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COMPARATIVE FOLIAR ANATOMY OF TEN SPECIES IN THE GENUS *HIBISCUS* LINN. IN NIGERIA

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ABSTRACT

The foliar anatomy of ten species of *Hibiscus* in Nigeria is described. The distinguishing characters of taxonomic value include the variation in the shapes of petioles in the proximal region, the variation in the number and arrangement of the vascular bundles, presence or absence of medullary bundles in the pith at the distal end of the petiole, types of trichomes on the lamina and petioles and presence or absence of cuticular striations on the epidermal surfaces. Druses of calcium oxalate crystals occur generally in the genus, however, occurrence, distribution and quantity of these crystals is quite diagnostic on the adaxial and abaxial epidermal surfaces of *H. rostellatus*.

INTRODUCTION

The genus *Hibiscus* Linn. belongs to the family Malvaceae. The family is cosmopolitan in its distribution and is represented by 85 genera (Gill, 1988) world wide. According to Hutchinson and Dalziel (1958), the genus is represented in Nigeria by twenty-three species.

The species of *Hibiscus* are very important economically. The outstanding economic importance of this genus is the fibres which they yield, hence some species are cultivated for their fibres (Schippers, 2000). The plants are either erect, procumbent or decumbent.

The taxonomic value of epidermal morphology is well documented in botanical literature, (Dilcher, 1974; Isawumi, 1984; Palmer and Gerbeth-Jones, 1986; Jayeola *et al.* 2001). Metcalfe and Chalk (1950) described the general anatomy of the family malvaceae. Isawumi (1992) also reported trichome studies in the West African species of *Hibiscus.* Given the available information, the report on the anatomy of the *Hibiscus* species in Nigeria is very scanty. The present study is therefore aimed at describing the anatomy of leaf epidermis and petiole of ten species of *Hibiscus* occurring in Nigeria with the view to establishing characteristics of foliar structures with taxonomic value useful in the delimitation and identification of the species.

MATERIALS AND METHODS

Fresh leaf materials were collected during regular field trips to various parts of the country and preserved in Formalin Acetic-Alcohol (F.A.A). The species used for this study are *H. lunarifolius* Willd., *H. rostellatus* Guill. and Perr., *H. scotellii* Bak. F., *H. sterculiifolius* (Guill. and Perr.) Steud., *H. tiliaceus* Linn., *H physaloides* Guill. and Perr., *H. acetosella* Welw., *H. sabdariffa* Linn., *H. vitifolius* var. *vitifolius* Linn. and *H. surattensis* Linn.

Sizeable portions of the leaves were cut from the median parts of mature and well expanded leaves. These were boiled for about 25 minutes in 90% alcohol in the oven at about 60°C in order to remove the chlorophyll. The leaf portions were then washed in 4 - 5 changes of water, after which they were boiled in 5% sodium hydroxide solution for about 40 minutes until the materials have become decolourized. They were then washed thoroughly in order to remove the alkaline solution. The partly cleared portions of the leaf were finally cleared in 5% solution of domestic bleach (Parozone) for about 30 minutes, The portions of the leaf were finally washed properly in 3 - 4 changes of water and stored in 50% ethyl alcohol for anatomical studies.

For the preparation of epidermal peels, the scrape technique was used whereby the required epidermis was obtained by scraping it from the unrequired mesophyll. The epidermal peels were stained in 1 % aqueous Safranin 0 for 5 - 10 minutes and rinsed carefully in water to remove excess stain. Temporary

mounts were made in 25% glycerol. For the purpose of studying the venation patterns, cleared portions of the leaf were stained in 1 % aqueous Safranin 0 and mounted in 25% glycerol.

Transverse sections of petioles were cut using Reichert sliding microtome at thickness between 10 - 15 µm. The specimens were stained in Alcian blue for 3 – 5 minutes, rinsed thoroughly in water to remove excess stain and counterstained in Safranin 0 solution for 3 - 5 minutes. The sections were again washed with water and mounted in 25% glycerol.

Illustrations were made with camera lucida fitted to M20 Wild microscope. All measurements were made with the aid of ocular micrometer and final figures got with ocular constant.

RESULTS

Transverse sections Petiole (Fig. 1).

Outline: Proximal region - adaxial side concave abaxial round in *H. acetosella, H. surattensis, H. sterculiifolius* and *H. sabdariffa* (Fig. 1A), adaxial and abaxial side round in *H. vitifolius* var. vitifolius, *H. tiliaceus, H. physaloides, H. scotellii, H. lunarifolius* and *H. rostellatus* (Fig. 1B). Median and distal regions generally round in all the species studied (Figs. 1C - H).

Epidermis: Uniseriate in all the three regions in all the species, moderately thickened. Cortex: Composed of angular collenchyma cells to the outer part and polygonal parenchyma cells on the inner part. Vasculature: Proximal region; vascular bundle occur in isolated collateral bundles of different sizes, 7 - 9 in *H. vitifolius* var. *vitifolius, H. acetosella* and *H. lunarifolius;* 8 - 10 in *H. physaloides, H. surattensis* and *H. scotellii;* 9 - 11 in *H. sterculiifolius* and *H. sabdariffa;* 10 - 12 in *H. tiliaceus* and *H. rostellatus.* Arrangement is ring-arc when the adaxial is concave and circular when round. Median region 6 - 7 in *H. vitifolius* var. *vitifolius* and *H. acetosella;* 7 - 8 in *H. tiliaceus, H. physaloides, H. surattensis, H. scotellii* and *H. sabdariffa;* 8 - 9 in *H. lunarifolius;* 9 - 11 in *H. rostellatus* and *H. sterculiifolius.* Distal region - vascular system is generally amphicribal, perivascular fibre form a continuous layer round the phloem (Figs. ID - H). Pith: The three regions, proximal, median and distal comprises polygonal parenchyma cells. Medullary bundles present in *H. tiliaceus, H. scotellii, H. rostellatus* and *H. acetosella.* Trichomes: Similar to those present on the lamina. Crystals: Druses of calcium oxalate clystals present, randomly distributed in the epidermides, cortex,

Fig. 1: Transverse sections of the petiole of the species of *Hibiscus*

A. Proximal region (adaxial side concave):
- *H. acetosella*
- *H. surattensis*
- *H. sterculiifolius*, *H. sabdariffa.*

B. Proximal regions (adaxial side round):
- *H. vitifolius* var. *vitifolius*
- *H. tiliaceus*
- *H. physaloides*
- *H. scotellii*
- *H. lunarifolius*
- *H. rostellatus*

C. Median region in the *Hibiscus* species.

D. Distal region in
- *H. lunarifolius*
- *H. vitifolius var. vitifolius*
- *H. sabdariffa*
- *H. sterculiifolius*
- *H. physaloides*
- *H. surattensis*

