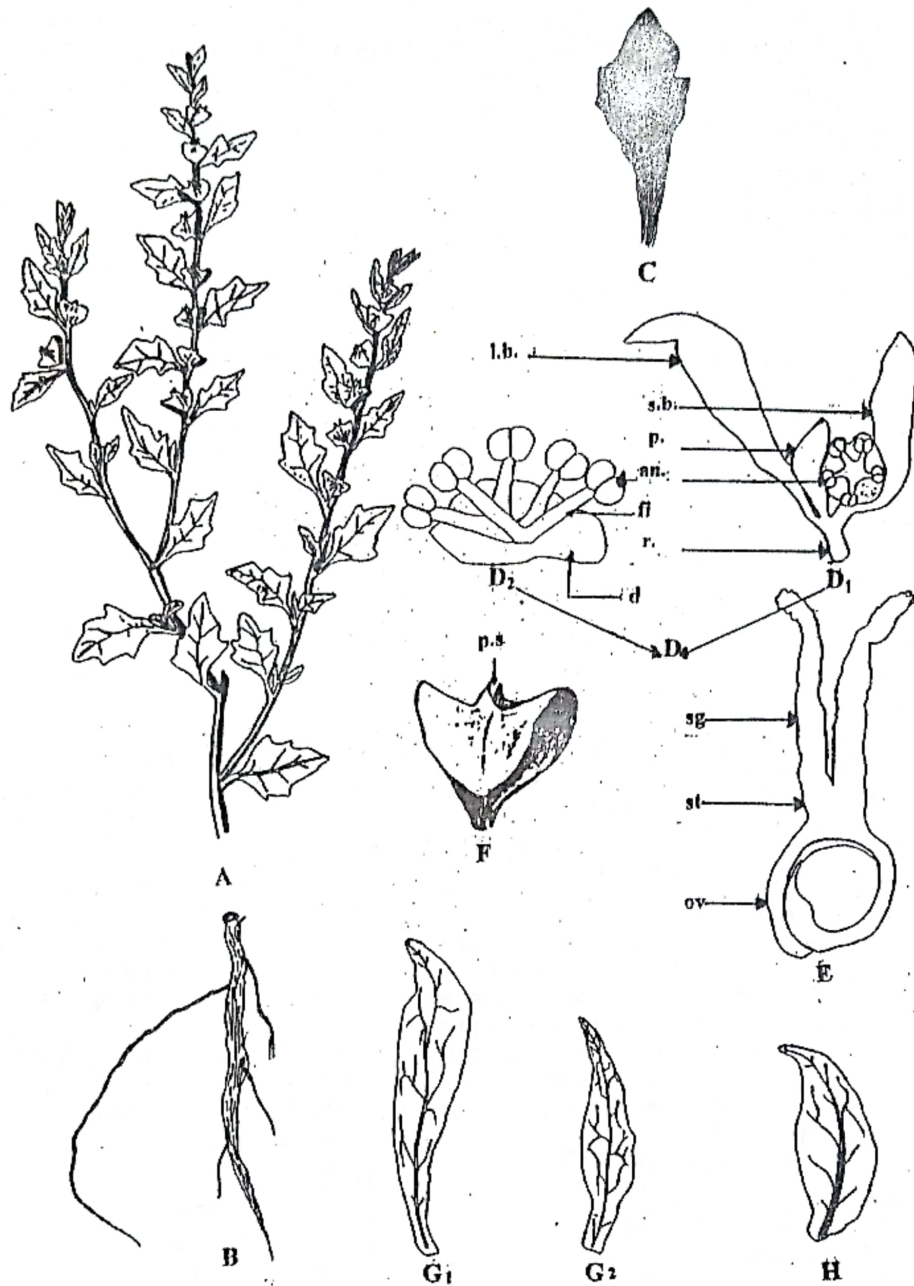
The leaves (Figs. 1A,1C) are simple, alternate, cauline, sessile and exstipulate. The upper surface of the leaf is usually greyish-green while the lower is paler in colour. They have pinnately reticulate venation and the midrib is usually prominent on the lower surface. They are ovate to lanceolate, with an elongated cuneate base, entire margins with 3 to 4 teeth at both sides and acute apices. The leaves measure 1.5 to 1.8 cm in length and 0.5 to 0.7 cm in breadth.

#### The rachis

The rachis (Fig. 1D<sub>1</sub>) is short, cylindrical, solid with dark green and hairy surface. It is flexible when fresh and easy break when dry with granular fracture. It measures 1.5 to 2 mm in length and 0.5 to 1 mm in diameter.

#### The bract

Each of the male and female flowers (Figs. 1D<sub>1</sub>, 1G<sub>1</sub> and 1G<sub>2</sub>) are subtended by two unequal bracts.



**Fig. 1: Macromorphology of *Atriplex inflata* F. Muell.**

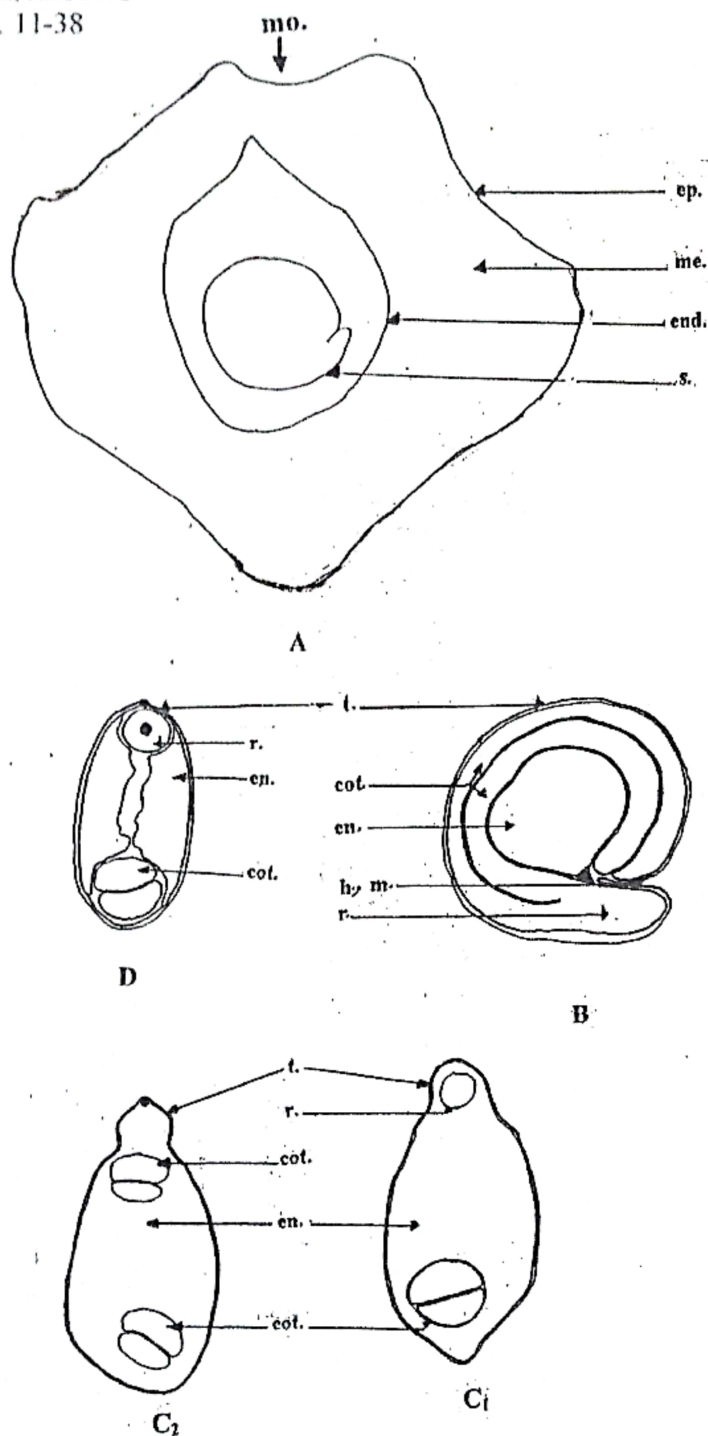
A- Sketch of aerial part (x 1.05)      B- The root (x 0.3)      C- The leaf (x 1.73)

D- The male flower (D<sub>1</sub> x 6, D<sub>2</sub> x 9.75)      E- The female flower (x 56)      F- The fruit (x 1.78)

G- The bract:      G<sub>1</sub> - The large bract (x 3.8)      G<sub>2</sub> - The small bract (x 4.87)

H- The perianth. (x 5.55)

an., anther; d., disc; fi., filament; l.b., large bract; ov., ovary; P., perianth; p.s., persistent stigma; r., rachis; s.b., small bract; sg., stigma; st., style.



**Fig. 2: The fruit**

- A- Longitudinal section in the fruit.
  - B- Longitudinal section of the seed parallel to the flat surface.
  - C- Longitudinal section of the seed at the cotyledons and the radicle region:
    - C1- showing 2 cotyledons at lower side only.
    - C2- showing 2 cotyledons at upper and lower side.
  - D- Transverse section of the seed at the radicle and cotyledons region
- (A x 8.25, B, C<sub>1</sub>, C<sub>2</sub>, D x 229.5)

cot., cotyledon; en., endosperm; end., endocarp; ep., epicarp; h., hilum; m., micropyl; me., mesocarp; mo., mouth; r., radicle; s., seed; t., testa

They are ovate to lanceolate, greyish-green in colour, sessile, showing entire margin and acute apices. The large bract measures 0.9 to 1 cm in length, 2.5 to 3 mm in breadth while the small bract measures 5 to 6 mm in length and 1.5 to 2 mm in breadth. In female flower, the ovary is included in between two flat, leaf-like bracts, one of them is growing in size enclosing the fruit, they have the same size as those of male flower.

#### The Flowers

The plant is monoecious, with a perianth in the staminate flowers. The staminate flowers (Fig. 1D) occur in small clusters occupying terminal parts of the plant. The androecium consists of 5 united stamens situated on a disc and laying between 5 unequal segmented perianth (Fig. 1H) which is green in colour, each segment is green in colour and measures 2 to 4 mm in length and 0.5 to 1 mm in breadth. The stamen is formed of a short filament (measuring 470 to 492  $\mu$  length and 247 to 294  $\mu$  in diameter) and spherical bilobed yellow anther. The anther lobe measures 424 to 470  $\mu$  in length and 350 to 352  $\mu$  in diameter.

The pistillate flowers (Fig. 1E) occur in small axillary clusters. The gynaeceum is monocarpellary formed of superior ovary with basal placentation, short filiform style and long bifid stigma. The ovary is subspherical, greyish-green in colour and measures 325 to 349  $\mu$  in length and 332 to 337  $\mu$  in diameter. The style is yellowish-green in colour and measures 96 to 108  $\mu$  in length and 165 to 170  $\mu$  in breadth. The stigma lobe is cylindrical, yellowish-green in colour and measures 530 to 580  $\mu$  in length, 55 to 84  $\mu$  in breadth.

#### The Fruit

The fruit (Figs. 1F), is superior achene, included in a small hanging basket-like body situated in the upper part of spongy perianth. The fruit perianth is yellowish green in colour, much swollen and completely joined into an obconical body flat-topped or umbo-shaped, above with a small mouth-like opening in the center and two lateral wings. It is green in colour and measure about 0.8 to 1.1 cm in length and up to 1 to 1.2 cm in breadth (including the wings). The pericarp is thin, hairy and yellowish green in colour enclosing one seed attached to basal placenta.

#### The seed

The seed (Figs. 2A), is oval to globular, small in size measuring about 2 mm in length and 1.5 mm in breadth and easily separated from the fruit. The testa is glossy brown and smooth. The hilum and micropyle appear as a slight depression at the upper end of the seed. No raphe present.

In longitudinal cut (Fig. 2B, 2C<sub>1</sub>, 2C<sub>2</sub>), the seed is albuminous with thin brown testa surrounding a wide endosperm and strongly curved embryo. The embryo is composed of two fleshy cotyledons and a radical directed towards the hilar end.

## B. Micromorphology

### 1) Old root and stem

A transverse section of the old root appears nearly rounded in outline. It shows narrow periderm consisting of several rows of cork cells and narrow phelloderm. The periderm surrounds a comparatively wide cylinder of vascular tissues formed of a matrix of connective tissue fibers in which 14-16 rows of radially arranged closed collateral vascular bundles are embedded (Figs 3A, 3B).

In the young stem, a transverse section (Figs. 5A, 5B) shows an outer epidermis, parenchymatous cortex with subepidermal collenchyma and an inner endodermis. The endodermis surrounds a parenchymatous pericycle with few patches of lignified pericyclic fibers and a ring of vascular tissue which is formed of 10-12 collateral vascular bundles surrounding a wide parenchymatous pith.

A transverse section of the old stem is almost circular in outline (Figs 7A, 7B). It is formed of several layers of cork cells and narrow phelloderm. The anomalous secondary thickening is formed of a matrix of connective tissue fibers in which scattered closed collateral vascular bundles are embedded. These anomalous structure is followed by primary vascular bundles which surround a thin-walled parenchymatous pith.

#### i) Epidermis of the young stem:

The epidermis of the young stem is formed of polygonal cells with thick straight anticlinal wall and covered with thick smooth cuticle (Fig. 6). The epidermis shows few anomocytic stomata and few trichomes of both glandular and covering type. The glandular hair (Fig. 6) consists of short unicellular stalk and a large spherical unicellular head, while the covering trichomes are uniseriate-bicellular with more or less rounded apex, some terminal cells are collapsed near the base.

