

COMPARATIVE MACRO - AND MICROMORPHOLOGICAL STUDY OF *ECHIMUM HORRIDUM*  
BATT. AND *ECHIMUM RAUWOLFII* DEL. (BORAGINACEAE)

Mahmoud M. Abdel Aal and Assem M. El-Shazly

Department of Pharmacognosy, Faculty of Pharmacy, University of Zagazig, Zagazig - Egypt

ABSTRACT

Chemical study of *Echium horridum* Batt. and *E. rauwolfii* Del. reveals isolation of echimidine and different picture of minor alkaloids. Thus, the macro - and micromorphological characters of roots, stems, leaves and flowers of *Echium horridum* Batt. and *E. rauwolfii* Del. are presented with the aim of finding out the characteristic feature by which the plants could be identified and differentiated from each other in both entire and powdered forms, and from other closely related species.

INTRODUCTION

Genus *Echium* belongs to family Boraginaceae and is represented in Egypt by 7 species (1). Chemical study concerning the alkaloidal contents of *Echium horridum* Batt. and *E. rauwolfii* Del. lead to the isolation of echimidine as a major pyrrolizidine alkaloid as well as 12 minor alkaloids identified by GLC - mass spectrometry (2). As other plants containing 1, 2 - unsaturated pyrrolizidine alkaloids, *Echium* plants considered to be hepatotoxic, mutagenic and carcinogenic in live stock and humans (3).

Literature review on *Echium horridum* Batt. and *E. rauwolfii* Del. revealed that only few brief morphological notes were reported in different floras (4, 4,5). In this study, the macro- and micromorphological characters of the roots, stems, leaves and flowers of these plants are presented in order to show the diagnostic characters by which the plants could be identified and differentiated both in the entire and powdered forms.

EXPERIMENTAL

Plant material :

The material used for this work was collected from plants cultivated in the experimental garden of medicinal plants, Faculty of Pharmacy, University of Zagazig, Egypt. The plants were kindly authenticated by Dr. A.El-Hadidi, Department of Botany, Faculty of Science, Cairo University, to whom the authors are indebted.

Fresh materials and samples kept in 70% glycerol were used.

1-Macromorphology :

*Echium horridum* Batt. (Fig. 1 A) is an erect, annual herb, reaches up to 50 cm in height, covered by spreading bulbous based setae (glabrous between the setae) and having one to many flowering stems. The plant shows large irregular flowers in terminal, simple or branched cymes.

The root (Fig. 1, A 1) is a dark brown tap root,

bearing several short tapering lateral roots and measures 16-20 cm in length and 0.3 - 0.5 in diameter. The fresh root is flexible, while the dry breaks with short fracture.

The stem (Fig. 1 A and A3) is herbaceous, erect and cylindrical with green surface, covered with stiff white tubercle - based prickles or bristles. The stem is one to several and often branched monopodially from the base into alternate branches. The internodes measure 2.0 - 3.0 cm in length and 0.3 - 0.4 in diameter. The fresh stem is flexible, but the dry breaks with a fibrous fracture.

The leaves (Fig. 1A and A2) are simple, cauline, alternate and exstipulate with entire margin. They are elliptic to lanceolate and measure 5 -15 cm in length and 0.3 - 0.7 in breadth the leaves have green surfaces covered with stiff white bulbous based setae and show ciliate margins, acute apices, symmetric bases and papery texture. They have reticulate pinnate venation with prominent midrib and main veins on the lower surface only. The lower leaves are tapering to petiolate, while the upper are sessile.

The inflorescence (Fig. 1A and 2A) is a bracteate cyme forming a panicle with violet to blue flowers measuring 1.1 - 2.2 cm in length and 0.3 - 0.5 cm in diameter. Bracts are foliaceous, similar to the leaves, but somewhat shorter, they measure 2.2 - 3 cm in length and 0.2 - 0.3 cm in breadth. The calyx consists of 5-partite, linear lanceolate with setose segments, enlarged in the fruiting stage and measure 11.5 - 12 mm in length and 1.5-1.9 mm in breadth. The corolla is violet, zygomorphic, infundibular with 5 - lobed limbs, necked throat and unequal short lobes; it is pubescent and measure 18 - 20 mm in length. The corolla tube measure 15 - 16 mm in length and the lobes measure 3-4 mm in length. The androecium consists of 4 or 5 unequal exerted, free epipetalous stamens formed of yellowish white filaments, measuring 6 - 8 mm in length and dorsifixed, bilobed, oblong obtus bluish- black anthers, measuring 1 mm long. The gynaecium is yellowish white, formed of superior yellowish- green, 4-lobed ovary, a filiform gynobasic style, two third of

which covered with bulbous - based setae, and short bifid stigma. The ovary measures 0.9 - 1.6 mm in diameter, the style measures 14 - 20 mm in length and 0.30 - 0.31 mm in diameter while the stigma measures 0.30 - 0.32 mm in length. The plant flowers from March to April.

*Echium rauwolfii* Del. (Fig. 1B and 2B) has similar characters in the morphological features, as *E. horridum* Batt. (Fig. 1A and 2A) but the main differences are summarized in Table (1).

## II-Micromorphology :

### The root :

The trasverse section in the root of *Echium horridum* Batt. (Fig. 3A) is circular in outline showing an outer brownish cork followed by a wide parenchymatous phelloderm surrounding a central cylinder of vascular tissue. The vascular tissue comprises a narrow phloem and a wide xylem with a central diarch primary xylem.

The cork (Fig. 3B and D) is narrow, consists of about 3-4 layers of polygonal moderately thick - walled suberized, tangentially elongated cells arranged in radial rows. They measure 37 to 74  $\mu$  in length and 28 to 44  $\mu$  in breadth.

The phelloderm (Fig. 3B) is wide, formed of 12 - 13 rows of thin - walled, more or less tangentially elongated parenchymatous cells.

The vascular tissue (Fig. 3B) is formed of an outer cellulosic phloem and a wide lignified central xylem; the cambium is almost indistinguishable. The xylem is formed mainly of fibers (Fig. 3B and E) having moderately thick lignified walls with few oval or slit-like pits, narrow or wide lumen and having acute to blunt apices. They measure 215 to 225  $\mu$  in length and 15 to 18  $\mu$  in diameter. Vessels (Fig. 3 B and E) are diffused either isolated or in radial or oblique rows; they are mostly pitted or occasionally spiral and annular and measure 17 to 44  $\mu$  in diameter. Tracheids (Fig. 3E) are few showing moderately thick lignified walls with numerous oval bordered pits and measure 160 to 171  $\mu$  in length and 15 to 17 in diameter. Wood parenchyma are diffused and formed of moderaely thick - walled pitted and lignified polygonal axially elongated cells. The meduallary rays (Fig. 3B) are 2 to 3 cells wide being cellulosic in the phloem and lignified in the xylem.

### Powdered root :

The powdered root (Fig. 3D and E) is brownish - yellow in color with bitter taste and characteristic odour. It is characterized microscopically by the following features :

1-Fragments of brownish cork showing polygonal cells

with moderately thick suberised walls.

- 2-Fragments of lignified spiral, annular and pitted vessel; few pitted tracheids are observed.
- 3- Numerous fragments of lignified wood fibres having moderately thick walls, wide lumen and acute apices.
- 4- Fragments of lignified polygonal and moderately thick - walled pited wood parenchyma.
- 5- Calcium oxalate crystals and strach are absent.

The transverse section of the root of *E. rauwolfii* Del. (Fig. 3C) is circular in outline showing an outer brownish cork cells followed by a narrow parenchymatous phelloderm surrounding a central cylinder of vascular tissue. The micromorphological differences between the root of *E. rauwolfii* Del. and *E. horridum* Batt. are shown in Tables 2 and 3.

### The stem :

The transverse section in the stem of *Echium horridum* Batt. (Fig. 4A and B) is more or less circular in outline. It shows an outer epidermis surrounding a relatively narrow parenchymatous cortex with outer 3-4 rows of collenchyma lined by differentiated endodermis enclosing a ring of vascular bundles surrounding a wide non-lignified pith.

The epidermal cells (Fig.4D) are polygonal axially elongated with straight anticlinal walls and covered with thick smooth cuticle. They measure 36 to 88  $\mu$  in length, 12 to 28  $\mu$  in breadth and 17 to 22  $\mu$  in height.

Stomata (Fig.4D) are few of the anomocytic type, each is surrounded by 5 to 6 cells and measures 22 to 29  $\mu$  in length and 16 to 21  $\mu$  in breadth.

Bulbous based bristles (Fig.4E) are present. They are long ensiform, unicellular, covered with thick warty cuticle, having wide lumen and subacute apices. They measure 606 to 1617  $\mu$  in length and 43 to 69  $\mu$  in diameter. Glandular and non-glandular trichomes are absent.

The cortex (Fig.4 A and B) is parenchymatous with subepidermal layer of collenchyma. The collenchyma consists of 3 to 4 rows of small thick - walled cellulosic cells. The parenchyma is formed of 7 to 10 rows of large thin - walled cells with narrow intercellular spaces.

The endodermis is well differentiated and having no casparian strip. The pericycle (Fig. 4A and B) is parenchymatous.

