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Foliar Epidermal Studies In Some Acanthaceae

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Abstract:

Foliar epidermal features amongst 20 acanthaceous species belonging 13 genera have been studied. Diacytic type of stomata is usually observed except few other types e.g., pericytic, anisocytic, co-pericytic, amphipericytic, polocytic and amphi-diacytic occassionaly on the same foliar surfaces. Stomatal index and frequency, types of subsidiaries, stomatal abnormalities, cell inclusions and other epidermal traits have been studied in detail. Their possible taxonomic significance is highlighted in the species investigated.

Key Words: Foliar epidermis, Stomata, Acanthaceae.

Introduction:

The family Acanthaceae is documented for anatomy of foliar epidermis especially by Solereder (1908) and Metcalfe and Chalk (1950). Of late, Indian workers studied occurrence, structure, development and taxonomic significance of foliar epidermal features of the family (Pant and Mehra, 1963; Paliwal, 1966; Kumar and Paliwal, 1975, 1978, 1982; Inamdar, 1970, 1983; Ahmad, 1973, 1974, 1975, 1976, 1979; Selvaraj and Subramanian, 1983; Varma and Murty, 1989). The present authors extended observations on hitherto unstudied 13 genera and 20 species of Acanthaceae, the results of which are being presented in this communication.

Materials and Methods:

Plant materials were obtained from T.B.G.R.I., Palode, Tiruvantapuram District (Kerala), Government Botanical Garden, Ooty (Tamilnadu), Lal Bag Garden, Bangalore (Karnataka). The chemical method was followed for the separation of peels (1974). Diluted nitric acid and chromic acid (5-10%) were used in different proportions. The peels were stained in 1% safranin and semiparmanant slides were prepared in 50% glycerine. They are sealed with nail paint / D.P.X. The stomatal index (SI) was decided as defined by Salisbury (1932). Stomatal frequency was calculated as by Ghosh and Davis (1973). The cellular sketches were drawn using prisamatic camera lucida. The terms describing stomata are those of Metcalfe and Chalk (1950), Van-Cotthem (1970), Stace (1965, 1989) and Dilcher (1974). The typification of subsidiary cells is after Ramaya and Rajagopal (1980). The stomatal indices and frequencies of each taxon are presented in Table-I.

Abbreviations used:

FC - Foot Cells of Trichomes, **Ct** - Cystolith; **S.I** - Stomatal Index; **S**.F. - Stomatal Frequency.

Observations:

1. ***Acanthus spinosus*** L.: Leaves hypostomatic.

Adaxial: Epidermal cells chlorophyllous, sides 4-7, undulate sinuses U-shaped. Foot cells of trichomes present. (Fig.1a).

Leaf Abaxial : Stomata diacytic, Leaf superficial, orientation random, distribution diffuse. S.I. 13.7, S.F.97.5. Subsidiaries 2, sides 3-8, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses U-shaped (Fig.1b).

2. ***Adhatoda beddomei*** C.B.CL.: Leaves amphistomatic.

Leaf Adaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.4.54, S.F.13.3. Subsidiaries 2, sides 4-8, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig.2a).

Leaf Abaxial : Stomata mostly diacytic, rarely anisocytic, superficial, orientation random, distribution diffuse. S.I.16.12, S.F.110. Subsidiaries 2-5, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-9, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig.2b).

3. ***Andrographis elongata*** (Vahl) Nees: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.3a).

Leaf Abaxial : Stomata mostly diacytic, rarely polocytic, superficial, orientation random, distribution diffuse. S.I.17.39, S.F.82. Subsidiaries 2, sides 5-6, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig.3b).

4. ***Andrographis macrobotrys*** Nees**:** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 4a).

Leaf Abaxial : Stomata mostly diacytic, rarely pericytic, superficial, orientation random, distribution diffuse. S.I.21.73, S.F.100. Subsidiaries 1-2, sides 3-7, mostly F-type, rarely C- type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-10, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.4b).

5. ***Andrographis stellulata C.*** B. Clarke: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 5-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 5a).

Leaf Abaxial : Stomata mostly diacytic, rarely anisocytic, pericytic, superficial, orientation random, distribution diffuse. S.I.18.6, S.F.260. Subsidiaries 2-4, rarely 4, sides3-5, mostly F-type, rarely C- type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-9, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.5b).

6. ***Beloperone nemorosa*** Nees: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-9, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 6a).

Leaf Abaxial : Stomata mostly diacytic, rarely amphidiacytic, superficial, orientation random, distribution diffuse. S.I.20, S.F.120. Subsidiaries 2, sides 3-8, mostly F-type, rarely, A and C type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.6b).

7. ***Graptophylum pictum*** (L.) Griffith: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 7a).

Leaf Abaxial : Stomata mostly diacytic, rarely pericytic, superficial, orientation random, distribution diffuse. S.I.23.80, S.F.300. Subsidiaries 2, sides 2-8, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig. 7b).