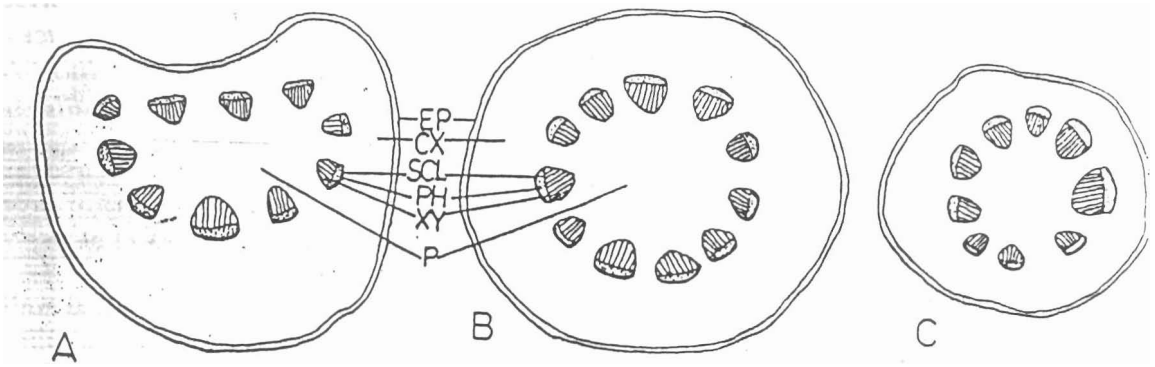
E Distal region in *H. tiliaceus*

F. Distal region in *H. scotellii*

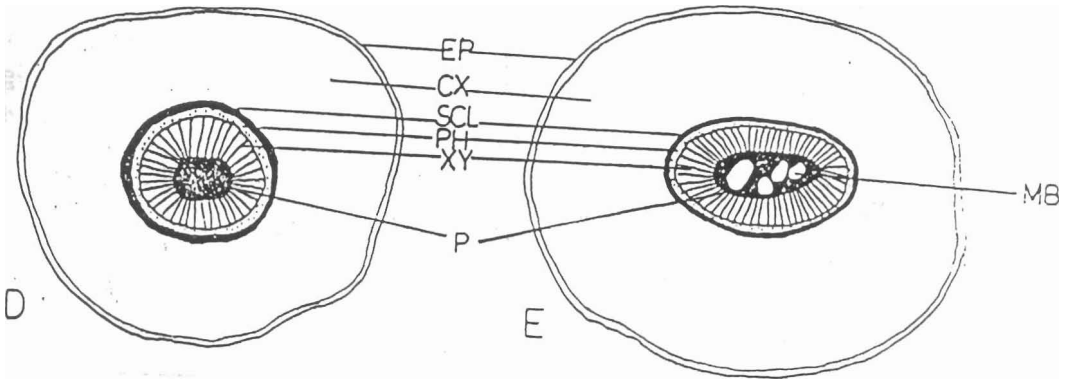
G. Distal region in *H. rostellatus*

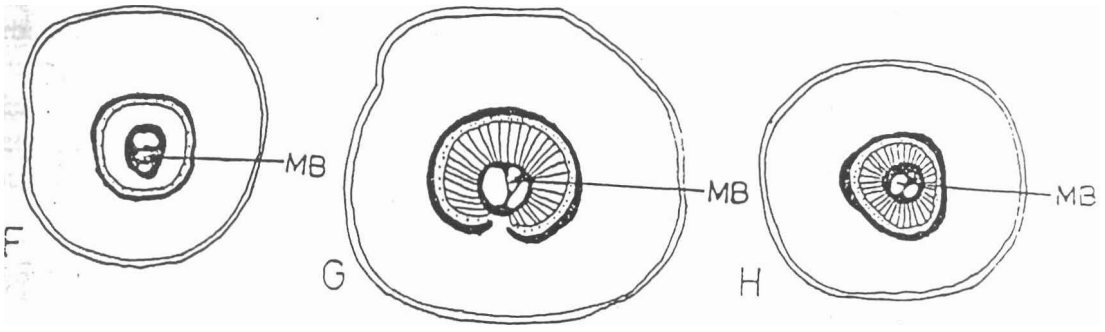
H. Distal region in *H. acetosella.*

EP. Epidermis; CX. Cortex; SCL. Sclerenchyma cells; PH. Phloem; XY. Xylem; P. Pith; MB. Medullary bundle.



115.0 µm





vascular bundles and pith. Mucilaginous cells: Occur in both cortical and pith parenchyma cells.

Venation (Fig. 2).

Venations generally palmate; primary veins 3 - 5 in number in *H. vitifolius* var. *vitifolius, H. surattensis, H. acetosella, H. scotellii, H. rostellatus* and *H. sabdariffa;* 3 - 6 *in H. tiliaceus;* 5 in *H. lunarifolius* and *H. sterculiifolius;* 7 - 9 in *H. physaloides.* Ramification of the lateral actinodromous veins is perfect reticulate. Areoles variable in size and shape. Veinlet endings 0 - 2 in *H. tiliaceus* and *H. sterculiifolius;* 0 - 3 in *physaloides, H. vitifolius* var. *vitifolius, H. acetosella, H. scotellii, H. lunarifolius, H. rostellatus;* 0 - 5 in *H. surattensis* and *H. sabdariffa.*

Lamina Surface View (Figs. 3 - 12).

H. vitifolius var. vitifolius Linn. (Fig. 3).

Epidermal cells polygonal to irregular in shape with straight anticlinal walls on the adaxial surface (Fig. 3A), polygonal to irregular with slightly wavy anticlinal walls on the abaxial surface (Fig. 3B). Stomata: Amphistomatic, anisocytic, occasionally anomocytic; guard cell area - adaxial 244.06 - 510.51 μm^2, abaxial 295.3 - 574.3 µm2; stomatal frequency - adaxial 33.3 - 66.6 mm^{-2}, abaxial 83.3 - 133.3 mm^{-2}; stomatal index - adaxial 7.3 - 16.7%, abaxial 16.1 - 26.3%. Trichomes: Stalked glandular (Figs. 3D and E) and stellate non-glandular (Figs. 3F - I) trichomes present on both surfaces. Trichome base: Often circular (Fig. 3C). Cuticular striations: Present only on the adaxial surface radiating from some guard cells, absent on the abaxial (Figs. 3A and C). Mucilaginous cells: Abundant, variable in shape (Figs. 3A and B). Crystals: Druses of calcium oxalate crystals and occasionally prismatic crystals present.

H. tiliacells Linn. (Fig. 4).

Epidermal cells polygonal to irregular with wavy anticlinal walls on both surfaces (Figs. 4A and B). Stomata: Amphistomatic, anisocytic, occasionally anomocytic; guard cell area adaxial 196.4 - 272.7 μm^2, abaxial 191.3 - 229.2 um2 stomatal frequency - adaxial 8.3 - 24.8 mm^{-2}, abaxial 41.7 - 99.8 mm^{-2}; stomatal index - adaxial 2.1 - 3.6%, abaxial 4.6 - 11.7%. Trichomes : Stalked glandular (Figs. 4D - F) and stellate non-glandular (Figs. 4G and H) trichomes present on both surfaces. Trichome base often circular (Fig. 4C). Cuticular striations: Present on both surfaces but sparse on the abaxial. Mucilaginous cells: Present, sparse (Fig. 4A). Crystals: Druses of calcium oxalate crystals and prismatic crystals occasionally present.

H. physaloides **Guill and Perr. (Fig. 5).**

Epidermal cells polygonal to irregular with slightly wavy anticlinal walls on the adaxial surface, irregular with wavy to undulating anticlinal walls on the abaxial surface (Figs. 5A and B). Stomata: Amphistomatic, anisocytic but occasionally anomocytic; guard cell area - adaxial 196.4 - 280.4 μm^2, abaxial 288.1 - 368.2 μm^2; stomatal frequency - adaxial 16.7 - 33.3 mm^{-2}, abaxial 108.3 - 141.6 mm^{-2}; Stomatal index - adaxial 4.8 - 10.3%, abaxial 15.1 - 19.5%. Trichomes: Stalked and uniseriate columnar glandular types (Figs. 5F, G and K), simple unicellular and stellate non glandular types present (Figs. 5H - J). Trichome base: circular to polygonal (Figs. 5C- E). Cuticular striations: Absent on both surfaces. Mucilaginous cells: Frequent (Fig. 5A). Crystals: Druses of calcium oxalate crystals and prismatic crystals present.

H. surattensis **Linn. (Fig. 6).**

Epidermal cells polygonal with straight anticlinal walls on the adaxial surface (Fig. 6A), polygonal with anticlinal wall straight to slightly wavy on the abaxial surface (Fig. 6B). Stomata: Amphistomatic, anisocytic occasionally anomocytic; guard cell area - adaxial 216.8 - 320.1 μm^2, abaxial 220.9 - 324.1 μm^2; stomatal frequency - adaxial 8.7 - 24.8 mm^{-2}, abaxial 83.3 - 149.8 mm^{-2}; stomatal index adaxial 2.3 - 7.2 %, abaxial 18.2 - 30.0%. Trichomes: Non-glandular types majorly simple unicellular type (Fig. 6D) and stalked glandular trichomes (Figs. 6E and F) present on both surfaces. Trichome base: Often oval (Fig. 6). Cuticular striations: Absent on both surfaces. Mucilaginous cells: Sparse (Figs. 6A and B). Crystals: Druses of calcium oxalate and prismatic crystals present.

H. acetosella **Welw. (Fig. 7).**

Epidermal cells polygonal to irregular with slightly wavy anticlinal walls on the adaxial surface (Fig. 7 A), irregular with anticlinal wall wavy on the abaxial surface (Fig. 7B). Stomata: Amphistomatic, anisocytic occasionally anomocytic; guard cell area - adaxial 501.9 - 675.8 μm^2, abaxial, 412.3 - 638.2 μm^2; stomatal frequency - adaxial 17.7 - 49.4 mm^{-2}, abaxial 50.1 - 99.6 mm^{-2}; stomatal index adaxial 7.7 - 21.4%, abaxial 15.8 - 30.6%. Trichomes: Non-glandular trichomes absent, stalked glandular trichomes present (Figs. 7E - H) on both surfaces. Trichomes base: Often circular to oval (Figs. 7C and D). Cuticular striations: Present on both surfaces. Mucilaginous cells: Frequent (Fig. 7B). Crystals: Druses of calcium oxalate crystals and prismatic crystals present.

H. scotellii **Baf. F. (Fig. 8).**

Epidermal cells polygonal with straight anticlinal walls on the adaxial surface (Fig. 8A), polygonal to irregular with anticlinal wall straight to slightly wavy on

area, length of panicle, above ground plant height, dry matter yields of panicle, culm, leafy portion and above ground plant.

Table 5 shows the correlation matrix for the forage yield parameters. Number of tillers per plant stand correlates highly positively with dry matter yield of culm, leafy portion and above ground plant. Higher positive correlations occur within lengths or heights of culm, leafy portion and above ground plant and also within dry matter yields of panicle, leafy portion, culm and above ground plant. The high positive correlations between number of tillers or culms per plant stand and dry matter yields of culm, leafy portion and above ground plant suggest that these parameters which are number of tillers and dry matter yield factors form the character complex involved in the determination of forage yield. These two factors were also indicated in the simple statistics. The parameters that depart from the general trends of correlation are number of leaves/tiller, leaf area and above ground plant height.

Table 6 shows a summary of the complete linkage cluster analysis of the accessions used for forage studies. There are 19 clusters on the whole and clusters are joined as shown on the table. Figure 1 shows the spatial relationship among the accessions. This is based on the 11 forage yield attributes used in the study (Table 2). From the cluster analysis, it is obvious that some accessions are more closely related than others based on the forage yield parameters. The distinct basic clusters are accessions 1, 16, 23, 7; accessions 6, 26, 14, 30, 15; accessions 5, 11, 32; accessions 18, 31, 24, 25 and accessions 12, 33, 34, 35. There are smaller clusters indicating closer relationship (Figure 1). It is also noteworthy that no groupings or associations or relationships occurred based on areas of collection.

Nutritive Value (Chemical Analysis).