The vascular tissue consists of an outer cellulosic phloem and a wide lignified xylem; the cambium is almost indistinguishable. The xylem is formed of fibers (Fig. 4B and E) having moderately thick - lignified

Table 1: The main macromorphological differences between *Echium horridum* Batt. and *E. rauwolfii* Del.

	<i>Echium horridum</i> Batt.	<i>E. rauwolfii</i> Del.
<b>1-The root</b>	Length: 16 - 20 cm Breadth: 0.3 - 0.5 cm	Length: 11 - 15 cm Breadth: 0.3 - 0.4 cm
<b>2 - The leaves</b>	Elleptic to lanceolate and measure 5 - 15 cm in length and 0.3 - 0.7 cm in breadth.  The midrib and main veins are prominent on the lower surface only.	Narrowly lanceolate to oblong and measure 5 - 12 cm in length and 0.3 - 0.6 cm in breadth.  The midrib and main veins are prominent on both surfaces, being more prominent on the lower surface.
<b>3-The inflorescence</b>		
a- The bract	Narrowly lanceolate and measures 2.2 - 3 cm in length and 0.2 - 0.3 cm in breadth.	Lanceolate and measure 1.9-2.3 cm in length and 0.3 - 0.31 cm in breadth.
b- The calyx	Linear lanceolate white setose segments and measures 11.5 - 12 mm in length and 1.5 -1.9 mm in breadth.	Lanceolate densely white setose segments especially at the lower part and measures 10 - 11 mm in length and 1-1.2 mm in breadth.
c- The corolla	Violet to blue in colour and measures 18 - 20 mm in length. The dried corolla is deep blue in colour.	White in colour and measures 12 - 15 mm in length. The dried corolla is buff in colour.
d- The androecium	Stamens are 4 - 5 in number and the anthers measures 1 mm in length.	Stamens are 3 - 4 in number and the anthers measure less than 1 mm in length.
e- The gynaecium	The overy measures 0.9 - 1.6 mm in diameter.  The style measures 14 - 20 mm in length and two third of which covered with bulbous based setae.  The stigma is shortly bifid and measures 0.3 - 0.32 mm in length.	The overy measures 0.8 - 1 mm in diameter.  The style measures 12 -16 mm in length and two three quarters of which covered with bulbous based setae.  The stigma is distinctly bifid, sometimes with two unequal lobes and measures 0.6 - 0.64 mm in length.

**Table 2:** The main micromorphological differences that can differentiate between *Echium horridum* Batt. and *E. rauwolfii* Del

	<i>E. harridum</i> Batt.	<i>E. rauwolfii</i> Del.
<b>1 - The root :</b> -the phelloderm -medullary rays	wide(12-13 rows). 2-3 cells wide.	narrow (7-8 rows). 3 - 4 cells wide.
<b>2 - The stem :</b> -subepidermal collenchyma -parenchymatous cortex  - medullary rays	3 - 4 rows  7 - 10 rows  present	2 - 3 rows  5 - 6 rows  absent
<b>3- The leaf :</b> -subepidermal collenchyma	present abutting the lower epidermis of the midrib.	absent.
<b>4 - The setae of the calyx :</b>	numerous on both surfaces and measures 140 - 930 $\mu$ in length and 21 - 55 $\mu$ in diam- eter.	more dense and longer on both sur- faces especially at the basal marginal regions and meas- ures 1386-1980 $\mu$ in length and 59- 60 $\mu$ in diameter.

walls, narrow or wide lumen and acute apices. They measure 1951 to 2739  $\mu$  in length and 25 to 31  $\mu$  in diameter. Vessels (Fig. 4B and E) are lignified, diffused either isolated or in radial rows being spiral, annular and pitted and measure 22 to 44  $\mu$  in diameter. Tracheids (Fig. 4E) are few, lignified and showing numerous pits. Wood parenchyma (Fig. 4D) is diffused and formed of moderately thick-walled, pitted and lignified polygonal axially elongated cells. The medullary rays (Fig. 4A and B) are 2 to 3 wide cells being cellulose in the phloem and lignified in the xylem.

The Pith (Fig. 4 A and B) is formed of moderately cellulose parenchyma with narrow intercellular spaces.

**Powdered stem :**

The powdered stem (Fig. 4 D and E) is green in colour having characteristic odour and bitter taste and characterized microscopically by :

**Table 3:** Cell dimensions in microns in the root, stem and leaf of *Echium horridum* Batt. and *E. rauwolfii* Del.

		<i>E. harridum</i> Batt.	<i>E. rauwolfii</i> Del.
<b>1 - The root:</b> - cork cells	L	37 - 74	59 - 81
	B	28 - 44	29 - 66
<b>2 - The stem:</b> -epidermal cells	L	36 - 88	37 - 162
	B	12 - 28	15 - 29
- the setae	L	606 - 1617	821 - 2055
	D	34 - 69	41 - 69
<b>3 - The leaf:</b> -upper epidermis	L	22 - 88	22 - 71
	B	21 - 55	18 - 40
	H	15 - 21	18 - 21
- lower epidermis	L	29 - 96	37 - 88
	B	19 - 59	18 - 41
	H	18 - 25	19 - 22
- neural epidermis	L	74 - 96	81 - 179
	B	16 - 27	18 - 37
	H	10 - 29	18 - 28
- stomata	L	19 - 22	16 - 24
	D	12 - 18	12 - 18
- the setae	L	221 - 240	273 - 606
	D	26 - 29	20 - 30
- the palisade	L	32 - 43	44 - 60
	D	6 - 15	15 - 25

L, length; B, breadth; D, Diameter; H, height

- 1-Fragments of epidermal cells; polygonal, axially elongated with straight anticlinal walls, covered with thick - smooth cuticle and showing few anomocytic stomata.
- 2-Numerous bulbous based bristles; long ensiform, unicellular covered with thick warty cuticle and having wide lumen and subacute apices.
- 3-Fragments of lignified spiral, annular and pitted vessels; few tracheids are present.
- 4-Fragments of wood fibers and wood parenchyma.
- 5-Calcium oxalate crystals and starch are absent.

The transverse section of the stem of *Echium*

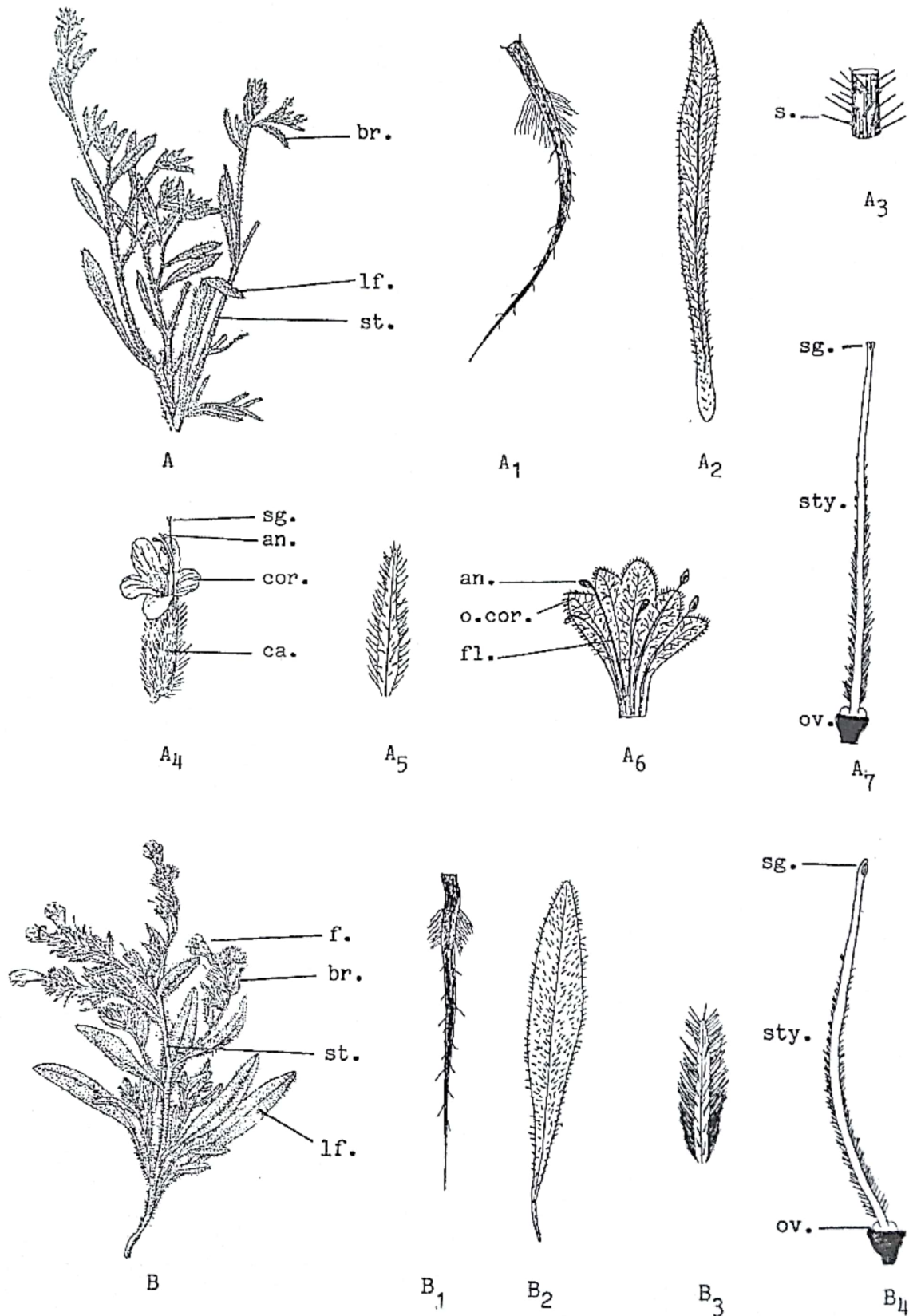


Fig. (1): Sketches of the flowering plants

A - *Echium horridum* Batt. (X 0.2)