#### ii) The cork:

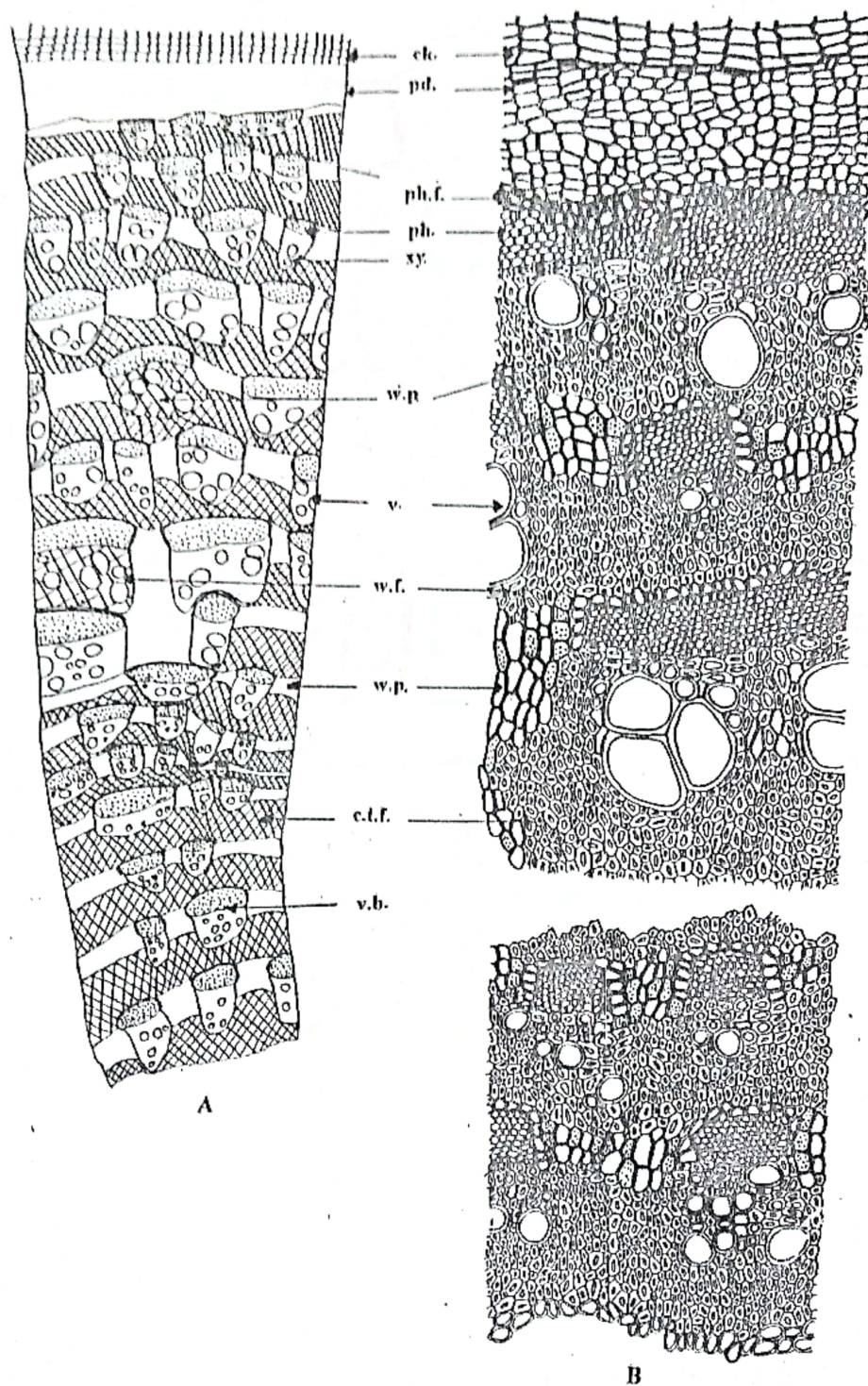
The cork cells of the old root and old stem (Figs. 3,4,7 and 8) are formed of 5-8 radially arranged rows of polygonal tabular, slightly elongated cells with slightly thick, lignified anticlinal walls.

#### iii) The cortex:

The cortex of the young stem is formed of 2-3 rows of rounded subepidermal collenchyma with thick cellulosic walls followed by 4-6 rows of large rounded parenchymatous cells. The inner most layer of cortex is endodermis which is well differentiated and formed of tangentially elongated cells with thin walls.

#### iv) The phelloderm

The phelloderm of the old root and old stem is consist of 6-12 rows of radially arranged parenchymatous cells, showing slightly thickened cellulosic walls with narrow intercellular spaces (Figs. 3,7).



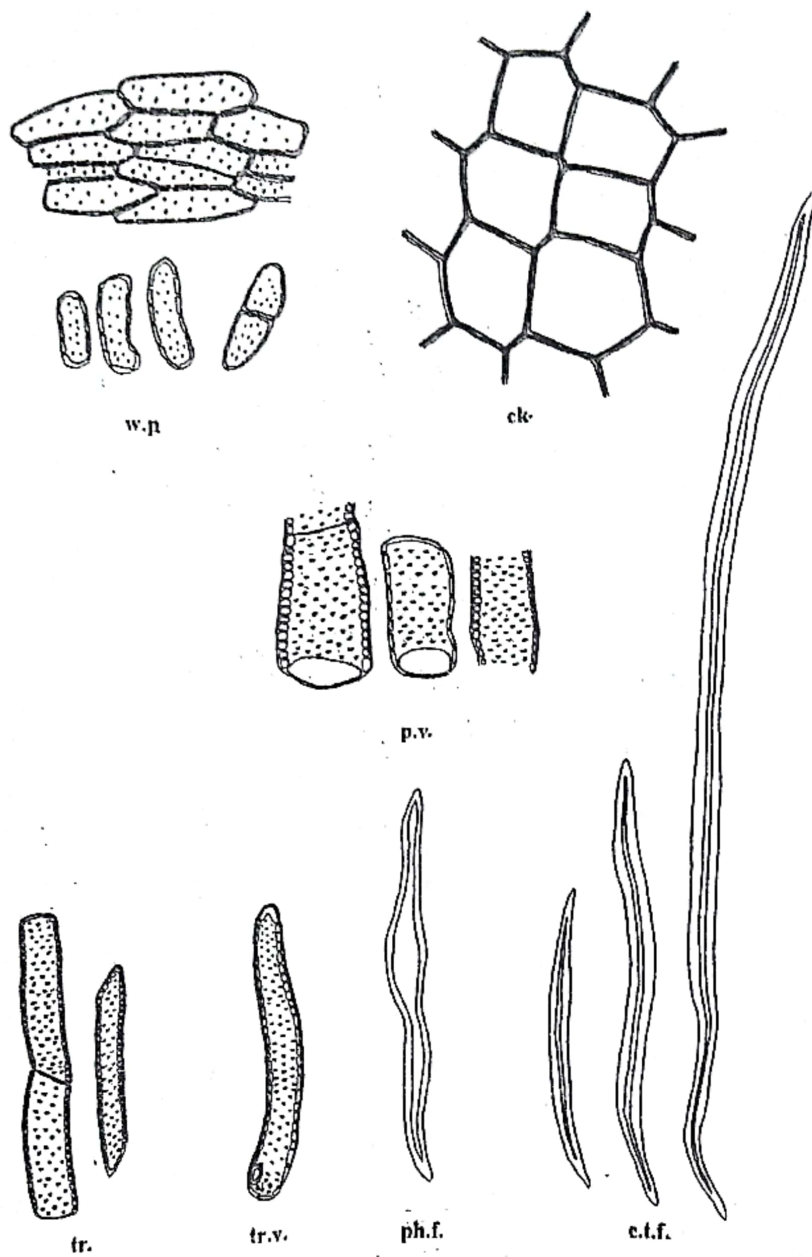
**Fig.3: The old root**

**A- Diagrammatic transverse section of old root**

**B- Detailed transverse section of old root**

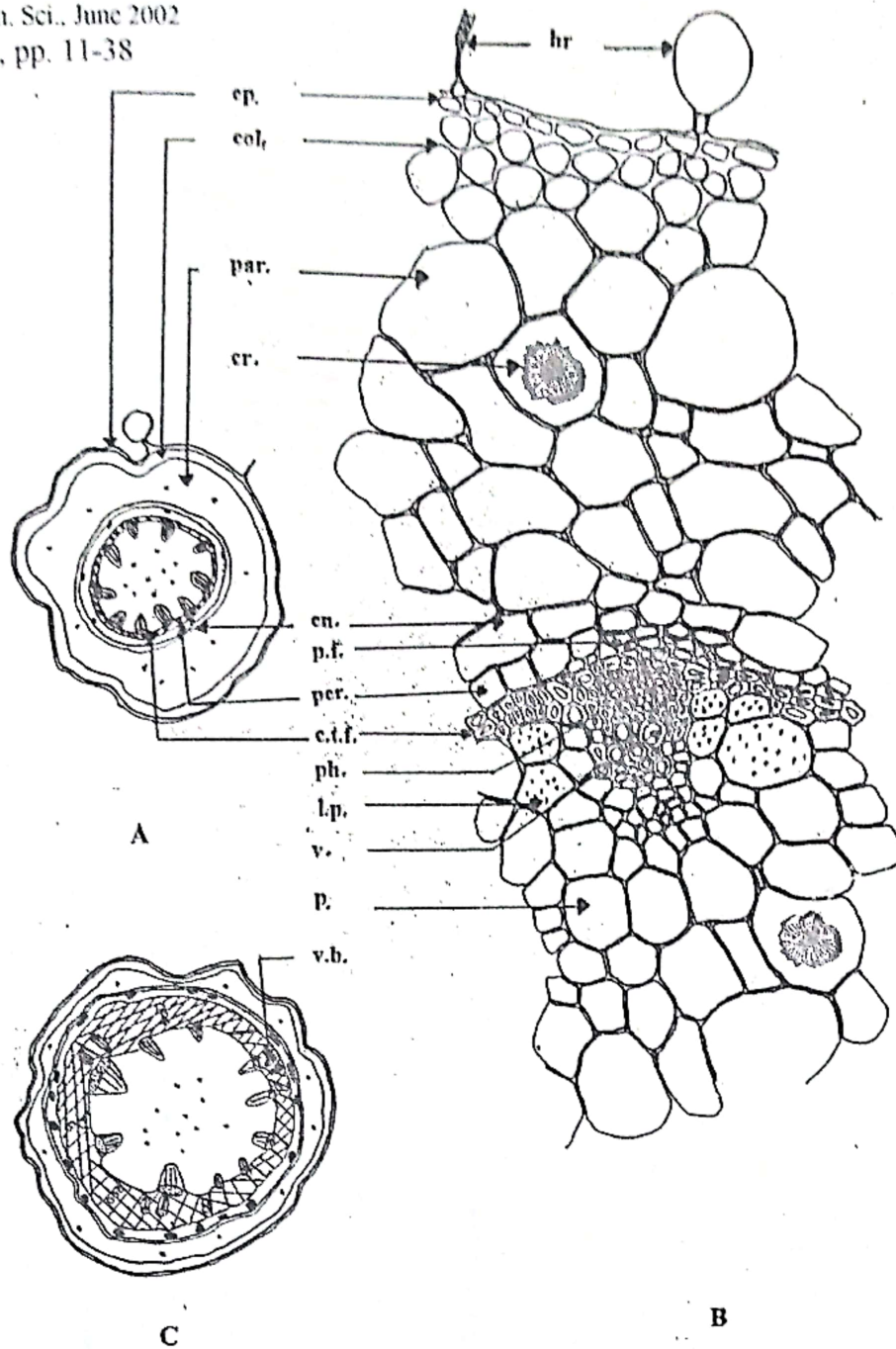
**(A x 51, B x 183.7)**

ck., cork cell; c.t.f., connective tissue fiber; pd., phelloderm; ph., phloem; ph.f., phloem fiber; v., vessel; v.b., vascular bundle; w.f., wood fiber; w. p., wood parenchyma; xy., xylem.



**Fig. 4: Isolated elements of old root**  
(All x 267.7 except ck. x 229.5)

**ck, cork cell; c.t.f., connective tissue fiber; ph.f., phloem fiber; p.v., pitted vessel; tr., tracheids; tr.v., tracheidal vessel; w.p., wood parenchyma.**



**Fig. 5: The young stem.**

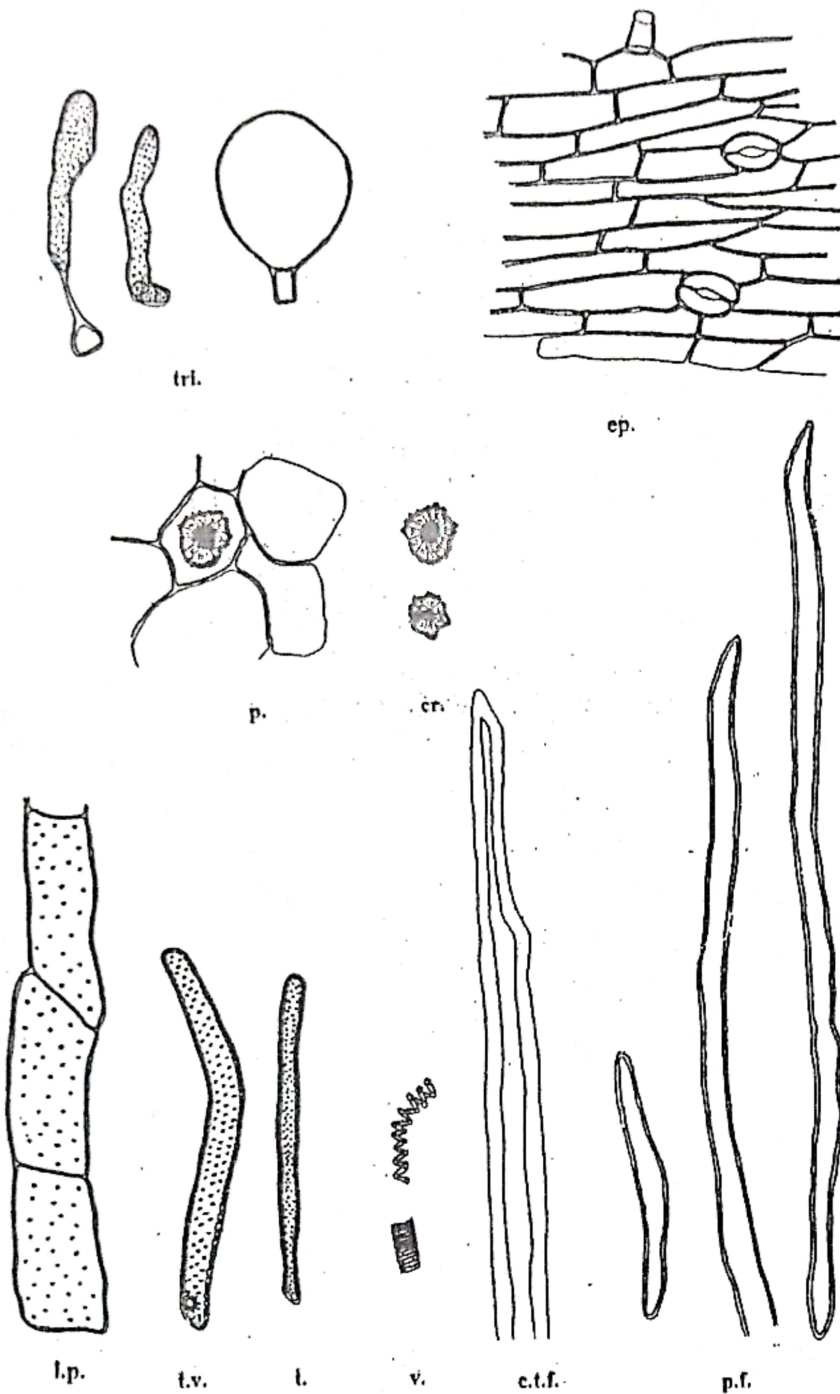
A- Diagrammatic transverse section in young green branch.

