Bull. Pharm. Sci., Assiut University
Vol, 9. Part 2, pp 187 - 209

MACRO-AND MICROMORPHOLOGY OF SALVIA FARINACEA BENTH (ROOT AND FLOWER)

A.A. Aly, D.W. Bishay, M.A. El-Shanawany and M.S. Kamel
Dept. of Pharmacognosy, Faculty of Pharmacy, Univeristy of Assiut, Assiut, Egypt.

ABSTRACT

The macro- and micromorphology of the root and flower of Salvia Farinacea Benth Cultivated in Egypt are presented with the view of determining the diagnostic features by which these organs can be identified both in the entire and powdered forms.

INTRODUCTION

Salvia comprises several species which are reputed by folklore medicinal uses as good cough sedatives, expectorants, diaphoretics and antituberculous[1]. Several workers reported that Salvia species contain volatile oils, terpenes and flavonoids[2,3].

In a pervious paper[4] the macro- and micromorphology of the leaves and stems of Salvia farinacea Benth. (Family Labiatae) was presented. This work deals with the macro- and Micromorphology of roots and flowers of the plant.

EXPERIMENTAL

Materials:

The roots and flowers of Salvia farinacea Benth were collected from plants that grown in the Experimental Station, Faculty of Pharmacy, University of Assiut. The identity of the plant was verified by Prof. Dr. M.N. El-Hadidy, Dept. of Botany, Faculty of Science, Cairo University.

The material used in this study was fresh or preserved in alcohol 70% containing 5% glycerin. The powder was prepared from air-dried plants.

Macromorphology

1- The Root (Fig. 1)

It is short, fusiform in shape, brown to drak brown in colour and penetrating the soil vertically. Externally it is longitudinally wrinkled and having a faint odour and a slight bitter taste.

2- The Inflorescence (Fig. 1)

It is verticillaster. In the axil of each leaf there is a dichasium biparous cyme which passes on either side into a uniparous scorpioid cyme formed of three flowers. Each scorpioid has a bract and these verticillasters are crowded on the apex of the main stem and lateral branches, with the subtending leaves being reduced to bracts, thus appearing as raceme or spike inflorescence.

The Bract (Fig. 2A):

It is linear, greenish-violet in colour, measuring 8 to 10 mm in length and 3 to 5 mm in breadth. It has an acute apex and entire margin.

Macro- and Micromorphology of Salvia Farinacea Benth (Root and Flower).

The Flower (Fig. 2B):

It is hypogenous zygomorphic, hermaphrodite, pedicellate and having the floral formula:

$$\% \ , \ \varphi \ ; \ K_{(5)} ; \ C_{(5)} , \ A_2 , \ G_{(\underline{2})}$$

It has an aromatic odour and pungent aromatic taste, measuring 0.8 to 1.2 cm in length.

The Calyx (Fig. 2C):

It is violet in colour and hairy. It consists of five sepals, which are gamosepalous forming a tube terminated by 5 toothed mouth. It is bilipped, the upper lip is bifid and the lower one is trifid. The calyx tube measures 0.5 to 0.8 cm in length, 2 to 3 mm in diameter at the base and 3 to 5 mm in diameter at the top. Each tooth measures 0.5 to 1 mm in breadth at the widest part.

The Corolla (fig. 2C):

It is pale-violet to mauve in colour, formed of five united petals. It is differentiated into a tube and a limb. The tube is straight, paler in colour than the limb and widening towards the mouth. The limb is markedly divided into lips, the posterior pair of petals forming the upper lip which is nearly flat, the three anterior petals form the lower lip, the median lobe of which is the most developed. The corolla tube measures 1 to 1.6 cm in length and 5 to 8 mm in diameter near the mouth.

The Androecium (Fig. 2C):

It consists of two epipetalous stamens alternating with the three lobes of the lower lip of the corolla. Each stamen is formed of short filament, elongated lever-like[5] connective with a fertile anther on the long arm and a sterile one on the short arm[6].

The filament measures 0.3 to 0.5 cm in length and the connective 0.6 to to 0.8 cm in length.

The fertile anther measures about 2 mm in length and 0.5 mm in diameter. The filament and connective are yellow in colour while the fertile anther is dark-brown.

The Gynaecium (Fig. 2C):

It consists of a syncarpous bicarpillary ovary. The ovary is superior, from 1.5 to 3 mm in length and about 0.8 mm in diameter. It is tetralocular, each locule having a single anatropus, erect, basal ovule.

The style is filiform, yellowish-brown in colour, gynobasic, springing from the base of the ovary between the locules. The style measures from 1.2 to 1.5 cm in length and from 0.5 to 1 mm in diameter. The stigma is bifid.

MICROMORPHOLOGY

1- The Root:

A transverse section in the root (Fig. 3A) is nearly rounded in outline The cork (Fig. 3B) consists of narrow zone of several rows of reddish-brown, somewhat tangentially elongated cells, which in surface view (Fig. 3C) appear polygonal to subrectangular with nonlignified thick walls measuring 35-49-62 μ in length, 25-31-37 μ in width and 11-13-15 μ in height.

The cortex (Fig. 3B) is narrow and consists of isodiametric, rounded to polygonal thin-walled parenchymatous cells with large intercellular spaces. Some of the cortical parenchyma contain starch granules which are mainly simple, rounded with a central point-like hilum measuring from 3 to 5 μ in diameter.

The phloem (Fig. 3B) consists of thin-walled soft cellulosic elements of sieve tubes, companion cells and phloem parenchyma.

The cambium (Fig. 3B) is formed of 2-3 rows of cellulosic thin-walled cambiform cells.

Macro-and Micromorphology of Salvia Farinacea Benth (Root and Flower).

The xylem (Fig 3B) is a comparatively wide cylinder of lignified elements. The vessels are mainly solitary or in small groups. They have pitted, reticulate and spiral thickenings and measuring 18-34-49 μ in diameter. Tracheids and tracheidal vessels have simple pits and measuring 164-199-233 u in length and 20-25-31 μ in diameter. Numerous wood fibres have slightly irregulax walls, wide lumena and acute or acuminate ends. They measure 20-28-36 u in diameter and 444-537-630 μ in length. The wood parenchyma cells are rectangular to subrectangular in shape with pitted lignified walls and measure 22-25-28 μ in width and 76-82-89 μ in length.

The medullary rays (Fig. 3B) are 3 to 7 cells wide. The cells are radially elongated, lignified and pitted in the xylem region and thin-walled parenchymatous in the phloem region.

Powdered Root

Powdered root (Fig. 3C) is yellowish-brown in colour with faint odour and slightly bitter taste.

Microscopically the powder shows the following:

1- Fragments of polygonal, thick-walled, reddish-brown cork cells.
2- Fragments of xylem vessels with reticulate, pitted and spiral thickenings.
3- Fragments of tracheids and tracheidal vessels with lignified walls showing simple pits.
4- Fragments of wood fibres with lignified, slightly pitted walls, wide lumena and acute or acuminate ends.
5- Fragments of medullary ray cells and wood parenchyma cells which have lignified pitted walls.
6- Fragments of thin-walled parenchymatous cells of the cortex containing simple starch granules with central point-like hilum.

2- The Inflorescence:

A- The Bract

A transverse section in the bract (Fig. 4A) shows a heterogeneous mesophyll, a vascular strand in the midrib as well as the cortical tissue.