A1- The root (X 0.3) A2- The leaf (X 0.4) A3- Part of the stem showing the setae (X 1.6)

A4- The flower (X 1.4) A5- The sepal (X 2) A6- Opend corolla (X 1.4)

A7- The gynaecium (X 3)

B - *Echium rauwolfii* Del. (X 0.3)

B1- The root (X 0.3) B2- The leaf (X 0.6) B3- The sepal (X 2) B4- The gynaecium (X 3.6)

an., androecium; br., bract; cor., corolla; f., flower; fl., filament; lf., leaf; o.cor., opend corolla; ov., ovary; s., setae; st., stem; sg., stigma; sty., style.



(A)



(B)

Fig. 2: Photographs of the flowers:  
A-*Echium horridum* Batt. (X 2.5)  
B-*Echium rouwolfii* Del. (X 2.5)

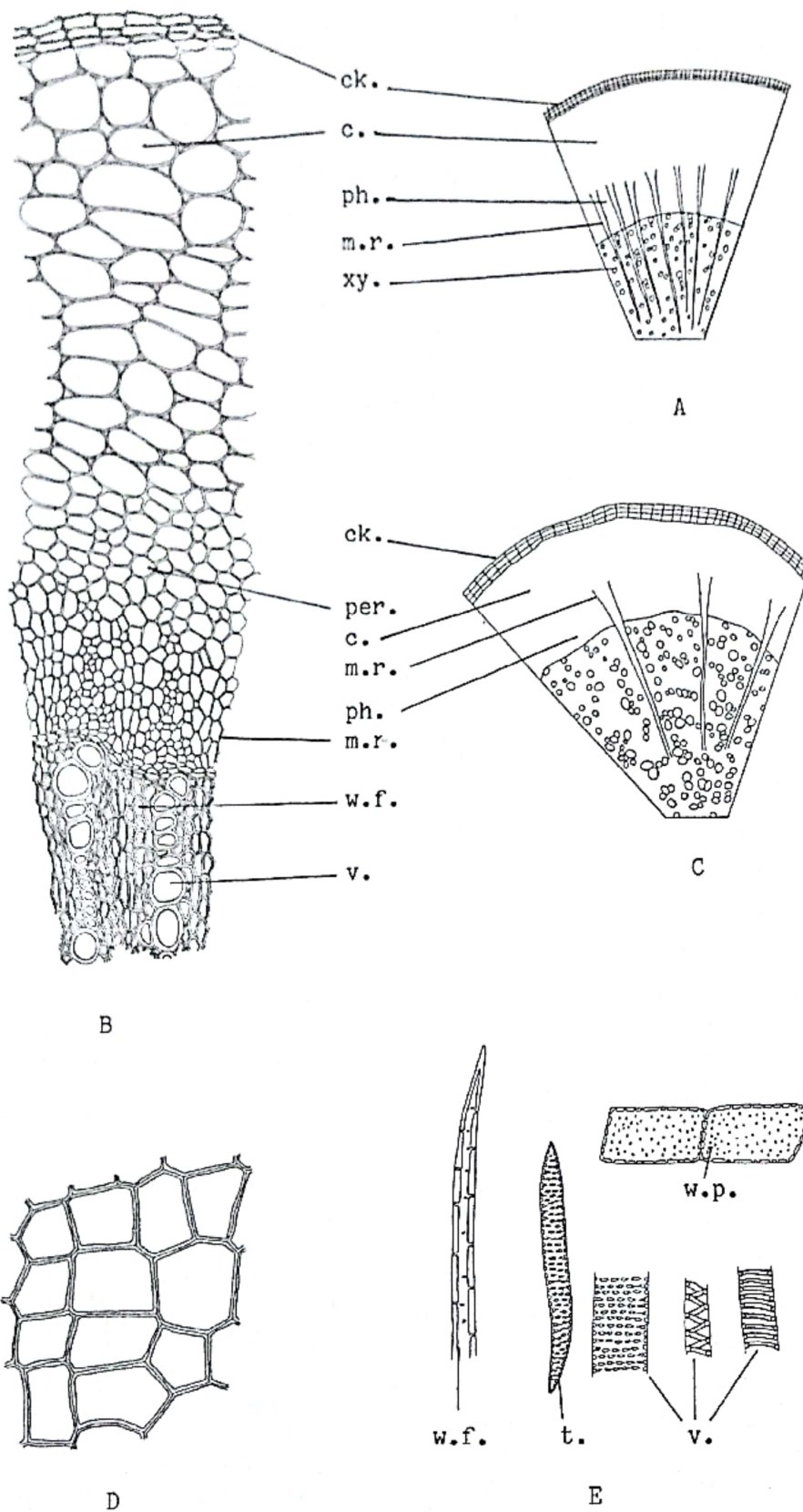


Fig. (3): The root

A- Diagrammatic transverse section of the root of *Echium horrodidium* Batt. (X 23).

B- Detailed transverse section of the root *Echium horrodidium* Batt. (X 122).

C- Diagrammatic transverse section of the root of *Echium rauwolfii* Del. (X30).

D- Cork cells in surface view (X 201)

E- Isolated elements of the root (X 201)

ck., cork; c., cortex; m.r., medullary ray; pd., phelloderm; per., pericycle; ph., phloem; t., tracheid; v., vessel; w.f., wood fibre; w.p., wood parenchyma; xy., xylem.

*rauwolfii* Del. (Fig. 4C) shows an outer epidermis surrounding a narrow parenchymatous cortex with 2 to 3 rows of collenchyma lined by differentiated endodermis enclosing a ring of vascular bundles surrounding a wide non-lignified pith. The microscopical aspects that can differentiate the stem of *Echium rauwolfii* Dil. from *Echium horridum* Batt. are listed in Tables (2 and 3).

**The leaf :**

The transverse section of the leaf (Fig. 5 A and B) of *Echium horridum* Batt. shows dorsiventral structure with a single row of upper palisade being interrupted in the midrib region. The midrib projects on the lower side only and shows a single crescent-shaped vascular bundle; the pericycle is collenchymatous.

The upper epidermal cells of the leaf (Fig. 6 A) are formed of a tabular, polygonal nearly isodiametric cells having slightly wavy anticlinal walls and covered with thick smooth cuticle. They measure 22 to 88  $\mu$  in length, 21 to 52  $\mu$  in breadth and 15 to 21  $\mu$  in height. The lower epidermis of the leaf (Fig. 6B) consists of tabular, polygonal, isodiametric cells with wavy anticlinal walls and covered with thick smooth cuticle. They measure 29 to 96  $\mu$  in length, 19 to 59  $\mu$  in breadth and 18 to 25  $\mu$  in height.

The upper and lower neural epidermal cells (Fig. 6 C) are polygonal axially elongated with straight anticlinal walls and covered with thick, smooth cuticle. They measure 74 to 96  $\mu$  in length, 16 to 27  $\mu$  in breadth and 10 to 29  $\mu$  in height.

Stomata (Fig. 6A and B) are present on both epidermises of the leaf being more numerous on the upper epidermis of the leaf and absent in the neural region. They are anisocytic rarely of anomocytic type. The measure 19 to 22  $\mu$  in length and 12 to 18  $\mu$  in breadth.

Bulbous - based bristles (Fig. 6 C) are present. They are ensiform, unicellular, covered with thick, warty cuticle and having wide lumen and subacute apices. They measure 221 to 240  $\mu$  in length and 26 to 29  $\mu$  in diameter. Glandular and non-glandular trichomes are absent.

The mesophyll (Fig. 5A and D) is dorsiventral with an upper palisade formed of one row of radially elongated columnar cells with straight anticlinal walls and measure 32 to 43  $\mu$  in length and 6 to 15  $\mu$  in breadth. It is interrupted by parenchyma in the midrib region. The spongy tissue (Fig. 5 D) is formed of 4 to 6 rows of thin-walled more or less parenchymatous cells with wide intercellular spaces.

The cortex of the leaf (Fig. 5A and B) is parenchymatous with a lower subepidermal collenchyma abutting lower equidermis and formed of 2 to 3 rows of thick-walled cellulose cells.

The pericycle (Fig. 5 A and B) consists of two arcs of collenchymatous cells above and below the vascular bundle.

