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Foliar Epidermal Studies In Some Rubiaceae

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Abstract

Foliar epidermal characters of 20 species belonging to 12 genera of the Rubiaceae are investigated. Paracytic type of stomata is generally recorded, although amphiparacytic, pericytic and anisocytic types occur rarely on the same surfaces. Observations pertaining to stomatal index, stomatal frequency, types of subsidiaries, stomatal anomalies, other epidermal contours and occurrence of cell inclusions, etc. have been made. Taxonomic significance of these characters have been discussed in the species studied.

Key Words: Foliar epidermis, Stomata, Rubiaceae.

Introduction:

The foliar epidermal features of Rubiaceae have been documented by Metcalfe and Chalk (1950). They are further studied by different workers (Pant & Mehra, 1965; Bahadur, Rajagopal & Ramayya, 1971; Patel & Zaveri, 1975; Singh, Jain & Sharma, 1975; Vales, 1982; Bhatt, 1985; Mathew & Sivarajan, 1986; Darok, Borhidi & Kaposvari, 2000). The present study deals with 20 unstudied species belonging to 12 genera of the Rubiaceae.

Materials and Methods:

The materials were collected from Tropical Botanical Garden and Research Institute, Palode, Tiruvanantpuram District (Kerala); Government Botanical Garden, Ooty (Tamilnadu) and Lal Bag Garden, Bangalore (Karnataka). The collected plant materials were fixed in F.A.A. and preserved in 70% ethyl alcohol.

The chemical method was used for the separation of peels (E 1974). Diluted nitric acid and chromic acid (5-10%) were used in different proportions as per plant material. The peels were stained in 1% safranin and mounted in 50% glycerin. The slides were sealed with nail paint and made semi-permanent.

The stomatal index was decided as defined by Salisbury (1932). Stomatal frequency was calculated as by Ghosh and Davis (1973). The cellular sketches were drawn using a prismatic camera lucida and were inked. The term used for describing stomata are as those of Metcalfe & Chalk (1950) Dilcher (1974) and Van-cotthem (1970). The typification of subsidiary cells is after Ramayya and Rajagopal (1980).

Observations:

1. *Coprosma baueri* Endl.: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-8, straight, slightly arched, penta to hexagonal, mostly isodiametric (Fig.1a).

Leaf Abaxial : Stomata mostly paracytic, rarely anisocytic, rarely superimposed and latero-contiguous stomata present. S.I. 26.19 and S.F. 225. Subsidiaries 2-3, sides 1-6, convex, and slightly, arched, mostly F-type, rarely A and C-type. Guard cells elliptical, chlorophyllous biconvex. Epidermal cells are chlorophyllous, sides 4-8, straight or arched, mostly isodiametric (Fig.1b).

2. *Gardenia latifolia* Aiton: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-8, straight, rarely arched, usually isodiametric (Fig. 2a).

Leaf Abaxial : Stomata paracytic, rarely superimposed and latero-contiguous and giant stomata also present, superficial, orientation random, distribution diffuse. S.I. 22.01, S.F. 240. Subsidiaries 2-4, sides 1-6,

biconvex, mostly F-type, rarely C-type. Guard cells chlorophyllous, elliptical. Epidermal cells are chlorophyllous, sides 4-9, straight, or arched oblique, usually isodiametric (Fig. 2b & 2c).

3. *Guettarda speciosa* L.: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-8, undulate, sinuses U-shaped (Fig.3a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse, rarely superimposed and latero-contiguous stomata present, giant stomata also present on veins and veinlets. S.I. 17.28, S.F. 140. Subsidiaries-2, sides 1-4, undulate, sinuses V-shaped, mostly F-type, rarely A & C-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 4-9, undulate, sinuses U and V-shaped (Fig. 3b).

4. *Hedyotis stylosa* R. Br.Ex. Wight & Arn***:*** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-8, straight and arched, isodiametric, crystal druses present (Fig. 4a).

Leaf Abaxial : Stomata paracytic, orientation random, superficial, distribution diffuse. S.I.18.91, S.F. 135. Subsidiaries 2, sides 3-5, walls undulate, sinuses U & V - shaped, mostly F-type, rarely C-type. Guard cells elliptical, chlorophyllous, biconvex, sides 5-9, undulate, sinuses U & V-shaped (Fig.4b).

5. *Ixora alba* L.: Leaves hypostomatic.

Leaf Adaxial : Epidermis chlorophyllous, sides 5-7, straight and arched, mostly penta to hexagonal, isodiametric striations present (Fig. 5a).

Leaf Abaxial : Stomata paracytic, superficial, orientation, random, distribution diffuse. S.I. 20.63, S.F.12. Subsidiaries 2, sides 1-4, convex and arched, mostly F-type, rarely C-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlrophylous, sides 5-8, straight or slightly arched (Fig. 5b).

