

## MACRO- AND MICROMORPHOLOGICAL CHARACTERS OF *CYPERUS ROTUNDUS* L. GROWING IN EGYPT

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تم إجراء دراسة عيانية ومجهرية لاوراق وسيقان ونورة نبات السيبرس روتندس ل. الذي ينمو في مصر بهدف التعرف على اجزاء النبات سواء كانت كاملة أو على هيئة مسحوق.

*The macro- and micromorphology of the aerial parts (leaves, culm and inflorescence) of *Cyperus rotundus* L. growing in Egypt are presented aiming for the determination of the diagnostic features by which each part can be identified in the entire and powdered forms.*

### INTRODUCTION

*Cyperus rotundus* L. (Cyperaceae) is a perennial herb growing in the margins of the bonds and banks of the River Nile, marshy places and in cultivated fields in Egypt.<sup>1-3</sup>

*Cyperus rotundus* L. is named "Se'd" which and its tubers used by the public as carminative, stimulant, diuretic, remove the colic in renal calculi, used as aphrodisiac, emmenagogue and anthelmintic.<sup>4</sup> It was also widely used as diaphoretic, astringent, demulcent, liver remedy, anti-dysentric and for cure of headache.<sup>5</sup> In Asia, the fresh tuber is used in heart diseases and as insect repellent.<sup>5</sup> In India, the tubers were used in treatment of leprosy, blood diseases, pruritis, pain, epilepsy, ophthalmia, ulcers and sores.<sup>6</sup> The tubers have been also used as an analgesic, anti-pyretic, anti-inflammatory and anti-malarial.<sup>7-14</sup> The powdered tubers of *Cyperus rotundus* L. is used in cosmetic preparations in the Egyptian pharmaceutical market.

Several studies have been carried out concerning its chemical constituents, mono- and sesquiterpenoids,<sup>13-18</sup> sterols, triterpenes,<sup>19</sup> flavonoids<sup>20</sup> and sesquiterpene alkaloids<sup>21</sup> have been isolated and identified from the studied plant. However only a single report was found concerning the botanical characters of the plant

tubers.<sup>4</sup> The present work deals with the macro- and micromorphological studies of the aerial parts, viz. leaves, culm and inflorescence of the Egyptian plant in order to identify them in the entire and powdered form. While a full phytochemical study of the plant is in progress.

### EXPERIMENTAL

#### Habitat

*Cyperus rotundus* L. (Figs. 1 & 2) is a perennial herb propagates by means of a creeping rhizome. The aerial shoots are given out from their underground rhizomes. The plant attains a height of about 20-30-40 cm. It carries alternate leaves, which are crowded on the lower part of the stem. The stem is solid, often triquetrous, mostly simple. The stem ends upwards in a compound umbel-like inflorescence of a spikate type. The flower is very small bisexual, arises in the axil of a single bract. The flowering season is from May to August. The fruit is an indehiscent achene.

#### Plant material

The plant material was obtained from plants growing in the Experimental Station of El-Safa and El-Marwa, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt. The plant was collected in July 1999 and was kindly identified



**Fig. 1:** Photograph of *Cyperus rotundus* L.

(X 0.2)

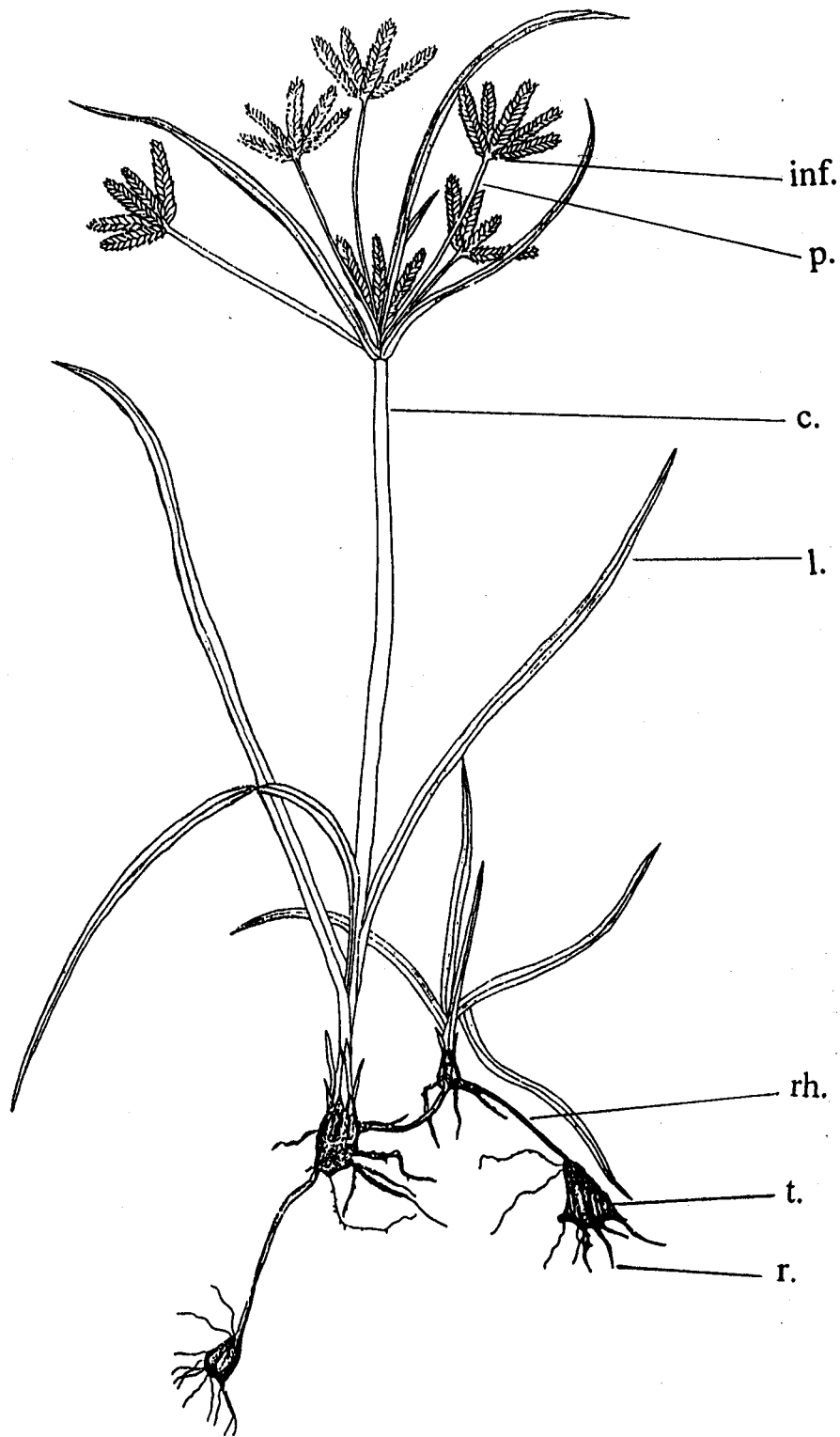


Fig. 2: Sketch of *Cyperus rotundus* L.

x 0.2

c., culm; inf., inflorescence; l., leaf; rh., rhizome; r., root; p., peduncle; t., tuber.

by Prof. Dr. Salah El-Nagar (Professor of Plant Botany and Taxonomy, Faculty of Science, Assiut University, Assiut, Egypt).

Fresh leaves, culm and inflorescence were preserved separately in alcohol 70% containing 5% glycerin and kept in tightly closed containers for microscopical examination. Each organ was separately air-dried, reduced to powder and kept for microscopical investigation.

## 1- The Culm

### A- Macromorphology (Figs. 1 & 2)

The culm (the aerial stem) is simple, solid, smooth and often triquetrous in shape. It is an erect, nodeless, ascending and stem-like. It is green in colour and glabrous. The fresh culm is flexible but it is broken with a short fracture when dried. It reaches about 15-25-35 cm in length and 3-4-5 mm in diameter. It has a slight odour and slight bitter taste.

### B- Micromorphology

A transverse section in the culm is nearly triangular in outline (Fig. 3A). It shows a single row of an outer epidermal cells. The ground tissue is composed of parenchymatous hypodermis, interrupted with several strands of lignified sclerenchymatous fibres, followed by several layers of thin-walled parenchymatous cells. The endodermis and pericycle are not distinct. The stele is of atactostele type in which a number of vascular bundles are irregularly scattered in the ground tissue. The vascular bundles are conjoint, collateral and closed type. The peripheral bundles are small, numerous and surrounded by a chlorenchymatous tissue, while those near to the centre of the ground tissue are larger in size and fewer in number.

### The epidermis

In transverse section (Figs. 4B & 5) it is composed of one row of thick-walled square to subrectangular cells and covered with thick smooth cuticle. In surface view (Fig. 3B) they are rectangular to subrectangular in shape, usually axially elongated, having thick sinuous

beaded walls and containing few silica bodies.<sup>22</sup> They are measuring about 24-40-50  $\mu$  in length, 12-15-20  $\mu$  in width and 10-12-15  $\mu$  in height. Numerous stomata of gramineous type are present having dumbel-shaped guard cells and measuring about 18-20-26  $\mu$  in length and 16-18-20  $\mu$  in width, trichomes are not present.