The vascular bundle (Fig. 5 A, B and 6D) consists of cellulosic phloem of thin-walled elements and xylem formed of lignified spiral and annular vessels, 10 to 28  $\mu$  in diameter and thin-walled cellulose parenchyma.

**Powdered leaf :**

The powdered leaves (Fig. 6) are dark green in colour and having bitter taste and characteristic odour. The powder is characterized microscopically by the following features :

- 1-Numerous fragments of the upper and lower epidermises showing polygonal cells with wavy anticlinal walls, covered with thick smooth cuticle and showing stomata of anisocytic or anomocytic type on both surfaces.
- 2-Fragments of bulbous - based bristles being long, ensiform, unicellular, covered with thick warty cuticle and having wide lumen and subacute apices.
- 3- Fragments of lignified spiral and annular vessels.
- 4-Calcium oxalate crystals and starch granules are absent.

The transverse section in the leaf of *E rauwolfii* Del. (Fig. 5C) shows a dorsiventral structure with a single row of upper palisade being interrupted in the midrib region. The midrib projects on both surfaces and shows a crescent-shaped vascular bundle with a collenchymatous pericycle. The micromorphological differences between the leaf structures of *E. rauwolfii* Del. and *E. horridum* Batt. are shown in Tables 2 and 3, while differences in the microscopical numerical values between both species are listed in Table (4).

**Table 4:** Microscopical numerical values of *Echium horridum* Batt. and *E. rauwolfii* Del. leaves.

The numerical value	<i>E. horridum</i> Batt.	<i>E. rauwolfii</i> Del.
Stomatal index of upper epidermis	23 - 25	10.7 - 11.8
Stomatal index of lower epidermis	20 - 23	12.1 - 12.9
Palisade ratio	1.3 - 1.9	0.9 - 1.5
Vein-islet number	5 - 8	3 - 6
Veinlet termination number	6 - 10	3 - 5



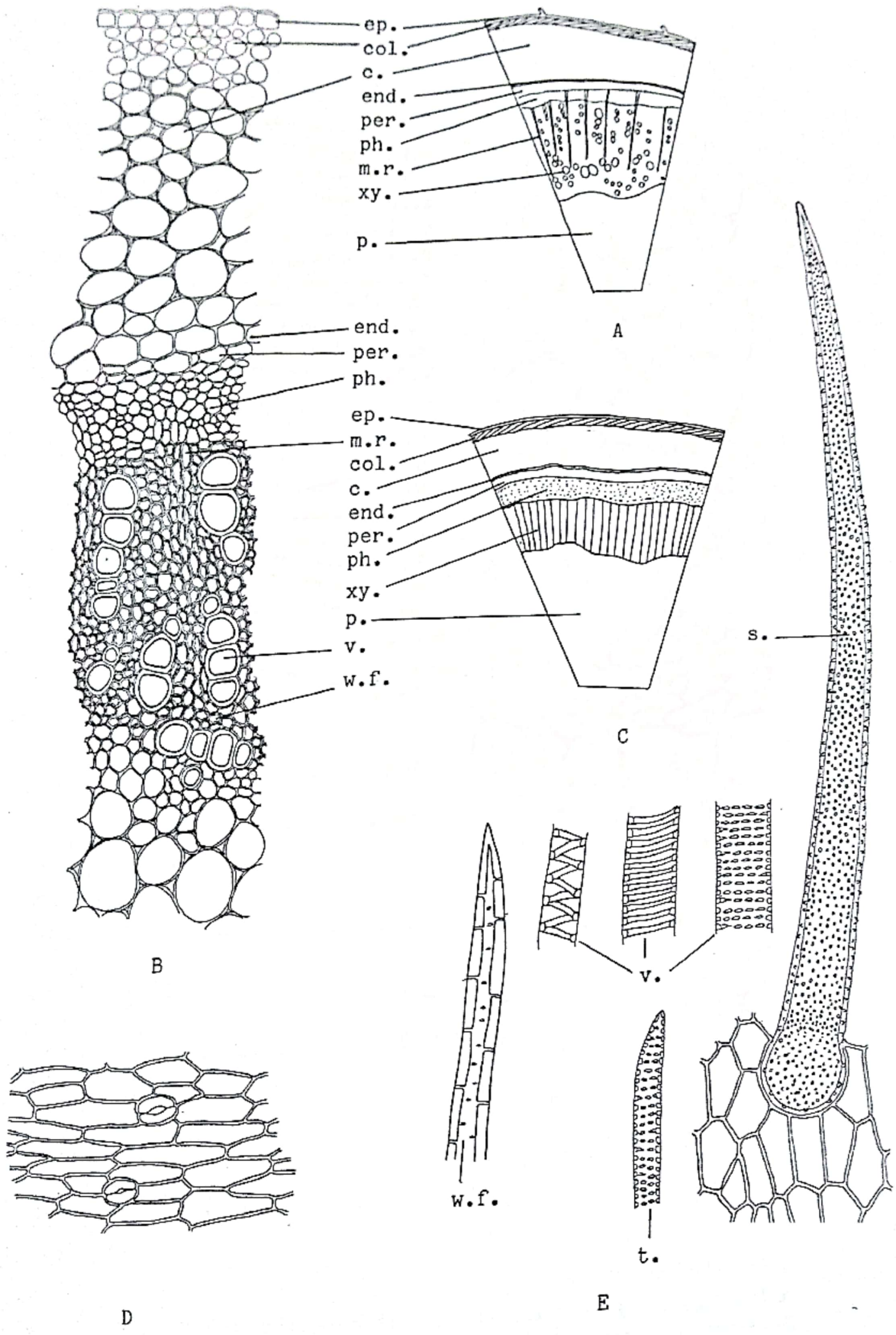


Fig. (4): The stem  
 A- Diagrammatic transverse section of the stem of *Echium horrodidium* Batt.  
 B- Detailed transverse section of the stem of *Echium horrodidium* Batt.  
 C- Diagrammatic transverse section of the stem of *Echium rauwolfii* Del.  
 D- Epidermal cells of the stem  
 E- Isolated elements of the stem.  
 All (X 140) except A (X 56) and C (X 64).  
 c., cortex; col., collenchyma; end., endodermis; ep., epidermis; m.r., medullary ray; p., pith; per., pericycle; ph., phloem; s., setae; t., tracheid; v., vessel; w.f., wood fibre; w.p., wood parenchyma; xy., xylem.

