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Foliar epidermal investigations in some hitherto unstudied Convolvulaceae-II

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Abstract
The present paper contributes to the anatomy of the family Convolvulaceae.In all, six genera and 10 species have been surveyed for epidermal features in detail. They have been investigated covering stomatal type, index, frequency and number of subsidiaries, cell wall contours and cuticular striations. The leaves are amphistomatic and have commonly paracytic types, apart from rare to occasional occurrence of other stomatal types and abnormalities.

Keywords: Foliar epidermis, Convolvulaceae

INTRODUCTION

The family Convolvulaceae consists of 50 genera 1200 species in the world (Lawrence, 1951). Anatomical investigations prior to 1950 have been summarized by Metcalfe and Chalk. Further studies by Leela and Shanmukha Rao (1994), Inamdar (1969), Pant and Banerjee (1965), Shah (1967), Inamdar and Patel (1971), Singh, Jain and Sharma (1974), Srivastava (1983), Karatela and Gill (1985), Lucansky (1986,1990), Tayade and Patil (2003) have particularly added anatomical information on the epidermis of the family. Still, there are many taxa unstudied on this line.The present investigation is an attempt to contribute to the epidermal features of such taxa.

MATERIALS AND METHODS

The plant materials were procured from Royal Botanic Gardens, Kew, England and Laboratoire de phanerogamie, Paris. Anantpur district of Andhra Pradesh, Toranmal Hills, Nandurbar district, Dhule, Dhule district of Maharashtra (India). Diluted nitric acid and chromic acid (5-10%) were used in different proportions to separate peels after boiling leaf bits in water for about 5-10 minutes. Epidermal peels were stained in safranin (1%) and mounted in glycerine. The stomatal index (SI) was calculated as defined by Salisbury (1927, 1932). The line and cellular sketches were drawn using prism type Camera Lucida. The terms used for describing stomates are Metcalf and Chalk (1950), Van Cotthem (1970) and Stace (1965). The typification of subsidiary cells followed is that of Rammaya and Rajgopal (1980).

OBSERVATIONS

1) *Calystegia affinis* Endl. : (Fig. 1 a-b) Leaves amphistomatic.

Leaf- adaxial: Stomata paracytic, orientation random, distribution diffuse. S.I. 7.44. Subsidiaries mostly 2-3, mostly F-type, walls straight, sides 2-3. Guard cells elliptical, chlorophyllous, pore elongated. Epidermal cells chlorophyllous, sides 5-7, walls straight. Foot cells of trichomes present (Fig. a). Leaf -abaxial : Stomata paracytic,orientation random, distribution all over the surface. S.I. 11.40. Subsidiaries mostly 2-3, mostly F-type, walls undulate, sinous U-shaped, sides 2-3. Guard cells chlorophyllous,elliptical, pore elongated. Epidermal cells chlorophyllous, sides mostly 5-6 rarely-7, walls undulate, sinous U-shaped, thick walled foot cells present (Fig. b).

2) *Cressa cretica* L.: (Fig.2 a-b) Leaves amphistomatic.

Leaf -adaxial: Stomata mostly paracytic, orientation random, distribution diffuse. S.I. 7.19. Subsidiaries mostly 2, F-type, walls straight, sides 3-4. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides mostly 5-6, walls straight, unequal. Foot cells of trichomes present (Fig. a). Leaf-abaxial: Stomata mostly paracytic; orientation random, distribution diffuse.S.I. 10.93. Subsidiaries mostly 2, F-type, walls straight, sides-2-3. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides mostly 6-7, walls straight. Foot cells many, unequal thick walled (Fig. b).

3) *Evolvulus alsinoides* L.: (Fig.3 a-b) Leaves amphistomatic.

Leaf -adaxial: Stomata mostly paracytic, anisocytic, contiguous; orientation random, distribution diffuse. S.I. 10.88. Subsidiaries mostly 2-7, mostly F-type, rarely c-type, walls undulate, sinuses U-shaped, sides 2-3. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides mostly 5-6, walls undulate, sinus U-shaped, unequal foot cells of trichomes preset (Fig. a). Leaf-abaxial: Stomata mostly paracytic, anisocytic and anomocytic, orientation random; distribution diffuse. S.I. 12.33. Subsidiaries mostly 2-6, mostly, F-type, walls undulate, sinus U-shaped, sides 2-3. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-7, walls undulate, sinus U-shaped, thick walled foot cells of trichomes present (Fig. b).