8. *Hypoestes sanguinolenta* Hook**.:** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-8, straight, slightly oblique, usually isodiametric. Foot cells of trichomes present (Fig. 8a).

Leaf Abaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.14.70, S.F.220. Subsidiaries 2, sides 3-5, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 6-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.8b).

9. *Justicia carnea* Edward F. Gilman: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.9a).

Leaf Abaxial : Stomata diacytic, rarely polocytic, superficial, orientation random, distribution diffuse. S.I.16.12, S.F.106.66. Subsidiaries 2, sides 3-5, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-8, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig. 9b).

10. *Libonia floribunda* K. Koch: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-7, mostly straight and slightly oblique. Foot cells of trichomes and cystoliths present (Fig.10a).

Leaf Abaxial : Stomata mostly diacytic, rarely amphidiacytic, superficial, orientation random, distribution diffuse. S.I.20, S.F.166.6. Subsidiaries 2, sides 4-9, F-type, walls undulate. Guard cells mostly elliptical, rarely rounded, chlorophyllous. Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.10b).

11. *Neuracanthus sphaerostaschys* (Nees) DC**. :** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 5-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 11a).

Leaf Abaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.21.87, S.F.163.3. Subsidiaries 2, sides 3-6, mostly F-type, rarely A and C-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 6-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 11b).

12. *Nilgirianthes asper* (Wight) Sant.: Leaves amphistomatic.

Leaf Adaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.9.09, S.F.10. Subsidiaries 2, sides 2-5, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses V-shaped. Foot cells of trichomes and cystoliths present (Fig.12a).

Leaf Abaxial : Stomata mostly diacytic, rarely pericytic, superficial, orientation random, distribution diffuse. S.I.21.42, S.F.122. Subsidiaries 2, sides 2-7, mostly C-type, rarely F-type, rarely contagious, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-12, undulate, sinuses V-shaped. Foot cells of trichomes and cystoliths present (Fig.12b & 12c).

13. *Pseuderanthemum reticulatum* Radlkf.: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-7, straight, slightly oblique, mostly penta to hexagonal, usually isodiametric. Cystoliths present (Fig. 13a).

Leaf Abaxial : Stomata mostly diacytic, rarely pericytic, copericytic, amphipericytic, superficial, orientation random, distribution diffuse. S.I.17.64, S.F.145. Subsidiaries 2, sides 2-5, mostly F-type, rarely C-type, walls straight slightly arched, usually isodiametric. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-8, walls straight slightly arched, usually isodiametric. Foot cells of trichomes and cystoliths present (Fig.13b).

14. *Stenosiphonium parviflorum* T. Anders.: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Cystoliths present (Fig.14a).

Leaf Abaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.21.87, S.F.150. Subsidiaries 2, sides 4-5, mostly F-type, rarely A-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-10, undulate, sinuses U-shaped Foot cells of trichomes and cystoliths present (Fig.14b).

15. *Stenosiphonium russellianum* *Nees*: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig.15a).

Leaf Abaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.21.73, S.F.108. Subsidiaries 2, sides 3-5, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-9, undulate, sinuses V-shaped. Foot cells of trichomes and cystoliths present (Fig.15b).

16. *Strobilanthes anamallaica* Wood.: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, sides 5-7, undulate, sinuses V-shaped. Foot cells of trichomes and cystoliths present (Fig. 16a).

Leaf Abaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S.I.17.85, S.F.112.5. Subsidiaries 2, sides 3-6, mostly F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses V-shaped. Foot cells of trichomes and cystoliths present (Fig.16b).

17. *Strobilanthes asperimus* *Nees*: Leaves amphistomatic.

Leaf Adaxial : Stomata mostly diacytic and pericytic, superficial, orientation random, distribution diffuse. S.I.10.52, S.F.30. Subsidiaries 2, sides 2-5, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 17a).

Leaf Abaxial : Stomata mostly pericytic, rarely diacytic, superficial, orientation random, distribution diffuse. S.I.24, S.F.170. Subsidiaries 1-2, sides 2-6, C-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig.17b).

18. *Strobilanthes bonaccordensis Santosh* and Raj: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells chlorophyllous, cells papillate, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 18a).

Leaf Abaxial : Stomata mostly diacytic, rarely pericytic, superficial, orientation random, distribution diffuse. S.I.23.80, S.F.87.5. Subsidiaries 2, sides 2-4, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 18b).