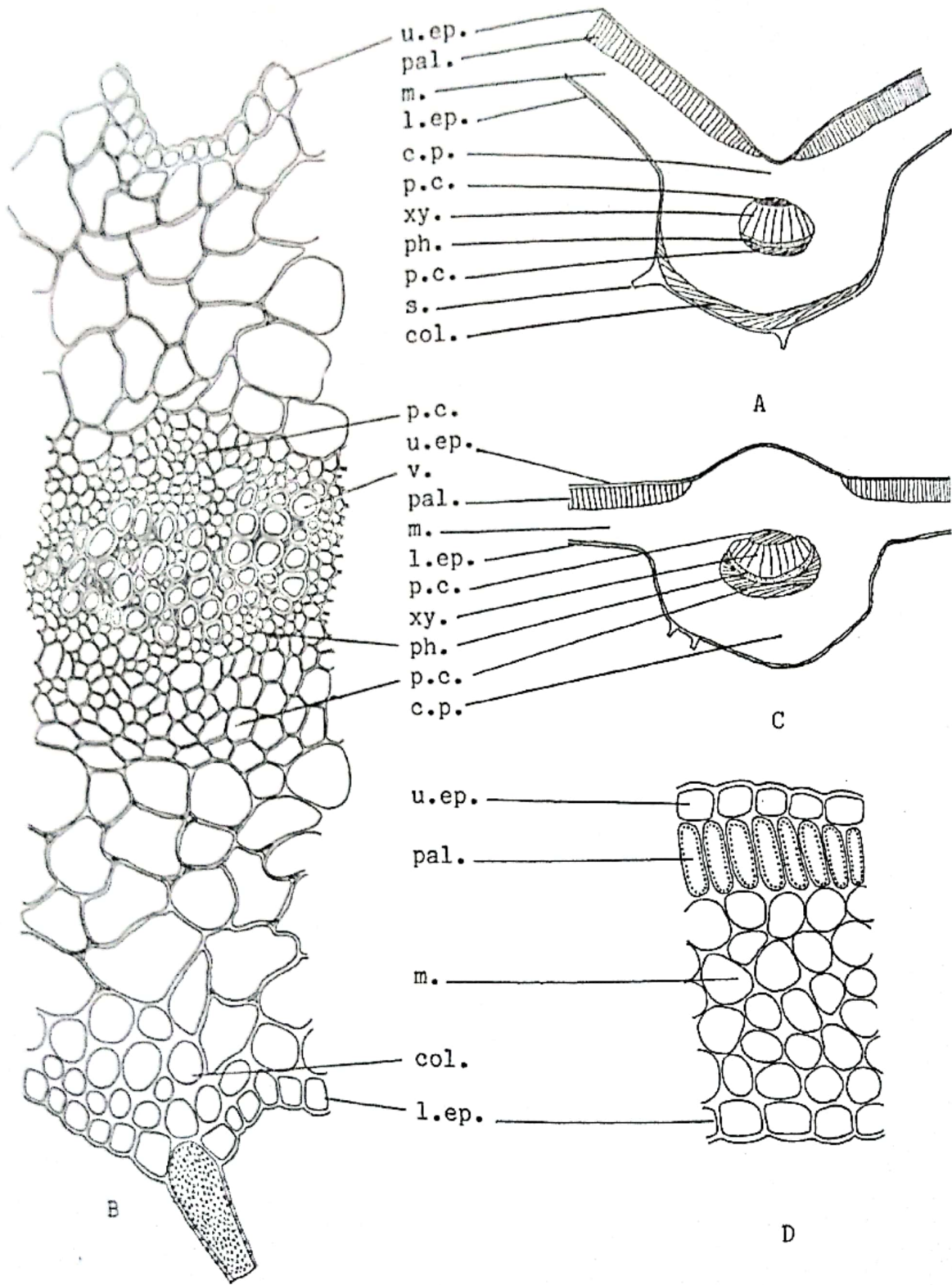


Fig. (5): The leaf

- A- Diagrammatic transverse section of the leaf of *Echium horrodidium* Batt. (X 25).
  - B- Detailed transverse section of the midrib of *Echium horrodidium* Batt. (X 205).
  - C- Diagrammatic transverse section of the leaf of *Echium rauwolfii* Del. (X 35).
  - D- Detailed transverse section of the lamina of *Echium horrodidium* Batt. (X 235).
- c.p., cortical parenchyma; col., collenchyma; l.ep., lower epidermis; m., mesophyll; p.c., pericyclic collenchyma; pal., palisade; ph., phloem; s., setae; u.ep., upper epidermis; v., vessel; xy., xylem.

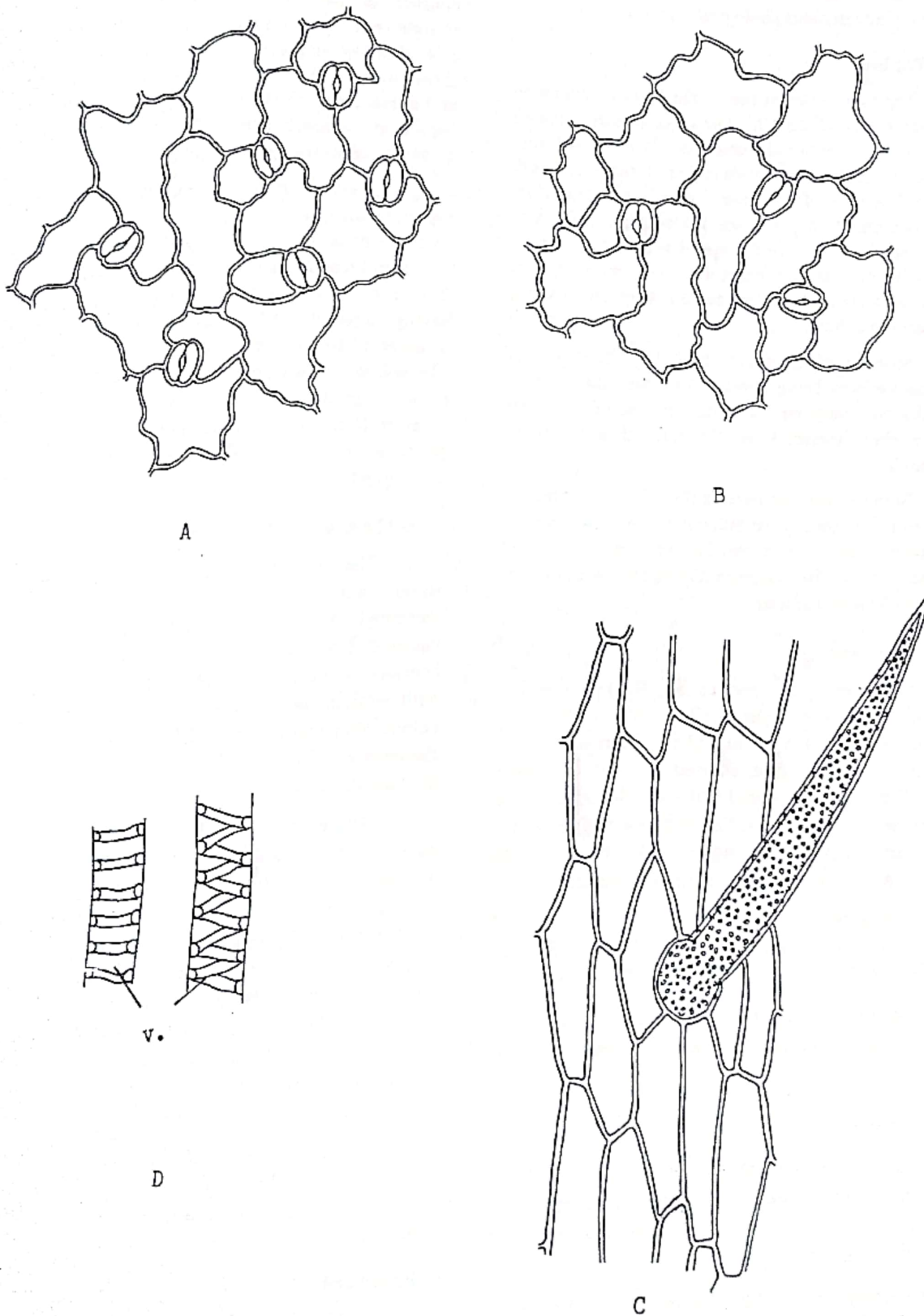


Fig. (6); The leaf

A- Upper epidermis of the leaf.  
C- Neural epidermis of the leaf.

B- Lower epidermis of the leaf.  
D- Vessels of the leaf.

All (X 334)

v., vessels.

### The flower:

The flower of *Echium horridum* Benth. showed the following micromorphological features:

#### a. The bract:

The transverse section in the bract is similar in structure to that of the leaf. The inner surface (upper) (Fig. 7A) consists of polygonal, axially elongated cells having straight anticlinal walls and covered with smooth cuticle. The cells of the outer (lower) epidermis (Fig. 7B) is formed of polygonal isodiametric cells with wavy anticlinal walls in the apical and middle region, and polygonal axially elongated cells with straight anticlinal walls in the basal region, they are covered with smooth cuticle.

Stomata of anomocytic type (Fig. 7) are present on both surfaces being numerous on the outer surface and observed only on the middle region of the inner surface. They measure 16 to 29  $\mu$  in length and 13 to 25 in breadth.

Both surface and margins (Fig. 7) are covered by long ensiform, unicellular bulbous based setae covered with thick warty cuticle and having wide lumen and subacute apices; they measure 331 to 1506  $\mu$  in length and 44 to 69  $\mu$  in diameter.

#### b. The calyx:

The inner (upper) surface (Fig. 8A) is formed of polygonal axially elongated cells with slightly wavy anticlinal walls in the apical and middle region while those of the basal region showed straight anticlinal walls. The cells are covered with smooth cuticle. The outer (inner) surface (Fig. 8B) is formed of polygonal isodiametric or axially elongated cells with straight anticlinal walls and covered with smooth cuticle.

Few anomocytic stomata (Fig. 8) are observed on both surfaces, especially on the middle region; they measure 18 to 27  $\mu$  in length and 12 to 22  $\mu$  in diameter.

Bulbous based setae (Fig. 8) are numerous on both surfaces especially at the basal and marginal regions.

#### c. The corolla:

The epidermises of corolla (Fig. 9A and B) consist of polygonal, axially elongated or isodiametric cells with slightly wavy or straight anticlinal walls and covered with smooth cuticle.

Covering bulbous based setae (Fig. 9) are present on both epidermises of the corolla. They are long, ensiform, unicellular, covered with warty cuticle and having wide lumen and subacute apices; they measure 191 to 1643  $\mu$  in length and 19 to 68  $\mu$  in diameter.

Stomata and glandular trichomes are completely absent on both surfaces of corolla.

#### d. The androecium:

The epidermis of the filament (Fig. 10A) consists of polygonal axially elongated cells with straight anticlinal walls and covered with smooth cuticle and showing neither stomata nor trichomes. They measure 91 to 154  $\mu$  in length and 6 to 22  $\mu$  in breadth at the apical part, 135 to 191  $\mu$  in length and 15 to 28  $\mu$  in breadth at the middle part, and 96 to 169  $\mu$  in length and 19 to 29  $\mu$  in breadth at the basal part.

The epidermal cells of the anther lobe (Fig. 10B) are polygonal, axially elongated and covered with smooth cuticle; they measure 16 to 29  $\mu$  in length and 4 to 9  $\mu$  in breadth. The fibrous layer of the anther (Fig. 10C) is composed of lignified cells, polygonal in shape, having straight and beaded anticlinal walls. They measure 17 to 26  $\mu$  in length and 8 to 18  $\mu$  in breadth. The pollen grains (Fig. 10D) are spherical with warty exine, 3 germ pores and 3 germinal furrows; they measure 16 to 20  $\mu$  in diameter (c. f., the diameter of the pollen grains of *Echium rauwolfii* Del. which measure 14 to 16  $\mu$ ).