The upper and lower epidermises (Fig. 4B,C) consists of polygonal cells with straight (upper) or sinuous (lower) anticlinal walls covered with smooth cuticle. The upper epidermal cells measure 30-47-64 µ in width while the lower epidermal cells measure 80-115-150 µ in length and 60-85-105 µ in width.

The stomata are present on both surfaces but more abundant on the lower one. They are of the diacytic type and measuring 25-27-29 µ in length and 20-22-24 µ in width.

Trichomes (Fig. 4D) of both non-glandular and glandular types are present on both surfaces. The non-glandular trichomes are of two types:

1- Curved unicellular hairs with warty cuticle, measuring 24-31-36 µ in width and 114-131-148 µ in length. They are mainly present on the upper epidermis
2- Multicellular, uniseriate hairs from 2 to 6 cells, covered with warty cuticle and measuring 25-27-29 µ in width and 410-818-1225 u in length.

The glandular trichomes have unicellular head measuring 28-40-52 µ in diameter and unicellular or bicellular uniseriate stalk measuring 13-15-17 µ in width and 15-18-22 µ in length. Labiaceous hairs are absent.

The mesophyll is dorsiventral, showing two rows of palisade cells followed by few rows of spongy parenchyma.

The vascular bundle in the midrib region is formed of xylem upwards and phloem underneath. The xylem consists mainly of lignified vessels and the phloem consists of thin-walled cellulosic elements.

B- The Flower

The Calyx

A transverse section in the sepal (Fig. 5A) reveals an inner and outer epidermises, enclosing in between a homogeneous mesophyll traversed by numerous vascular strands.

The inner epidermis (Fig. 5B) is formed of polygonal, axially elongated cells with straight anticlinal walls and covered with thin, smooth cuticle. They measure 71-86-101 μ in length and 28-31-44 μ in width.

The outer epidermis (Fig. 5C) is formed of polygonal cells with wavy anticlinal walls and covered with thin smooth cuticle. They measure 66-80-94μ in length and 32-44-53 μ in width. Stomata are of diacytic type, being rare on the inner epidermis and abundant on the outer epidermis. They measure 22-44-26 μ in length and 18-20-22 μ in width.

Trichomes (Fig. 5D) are present on both epidermises, being numerous on the outer epidermis. The non-glandular hairs are similar to those of the bract but the unicellular type measures 146-155-165 μ in length and 32-38-44 u in width while, the multicellular type measures 164-780-1398 μ in length and 28-33-43 μ in width.

The glandular trichomes are of two types:

1- Unicellular head of 34-37-40 μ in diameter and uni-or bicellular uniseriate stalk of 18-25-33 μ in length and 13-15-17 μ in width.
2- Labiaceaus hairs of short unicellular stalk measuring 20-22-24 μ in length and 17-19-21 μ in width and large globular, multicellular head composed of 8 radiating cells, covered with smooth cuticle and measure 67-73-79 μ in diameter.

The mesophyll (Fig. 5A) is undifferentiated and parenchymatous. The mesophyll is traversed lengthwise by numerous vascular strands, each formed of cellulosic phloem and narrow xylem showing lignified vessels.

The cortical tissue is formed of rounded parenchymatous cells.

The Corolla

A transverse section in the petal (Fig. 6A) shows an outer and inner epidermises enclosing in between a narrow parenchymatous homogeneous mesophyll traversed by narrow vascular strands.

The inner epidermal cells (Fig. 6B) at the apical region of the lip are polygonal with straight anticlinal walls, usually papillosed and measuring 31-48-69 μ in length and 28-34-40 μ in width. Those of the middle region of the lip are polygonal, usually isodiametnic with straight anticlinal walls and measure 42-53-64 μ in length and 32-39-45 u in width. Those of the basal region of the lip are polygonal, axially elongated with straight anticlinal walls and measure 60-83-106 μ in length and 28-31-34 μ in width. In the tubular region, the cells are more axially elongated with straight anticlinal walls and measure 88 115-142 μ in length and 25-28-30 μ in width.

The outer epidermal cells (Fig. 6C) are similar to those of the inner epidermis in dimensions but having sinuous anticlinal walls. Both the inner and outer epidermal cells are covered with smooth cuticle in different regions of the corolla.

Stomata are of diacytic type present only on the outer epidermis.

Trichomes are present only on the outer epidermis. They are of both non-glandular and glandular types and similar to those of the calyx but the non-glandular unicellular type is absent. The non-glandular multicellular (2-6 cells) uniseriate hairs measure 200-399-600 μ in length and 20-22-24 μ in width.

The Androecium

The filament shows an epidermis (Fig. 7D) formed of polygonal, somewhat elongated cells having straight anticlinal walls and covered with thin smooth cuticle. The cells measure 80-113-147 μ in length and 29-34-40 μ in width.

The connective epidermal cells (Fig. 7E) are similar to those of the filament except being smaller in size. They measure 48-63-78 µ in length and 19-26-33 µ in width. Glandular trichomes similar to those of the calyx and corolla are persent on both filament and connective. Non-glandular trichomes and stomata are absent.

The fertile anther, in a transverse section (Fig. 7A), shows two lobes attached by the connective with a central vascular strand. Each anther lobe is formed of two pollen sacs containing numerous pollen grains. The anther wall is thin, consisting of an epidermis, a fibrous layer and the remains of the tapetal layer.

The epidermis (Fig. 7F) is polygonal with straight anticlinal walls and smooth cuticle, attaining 35-47-50 µ in length, 22-28-35 µ in width and 13-15-17 µ in height. Stomata and trichemes are absent.

The fibrous layer (Fig. 7B,C) is formed of one row of lignified cells with bar-like thickened walls. They measure 24-29-33 µ in length, 13-17-20 µ in width and 25-28-31 µ in height.

The pollen grains (Fig. 7G) are spherical, each with 6 germinal pores and 6 germinal furrows and a minutely pitted exine. They attain 24-27-29 µ in diameter.

The Gynaecium

The ovary, in a transverse section (Fig. 8A), shows an epidermis enclosing the ground tissue with 4 lateral locules containing 4 ovules and a central vascular strand.

The epidermis of the ovary (Fig. 8C) is formed of polygonal isodiametric cells with straight anticlinal walls and covered with thin smooth suticle. They measure 11-13-15 µ in both length and width. Stomata and trichomes are absent.

The style shows an epidermis (Fig. 8B) of polygonal isodiametric cells with straight anticlinal walls and covered with striated cuticle. They measure 22-35-49 μ in length and 20-22-24 μ in width. Glandular and non-glandular trichomes of the predominent types are present. Stomata are absent.

The stigma shows polygonal epidermal cells (Fig. 8D) with straight anticlinal walls and covered with striated cuticle. Near the tip of the stigma they show rounded papillae and measure 24-34-44 μ in length and 15-17-19 μ in width.

The Pedicel:

A transverse section of the pedicel (Fig. 9A) appears rounded, showing hairy epidermis, parenchymatous cortex occupying more than half the diameter of the pedicel and a central stele formed of a ring of phloem to the outside and xylem to the inside.

The epidermis (Fig. 9B) consists of polygonal, somewhat rectangular cells with straight anticlinal walls and covered with thin smooth cuticle. They measure 31-35-38 u in length, 20-22-24 μ in width and 11-13-15 μ in height.

