Investigations on foliar epidermis in some Rubiaceae

C. R. Patil1 and D. A. Patil2

1Department of Botany, Rani Laxmibai College, Parola-425111, District Jalgaon, Maharashtra, India.
2P.G. Department of Botany, S.S.V.P.'s L.K.Dr.P.R.Ghogrey Science College, Dhule – 424005, Maharashtra, India.

Abstract

The paper reports foliar epidermal features of 20 unstudied species belonging 12 genera of the family Rubiaceae. The foliar stomates although paracytic generally in the taxa investigated, other types are also noticed rarely or occasionally on the same surface. The other epidermal features such as stomatal index (S.I) and frequency (S.F), stomatal abnormalities, cell wall contours, cell inclusions, etc. have been described in detail. Significance of various epidermal features in taxonomy of the taxa investigated is discussed.

Keywords: Foliar epidermis, Stomata, Cell wall contours, Rubiaceae.

INTRODUCTION


MATERIALS AND METHODS

The plant materials were collected from Tropical Botanic Garden and Research Institute, Palode, Thiruvanthapuram District (Kerala); Forest Research Institute, Peechi, Trichur (Kerala); Calicut University, Botanical Garden (Kerala); Malbar Botanical Garden, Kozhikode (Kerala); Government Botanic Garden, Otacamund (Tamilnadu) and Lal Bag Botanic Garden, Bangalore (Karnataka). The collected materials were fixed in F.A.A. solution and then permanently preserved in (70%) alcohol. Healthy herbarium materials were also obtained from Calicut University Herbarium (Kerala). Herbarium materials whenever used were first boiled in water for 5-10 minutes. Few drops of acetic acid were added to soften and to help recovery of tissue to natural state with a gap of few minutes after boiling. The materials were washed in water and kept ready for next stage of operation. For the study of the paradermal view of the epidermis small rectangular area of epidermal were removed from the middle portion of the leaf blade. The chemical method was followed for the separation of peels. Diluted nitric acid and chromic acid (5-10%) were used in different proportions. In case of some leaves, the chemical method is not suitable. The mecanachal scratching method was used for obtaining the peels. Epidermal peels were stained in safranin (1%). They were mounted in (50%) glycerin and ringed with nail paints. The sketches were drawn using prism type camera lucida. The sketches were inked by using Camligraph or Rotring isographs technical inking pens with 0.1, 0.2, 0.3 points. The observations have been provided in table – I.

The stomatal index was decided as defined by Salisbury (1932). Stomatal frequency was calculated as by Ghosh and Davis (1973). The term used for describing stomata are as those of Metcalfe and Chalk (1950) Dilcher (1974) and Van-cothem (1970). The typification of subsidiary cells is after Ramayya and Rajagopal (1980).

Abbreviations


OBSERVATIONS

Canthium coromandelicum (Burm. f.) Alston : Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls undulate or arched, foot cells of trichomes present (Fig. 1a).

Leaf Abaxial: Stomata usually paracytic, superficial, orientation random, distribution diffuse, juxtaposed and superimposed contiguous stomata present, S.I. 21.10 and S.F. 210. Subsidiaries cells 2, sides 2-5, walls arched and undulate, mostly F-type, rarely A and C-type. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-9, walls straight, arched or undulate, sinuses U-shaped (Fig. 1b).

Canthium rheedei DC. : Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, side 4-8, walls
arched and undulate, sinuses U-shaped (Fig. 2a).

Leaf Adaxial: Stomata mostly paracytic, rarely parahexacytic-dipolar, superficial, orientation random, distribution diffuse, rarely juxtaposed contiguous stomata present, S.I. 24.08 and S.F. 250. Subsidiaries cells 2-4, sides 2-6, walls arched, mostly F-type, rarely C-type. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-9, straight, walls arched and undulate, sinuses U-shaped (Fig. 2b).

Chassalia ophioxyloides (Wall.) Craib: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls straight, isodimetric, hexagonal or polygonal, striations and foot cell of trichome present (Fig. 3a).

Leaf Abaxial: Stomata mostly paracytic, rarely pericytic, superficial, orientation random, distribution diffuse, S.I. 22.15 and S.F. 245. Subsidiaries cells 1-2, sides 3-4, walls arched, F-type. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-7, walls straight and slightly arched, or undulate, sinuses U-shaped (Fig. 3b).

Coprosma lucida J. R. et G. Forst.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls straight and arched, polygonal (Fig. 4a).