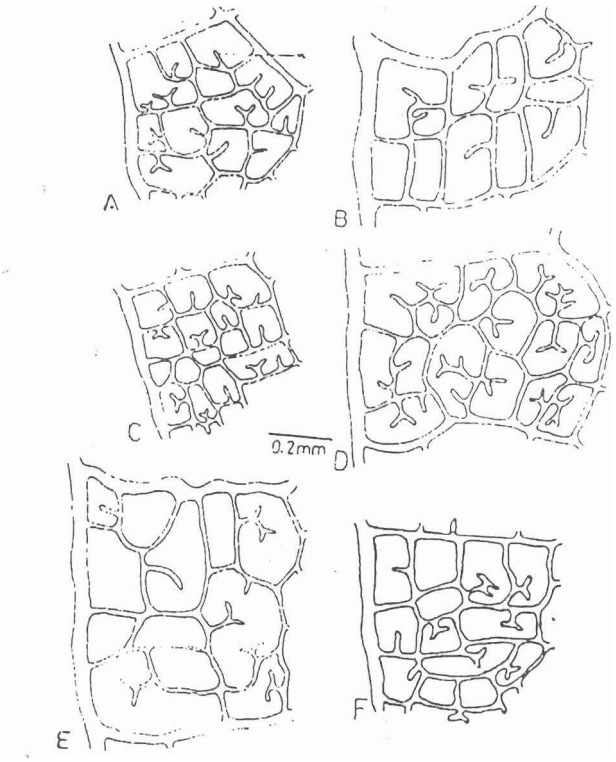
Acid Detergent Fibre (ADF) concentration is lowest (35.80%) in accession 23 and highest (53.07%) in accession 1 (Table 7). Acid Detergent Lignin (ADL) concentration is lowest (1.17%) in accession 24 and highest (5.86%) in accession 14. Crude protein has the highest concentration (14.96%) in accession 26 and lowest 11.03% in accession 7. ADF concentrations are generally the highest, followed by Crude Protein and ADL in all the accessions studied. No accession can be said to be consistently high or low in concentration for any parameter.

Potassium concentration range from 2.25% in accessions 25 and 33 to 3.70% in accession 26 (Table 8). This is followed by Nitrogen which range from 1.764 2.394% with the lowest concentration occurring in accession 7 and the highest in accession 26. Nitrogen concentration is followed by Calcium concentration with the lowest value (0.074%) occurring in accession 33 and the highest (0.34%) occurring in accession 16. This is followed by Sodium concentration which ranged from 0.01 0.15% with the lowest concentration in accession 1 and highest in accessions 5 and 18 (Table 8). Next is Magnesium with concentration from 0.003 0.015%, the least concentration occurring in accessions 14, 31 and 33 and highest in accession 16. Lastly, Phosphorus concentration ranges from 0.002 0.013%, lowest in accession 11 closer relationship (Figure 1). It is also noteworthy that no groupings or associations or relationships occurred based on areas of collection.

Fig. 2 Venation system of the species of *Hibiscus*

A. *H. vitifolius* var. *vitifolius*
B. *H. tiliaceus*
C. *H. physaloides*
D. *H. surattensis*
E. *H. acetosella*
F. *H. scotellii*
G. *H. lunarifolius*
H. *H. rostellatus*
I. *H. sterculiifolius*
J. *H. sabdariffa.*

VL = Veinlet ending


A
B
C
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D
E
F

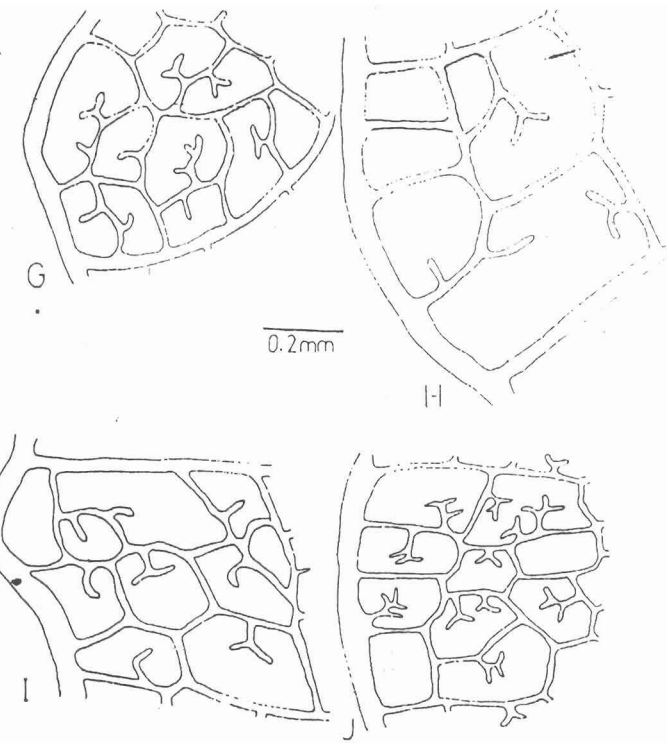
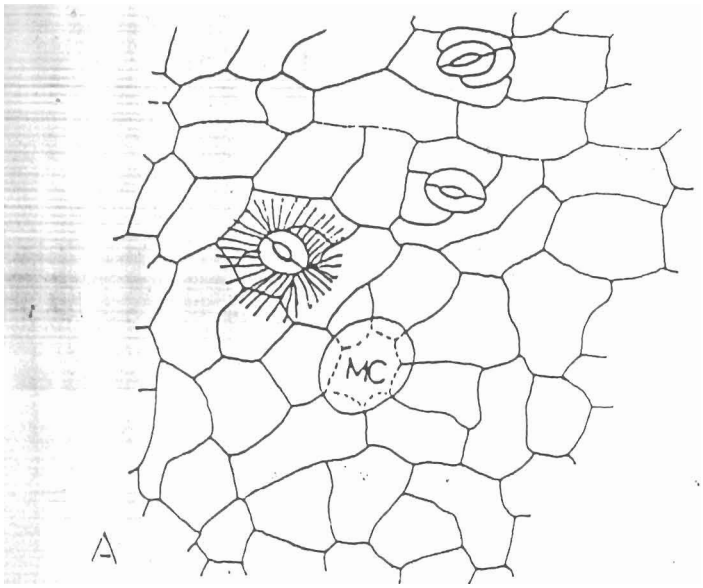
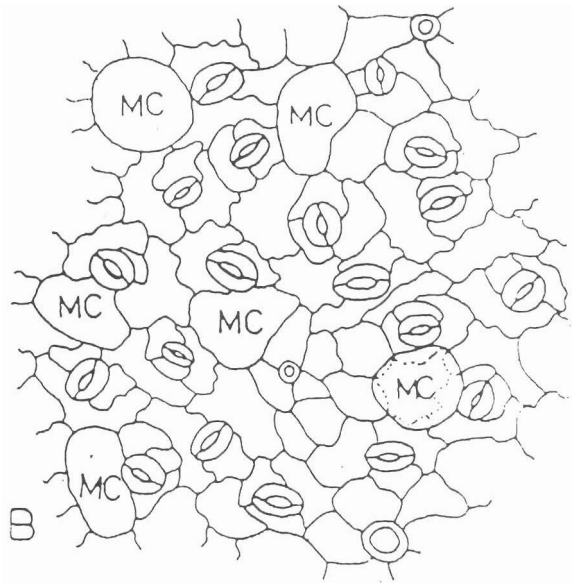
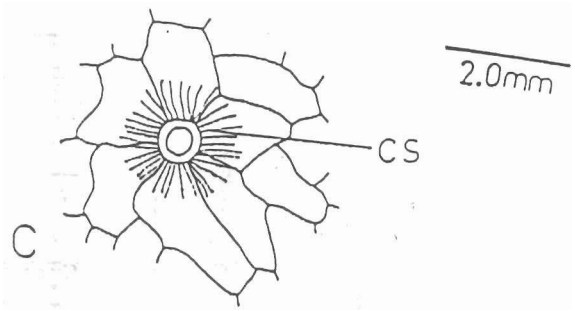

G
0.2mm
H
I
J

Fig. 3: Lamina in surface view: *H. vitifolius* var. *vitifolius*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C. Trichome base
D - I Trichome types:
D, E. Stalked glandular
F - I. Non-glandular.
MC. Mucilaginous cell
CS. Cuticular striation


MC
A


MC
MC
MC
MC
MC
MC
B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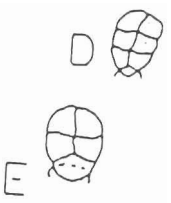
CS
C