Stomata of diacytic type are very rare. Trichomes are similar to those of the corolla but the glandular type are rare and the non-glandular type is very common.

The cortex (Fig. 9B) shows several rows of rounded thin-walled parenchymatous cells containing few starch granules. The endodermis is indistinguishable and the pericycle is parenchymatous. The vascular bundle (Fig. 9B) is formed of a ring of phloem surrounding the xylem vessels. The phloem is formed of thin-walled sieve elements and parenchyma. The xylem is formed of spiral, scalariform and pitted lignified vessels attaining 13-16-18 μ in diameter and lignified wood parenchyma.

The medullary rays (Fig. 9B) are of 2-4 cells in width, being parenchymatous in the phloem region and lignified in the xylem region.

Macro-and Micromorphology of Salvia Farinacea Benth (Root and Flower).

Powdered Flower

The powdered flower is pale-brown in colour with violet tinge, having aromatic odour and slightly bitter taste.

It is characterized microscopically by :

1- Numerous multicellular, uniseriate non-glandular trichomes with warty cuticle.
2- Abundant glandular trichomes of two types:
   a) Labiaceous hairs
   b) Unicellular head and uni-or bicellular uniseriate stalk.
3- Numerous spherical pollen grains with 6 germ pores and 6 germinal furrows.
4- Fragments of the outer epidermal cells of the calyx which are polygonal with wavy anticlinal walls and covered with thin smooth cuticle.
5- Fragments of the inner epidermal cells of the calyx which are polygonal with straight anticlinal walls and covered with thin smooth cuticle.