Leaf Abaxial: Stomata mostly paracytic, rarely anisocytic, superficial, orientation random, distribution diffuse, suprasedmocytic contemporaneous stomata present rarely, S.I. 22.43, S.F. 265. Subsidiaries cells 2-4, sides 5-8, walls arched and undulate, sinuses U-shaped, mostly F-type, rarely A-and C-type. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-8, walls arched or undulate, sinuses U and V-shaped (Fig. 4b).

Gardenia gummifera L. f.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls arched and undulated, sinuses U-shaped, rarely V-shaped, foot cell of trichome present (Fig. 5a).

Leaf Abaxial: Stomata mostly paracytic, rarely anisocytic superficial, orientation, random, distribution diffuse, juxtaposed, superimposed and obliquely oriented contiguous stomata present, stomata with single guard cells and giant stomata also present. S.I. 19.38, S.F. 195. Subsidiaries cells 2-4, sides 3-5, walls arched, mostly F-type, rarely A-and C-type. Guard cells elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 4-8, walls arched and undulate, sinuses U-shaped, foot cells of trichomes present (Fig. 5b, 5c, 5d).

Gardenia jasminoides Ellis: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-7, walls arched and undulate, sinuses U-shaped (Fig. 6a).

Leaf Abaxial: Stomata mostly paracytic, rarely pericytic, superficial, orientation random, distribution diffuse, rarely superimposed contiguous stomata present, stomata with single guard cells and giant stomata also present. S.I. 23.8, S.F. 218. Subsidiaries cells 2, sides 5-7, walls arched and undulate, sinuses U-shaped, mostly F-type, rarely A-type. Guard cell elliptical, chlorophyllous. Epidermal cells chlorophyllous, sides 5-11, walls arched and undulate, sinuses U-shaped (Fig. 6b, 6c, 6d).

Gardenia longistyla (DC.) Hook: Leaves amphistomatic.

Leaf Adaxial: Stomata paracytic, superficial, orientation random, distribution diffuse, S.I. 1.50, S.F. 11. Subsidiaries cells 2, sides 2-3, walls arched, F-type. Guard cells elliptical, Chlorophyllous. Epidermal cells chlorophyllous, sides 5-7, walls undulate, sinuses U-shaped (Fig. 7a).

Leaf Abaxial: Stomata mostly paracytic, rarely pericytic, superficial, orientation random, distribution diffuse. S.I. 21.25, S.F. 205. Subsidiaries cells 2, sides 2-8, walls arched and undulate, sinuses U-shaped, F-type. Epidermal cells chlorophyllous, sides 5-9, walls undulate, sinuses U-shaped rarely V-shaped (Fig. 7b).

Geophila repens (L.) Johnston: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-8, walls straight, isodimetric, pentagonal to polygonal (Fig. 8a).

Leaf Abaxial: Stomata mostly paracytic and rarely amphiparacytic, superficial, orientation random, distribution diffuse, rarely superimposed contiguous stomata present, S.I. 15.35, S.F. 140. Subsidiaries cells 2-4, sides 3-4, walls arched, F-type. Guard cells elliptical. Chlorophyllous, papillate, Epidermal cells chlorophyllous, sides 4-7, walls straight and slightly arched or undulate, sinuses U-shaped (Fig. 8b, 8c, 8d).

Haldina cordifolia (Roxb.) Ridsd.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls arched and undulate, sinuses U-shaped (Fig. 9a).

Leaf Abaxial: Stomata mostly paracytic, rarely pericytic, superficial, orientation random, distribution diffuse, rarely superimposed contiguous stomata present, S.I. 20.47, S.F. 235. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 3-6, walls arched, mostly F-type, rarely A and C-type. Epidermal cells chlorophyllous, sides 5-8, walls arched and undulate, sinuses U-shaped (Fig. 9b).

Hymenodictyon orixense (Roxb.) Mabb.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-7, walls arched and undulate, sinuses U-shaped, foot cell of trichome present (Fig. 10a).

Leaf Abaxial: Stomata usually paracytic, superficial, orientation random, distribution diffuse, juxtaposed contiguous stomata present, S.I. 17.80, S.F. 179. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 4-10, walls undulate, sinuses U-shaped, A, C and F-type. Epidermal cells chlorophyllous, sides 4-8, walls undulate, and sinuses U-shaped, foot cell of trichome present (Fig. 10b).