19. *Strobilanthes ciliatus* Nees: Leaves amphistomatic

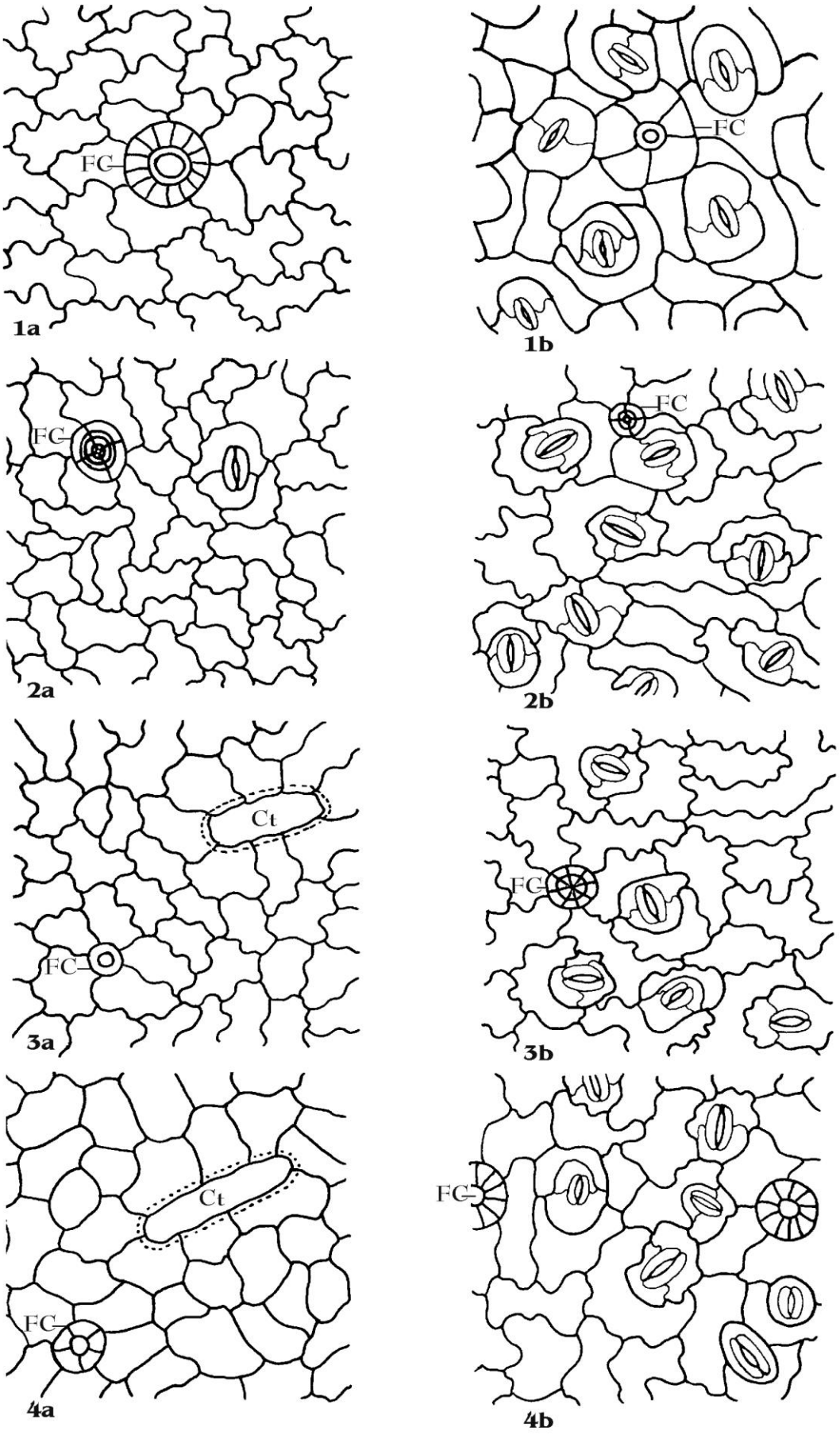
Leaf Adaxial : Stomata diacytic, superficial, orientation random, distributed along midvein. S.I.15, S.F.36.60. Subsidiaries 2, F-type. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 19a & 19b).

Leaf Abaxial : Stomata diacytic, superficial, orientation random, distribution diffuse. S. I21.42, S.F.135. Subsidiaries 2, sides 3-6, mostly F-type, rarely A-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-8, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 19c).

20. ***Strobilanthes glandulosus*** Kuntze: Leaves amphistomatic.

Leaf Adaxial : Stomata mostly diacytic, rarely, pericytic, superficial, orientation random, distribution diffuse. S.I.15.78, S.F.33.3. Subsidiaries 2, sides 2-6, F-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-7, undulate, sinuses U-shaped. Foot cells of trichomes and cystoliths present (Fig. 20a).

Leaf Abaxial : Stomata mostly diacytic, rarely pericytic, polocytic, superficial, orientation random, distribution diffuse. S.I.20.83, S.F.96.66, rarely giant stomata are present. Subsidiaries 1-2, sides 2-4, mostly F-type, rarely C-type, walls undulate. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-9, undulate, sinuses U-shaped. Foot cells of trichomes present (Fig. 20b).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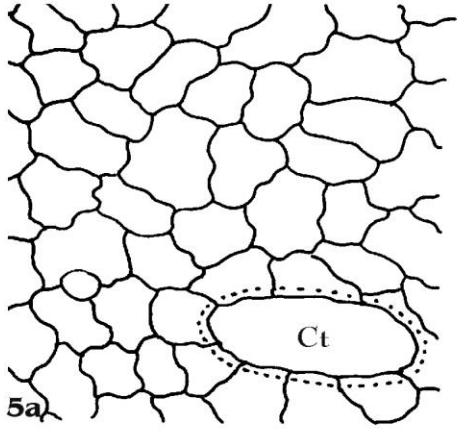