6- Fragments of inner and outer epidermal cells of the corolla. The inner epidermal cells are polygonal with straight anticlinal walls, many of them with rounded papillae and covered with smooth cuticle. The outer epidermal cells are more wavy than the inner epidermal cells and covered with smooth cuticle while papillae are absent.
7- Fragments of the epidermal cells of the filament, consisting of polygonal somewhat elongated cells, with straight anticlinal walls, and covered with thin, smooth cuticle.
8- Fragments of the anther, showing epidermal cells with straight anticlinal walls, and covered with thin, smooth cuticle, and polygonal lignified cells of the fibrous layer with bar-like thickening which appear beaded in surface view.
9- Fragments of ovary, showing very small polygonal epidermal cells with straight anticlinal walls, and covered with thin, smooth cuticle.
10- Fragments of the epidermal cells of the style, which are polygonal, axially elongated, with straight anticlinal walls and covered with thin, striated cuticle.

11- Fragments of the epidermal cells of the pedicel, which are polygonal, somewhat rectangular, with straight anticlinal walls, and covered with thin, smooth cuticle.

12- Fragments of spiral, scalariform and pitted lignified xylem vessels.

Macro-and Micromorphology of Salvia Farinacea Benth (Root and Flower).

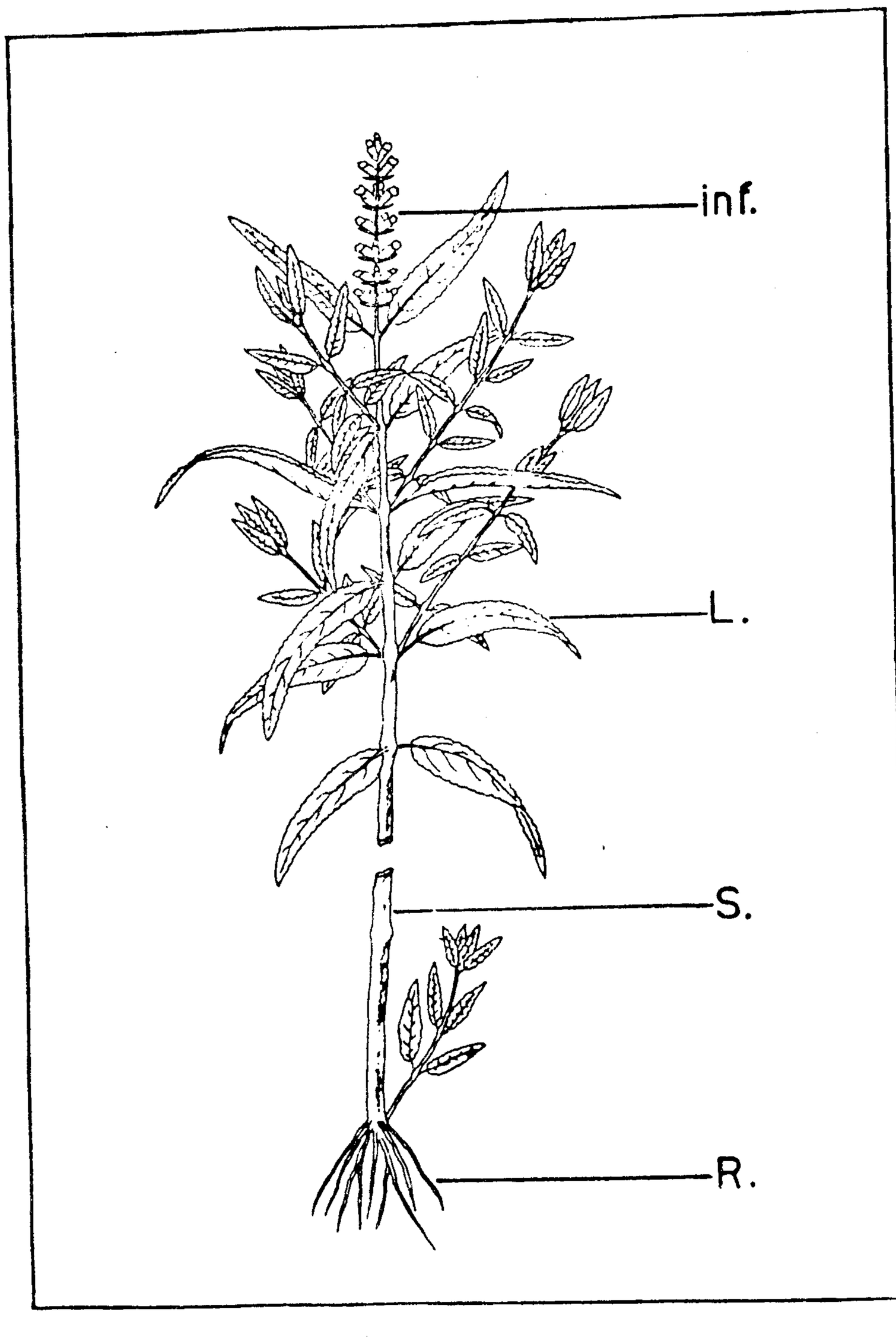
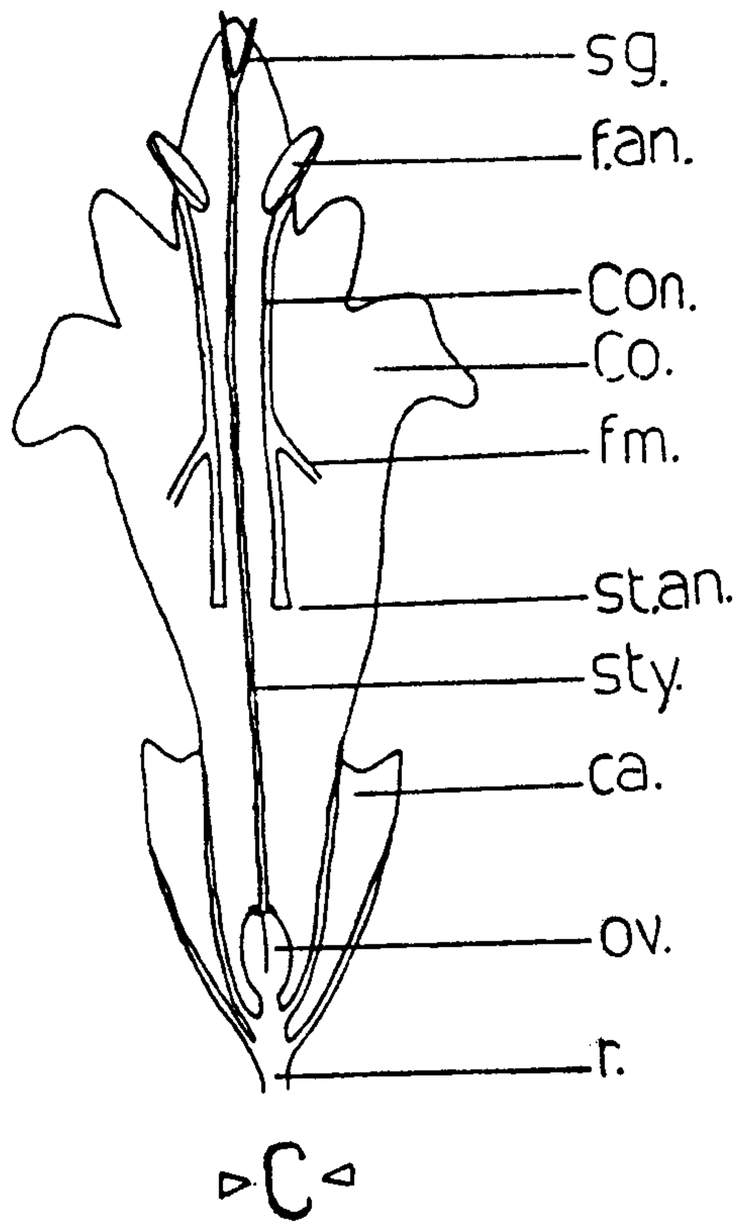
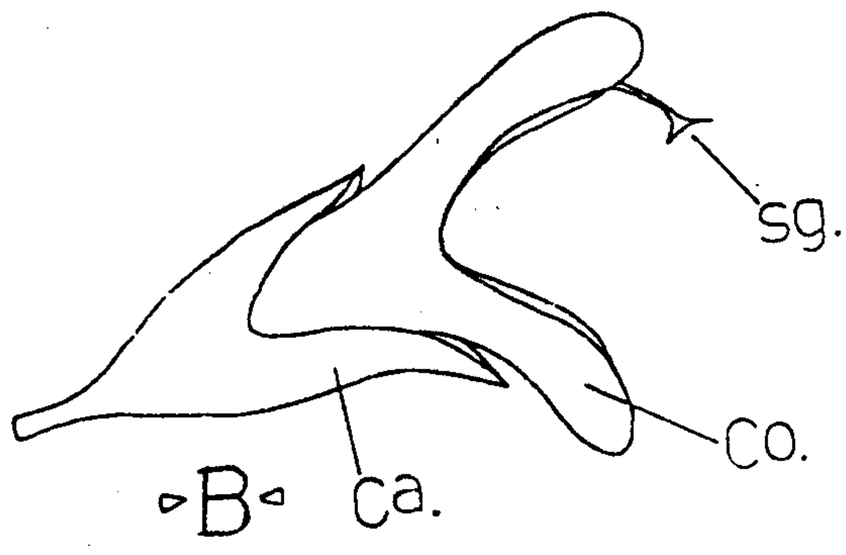
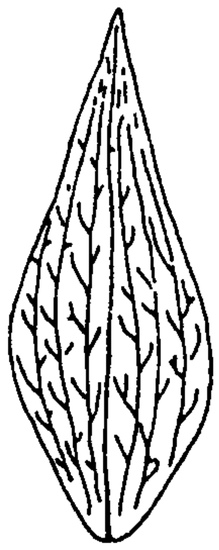