Ixora finlaysoniana Wall. ex Don.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls straight, slightly arched, n hexagonal to polygonal, striations present (Fig. 11a).

Leaf Abaxial: Stomata mostly paracytic, rarely amphiparacytic and desmocytic, superficial, orientation random, distribution diffuse, rarely stomata with single guard cells present. S.I. 16.56, S.F. 175. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2-4, sides 2-6,
Ixora javanica  DC.: Leaves amphistomatic.

Leaf Adaxial: Stomata usually paracytic, superficial, orientation random, distribution diffuse, S.I. 2.75, S.F. 22. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 4-6, walls arched F-Type. Epidermal cells chlorophyllous, sides 5-8, walls arched and undulate, sinuses U-shaped, striations present (Fig. 12a). Leaf Abaxial: Stomata mostly paracytic, rarely amphiparacytic and anomocytic, superficial, orientation random, distribution diffuse, superimposed contiguous stomata present. S.I. 1.88, S.F.195. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2-4, sides 3-5, walls arched, mostly F-type, rarely A-type. Epidermal cells chlorophyllous, sides 5-9, walls undulate, sinuses U-shaped, striations present (Fig.12b, 12c).

Ixora lanceolaria  Colebr.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-8, walls straight and slightly arched, striations present (Fig. 13a).

Leaf Abaxial: Stomata usually paracytic, superficial, orientation random, distribution diffuse, rarely justposed and superimposed contiguous stomata and rarely stomata with single guard cells present, S.I. 19.25,S.F.216. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 4-7, walls arched, mostly F-type, rarely A and C-type. Epidermal cells chlorophyllous, sides 6-10, walls arched and undulated, sinuses U-shaped, striations present (Fig.13b,13c, 13d).

Ixora monticola  Gamble: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-8, walls straight, slightly arched isodiametric, hexagonal, striations present (Fig. 14a).

Leaf Abaxial: Stomata usually paracytic, superficial, orientation random, distribution diffuse, juxtaposed and superimposed contiguous stomata present, S.I. 18.90, S.F.198. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2 , sides 4-7, walls arched, mostly F-type, rarely A-type. Epidermal cells chlorophyllous, sides 4-10, walls arched and undulate, sinuses U-shaped, striations present (Fig. 14b, 14c).

Ixora thwaitesii  Hook. f.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-8, walls straight, slightly arched, isodiametric, hexa to polygonal, striations present (Fig.15a).

Leaf Abaxial: Stomata mostly paracytic, rarely amphiparacytic, superficial, orientation random, distribution diffuse, rarely stomata with single guard cells present and arresting development present. S.I. 20.58, S.F. 208. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2-4, sides 4-6, walls arched, mostly F-type, rarely A and C-type. Epidermal cells chlorophyllous, sides 5-9, walls arched and undulate, sinuses U-shaped, striations present (Fig.15b).

Luculia gratissima  (Wall.) Sweet: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-7, walls straight, slightly arched, hexagonal, isodiametric, foot cells of trichome present (Fig. 16a).

Leaf Abaxial: Stomata mostly paracytic, rarely anisocytic, superficial, orientation random, distribution diffuse, S.I. 15.49, S.F. 160. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2-3, sides 4-8, walls undulate, sinuses U-shaped, F-type. Epidermal cells chlorophyllous, sides 4-8, walls undulate, sinuses U-shaped (Fig. 16b).

Nauclea orientalis  : (L..) L. Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-8, walls straight, isodiametric, penta to polygonal, foot cells of trichomes and striations present (Fig.17a).

Leaf Abaxial: Stomata usually paracytic superficial, orientation random, distribution diffuse, stomata with arresting development present, S.I. 18.35, S.F. 178. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 3-7, walls arched, F-type. Epidermal cells chlorophyllous, sides 5-8, walls straight and arched (Fig.17b).

Pavetta breviflora  DC.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-7, walls undulate, sinuses U-shaped, (Fig.19a).

Leaf Abaxial: Stomata mostly paracytic, rarely pericytic, superficial, orientation random, distribution diffuse, S.I. 17.40, S.F. 180. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 4-7; walls undulate, sinuses U-shaped, F-type. Epidermal cells are, chlorphyllous, sides 5-8, walls undulate, sinuses U-shaped (Fig.18b).

Pavetta tomentosa  Roxb. ex J. E. Smith: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 5-8, walls undulate, sinuses U and V-shaped, foot cells of trichome is present (Fig. 19a).