### The ground tissue (Figs. 4 & 5)

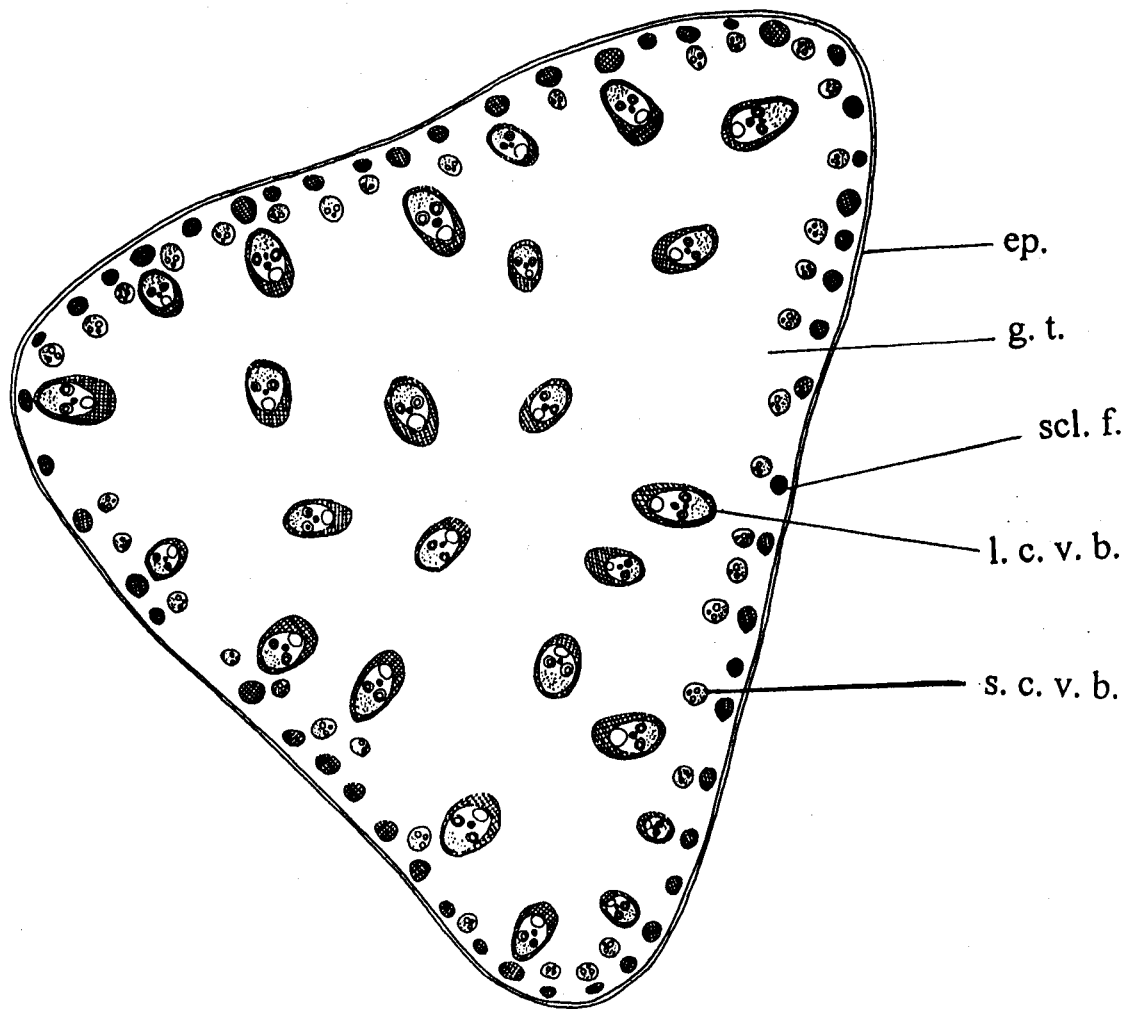
The ground tissue showed an outer parenchymatous hypodermis interrupted with numerous strands of sclerenchymatous fibres. The fibre is spindle in shape, having moderately wide lumen, thick lignified wall and tapering acute to acuminate apex and measuring about 250-350-550  $\mu$  in length and 10-15-20  $\mu$  in diameter. The remaining of the ground tissue consists of several rows of oval to rounded, thin-walled parenchymatous cells, of various shapes and sizes showing wide intercellular spaces. These cells are free from calcium oxalate and starch granules. A large number of small nearly rounded vascular strands are scattered in the outer region of the ground tissue.

### The small vascular bundles (Figs. 4 & 5)

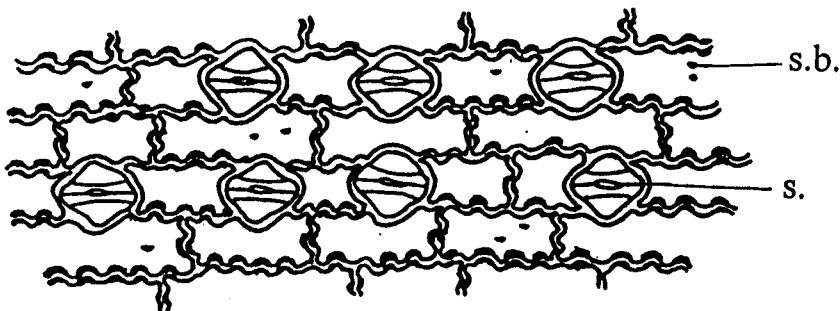
Each small bundle is surrounded by two sheaths.<sup>22</sup> The outer sheath consists of chlorenchymatous tissue which is arranged in a radiating manner and represented by thin-walled, polygonal cells containing chloroplasts. They are measuring about 8-20-24  $\mu$  in length and 8-10-18  $\mu$  in width. While the inner sheath consists of about two rings of compactly arranged thin-walled parenchymatous cells. Each bundle is composed of small sized, lignified xylem vessels having spiral thickening and measuring about 6-8-10  $\mu$  in diameter. In addition to, a soft phloem tissue consisting of sieve tubes and companion cells.

### The large vascular bundles (Figs. 4 & 5)

Each large vascular bundle is surrounded by two sheaths.<sup>22</sup> The outer sheath consists of one row of parenchymatous cells, while that of the terminal bundles towards the epidermis shows few chlorenchymatous cells. The inner sheath consists of lignified sclerenchymatous



A



B

Fig. 3: The culm of *Cyperus rotundus* L.

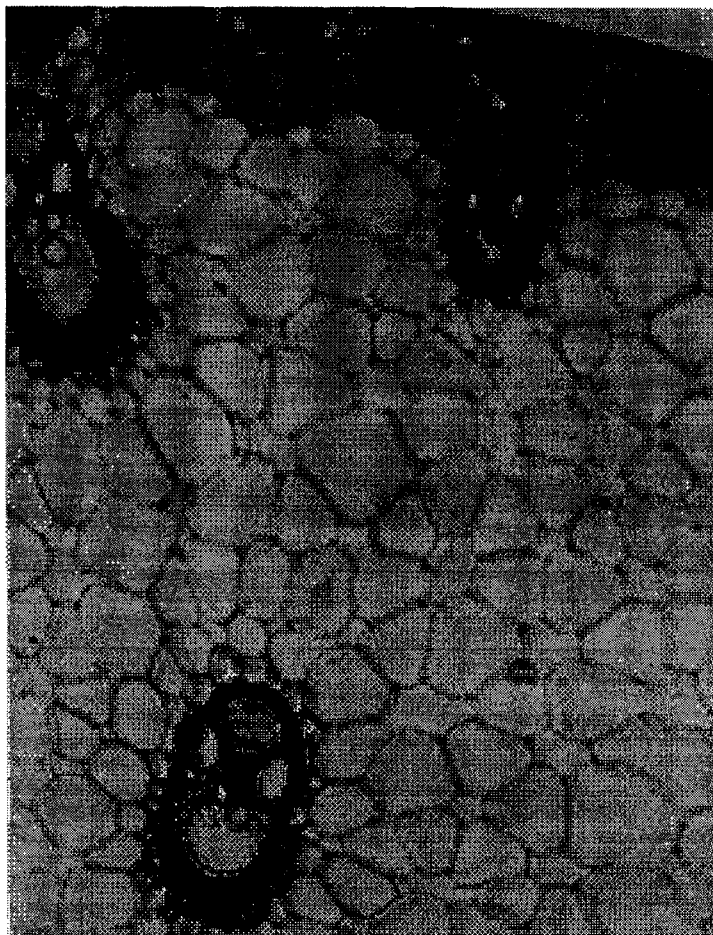
A- Diagrammatic T.S. in the culm

x 65

B- Surface preparation of the culm

x 500

ep., epidermis; g.t., ground tissue; l.c.v.b., large closed vascular bundle; scl.f., sclerenchymatous fibre; s.b., silica bodies; s.c.v.b., small closed vascular bundle; s., stomata.



A



B

Fig. 4A,B: Detailed T.S. in the culm.

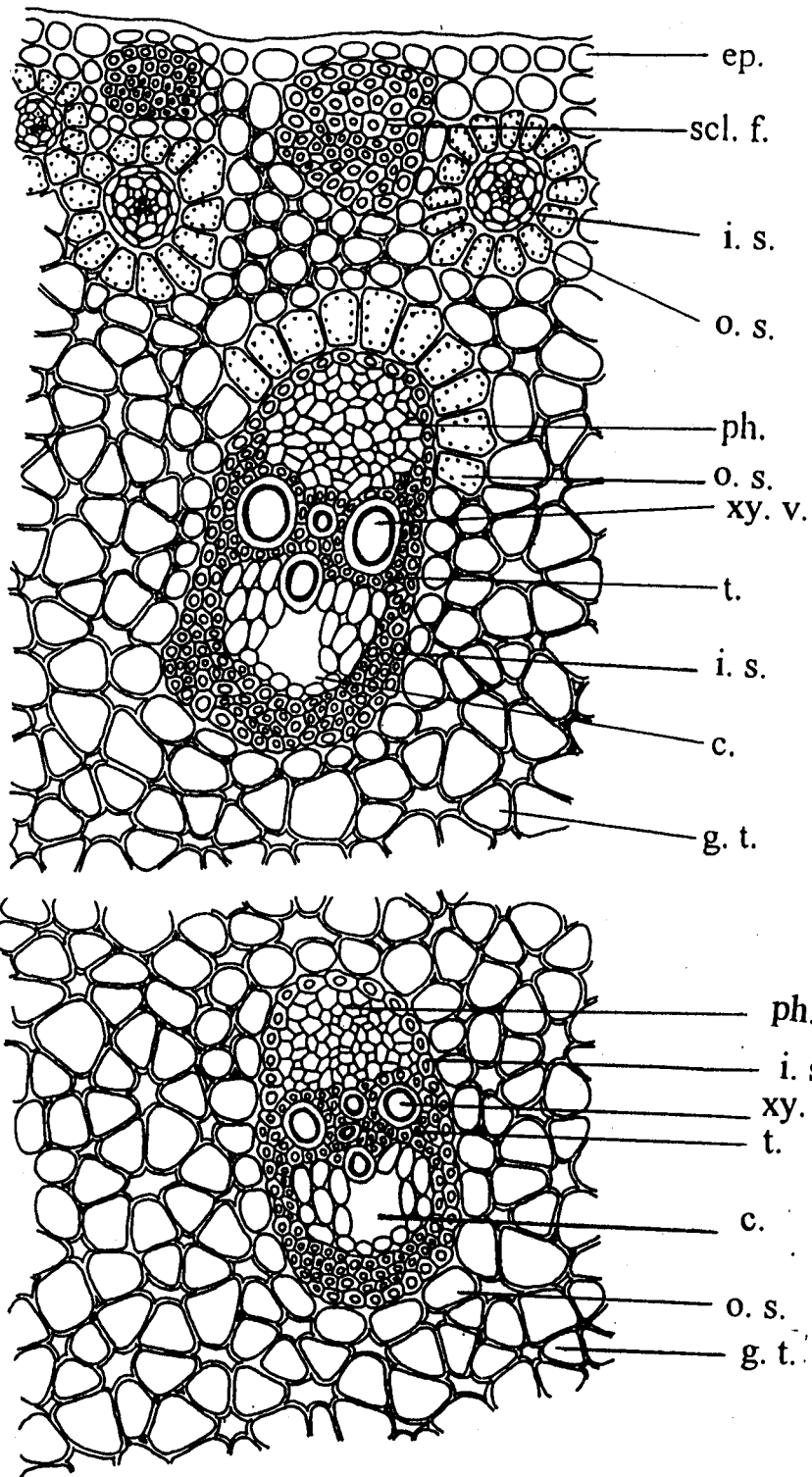


Fig. 5: Detailed T.S. in the culm

x 350

c., cavity; ep., epidermis; g.t., ground tissue; i.s., inner sheath; o.s., outer sheath; ph., phloem; scl.f., sclerenchymatous fibre; t., tracheid; xy.v., xylem vessel.