Fig. 1- Sketch of Salvia farinacea Benth.

inf., inflorescence; L., leaf; R., root; S., stem.







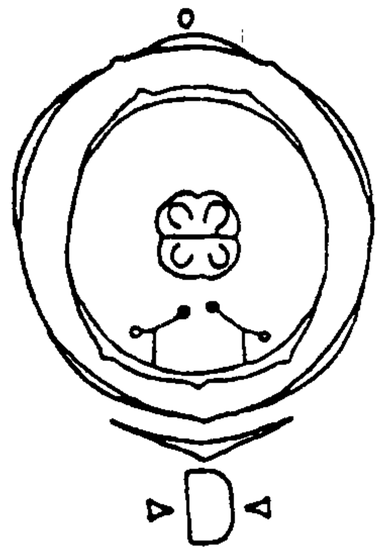


Fig.2 - The Inflorescence

A- The bract x 6.8

B- The flower x 4.5

C- The opened flower x 6.5

D- Floral diagram of the flower.

ca., calyx; co., corolla; con., connective; f.an., fertile anther; fm., filament; ov., ovary; r., receptacle; sg., stigma; sty., style; st.an., sterile anther.

Macro-and Micromorphology of Salvia Farinacea Benth (Root and Flower).

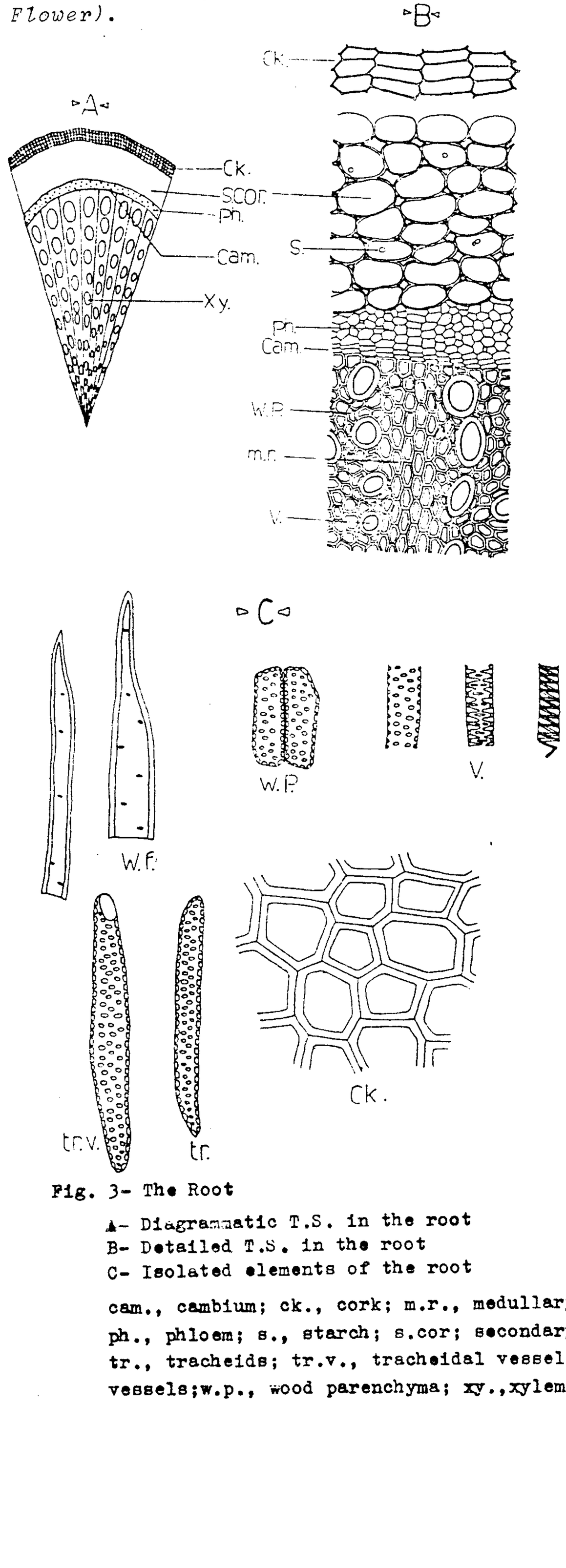


Fig. 3- The Root

A- Diagrammatic T.S. in the root x 51
B- Detailed T.S. in the root x 246
C- Isolated elements of the root x 255

cam., cambium; ck., cork; m.r., medullary ray; ph., phloem; s., starch; s.cor; secondary cortex; tr., tracheids; tr.v., tracheidal vessels; v., vessels;w.p., wood parenchyma; xy.,xylem.

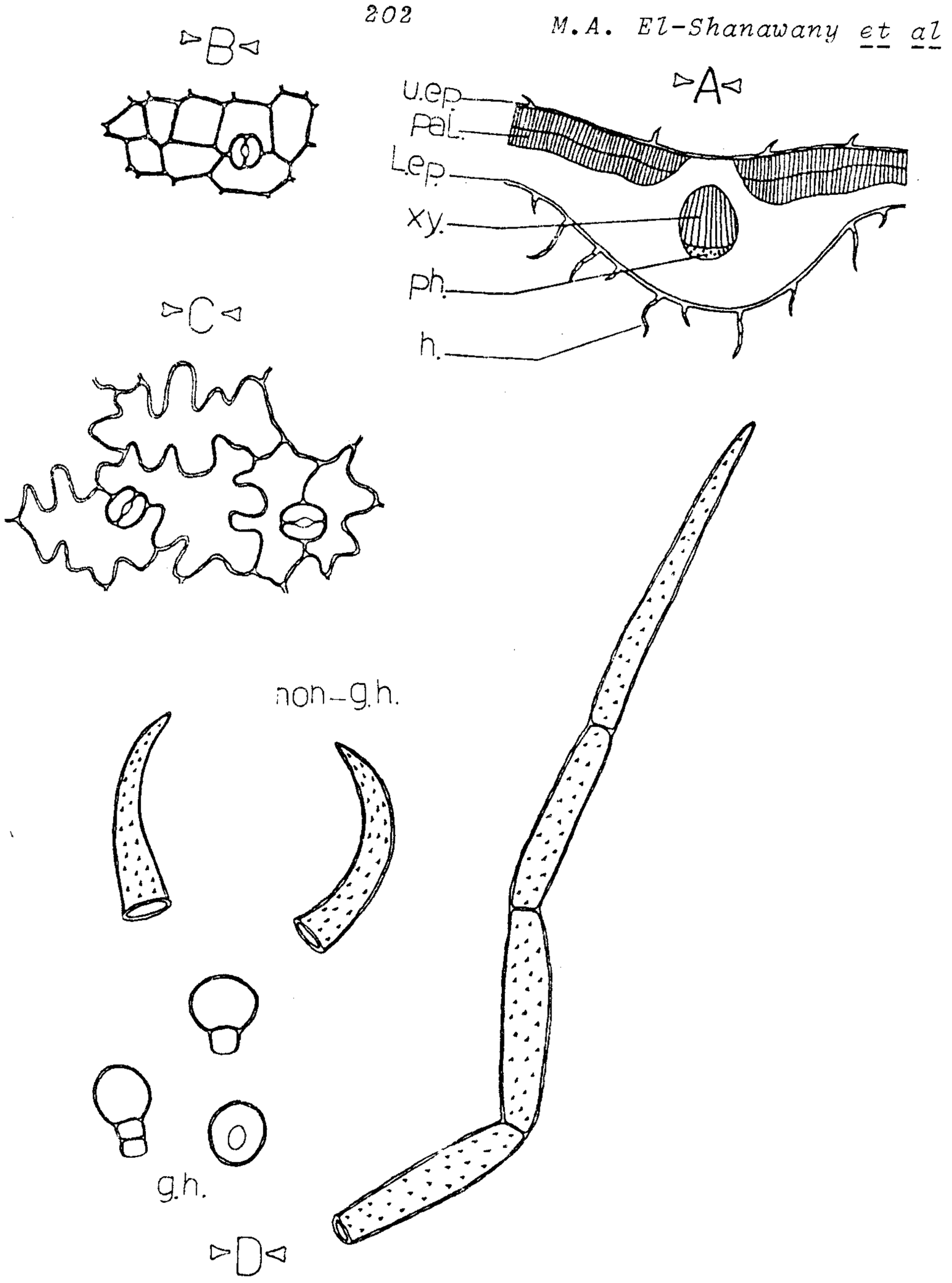


Fig. 4 - The Bract

A- Diagrammatic T.S.in the bract. x 66

B- Upper (Inner) epidermis x 295

C- Lower (Outer) epidermis x 295

D- Trichomes x 295

g.h., glandular hairs; h., hairs; l.ep., lower epidermis; non-g.h., non-glandular hairs; pal., palisade; ph., phloem; xy., xylem.

Macro-and Micromorphology of Salvia Farinacea Benth (Root and Flower).