6. *Ixora brachiata* Roxb. ex DC.: Leaves amphistomatic.

Leaf Adaxial : Stomata anisocytic, superficial, orientation random, distributed rarely along only midvein. S.I. 1.31, S.F. 10. Subsidiaries 3, sides 3-5, straight, F-type. Guard cells elliptical, chlorophyllous. Epidermal cells are chlorophyllous, sides 5-9, straight or arched, usually isodiametric, striations present (Fig. 6a & 6b).

Leaf Abaxial : Stomata paracytic, rarely anisocytic, superficial, orientation random, distribution diffuse, rarely juxtaposed contiguous stomata present. S.I.20.30, S.F. 103. Subsidiaries 2-3, sides 2-5, walls straight or convex, F-type, rarely A & C type. Guard cell elliptical, chlorophyllous biconvex. Epidermal cells are chlorophyllous, sides 5-9, straight and arched, usually isodiametric, striations present (Fig.6c).

7. *Ixora johnsonii* Hook.f***.:*** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 5-7, straight or arched, penta to hexagonal, isodiametric, striations present (Fig.7a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse, superimposed, juxtaposed and latero-contiguous stomata present, rarely giant stomata also present, S.I. 19.73, S.F. 142. Subsidiaries 2-4, sides 1-3, walls convex or slightly arched, F-type, rarely A & C type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, straight, and arched, sides 4-7, isodiametric, striations present (Fig. 7b, 7c & 7d).

8. *Ixora malabarica* (Dennst.) Mabberley: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-7, undulate, sinuses slightly wavy & U-shaped, striations present (Fig. 8a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse, rarely superimposed contiguous stomata present, S.I.20, S.F. 140. Subsidiaries 2-3, sides 1-5, walls convex, rarely undulate, F-type, rarely A & C type. Guard cells elliptical, chlorophyllous biconvex. Epidermal cells are chlorophyllous, sides 5-8, undulate, sinuses U-shaped, striations present (Fig. 8b).

9. *Ixora nigricans* R.Br. ex Wight & Arn***.:*** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-7, straight and arched, Penta to hexagonal, isodiametric, striations present (Fig. 9a).

Leaf Abaxial : Stomata paracytic, rarely pericytic, superficial, orientation random, distribution diffuse, rarely latero-contiguous stomata present. S.I .24.41, S.F. 210. Subsidiaries 2, convex or arched, mostly F-Type,

rarely A and C-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 4-6, straight and arched, isodiametric (Fig. 9b & 9c).

10. ***Ixora polyantha*** Wight: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 5-8, straight and arched, mostly hexagonal, isodiametric striations present (Fig.10a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse, rarely superimposed and latero-contiguous stomata present, giant stomata also present. S.I. 18.42, S.F. 125. Subsidiaries 2, convex, mostly F-type, rarely A & C type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 5-8, straight or arched, isodiametric, striations present (Fig. 10b & 10c).

11. ***Ixora singaporensis*** Linn.: Leaves amphistomatic.

Leaf Adaxial : Stomata paracytic, superficial, orientation random, distributed on only mid-vein. S.I.2.40, S.F. 20. Subsidiaries 2, sides 1-6, convex and slightly undulate, F-type. Guard cells elliptical, chlorophyllous. Epidermal cells are chlorophyllous, sides 4-8, undulate, sinuses U-shaped, striations present (Fig. 11a & 11b).

Leaf Abaxial : Stomata paracytic, rarely pericytic, orientation random, distribution diffuse, superimposed contiguous stomata present, S.I. 18.91, S.F.140. Subsidiaries 2-3, sides 1-3, convex, mostly F-type, rarely A and C type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 5-7, undulate or straight, sinuses U-shaped, striations present (Fig. 11c).

12. ***Morinda reticulata*** Gamble*:* Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 5-7, straight and arched, isodiametric, striations present (Fig. 12a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse, superimposed contiguous stomata present. S.I.21.56, S.F. 220. Subsidiaries 2-3, convex, F-type. Guard cells elliptical, chlorophyllous, biconvex, arched. Epidermal cells are chlorophyllous, sides 5-9, undulate, sinuses U-shaped, striations present (Fig. 12b).

13. ***Nauclea parvifolia*** Roxb.: Leaves amphistomatic.

Leaf Adaxial : Stomata paracytic, anisocytic superficial orientation random, distributed on only mid-vein. S.I. 2.7, S.F. 20. Subsidiaries 2-3, convex, F-type. Guard cells chlorophyllous, elliptical, biconvex. Epidermal cells are chlorophyllous, sides 4 -7, straight or arched, mostly hexagonal, isodiametric, striations present (Fig. 13a & 13b).

Leaf Abaxial : Stomata paracytic and amphiparacytic, superficial, orientation random, distribution diffuse, latero-contiguous stomata present rarely stomata with single guard cell. S.I. 18.36, S.F. 16. Subsidiaries 2-4, sides 1-3, convex, F-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 4-7, undulate, sinuses U-shaped striations present (Fig.13c, 13d &13e).