D
E

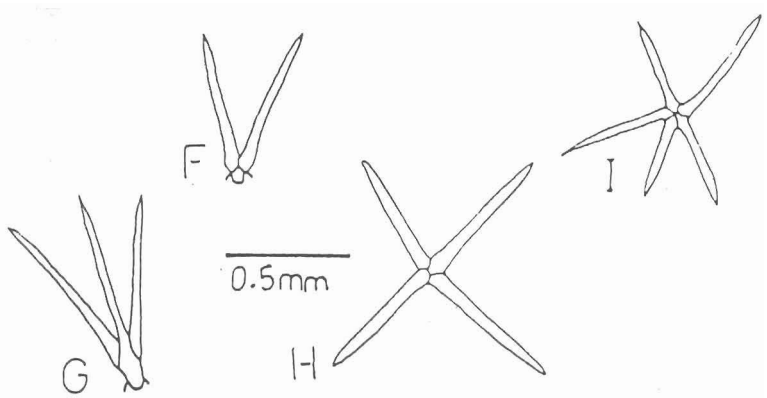
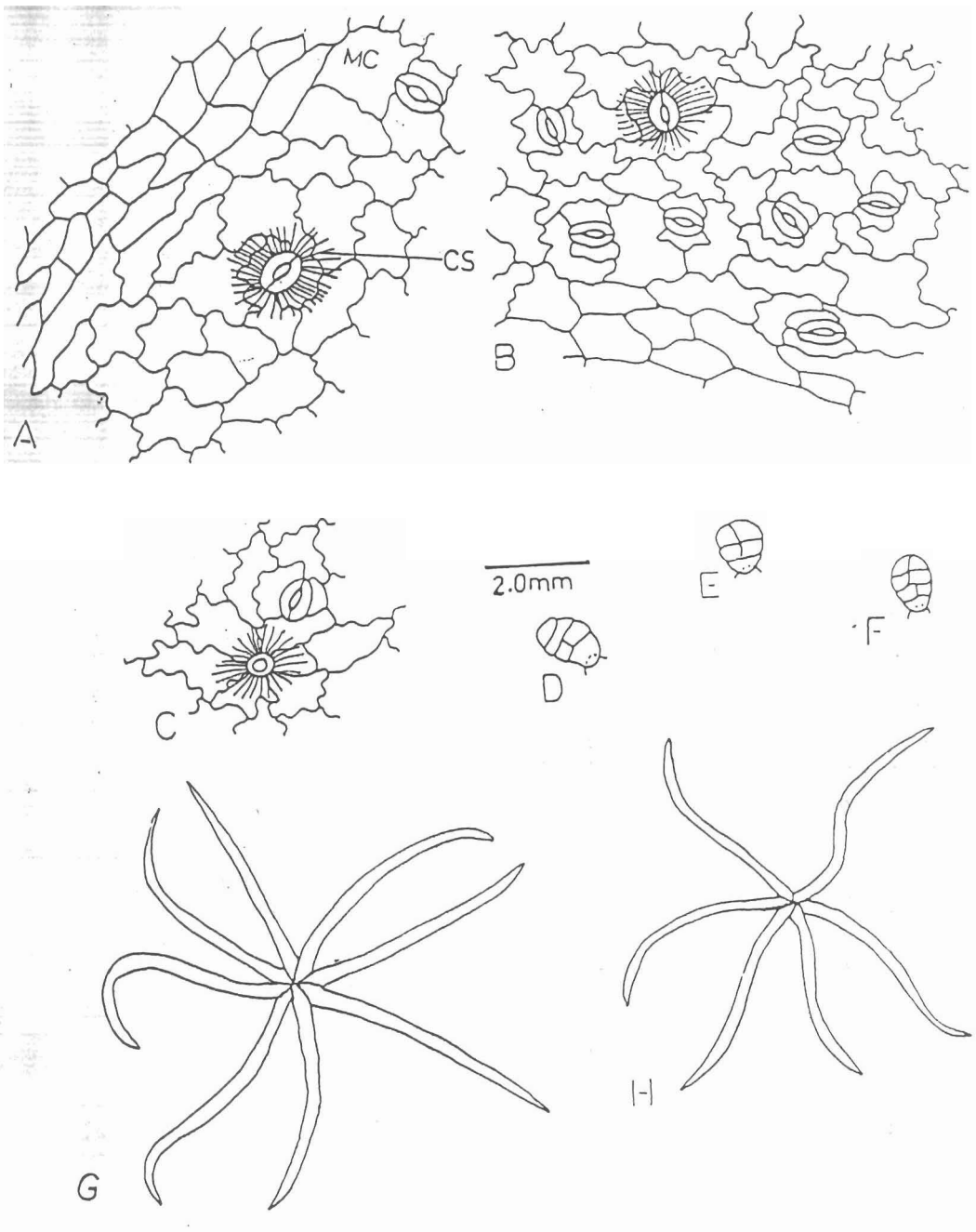

F
I
0.5mm
G
H

Fig. 4: Lamina in surface view: *H. tiliaceus*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C. Trichome base
D - H. Trichome types:
D - F: Stalked glandular
G, H: Non- glandular.

MC: Mucilaginous cell.

CS: Cuticular striation.


MC
CS
A
B
C
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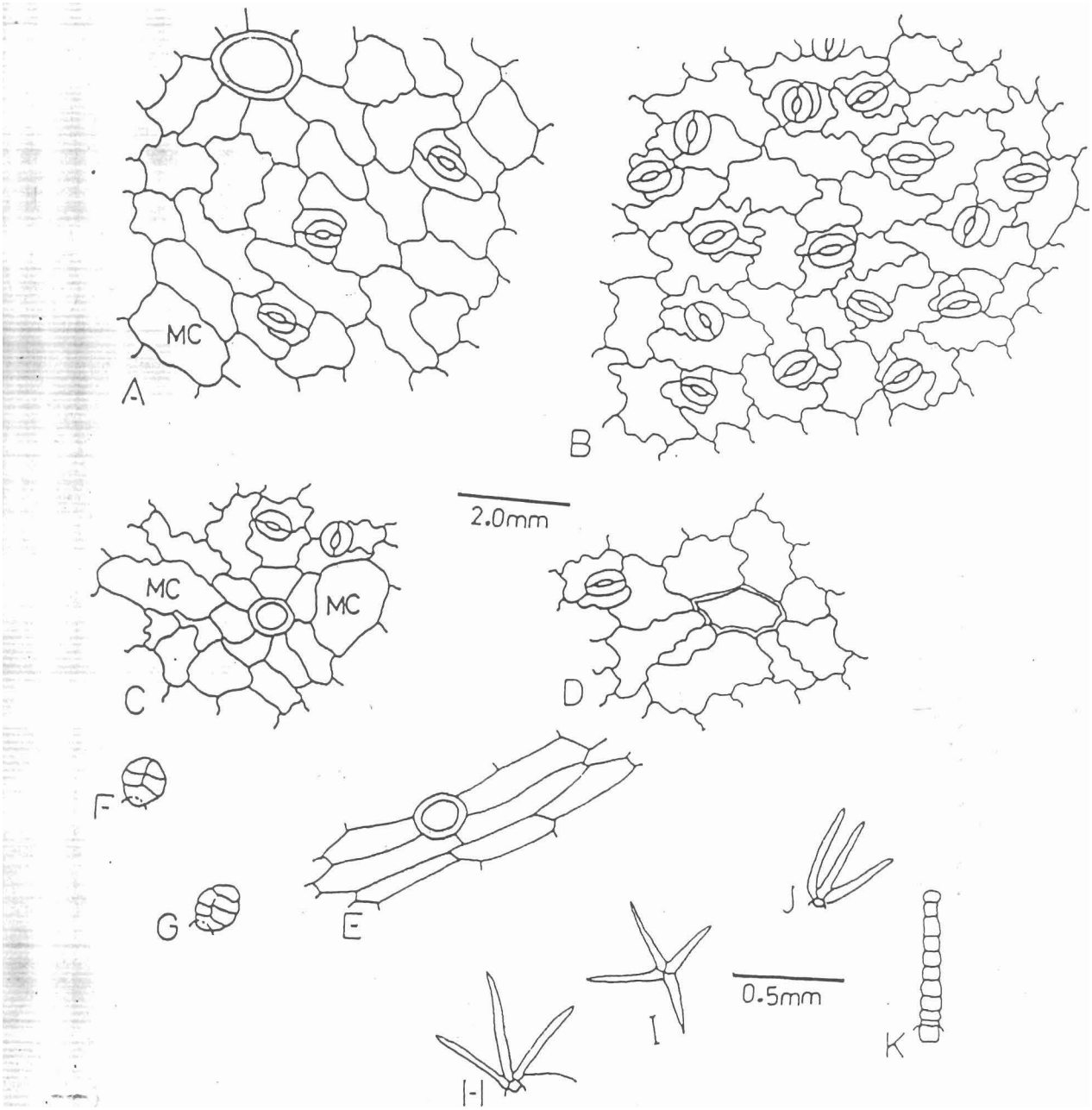
D
E
F
G
H

Fig. 5: Lamina in surface view: *H. physaloides*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C - E. Trichome bases
F - K Trichome types:
F, G. Stalked glandular
K. Glandular; uniseriate columna
H - J. Non-glandular
MC. Mucilaginous cell


MC
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B
2.0mm
MC
MC
C
D
F
E
G
J
0.5mm
I
K
H

Fig. 6: Lamina in surface view: *H. surattensis*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C. Trichome base
D - F Trichome types:
D. Non-glandular
E, F. Stalked glandular
MC Mucilaginous cell.

