

MACRO-AND MICROMORPHOLOGY OF TABEBUIA PENTAPHYLLA HEMS L.

Part 1: THE STEM AND LEAF

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ABSTRACT

*The macro-and micromorphology of the stem and leaf of Tabebuia pentaphylla hemsl, cultivated in Egypt at Aswan botanical garden have been investigated in order to determine the diagnostic features by which each organ could be identified both in the entire and powdered forms.*

INTRODUCTION

Tabebuia pentaphylla hemsl is a large tree belonging to the family bignoniaceae, order Schrophulariales. The species is native to tropical and subtropical countries and is cultivated in Egypt in Aswan botanical garden and other parts of the world as an ornamental plants for its showy yellow flower, for construction and in bulding of ships<sup>1-7</sup>.

Tabebuia pentaphylla hemsl as well as other Tabebuia species contains several quinones and flavonoids<sup>9-13</sup>. Some of these compounds were reported to have an antimicrobial and antiviral activities<sup>14-15</sup>.

The aqueous extract of the dried stem bark of *Tabebuia pentaphylla* hemsl is used as an antipyretic, hypnotic, and diuretic<sup>8</sup>.

Reviewing the current literature nothing has been reported regarding the macro-and micromorphology of the different organs of *Tabebuia pentaphylla* hemsl, hence detailed study was thought to be pertinent.

## EXPERIMENTAL

### Material

The material used in this investigation was obtained from the plant cultivated in Aswan botanical garden. Identification of the plant was done by agricultural engineer Mr. Ali Mossa Director of Aswan Botanic Garden. Fresh samples as well as samples preserved in ethanol (70%) containing 5% of glycerol were used.

Habitat: *Tabebuia pentaphylla* hemsl is a large garden tree with monopodial and attaining up to 7-10 meters in height. It carries opposite decussate compound leaves and yellow bell or funnel shaped flowers. The fruit is capsule containing numerous seeds.

### A- THE STEM

#### Macromorphology: (Fig. 1).

The main stem of the plant is erect, cylindrical, solid reaching up to 5-7 meters in height and up to 25-35 cm in diameter near the ground. The young branches are green to yellowish-green in colour, smooth while the older parts are yellowish-brown to light-brown with a longitudinal fissured and cracked surface. The stem breaks with a fibrous fracture. It has a faint characteristic odour and slight bitter and astringent taste.

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Micromorphology:

A transverse section in the young stem (Fig 2A) shows an outer epidermis followed by a moderately wide cortex. The pericycle is formed of an alternating groups of lignified fibers and parenchyma. The vascular bundles include a continuous band of phloem and xylum radially traversed by numerous medullary rays and enclosing a wide pith.

A transverse section in the old stem (Fig. 2B,3) shows the same structure of the young stem with the difference in the presence of cork instead of the epidermis and small groups of phloem fibers in the phloem region.

The epidermis : (Fig. 2C)

The epidermis of the young stem is formed of one row of tabular cells. In surface view the cells are square axially elongated with straight anticlinal walls and measure 30-35-43  $\mu$  in length, 23-29-34  $\mu$  in width and 25-34-40  $\mu$  in height. The epidermal cells are covered with a moderately thick cuticle. Stomata are rare and of anomocytic type surrounded by 5-8 epidermal cells. They are oval in shape sometimes rounded, measuring 35-42-47  $\mu$  in diameter. The glandular trichomes are sunken, or with unicellular, or bicellular stalk and multicellular head of 12-17-28 radiating cells, measuring 60-100-134  $\mu$  in diameter, and 20-27-30  $\mu$  in length. Other type formed of multicellular head, formed of 15-22-30 parallel cells and covered 5-9 epidermal cells measuring 160-200-240  $\mu$  in width. In the transverse section of the old stem (Fig.3) a cork is present which is formed of several rows of thin walled, fitted cells containing yellowish-brown contents, measuring 52-65-80  $\mu$  in length, 45-54-62  $\mu$  in width, and 15-25-36  $\mu$  in height. The cork cells are interrupted by 1-3 rows of thickened lignified cork cells which are subrectangular or tangentially elongated, in surface view they appear polygonal having somewhat wide lumina and lignified walls, measuring 70-94-115  $\mu$  in length, 27-45-62  $\mu$  in width and 18-22-27  $\mu$  in height.

The cortex; (Fig. 3)

The cortex has an outer zone of 3-5 rows of thick walled parenchyma cells, followed by wide zone of parenchyma cells containing simple or compound starch granules with pointed or branched hilum and prismatic crystals of calcium oxalate measuring 75-45-18  $\mu$  in length. In old stem, sclereids in small groups or solitary are scattered in the cortical region. Each sclereid is oval, rounded or slightly elongated in shape with lumen, pitted and lignified walls measuring 35-47-60  $\mu$  in diameter.

The pericycle; (Fig. 3)

The pericycle is formed of 3-6 rows of parenchyma cells interrupted by somewhat large groups of fibers. The fibers are lignified with wide lumena and acuminate or tapering apices 14-26-38  $\mu$  in diameter.

The vascular tissue: (Fig. 3)

The vascular tissue is formed of a phloem region and xylem region separated by a zone of cambiform cells. The phloem region is formed of sieve elements and phloem parenchyma. In old stem groups of lignified phloem fibers are scattered in the phloem as well as branched secretory vessels, forming network-like structure and containing yellowish-brown contents, stained brown with iodine solution.

The xylem: (Fig. 3)

It is formed of lignified elements including vessels, fibers, tracheids and wood parenchyma. The vessels are mainly pitted, few spiral, measuring 18-48-75  $\mu$  in diameter. Tracheids are narrow elongated, with pitted lignified walls, measuring 125-190-260  $\mu$  in length, and 28-46-60  $\mu$  in diameter. The wood fibers are lignified walls and wide lumena with blunt to rounded apices, measuring 13-22-32  $\mu$  in diameter. The wood parenchyma consists of elongated cells with lignified simply pitted walls. The medullary rays are uniseriate or biseriate, they are formed of rectangular cells which are thin walled and cellulosic

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in the phloem region but lignified in the xylem region and having thick, pitted and lignified walls.

The pith: (Fig. 3)

The pith is comparatively wide zone and is composed of rounded parenchyma cells with wide intercellular spaces. In old stem some cells are pitted and lignified. They contain starch granules which are simple and compound with point like or branched hilum as well as prismatic crystals of calcium oxalate measuring 18-50-80  $\mu$  in length.

The powder: (Fig. 4)

The powdered old stem is yellowish to yellowish-brown in colour, with faint characteristic odour and slight bitter astringent taste. The important microscopical features of the powdered stem are:

- 1- Fragments of the cork cells which are yellowish-brown in colour, polygonal in surface view, containing yellowish-brown contents.
- 2- Fragments of cork cells, polygonal in shape, which are lignified and pitted
- 3- Fragments of the cortex parenchyma, which are rounded or oval in shape, containing starch granules and prismatic crystals of calcium oxalate.
- 4- Sclereids either isolated or in groups with thick, lignified walls and relatively wide lumina.
- 5- Fragments of lignified pericyclic fibers surrounded by parenchyma containing prisms of calcium oxalate giving crystal sheath like appearance.
- 6- Fragments of secretory vessels containing yellowish-brown contents and forming network-like structure.
- 7- Starch granules either simple or compound having centric pointed or branched hilum.
- 8- Prisms of calcium oxalate scattered in the field.
- 9- Wood vessels which are lignified, mainly with pitted and few with spiral thickening.
- 10- Wood parenchyma with pitted and lignified walls.

- 11- Fragments of wood fibers which are lignified with wide lumena and blunt or rounded apices.
- 12- Fragments of tracheids having pitted and lignified walls.