fibres. The fibres are similar to those of the hypodermal strands but being more lignified and smaller in dimensions. The bundle comprises an upper phloem consisting of sieve tubes and companion cells. The xylem shows Y-shaped structure of two metaxylem vessels lying at the two lateral arms and having thick, lignified walls, mainly with reticulate and pitted thickenings and measuring about 16-25-35  $\mu$  in diameter. The protoxylem vessels having spiral thickening and measuring about 10-15-20  $\mu$  in diameter. Below the protoxylem vessels, there is a protoxylem air cavity. The xylem vessels are surrounded by few tracheids (Fig. 6) and small thin-walled xylem parenchymatous cells. The tracheids are subrectangular to elongated in shape, with blunt ends, having thick simple pitted and lignified walls. They are measuring about 90-120-140  $\mu$  in length and 10-14-18  $\mu$  in width.

#### The powder of the culm

The powdered culm of *Cyperus rotundus* L. (Fig. 6) is greenish-yellow in colour, with a slight odour and slight bitter taste. It is characterized microscopically by the following features:

- 1- Fragments of the epidermal cells of the culm consisting of rectangular to subrectangular, axially elongated cells, having thick sinuous beaded walls, covered with thick smooth cuticle, containing few silica bodies and showing dumbel shaped gramineous stomata.
- 2- Fragments of sclerenchymatous fibres of various sizes, having thick, slightly lignified walls with moderately wide lumina and acute apices.
- 3- Fragments of few tracheids having different sizes with thick, simple pitted, lignified walls and wide lumina.
- 4- Fragments of large oval to rounded, thin-walled parenchymatous cells of the ground tissue.
- 5- Fragments of the hypodermal sclerenchymatous fibres accompanying the epidermal cells which are spindle-shaped with thick lignified walls and moderately wide lumina.
- 6- Fragments of chlorenchymatous cells which are polygonal, elongated in shape, thin-walled, variable in size and containing chloroplasts.
- 7- Fragments of lignified xylem vessels having spiral, pitted, reticulate and scalariform thickenings.
- 8- The powdered culm is characterized by absence of hairs, calcium oxalate, starch and sclereids.

## 2- The Leaf

### A- Macromorphology (Figs. 1 & 2)

The leaves of *Cyperus rotundus* L. are crowded only at the base of the stem forming a basal tuft. They are dark green in colour, linear-lanceolate with a narrow grass-like blade and they are broad at the middle. They have entire margins, acuminate apices, with a parallel venation and measuring about 20-30-40 cm in length and 6-7-8 mm in width. They are sessile having closed sheathing base which is continuous around the lower part of the culm. The two margins of the sheath are free from one another. The blade of the mature leaf is generally appeared to be more or less flat, although the midrib may project prominently on the abaxial (lower) surface. Both surfaces are longitudinally ribbed.

The surface of the leaf is somewhat hairy at the abaxial surface especially at the margins and the apices. The dried leaves are brittle in texture, having a slight odour and slight bitter taste.

### B- Micromorphology

A transverse section in the lamina of the leaf through the midrib (Fig. 7A) is almost V-shaped. It shows an upper and a lower epidermis, each is composed of thick-walled parenchymatous cells, enclosing a homogenous mesophyll, which is not differentiated into palisade and spongy tissue, containing conjoint, collateral and closed vascular bundles. The vascular bundles are arranged in parallel strands at regular intervals. In the midrib region there is a large vascular bundle. The number of the



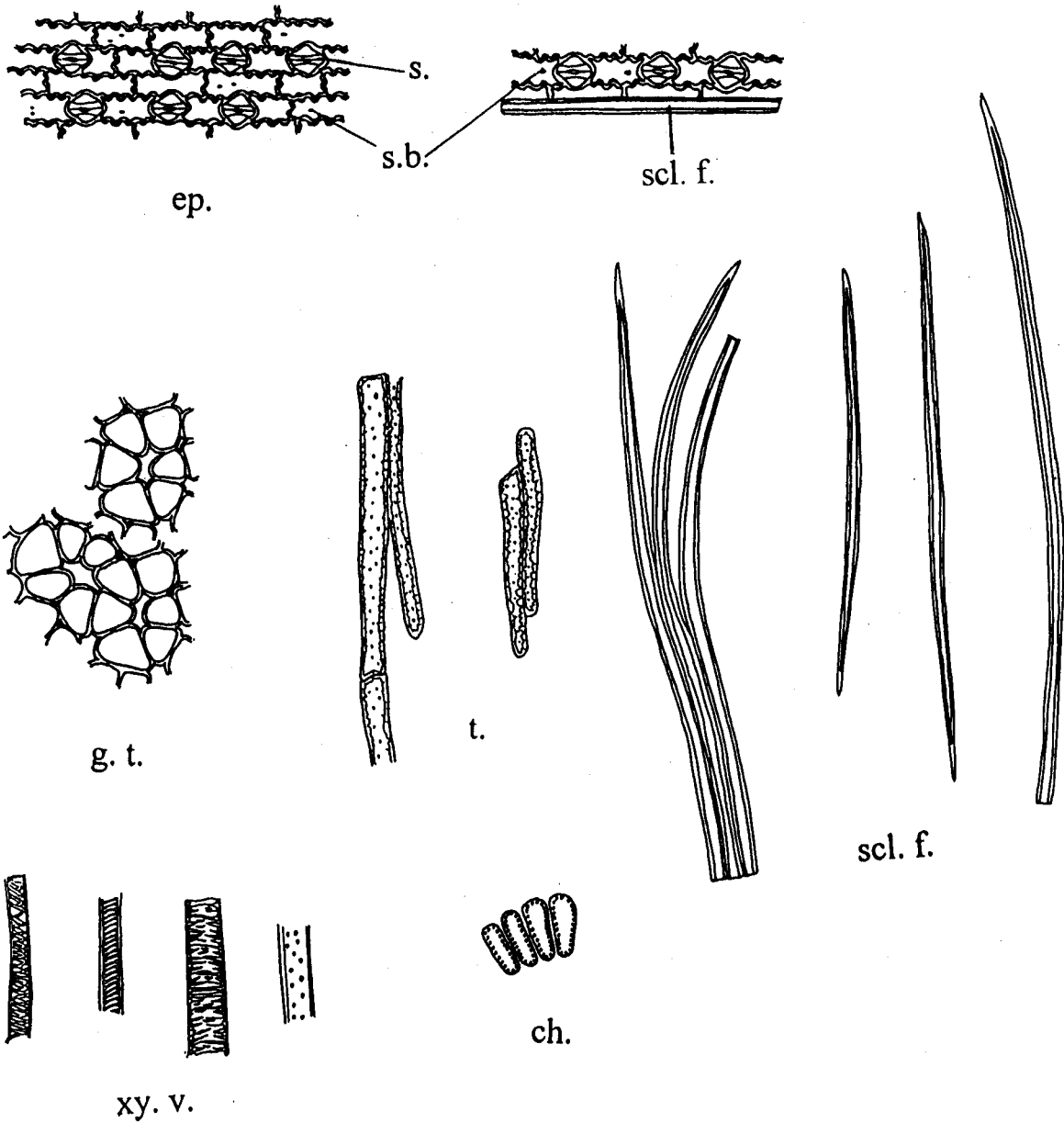


Fig. 6: Isolated elements of the culm

x 250

ch., chlorenchyma; ep., epidermis; g.t., ground tissue; scl.f., sclerenchymatous fibre; s.b., silica bodies; s., stomata; t., tracheid; xy.v., xylem vessel.