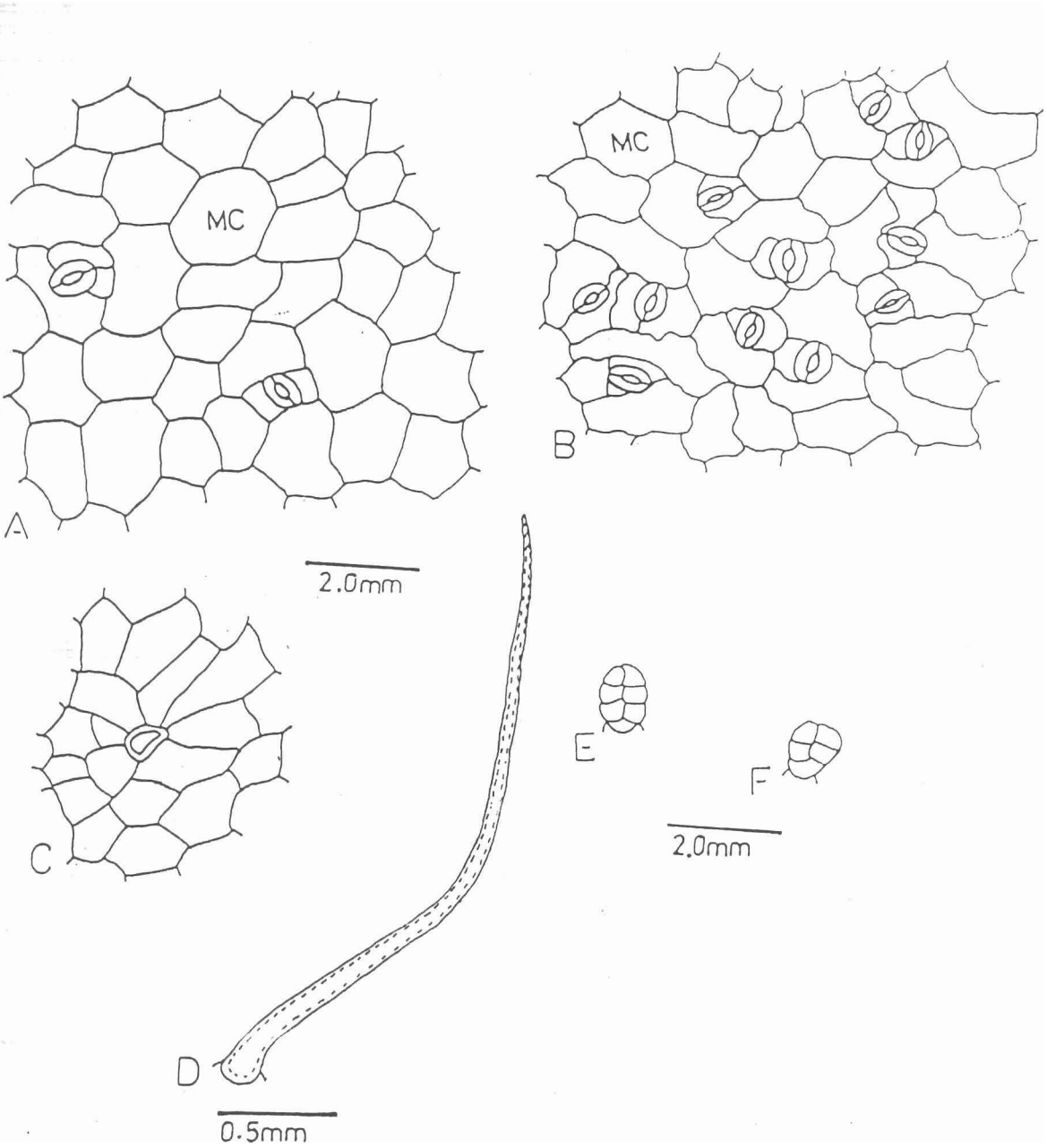
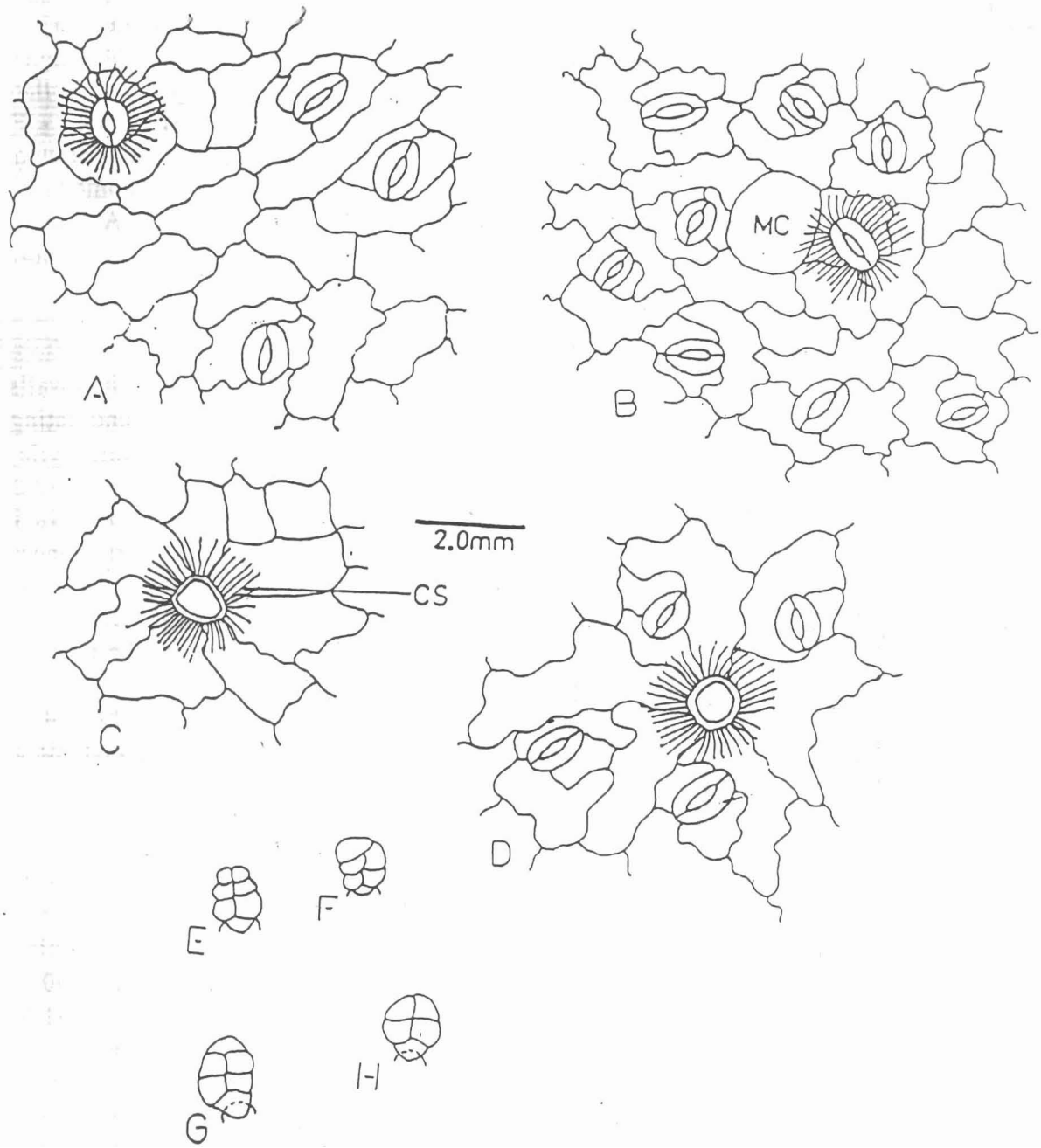

MC
A
MC
B
2.0mm
C
D
0.5mm
E
F
2.0mm

Fig. 7: Lamina in surface view: *H. acetosella*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C, D. Trichome bases
E - H. Stalked glandular trichomes
MC. Mucilaginous cell
CS. Cuticular striation.


A
MC
B
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CS
C
D
E
F
G
H

the abaxial surface (Fig. 8B). Stomata: Amphistomatic, anisocytic, occasionally anomocytic; guard cell area - adaxial 378.1 - 530.2 μm^2, abaxial 343.6 - 432.1 μm^2; stomatal frequency - adaxial 33.3 - 66.6 mm^{-2}, abaxial 83.3 -124.9 mm^{-2}; stomatal index - adaxial 13.3 - 23.5%, abaxial 18.5 - 30.8%. Trichomes: Stellate non glandular types (Figs. 8G - M) and stalked glandular types (Figs. 8D - F) present on both surfaces. Trichome base: Often circular (Fig. 8C). Cuticular striations: Present on both surfaces radiating from some stomata and trichome bases (Figs. 8A - C) Mucilaginous cells: Present, sparsely distributed (Figs. 8A and B). Crystals: Druses of calcium oxalate crystals and prismatic crystals present on both surfaces.

H. lunarifolius **Willd. (Fig. 9).**

Epidermal cells polygonal to occasionally irregular with wavy anticlinal walls on the adaxial surface (Fig. 9A), irregular with anticlinal wall wavy to undulating on the abaxial surface (Fig. 9B). Stomata: Amphistomatic, often anisocytic, occasionally anomocytic; guard cell area - adaxial 373.9 - 560.8 μm^2, abaxial 332.2 - 530.2 μm^2; stomatal frequency - adaxial 41.6 - 75.1 mm^{-2}, abaxial 91.6 - 158.3 mm^{-2}; stomatal index - adaxial 11.9 - 18.2%, abaxial 17.5 - 31.6%. Trichomes: Non-glandular majorly simple unicellular type, occasionally stellate (Figs. 9H - J), glandular mainly the stalked type on both surfaces (Figs. 9E - G). Trichome base circular to polygonal (Figs. 9C and D). Cuticular striations: Present on the adaxial surface, absent on the abaxial surface (Figs. 9A - D). Mucilaginous cells: Present on both surfaces as large irregular cells in between the epidermal cells (Fig. 9B). Crystals: Druses of calcium oxalate crystals and occasionally prismatic crystals present on both surfaces.