## B- THE LEAF

### Macromorphology: (Fig. 5)

The leaves of *Tabebuia pentaphylla* hemsl are opposite decussate, palmate, exstipulate, compound leaf. Each leaf usually formed of 5-leaflets arranged as the largest one in the center and the smallest at the sides.

Each leaflet is petiolate, ovate-lanceolate in shape with entire margin, acute apex and symmetric base. The venation is reticulate and anastomosing near the margin. The midrib is more prominent on the lower surface. The leaves having green colour, the upper surface is darker than the lower one. The leaflets measure 5-13 cm in length and 1.5-3.5 cm in width.

The petiole is planoconvex in outline with two lateral projection and measuring 2.5-6.5 cm in length and 1.5-3.5 mm in diameter. The leaf rachis is planoconvex with two prominent lateral wings especially towards the base, but cylindrical upwardly, measuring 7-15 cm in length and 2-6 mm in diameter.

The leaf has characteristic odour and slight bitter to astringent taste.

### Micromorphology:

A transverss section in the leaflet (Fig. 6A) appears more or less biconvex in outline with the midrib is prominent on the lower surface. It shows a dorsiventral structure with upper palisade layer formed of two rows of cells. In some places above the palisade there is a single layer of hypodermal cells (Fig. 7A,B). The palisade and the hypodermis are not continuous in the region of the midrib where they are replaced by a subepidermal mass of collenchyma.

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Another mass of collenchyma is present on the lower part of the midrib. The bundle of the main vein has a central pith surrounded by a continuous ring of xylem and phloem. The pericycle appears as groups of lignified pericyclic fibers separated by parenchyma surrounding the vascular bundle.

The upper epidermis : (Fig 6B)

The upper epidermis is formed of one row of rectangular or subrectangular cells. In surface view, the cells appear as polygonal, isodiametric, slightly elongated cells measuring 24-38-55  $\mu$  in length, 20-25-35  $\mu$  in width, and 16-20-25  $\mu$  in height. The cells are covered with moderately thick, smooth cuticle. Stomata are rare, they are of anomocytic type mainly surrounded by 5-8 cells. Glandular hairs consists of unicellular or bicellular stalk, sometimes sunken and with multicellular head of 12-18-26 radiating cells. Each head measures 60-100-125  $\mu$  in diameter and 27-42-50  $\mu$  in height. Another type of glandular hair of rare occurrence having a head formed of 15-22-30 cells and covered about 5-9 epidermal cells, measuring 170-210-230  $\mu$  in width (patelli-form gland)<sup>6</sup>.

The lower epidermis : (Fig. 6C)

The lower epidermis is formed of square to subrectangular cells. In surface view, the cells are polygonal, mostly isodiametric with straight anticlinal walls, covered with smooth cuticle and measuring 20-29-47  $\mu$  in length, 14-21-30  $\mu$  in width, and 16-19-25  $\mu$  in height. Stomata are more numerous on the lower surface measuring 35-46-52  $\mu$  in length and 31-36-42  $\mu$  in width. The glandular hairs are similar to those present on the upper epidermis.

The mesophyll : (Fig. 7A,B)

The mesophyll tissue is heterogeneous consisting of two layers of upper palisade which are interrupted by groups of parenchyma cells in the lamina region and by collenchymatous mass in the midrib region. The upper palisade cells measure 47-58-70  $\mu$  in length and 10-13-17  $\mu$  in width, while the lower palisade measures 41-48-56  $\mu$  in length, and 10-15-17  $\mu$  in width.

The spongy tissue consists of 6-10 rows of irregular parenchyma cells with wide intercellular spaces. They contain chloroplasts, small starch granules, small prisms and twins of calcium oxalate.

The cortical tissues : (Fig. 8)

The cortical tissues show an upper and lower subepidermal collenchymatous masses. The upper is formed of 5-8 and the lower of 4-6 rows. The rest of the cortical tissues consists of rounded or oval parenchyma cells containing prisms of calcium oxalate and small starch granules.

The vascular tissue : (Fig. 8)

The pericyclic fibers are lignified, having acuminate or acute apices. They measure 800-1200-1600  $\mu$  in length and 15-20-26  $\mu$  in diameter. The parenchyma cells surrounded the fibers containing prisms of calcium oxalate giving rise to crystal sheath like appearance. The phloem is formed of narrow zone of soft elements and shows branched secretory vessels forming network-like structure.

The vessels are lignified radially arranged and having mainly pitted thickening, rarely spiral and scleriform, measuring 16-29-40  $\mu$  in diameter. The tracheids have pitted lignified walls, measuring 95-125-180  $\mu$  in length, and 21-26-30  $\mu$  in diameter.

The wood fibers are lignified with acute to rounded apices and lignified walls, measuring 390-880-1360  $\mu$  in length, and 10-18-30  $\mu$  in diameter. The wood parenchyma are polygonal, thick walled, pitted and lignified.

The pith is formed of rounded parenchyma with wide intercellular spaces containing prisms of calcium oxalate and small starch granules. Some of these cells are slightly thickened and pitted.

The petiole : (Fig. 9A)

A transverse section of the petiole is somewhat rounded in outline showing two small ridges on its upper side.



It consists of an epidermis and cortical tissues surrounding the main vascular stele.

The epidermis (Fig. 9C) is formed of a row of subrectangular cells. In surface view (Fig. 9B) they appear as polygonal mostly subrectangular, axially elongated with almost straight anticlinal walls measuring 19-28-33  $\mu$  in height, 28-32-38  $\mu$  in length, and 18-25-30  $\mu$  in width. The epidermis is covered with smooth cuticle. Stomata are rare and similar to that of the leaf. Glandular hairs are similar to those present on the lamina in all aspects.

The epidermis is followed by a narrow cortex formed of 3-5 rows collenchyma and 4-6 rows of parenchyma ended by a group of pericyclic fibers which are lignified.

The vascular strands showing a complete ring of xylem and phloem with central wide pith. In the outer layers of the pith there are small groups of lignified fibers.

The powder : (Fig.10)

The powdered leaf is light green to greyish-green in colour odourless with slight bitter and astringent taste. It is characterised microscopically by the followings:

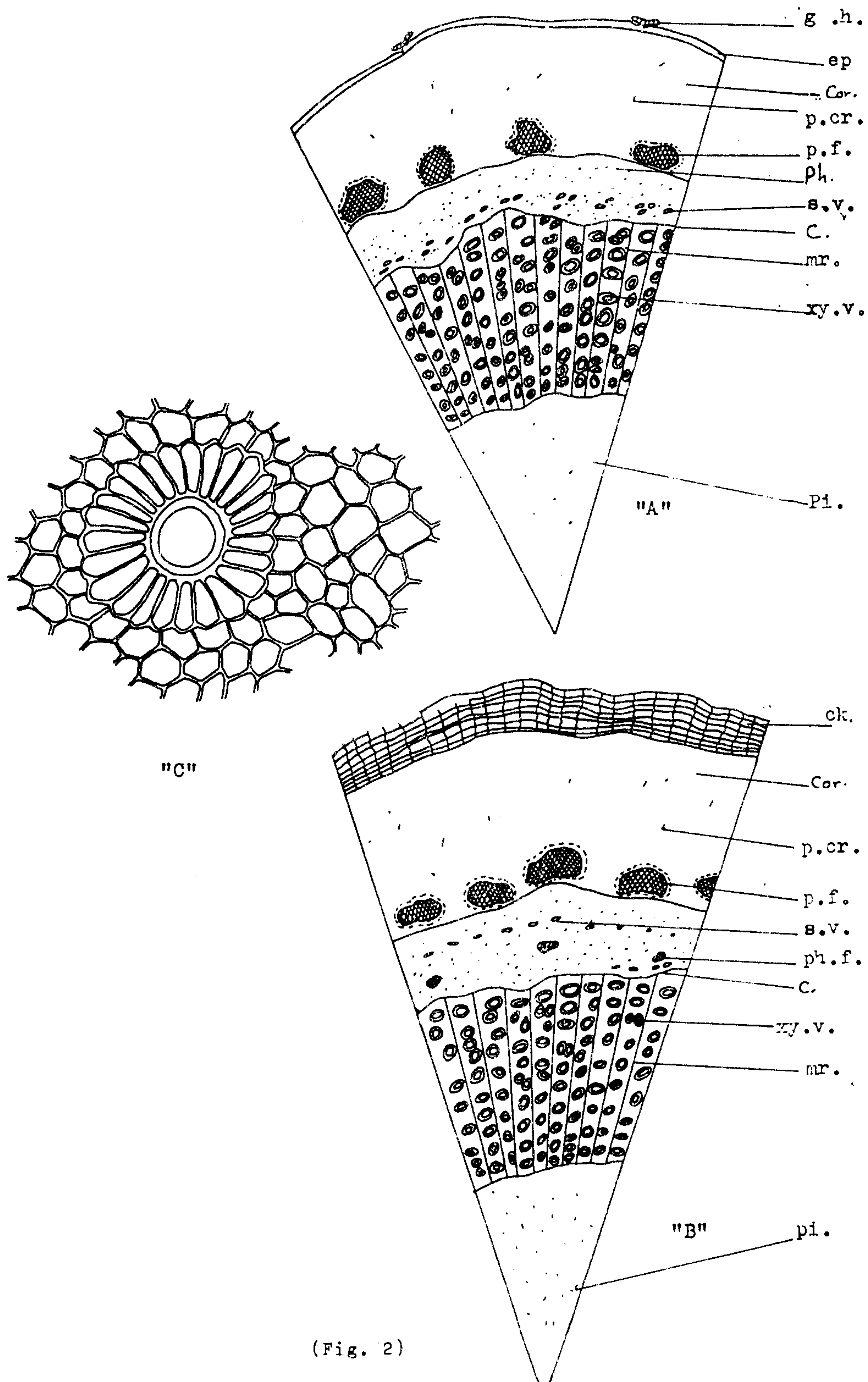
- 1- Fragments of the upper epidermis showing glandular hairs sunken or with unicellular or bicellular stalk and multicellular heads with 15-28 radiating cells, and few anomocytic stomata.
- 2- Fragments of the lower epidermis showing anomocytic stomata surrounded by 5-9 epidermal cells, and glandular hairs similar to those present on the upper surface.
- 3- Fragments of lignified pericyclic fibers surrounded by parenchyma cells containing prisms of calcium oxalate forming crystal sheath like appearance.

- 4- Fragments of mesophyll showing palisade cells and spongy cells containing prisms of calcium oxalate
- 5- Prisms of calcium oxalate scattered in the field.
- 6- Patelliform glandular hairs in which the head is formed of 15-30 cells and peltate hair of 12-28-cells.
- 7- Fragments of pitted and spiral xylem vessels with lignified walls.
- 8- Numerous parenchyma cells containing prisms of calcium oxalate and small starch granules.
- 9- Fragments of tracheids with pitted and lignified walls .
- 10- Fragments of secretory vessels which are branched and containing yellowish-brown contents.

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Fig. 1: Photograph of *Tabebuia pentaphylla* Hemsl. (X  $\frac{1}{100}$ )



(Fig. 2)

Fig. 2: A .Diagrammatic T.S. of the young stem (X33) —  
 B. Diagrammatic T.S. of the old stem (X33)  
 C. Surface preparation of the young stem (X280)  
 c., cambium; cor., cortex; ep., epidermis; g.h., glandular hair; mr., medullary ray; p.cr., prisms of calcium oxalate; p.f., pericyclic fiber; ph., phloem; pi., pith; s.v., secretory vessel;

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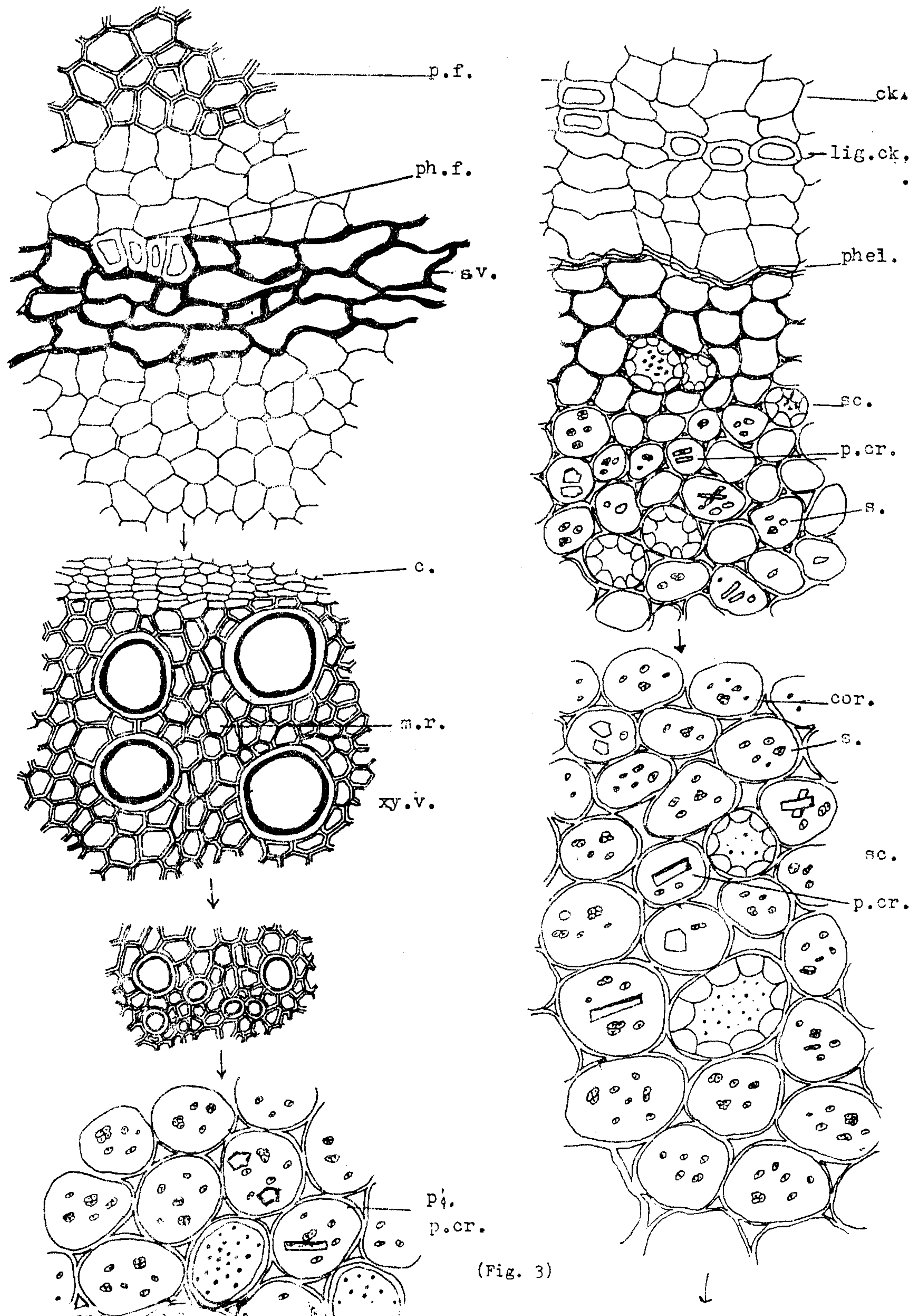