Leaf Abaxial: Stomata mostly paracytic, rarely pericytic, superficial, orientation random, distribution diffuse, S.I. 15.90, S.F. 170. Guard cells elliptical, chlorophyllous. Subsidiaries cells 2, sides 2-8, walls undulate, sinuses U, U-shaped, F-type. Epidermal cells are, chlorphyllous, sides 5-8, walls undulate, sinuses U and V-shaped (Fig. 19b).

Pentas carnea  Benth.: Leaves hypostomatic.

Leaf Adaxial: Epidermal cells chlorophyllous, sides 4-7, walls arched and undulated, sinuses U-shaped (Fig. 20a).

Leaf Abaxial: Stomata usually paracytic, superficial, orientation random, distribution diffuse, rarely stomata with single guard cells present, S.I. 19.48, S.F. 205. Guard cells elliptical, chlorophyllous. Subsidiaries cells2, sides 3-5, walls undulate, sinuses, U-shaped, F-type. Epidermal cells chlorophyllous, sides 4-10, walls undulate, sinuses U-shaped (Fig. 20b).
Table 1. Stomatal Index and Stomatal Frequency (Per sq.cm.)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Plant Species Studied</th>
<th>Stomatal Index</th>
<th>Stomatal Frequency</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Leaf Adaxial</td>
<td>Leaf Abaxial</td>
</tr>
<tr>
<td>1</td>
<td>Canthium coromandelcum</td>
<td>21.10</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>Canthium rheedei</td>
<td>24.08</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>Chassalia ophiomyxoides</td>
<td>22.15</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>Coprosma lucida</td>
<td>22.43</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>Gardenia gummifera</td>
<td>19.38</td>
<td>A</td>
</tr>
<tr>
<td>6</td>
<td>Gardenia jasminoides</td>
<td>23.80</td>
<td>A</td>
</tr>
<tr>
<td>7</td>
<td>Gardenia longistyfe</td>
<td>21.25</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>Geophila repens</td>
<td>15.35</td>
<td>A</td>
</tr>
<tr>
<td>9</td>
<td>Hakeina cordifolia</td>
<td>20.47</td>
<td>A</td>
</tr>
<tr>
<td>10</td>
<td>Hymanodicynon oitense</td>
<td>17.47</td>
<td>A</td>
</tr>
<tr>
<td>11</td>
<td>Ixora finlaysoniana</td>
<td>16.56</td>
<td>A</td>
</tr>
<tr>
<td>12</td>
<td>Ixora javanica</td>
<td>2.75</td>
<td>18.88</td>
</tr>
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<td>13</td>
<td>Ixora lanceolamia</td>
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<td>A</td>
</tr>
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<td>14</td>
<td>Ixora monticola</td>
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<td>A</td>
</tr>
<tr>
<td>15</td>
<td>Ixora thwaitesii</td>
<td>20.58</td>
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<td>Lucula gratissima</td>
<td>15.49</td>
<td>A</td>
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<tr>
<td>17</td>
<td>Nauclea orientalis</td>
<td>16.35</td>
<td>A</td>
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<td>18</td>
<td>Pavetta brevillora</td>
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<td>Pavetta tomentosa</td>
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<td>20</td>
<td>Pentas carnea</td>
<td>19.48</td>
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DISCUSSION

The paracytic stomatal type (sensu Metcalfe and 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 types e.g. anisocytic, anomocytic, pericytic, desmocytic, parahexacytic-dipolar and amphiparacytic are also observed rarely in few taxa investigated.

Few stomatal abnormalities such as contiguous stomata – (i) amphiparacytic are also observed rarely in few taxa investigated. Additionally, some others. The foliar surfaces are striated on either side in eight species, whereas in rest others leaves are want of striations.

Epidemial cell walls are either undulate or straight. The former case is observed on both surfaces in Canthium rheedei, Gardenia gymnifera, Gardenia jasminoides, Gardenia longistyla, Haldina cordifolia, Hymenodictyon oxiinense, Ixora lanceolaria and Ixora thwaitesi.

Epidermal cell walls are either undulate or straight. The former case is observed on both surfaces in Canthium rheedei, Gardenia gymnifera, Gardenia jasminoides, Gardenia longistyla, Haldina cordifolia, Hymenodictyon oxiinense, Ixora javanica, Pavetta breviflora, Pavetta tomentosa and Pentas carnea. The cell walls are straight on both surfaces in Chassalia ophioxyloides and Geophila repens. They are either straight or undulate 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.

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.

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