14. ***Ophiorrhiza mungos*** L.***:*** Leaves hypostomatic.

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

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse. S.I.15.25, S.F. 90. Subsidiaries 2, sides 1-5, F-type. Guard cells elliptical, chlorophylous, biconvex. Epidermal cells are chlorophyllous, sides 4-8, undulate, sinuses U-shaped (Fig. 14b).

15. ***Ophiorrhiza pectinata*** Arn.***:*** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-8, straight or arched, mostly penta to hexagonal, isodiametric (Fig. 15a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse. S.I. 18.03, S.F. 123. Subsidiaries 2, convex, F-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 4-8, straight or arched, mostly hexagonal (Fig.15b).

16. ***Ophiorrhiza tirunelvelica*** Henry & Sabrum: Leaves hypostromatic.

Leaf Adaxial : Epidermal chlorophyllous, sides 4-8, undulate, sinuses U-shaped (Fig. 16a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse. S.I. 15.15, S.F. 85. Subsidiaries 2, mostly F-type, rarely C-type. Guard cells elliptical, chlorophyllous biconvex. Epidermal cells are chlorophyllous, sides 4-7, undulate, sinuses U-shaped (Fig. 16b).

17. ***Pavetta calophylla*** Bremek.: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-8, undulate, sinuses U-shaped (Fig. 17a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse. S.I. 16.66, S.F. 110. Subsidiaries 2, sides 1-5, mostly F-type, rarely C-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells, chlorphyllous, sides 5-8, undulate, sinuses U-shaped (Fig. 17b).

18. Psilanthus travancorensis (Wight & Arn.) Leroy: Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-7, undulate, sinuses U-shaped (Fig.18a).

Leaf Abaxial : Stomata paracytic, rarely pericytic, orientation random, superficial, distribution diffuse. S.I. 20.19, S.F. 200. Subsidiaries 2-4, walls undulate, F-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides mostly 5-7, undulate, sinuses U-shaped (Fig. 18b).

19. ***Psychotria nudiflora*** Wight & Arn.: Leaves hypostomatic.

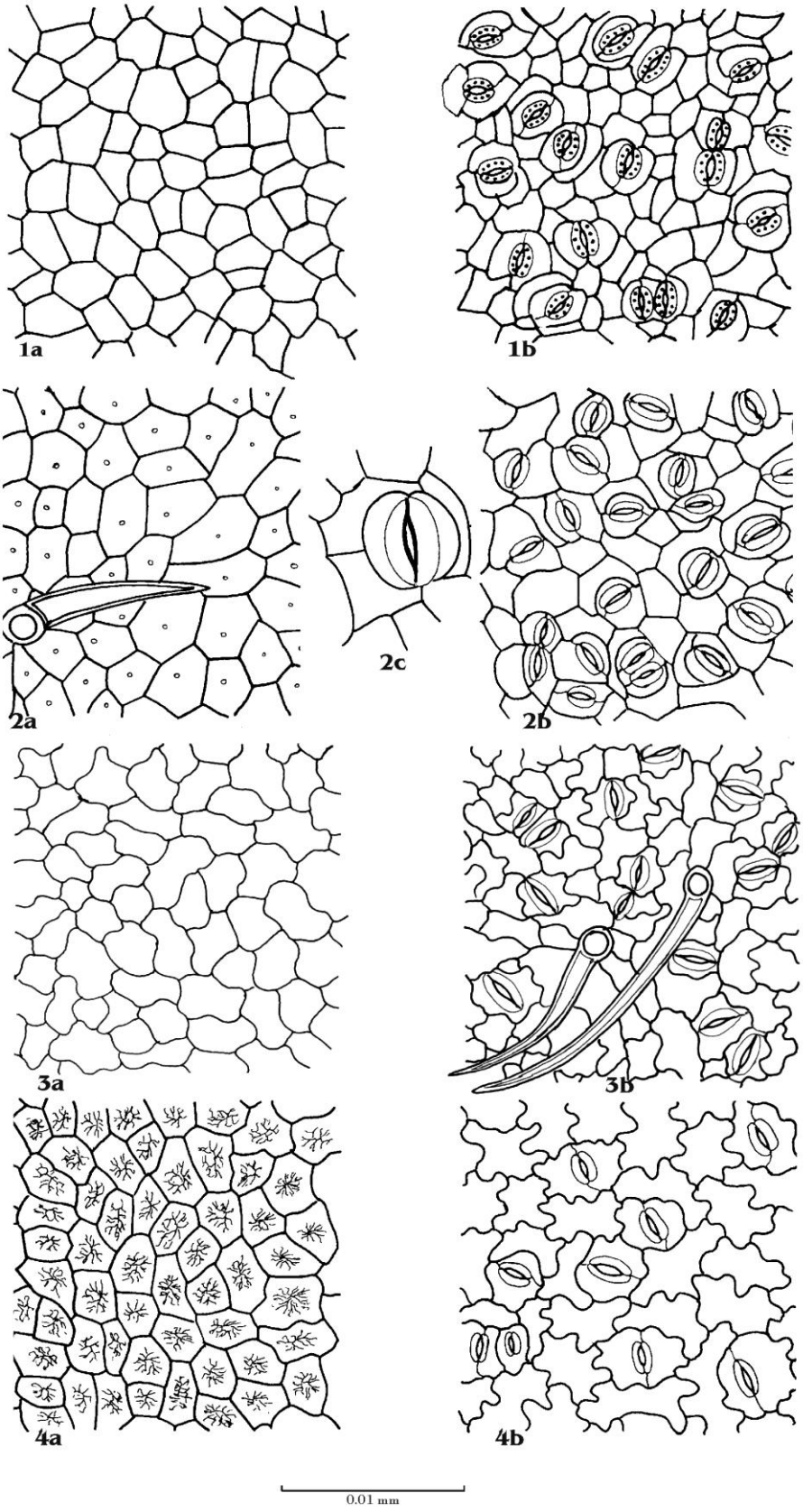
Leaf Adaxial : Epidermal cells, chlorophyllous, sides 4-7, straight, or arched, hexagonal, isodiametric, striations present (Fig.19a).

