

MACRO-AND MICROMORPHOLOGY OF THE STEM AND LEAVES  
OF LIMONIUM SINUATUM (L.) MILL. GROWN IN EGYPT

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*Abstract* : The macro and micromorphology of the stem and leaves of *Limonium sinuatum* (L.) Mill. are presented with the aim of finding their characters by which they could be identified and differentiated.

INTRODUCTION

*Limonium sinuatum* (L.) Mill. (= *Statice sinuata* L.) (Fam. Plumbaginaceae) is a rough hairy perennial or biennial plant, up to one metre high and grows in the Mediterranean regions<sup>1,2</sup>. From the leaves and flowers several flavonoids were isolated<sup>3-6</sup>. Some limonium species are used medicinally as astringent and against diarrhoea and dysentery<sup>7</sup>.

In the present work, the macro as well as micromorphological features of the stem and leaves of *Limonium sinuatum* (L.) Mill. are illustrated.

Material :

Collection was made from plants cultivated in the Experimental Station of Medicinal Plants, Faculty of Pharmacy, Assiut University. The plant was identified by Prof. Dr. Foad Y. Amin, Prof. of Floriculture, Faculty of Agriculture, Assiut University. Fresh stems and leaves as well as preserved in a mixture of : alcohol : glycerin : water (1 : 1 : 1) were used.

Habitat :

*Limonium sinuatum* (L.) Mill. is a small shrub, attaining up to about 90 cm in height. The plant (Fig. 1,2) has erect stems which show a whorl of lower radical leaves at their basis originating from the upper part of the root and others of cauline leaves at the other parts. The flowering period is from



Fig.1- Photograph of *Limonium sinuatum* (L.) Mill.