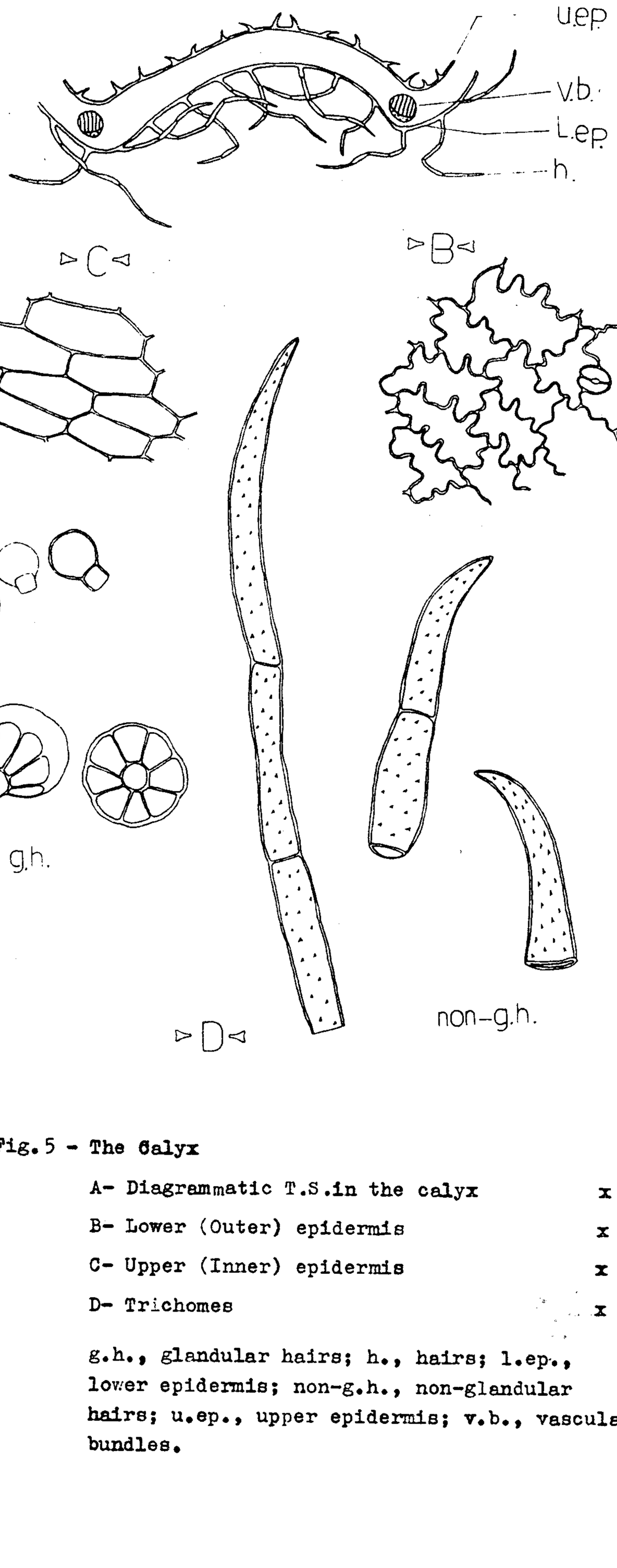


Fig. 5 - The Calyx

A- Diagrammatic T.S.in the calyx x 32

B- Lower (Outer) epidermis x 295

C- Upper (Inner) epidermis x 295

D- Trichomes x 295

g.h., glandular hairs; h., hairs; l.ep., lower epidermis; non-g.h., non-glandular hairs; u.ep., upper epidermis; v.b., vascular bundles.

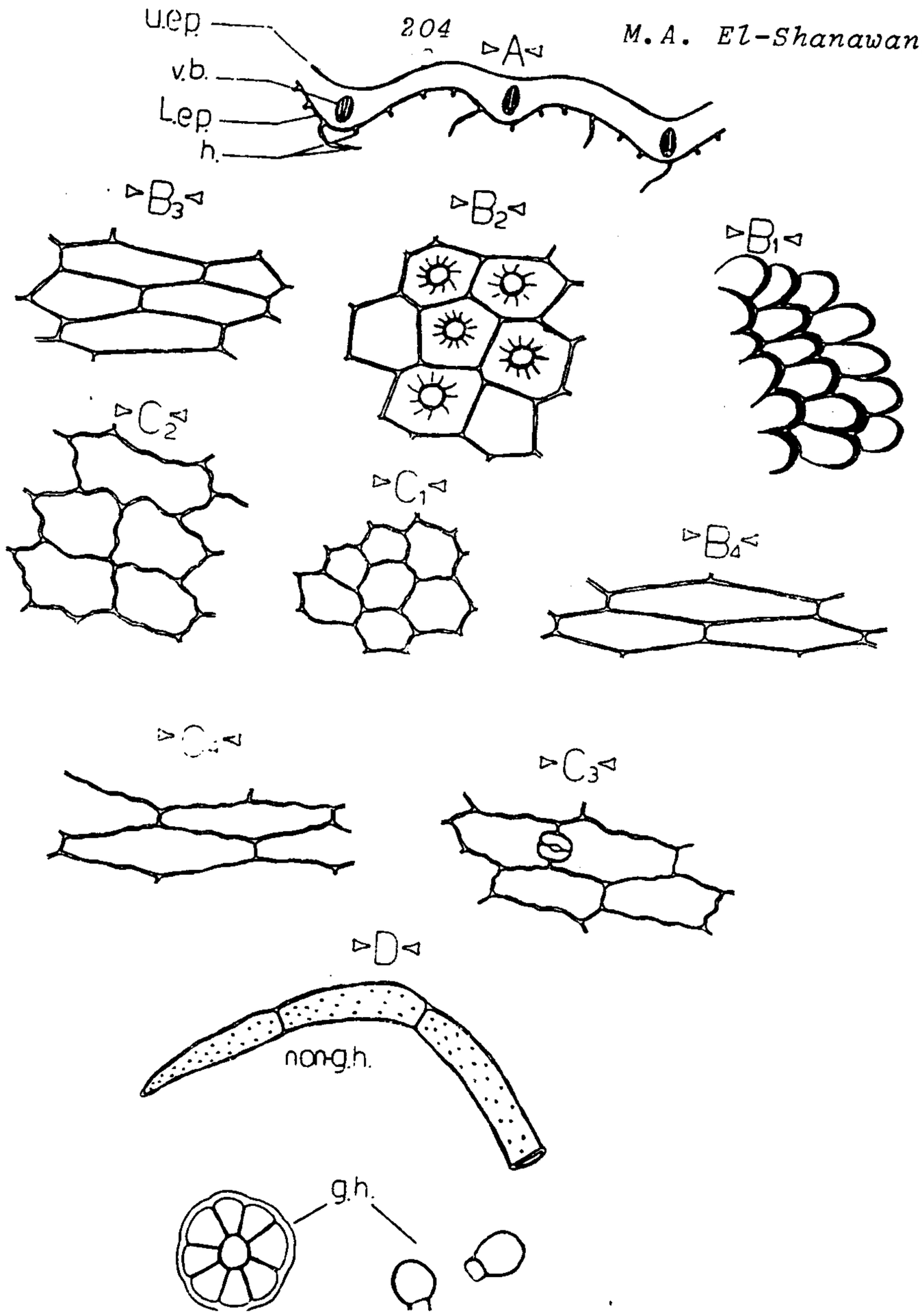


Fig. 6 - The Corolla

A- Diagrammatic T.S.in the corolla x 32

B_1- Upper (Inner) epidermis of the apical part of the lip. x 295

B_2- Upper (Inner) epidermis of the middle part of the lip. x 295

B_3- Upper (Inner) epidermis of the lower part of the lip. x 295

B_4- Upper (Inner) epidermis of the tubular part of the corolla. x 295

C_1- Lower (Outer) epidermis of the upper part of the lip. x 295

C_2- Lower (Outer) epidermis of the middle part of the lip. x 295

C_3- Lower (Outer) epidermis of the lower part of the lip. x 295

C_4- Lower (Outer) epidermis of the tubular part of the corolla. x 295

D- Trichomes x 295

g.h., glandular hairs; h., hairs; l.ep., lower epidermis; non-g.h., non-glandular hairs; u.ep., upper epidermis; v.b., vascular bundles.

Macro-and Micromorphology of Salvia Farinacea Benth (Root and Flower).