B- Detailed transverse section in young green branch.

C- Diagrammatic transverse section in old green branch.

(A x 44, B x 250.5)

col., collenchyma; cr., rosette crystals of calcium oxalate; c.t.f.; connective tissue fiber;  
 en., endodermis; ep.; epidermis; hr.; hair; l.p. lignified parenchyma; p., pith; par.,  
 parenchyma; per. pericycle; p.f., pericyclic fiber; ph, phloem; v., vessel; v.b., vascular bundle.

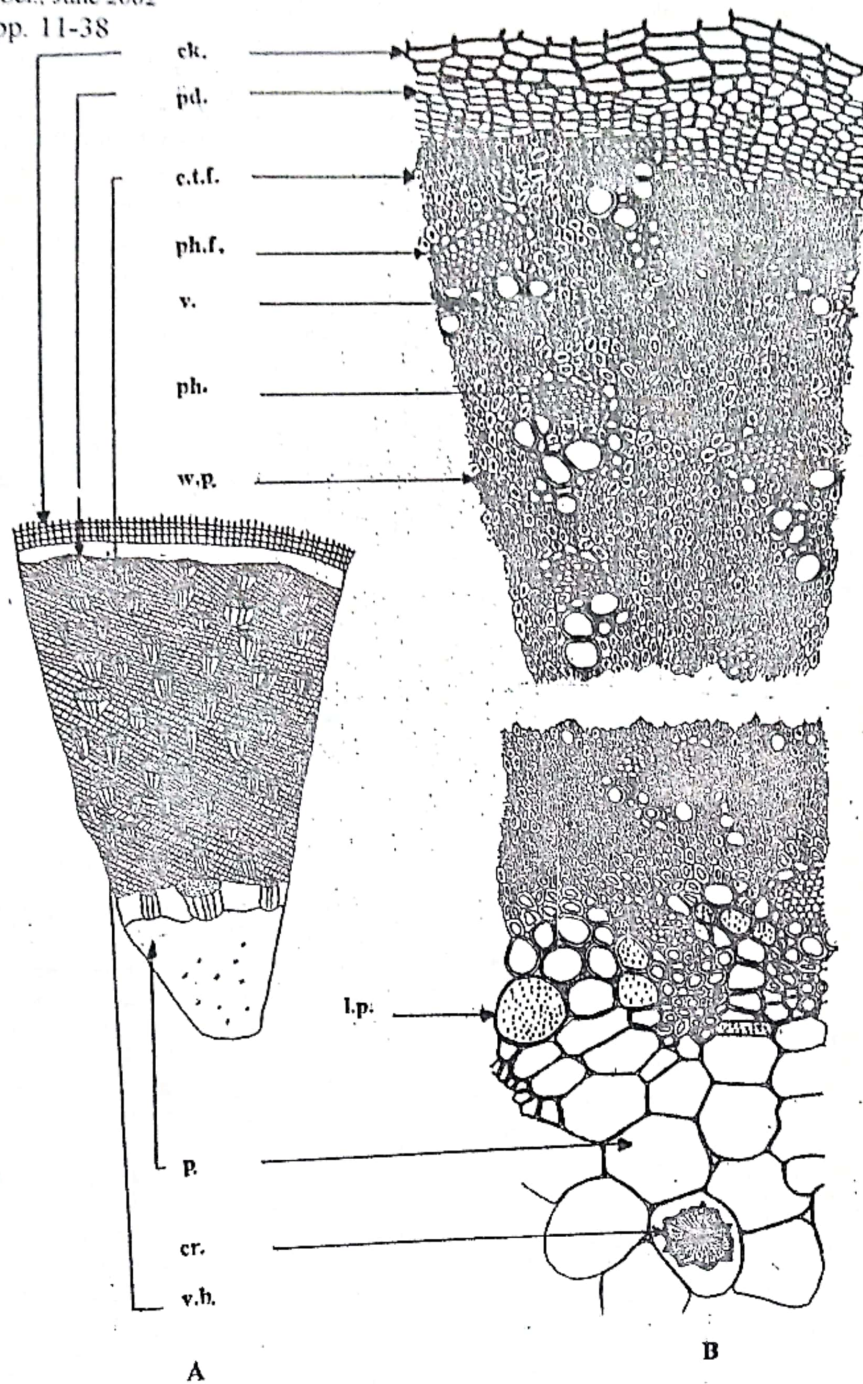


**Fig. 6: Isolated elements of young stem.**

(ep., cr., p. x 230, p.f., c.t.f. x 159, the rest x 262.5)

cr., rosette crystals of calcium oxalate; c.t.f., connective tissue fiber; ep., epidermis with stomata; l.p., lignified parenchyma with pits; p.f., pericyclic fiber; p., pith; tri., trichomes; tr., tracheids; tr.v., tracheoidal vessel; v., vessel.





**Fig. 7: The old stem:**

**A- Diagrammatic transverse section.**

**B- Detailed transverse section.**

(A x 36, B x 153)

ck., cork; cr., rosette crystals calcium oxalate; c.t.f., connective tissue fiber; l.p., lignified parenchyma with pits; p., pith; pd., phelloderm; ph., phloem; ph.f., phloem fiber; v., vessel; v.h., vascular bundle; w.p., wood parenchyma.

**v) The pericycle**

The pericycle of the young stem (Figs. 5B, 6) consists of 1-2 layers of polygonal slightly elongated thin-walled parenchymatous cells showing scattered 2-6 groups of lignified pericyclic fibers with thin walls, wide lumens and blunt apices.

**vi) The connective tissue**

Both old root and old stem show anomalous secondary thickening formed of matrix of connective tissue fibers but in young stem the pericycle region is followed by a continuous ring of 2-3 rows of connective tissue fiber. These fibers have thick lignified walls, narrow lumens and acute apices (Figs. 3, 4, 5, 6, 7 and 8).

**Table 1: Cell dimensions of different tissues of old root and stem of *Artiplex inflata* F. Muell. (in  $\mu$ ).**

Tissues	Dimension			
	Length	Breadth	Height	Diameter
Epidermal cell	65-110	14-21	6-10	-
Stomata	25-29	19-21	-	-
Glandular hair				
- unicellular stalk	12-14	10-12	-	-
- unicellular head	-	71-74	-	-
Covering hair				
- uniseriate	98-100	10-12	-	-
- bicellular			-	-
- collapsed hair near base	139-142	12-22		
Cork cells				
- old root	37-55	31-49	8-13	-
- old stem	31-39	21-31	12-18	-
Connective tissue fiber				
- old root	182-549	-	-	10-19
- young stem	580-690	-	-	20-29
- old stem	141-343	-	-	10-15
Phloem fibers				
- old root	215-245	-	-	17-23
- old stem	188-200	-	-	14-16
Pericyclic fibers				
- young stem	223-591	-	-	14-16
Xylem vessels				
- old root	-	-	-	43-49
- young stem	-	-	-	8-12
- old stem	-	-	-	19-37
Tracheids				
- old root	88-114	-	-	23-25
- young stem	173-176	-	-	10-12
- old stem	59-98	-	-	10-14
Tracheidal vessels				
- old root	160-162	-	-	20-22
- young stem	250-254	-	-	20-24
- old stem	160-162	-	-	20-22
Rosette crystals of calcium oxalate in old and young stem				20-94

**vii) The vascular tissue**

Each primary vascular bundle of the young stem is formed of an outer phloem and inner xylem. The phloem consists of polygonal moderately thick-walled cellulosic elements. The xylem (Figs. 6) consists of

lignified spiral and annular vessels, few tracheids and tracheidal vessel as well as slightly lignified xylem parenchyma. Between the vascular bundles there are lignified parenchyma with occasional pits.

The vascular tissue of the old root and old stem is formed of numerous vascular bundles embedded in a wide matrix of connective tissue fibers. The vascular bundles are radially arranged in the old root and found in irregularly diffused circles in the old stem. The phloem of all vascular bundles in old root and old stem are abutting by 1-2 layer (usually one) of lignified phloem fibers. The phloem fibers in old root after phelloderm is composed of 2-3 rows.

The xylem tissue of the old root (Figs. 3, 4) is formed of pitted vessels, tracheids, tracheidal vessels and lignified bands of wood parenchyma.

In the old stem, the xylem tissue (Figs. 7,8) composed of annular, spiral and pitted vessels, few tracheids, tracheidal vessels and few band of lignified wood parenchyma. Between the primary vascular bundles, there are large lignified parenchyma with pits.

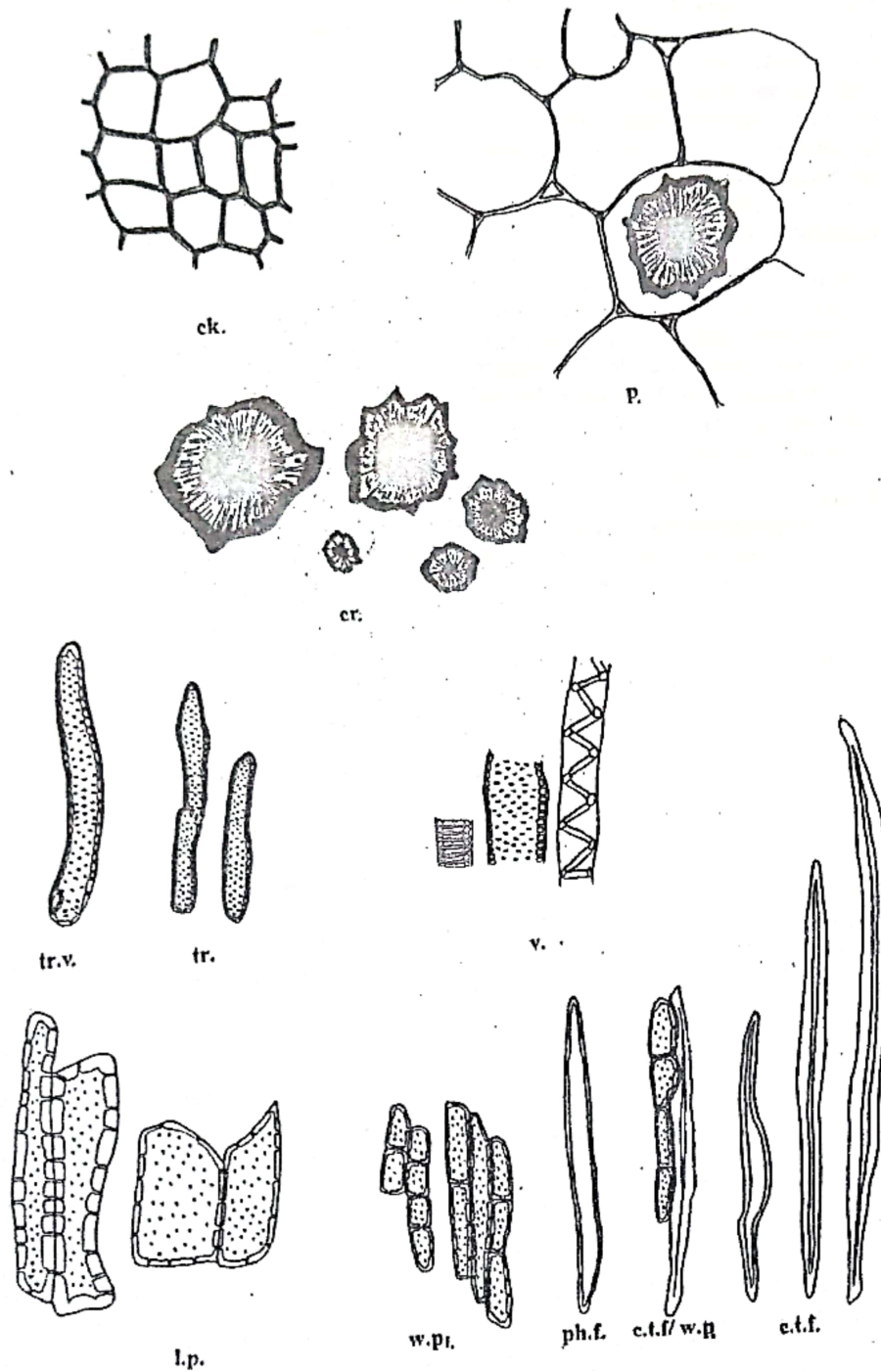
**viii) The pith**

Pith of the stem (Figs. 5, 6, 7 and 8) is composed of nearly rounded thin-walled parenchymatous cells with narrow intercellular spaces and occasionally contain rosette crystals of calcium oxalate.