Fig. 3: Detailed T.S. in old stem (X 290)

c., cambium; ck., cork; cor., cortex; lig.ck., lignified cork cell; mr., medullary ray; p.cr., prisms of calcium oxalate; p.f., pericyclic fiber; ph.f., phloem fiber; phel., phelloderm; pi., pith; s., starch; sc., sclereid; s.v., secretory vessel; xy.v., xylem vessel;

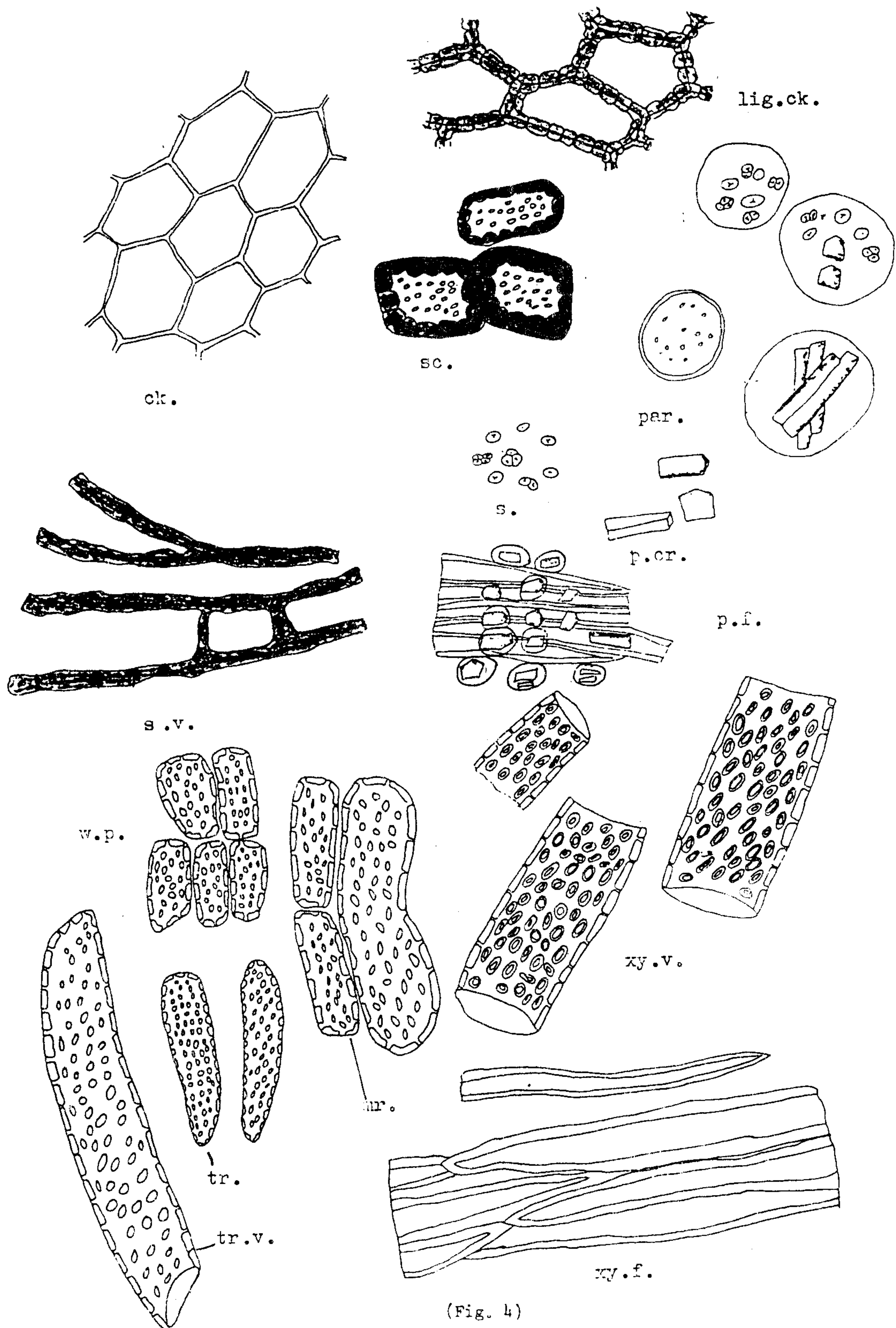


Fig. 4: The powder of the old stem (X 280)  
 ck., cork; lig. ck., lignified cork; mr., medulary ray; p. cr., prisms of calcium oxalate; p.f., pericyclic fiber; par., parenchyma; s., starch; sc., sclereid; s.v., secretory vessel; tr., tracheid; tr. v., tracheidal vessel; w.p.; wood parenchyma; xy.f., xylem fiber; xy.v., xylem vessel;