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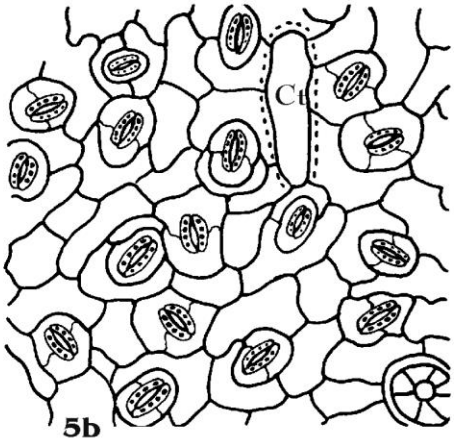

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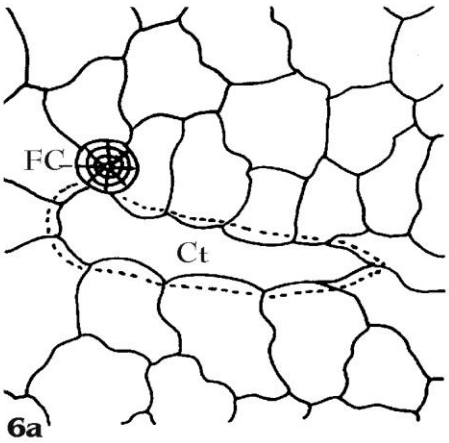

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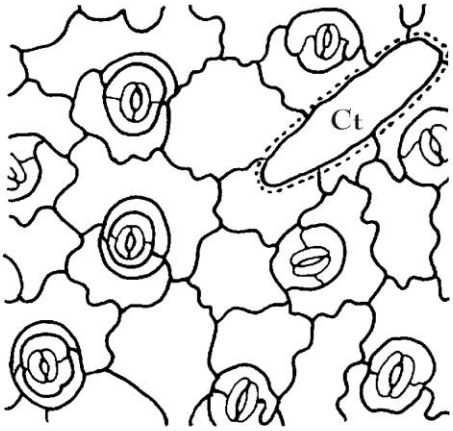

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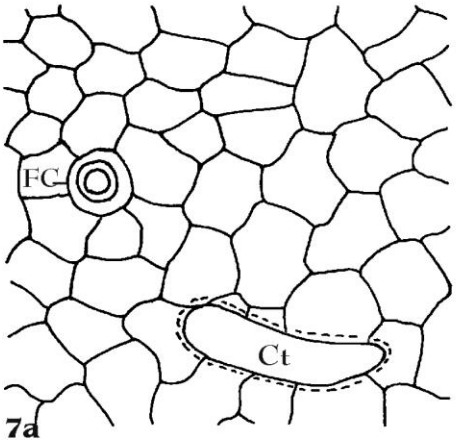

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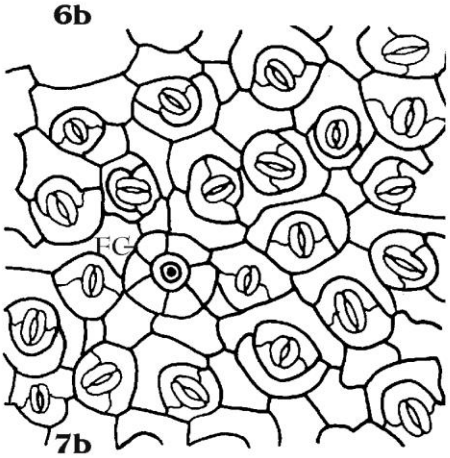

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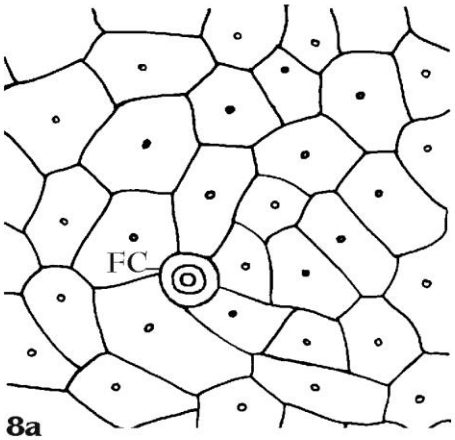

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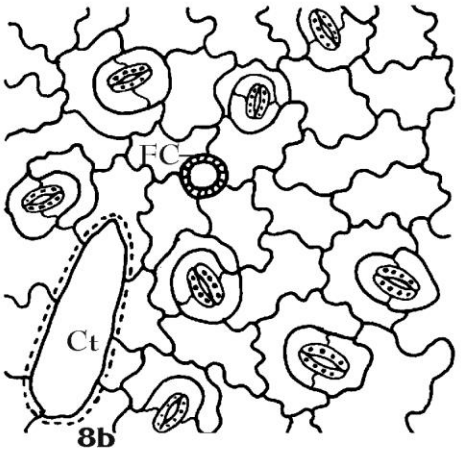