**Powdered old root and stem**

The powder of the old root is yellowish brown but of the stem is yellowish-green in colour. They have faint odour and salty taste. They are characterized microscopically by the following fragments:

1. Fragments of epidermal cells of the young stem; the cells are polygonal with thick straight anticlinal walls and covered with thick smooth cuticle. It shows anomocytic stomata, glandular and covering trichomes or their scars.
2. Few Number of glandular trichomes with unicellular stalk and large balloon-like unicellular head.
3. The covering trichome being uniseriate bicellular and covered with warty cuticle and some terminal cells are collapsed near the base.
4. Fragments of cork formed of polygonal cells with slightly thick lignified walls.
5. Fragments of pitted lignified wood parenchyma
6. Fragments of lignified connective tissue fibers with thick lignified walls, narrow lumens and acute apices.
7. Fragments of lignified phloem and pericycle fibers with thin walls, wide lumens and blunt apices.
8. Fragments of lignified annular, spiral and pitted xylem vessels.
9. Fragments of lignified tracheids and tracheidal vessels.
10. Fragments of parenchyma of cortex and pith occasionally contain rosette crystals of calcium oxalate.



**Fig .8: Isolated elements of old stem.**  
 (All x 244.5)

ck., cork; cr., rosette crystals of calcium oxalate; c.t.f., connective tissue fiber; c.t.f. w.p., connective tissue fiber with wood parenchyma; l.p., lignified parenchyma with pits; ph.f., phloem fiber; p., pith; tr., tracheids; tr.v., tracheidal vessel; v., vessel; w.p., wood parenchyma between vascular bundle which exist in connective tissue matrix.

## 2. The leaf

A transverse section of the leaf (Figs. 9A, 9B and 9C), show kranz type of structure in the lamina<sup>(5)</sup>. It shows 4-9 small vascular bundles surrounded by incompleated sheath of chlorenchyma and the palisade like cells being oriented radially around the circum-vascular sheath. The midrib region shows three vascular bundles, two of them are surrounded by incomplete archs of large thick-walled chlorenchymatous cells.

### i) Epidermis

The epidermal cells in the lamina (Figs. 10B, 10C) are polygonal with thin straight anticlinal walls and covered with thin smooth cuticle. The epidermal cells in the midrib region (Fig. 10D) are polygonal axially elongated with straight anticlinal walls and covered with thin smooth cuticle.

### ii) Stomata

They occur on both surfaces of the leaf (Figs. 10B, 10C and 10D) being numerous on the lower one. They are of anomocytic type and oval or rounded in outline.

### iii) Trichomes

They are of glandular and non-glandular types and including:

#### a- The glandular hairs:

- 1- Unicellular stalk with large balloon-like spherical unicellular head (Fig. 10F).
- 2- Short bicellular stalk and large multicellular head (3-4 cells) (Fig. 10F).

#### b- Non-glandular trichomes covered with thin smooth cuticle include:

- 1- Uniseriate multicellular with rounded apex and collapsed near the base (Fig. 10F).
- 2- Bicellular trichomes with acute apex and collapsed cell near the base (Fig. 10F).

### iv) Mesophyll

The mesophyll (Fig. 9C) is formed of 1-3 rows of large more or less rounded parenchymatous cells with thin cellulosic walls. They measure 29-63 $\mu$  in diameter. In mesophyll, there are a small vascular bundles of lateral veins which are surrounded by chlorenchyma. The chlorenchyma cells measure 12-25 $\mu$  in length and 10-15 $\mu$  in breadth. The palisade-like cells being oriented radially around the circum-vascular sheath. This called kranz type of structure<sup>(5)</sup>. The palisade cells measures 6-23 $\mu$  in length and 4-8 $\mu$  in diameter.

### v) Cortex

The cortex of the midrib of the leaf (Fig. 9B) are parenchymatous cells which are more or less rounded with thin cellulosic walls and narrow intercellular spaces. Some of these parenchyma contain rosette crystals of calcium oxalate.

### vi) Vascular Tissue

The vascular tissue of the leaf (Fig. 10G) consists of closed collateral vascular bundles which is formed

of radiating xylem and cellulosic phloem. The phloem, consists of moderately thick cellulosic parenchymatous cells. The xylem is formed of lignified annular or pitted vessels which measure 10 to 17  $\mu$ . In-addition, cellulosic wood parenchyma are also observed. Cell dimensions of different tissues of leaf are summarized in Table 2, and the numerical values are summarized in Table 3.

**Table 2: Cell dimensions of different tissue of the leaf (in  $\mu$ ).**

Tissues	Dimension			
	Length	Breadth	Height	Diameter
<b>Epidermal cells</b>				
*upper lamina	52-78	27-49	20-39	
*lower lamina	37-60	19-39	13-23	
*upper neural	50-70	20-27	8-17	
*lower neural	49-65	17-23	4-10	
<b>Stomata</b>	19-27	19-21	-	
<b>Glandular hair</b>				
*unicellular stalk	12-14	10-12	-	
*unicellular head	-	71-74	-	
*bicellular stalk	31-33	10-15	-	
*multicellular head	-	48-50	-	
<b>Covering hairs with smooth cuticle</b>				
*uniseriate multicellular	115-117	10-19	-	
*uniseriate bicellular	193-196	19-39	-	
<b>Rosette crystals of clacium oxalate</b>				14-51

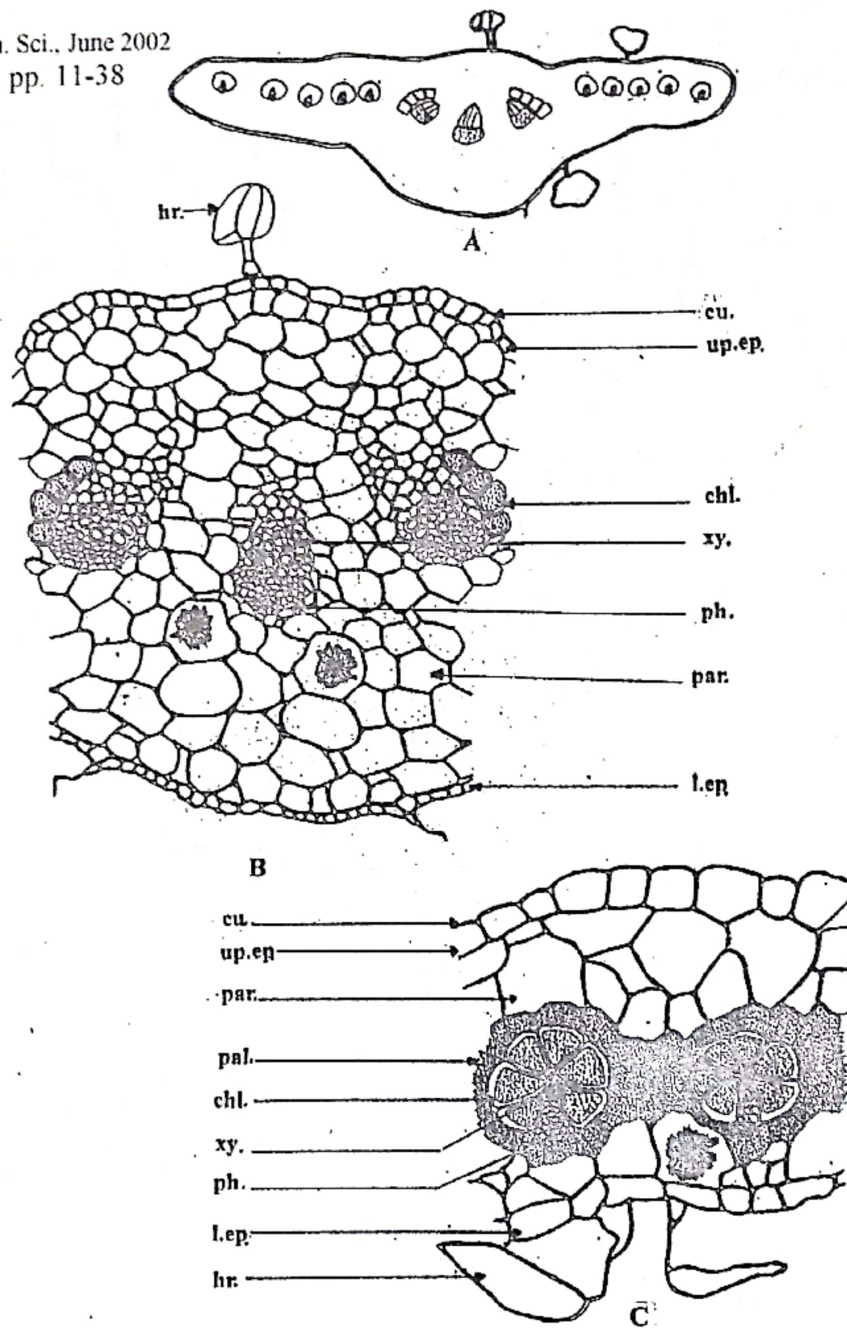
**Table 3: Numerical values of leaf**

Values	Numbers
<b>1-Stomatal index</b>	
a-upper epidermis	5.5- 11.7
b-lower epidermis	12.5-16.6
<b>2-Vein-islet number</b>	7-12
<b>3- Vienlet-termination number</b>	9-13

### Powdered leaf

The powdered leaf is greyish-green in colour with faint odour and slightly bitter salty taste. The powder is characterized microscopically by the following fragments:

1. Fragments of epidermal cells of the lamina, the cells are polygonal with thin straight anticlinal walls and covered with smooth cuticle. Anomocytic stomata, glandular and covering trichomes are present on both epidermises of the leaf.
2. Fragments of epidermal cells of the midrib, the cells are polygonal elongated with straight anticlinal wall and showing anomocytic stomata.



**Fig. 9: The leaf.**

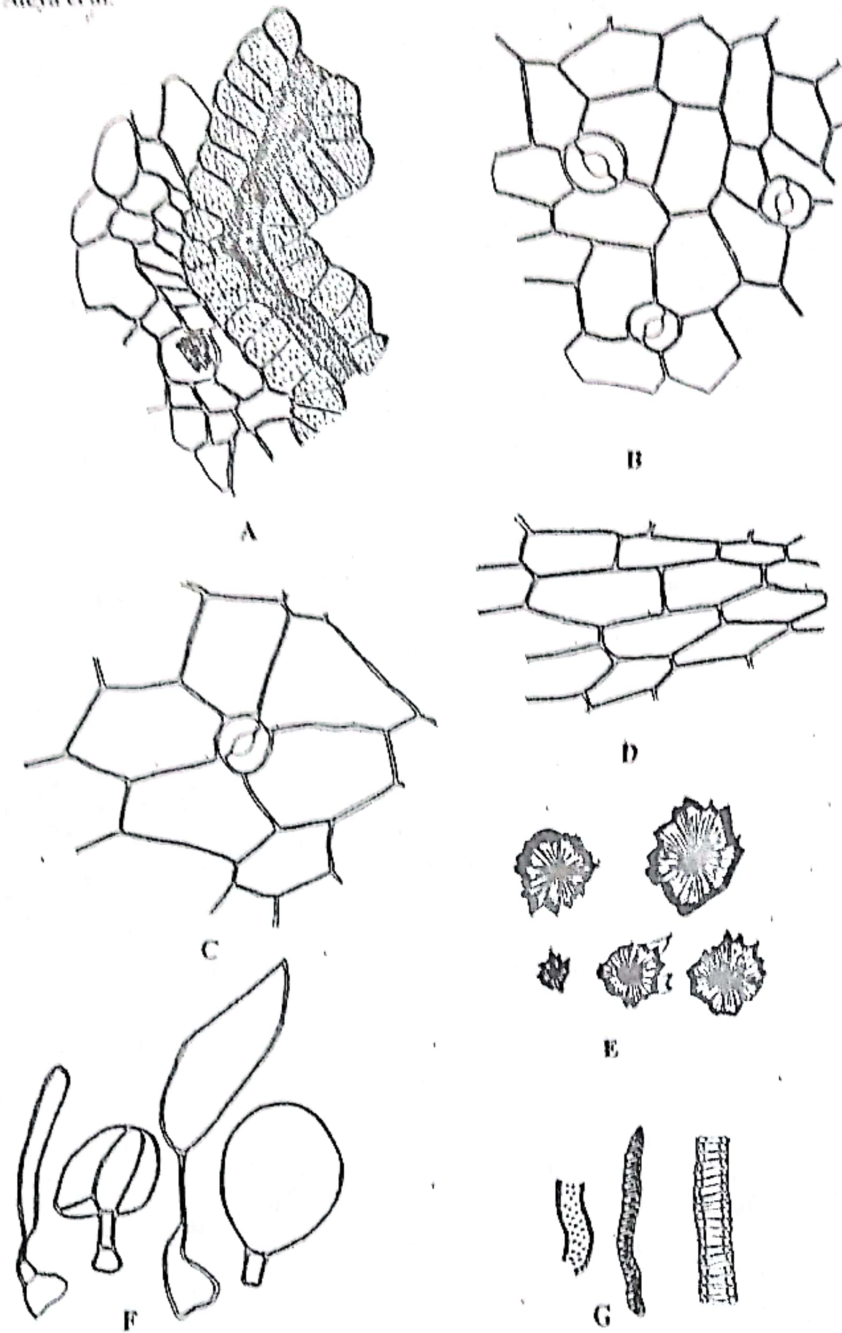
A- Diagrammatic transverse section of leaf.

B- Detailed transverse section in the midrib

C- Detailed transverse section in the lamina.

(A x 25.5, B x 153, C x 191)

chl., chlorenchyma; cu., cuticle, hr., hair; l. ep., lower epidermis; ph., phloem; par., parenchyma; pal., palisade like cell; up. ep., upper epidermis; v., vessel; xy., xylem.