Leaf Abaxial : Stomata paracytic, superficial, orientation random, distribution diffuse, latero-contiguous stomata present. S.I. 15.78, S.F. 142. Subsidiaries 2, sides 1-5, F-type, rarely A-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells, chlorophyllous, sides 4-8, straight or arched, mostly penta to hexagonal, isodiametric, striations present (Fig. 19b).

20. ***Rondeletia amoenea*** **(**Planch) Hemsl.***:*** Leaves hypostomatic.

Leaf Adaxial : Epidermal cells are chlorophyllous, sides 4-7, undulate, sinuses U-shaped, striations present (Fig. 20a).

Leaf Abaxial : Stomata paracytic, anisocytic, superficial, orientation random, distribution diffuse, latero-contiguous stomata present, giant stomata also present. S.I. 29.41, S.F. 150, Subsidiaries 2-5, mostly F-type, rarely A & C-type. Guard cells elliptical, chlorophyllous, biconvex. Epidermal cells are chlorophyllous, sides 5-8, undulate, sinuses U-shaped, striations present (Fig. 20b , 20c & 20d).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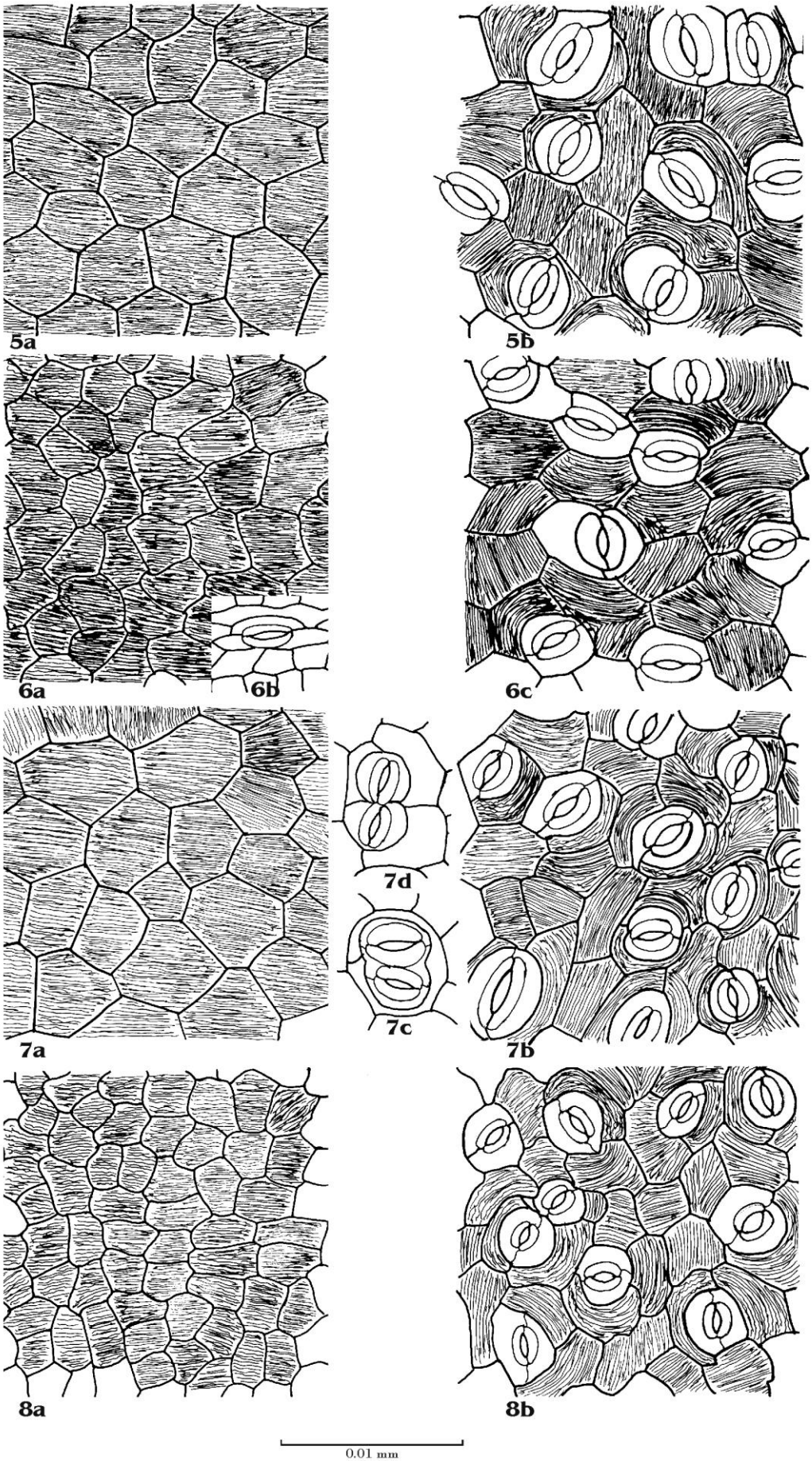
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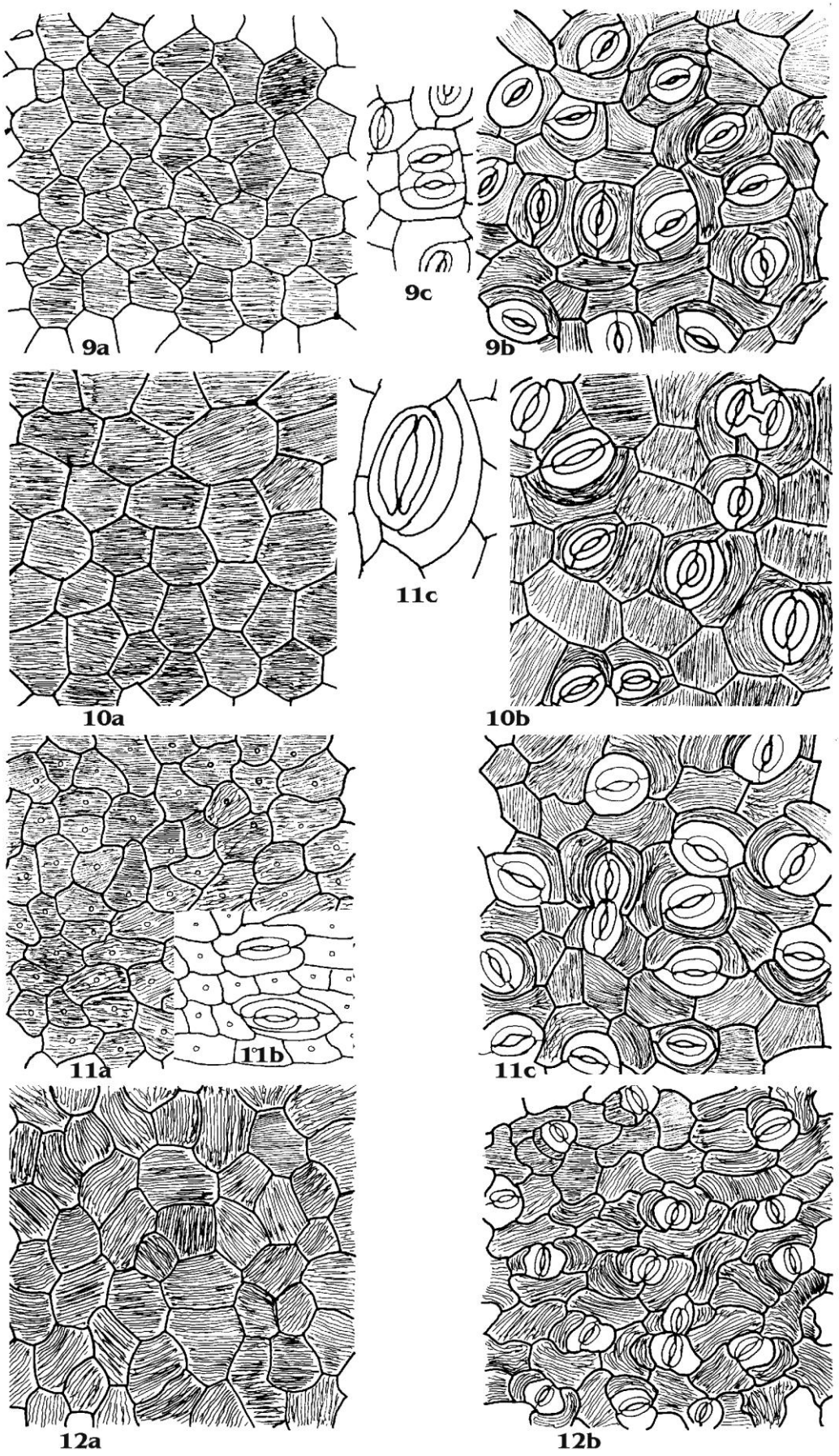
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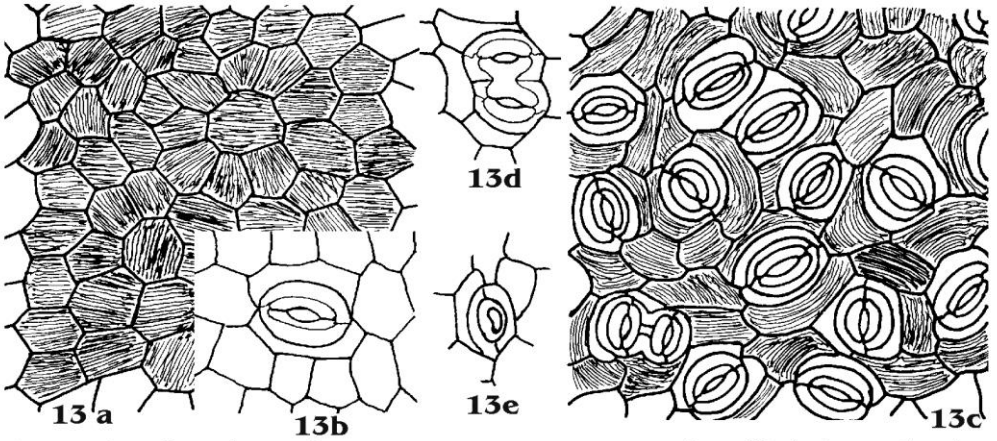