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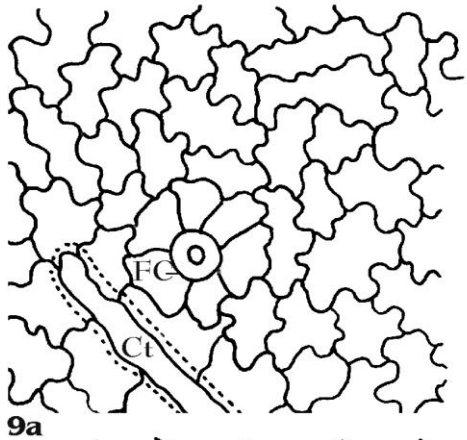

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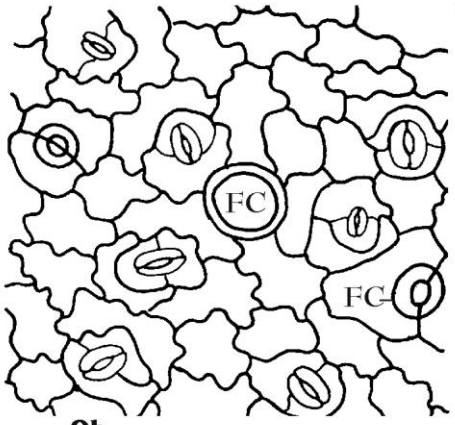

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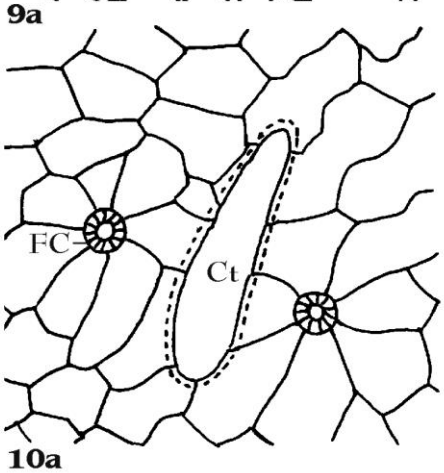

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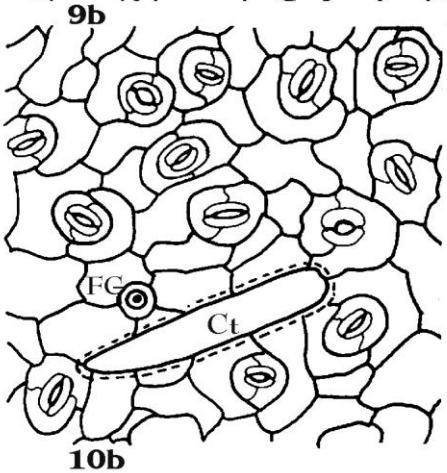

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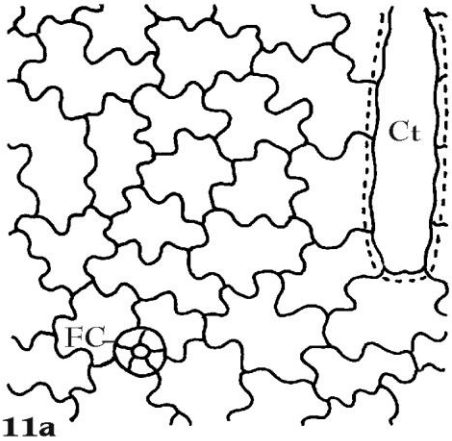

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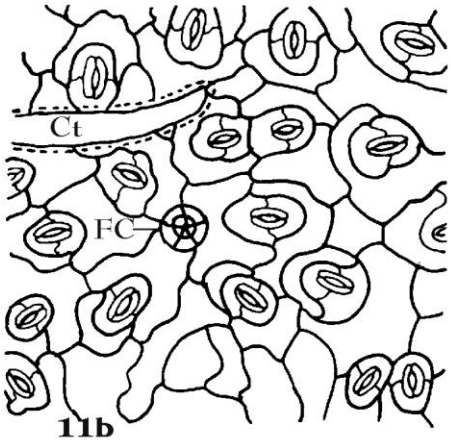

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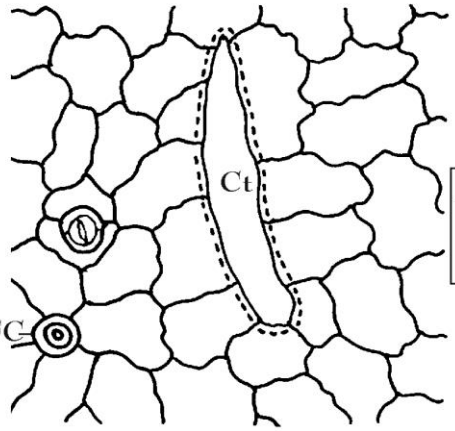