**Fig. 10: Isolated elements of the leaf.**

A-Vein islets with parenchyma contain rosette crystals of ca. ox.  
B-Epidermis of lower surface of lamina. C- Epidermis of upper surface of lamina.  
D- Epidermis of the midrib. E- Rosette crystal of calcium oxalate.  
F- Hairs. G- Spiral, pitted and annular xylem vessel.

(All x 306 except upper and lower epidermis x 267.7)

3. Fragments of lamina showing vein-islet in which veins are surrounded by chlorenchyma. The parenchyma in vein-islet contain rosette crystals of calcium oxalate.
4. Large number of glandular and non-glandular covering trichomes, the glandular trichomes have unicellular or bicellular stalk with large balloon-like unicellular or multicellular head. The covering types may be uniseriate multicellular and uniseriate bicellular hair.
5. Fragments of lignified, annular and pitted vessels.
6. Numerous rosette crystals of calcium oxalate

### 3- The flowers

A transverse section of the rachis (Figs. 11A, 11B) shows circular with wavy outline and composed of an outer epidermis, wide cortex, parenchymatous pericycle and vascular tissue which is formed of a ring of 5-7 closed collateral vascular bundles surrounding a narrow parenchymatous pith.

In the large bract, a transverse section (Figs. 12A, 12B), shows an upper and lower epidermis enclosing in between a homogenous mesophyll which traversed longitudinally by 11-13 small vascular bundles. The cortical tissue of the midrib shows the presence of a large vascular bundle.

Small bract transverse section (Figs. 13A, 13B) is similar to that in the lamina of the large bract but it differs only in the midrib region where the vascular bundle is surrounded by large thick-walled cells and palisade like cells are continuous around vascular bundle in lamina and midrib regions.

A transverse section of the perianth (Figs. 14A, 14B and 14C) is similar to that of the leaf but the mesophyll of the lamina is traversed longitudinally by 3-5 vascular.

#### i) Epidermis

The epidermal cells are polygonal with thin straight anticlinal walls and covered with thin smooth cuticle; rachis (Fig. 11C<sub>1</sub>), large bract (Fig. 12B), small bract (Fig. 13C) and perianth (Figs. 14B, 14C).

#### ii) Stomata

They are observed on the epidermis of the rachis (Fig. 11, C<sub>1</sub>), both surfaces of the large bract, small bract and perianth (Figs. 12B, 13C and 14B, 14C, respectively). They are of anomocytic type and oval or rounded in outline.

#### iii) Trichomes

They are of glandular and non-glandular types. The glandular hairs may be with unicellular stalk and large balloon-like spherical unicellular head as in large bract (Fig. 12C<sub>2</sub>) and perianth (Fig. 14D), long bicellular stalk and large balloon-like unicellular head as in rachis (Fig. 11C<sub>2</sub>) and perianth (Fig. 14D), in addition uniseriate-unicellular or multicellular stalk and small unicellular head as in small bract (Fig. 13E).

Non-glandular trichomes are covered with thin smooth or warty cuticle are also observed. They may be uniseriate multicellular (2-3 cells) as in rachis (Fig.

11C<sub>2</sub>) and perianth (Fig. 14D). Trichomes which covered with warty cuticle may be, uniseriate-bicellular and unicellular as in large bract (Fig. 12C<sub>2</sub>).

#### iv) Cortex

The cortex of the rachis (Fig. 11B), large bract (Fig. 12B), small bract (Fig. 13B) and perianth (Fig. 14B), are parenchymatous; the cells are more or less rounded with thin cellulosic walls and narrow intercellular spaces. Some parenchyma cells contain rosette crystals of calcium oxalate. The inner most layer of cortex in rachis (Fig. 11B) is well differentiated endodermis.

#### v) Pericycle

The pericycle of rachis (Fig. 11B) consists of 2-3 rows of polygonal slightly elongated thin walled parenchymatous cells.

#### vi) Vascular tissue

The vascular tissue of rachis (Fig. 11C<sub>3</sub>), large bract (Fig. 12B), small bract (Fig. 13F) and perianth (Fig. 14E), consists of closed collateral vascular bundles which is formed of radiating xylem and cellulosic phloem. The phloem, consists of moderately thick-walled cellulosic parenchymatous cells. The xylem formed of lignified spiral, annular vessels in case of rachis measuring 6 to 10  $\mu$  in diameter, lastly annular vessels only in case of large bract, small bract and perianth measuring 10-17  $\mu$  and 6 to 10  $\mu$  in diameter, respectively. In addition, cellulosic wood parenchyma in all above organs are observed.

#### vii) The pith

The pith of rachis is narrow (Fig. 11A) and is formed of rounded parenchymatous cells measuring 9-13  $\mu$  in diameter.

**Table 4: Dimensions of different tissues of rachis, large bract, small bract and perianth (in  $\mu$ ).**

Tissues	Dimension			
	Length	Breadth	Height	Diameter
<b>Epidermal cells</b>				
-rachis	25-78	19-41	4-6	
-large bract				
*upper lamina	52-78	27-49	20-29	
*lower lamina	37-60	19-39	13-23	
-small bract and perianth				
*upper and lower lamina	21-39	16-29	6-8	
<b>Stomata</b>				
- large bract	19-27	19-21	-	
- rachis	17-20	25-27	-	
- small bract, perianth	19-23	15-17	-	

Table 4: *continued*

Glandular hair -large bract, perianth *unicellular stalk *unicellular head	40-43 -	8-10 113-115	- -	
-rachis, perianth *bicellular stalk *unicellular head	112-114	7-9 90-93	- -	
-small bract *uniserial unicellular *uniserial multicellular	78-124 153-160	12-14 8-9		
Covering hair with smooth cuticle -rachis, perianth *uniserial multicellular	213-215	12-15		
Covering hair with warty cuticle - large bract, *uniserial bicellular - large bract * unicellular	242-245 195-196	12-19 12-19		
Rosette crystals of calcium oxalate in rachis, large bract, small bract and perianth				10-33

**The androecium****1- The anther**

A transverse section of the anther (Fig. 15A, 15B) shows two anther-lobes, each enclosing two pollen sacs separated by a connective tissue. The anther wall is formed of an outer epidermis followed by a single row of fibrous layer and collapsed tapetum.

The epidermis (Fig. 15B) consists of polygonal cells with thin straight anticlinal walls and covered with thin smooth cuticle. Stomata and trichomes are completely absent.

The fibrous layer of the anther (Fig. 15E), is formed of one row of polygonal, radially elongated cells having straight beaded anticlinal walls.

Pollen grains (Fig. 15F) are spherical with 6 germ pores and finely granular exine and yellow in colour.

**2- The filament**

A transverse section of the filament (Fig. 15C, 15D), appear round in outline. It is formed of epidermis and ground tissue. There is vascular strand in the ground tissue of the filament. This vascular

strand formed of small patch of phloem and delicate xylem vessels which are spiral and annular.

The epidermis of the filament (Fig. 15H<sub>1</sub>, 15H<sub>2</sub>), consists of polygonal axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle. Stomata and hairs are completely absent.

The ground tissue of the filament (Fig. 15D) formed of 6-7 rows of more or less rounded thin-walled cellulosic parenchymatous cells with narrow intercellular spaces.

The epidermal cells of the disc (Fig. 15I) are polygonal axially elongated with wavy anticlinal walls and covered with thin smooth cuticle. They measure 51 to 102 $\mu$  in length and 16 to 20 $\mu$  in breadth. The measurement of elements of stamens are listed in Table 5.

Table 5: Dimensions of elements of the stamens (in  $\mu$ )

Tissue	Length	Breadth	Height	Diameter
<b>Anther</b>				
- pollen grain				18-25
<b>Filament</b>				
- epidermis at the upper part	18-39	12-20	6-8	
- epidermis at the middle and lower part	53-92	12-25	6-8	
<b>Xylem vessels</b>				6-8

**The gynaecium**

A transverse section in the ovary (Fig. 16A, 16B) shows an outer and inner epidermis enclosing in between a parenchymatous mesophyll which is transversely by five small collateral vascular bundles.

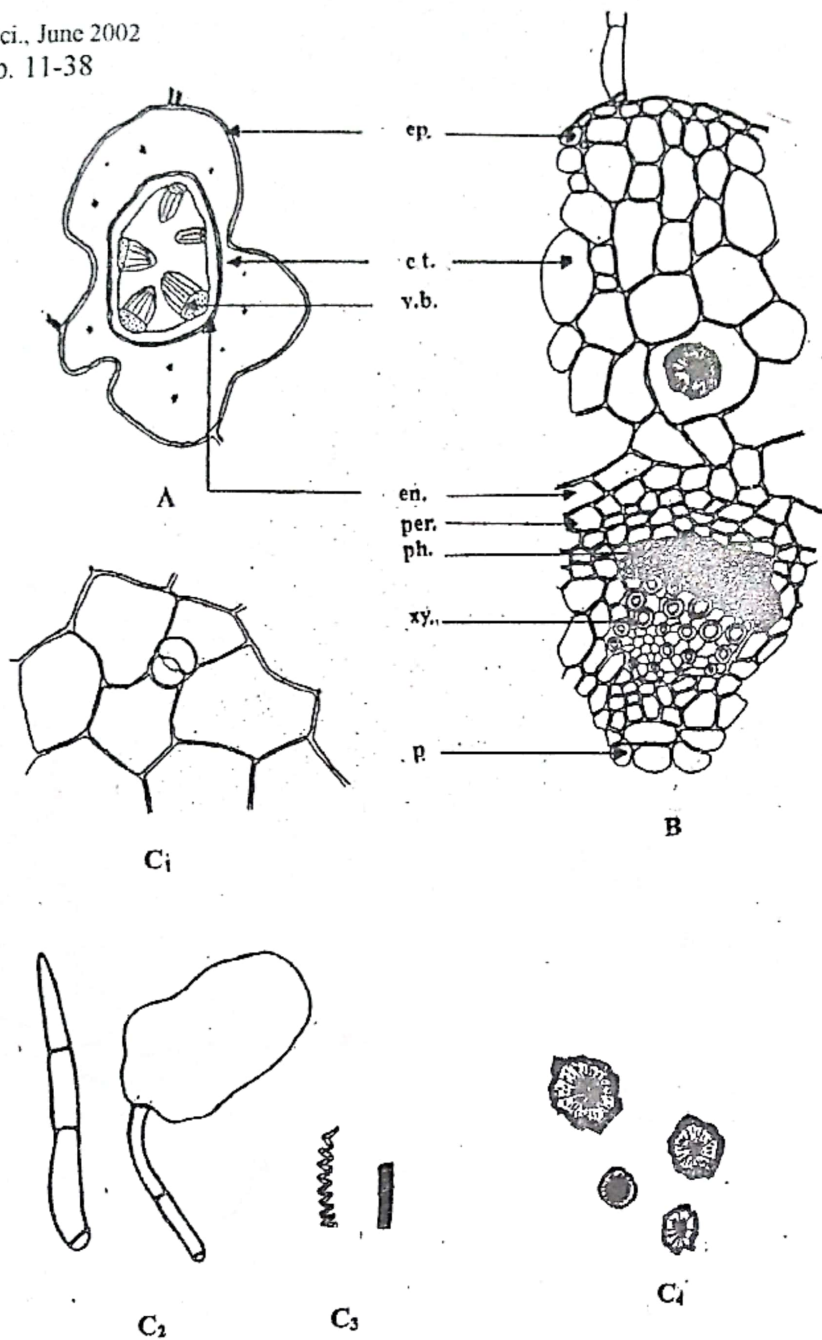
The outer and inner epidermises are formed of polygonal cellulosic cells with straight anticlinal walls and covered with thin smooth cuticle. They differ only in dimensions

The ovary wall shows the presence of non-glandular branched and glandular trichomes (Fig. 17G). Non glandular trichomes are multicellular branched with thin walls, smooth cuticle and measure 55 to 98  $\mu$  in length and 6 to 12  $\mu$  in diameter. Glandular trichomes are of 3 types;

1. With short unicellular stalk and large balloon-like spherical unicellular head the stalk measures 12 to 14 $\mu$  in length and 10 to 12  $\mu$  in diameter, while the diameter of head is 71 to 74  $\mu$ .
2. With bicellular stalk and multicellular head (3-4 cells), the stalk measures 31 to 33  $\mu$  in length and 10 to 15 $\mu$  in diameter, but the head measures 48 to 50 $\mu$  in diameter.
3. With long bicellular stalk and bicellular wavy head. The stalk measures 137 to 138  $\mu$  in length and 10 to 13 $\mu$  in diameter while the head is 99 to 101 $\mu$  in diameter.

The mesophyll of the ovary-wall (Fig. 16A, 16B) consists of 6-7 rows of thin-walled more or less





**Fig. 11: The rachis of male flower.**

A- Diagrammatic transverse section of the rachis.