#### e. The gynaecium:

The ovary wall (Fig. 11A and B) is composed of an outer and inner epidermises enclosing a homogeneous mesophyll transversed longitudinally by 4 small vascular bundles. The outer epidermis (Fig. 11C) consists of thin-walled, polygonal, isodiametric cells with straight anticlinal walls and covered by smooth cuticle; they measure 18 to 24  $\mu$  in length, 19 to 22  $\mu$  in diameter and 7 to 9  $\mu$  in height. The epidermis shows no stomata or trichomes.

The epidermis of the style (Fig. 11D) is formed of polygonal to subrectangular axially elongated cells and covered with smooth cuticle. They measure 147 to 178  $\mu$  in length and 15 to 21  $\mu$  in breadth at the apical part, 106 to 147  $\mu$  in length and 12 to 22  $\mu$  in breadth at the middle part, and 32 to 66  $\mu$  in length and 12 to 15  $\mu$  in breadth at the basal part. Covering bulbous based setae (Fig. 11D) are numerous, especially at the middle and basal regions. They are ensiform, unicellular and covered with warty cuticle; they measure 305 to 404  $\mu$  in length and 18 to 26  $\mu$  in diameter.

The epidermis of stigma (Fig. 11E) is formed of polygonal, papillosed cells with straight anticlinal walls, smooth cuticle and measure 9 to 22  $\mu$  in length and 7 to 21  $\mu$  in breadth.

#### Powdered flower:

The powdered flower is violet to blue in colour, with no characteristic odour and slightly bitter taste. It is characterized microscopically by:

- 1-Fragments of the floral leaves showing anomocytic stomata and covered by bulbous based setae.
- 2-Fragments of the epidermal cells of the filament and anther lobes.

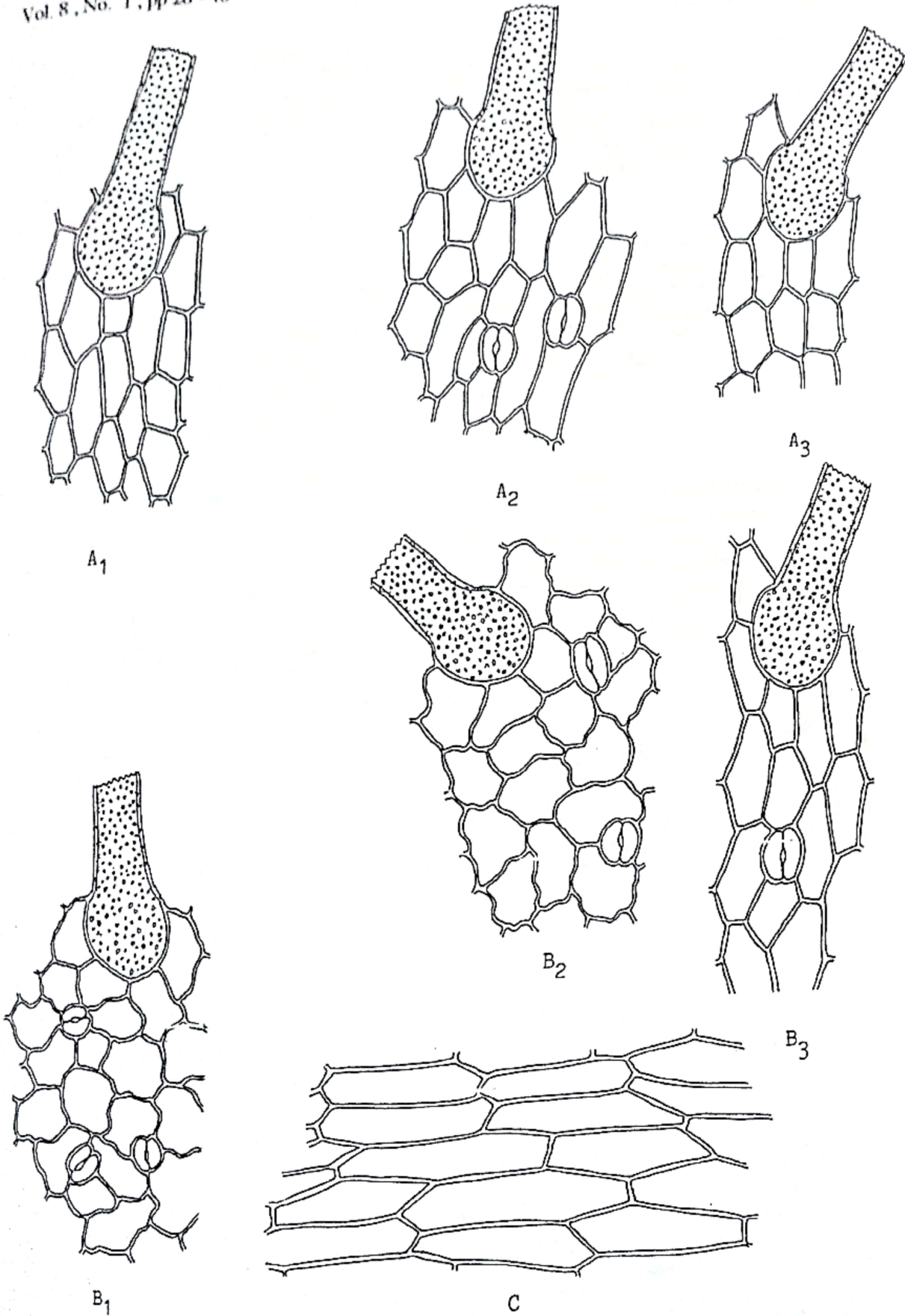


Fig. (7): The bract

A - Inner (upper) epidermis.

A<sub>1</sub> - At the apex    A<sub>2</sub> - At the middle    A<sub>3</sub> - At the lower part

B - Outer (lower) epidermis.

B<sub>1</sub> - At the apex    B<sub>2</sub> - At the middle    B<sub>3</sub> - At the lower part

C - Neural epidermis.

All (X 334)

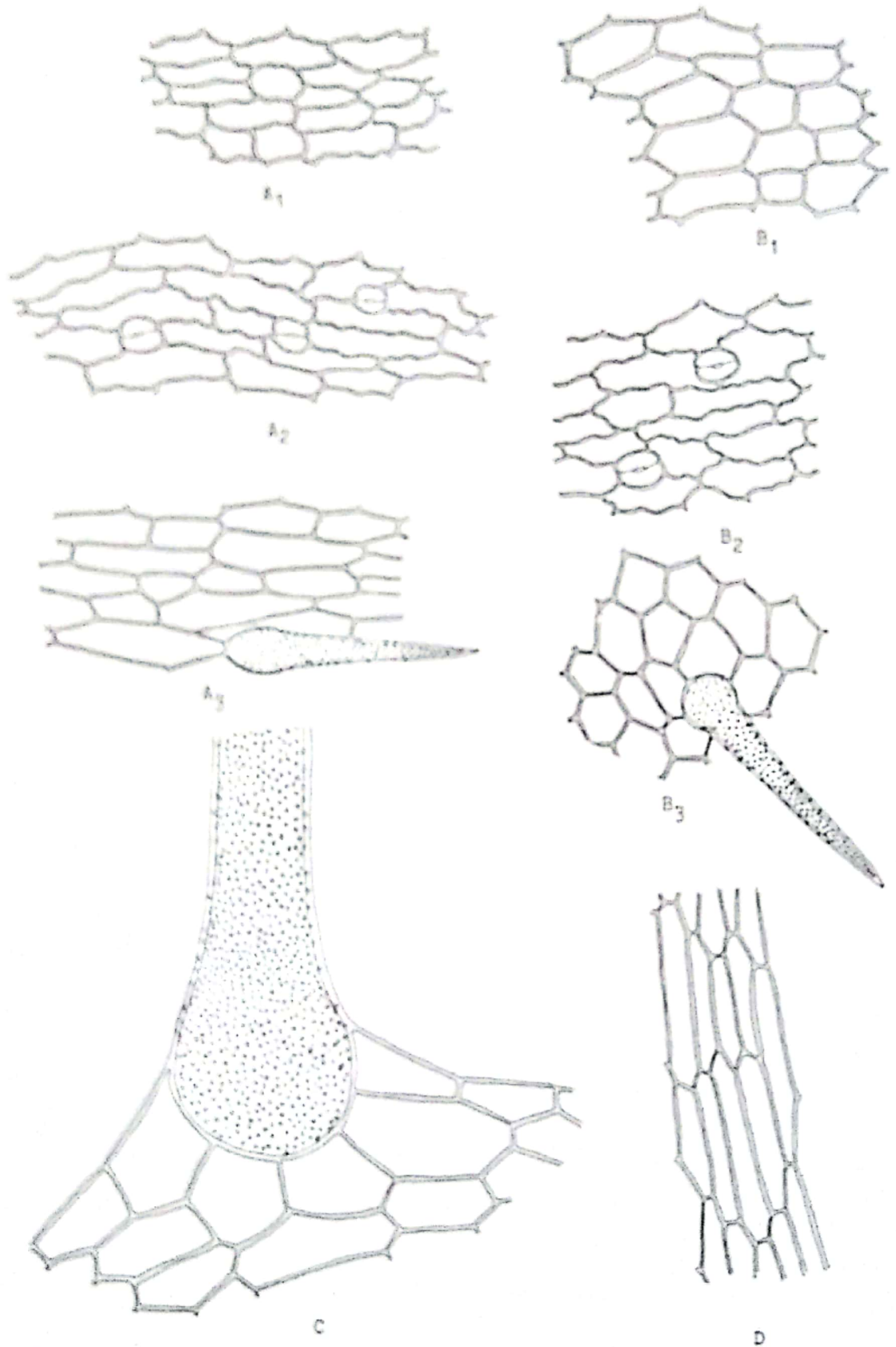


Fig (8) The calyx

A - Inner (upper) epidermis.