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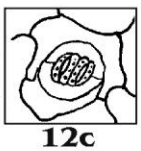

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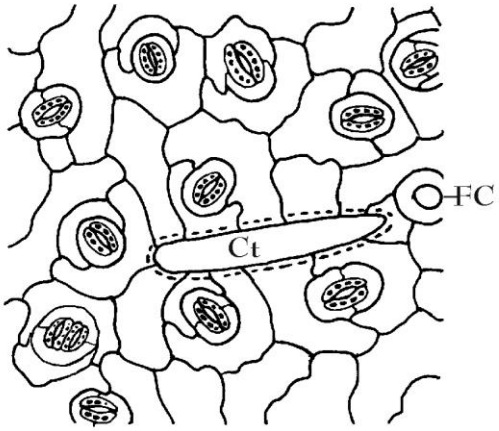

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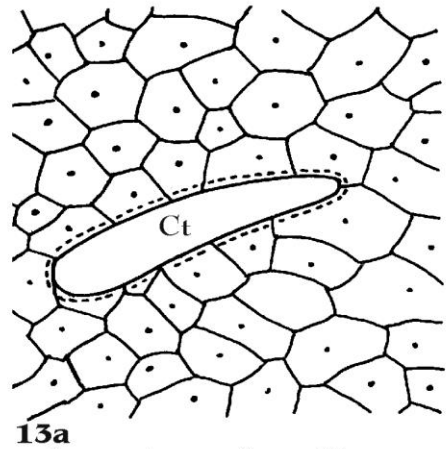

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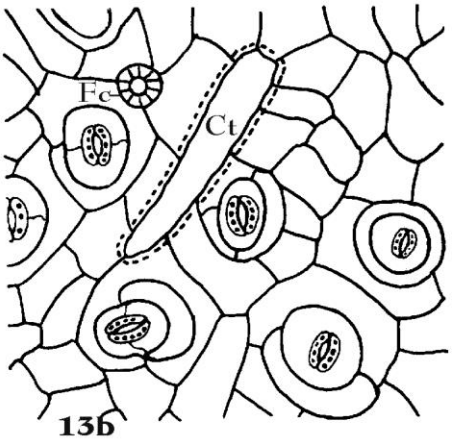

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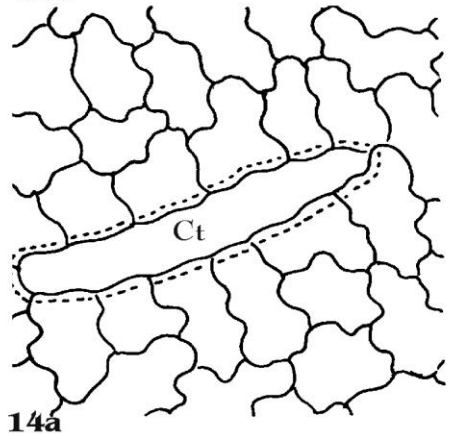

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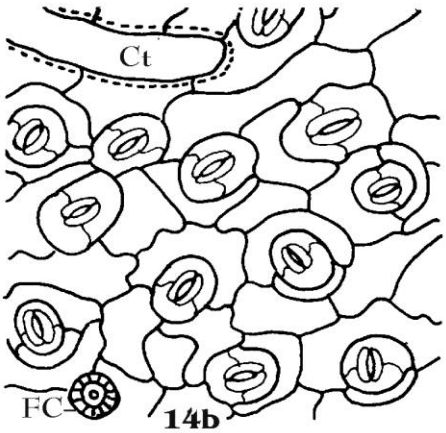

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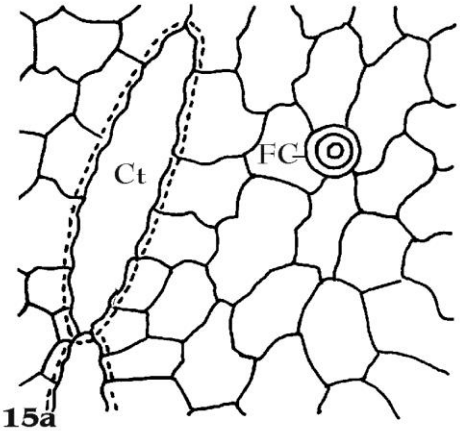

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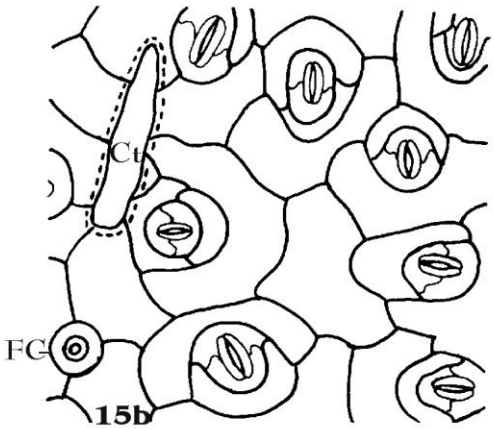