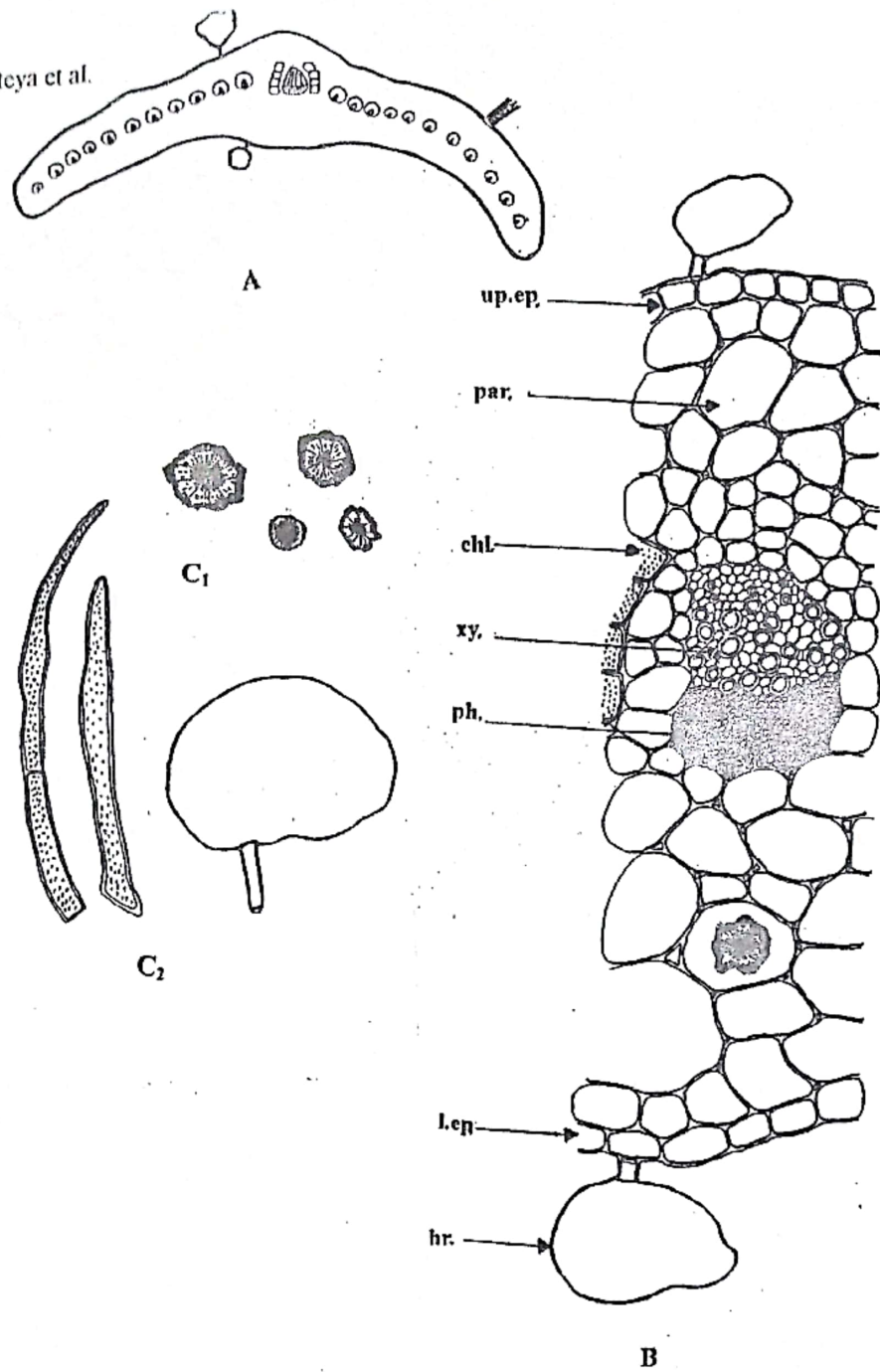
B- Detailed transverse section of the rachis.

C<sub>1</sub>- Epidermis of the rachis C<sub>2</sub>- Hairs. C<sub>3</sub>- Vessels.

C<sub>4</sub>-Rosette crystals of calcium oxalate.

(A x 55.5, B, C<sub>4</sub> x 267.7, C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub> x 229.5)

ct., cortex; en., endodermis; ep., epidermis; p., pith; ph., phloem; per., pericycle; v.b., vascular bundle; xy., xylem vessel.



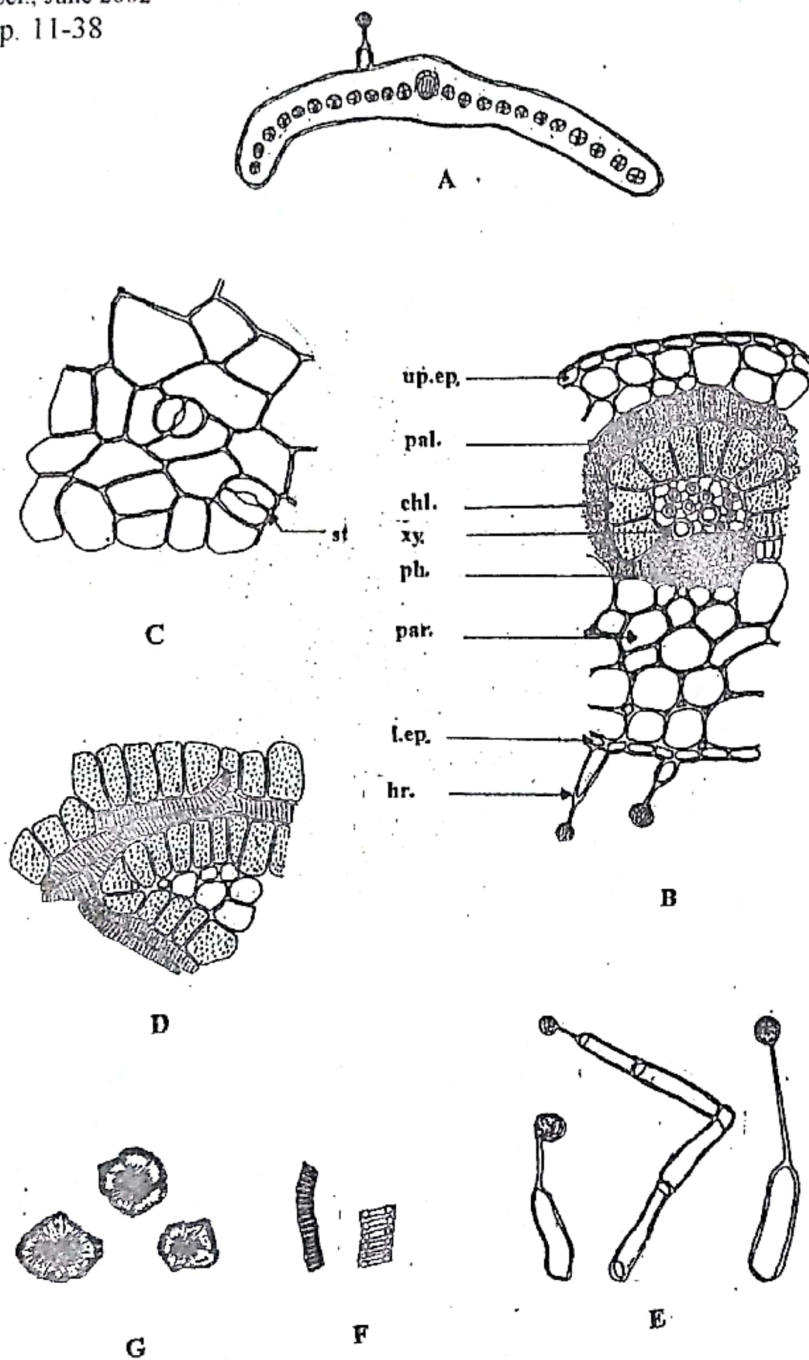
**Fig. 12: The large bract.**

A - Diagrammatic transverse section B - Detailed transverse section

C<sub>1</sub>. Rosette crystals of calcium oxalate. C<sub>2</sub>- Hairs

(A x 41, B, C<sub>1</sub> x 267.7, C<sub>2</sub> x 229.5)

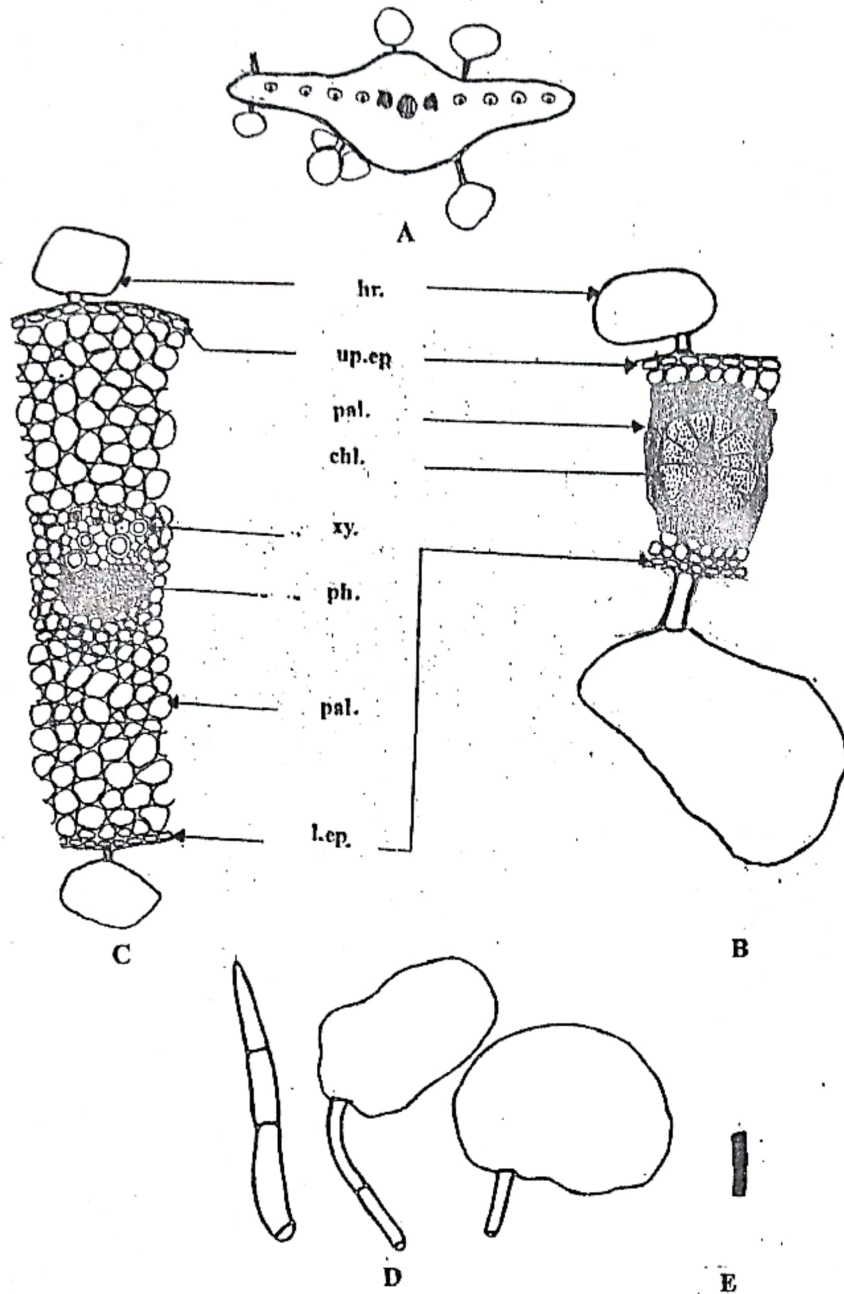
chl., chlorenchyma; hr., hair; l.ep., lower epidermis; ph., phloem; par., parenchyma; up. ep., upper epidermis; xy., xylem vessel.



**Fig. 13: The small bract.**

A- Diagrammatic transverse section B- Detailed transverse section in the midrib.  
 C- Epidermis with stomata of both surfaces.  
 D- Vein-islet surrounded by chlorenchyma cells.  
 E- Hairs F- Vessels. G- Rosette crystals of calcium oxalate.  
 (A x 344, B x 267.5, C, D, E, F, G x 306).

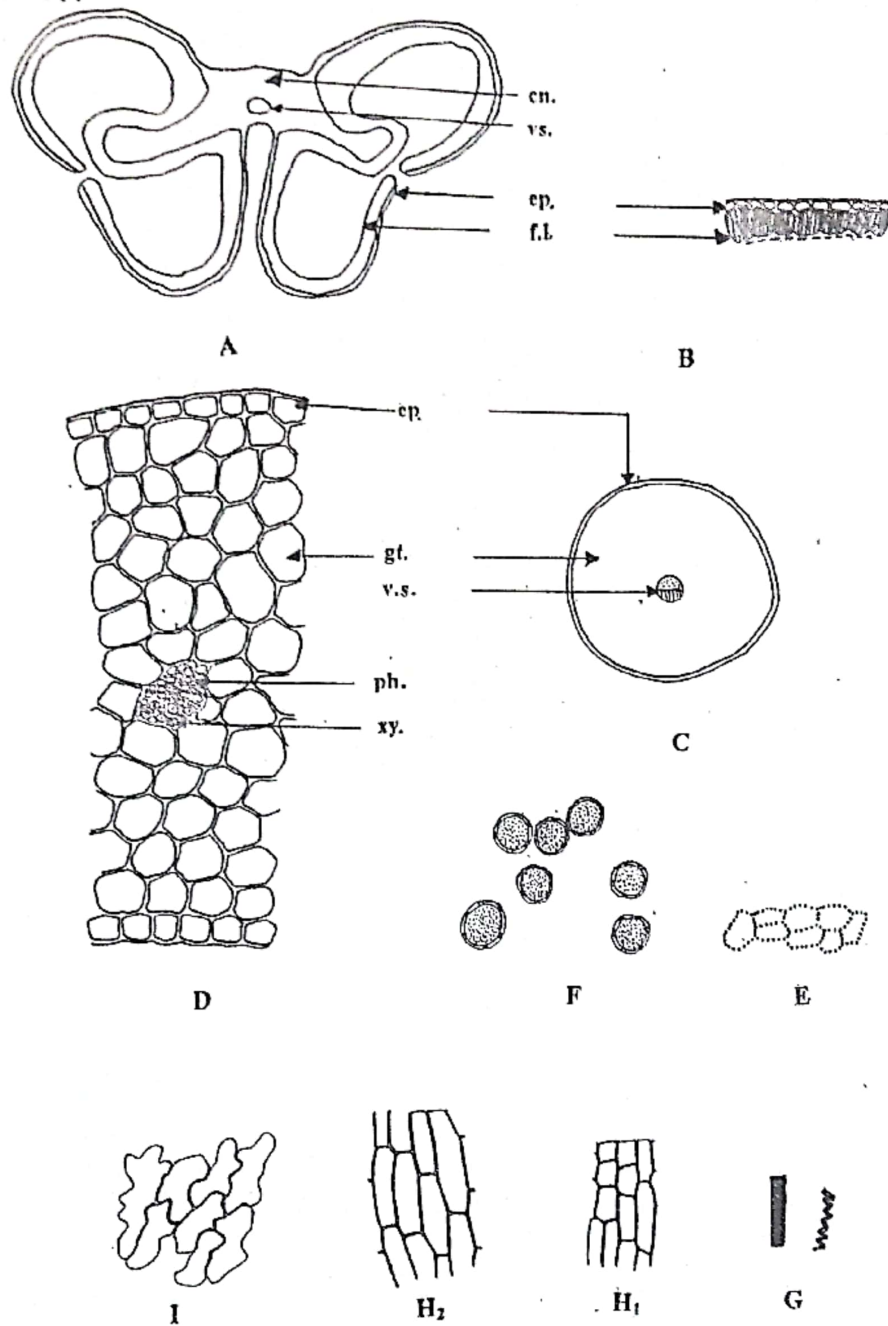
chl., chlorenchyma; hr., hair; l. ep., lower epidermis; ph., phloem; pal., palisade like cell; par., parenchyma; st., stomata; up. ep., upper epidermis; xy., xylem vessel.