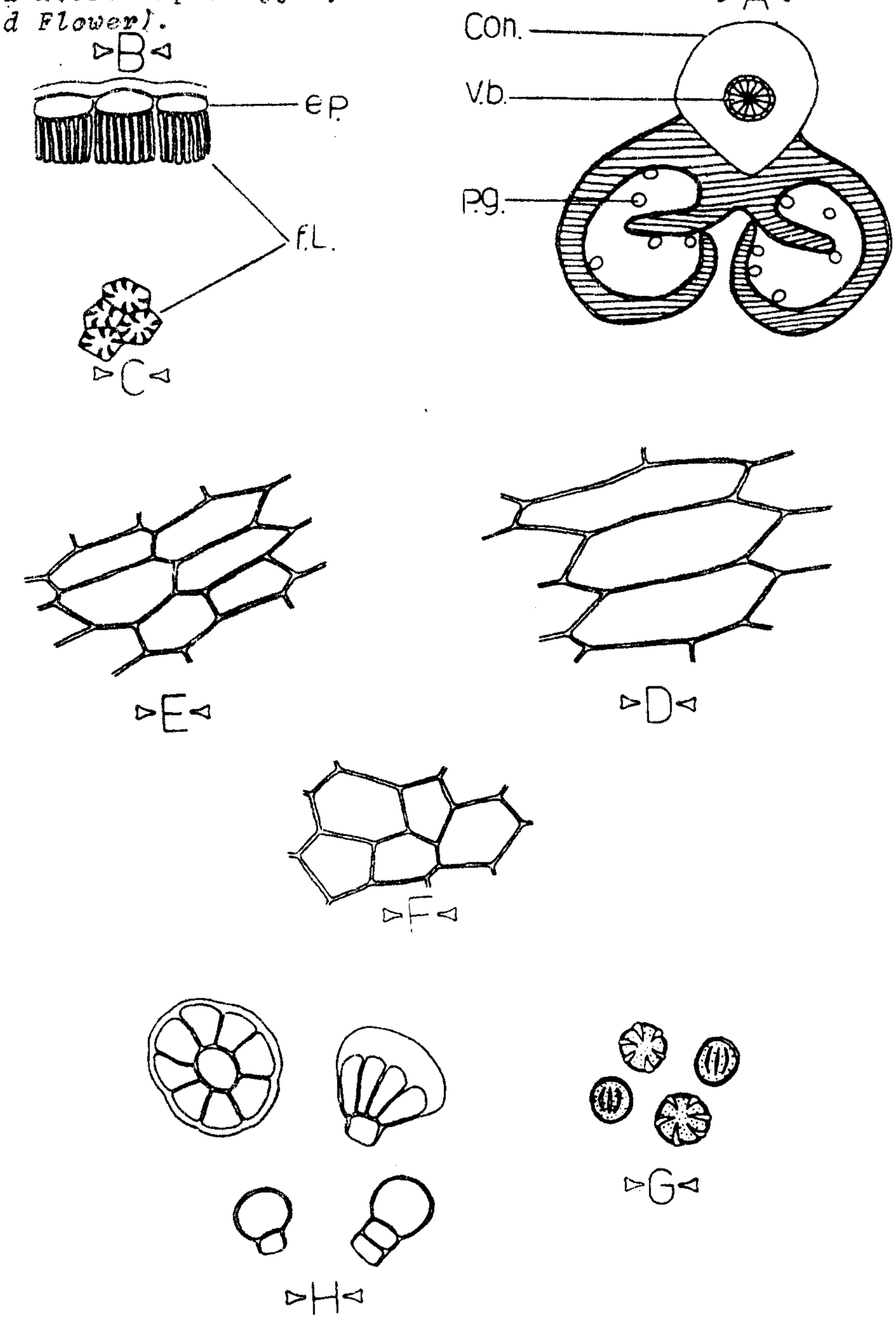


Fig. 7 - The Androecium

A- Diagrammatic T.S.in the fertile anther	x 66
B- Detailed T.S. in the anther	x 295
C- Fibrous layer of anther	x 295
D- Surface Preparation in the filament	x 295
E- Surface Preparation in the connective	x 295
F- Surface Preparation in the anther	x 295
G- Pollen grains	x 295
H- Trichomes	x 295

con., connective; ep., epidermis; f.l., fibrous layer; p.g., pollen grains; v.b., vascular bundle.

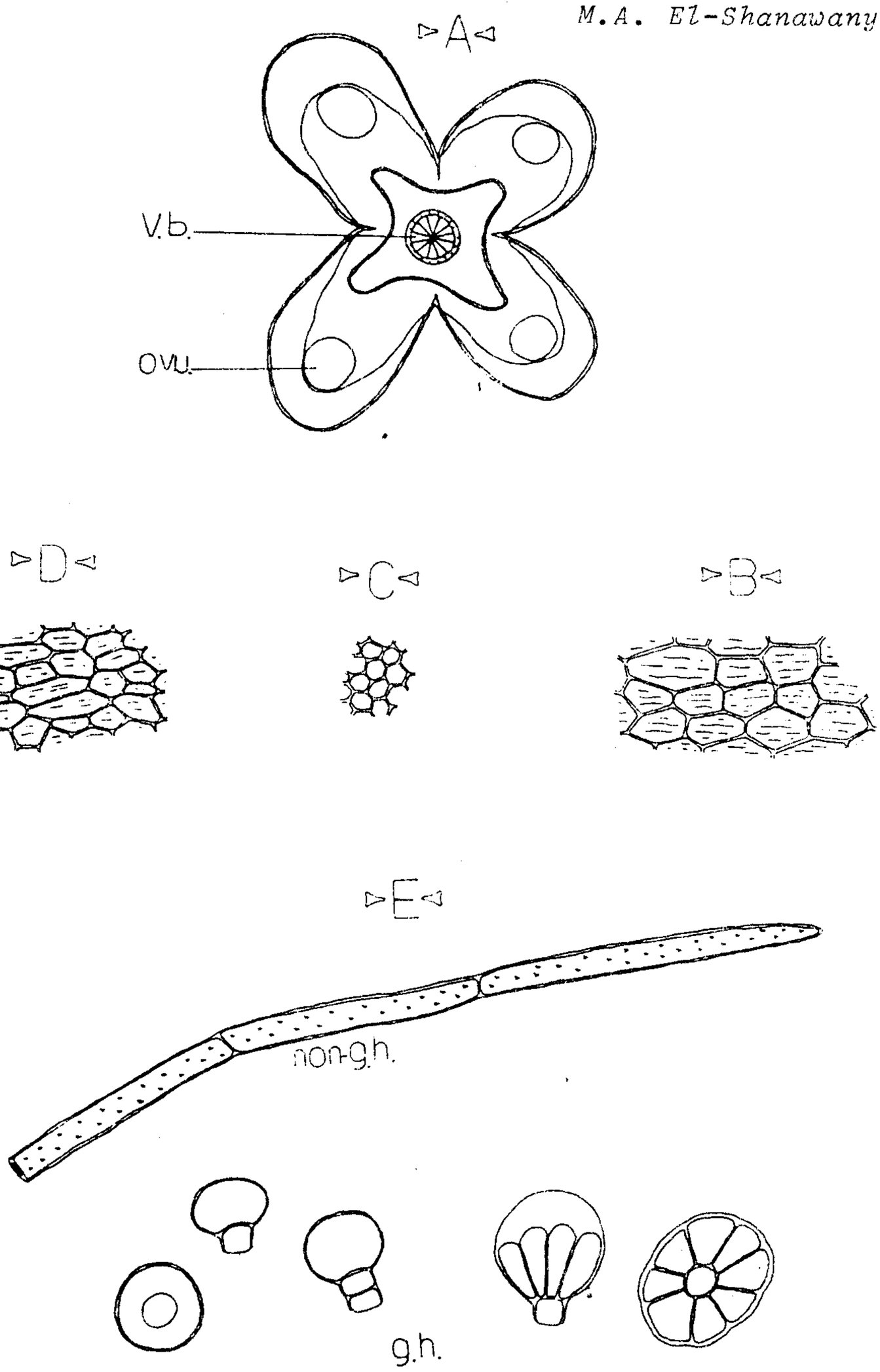


Fig. 8 - The Gynaecium

A- Diagrammatic T.S. in the ovary **x 66**

B- Surface preparation in the style **x 295**

C- Surface preparation in the ovary **x 295**

D- Surface preparation in the stigma **x 295**

E- Trichomes **x 295**

g;h., glandular hairs; non-g.h., non-glandular hairs; ovu., ovule; v.b., vascular bundle.