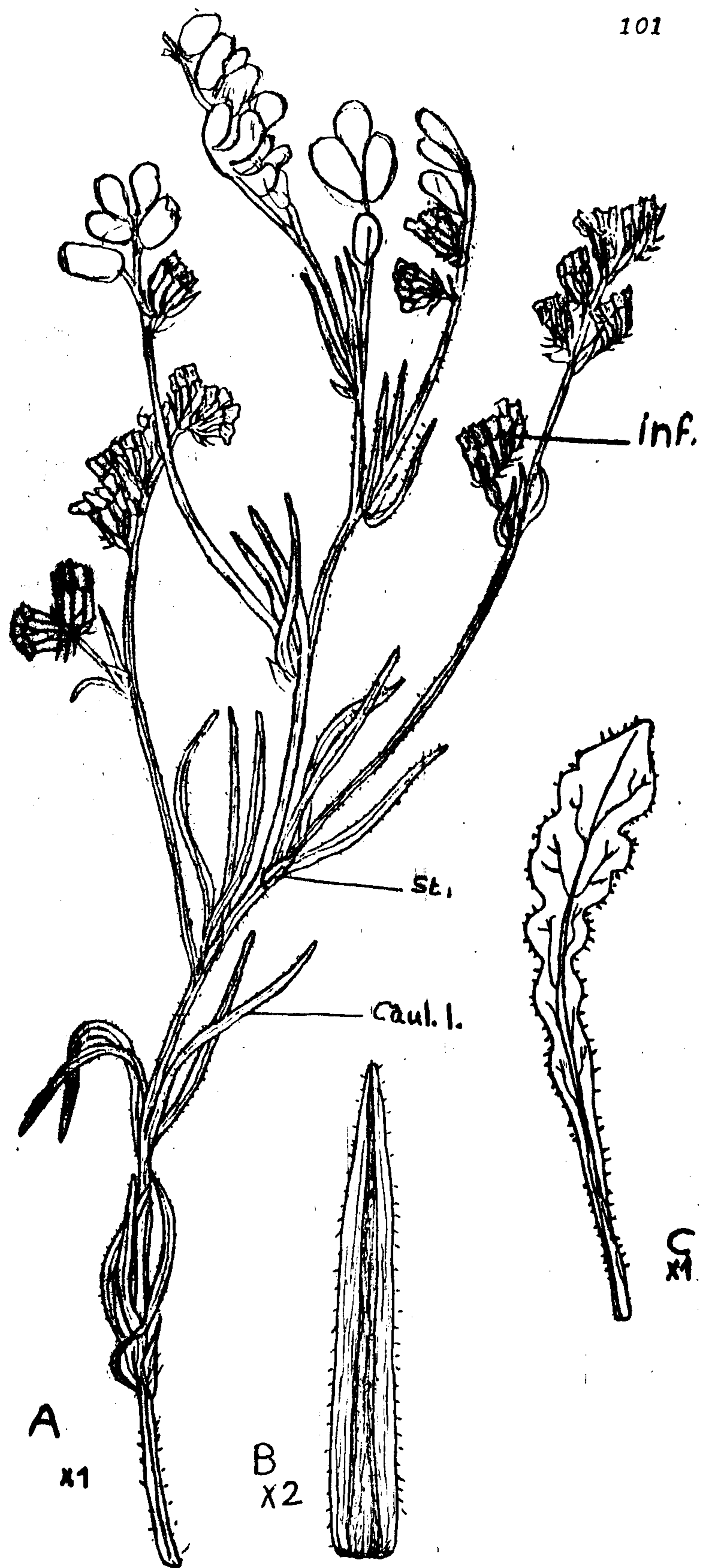


Fig.2- A. Sketch of a flowering branch X I  
 B. Sketch of a cauline leaf . X I  
 C. Sketch of a radical leaf . X I  
 Caul. L., cauline leaf; inf., inflorescences ;  
 St., stipule .

the end of February to May and the flowers produce no fruits. Vegetation of the plant is accomplished by spreading the flowers. The latter are papery, light purple and arranged in 3-bracted spikelets together forming branched one-sided spikes.

#### A. THE STEM

##### Macromorphology : (Fig. 2 A)

The mature plant stem is erect, hollow and cylindrical to quadrangular reaching to about 50 to 80 cm in length and up to 1 cm in diameter near the ground level. They bear mostly 1 to 3 sometimes 4 wings which extend along the basal side of the midrib region on the cauline leaves and around the petiole and inflorescence rachis. The stem and branches are hairy, greenish in colour, odourless and with a slight bitter taste.

##### Micromorphology :

A transverse section through the young stem (Fig. 3 A) is somewhat rhomboidal in outline showing 1 to 3 wings extending from the angles. It shows a hairy outer epidermis enclosing a chlorenchymatous hypodermis followed by a comparatively narrow parenchymatous cortex. The pericycle is formed of a continuous band of lignified fibres in which are embedded small abnormal collateral vascular bundles with an outer soft phloem and inner lignified xylem. The pericycle surrounds a circle of 10 to 16 vascular bundles having a lignified internal xylem and outer soft phloem and separated by fairly wide medullary rays. The vascular bundles enclose a whitish parenchymatous pith and the central part is hollow.

##### The epidermis : (Fig. 3 B + C)

The epidermis is formed of polygonal, axially elongated cells with straight anticlinal walls, covered with striated, somewhat thick cuticle. They measure from 29 to 37 microns in height, 177, to 148 microns in length and 25 to 48 microns in width.

The epidermal cells covering the wings are mostly having beaded anticlinal walls and covered with more distinctly striated cuticle. The stomata are oval, mostly ranunculaceous but some caryophyllaceous stomata are observed. They measure from 43 to 60 microns in length and 28 to 38 microns in width. Non-glandular unicellular conical to elongated hairs are present with acute or pointed apices, covered with warty cuticle, measuring from 128 to 2000 microns in length and 60 to 151 microns in width at the base. Chalk glands<sup>8</sup> are present composed of 4 to 8 palisade-like cells surrounded by a layer of about 4 cells and secrete calcium carbonate .

The cork appears in the older stems being formed of radially arranged, tangentially elongated lignified cells showing lenticells at the outer parts and filled with brownish contents. It is formed by a phellogen developing in the outermost layers of the cortex .

The cortex : (Fig. 3 D)

The cortex shows an outer layer of 3 to 5 rows of small rounded cells containing greenish to greenish-brown contents staining pale green with ferric chloride T.S. These are followed by 3 to 5 rows of tangentially elongated parenchyma cells containing starch granules which are simple or compound of 2 to 5 components. Secretory cells filled with brownish contents staining greenish-blue with ferric chloride T.S. and dull yellow with potassium hydroxide solution (10%) are scattered.

The pericycle : (Fig. 3 D & E)

The pericyclic fibres of the stem are thick-walled showing more or less narrow lumen, straight, lignified walls which show slit-like pits and tapering, somewhat acute apices. They measure from 220 to 990 microns in length and 20 to 32 microns in diameter.