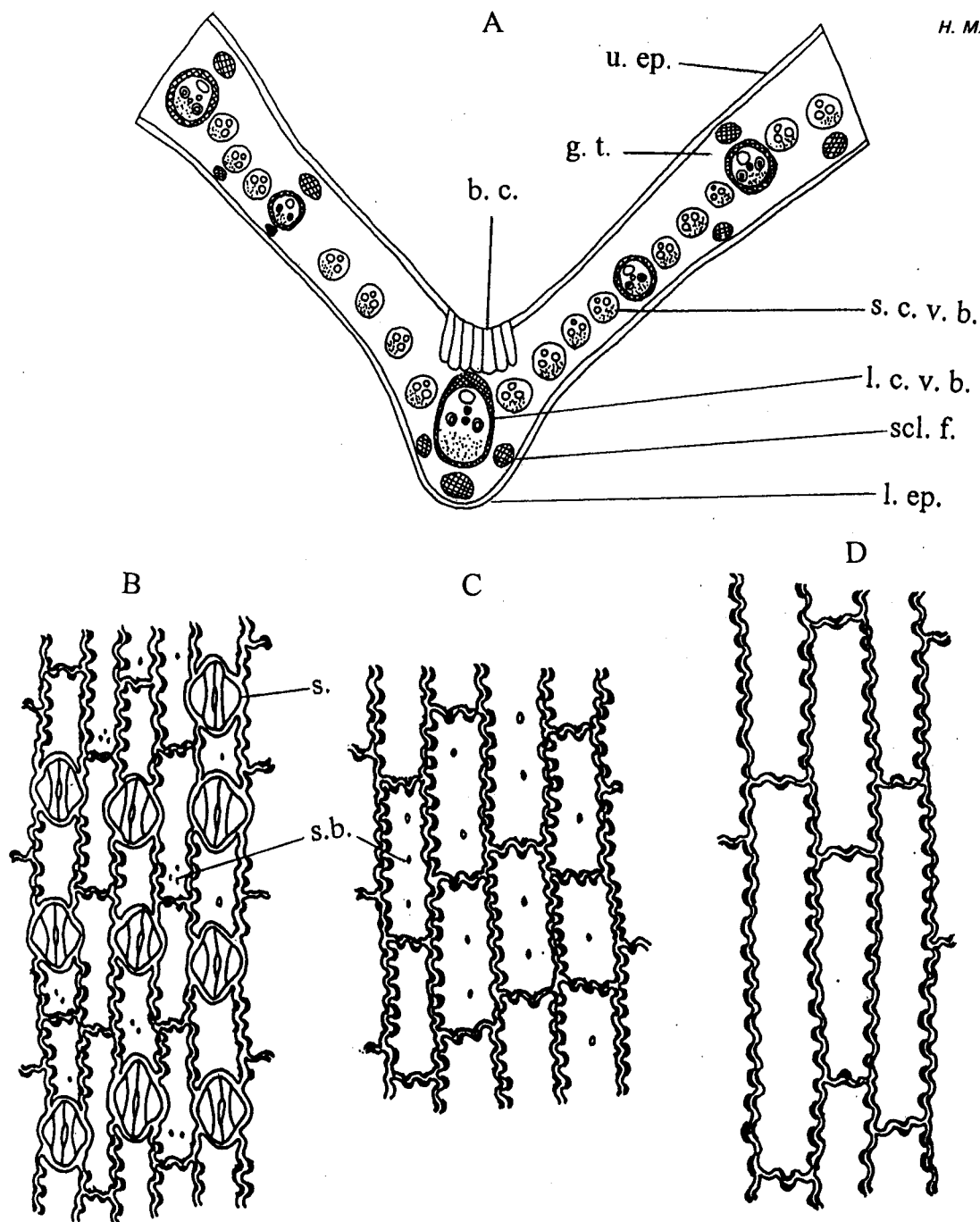


Fig. 7: The leaf of *Cyperus rotundus* L.

- |                                                          |        |
|----------------------------------------------------------|--------|
| A- Diagrammatic T.S. in the leaf                         | x 76.5 |
| B- Surface preparation of the leaf (Lower epidermis)     | x 450  |
| C- Surface preparation of the leaf (Upper epidermis)     | x 450  |
| D- Surface preparation of the leaf (Upper neural region) | x 450  |

b.c., bulliform cells; g.t., ground tissue; l.c.v.b., large closed vascular bundle; l.ep., lower epidermis; scl.f., sclerenchymatous fibre; s.b., silica bodies; s.c.v.b., small closed vascular bundle; s., stomata; u.ep., upper epidermis.

smaller bundles is more than that of the larger ones. A protoxylem air cavity is observed above the protoxylem vessels opposite to the phloem. Few upper epidermal cells in the midrib region are large, radiating, elongated and transparent, called bulliform cells.<sup>22,23</sup> The upper and lower surfaces show groups of hypodermal strands of sclerenchymatous fibres.

#### **The upper epidermis**

The upper epidermis in transverse section (Figs. 8, 9, 10 & 11A) is formed of one row of compact square to subrectangular cells. In the midrib region, the cells are large polygonal to barrel-shaped and radially elongated. In surface view (Figs. 7C & 12C) the upper epidermal cells are rectangular to subrectangular in shape and axially elongated. The cells have thick sinuous beaded walls, covered with thick smooth cuticle and containing few silica bodies.<sup>22</sup> They are measuring about 40-50-60  $\mu$  in length, 16-18-20  $\mu$  in width and 30-45-60  $\mu$  in height. There are few cells of the upper epidermis in the midrib region (Fig. 7D) (neural epidermal cells) which are transparent and differ from their neighbours in being larger in dimensions and more inflated. They are often referred to be bulliform cells and known as motor cells.<sup>22,23</sup> They are measuring about 75-110-130  $\mu$  in length 16-18-20  $\mu$  in width and 65-85-96  $\mu$  in height. Stomata and trichomes are completely absent.

#### **The lower epidermis**

The lower epidermis in transverse section (Figs. 8, 9, 10 & 11B) is formed of one row of square to subrectangular cells, covered with thick smooth cuticle, showing few prickles. In surface view (Figs. 7B & 12A) the cells are similar to those of the upper epidermis in shape but differ in size, being about 40-45-50  $\mu$  in length, 10-12-16  $\mu$  in width and 8-10-14  $\mu$  in height. The neural epidermal cells have the same shape and dimensions. Numerous stomata of gramineous type are present on the lower epidermis only, so the leaf is called hypostomatic.<sup>22</sup> The stomata is surrounded by two dumbel-shaped guard cells, measuring about 20-24-26  $\mu$  in length and 16-18-24  $\mu$  in width.

There are prickles or hooks<sup>22</sup> (Figs. 12B & 13) projecting from the surface and at the leaf margins. They are non-glandular, unicellular, conical, sharply to strongly pointed structures with swollen bases, having thick non-lignified walls, wide lumina and measuring about 70-100-120  $\mu$  in length and 20-30-80  $\mu$  in width at the base.

#### **The mesophyll (Figs. 8, 9 & 10)**

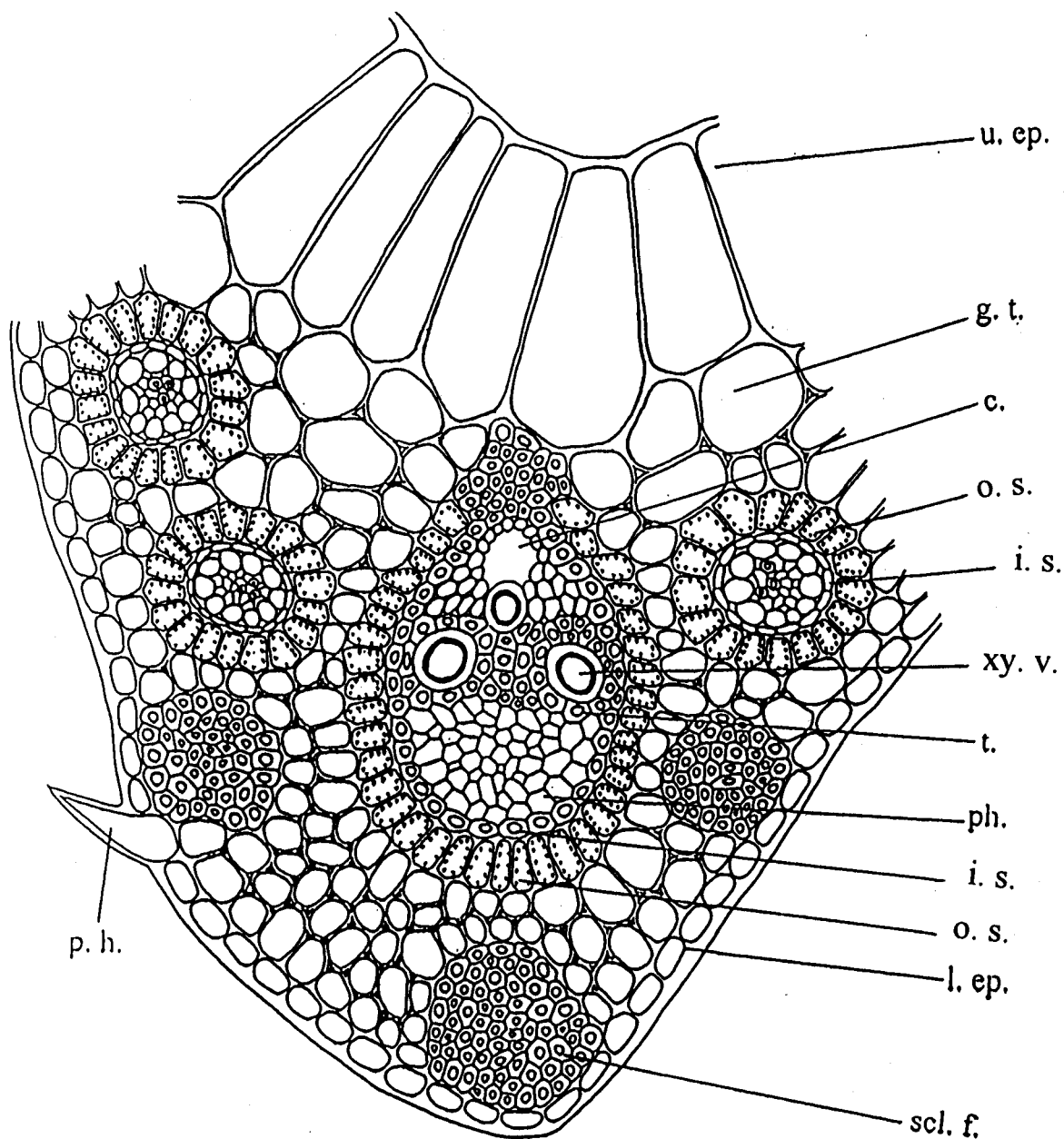
The term mesophyll is generally applied to all of the ground tissue between the upper and lower epidermises.<sup>22</sup> The ground tissue is not well differentiated into palisade and spongy tissue. It is composed of one row of compact square to polygonal parenchymatous hypodermis, followed by ordinary parenchyma, including separate groups of hypodermal strands of sclerenchymatous fibres as well as numerous vascular strands. The hypodermal strands are lignified, spindle-shaped, with slightly acute to acuminate apices and measuring about 220-350-500  $\mu$  in length and 6-8-10  $\mu$  in diameter. The vascular strands are of different sizes and each strand is surrounded by a chlorenchymatous tissue. The remaining of the ground tissue between the large and small vascular bundles consists of a loosely arranged oval to rounded thin-walled parenchymatous cells with intercellular spaces and free of contents.

#### **The vascular system (Figs. 8, 9, 10 & 11B)**

The vascular system is represented by a large central vascular bundle in the midrib region and other lateral smaller bundles on each side representing the veins. The vascular bundles are conjoint, collateral, closed type and arranged in parallel strands at regular intervals. They are nearly oval in shape, while the smaller ones are rounded. Each vascular bundle has an upper xylem and a lower phloem.