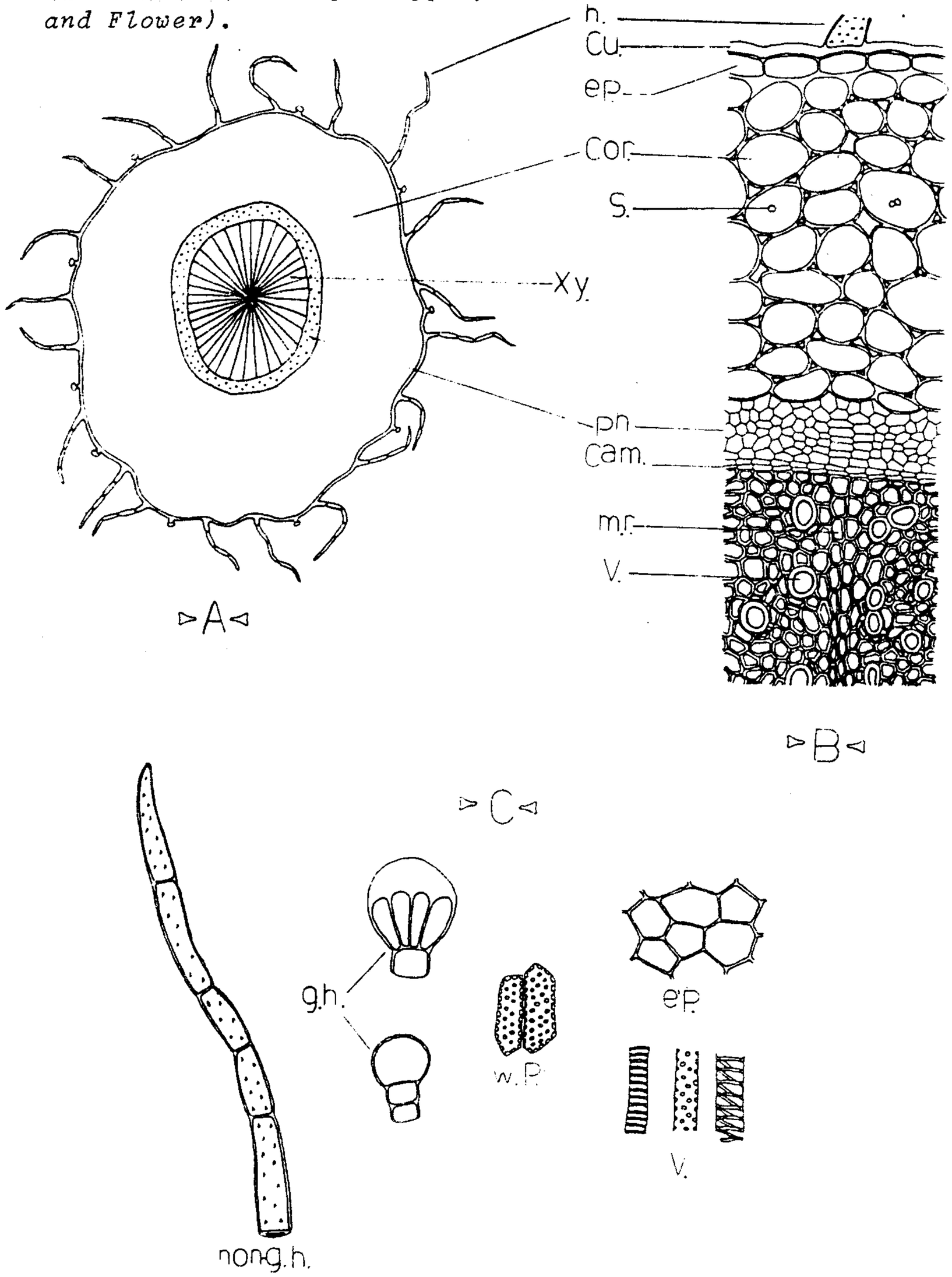


Fig. 9 - The Pedicel

A- Diagrammatic T.S in the pedicel **x 66**

B- Detailed T.S. in the pedicel. **x 295**

C- Isolated elements **x 295**

cam., cambium; cor., cortex; cu., cuticle; ep., epidermis; g.h., glandular hairs; h., hair; m.r., medullary ray; non-g.h., non-glandular hairs; ph., phloem; s., starch; v., vessels; w.p., wood parenchyma, xy., xylem.

REFERENCES

1) *J.M. Watt and M.G. Beyer; "The Medicinal and Poisonous Plants of Southern and Eastern Africa"; E., S. Livingstone, LTD;525-27 (1962).*

2) *E. Guenther; "The Constituents of the Essential Oils", V.II, D. Van. Nostrand Company, Inc., USA (1966).*

3) *L.P. Smirnova; V.I. Glyzin; A.V. Patudin and A.I. Bankovskii; Khim. Prir. Soedin, 10, 668 (1974).*

4) *A.A. Ali; D.W. Bishay; M.A. El-Shanawany and M.S. Kamel; Bull. Pharm. Sci., Univ. of Assiut, 8(I), 80 (1985).*

5) *O. Polunin;" Flowers of Europe", London, Oxford Univ. Press., New-York, Toronto, 344 (1969).*

6) *A.H. Saber; "Practical Pharmacognosy", 4th. End., Al- Shaab Printing House, Cairo, 98 (1966).*

"دراســـــات عيانيـــه ومجهريه لنبـــات سالفيا فارناسيـــا بنثـــام"

أحمد عبـــد الرحمن علـــى ، داود ونيس بشـــاى ،محمـــــد أحمد الشنوانـــى
ومحمـــــد صلاح كامـــــل .
قسم العقاقـــير ـ كلية الصيدلـــة ـ جامعـــة أسيـــوط .

تنـــاول هـــذا البحـــث دراســـة الصفات العيانيـــه والمجهريـــة لجـــذور وأزهـــار نبـــات " سالفيا فارناسيا بنثام " الـــذى يـــزرع فى مصـــر والتى يعتمـــد عليهـــا فـــى التعـــرف على هـــذا النبـــات وعلى التفرقـــة بينـــه وبين الأنـــواع الأخـــرى التـــى تنتمـــى الـــى جنس السالفيـــا .

received in 30/10/1986 & accepted in 30/12/1986