The vascular system : (Fig. 3 D & E)

The individual vascular bundle shows an outer phloem formed of sieve tubes, companion cells and phloem parenchyma, followed by comparatively narrow indistinct cambium. The xylem

elements are presented by lignified pitted and reticulate, sometimes scalariform and spiral vessels accompanied by wood fibres, tracheids and parenchyma. The vessels measure from 35 to 94 microns in diameter. The fibres are lignified having thick straight walls, narrow lumen and tapering apices, measuring from 190 to 600 microns in length, 20 to 28 microns in width. The tracheids and wood parenchyma are pitted.

The xylem of the abnormal vascular bundles present in the pericycle consists mainly of pitted, scalariform and spiral lignified vessels, lignified fibres and parenchyma.

The pith is formed of somewhat large, rounded, isodiametric, moderately thin-walled, pitted and rarely lignified parenchyma. The cells contain starch granules.

#### The Powder :

Powdered stem of Limonium sinuatum (L.) Mill. is dull green to greenish-brown in colour having a faint odour and slightly bitter taste. Microscopically, it is characterised by the following :

- 1- Fragments of polygonal, axially elongated epidermal cells showing straight anticlinal walls and covered with striated cuticle. The fragments show oval, ranunculaceous or caryophyllaceous stomata, non-glandular unicellular hairs and secretory chalk glands.
- 2- Fragments showing axially elongated epidermal cells with straight, beaded anticlinal walls and covered with thick striated cuticle carrying stomata and hairs.
- 3- Unicellular non-glandular conical to elongated hairs with wide lumen, thin walls, covered with warty cuticle and having pointed apices are scattered in the field.
- 4- Fragments showing polygonal, isodiametric or elongated cork cells which are brownish and slightly lignified.
- 5- Fragments showing lignified vessels carrying simple and bordered pits or reticulations together with pitted lignified tracheids and wood parenchyma.