#### **The large vascular bundles (Figs. 8, 9 & 10)**

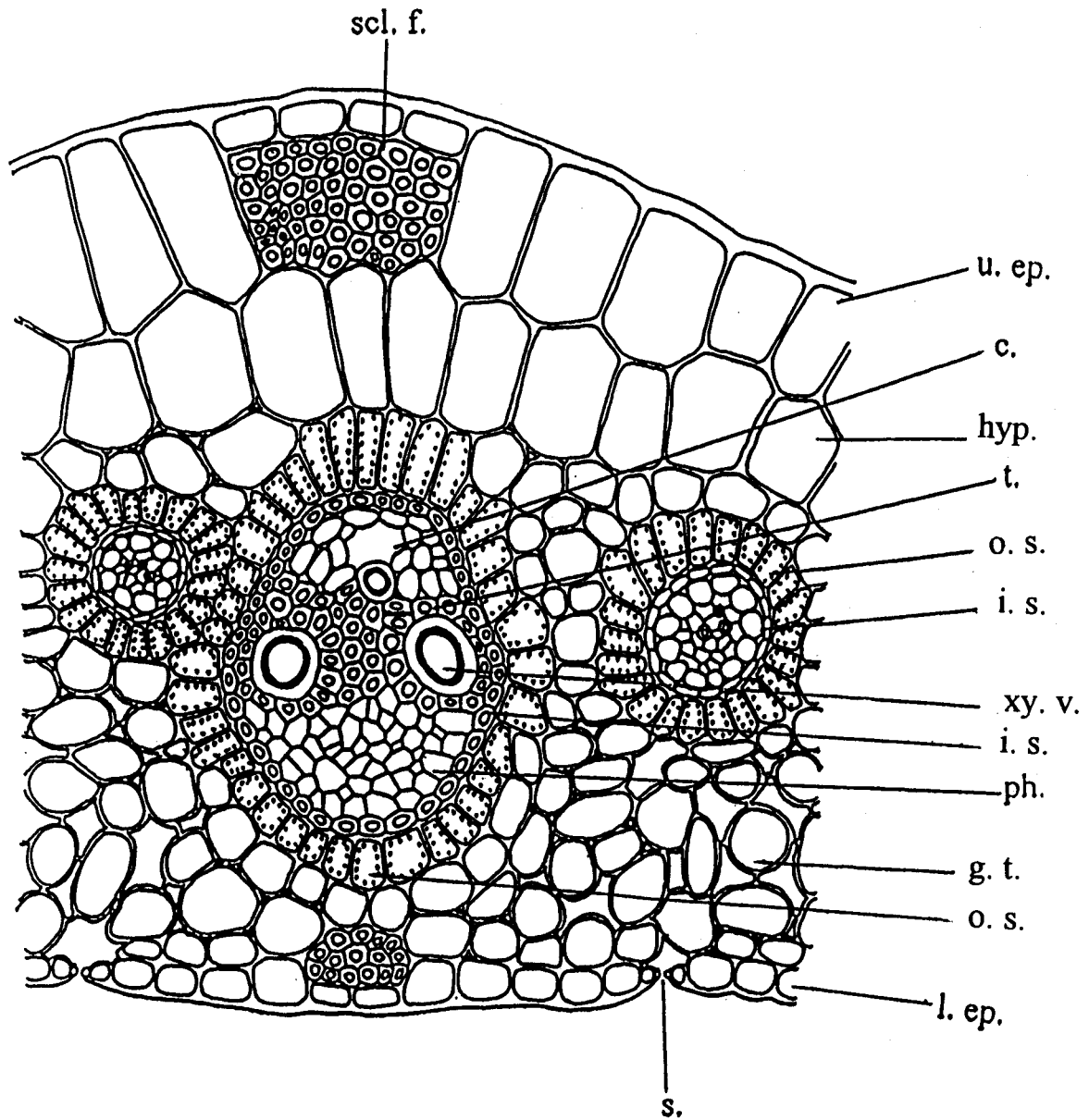
Each large vascular bundle is surrounded by two sheaths.<sup>22</sup> The outer one consists of a chlorenchymatous tissue which is arranged in a radiating manner and represented by thin-walled, polygonal cells containing chloroplasts, while the vascular bundle of the midrib is surrounded by incomplete sheath of chlorenchyma. They are



**Fig. 8:** Detailed T.S. in the midrib

x 400

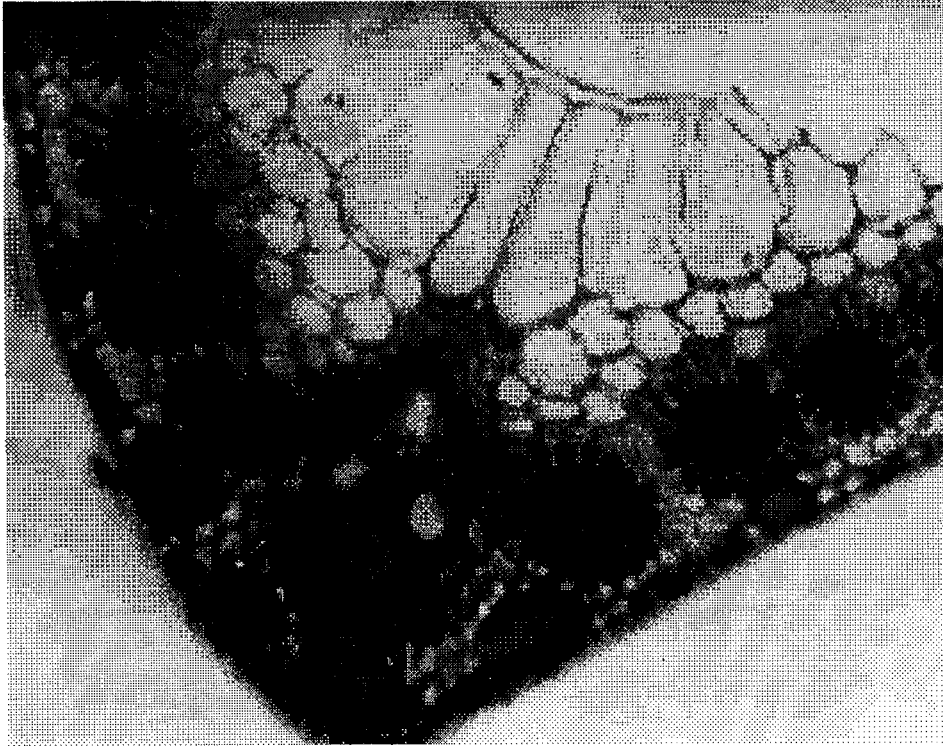
c., cavity; g.t., ground tissue; hyp., hypodermis; i.s., inner sheath; l.ep., lower epidermis; o.s., outer sheath; ph., phloem; p.h., prickle hair ; scl.f., sclerenchymatous fibre; t., tracheid; u.ep., upper epidermis; xy.v., xylem vessel.



**Fig. 9:** Detailed T.S. in the lamina

x 400

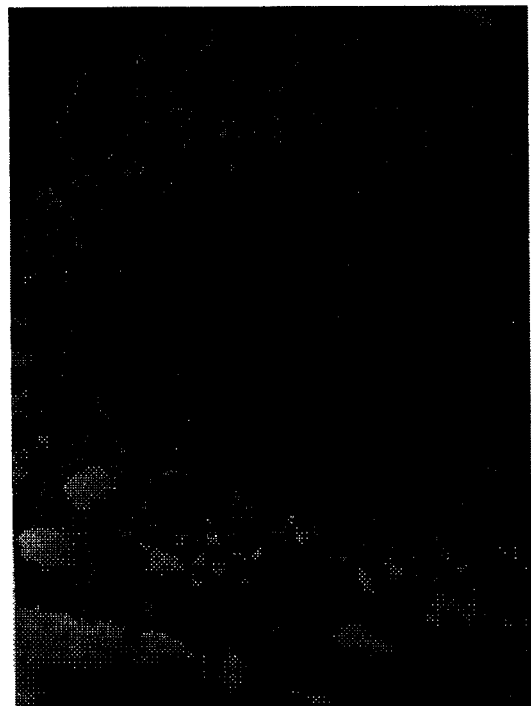
c., cavity; g.t., ground tissue; hyp., hypodermis; i.s., inner sheath; l.ep., lower epidermis; o.s., outer sheath; ph., phloem; scl.f., sclerenchymatous fibre; s., stomata; t., tracheid; u.ep., upper epidermis; xy.v., xylem vessel.