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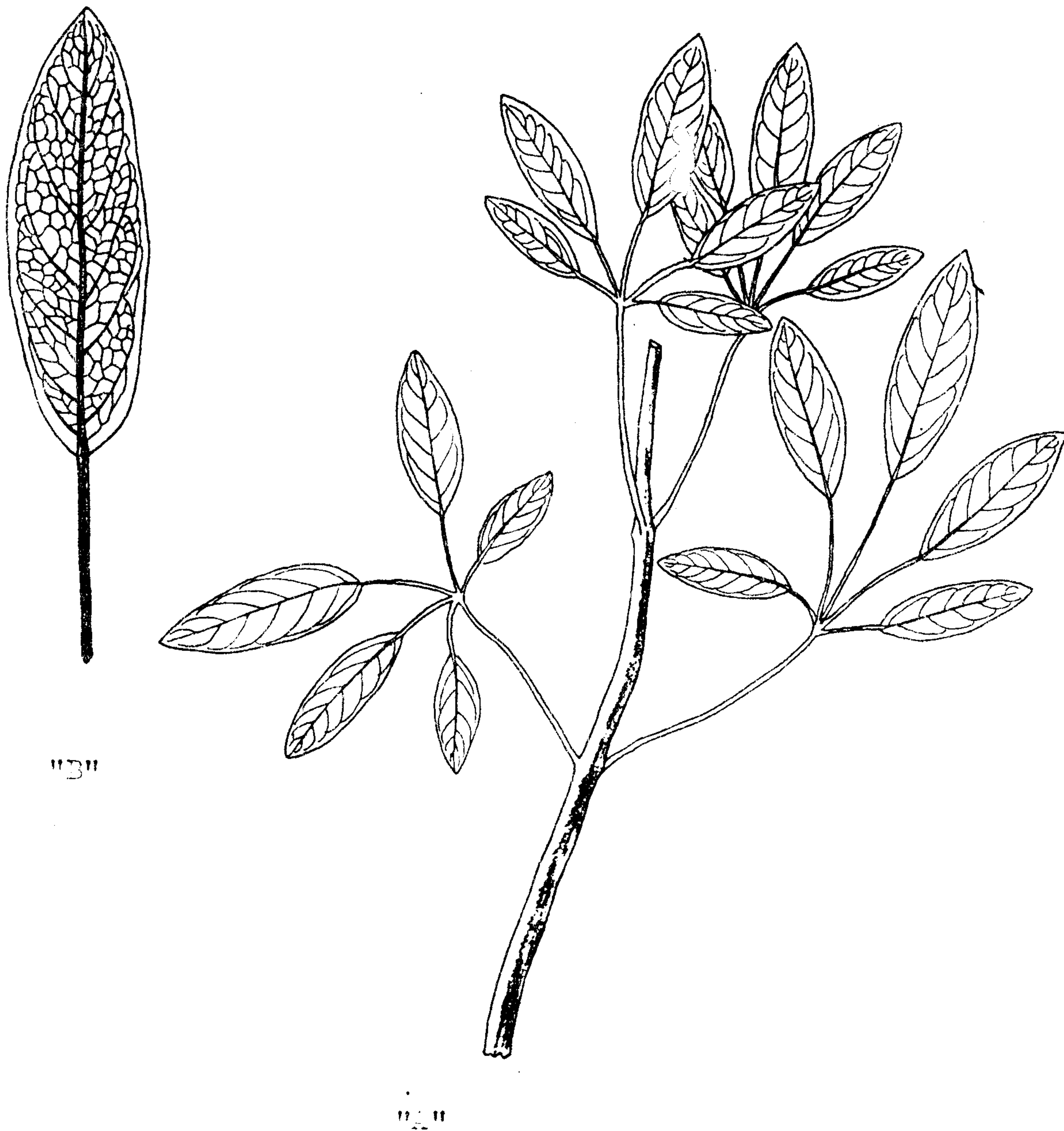
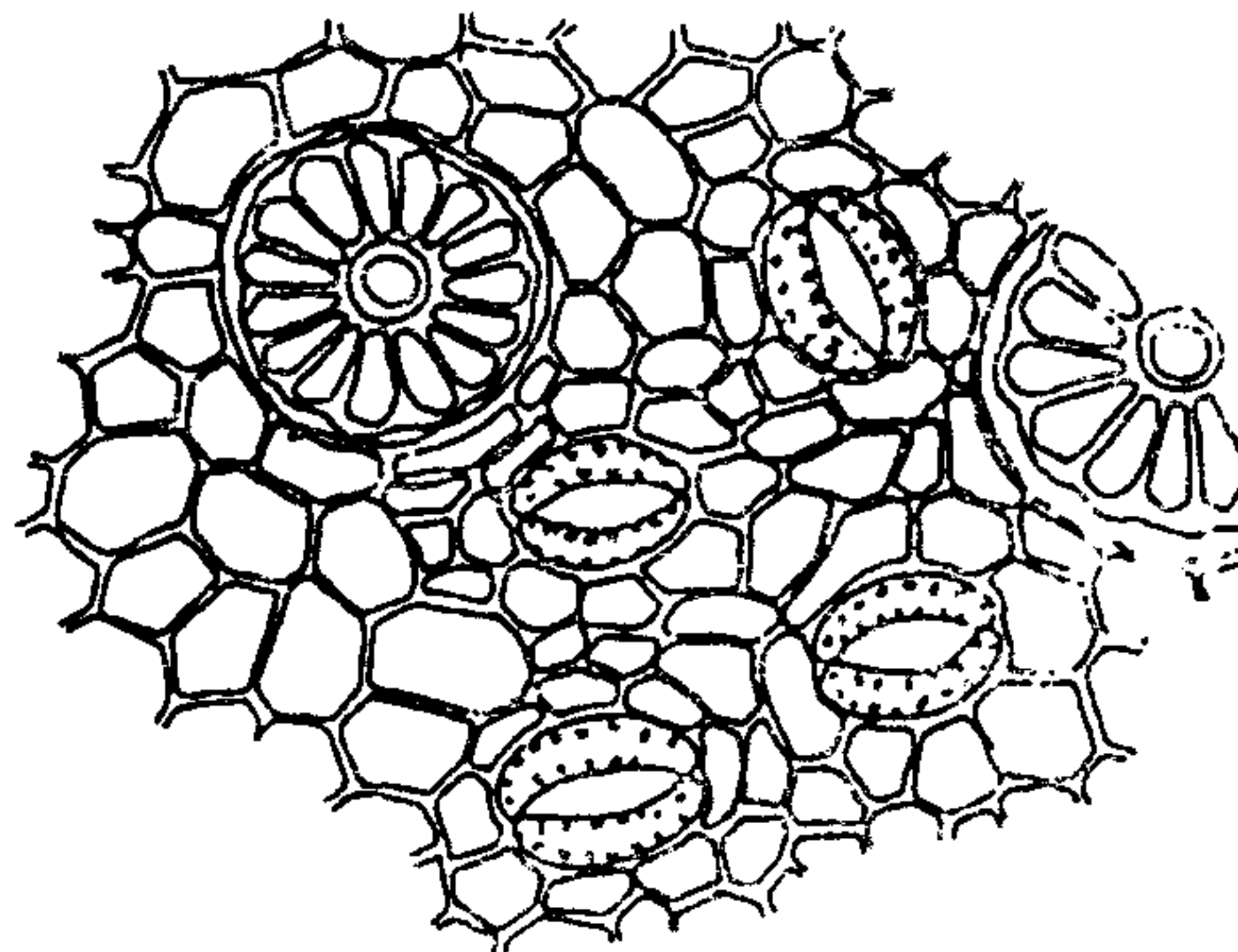
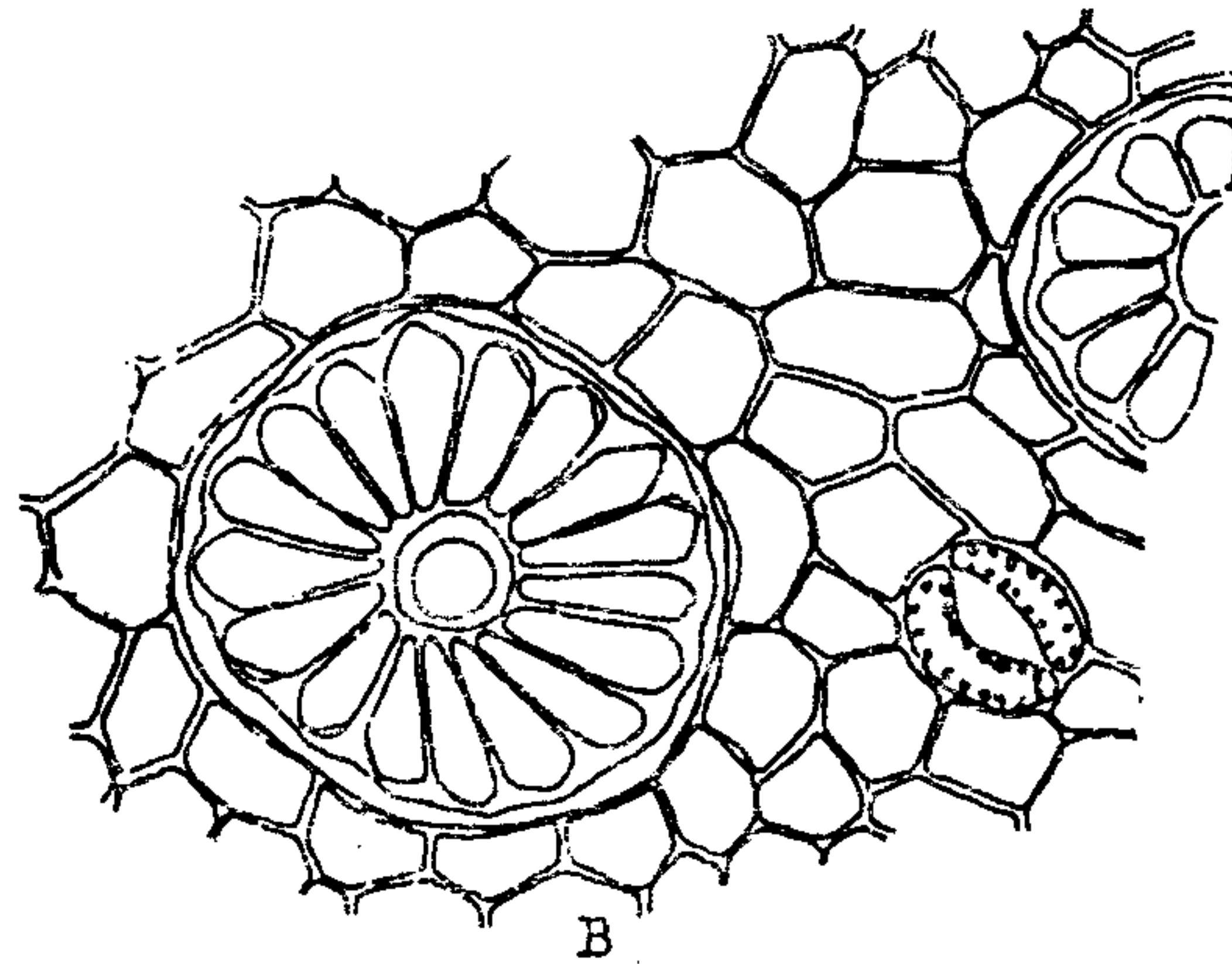
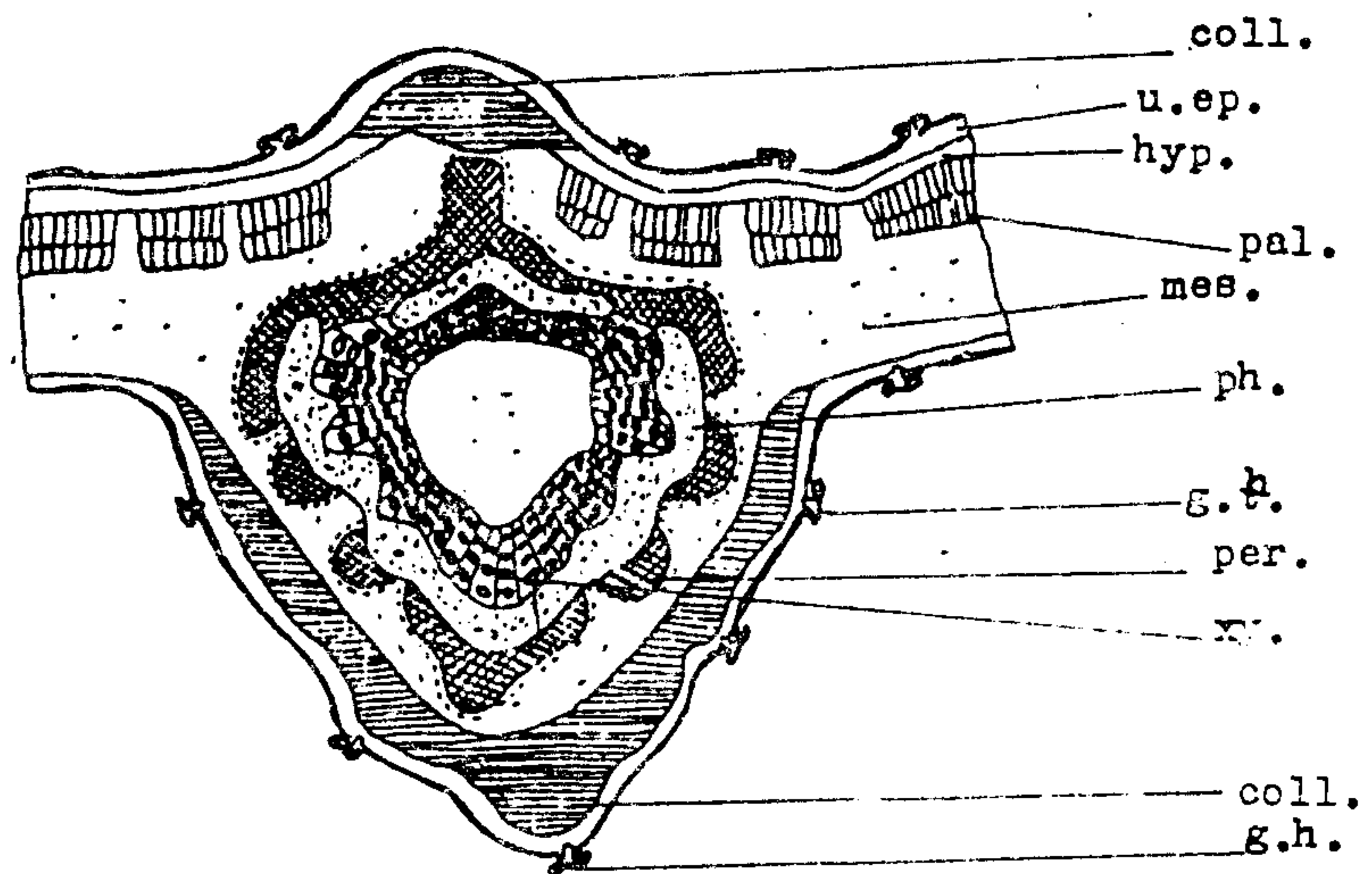