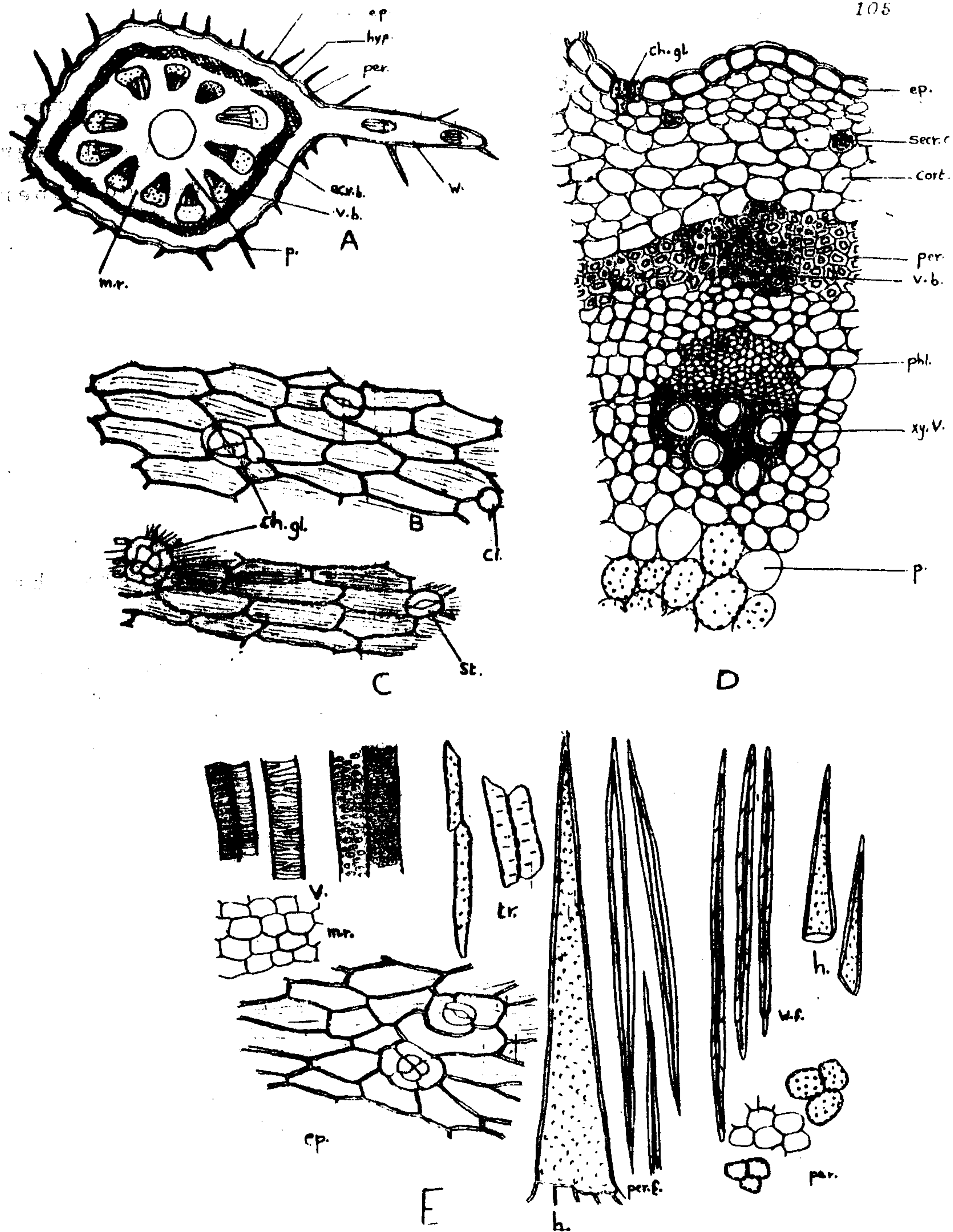


Fig.3- A. Diagrammatic T.S. of the stem. X 12  
 B. Surface preparation of the stem. X 140  
 C. Surface preparation from the wing. X 140  
 D. Detailed T. S. of the stem. X 140  
 E. Isolated elements of the stem. X 140

ac. V.b., accessory vascular bundle; ch. gl., chalk gland; ci., cicatrix; cort., cortex; ep, epidermis; h., hair; hyp., hypodermis ;m.r. medullar ray; p., pith; par., parenchyma; per. f., pericyclic fibre; phl., phloem; secr. c., secretory cell; st., stomata; tr., tracheid; w., wing; w.f., wood fibre; v., vessels; v.b., vascular bundle; xy.v., xylem vessel.

- 6- Lignified wood fibres which have thick walls, narrow lumen and tapering apices, in addition to pericyclic fibres with lignified moderately thick walls having slit-like pits and tapering acute apices.
- 7- Absence of sclereids and calcium oxalate.

## B. THE LEAVES

### 1-RADICAL LEAVES

#### Macromorphology : (Fig. 2 C)

The radical leaves form clusters or whorls at the stem basis near the ground level and originating from the upper part of the root. The individual leaf is simple, petiolate, exstipulate, coriaceous, oblong-lanceolate to spatulate in outline, measuring from 8 to 13 cm in length and 9 to 20 mm in width. The lamina is entire with about 5 to 7 sinuations at each side. It is hairy, decurrent at the base and joined with the wings of the petiole. The base is symmetric and apex is acuminate to rounded. Venation is pinnate-reticulate and the midrib is prominent on both surfaces, sometimes more projecting on the lower one and the lateral veins are more visible on the lower surface. The fresh leaves are dark green on the upper surface and pale green on the lower and on drying they become, paler in colour. The leaf is odourless with a slightly acrid to bitter taste. The petiole is cylindrical showing prominent wing on each side extending with those present on the stem. It is hairy and pale green in colour.

#### Micromorphology :

##### 1-The Lamina :

A transverse section through the midrib (Fig. 4 A) is biconvex in outline. It shows an upper and lower epidermises enclosing an isobilateral, heterogeneous mesophyll. The latter is formed of upper and lower palisade; each of one row interrupted in the midrib region by a collenchymatous hypodermis and accompanied with parenchyma. The vascular system is represented



by a main central vascular bundle and another 3 to 5 subsidiary ones scattered in the cortical tissue of the midrib region.

The epidermis :

The upper epidermis (Fig. 4 B) is formed of polygonal, isodiametric or elongated cells with straight anticlinal walls and covered with striated cuticle. The cells of the lower epidermis (Fig. 4 C) are similar to those of the upper but slightly smaller in size. The upper epidermal cells measure from 29 to 32 microns in height, 70 to 149 microns in length and 37 to 92 microns in width. The lower epidermal cells measure from 19 to 29 microns in height, 62 to 115 microns in length, and 32 to 75 microns in width. Stomata are mostly caryophyllaceous, rarely ranunculaceous, or rubiaceus measuring from 40 to 53 microns in length and 29 to 35 microns in width. Unicellular non-glandular conical hairs resembling those present in the stem are observed. Secretory chalk glands as those of the stem are present but in a smaller number.