4) *Hewittia sublobata* (L.f.) O.Ktze.: (Fig. 4 a-b) Leaves amphistomatic.

Leaf-adaxial: Stomata paracytic, contiguous, orientation random, distribution diffuse, on and arround mid-vein and veinlets. S.I. 10.12. Subsidiaries mostly 2, mostly F-type, rarely C-type, walls straight, sides 2-3. Guard cells chlorophyllous, ellptical, pore elongated. Epidermal cells chlorophyllous, sides 6-7, walls straight. Foot cells present (Fig. a). Leaf- abaxial: Stomata paracytic; contiguous;

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orientation random, distribution diffuse, on and arround mid-vein and veinlets, S.I. 16.57. Subsidiaries 2, mostly F-type, rarely C-type, sides 2-3. Guard cells chlorophyllous, elliptical, pore elongated. Foot cells present (Fig. b).

5) *Hildebrandtia valo* Deroin.: (Fig.5 a-b) Leaves amphistomatic.

Leaf-adaxial: Stomata paracytic; orientation random, distribution diffuse, on and arround mid-vein. S.I. 5.02. Subsidiaries 2, mostly F-type, walls slightly undulate, sides 2-3. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, slightly undulate, thick walled. Foot cells present, ssent (Fig. a). Leaf-abaxial: Stomata paracytic, contiguous; orientation random, distribution diffuse. S.I.11.65. Subsidiaries 2, cells slightly undulate, mostly F-type, rarely C-type, sides 2-3. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, slightly undulate. Foot cells of trichomes present, striations present (Fig. b).

6) *Ipomoea biloba* Forsk.: (Fig.6 a-b) Leaves amphistomatic.

Leaf- adaxial: Stomata mostly paracytic; orientation random, distribution diffuse. S.I. 5.06. Subsidiaries 2, cells mostly F-type, walls straight, sides 2-3. Guard cells chlorophyllus, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, walls straight, thick walled, scales present (Fig a). Leaf -abaxial: Stomata mostly paracytic; orientation random, distribution diffuse. S.I. 13.92. Subsidiaries 2, cells mostly F-type, rairely C-type, sides 2-3, wall straight. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, walls straight, slightly undulate, many scales present (Fig. b).

7) *Ipomoea clarkei* Hook.*f*. : (Fig 7 a-b) Leaves amphistomatic.

Leaf-adxial: Stomata mostly paracytic; orientation random, distribution diffuse, S.I. 5.34. Subsidiaries cells-2, mostly F-type, sides 2-3 to 4, walls undulate, sinuses U-shaped, sides 5-6. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, walls undulate, sinuses U-shaped. Foot cell of trichomes present (Fig. a). Leaf-abaxial: Stomata mostly paracytic; orientation random, distribution diffuse. S.I. 14.93. Subsidiaries cells 2, mostly F-type, rarely C-type, walls undulate, sinuses U-shaped, sides 2-3 or 4. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, walls undulate, sinuses U-shaped. Foot cells of trichomes present (Fig.b).

8) *Ipomoea illustris* (Clarke) Prain.: (Fig. 8 a-b) Leaves amphistomatic.

Leaf-abaxial: Stomata paracytic; orientation random, distribution diffuse. S.I. 5.23. Subsidiaries 2, mostly F-type, rarely C-type, walls undulate, sinuses U-shaped, sides 6-7. Guard cells chlorophyllous, walls undulate, sinsuses U-shaped, sides- 5-6. Foot cells present, striations present (Fig. a). Leaf-abaxial: Stomata paracytic; orientation random, distribution diffuse. S.I. 14.13. Subsidiaries- 2, mostly F-type, walls straight, sides 6-7. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 6-7, walls straight (Fig. b).

9) *Ipomoea mauritiana* Jacq.*:* (Fig. 9 a-b) Leaves amphistomatic.

Leaf- adaxial: Stomata paracytic; orienation random, distribution diffuse. S.I. 3.70. Subsidiaries-2, mostly F-type, walls slightly undulate, sinuses U-shaped, sides 5-7. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, slightly undulate, sinuses U-shaped, sides- 5-7. Epidermal cells straight near mid-vein and veinlets (Fig. a). Leaf -abaxial: Stomata paracytic; orientation random, distribution diffuse. S.I.14.23. Subsidiaries- 2, mostly F-type, walls undulate, sinuses U-shaped, sides- 5-6. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 4-5, wall undulate, sinuses U-shaped, striations present. Epidermal cells straight near mid-vein and veinlet (Fig. b).