**Fig. 14 :The perianth of the male flower .**

A- Diagrammatic transverse section B- Detailed transverse section in the lamina region  
 C- Detailed transverse section in the midrib region. D- Hairs E- Vessels.  
 (A x 68.6, B, C, x 267.7, D, E x 229.5)

chl., chlorenchyma; hr., hair; l. ep., lower epidermis; ph., phloem; pal., palisade like cells; par.,  
 parenchyma; up. ep., upper epidermis; xy., xylem vessel.

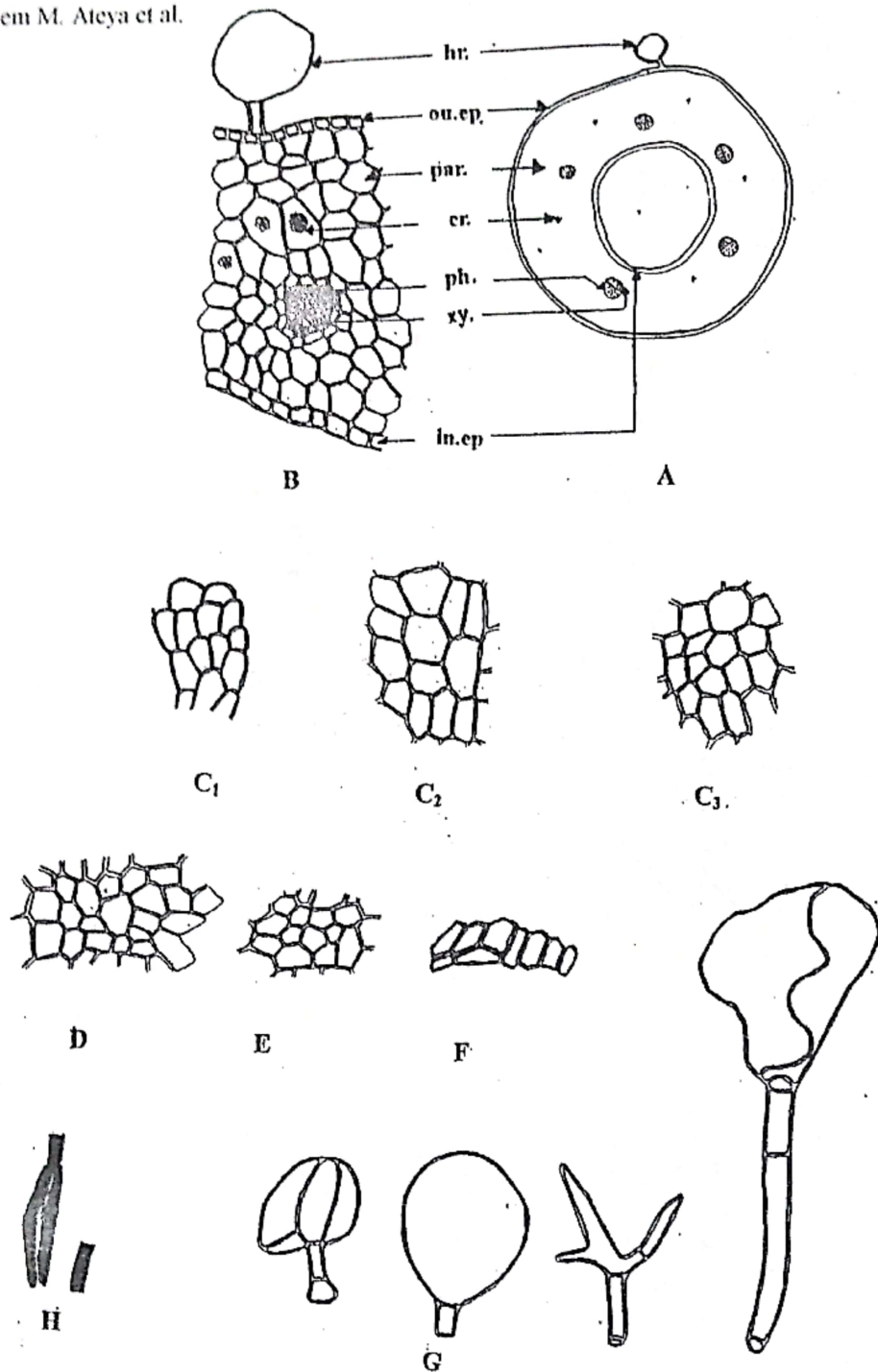


**Fig. 15: The androecium**

A- Diagrammatic transverse section in the anther. B- Detailed transverse section in the anther.  
 C- Diagrammatic transverse section in the filament. D- Detailed transverse section in the filament.  
 E- Fibrous layer of the anther in surfaces view. F- Pollen grains. G- Vessels.  
 H- Epidermis of the filament: H<sub>1</sub>- at the upper part. H<sub>2</sub>- at the middle and lower parts.  
 I- Epidermis of the disc.

(A x 55.5, B, E, F, G x 267.6, D x 306, H<sub>1</sub>, H<sub>2</sub>, I x 153, C x 66)

cn., connective; ep., epidermis; f.l., fibrous layer; g.t., ground tissue; ph., phloem; v.s., vascular strand; xy., xylem.



**Fig. 16: The gynaecium:**

A- Diagrammatic transverse section of the ovary wall.

B- Detailed transverse section of the ovary wall.

C- Epidermis of stigma: C<sub>1</sub>- At the upper part. C<sub>2</sub>- At the middle part. C<sub>3</sub>- At the lower part.

D- Epidermis of style.

E- Outer epidermis of the ovary wall. F- Scleried of the ovary.

G- Hairs.

H- Vessels.

(A x 57, B x 229.5, C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, D, E, F, G, H x 267.6).

cr., rosette crystals of calcium oxalate; hr., hair; in.ep., inner epidermis; ou.ep., outer epidermis; ph., phloem; par., parenchyma; xy., xylem.

polygonal parenchymatous cells with narrow intercellular spaces and measure 12 to 30 $\mu$  in diameter. Some of these parenchyma contain rosette crystals of calcium oxalate which measure 8 to 12 $\mu$  in diameter. It is transversed by small vascular bundles formed of small patch of parenchymatous phloem and annular xylem vessels measuring 6 to 8 $\mu$  in diameter.

The basal sclereids of the ovary (Fig. 16F) are polygonal slightly elongated with moderately thick lignified walls. They measure 12 to 25 $\mu$  in length and 8 to 14 $\mu$  in breadth.

The epidermal cells of style (Fig. 16D) and stigma (Figs. 16C<sub>1</sub>, 16C<sub>2</sub> and 16C<sub>3</sub>) are polygonal axially elongated cells with straight anticlinal walls. The upper part of stigma shows papillosed cells.

Trichomes and stomata are completely absent from the epidermis of style and stigma. The measurements of epidermal cells of the ovary, style and stigma are listed in Table 6.

#### The powdered flowers.

The powder is yellowish green in colour with slight odour and salty bitter taste. It is characterized microscopically by the following fragments.

1. Fragments of epidermal cells of rachis, large bract, small bract and perianth; the cells are polygonal with thin straight anticlinal walls and covered with smooth cuticle.
2. Fragments of epidermal cells of the filament, consisting of polygonal axially elongated cells with straight anticlinal walls and smooth cuticle.
3. Fragments of epidermal cells of the disc with wavy cells and smooth cuticle.
4. Fragments of epidermal cells of the ovary wall which is polygonal cells with straight anticlinal walls
5. Fragments of epidermal cells of the style and stigma formed of polygonal axially elongated cells with straight anticlinal walls, in addition, the cells of the upper part of stigma show elongated papillae.
6. Fragments of lamina showing vein-islet in which veins are surrounded by chlorenchyma.
7. Fragments of sclereids of the ovary which are polygonal cells with moderately thick-lignified walls
8. Fragments of fibrous layers of anther showing polygonal isodiametric cells with lignified beaded walls.
9. Covering trichomes either branched with smooth cuticle or non-branched with warty cuticle.
10. Glandular hair have short unicellular, bicellular or long bicellular stalk with large spherical unicellular, bicellular or multicellular (3-4) head.
11. Fragments of lignified spiral and annular vessels.
12. Numerous rosette crystals of calcium oxalate free or present in the parenchymatous cells of the ovary walls.

13. Numerous spherical pollen grains, they are yellow in colour with finely granular exine and 6-germ pores.

#### 4- The fruit

##### a) The pericarp:

A transverse section of the pericarp (Figs. 17A and 17B) is formed of an outer epicarp and inner endocarp enclosing in between wide spongy mesocarp traversed by small vascular strands and groups of lignified fiber.

The epicarp (Fig. 18A), consists of polygonal, axially elongated cells with straight anticlinal walls and covered with thin smooth cuticle.

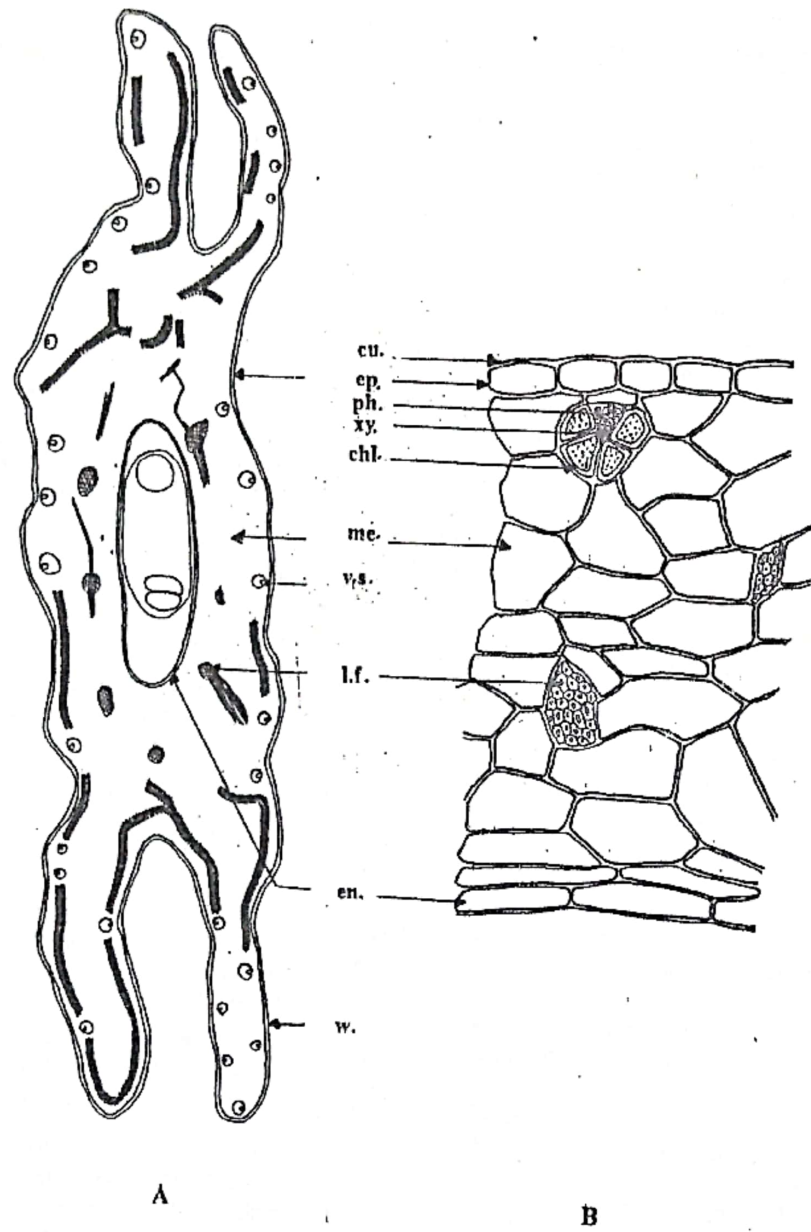
Few anisocytic and anomocytic stomata are observed on the epicarp (Fig. 18A). Branched and non branched covering trichomes are also present on the epicarp (Figs. 18G<sub>1</sub>, 18G<sub>2</sub>). The covering non branched type may be unicellular or uniseriate-bicellular and covered with warty cuticle. The other type is uniseriate-multicellular and covered with smooth cuticle.

The mesocarp (Figs. 17A, 17B) is composed of 8-9 rows of large thin-walled parenchymatous cells traversed by small vascular strand. The vascular strand consists of small patch of phloem and lignified spiral and annular xylem vessels (Fig. 18E). The vascular strand surrounded by larger thick-walled chlorenchymatous cells. Also, mesocarp is traversed by branched groups of lignified fibers each fiber has narrow lumen and blunt ends (Fig. 18D). Some fibers are long with thick lignified walls and show funnel-shaped lumen. Few parenchyma cells of mesocarp contain rosette crystals of calcium oxalate.