**Fig. 10:** Detailed T.S. in the leaf in the midrib.

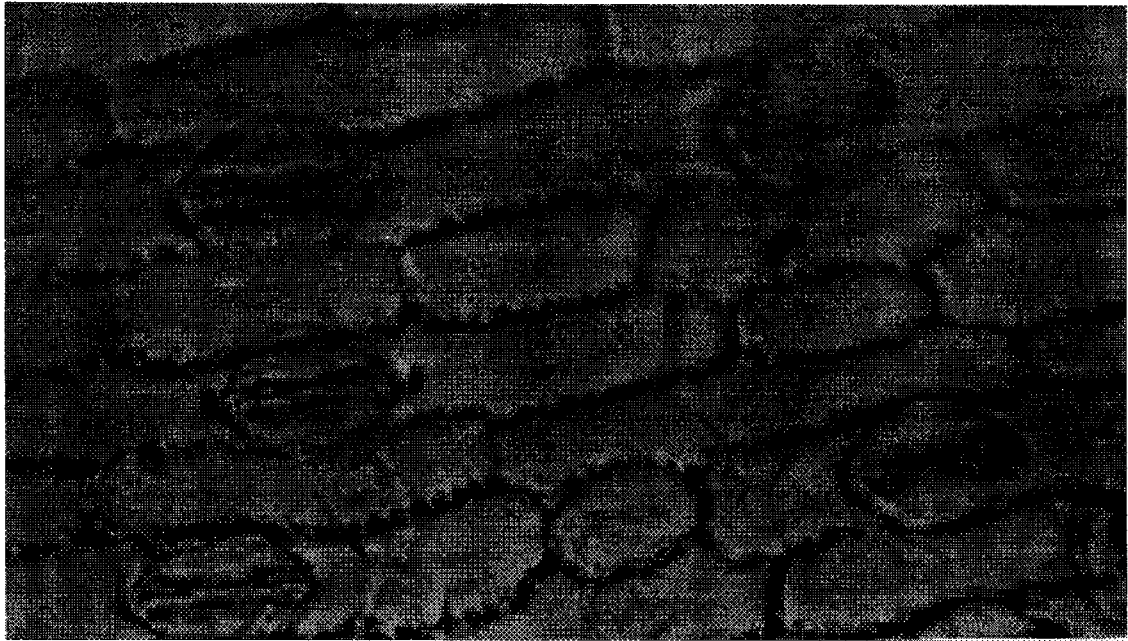


**Fig. 11A**

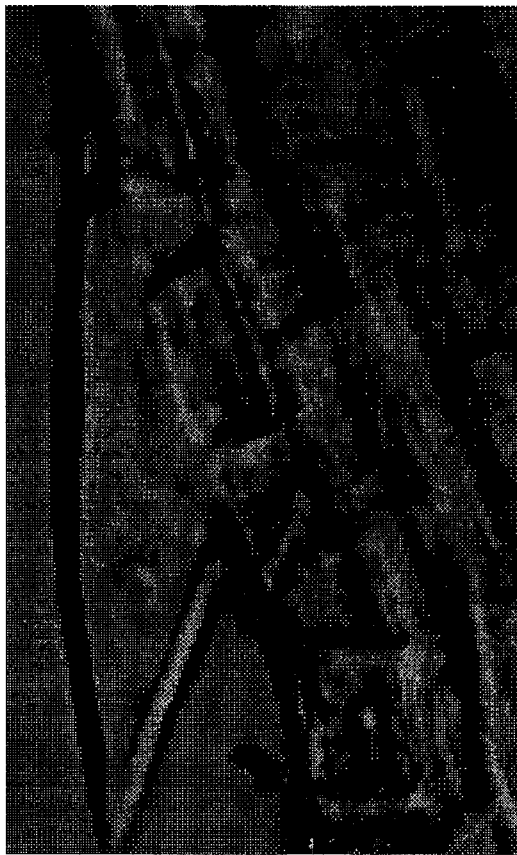


**Fig. 11B**

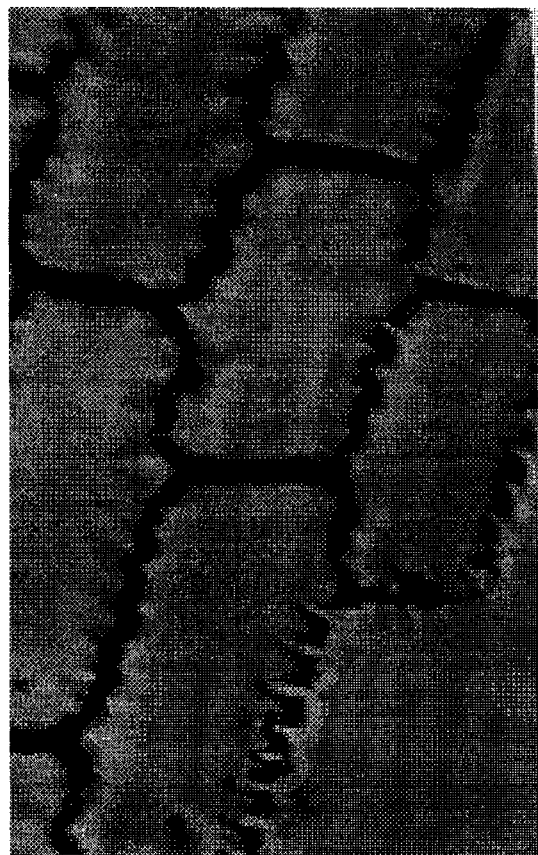
**Fig. 11A,B:** Detailed T.S. in the leaf in the lamina.



A

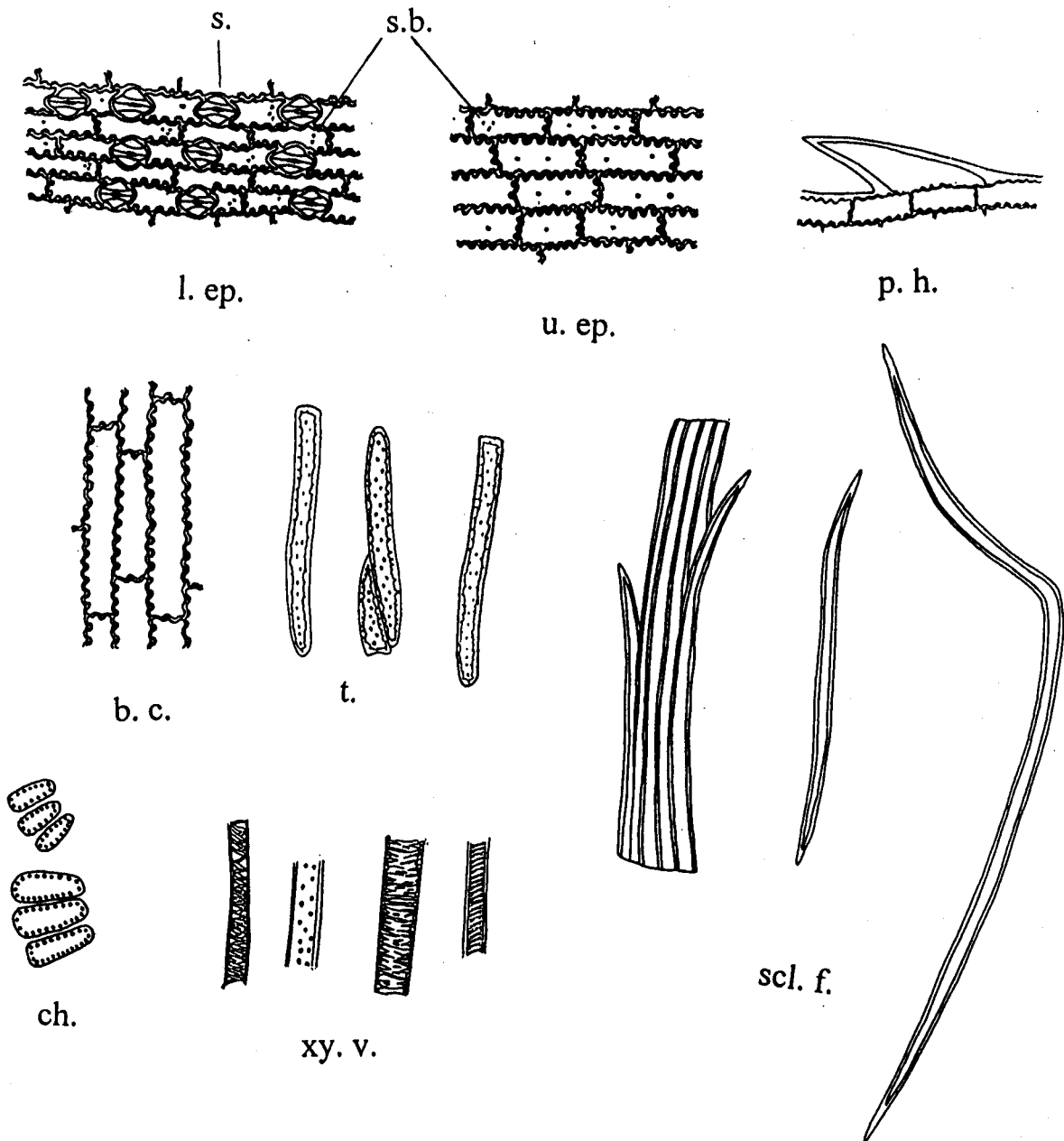


B



C

**Fig. 12:** A- Surface preparation of the leaf (lower epidermis).  
B- Leaf margin showing prickly hair.  
C- Surface preparation of the leaf (upper epidermis).



**Fig. 13:** Isolated elements of the leaf

x 250

b.c., bulliform cells; ch., chlorenchyma; l.ep., lower epidermis; p.h., prickle hair; scl.f., sclerenchymatous fibre; s.b., silica bodies; s., stomata; t., tracheid; u.ep., upper epidermis; xy.v., xylem vessel.



measuring about 16-20-28  $\mu$  in length and 8-10-14  $\mu$  in width. The inner sheath is represented by lignified sclerenchymatous fibres which are similar to those of the hypodermal sclerenchyma in all aspects. Each bundle shows a lower phloem consisting of sieve tubes and companion cells. The xylem has an inverted Y-shaped structure of two metaxylem vessels lying at the two lateral arms and having thick, lignified walls, mainly with reticulate and pitted thickenings, they are measuring about 16-18-22  $\mu$  in diameter. The protoxylem vessels having spiral thickening and measuring about 8-10-12  $\mu$  in diameter. Above the protoxylem vessels, there is a protoxylem air cavity. The xylem vessels are surrounded by few tracheids and thin-walled xylem parenchymatous cells. The tracheids (Fig. 13) are elongated, subrectangular in shape with blunt ends, having thick simple pitted and lignified walls. They are measuring about 80-100-130  $\mu$  in length and 10-12-14  $\mu$  in width.

#### The small vascular bundles (Figs. 8, 9, 10 & 11B)

Each small vascular bundle is also surrounded by two sheaths.<sup>22</sup> The outer one consists of a chlorenchymatous tissue which appears radiating around the vascular bundles in the transverse section. The chlorenchymatous tissue is composed of thin-walled parenchymatous cells, containing chloroplasts and measuring about 12-20-24  $\mu$  in length and 6-8-10  $\mu$  in width. While the inner sheath consists of about two rings of compactly arranged small thin-walled parenchymatous cells. The bundle is composed of small sized, lignified xylem vessels having spiral thickening and measuring about 6-8-10  $\mu$  in diameter. In addition to, a soft phloem tissue consisting of sieve tubes and companion cells.

#### The powder of the leaf

The powdered leaf of *Cyperus rotundus* L. (Fig. 13) is yellowish-green in colour, with a slight odour and slight bitter taste. It is characterized microscopically by the following features:

1- Fragments of the upper epidermal cells which are rectangular to subrectangular and axially elongated. The cells have thick

sinuous beaded walls, covered with thick smooth cuticle and containing few silica bodies. Stomata and hairs are completely absent.

- 2- Fragments of the upper epidermis in the neural region represented by subrectangular axially elongated cells with sinuous beaded walls and covered with thick smooth cuticle.
- 3- Fragments of the lower epidermal cells which are similar to those of the upper ones but showing dumbel-shaped gamineous stomata and few prickly hairs, which are non-glandular, unicellular, conical, sharply pointed, having thick non-lignified walls with wide lumina and swollen bases.
- 4- Fragments of sclerenchymatous fibres of variable sizes, with thick lignified walls, having moderately wide lumina and acute apices.
- 5- Fragments of few tracheids of different sizes, having slightly wide lumina, thick lignified and simple pitted walls.
- 6- Fragments of thin-walled parenchymatous cells of variable sizes and containing chloroplasts.
- 7- Fragments of lignified xylem vessels having spiral, simple pitted, reticulate and scalariform thickenings.
- 8- The powder is characterized by the absence of calcium oxalate, starch and sclereids.