Fig. 5: Sketch of the leaf (A X  $\frac{2}{3}$  , B X  $\frac{1}{3}$  )



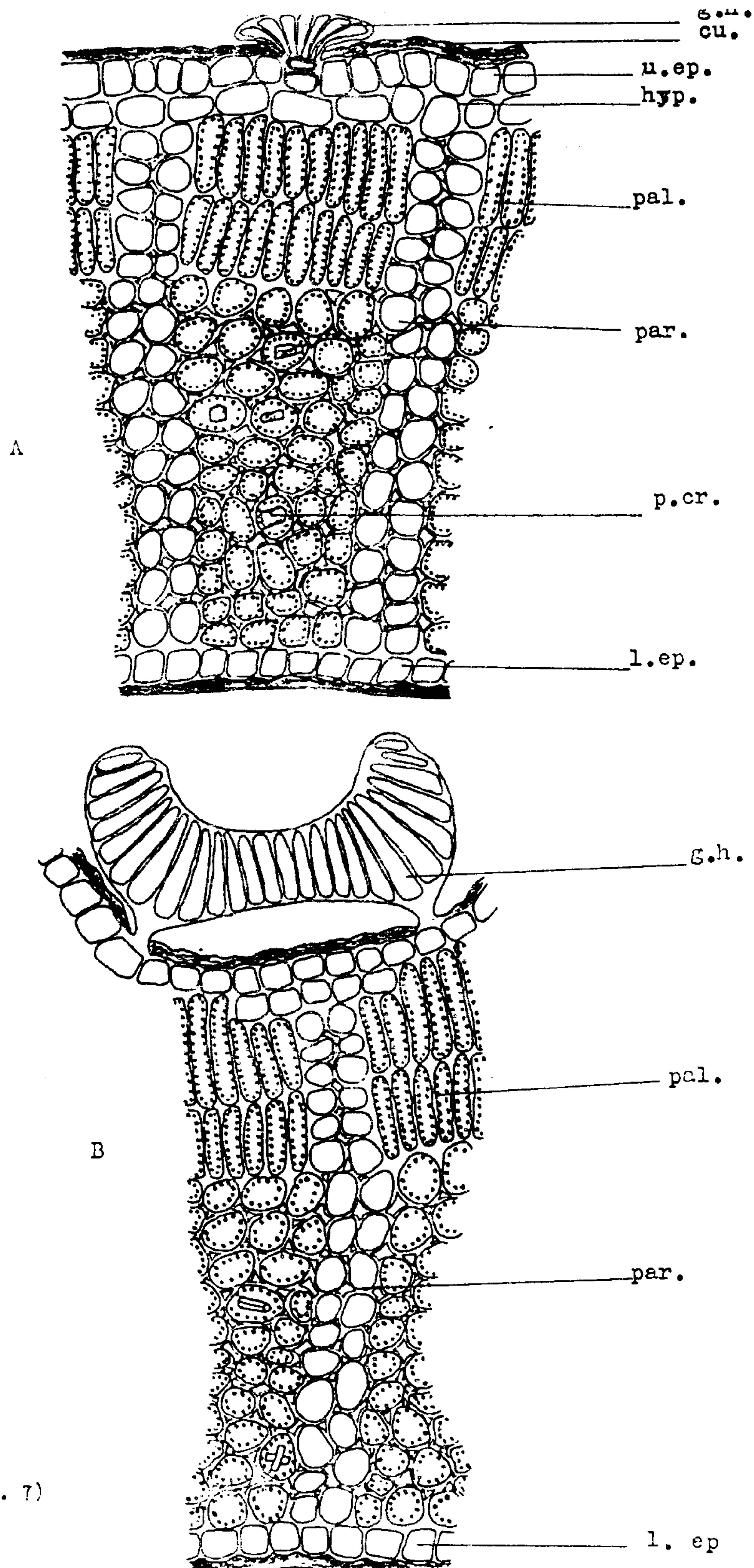
(Fig. 6)