The cortical tissue : (Fig. 4 D)

It shows upper and lower collenchyma formed of about 2 to 4 rows of rounded cells with narrow intercellular spaces and containing chloroplasts. The rest is formed of parenchyma cells with narrow intercellular spaces containing starch granules which are simple and compound of 2 to 5 components. Secretory cells as those of the stem are present in the cortex.

The mesophyll : (Fig. 4 E)

The upper and lower palisade are formed of one row of columnar cells containing chloroplasts. The spongy mesophyll is formed of irregular parenchyma with wide intercellular spaces and containing starch granules and secretory cells.

The vascular system : (Fig. 4 D & 5 C)

The main vascular bundle has a pericycle consisting of two arcs (upper and lower) of lignified fibres interrupted with parenchyma cells. The pericyclic fibres have straight, thin, lignified walls, tapering ends and wide lumen. The phloem is

formed of soft cellulosic elements showing sieve tubes, companion cells and phloem parenchyma together with few scattered suberised cells free from contents. The xylem consists of spiral, reticulate, annular and pitted lignified vessels reaching up to 55 microns in diameter. Uniseriate medullary rays traversing and nonlignified xylem parenchyma present.

The subsidiary vascular bundles show the same general characters as described above except that the pericycle is composed of mainly parenchyma with small arcs of lignified fibres.

#### 2-The petiole :

A transverse section through the petiole (Fig. 5 A) is somewhat oval in outline showing a wing at each side and a central oval vascular bundle. This bundle has a central crescent-shaped radiating narrow xylem surrounded by soft phloem. The cortex is formed of parenchyma containing starch granules and secretory cells as those of the lamina and 2 to 3 rows of collenchyma abutting on the epidermis. Xylem composed mainly of reticulate, spiral and pitted lignified vessels, uniseriate medullary rays and nonlignified parenchyma.

#### The epidermis : (Fig. 5 B)

It is formed of axially elongated narrow cells with straight anticlinal walls, covered with striated cuticle and measuring from 30 to 35 microns in height, 90 to 200 microns in length and 35 to 68 microns in width. Stomata, hairs and chalk glands (cystolith) are present and resemble those on the lamina.

On the edges of the wings the cells show beaded anticlinal walls and are covered with thick striated cuticle.

#### The Powder :

The powdered radical leaves of *Limonium sinuatum* (L.) Mill. is green in colour, odourless with slightly bitter and acrid taste. Microscopically, it is characterised by the followings:  
1- Fragments of epidermal cells showing isodiametric to elongated cells with straight anticlinal walls and covered with striated cuticle. These fragments carry caryophyllaceous stomata, unicellular nonglandular conical hairs covered with