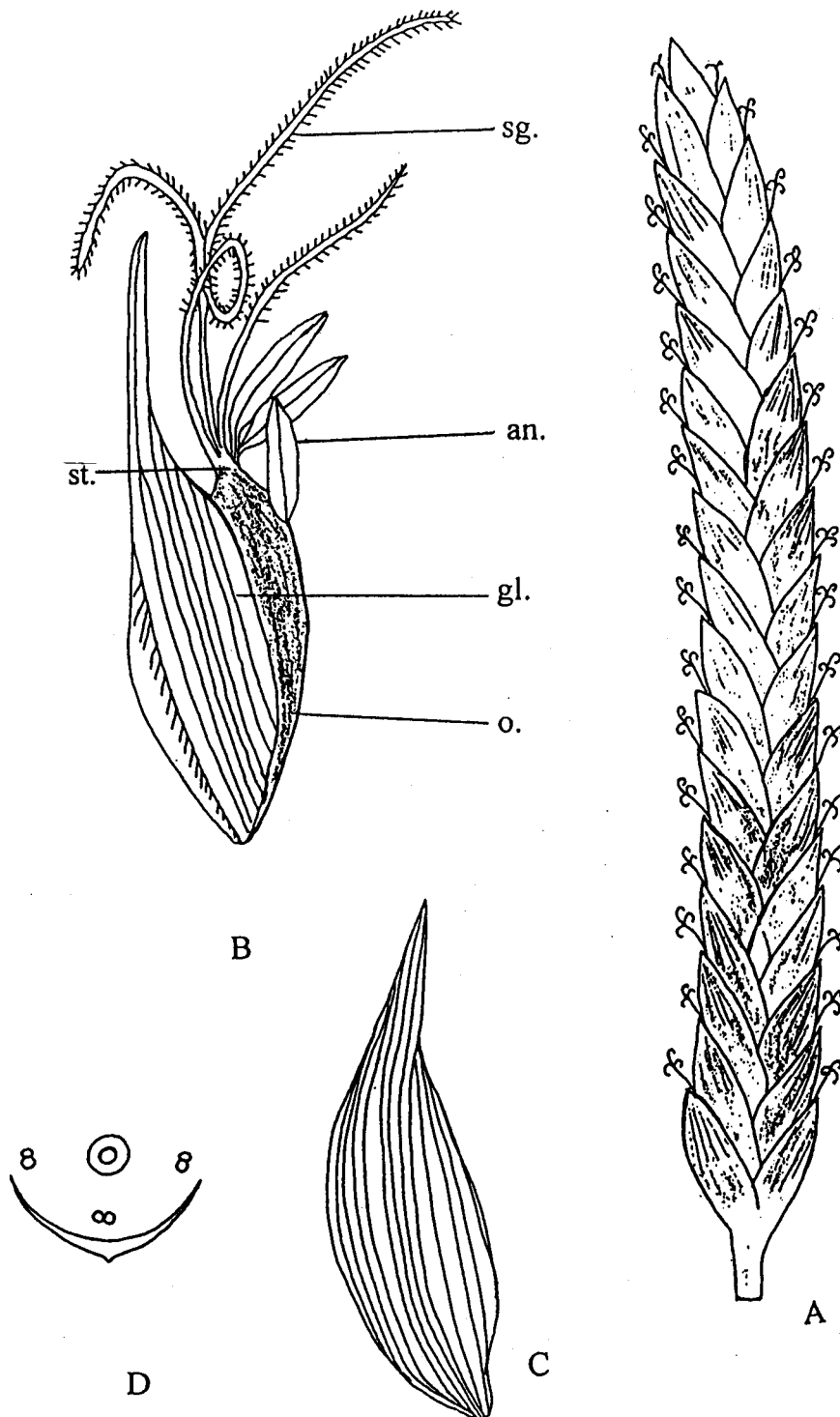
### 3- The Inflorescence

#### A- Macromorphology (Figs. 1 & 2)

The inflorescence is a spikate consisting of about 5-8 spikelets which are arranged in an umbellate form. They are carried on a peduncle measuring about 6-9-12 cm in length and 1-2-3 mm in width. The spikelet (Fig. 14A) is broadly ovate in shape, greenish in colour when young to reddish-brown when mature, measuring about 30-45-60 mm in length and 1-1.5-2 mm in width. Each spikelet carries about 15-35-40 flowers.

#### The flower (Fig. 14B)

The flower is minute, sessile, bisexual, subtended by a glume, which is oblong to



**Fig. 14:** Sketch of the inflorescence of *Cyperus rotundus* L.

A- The spikelete

x 6.75

B- The flower

x 20.3

C- The glume

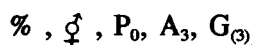
x 20.3

D- Floral diagram

an., anther; gl., glume; o., ovary; sg., stigma; st., style.

obtuse, reddish-brown to blackish-brown in colour and measuring about 2-4-6 mm in length and 2-3-4 mm width.

The androecium consists of three stamens with long bilobed and basifixed anthers, carried on free filaments. The gynoecium consists of a unilocular, tricarpeal, superior ovary enclosing a solitary erect ovule with basal placentation. The style is branched and carry three papillose stigmas. The flower has the floral formula:



### B- Micromorphological study of the peduncle

A transverse section in the peduncle is nearly triangular in outline (Fig. 15A). It shows, a single row of an outer epidermal cells. The ground tissue is composed of parenchymatous hypodermis interrupted by strands of lignified sclerenchymatous fibres, followed by several layers of thin-walled parenchymatous cells showing numerous scattered vascular bundles. The endodermis and pericycle are not distinct. The stele is of atactostele type. The vascular bundles are conjoint, collateral and closed type.

### The epidermis

In transverse section (Fig. 16) it is composed of one row of thick-walled square to subrectangular cells, covered with thick cuticle. While in surface view (Fig. 15B) they appear rectangular to subrectangular in shape, axially elongated, having thick sinuous beaded walls and containing few silica bodies. They are measuring about 24-30-40  $\mu$  in length, 8-10-14  $\mu$  in width and 6-10-12  $\mu$  in height. Stomata and hairs are not present.

The remaining structure of the peduncle is similar to that of the culm but differs only in the size of the cells.

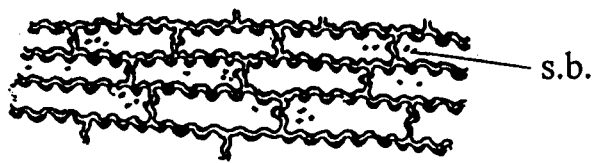
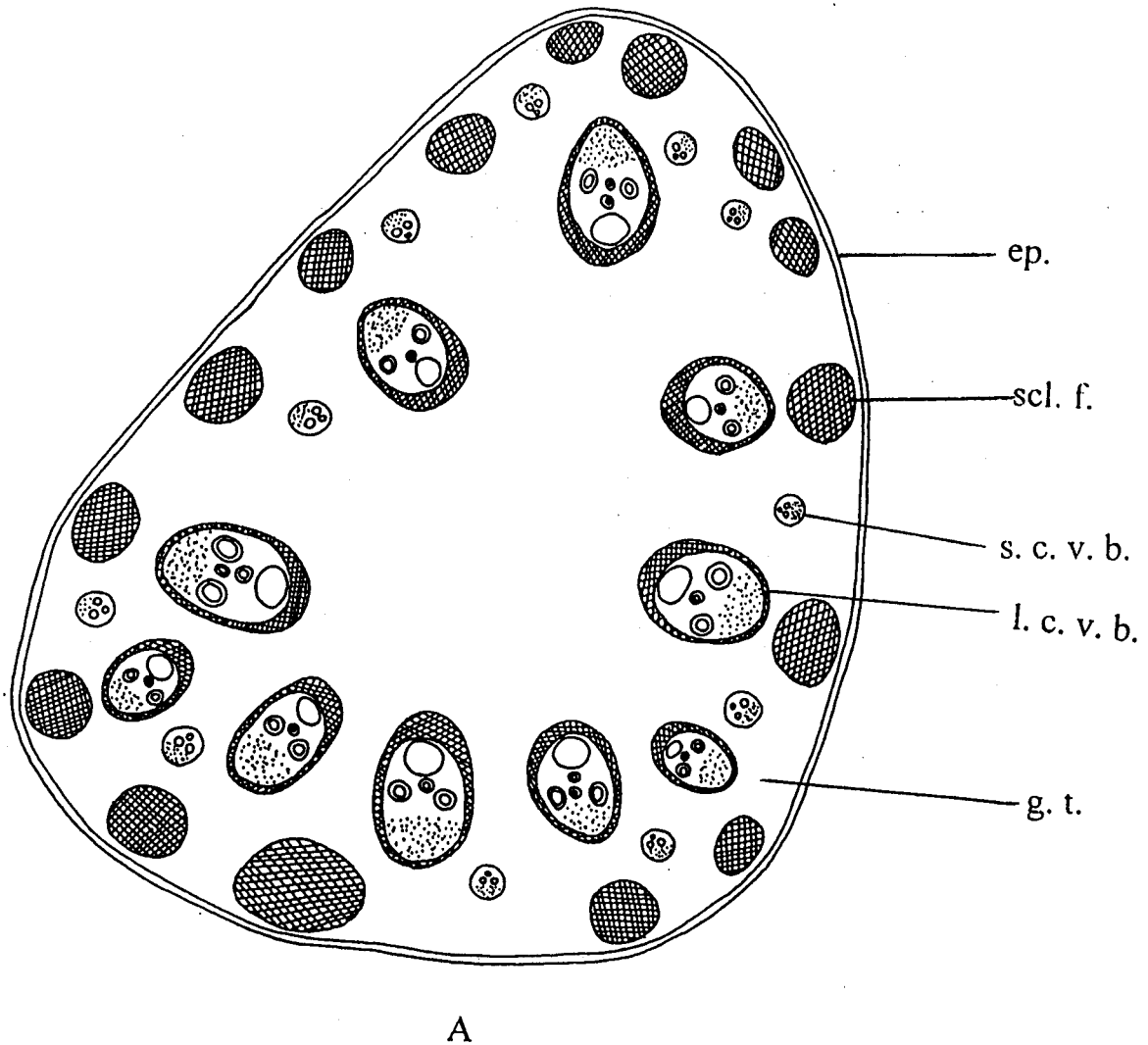
### The powder of the inflorescence

The powdered inflorescence of *Cyperus rotundus* L. (Fig. 17) is greenish to reddish-brown in colour with slight odour and it is usually tasteless. It is characterized microscopically by the following features.

1- Fragments of the outer epidermis of the glume which are rectangular to subrectangular, axially elongated, having

thick sinuous beaded walls, covered with thick smooth cuticle and having few silica bodies. They are measuring about 30-40-50  $\mu$  in length and 10-12-18  $\mu$  in width. Stomata are absent.