H. rostellatus **Guill. and Perr. (Fig. 10).**

Epidermal cells polygonal with straight anticlinal walls on the adaxial surface (Fig. 10A), irregular to occasionally polygonal with anticlinal wall wavy to slightly undulating on the abaxial surface (Fig. 10B). Stomata: Amphistomatic, anisocytic, occasionally anomocytic; guard cell area - adaxial 324.8 - 501.9 μm^2, abaxial460.1 530.2 μm^2; stomatal frequency - adaxial 16.7 - 25.1 mm^{-2}, abaxial 91.6 - 141.6 mm^{-2}; stomatal index - adaxial 5.1 - 9.7%, abaxial 21.2 - 32.7%. Trichomes: Non-glandular majorly simple unicellular occasionally stellate (Figs. 10E - G), glandular mainly the stalked type (Fig. 10D), on both surfaces. Trichome base: Often oval. Cuticular striations: Present on the adaxial, absent on the abaxial (Figs. 10 A and C). Mucilaginous cells: Present on both surfaces, sparse in distribution. Crystals: Druses of calcium oxalate crystals abundant in circular canals in between epidermal cells, prismatic crystals sparsely distributed.

Fig. 8: Lamina in surface view: *H. scotellii*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C. Trichome base
D-M. Trichome types:
D - F. Stalked glandular
G - M. Non-glandular.
MC. Mucilaginous cell
CS. Cuticular striation.

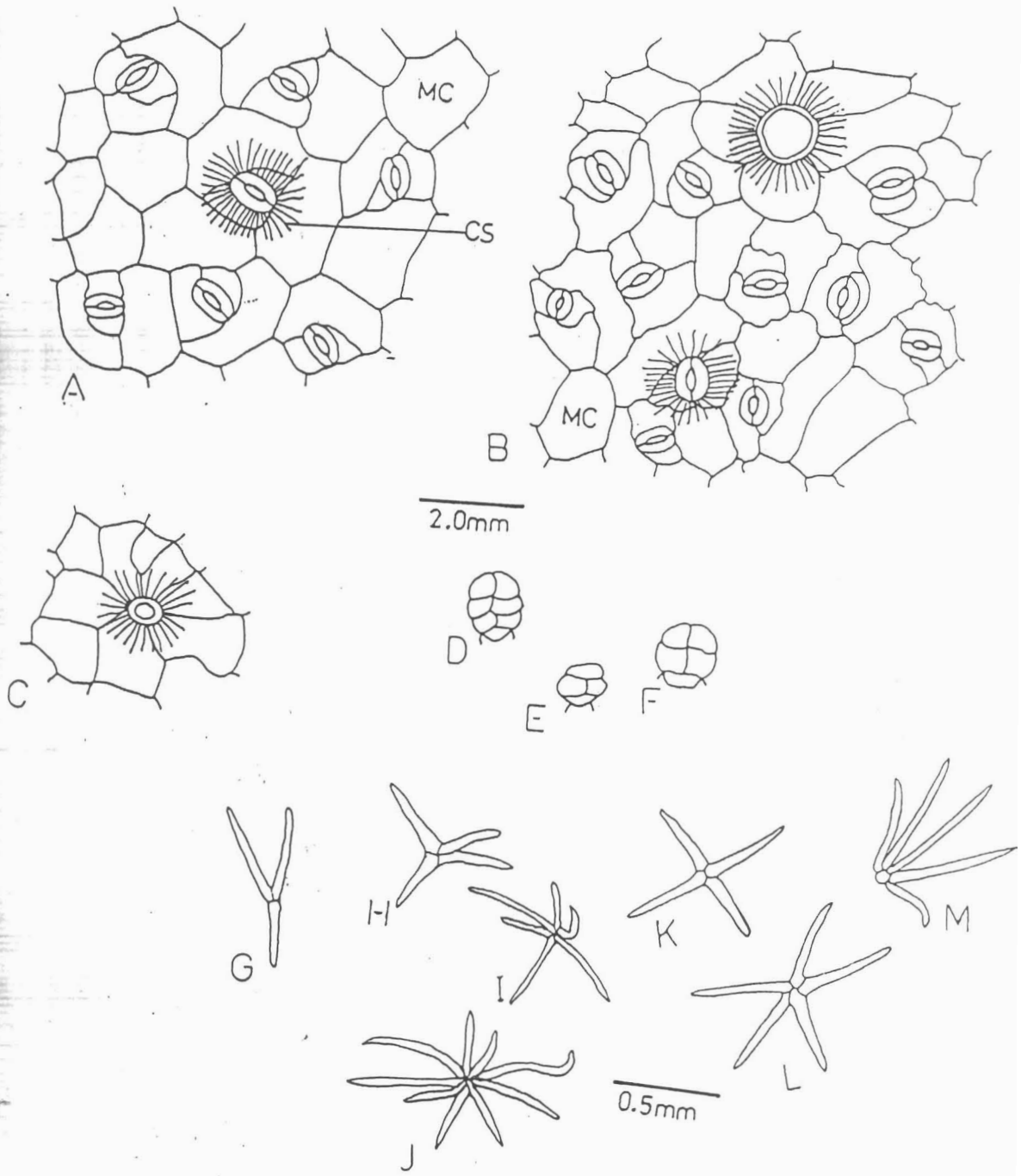
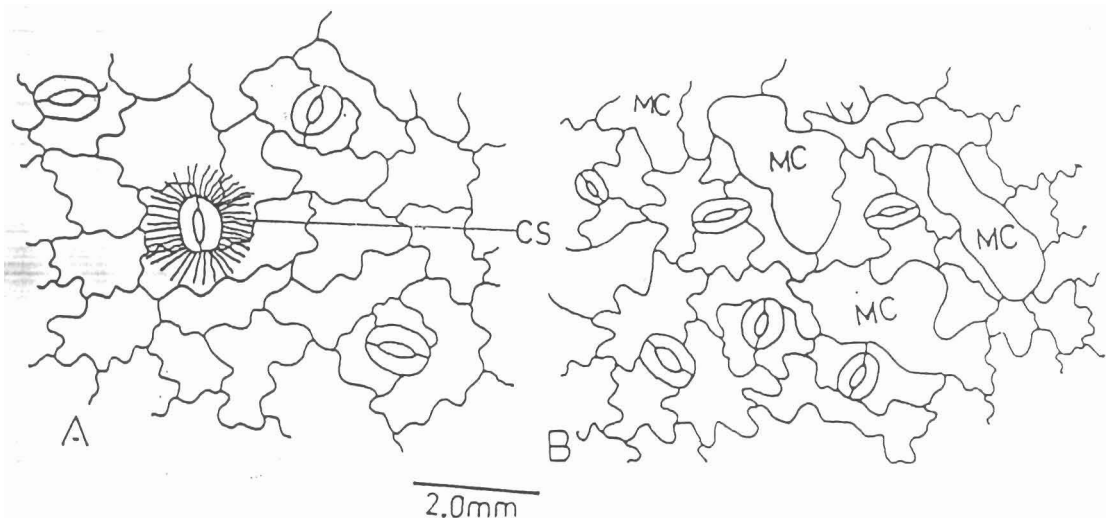

MC
CS
A
B
MC
2.0mm
C
D
E
F
G
H
I
J
K
L
M
0.5mm

Fig. 9: Lamina in surface view: *H. lunarifolius*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C, D. Trichome bases
E - J. Trichome types:
    E - G. Stalked glandular
    H - J. Non-glandular
MC. Mucilaginous cell
CS. Cuticular striation.