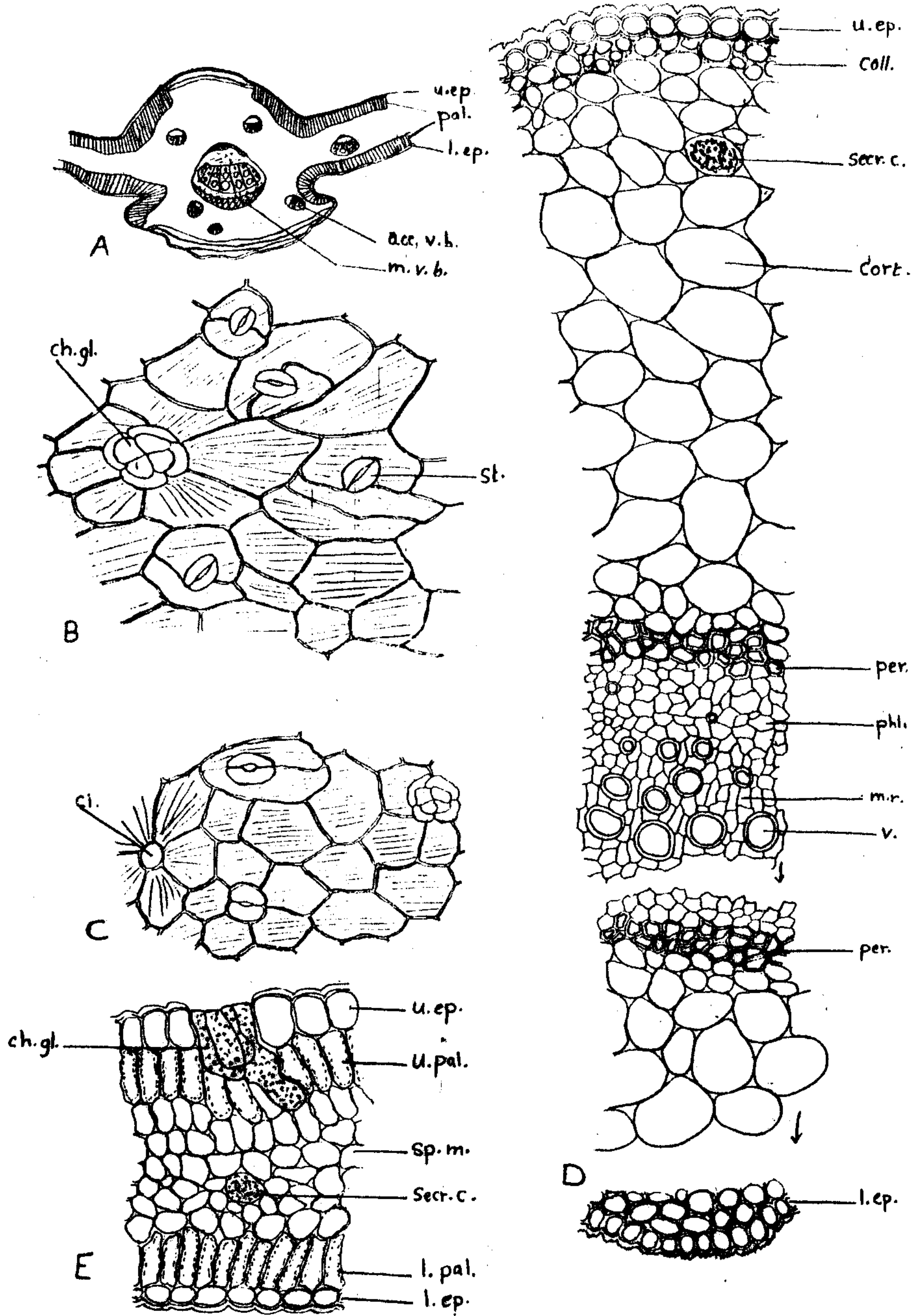


Fig.4- A. Diagrammatic T. S. of the radical leaf. X 12  
 B. Surface preparation of the upper epidermis. X 132  
 C. Surface preparation of the lower epidermis. X 132  
 D. Detailed T. S. of the midrib region. X 132  
 E. Detailed T.S. of the lamina. X 132

acc. v.b., accessory vascular bundle; ch. gl. chalk gland; ci., cicatrix; coll., collenchyma; cort, cortex.; l. ep., lower epidermis; l. pal., lower palisade; m.r., medullary ray; m.v.b, main vascular bundle; pal., palisade; per., pericycle, phl., phloem; secr. c., secretory cell; sp. m. , spongy mesophyll; st., stomata; u. ep., upper epidermis; u. pal., upper palisade ;v., vessels.



- warty cuticle and secretory chalk glands.
- 2- Unicellular nonglandular conical hairs are scattered. They are mainly very long and covered with warty cuticle showing wide lumen, thin walls and rounded apices.
  - 3- Fragments of the epidermal cells of the petiole which are axially elongated, with straight walls, covered with striated cuticle, having stomata, hairs and secretory glands. Some of these fragments show beaded anticlinal walls.
  - 4- Fibres isolated or in groups with wide lumen, lignified walls and tapering ends.
  - 5- Reticulate, spiral, annular, pitted and lignified xylem vessels.
  - 6- Fragments from the mesophyll showing palisade cells and spongy parenchyma.
  - 7- Rounded parenchyma cells showing secretory cells with granular contents.
  - 8- Absence of calcium oxalate crystals.