A1 - At the apex

A2 - At the middle

A3 - At the lower part

B - Outer (lower) epidermis

B1 - At the apex

B2 - At the middle

B3 - At the lower part

C - Marginal setae

D - Neural epidermis

All (X 316)

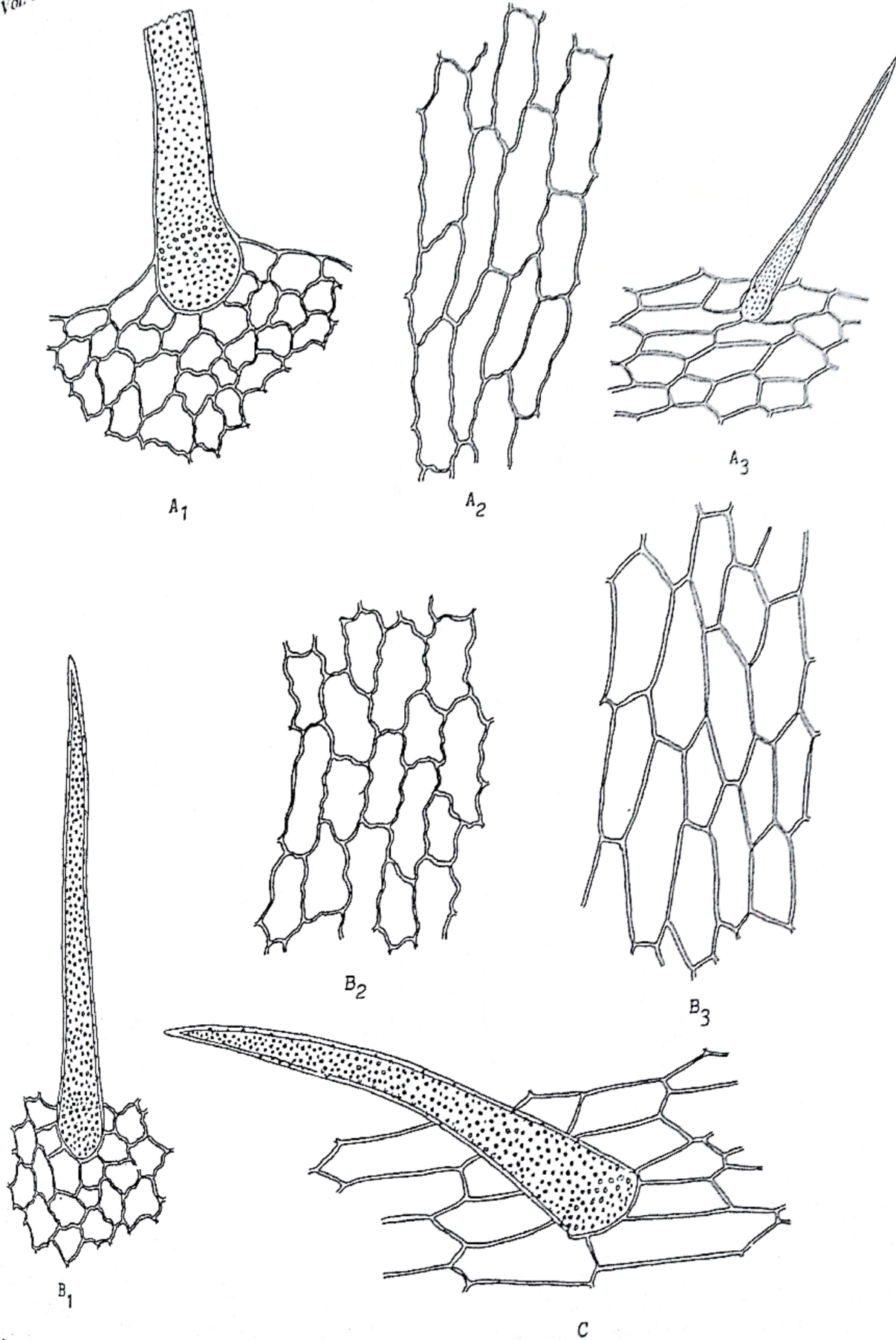


Fig. (9). The corolla

A - Inner (upper) epidermis.

A<sub>1</sub> - At the apex

A<sub>2</sub> - At the middle

A<sub>3</sub> - At the lower part

B - Outer (lower) epidermis.

B<sub>1</sub> - At the apex

B<sub>2</sub> - At the middle

B<sub>3</sub> - At the lower part

C - Neural epidermis.

Alt (X 309)

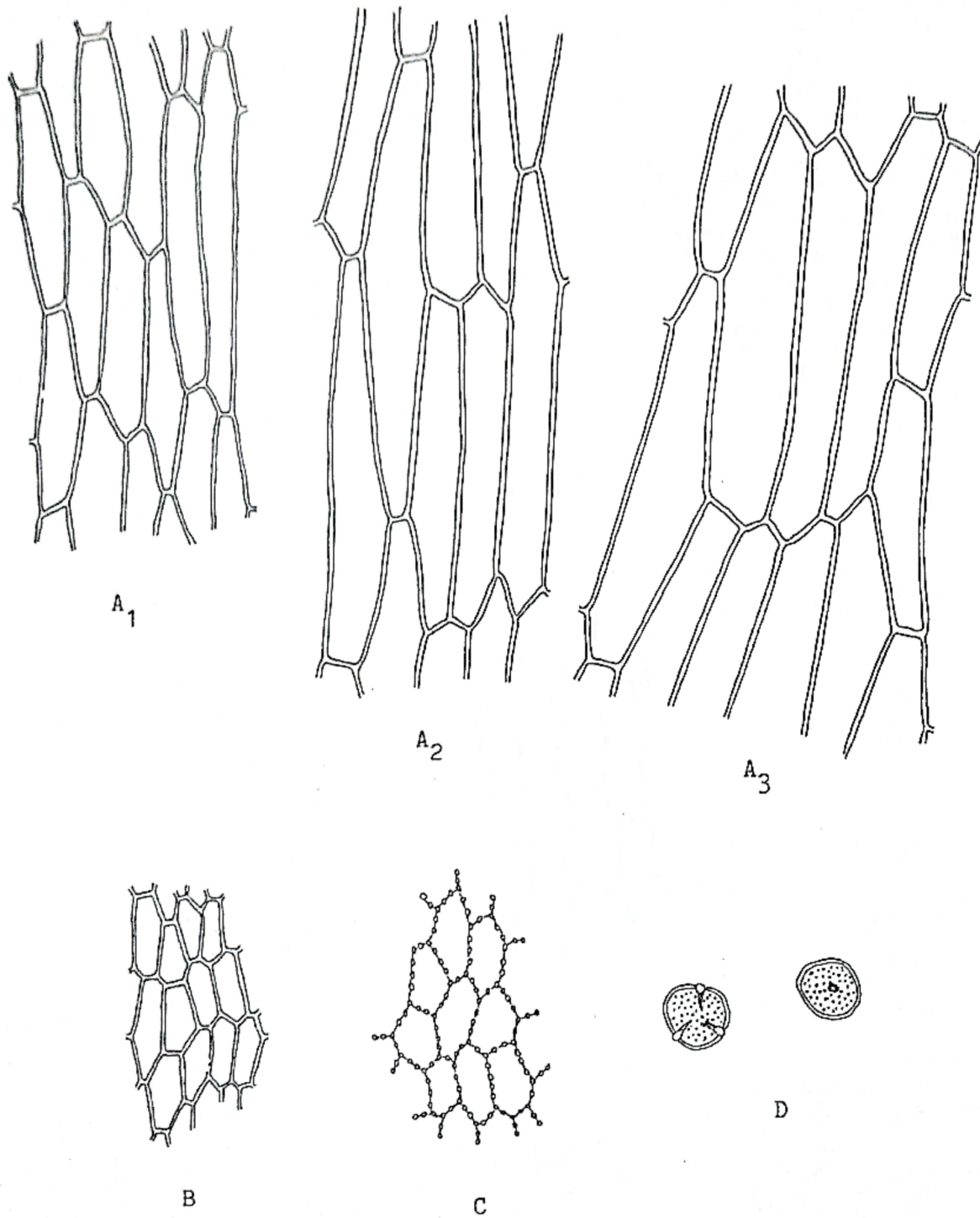


Fig. (10): The androecium

A - Epidermis of the filament

A<sub>1</sub> - At the apex    A<sub>2</sub> - At the middle    3 - At the base

B- Epidermis of the anther

C- The fibrous layer in surface view.