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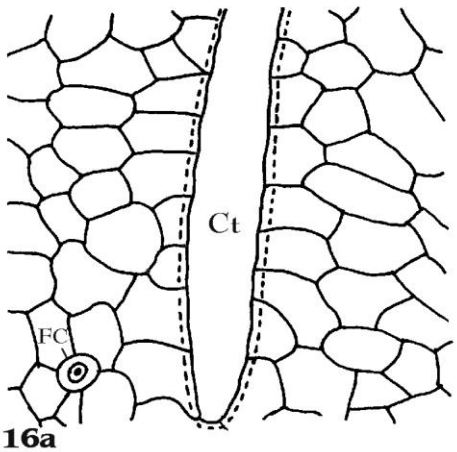

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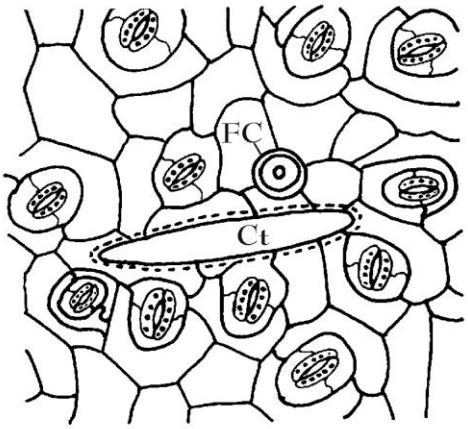

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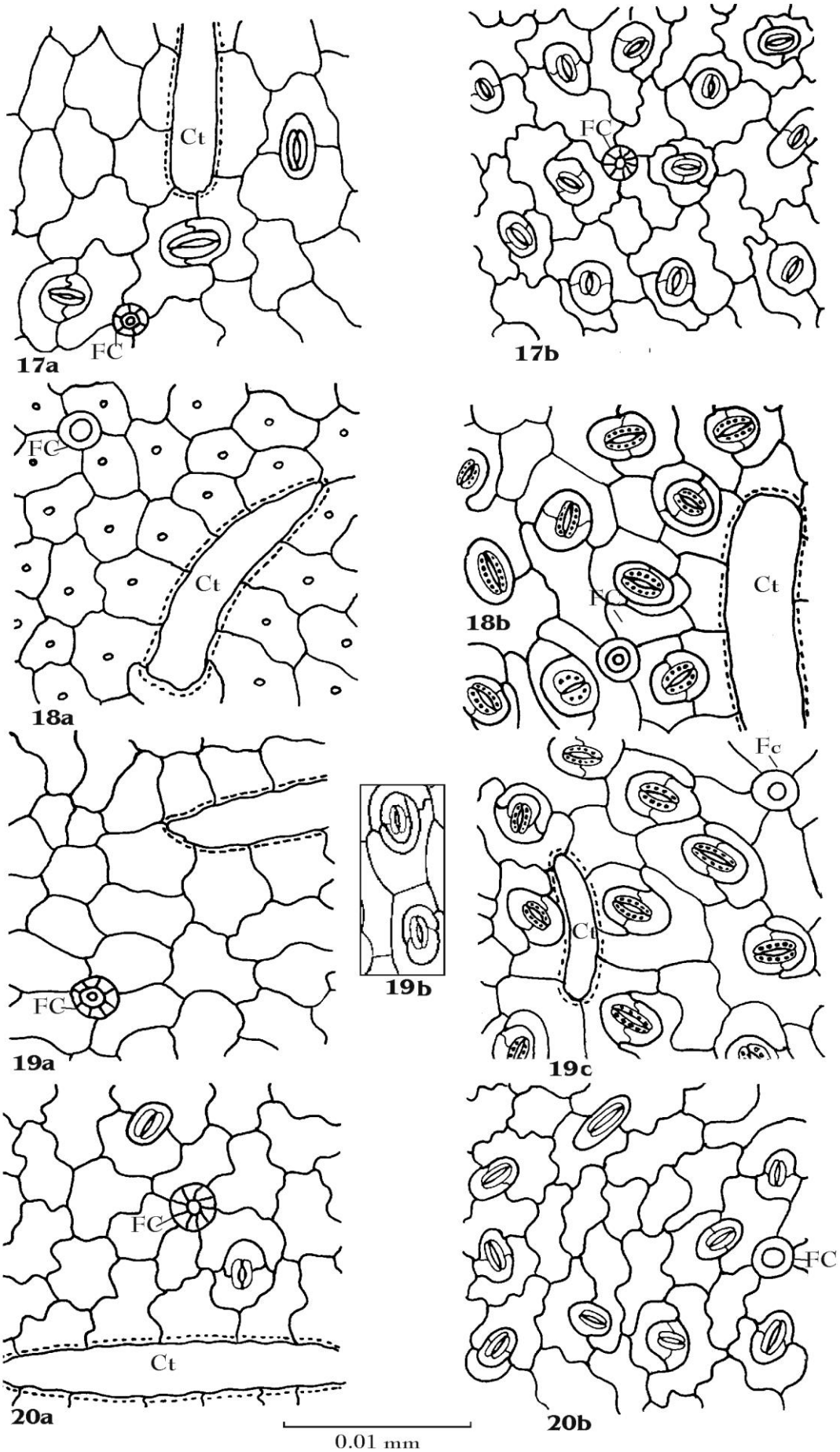
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19b
Fc
Ct
19c
FC
Ct
20a
FC
20b
0.01 mm