- 2- Fragments of the inner epidermis of the glume which are similar to those of the outer surface. They are measuring about 40-60-70  $\mu$  in length, and 8-10-12  $\mu$  in width, showing few dumbel-shaped gramineous stomata that measuring about 20-22-24  $\mu$  in length and 12-14-20  $\mu$  in width.
- 3- Fragments of sclerenchymatous fibres from the glume and peduncle having thin, slightly lignified walls, moderately wide lumina and acute to acuminate apices. They are measuring about 145-300-450  $\mu$  in length and 6-8-10  $\mu$  in diameter.
- 4- Fragments of the fibrous layer of the anther consisting of polygonal, axially elongated cells, having beaded walls and distinct bar-like thickening.
- 5- Numerous small pollen grains which are triangular in shape, having smooth exine.
- 6- Fragments of the epidermal cells of papillose stigma which are polygonal, axially elongated, having thin walls and covered with thin smooth cuticle. They are measuring about 24-26-50  $\mu$  in length and 6-8-10  $\mu$  in width.
- 7- Fragments of the epidermal cells of the style consisting of polygonal, axially elongated cells having thin walls, covered with thin smooth cuticle and measuring about 25-50-55  $\mu$  in length and 5-10-15  $\mu$  in width.
- 8- Fragments of the epidermal cells of the ovary which are polygonal, nearly isodiametric cells and covered with thin smooth cuticle.
- 9- Fragments of the chlorenchymatous cells of the peduncle consisting of thin-walled polygonal cells, with variable sizes and containing chloroplasts.
- 10- Fragments of the peduncle showing oval to rounded, thin-walled parenchymatous cells of the ground tissue.
- 11- Fragments of the epidermal cells of the peduncle which are rectangular to

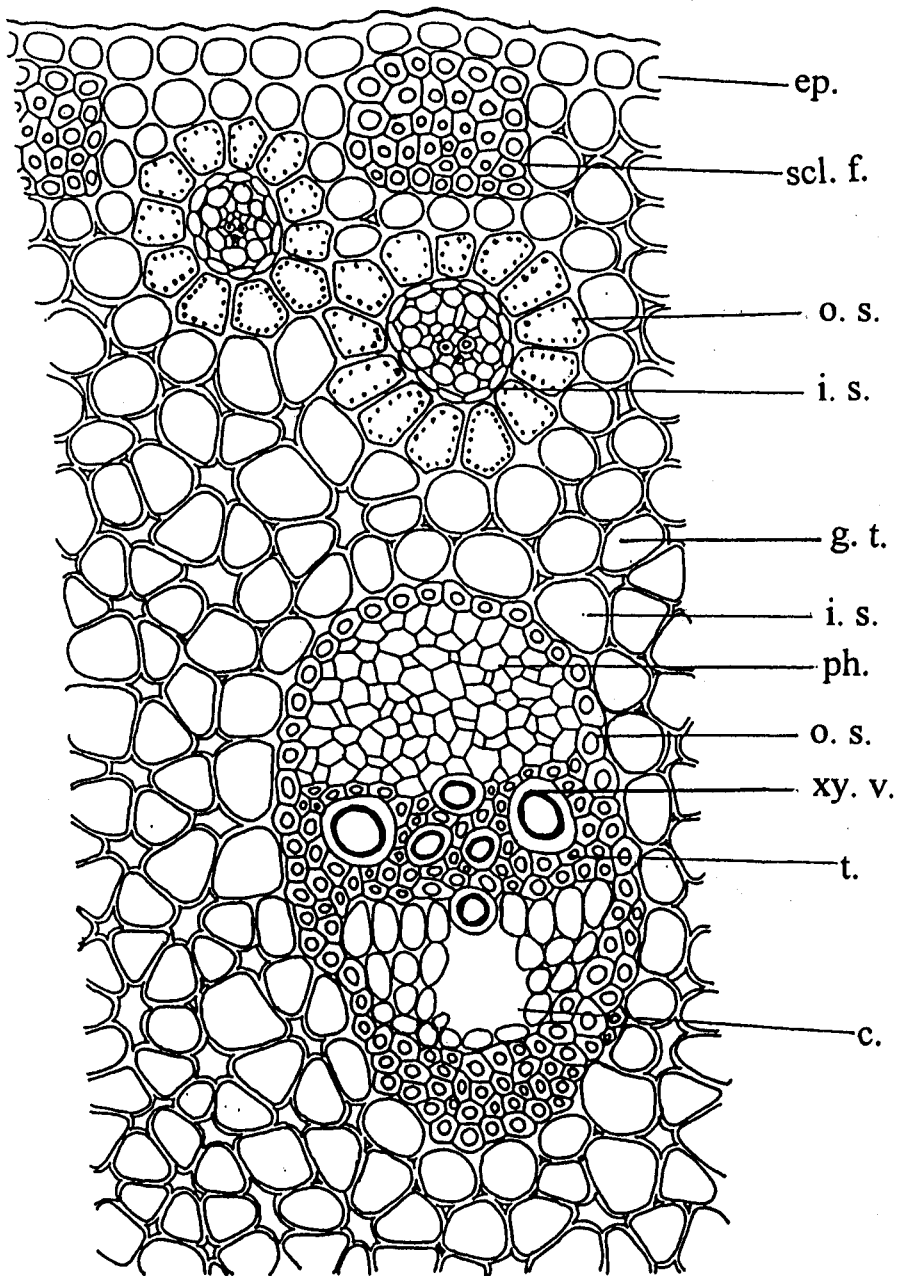


**Fig. 15:** The peduncle of *Cyperus rotundus* L.

A- Diagrammatic T.S. in the peduncle x 116

B- Surface preparation of the peduncle x 500

ep., epidermis; g.t., ground tissue; l.c.v.b., large closed vascular bundle; scl.f., sclerenchymatous fibre; s.b., silica bodies; s.c.v.b., small closed vascular bundle; s., stomata.



**Fig. 16:** Detailed T.S. in the peduncle

x 540

c., cavity; ep., epidermis; g.t., ground tissue; i.s., inner sheath; o.s., outer sheath; ph., phloem; scl.f., sclerenchymatous fibre; t., tracheid; xy.v., xylem vessel.

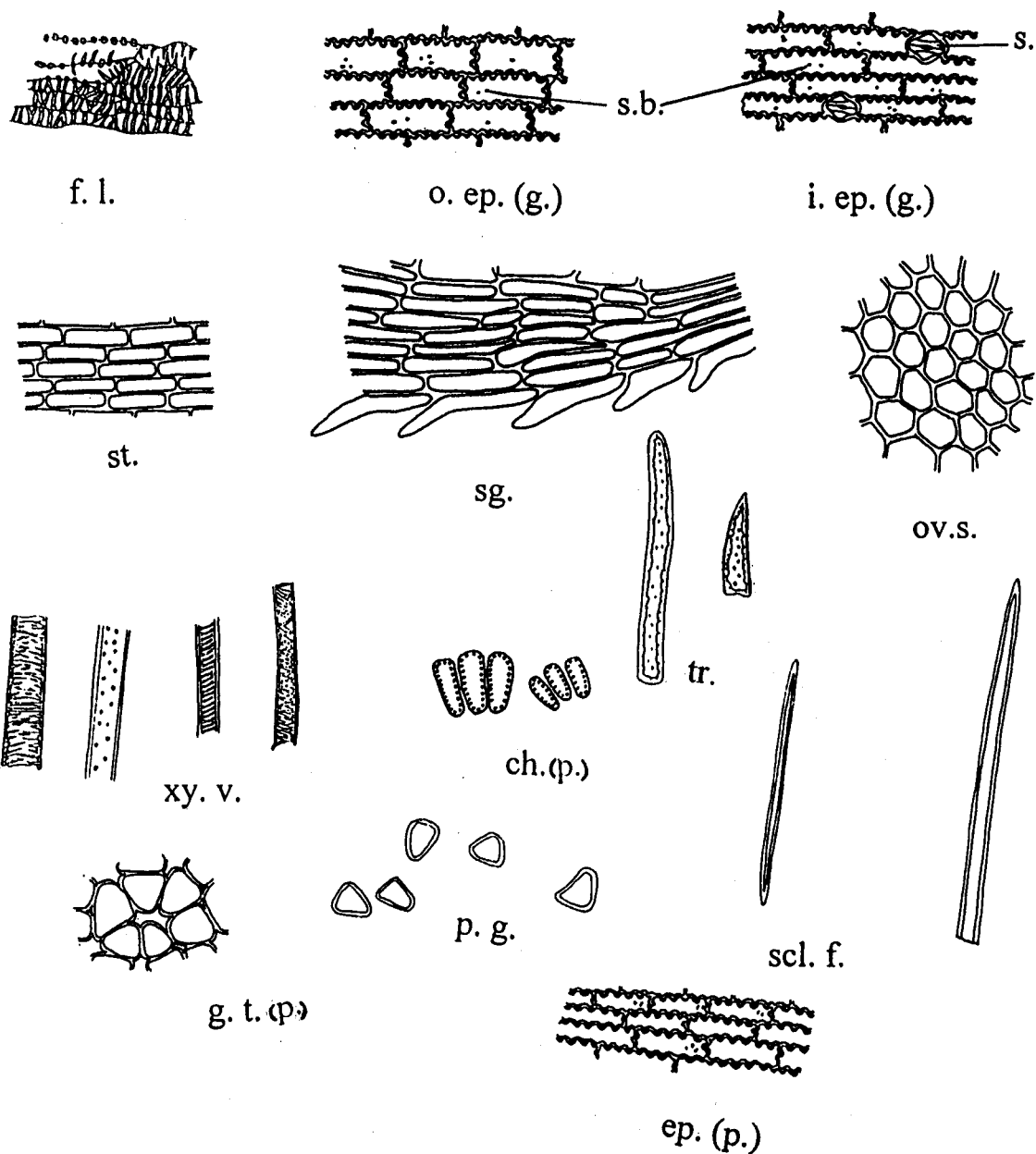


Fig. 17: Isolated elements of the inflorescence

x 300

ch., chlorenchyma; ep.(p.), epidermis of peduncle; f.l., fibrous layer ; g.t.(p.), ground tissue of peduncle; i.ep.(g.), inner epidermis of glume; ov.s., ovary surface; o.ep.(g.), outer epidermis of glume; p.g., pollen grain; scl.f., sclerenchymatous fibre; s.b., silica bodies; s., stomata; sg., stigma; st., style; t., tracheid; xy.v., xylem vessel.

subrectangular, axially elongated, having thick sinuous beaded walls, covered with thick smooth cuticle and containing few silica bodies.

- 12- Fragments of lignified xylem vessels with spiral, simple pitted, reticulate and scalariform thickenings.
- 13- Fragments of few tracheids from the peduncle, having different sizes with thick, simple pitted, lignified walls and slightly wide lumina.

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