MC
MC
MC
MC
CS
A
B
2.0mm

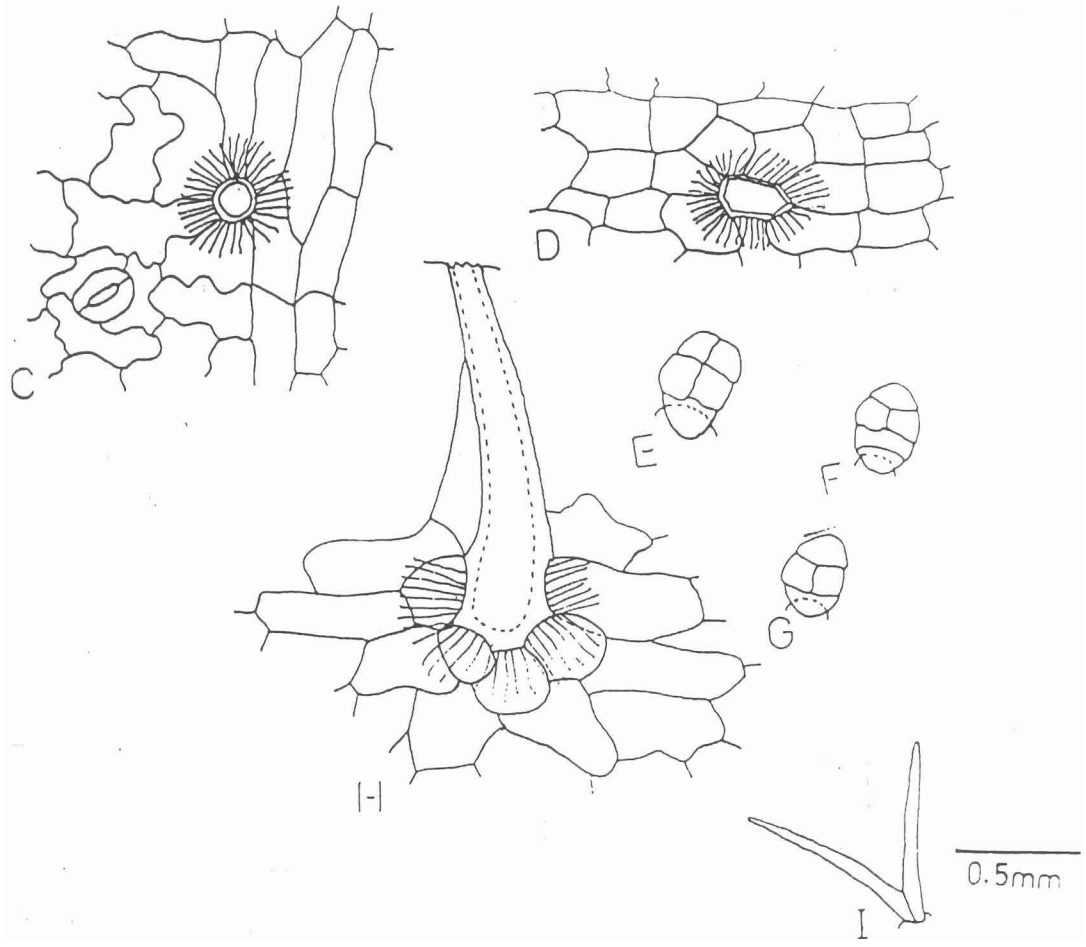
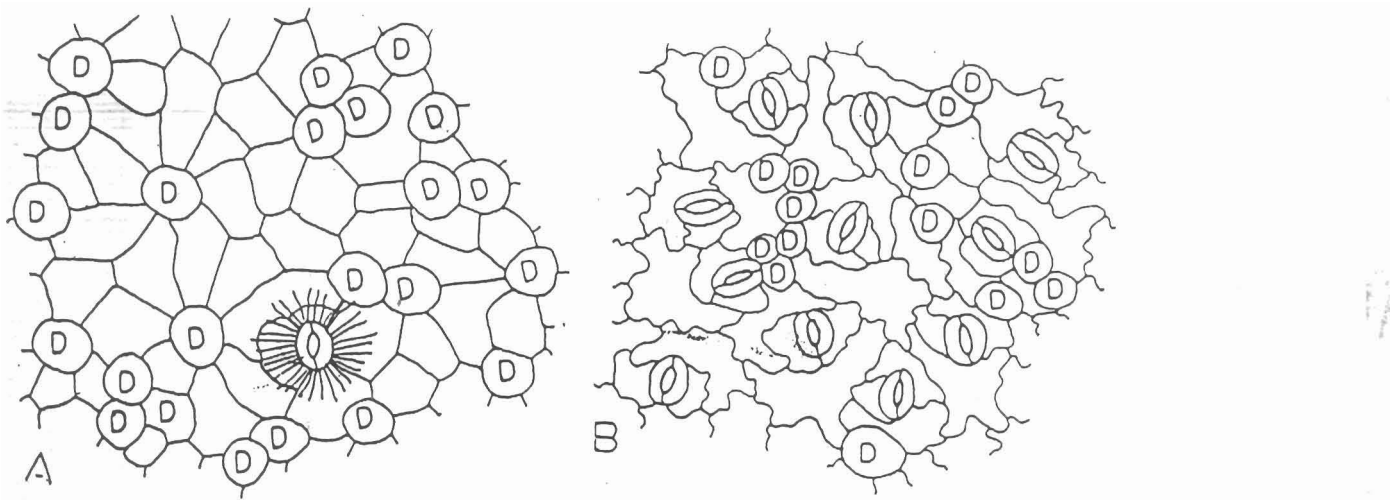

C
D
E
F
G
H
I
0.5mm

Fig. 10: Lamina in surface view: *H. rostellatus*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C. Trichome base
D-G. Trichome types:
D. Stalked glandular
E - G. Non - glandular
CS Cuticular striations
D. Druses.


A
B

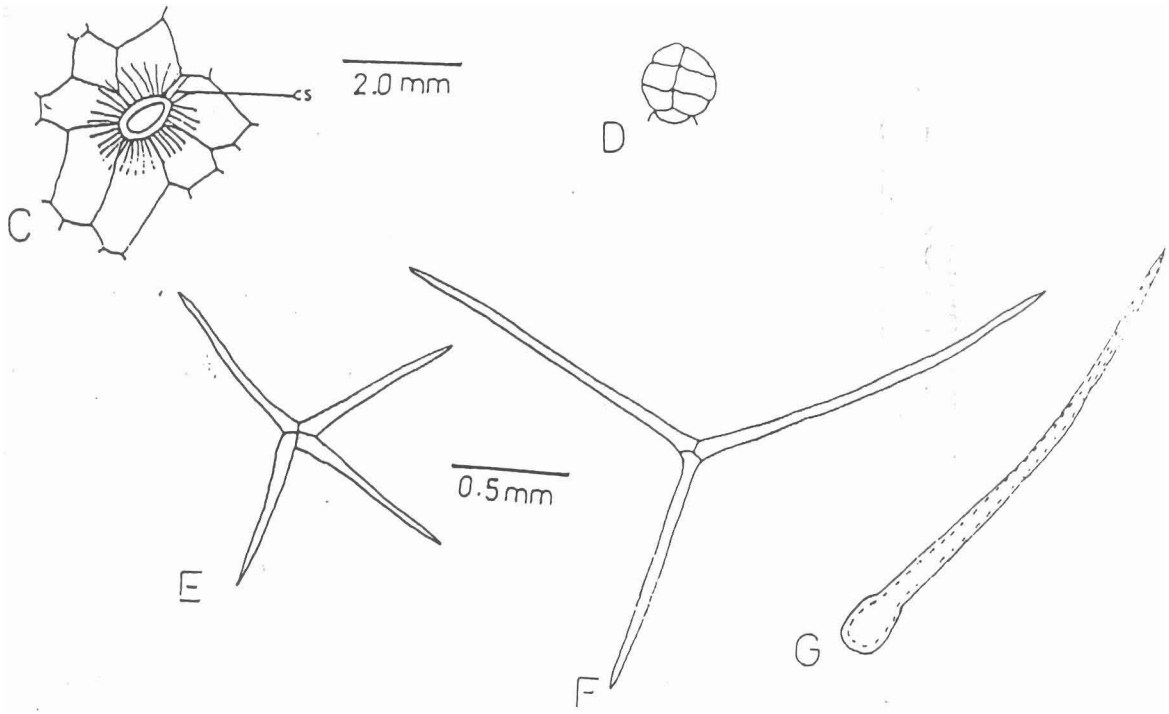
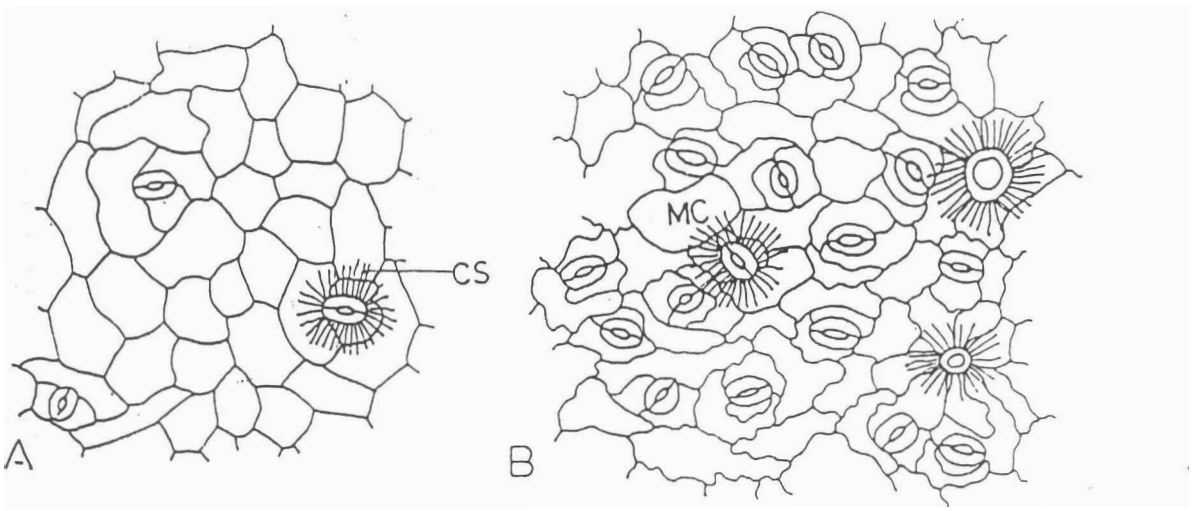
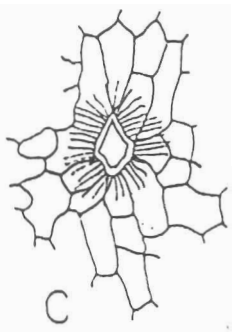
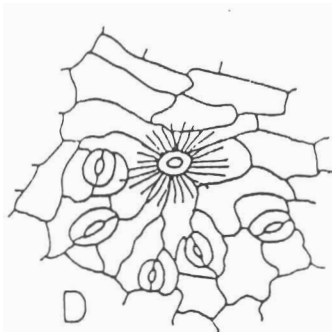

cs
2.0 mm
C
D
0.5 mm
E
F
G

Fig. 11: Lamina in surface view: *H. sterculiifolius*

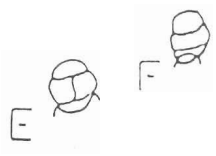
A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C, D. Trichome bases.
E - I. Trichome types:
E, F. Stalked glandular
G - I. Non-glandular
MC. Mucilaginous cell
CS. Cuticular striation.