Table - I: Stomatal Index and Stomatal Frequency (Per sq.cm.)

Sr. No.	Taxon studied	Stomatal Index		Stomatal Frequency	
		Leaf Adaxial	Leaf Abaxial	Leaf Adaxial	Leaf Abaxial
1	*Acanthus spinosus*	A	13.79	A	97.50
2	*Adhatoda beddomei*	4.54	16.12	13.3	110.00
3	*Andrographis elongate*	A	17.39	A	82.00
4	*Andrographis macrobotrys*	A	21.73	A	100.00
5	*Andrographis stellulata*	A	18.60	A	260.00
6	*Beloperone nemorosa*	A	20.00	A	120.00
7	*Graptophylum pictum*	A	23.80	A	300.00
8	*Hypoestes sanguinolenta*	A	14.70	A	220.00
9	*Justicia carnea*	A	16.12	A	106.66
10	*Libonia floribunda*	A	20.00	A	166.66
11	*Neuracanthus sphaerostaschys*	A	21.87	A	163.33
12	*Nilgirianthes asper*	9.09	21.42	10.00	122.00
13	*Pseuderanthemum reticulatum*	A	17.64	A	145.00
14	*Stenosiphonium parviflorum*	A	21.87	A	150.00
15	*Stenosiphonium russellianum*	A	21.73	A	108.00
16	*Strobilanthes anamallaica*	A	17.85	A	112.50
17	*Strobilanthes asperimus*	10.52	24.00	30.00	170.00
18	*Strobilanthes bonaccordensis*	A	23.80	A	87.50
19	*Strobilanthes ciliatus*	15.00	21.42	36.66	135.00
20	*Strobilanthes glandulousus*	15.78	20.83	33.30	96.66

Discussion:

The foliar epidermal characteristics of 20 species belonging to 13 genera of the Acanthaceae are investigated. This study ascertains various features of stomata, epidermal cells and cell inclusions. The leaves are hypostomatic in majority of the species studied. Only five species exhibited amphistomatic condition. The stomata are generally, diacytic type. However, the types such as pericytic, co-pericytic, amphipericytic, anisocytic, amphidiacytic and polocytic are occasionally recorded on the same surfaces. Subsidiaries belong usually to the F-type. In few cases, they are observed rarely of C or A type on the same surfaces. All the three types of subsidiaries *viz.*, F, A and C types are noted in case of *N. sphaerostaschys.* The walls of subsidiaries are always undulate, except *P. reticulatum*.

Other epidermal cells are usually undulate on both surfaces with U-shaped sinuses. However, they are undulate but V-shaped on both surfaces in case of *N. asper* and straight or slightly arched abaxially in *P. reticulatum*. Highest stomatal index is observed adaxially (15.78) in *S. glandulosus* and abaxially (24.00) in *S. asperimus*. Lowest stomatal index is observed adaxially (4.54) in *A. beddomei* and abaxially (13.79) noted in *A. spinosus*.

The highest frequency (36.66) is observed on adaxial surface of *S. ciliates*, whereas it is the lowest in *A. beddomei* adaxially (13.3). It is the lowest abaxially (82) in *A. elongate* and the highest (300) in *G. pictum*. Rarely, stomatal anomaly as contiguous stomata in *N. asper* abaxially have been noted.

Occurrence of cystoliths have been recorded in the Acanthaceae (c*f.* Solereder, 1908; Metcalfe and Chalk, 1950; Ahmad, 1979). Their features such as (i) shape, (ii) size, (iii) distribution, (iv) single, twin or in aggregates, (v) cystolith end-pointed or obtuse, etc. have found systematically useful. In the present account, they are noted in the epidermal cells abaxially as well as adaxially. In most species, they occur in both surfaces but they are restricted on both surfaces in *A. spinosus, A. beddomei.* They appear restricted abaxially in *G. pictum, J. carnea, S. asperimus* and *S. glandulosus*, whereas, adaxially only in *H. sanguinolenta*. They are

mostly singly and elongated with one end pointed. They appear to be of systematic significance; however, more in-depth studies are still desired.

Although stomates are mostly diacytic type and the members of the family show homogeneity, the features e.g., distribution of stomata, types of subsidiaries, cell wall contours, presence/absence of cystoliths, their distribution and other characteristics appear helpful in identification of different taxa at species level.

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