Fig. 6: A. Diagrammatic T.S. of the leaf let ( X 290)  
 B. Surface preparation of the upper epidermis (X300)  
 C. Surface preparation of the lower epidermis (X300)

coll., collenchyma; g.h., glandular hair; hyp., hypodermis; mes., mesophyll; pal., palisade; per., pericycle; ph., phloem; u.ep., upper epidermis; xy., xylem;



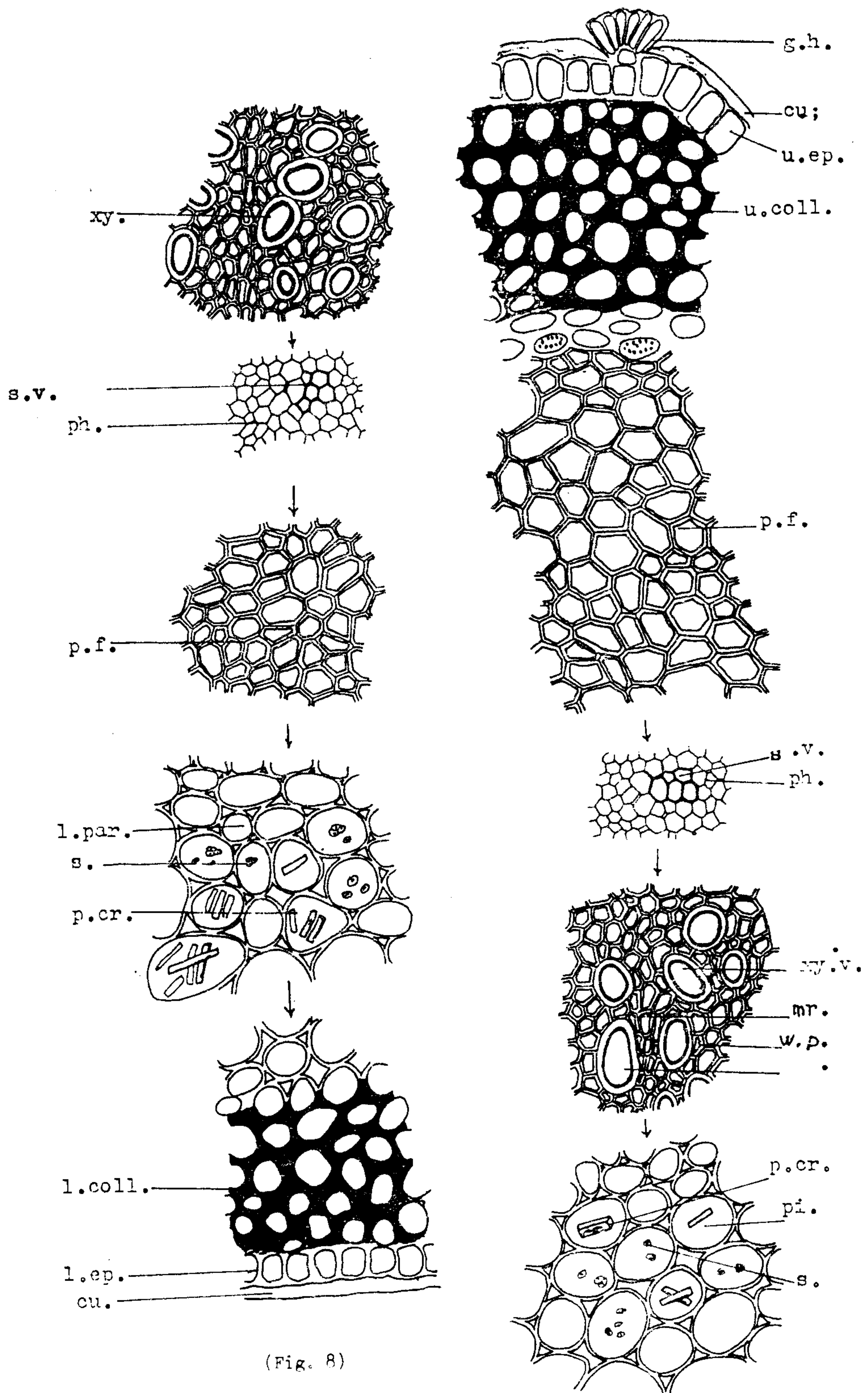
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(Fig. 7)

Fig. 7: Detailed T.S. of the lamina (X 290)

cu., cuticle; g.h., glandular hair; hyp., hypodermis; l.ep., lower epidermis; p.cr., prisms of calcium oxalate; pal., palisade; par., parenchyma;



(Fig. 8)

Fig. 8: Detailed T.S. of the midrib (X300).

cu., cuticle; g.h., glandular hair; l.coll., lower collenchyma; l.ep., lower epidermis; l.par., lower parenchyma; mr., medullary ray; p.cr., prisms of calcium oxalate; p.f., pericyclic fibres; ph., phloem; pi., pith; s., starch; s.v., secretory vessel; w.p. wood parenchyma; xy.v., xylem vessel;