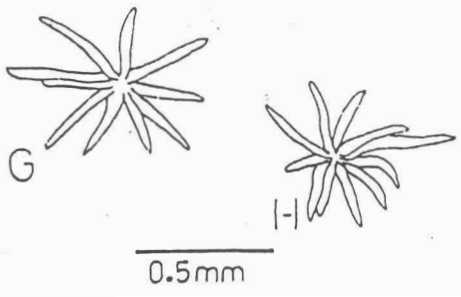






2.0mm





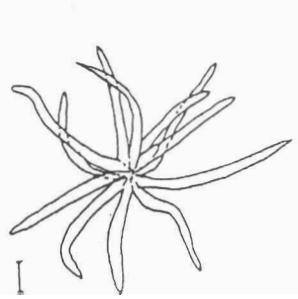
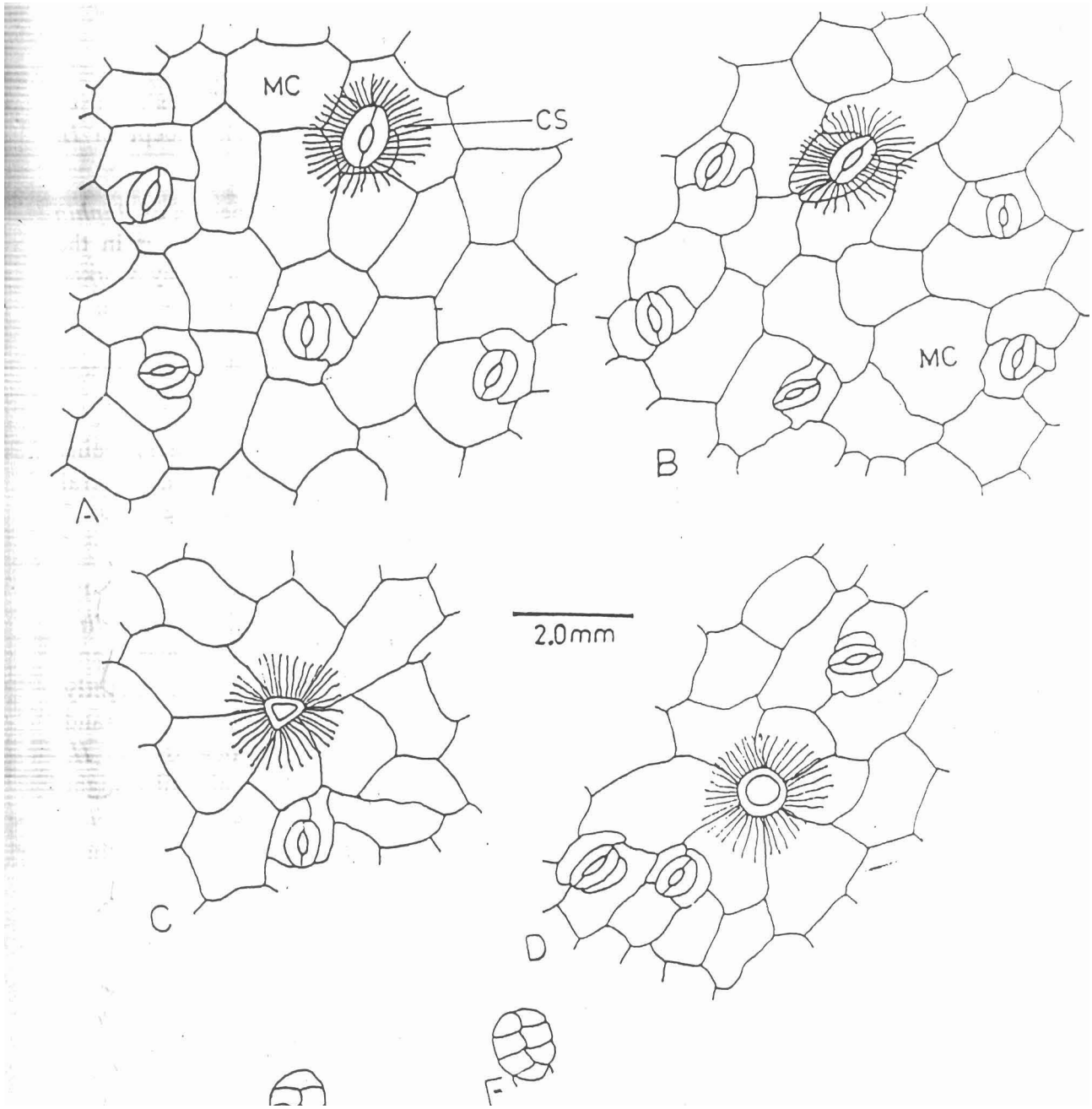


Fig. 12 : Lamina in surface view: *H. sabdariffa*

A. Adaxial epidermis of lamina
B. Abaxial epidermis of lamina
C, D. Trichomes bases
E, F. Stalked glandular trichomes.
MC. Mucilaginous cell
CS. Cuticular striation.


MC
CS
A
MC
B
2.0mm
C
D
F
E

in the median region. In the distal region of the petiole, the xylem forms a closed ring surrounded by phloem in all the species (amphicribal type), except in *H. rostellatus* where it is not completely closed.

Soladoye (1982) and Bakare (1991) in their works on the species of *Baphia* and *Sida* respectively used the presence or absence of medullary bundles in the pith of the distal end of the petiole to delimit some of the species they worked on. In the present study, the presence or absence of medullary bundles can be used to delimit some species from the others. These bundles are present in *H. tiliaceus, H. scotellii, H. rostellatus* and *H. acetosella* while they are absent in the other species.

The venation is palmate in all the species studied. The primary veins generally radiate from a single point at the base. Ramification of the lateral actinodromous vein is generally perfect reticulate. Number of veinlet endings 0 - 5.

On the adaxial surface, the epidermal cell is generally polygonal occasionally irregular in all the species while the anticlinal walls are straight in *H. vitifolius* var. *vitifolius, H. scotel/ii, H. rostellatus, H. sterculiifolius, H. sabdariffa* and *H. surattensis;* wavy in *H. tiliaceus, H. acetosella* and *H. lunarifolius,* slightly wavy in *H. physaloides.* On the abaxial surface, epidermal cell is irregular and anticlinal wall wavy to undulating in *H. physaloides, H. acetosella, H. lunarifolius,* while epidermal cell is polygonal to irregular and anticlinal wall straight to wavy in *H. vitifolius var. vitifolius, H.* s *urattens is, H. tiliaceus, H. scotellii, H. rostellatus, and H. sterculiifolius.* Epidermal cell is polygonal and anticlinal wall straight in *H. sabdariffa.*

From the result of this work, presence or absence of cuticular striations can be used for both classification and delimitation in the genus *Hibiscus.* They are found occurring on the epidermal cells of some species. They radiate from the guard cells of the stomata and from trichome bases. This attribute is presented on both the adaxial and abaxial epidermal surfaces of *H. tiliaceus, H. acetosella, H. scotellii, H. sterculiifolius* and *H. sabdariffa.* The striations are present on the adaxial surface but absent on the abaxial surfaces of *H. vitifolius* var. *vitifolius, H. lunarifolius,* and *H. rostellatus. H. surattensis* and *H. physaloides* are characteristically distinct in not having cuticular striations on both epidermal surfaces.

The leaves are amphistomatic but generally, the stomata are more numerous on the abaxial surface than on the adaxial surface. Guard cell area, although quantitative, is of taxonomic interest. On the adaxial surface, *H. acetosella* has the highest values while *H. physaloides* has the least. On the abaxial surface,

H. acetosella also has the highest value while *H. sterculiifolius* has the least. Thus, based on quantitative values the taxa can be separated as different species.

Whilst stomatal frequency varies considerably with the age of the leaf, stomatal index is highly constant for any given species. Thus on the adaxial epidermal surface, stomatal index is low in *H. sterculiifolius, H. tiliaceus, H. surattensis, H. physaloides, H. rostellatus,* and comparatively high in *H. sabdariffa, H. scotellii, H. lunarifolius, H. acetosella* and *H. vitifolius* var. *vitifolius*. On the abaxial surface, it is considerably high in all the species except in *H. tiliaceus*. Stomatal index can therefore be used for both classification and delimitation purpose in the taxa. In this study, *H tiliaceus* a tree species can be delimited from the other species in having low stomatal index on both the adaxial and abaxial epidermal surfaces.

Mucilaginous cells are generally found occurring among the epidermal cells of both the adaxial and abaxial surfaces as distinct cells. They are usually larger than the epidermal cells. Trichomes are found in all the species of *Hibiscus* studied. The difference observed in the types, arms, occurrence and pattern of distribution of the trichomes could be used to separate the species. The trichome types observed are the stalked glandular and the non-glandular types. With the exception of *H. acetosella* and *H. sabdariffa* with only the stalked glandular trichomes, both types are found occurring in all the other species. The non-glandular trichomes are of two types, the simple and the branched (stellate).

On both the adaxial and abaxial epidermal surfaces, the non-glandular simple unicellular trichome type is found occurring as the main type in *H. surattensis, H. lunarifolius* and *H. rostellatus*. Stellate types from triradiate to multiradiate are found predominantly occurring in *H. tiliaceus, H. physaloides, H. scotellii* and *H. sterculiifolius*. In *H. vitifolius* var. *vitifolius* both simple unicellular and stellate types occur in almost equal proportions. Areas of distribution are in both venous and non venous regions. Generally for both glandular and non-glandular trichome types the density is more on the abaxial surfaces than on the adaxial surfaces. The trichome base shapes occurring often in each species are recorded ranging from circular to oval to polygonal with no strict shape belonging to a species, hence this character is not of taxonomic value. Crystals which are druses of calcium oxalate are commonly encountered in the genus but are quite diagnostic in the leaf epidermal surfaces of *H. rostellatus* where they occur in distinct canals, often in clusters and interfering much with the epidermal cells.

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