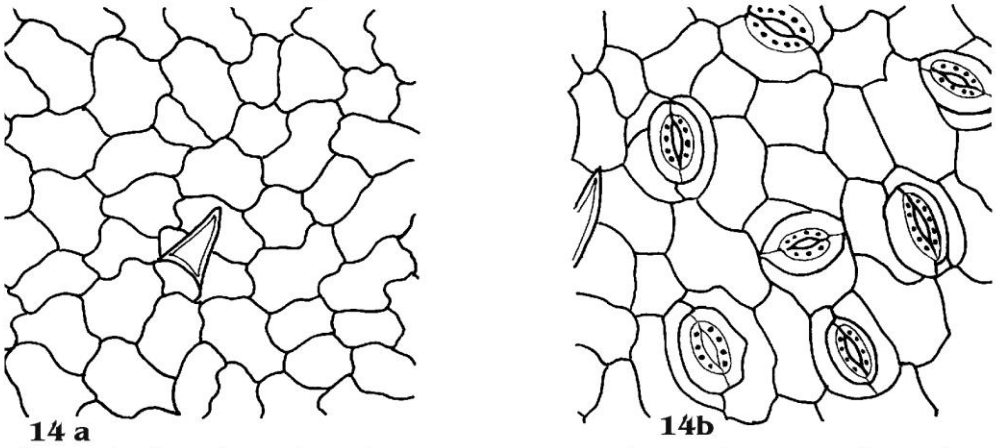

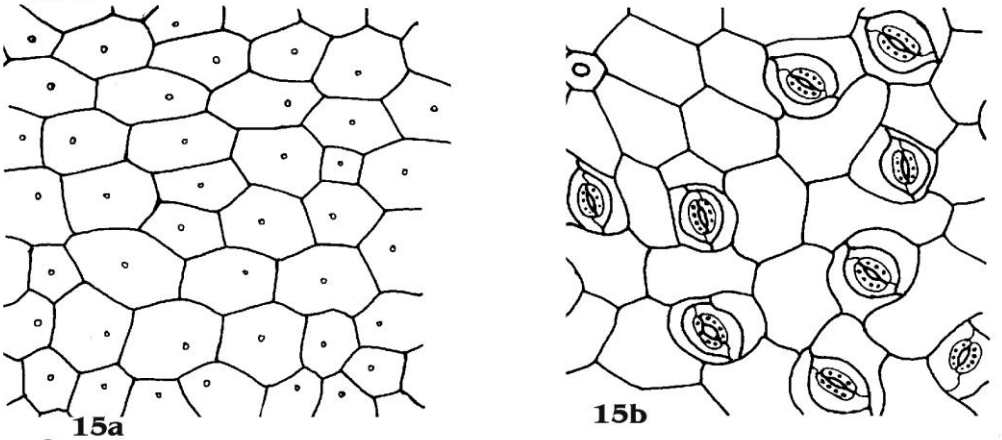

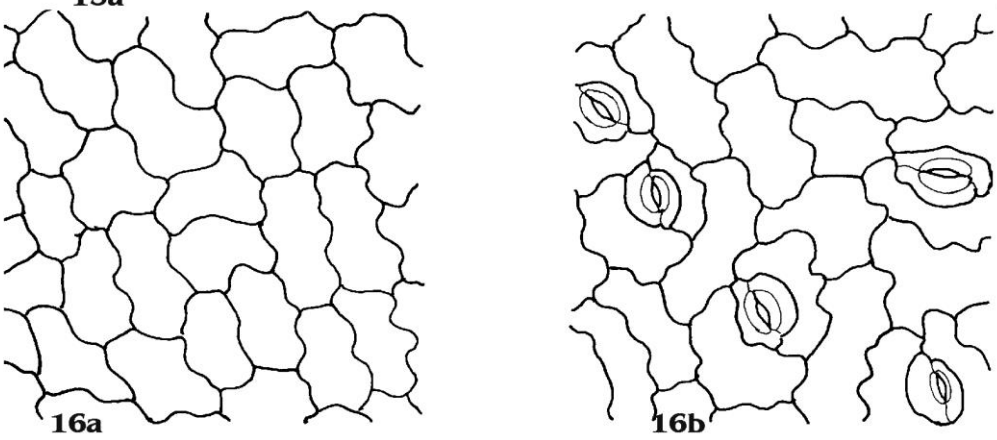

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