### 2-Cauline Leaves

#### Macromorphology: (Fig. 2 B)

The cauline leaves are present in groups (3 to 4) around the stems at the nodes. Each group has an ovate hairy scaly stipule. The individual leaf is linear to linear-lanceolate, sessile and has a conspicuous wing at its lower surface extending from base to apex and joined with that on the stem. The leaf is symmetric at the base having an entire margin and nearly rounded apex. Venation is parallel and the surface is hairy, dark green in colour. The lamina measures from 3 to 5.5 cm in length and 3 to 7 mm in width. The leaf is odourless with slight bitter and acrid taste.

#### Micromorphology:

A transverse section through the midrib (Fig. 6 A) is triarc in outline showing a central midrib and a narrow wing pulging at the lower side of the midrib. The leaf is isobilateral showing an upper and lower epidermises enclosing a heterogeneous mesophyll. The palisade is represented by 1 to 3 rows forming a complete circle abutting on the epidermises on all sides,

and rarely interrupted in the midrib region by an upper collenchymatous matrix of about 3 rows. The vascular system is represented by a central main concentric vascular bundle in the midrib region, 3 to 5 accessory bundles in each side of the lamina and another similar ones in the wing below the midrib.

The epidermis : (Fig. 6 B , C & D)

Both upper and lower epidermal cells are polygonal, isodiametric, nearly quadrangular and covered with striated cuticle. The upper epidermal cells show straight anticlinal walls and measure from 31 to 40 microns in height, 60 to 148 microns in length and 32 to 80 microns in width. The lower epidermal cells have slightly wavy walls and measure from 26 to 37 microns in height, 52 to 137 microns in length and 35 to 78 microns in width. The epidermal cells covering the wings and neural regions are axially elongated with straight, distinctly beaded walls. Stomata are mainly caryophyllaceous, resembling those of the radical leaf and present on both surfaces. Nonglandular hairs as well as secretory glands as those of the stem and radical leaves are present.

The cortical tissue : (Fig. 6 E)

It is formed of thin-walled parenchymatous cells containing starch granules and secretory cells.

The mesophyll : (Fig. 6 E)

The palisade cells are irregular. The spongy parenchyma contain secretory cells as those of the radical leaves.

The vascular system : (Fig. 6 E)

The pericycle forms a complete ring around the bundles. The pericyclic fibres have lignified, thick straight walls, moderately wide lumen, blunt apices and measure from 110 to 200 microns in length.

The xylem is formed of lignified spiral, pitted and scalariform vessels measuring up to 55 microns in diameter, accompanied by nonlignified xylem parenchyma. The phloem surrounding the xylem is formed of soft elements.

The powder :

The powder of cauline leaves of *limonium sinuatum* (L.) Mill. is green in colour, odourless with a slightly bitter acrid taste. Microscopically, it is characteried by the followings ;

- 1- Fragments of epidermal cells which are polygonal, isodiametric, sometimes axially elongated with straight , sometimes beaded walls and covered with striated cuticle. These fragments carry mainly caryophyllaceous stomata, unicellular non-glandular conical hairs and secretory chalk glands.
- 2- Nonglandular , unicellular conical hairs covered with striated cuticle and have pointed apices.
- 3- Fragments showing irregular palisade cells and spongy parenchyma.
- 4- Lignified spiral, pitted and scalariform vessels.
- 5- Pericyclic fibres which are lignified with moderately thick walls, wide lumen, blunt apices.
- 6- Absence of calcium oxalate crystals.