10) *Ipomoea triloba* L. : (Fig. 10 a-b) Leaves amphistomatic.

Leaf-adaxial: Stomata mostly paracytic; orienation random, distribution diffuse. S.I. 7.03. Subsidaries 2-3, mostly F-type, walls undulate, sides 5-6. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-7, walls undulate, sinuses U- shaped. Striations present (Fig. a). Leaf-abaxial: Stomata mostly paracytic, contiguous, orientation random, distribution diffuse S.I. 12.80. Subsidiaries 2-3 , mostly F-type, rarely C- type, walls undulate, sides 5-6. Guard cells chlorophyllous, elliptical, pore elongated. Epidermal cells chlorophyllous, sides 5-6, rarely 7, walls undulate, sinuses U-shaped, striations present. Foot cells present (Fig. b).

Table-1: Stomatal Index

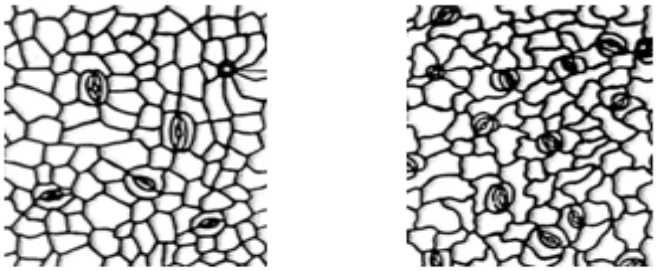
Sr.No	Name of Plants	Upper Epidermis	Lower Epidermis
1	*Calystegia affinis* Endl.	7.44	11.46
2	*Cressa cretica* L.	7.19	10.93
3	*Evolvulus alsinoides* L.	10.88	12.33
4	*Hewittia sublobata* (*L.f.*) O.Ktze.	16.12	16.57
5	*Hildebrandtia valo* Deroin.	5.02	11.65
6	*Ipomoea biloba* Forsk.	5.06	13.92
7	*Ipomoea clarkei* Hook.*f*.	5.34	14.93
8	*Ipomoea illustris* (Clarke) Prain,Beng.	5.23	14.13
9	*Ipomoea mauritiana* Jacq.	3.70	14.23
10	*Ipomoea triloba* L.	7.03	12.80

* The figures relate to a mean of ten counts.

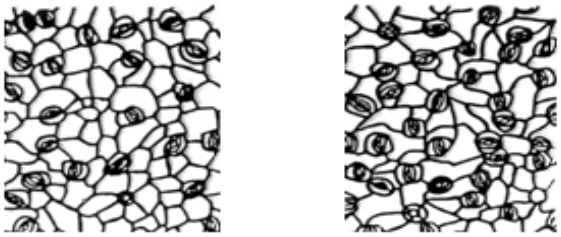
Table-2: Stomatal Frequency (per sq. cm.)

Sr.No	Name of Plants	Upper Epidermis	Lower Epidermis
1	*Calystegia affinis* Endl.	2.9	5.3
2	*Cressa cretica* L.	5.6	7.2
3	*Evolvulus alsinoides* L.	3.1	3.9
4	*Hewittia sublobata* (*L.f.*) O.Ktze.	5.3	12.4
5	*Hildebrandtia valo* Deroin.	2.6	10.6
6	*Ipomoea biloba* Forsk.	3.8	5.9
7	*Ipomoea clarkei* Hook.*f.*	2.0	5.7
8	*Ipomoea illustris* (Clarke) Prain,Beng.	2.0	11.9
9	*Ipomoea mauritiana* Jacq.	0.9	8.6
10	*Ipomoea triloba* L.	2.5	8.3

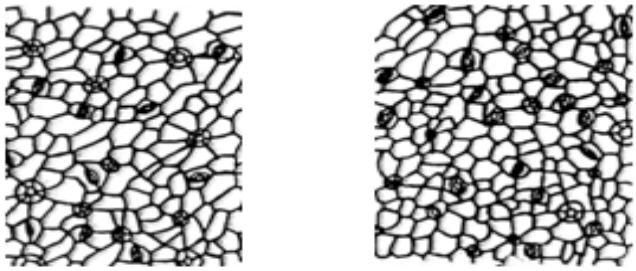
* The figures relate to a mean of ten counts.