The endocarp (Figs. 18C<sub>1</sub>, 18C<sub>2</sub> and 18C<sub>3</sub>) is formed of polygonal or axially elongated cells with thin straight anticlinal walls and covered with thin smooth cuticle. The stomata of anomocytic type and present specially at the upper and middle part. Trichomes are completely absent in endocarp. The measurements of epidermal cells, stomata and hairs of pericarp are listed in Table 7.

Table 6: Dimension of epidermal cells of ovary wall, style and stigma (in  $\mu$ )

Epidermal cells	Length	breadth	Height
<b>Epidermal cell of the ovary</b>			
1-outer epidermis	8-24	8-21	4-6
2-inner epidermis	10-26	10-22	8-10
<b>Epidermis of the style</b>	10-22	8-12	-
<b>Epidermis of the stigma</b>			
1-at upper part	14-24		
2-at middle part	16-31	12-22	-
3-at lower part	12-24	10-24	
		8-20	



**Fig. 17: The fruit.**

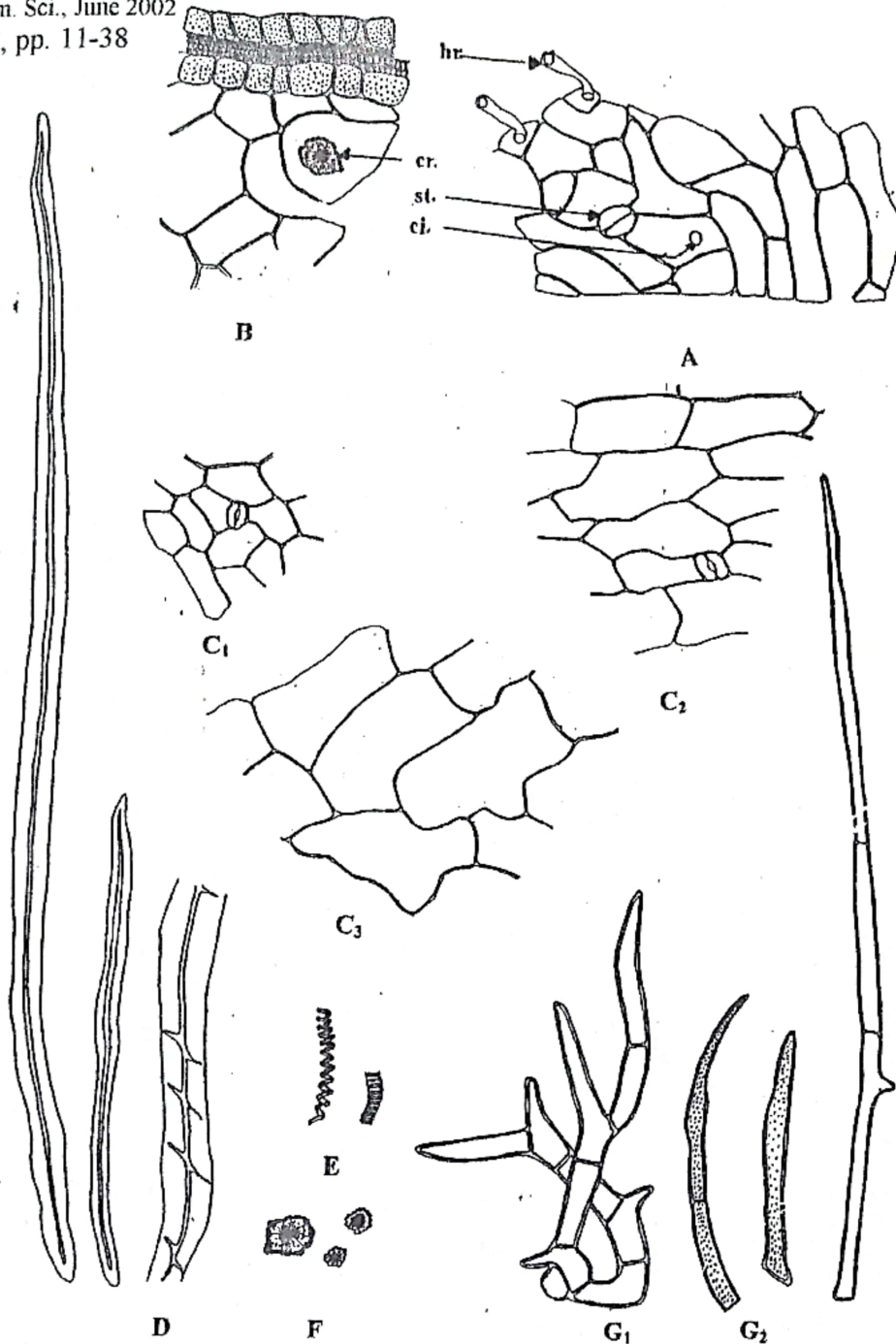
A- Diagrammatic transverse section of the fruit.

B- Detailed transverse section of the pericarp

(A x 15, B x 114)

cu., cuticle; ep., epicarp; en., endocarp; l.f., Lignified fiber; me., mesocarp; ph., phloem; t.l.c., thick large cell around small vascular bundle; v.s., vascular strand; w., wing; xy., xylem vessel.





**Fig. 18: Isolated elements of the pericarp.**

- A- Epidermal cells with hairs and stomata
- B- Vein islets with rosette crystals of Calcium oxalate.
- C- Epidermis of endocarp: C<sub>1</sub>- At the upper part. C<sub>2</sub>- At the middle part. C<sub>3</sub>- At the lower part.
- D- Fragment of lignified fiber      E- Spiral and annual vessel.
- F- Rosette crystals of calcium oxalate. G- Hairs: G<sub>1</sub>- Branched non-glandular hair.
- G<sub>2</sub>- Non-glandular unicellular and uniseriate-multicellular hair.

(A, B, C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, x 191, D x 272, E, F x 229.5, G x 267.6)  
 cl., cicatric; cr., rosette crystals of calcium oxalate; hr., hair; st., stomata.

Table 7: Dimension of some tissues of epicarp (in  $\mu$ )

Tissue	Length	Breadth	Height	Diameter
<b>Epicarp</b>				
- the epidermal cell	49-108	23-45	53-59	
- stomata	20-22	20-29		
- hairs				
- branched hair	140-225	12-18		
- unicellular with warty cuticle	198-198	13-19		
- uniseriate-bicellular with warty cuticle	242-245	10-17		
- uniseriate-multicellular	680-688	10-18		
<b>Mesocarp</b>				
- xylem vessels				6-8
- lignified fiber	265-618	10-18		
- fiber with funnel-shaped lumen	1530-1539	16-29		
- rosette crystals of calcium oxalate				12-29
<b>Endocarp</b>				
- epidermis at the upper part	35-59	18-31	19-32	
- epidermis at the middle part	59-124	23-49	20-35	
- epidermis at the lower part	110-139	43-82	23-40	
- stomata	20-22	14-20		

#### b- The seed

A transverse section of the seed (Figs. 2D, 19A) is nearly oval in outline and shows an outer testa surrounding a kernel composed of an endosperm and strongly curved embryo.

The testa is formed of outer and inner epidermises with collapsed layer inbetween. The outer epidermis (Fig. 19B) is composed of polygonal tangentially elongated cells with straight anticlinal walls and covered with thin smooth cuticle. The periclinal walls shows non lignified bar-like thickening. The epidermal cells measure 25 to 67  $\mu$  in length, 18 to 37  $\mu$  in breadth and 10 to 12  $\mu$  in height. The hypodermis consists of flattened collapsed cells. The inner epidermis (Fig. 19C) is formed of polygonal cells with straight anticlinal walls, appearing striated parquetry striated in surface view. They are filled with reddish brown tannoid contents and measure 14 to 39  $\mu$  in length, 14 to 33  $\mu$  in breadth and 4 to 6  $\mu$  in height.

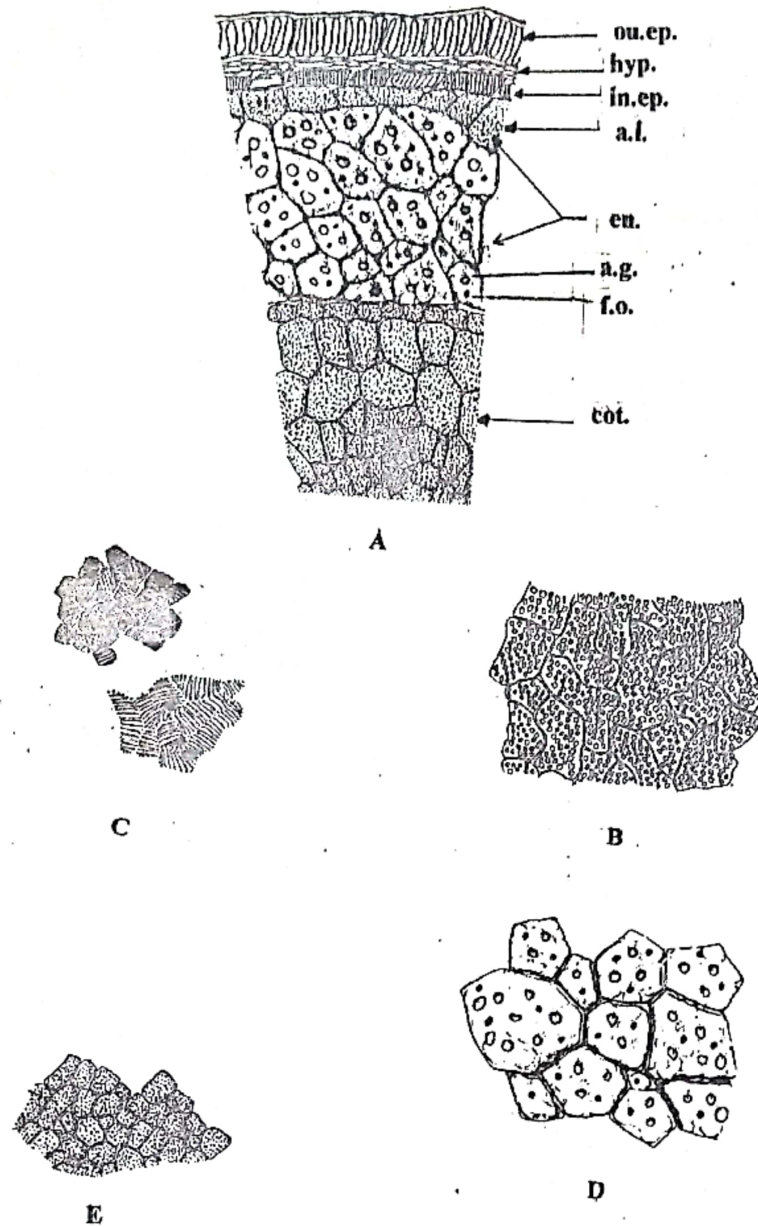
The endosperm (Fig. 19D) showed an outer aleurone layer formed of one row of polygonal cells with straight cellulosic anticlinal walls and containing aleurone grains. They measure 15 to 27  $\mu$  in diameter.

The rest of the endosperm (Fig. 19D) is formed of large polygonal, thin-walled cellulosic cells, contain large rounded aleurone grains (25 to 59  $\mu$  diameter) and fixed oil droplets (10 to 16  $\mu$  in diameter). The embryo consists of thin-walled parenchyma with aleurone grains (Fig. 19E).

#### Powdered fruit

The powdered fruit is reddish-brown in colour with characteristic odour and slightly bitter taste. Microscopically, it is characterized by the following fragments:

1. Fragments of epicarp formed of polygonal slightly elongated cells with straight anticlinal walls and covered with thin smooth cuticle. They show anomocytic stomata.
2. Fragments of mesocarp which consist of large thin walled parenchymatous cells containing rosette crystals of calcium oxalate and traversed by vascular strands which surrounded by chlorenchyma.
3. Fragments of endocarp, which is polygonal, elongated parenchyma cell with thin straight anticlinal walls and covered with thin smooth cuticle and also stomata are present.
4. Numerous rosette crystals of calcium oxalate free or in mesocarp cells.
5. Fragments of lignified fiber with narrow lumens some with funnel-shaped pits.
6. Fragments of lignified spiral and annular xylem vessels.
7. Branched and non-branched covering trichomes. The non-branched hair may be:
  - a) Unicellular or bicellular and covered with warty cuticle.
  - b) Uniseriate-multicellular and covered with thin smooth cuticle.
8. Fragments of outer epidermis of seed coat formed of polygonal elongated cells with bar-like thickened wall and show pores in surface view.
9. Fragments of inner epidermis which is polygonal and striated (parquetry arranged) with beaded walls in surface view and contain reddish-brown tannoid contents.
10. Fragments of endosperm composed of large polygonal thin cellulosic parenchyma cells which contain aleurone grains and fixed oil droplets.
11. Fragments of embryo formed of thin-walled parenchyma with aleurone grains.



**Fig. 19: The seed.**

A- Detailed transverse section of the seed. B-Outer epidermis.

C- Inner epidermis. D- Fragment of endosperm. E- Fragment of cotyledon.

(A x 196.5, B, C, D, E, F, G x 229.5)

a.g., aleuron grain; a.l., aleuron layer; cot., cotyledons; en., endosperm; f.o., fixed oil; hyp., hypodermis; in.ep., inner epidermis; ou.ep., outer epidermis.

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### دراسة الصفات العيانية والمجهريّة لنبات أتريلكس أنفلاتا موللي (العائلة الرمامية - السينوبوديّة)

عبد المنعم محمد عطية - عزة محمد الشافعى - عاصم محمد الشاذلى

و داليا إبراهيم على حمدان

قسم العقاقير - كلية الصيدلة - جامعة الزقازيق

مصر

يتناول هذا البحث دراسة الصفات العيانية والمجهريّة للجذر والساق والأوراق والأزهار والثمار لنبات أتريلكس أنفلاتا بهدف التعرف على أجزاء النبات المختلفة سواء كانت صحيحة أو على هيئة مسحوق.