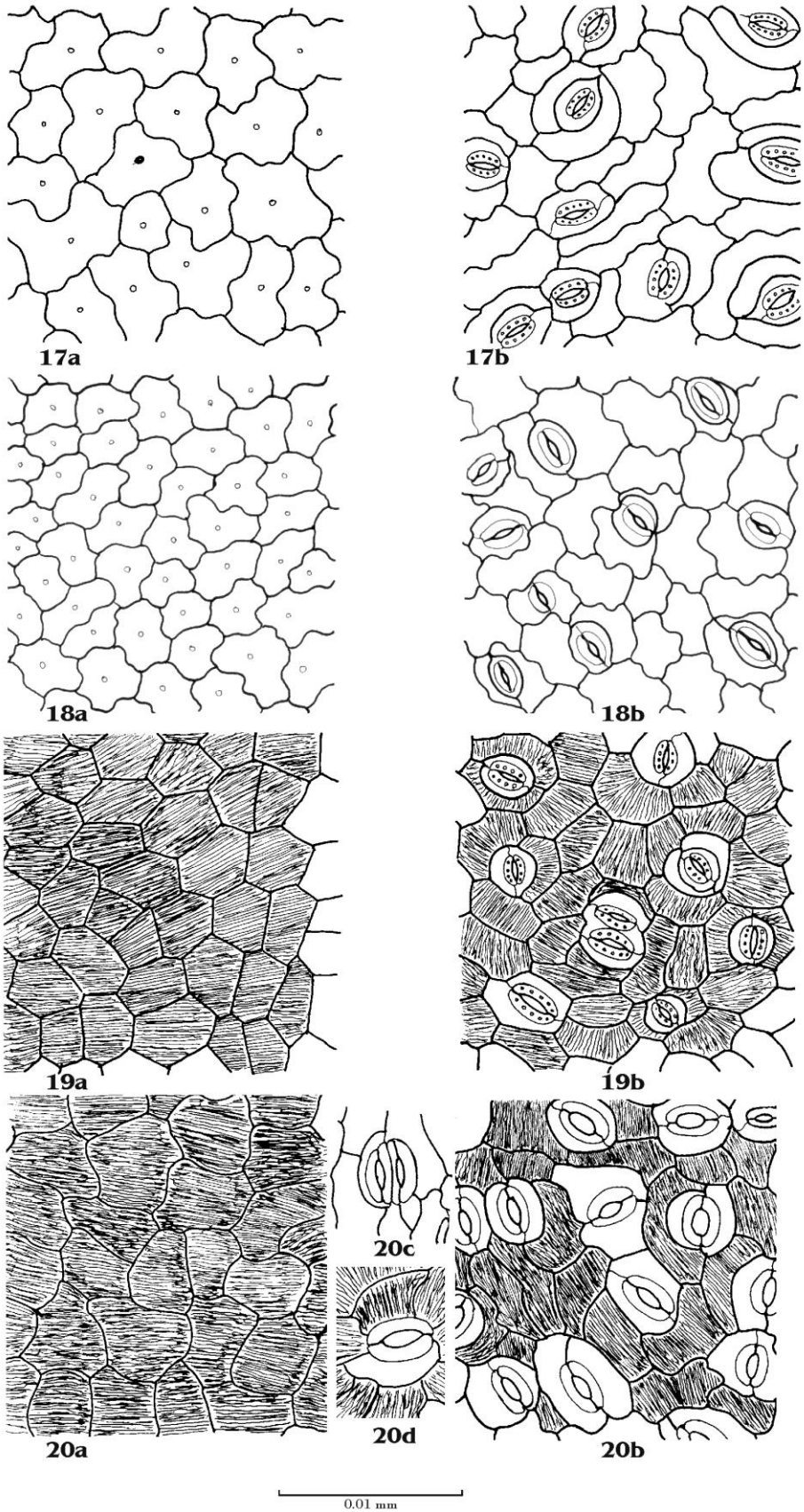
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Table -I: Stomatal Index and Stomatal Frequency (Per sq.cm.)