a FIG.1 b

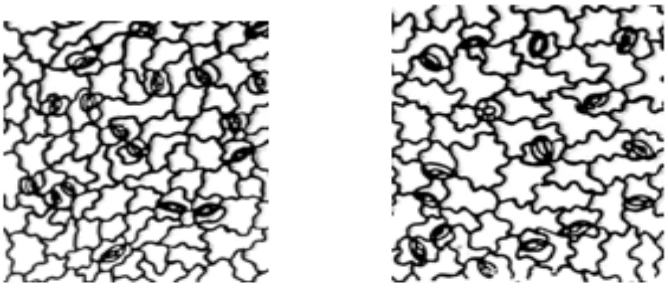


a FIG.4 b

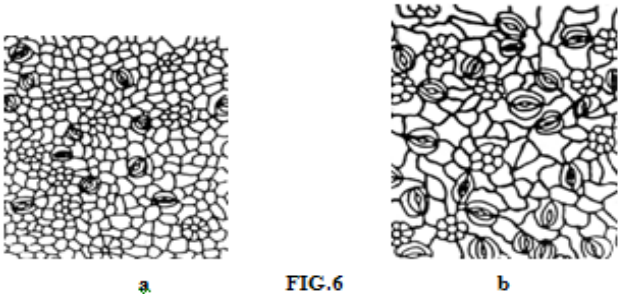


a FIG.2 b

a FIG.5 b



a FIG.3 b



a FIG.6 b

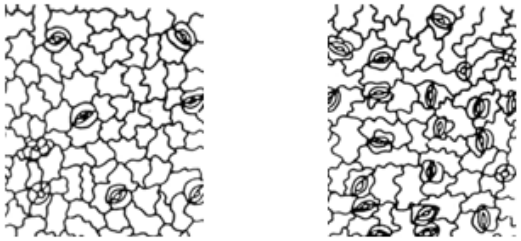


FIG.7

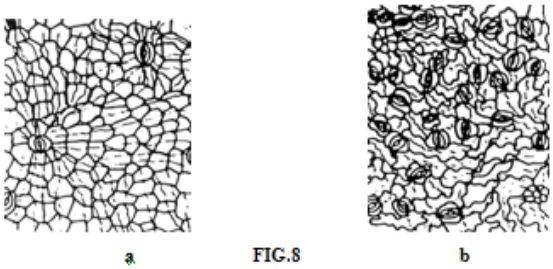


FIG.8

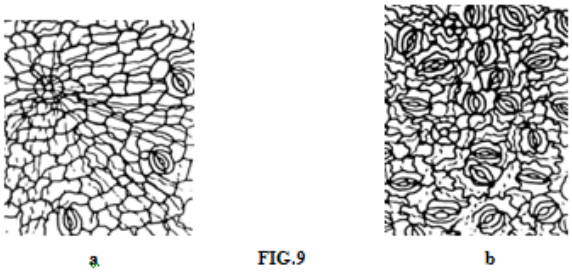


FIG.9

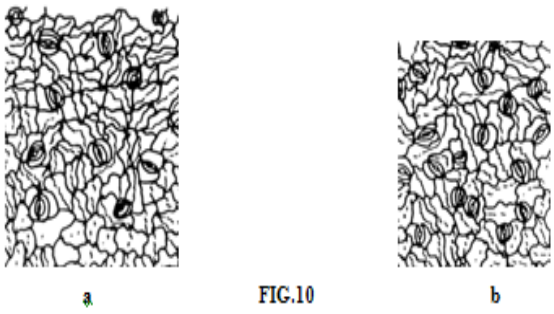


FIG.10

DISCUSSION

The epidermal cells on both sides in the intercostal zone of leaves are usually pentagonal to hexagonal and isodiametric or uneven shaped rarely. They are rarely septa to decagonal. Cell walls are mostly straight and sometimes undulate. The cell walls are straight on both sides in *Calystegia affinis* and *Hewittia sublobata*. The walls are undulate on both sides in *Evolvulus alsinoides, Hildebrandtia valo, Ipomoea clarkei, I. mauritiana* and *I. triloba*.The cell walls are straight on adaxial surface and undulate abaxially in *Calystegia affinis* and *Ipomoea biloba.*They are undulate adaxially and straight abaxially in *Ipomoea illustris.* In few others, they are usually straight but slightly undulate. The sinuses of undulate walls are consistently U-shaped. Metcalfe and Chalk (1950) also mentioned their occurrence in some taxa.