D- Pollen grains

All (X 498) except A (X 340).



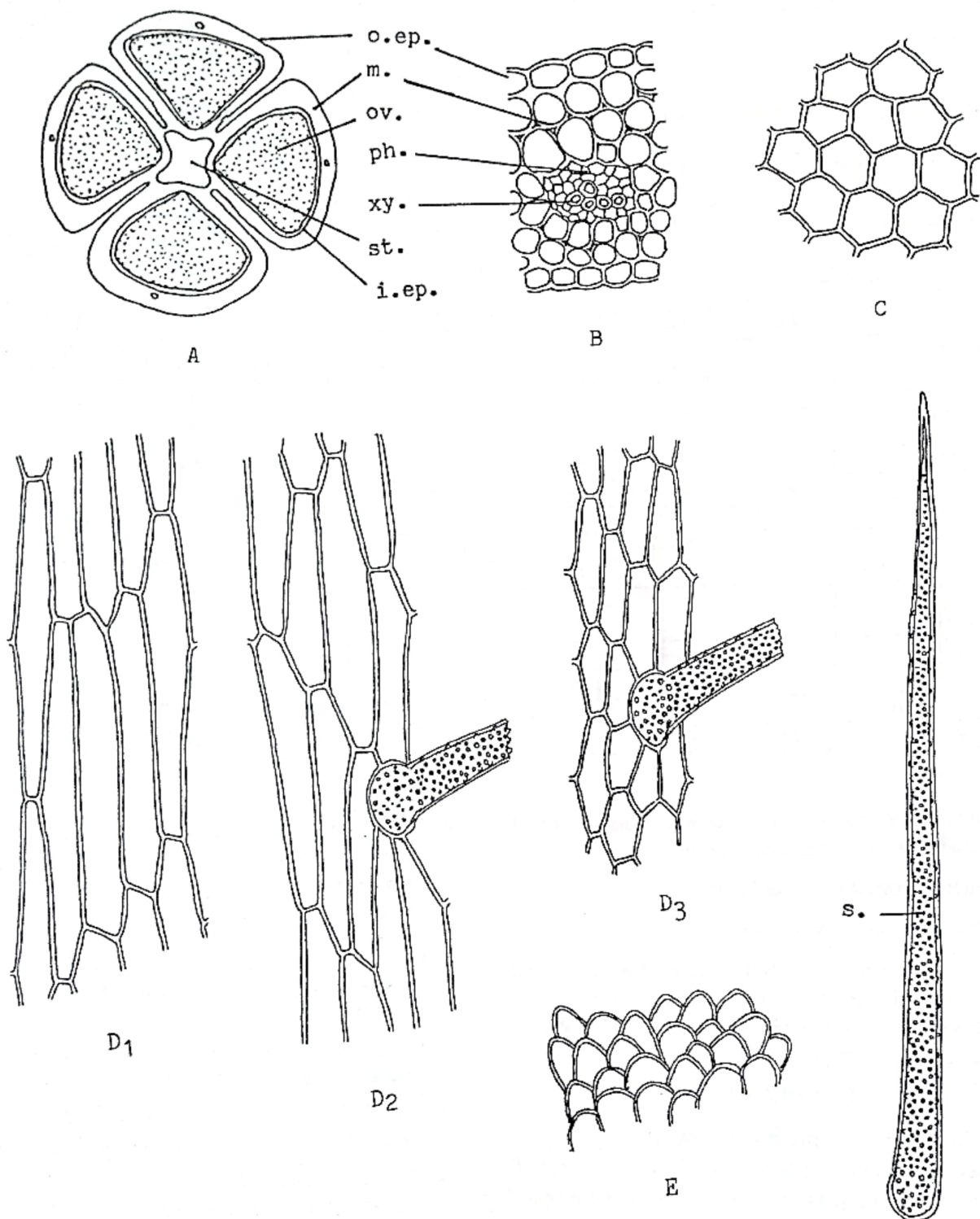


Fig. (11): The gynaecium

A- Diagrammatic transverse section in the ovary.

B- Detailed transverse section of the ovary wall.

C- Outer epidermis of the ovary.

D- Epidermis of the style

D1 - At the apex    D2 - At the middle.

D3 - At the base

E- Epidermis of the stigma

All (X 309) except A (X 40 ) and B and C (X 369).

i. ep., inner epidermis; m., mesophyll; o. ep., outer epidermis; ov., ovule; ph., phloem; st., style; xy., xylem.

Table 5 Dimensions in microns of the epidermal cells of the bract, calyx and corolla of *Echium horridum* Batt and *E. rauwolfii* Del.

	Inner epidermis				Outer epidermis			
	Length		Breadth		Length		Breadth	
	<i>E. horr.</i>	<i>E. rauw.</i>	<i>E. horr.</i>	<i>E. rauw.</i>	<i>E. horr.</i>	<i>E. rauw.</i>	<i>E. horr.</i>	<i>E. rauw.</i>
<b>The bract</b>								
at apex	28-42-52	22-29-38	12-17-22	13-16-22	19-30-43	21-35-46	15-23-31	15-19-24
at middle	27-54-81	31-42-52	12-20-28	16-23-32	22-38-52	28-32-41	16-21-29	16-19-25
at lower part	19-32-52	29-50-69	13-61-24	18-21-25	31-50-72	44-59-69	13-20-28	15-17-22
neural epidermis	66-95-125	44-60-74	12-18-25	13-15-16	66-90-125	44-62-74	12-16-25	13-14-16
<b>The calyx</b>								
at apex	31-45-59	22-38-52	9-13-18	7-11-16	24-45-63	37-51-69	16-22-29	21-26-29
at middle	35-62-88	44-59-74	9-16-22	10-12-15	41-60-78	37-51-66	10-18-29	15-21-27
at lower part	31-66-101	37-51-66	13-15-22	7-11-15	24-31-44	37-45-56	16-25-37	12-20-25
neural epidermis	59-85-110	91-115-147	9-12-15	12-18-25	59-87-110	61-101-147	9-11-15	12-18-25
<b>The corolla</b>								
at apex	16-39-62	22-31-43	9-17-37	22-29-37	13-20-28	13-18-28	9-15-24	7-10-15
at middle	69-91-115	44-71-96	15-22-29	24-32-40	35-54-72	37-65-74	16-20-28	19-26-32
at lower part	25-50-75	74-100-140	10-15-27	12-25-32	35-75-112	81-120-169	21-27-35	27-36-44
neural epidermis	50-80-110	29-61-103	16-23-29	22-29-37	50-75-110	29-60-103	16-22-29	22-31-40

3-Numerous spherical pollen grains with 3 germ pores, 3 germinal furrows and granular exine.

4-Fragments from the fibrous layer.

5-Fragments of papillosed stigma.

*Echium rauwolfii* Del. and *E. horridum* Batt. flowers differ also in many micromorphological aspects, that are summarised in table 2 and in cell dimensions listed in table 5 (above).

#### CUNCLUSION

The previous macro-and micromorphological differences between *Echium horridum* Batt. and *E. rauwolfii* Del. besides the different microscopical numerical values of the leaves of both species help in their differentiation. The obtained results in addition to the alkaloid profile of *E. rauwolfii* Del. which vary

quantitatively from that of *E. horridum* Batt. and by the absence of lycopsamine alkaloid (2) provide firm, unambiguous differentiation between both species.

#### REFERENCES

- 1- Täckholm, V. , "Students' Flora of Egypt", Cairo University. Cooperative printing Co. Beirut. 2nd, Ed., pp. 450-451 (1974).
- 2- El-Shazly, A., Abdel Aal, M., Tei, A. and Wink, M. ; Z *Naturforsch*, 54c, 295 - 300 (1999).
- 3- Mattocks, A. R., "Chemistry and toxicology of pyrrolizidine alkaloids". Academic press, London (1986).
- 4- Feinbrun-Dothan N. , "Flora Palaestina", The Israel Academy of Sciences and Humanities, 3 pp. 74-77 (1978).
- 5- Jafri, S. M. H. and El-Gadi, A. , "Flora of Libya", Al-Faateh University, Tripoli. 68. pp. 33-49 (1979).

## دراسة مقارنة للصفات العيانية والمجهرية لنباتى إشيـم هوريدم وإشيـم راؤلفى من العائلة البوراجينية

محمود محمد عبدالعال و عاصم محمد الشاذلى

قسم العقاقير - كلية الصيدلة - جامعة الزقازيق - مصر

سبق أن تمت دراسة المحتويات القلوانية لنباتى إشيـم هوريدم وإشيـم راؤلفى وأمكن فصل مادة الأشيـميدىن من كليهما بالاضافة إلى العديد من القلوانيات البيروليزدينية الأخرى . ونتيجة لهذه الدراسة تم تحديد الفروق الكمية والكيفية لهذه القلوانيات . ولما كانت تلك المركبات ذات سمية عالية للإنسان والحيوان على حد سواء . لذا كان من الضرورى إجراء هذه الدراسة النباتية لمقارنة الصفات العيانية والمجهرية لهذين النباتين حتى يسهل التعرف عليهما سواء فى حالتيهما الصحيحة أو على هيئة مسحوق.