Sr. No.	Taxon studied	Stomatal Index		Stomatal Frequency	
		Leaf Adaxial	Leaf Abaxial	Leaf Adaxial	Leaf Abaxial
1	*Coprosma baueri*	A	20.19	A	200
2	*Gardenia latifolia*	A	22.01	A	240
3	*Guettarda speciosa*	A	17.28	A	140
4	*Hedyotis stylosa*	A	18.91	A	135
5	*Ixora alba*	A	20.63	A	125
6	*I.brachiata*	1.31	20.33	10	103
7	*I.johnsonii*	A	19.73	A	142
8	*I.malabarica*	A	20.00	A	140
9	*I.nigricans*	A	24.41	A	210
10	*I.polyantha*	A	18.42	A	125
11	*I.sigaporensis*	2.40	18.91	20	140
12	*Morinda reticulata*	A	21.56	A	220
13	*Nauclea parvifolia*	2.7	18.36	20	176
14	*Ophiorrhiza mungos*	A	15.25	A	90
15	*O.pectinata*	A	18.03	A	123
16	*O.tirunelvelica*	A	15.15	A	85
17	*Pavetta calophylla*	A	16.66	A	110
18	*Psilanthus travancorensis*	A	16.12	A	100
19	*Psychotria nudiflora*	A	15.78	A	142
20	*Rondeletia amoenea*	A	29.41	A	150

Discussion:

The paracytic stomatal type (sensu Metcalfe & Chalk, 1950) has been typified as Rubiaceous type by Vesque (1889). This type is widely documented in the family as stated earlier.

The present authors also recorded it in 20 species belonging 12 genera of the Rubiaceae. Rare occurrence of other normal types e.g., anisocytic, pericytic and amphiparacytic are also observed rarely in few taxa investigated. Few stomatal abnormalities such as contiguous stomata - (i) latero-contiguous. (ii) superimposed, (iii) juxtaposed and giant stomata are occasionally noted. The leaves are hypostomatic except *Ixora brachiata, I. singapurensis* and *Nauclea parviflora*. The comparative distribution of stomata in these three taxa needs a mention. The stomatal index or frequency of adaxial foliar surface is far lower in comparison to the abaxial one. Such a condition of leaves is considered as functionally hypostomatic. The highest stomatal index (29.41) is noted abaxially in *Rondeletia amoenea*, whereas if the lowest (1.31) in *Ixora brachiata*. Three types of subsidiaries are recognized in angiosperms (Ramayya and Rajgopal, 1980). Of these, F-type subsidiaries occur predominantly, while other types *viz*., A and C are rarely observed on the

same surfaces. All the three types on the same surface are noted in *Coprosma baueri, Guettarda speciosa, Ixora brachiata, I. johnsonii, I. malabarica, I. nigricans, I. polyantha, I. sigaporensis* and *Rondeletia amoenea*.

Epidermal cell walls are either undulate or straight. The former case is observed on both surfaces in *Psilanthus travencorensis, Guettarda. speciosa, Ixora malabarica, I. singaporensis, Ophiorrhiza mungos, O. tirunelvelica* and *Pavetta calophylla*. The cell walls are straight on both surfaces in *Coprosma bauri, Gardenia latifolia, Ixora brachiata, I. johsonii, I. nigricans, I. polyantha, Ophiorrhiza pectinata, Psychotria nudiflora* and *Ixora alba*. They are ether straight or indulate abaxially and adaxially in some others. The foliar surfaces are striated on either side in eight species, whereas in rest others leaves are want of striations. The crystals are noted in adaxial epidermis in case of *Hedyotis stylosa* exclusively.

Although the members of Rubiaceae show uniform stomates, other epidermal characters appear to be of taxonomic significance as they occur differently and constantly in various species studied. Such characters are: (i) distribution of stomata, (ii) stomatal index and frequency, (iii) cell wall contours, (iv) types of subsidiaries and their distribution, (v) presence of crystals and, (vi) striations, etc. These can be conveniently employed to distinguish the rubiaceous taxa. Further investigations are, however, in order.

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* Origin not consulted