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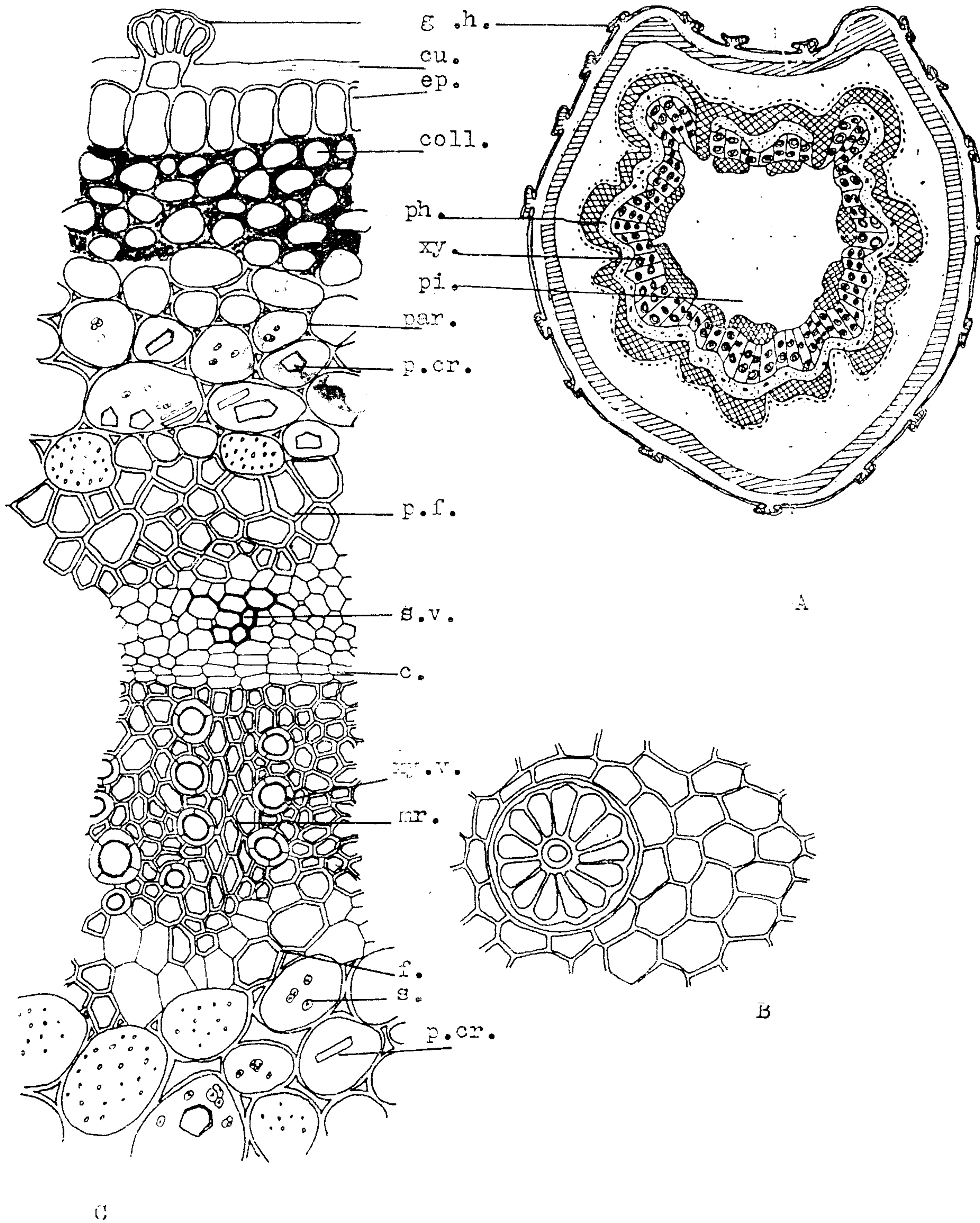


Fig. 9:A- Diagrammatic T.S. in the petiole (X 33)

B- Surface preparation of the petiole (X 33 )

C- Detailed T.S. in the petiole (X 300)

c., cambium; cu., cuticle; coll., collenchyma; ep., epidermis; f., fiber; g.h., glandular hair; mr., medullary ray; p.cr., prisms of calcium oxalate; p.f., pericyclic fiber; par., parenchyma; ph., phloem; pi., pith; s., starch; s.v., secretory vessel; xy., xylem; xy.v., xylem vessel;

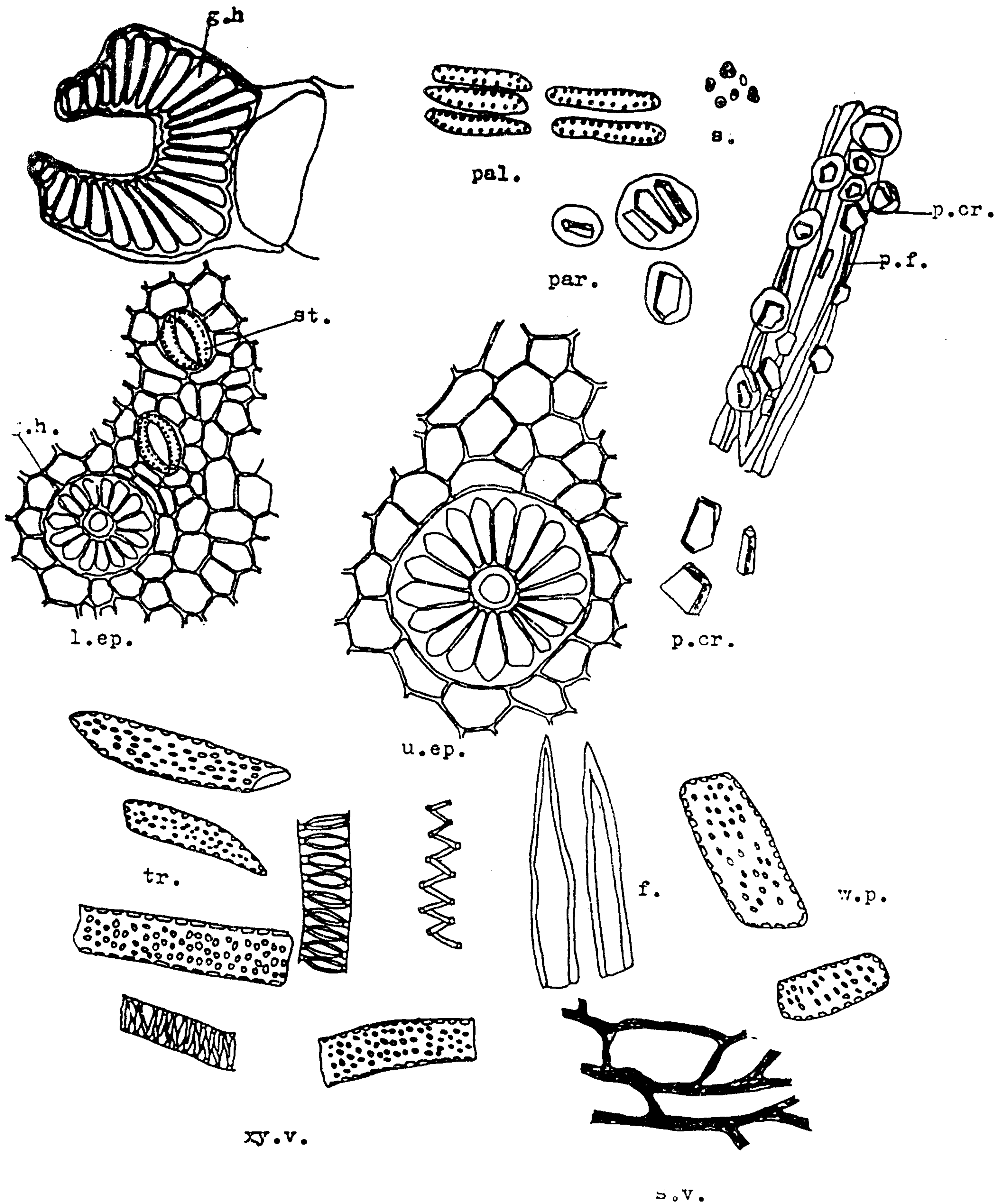


Fig. 10: The powder of the leaf (X 290)

g.h., glandular hair; f. fiber; l.ep., lower epidermis; p.cr., prisms of calcium oxalate; p.f., pericyclic fiber; pal., palisade; par., parenchyma; s., starch; st., stomata; s.v., secretory vessel; tr., tracheid; u.ep., upper epidermis; w.p., wood parenchyma; xy.v., xylem vessel;

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" الصفات العيانية والمجهريية لنبات التابيبيا  
بنتا فيلاهيمل المنزع فى مصر "

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الجزء الأول : الساق والأوراق

نبات التابيبيا بنتا فيلاهيمل هو من نباتات الزينة  
التي ادخلت زراعتها فى مصر لجمال ازهارها وينتمى هذا النبات  
الى العائلة البجنونية .

وقد استعمل هذا النبات فى الطب الشعبى كمدر للبول  
وخافض للحرارة ومنوم وحديثا تم استخدام بعض النباتات من  
جنس التابيبيا فى علاج بعض الاورام لذلك قد روى من المناسب عمل  
دراسة عقاقيرية نباتية وكيميائية لدراسة فوائد هذا  
النبات .

وفى هذا الجزء تم دراسة الصفات العيانية والمجهريية  
للساق والأوراق لأمكان التعرف عليها سواء كانت كاملة أو على  
هيئة مسحوق .