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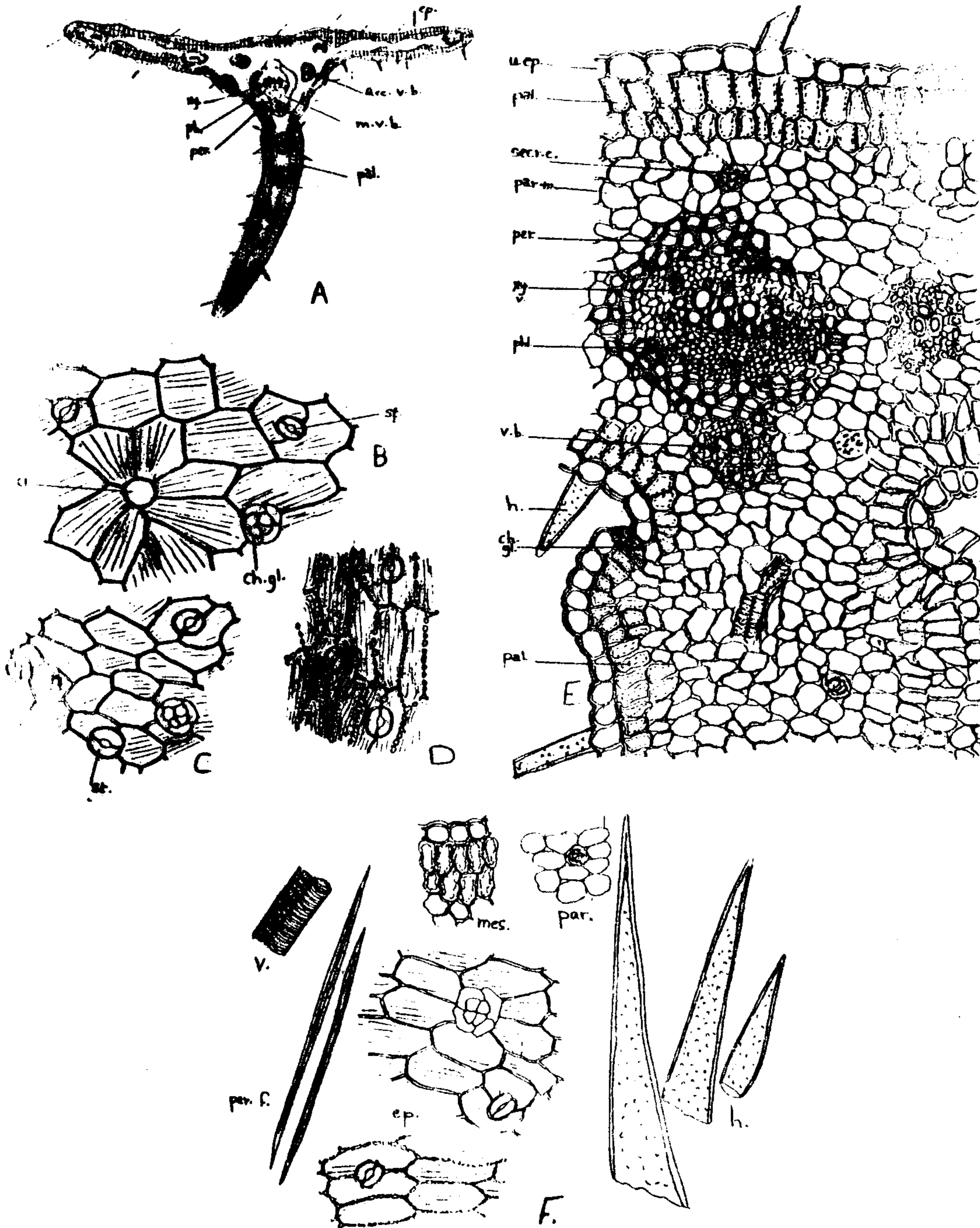


Fig.6- A. Diagrammatic T.S. of caluline leaf, X 14  
 B. & C.-surface preparations of cauline leaf, X 140  
 D. Surface preparations from the wing, X 140  
 E. Detailed T.S. of cauline leaf, X 140  
 F. Isolated elements of cauline leaf, X 140

acc., v.b., accessory vascular bundle; ch. gl., chalk gland; ci., cikatres; ep., epidermis; h., hairs; m.v.b., main vascular bundle; mes., mesophyll; pal, palisad; par. m., parenchymatous mesophyll ; per., pericycle; per. f., pericyclic fibre; secr., secretory cell;st., stomata; u.ep., upper epidermis; v., vessels; v.b., vascular bundle;xv, xylem.



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الصفات العيانية والمجهريسة لسيقان واوراق  
 الليمونيم سنيواتم ميل الذى ينمو فى مصر  
 سامية محمد الصياد - سير انيس روس  
 قسم العقاقير - كلية الصيدلة - جامعة اسبوط

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نبات الليمونيم سنيواتم ميل او الستاتيس سنيواتم ينمو فى مصر  
 ومناطق البحر الابيض المتوسط.

وقد تم فصل هذه مواد فلافونويدية من اوراق وازهار وحيث أن  
 لبعض انواع من الليمونيم هذه استعمالات طبية فقد وجد من  
 الضرورى دراسته عيانيا وجهريا لا مكانية التعرف على اجزائه سواء كانت  
 كاملة او على هيئة مسحوق

وتشمل هذه الدراسة السيقان والاوراق التى توجد على نوعين وقد درست كاملة  
 وكذلك مساحيقها .

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