The intercostal epidermal cells are similar in size on both surfaces in majority of species. These cells are smaller adaxially and larger abaxially in *Evolvulus alsinoides, Ipomoea biloba* and *I. illustris.*

The leaves in all the species investigated are amphistomatic. The stomates generally show random orientation and distributed diffusely. They are observed in the intercostal region and around the veins and veinlets also. But they are never observed on the veins and veinlets. Stomata are generally paracytic on adaxial and abaxial foliar surfaces in the taxa investigated. Different stomatal types are also observed rarely in few species.They are rarely anisocytic on the upper surface and anisocytic and anomocytic on lower surface, apart from paracytic ones in case of *Evolvulus alsinoides.* Rarely, stomata are anomocytic on lower foliar surface of *Ipomoea clarkei.*

Metcalfe and Chalk (1950), Leela and Shanmukha Rao (1994), Inamdar (1969), Pant and Banerji (1965), Shah (1967), Inamdar and Patel (1971), Singh, Jain and Sharma (1974), Srivastava (1983), Karatela and Gill (1985), Lucansky (1986, 1990),Tayade and Patil(2003) also described the stomata in the family Convolvulaceae as paracytic and leaves amphistomatic. They also reported occurrence of anisocytic, anomocytic and brachyparacytic types rarely. The occurrence of different types of stomata on the same surface of the leaf in this family is also noted by Pant and Banerji (1965) and Shah (1967). This is also reported elsewhere in the Dicotyledonous families (Tognini 1897; Solereder 1908; Inamdar and Patel 1969; Patel and Inamdar 1971; Shah and Gopal 1971; Rajgopal 1973; Shanmukha Rao and Ramayya 1981; Raju and Rao 1977; Shah 1967).Guard cells are generally elliptical and chlorophyllous, their inner walls being generally thicker.

Ramayya and Rajagopal (1980) categorized the subsidiary cells into seven types. They are usually F-type in the species investigated. However, in some species, apart from F-type, rarely C-type is noted on one or both surfaces. In *Hewittia sublobata,* F-type occurs predominantly and the C-type as rare on both foliar surfaces. This condition is recorded only on the upper surface in *Evolvulus alsinoides* and *Ipomoea illustris*. Similarly, these types occur exclusively on the lower foliar surface in *Hidebrandtia valo, Ipomoea biloba, I. clarkei, I. mauritiana* and *I. triloba*. The number of subsidiary cells is mostly two; rarely they are one, three or four depending upon the types of stomata on the foliar surface. The subsidiaries are mostly four to six sided; rarely they are two to five, three to four, three to six and six to seven sided. The walls are either straight or undulate. The walls are either straight on both foliar surfaces in *Cressa cretica, Hewittia sublobat* and *Ipomoea biloba*.The walls of subsidiaries are undulate on both foliar surfaces e.g. in *Evolvulus alsinoides, Hildebrandtia valo, Ipomoea clarkei, I. mauritiana* and *I. triloba*. They are usually undulate only on upper foliar surface in *Ipomoea illustris.* They are usually undulate only on lower foliar surface in *Calystegia affinis*.

The highest stomatal index 16.12 is observed on adaxial surface in *Hewittia sublobata,* whereas it is the lowest 1.40 in case of *Ipomoea mauritiana.* On abaxial side, the highest stomatal index is 16.57 in case of *Hewittia sublobata* and the lowest is 8.15 in *Ipomoea triloba.*(Table.1).The highest stomatal frequency (per sq. cm.) is 5.3 on adaxial epidermis in *Ipomoea triloba,* whereas it is the lowest 1.1 in *Ipomoea illustris.* The highest stomatal frequency 12.4 is observed in *Hewittia sublobata* on abaxial epidermis, whereas it is the lowest 3.9 in case of *Evolvulus alsinoides.*(Table.2).Few stomatal abnormalities are also recorded in the taxa investigated. They fall in the category of contugious stomata. In this, two or three adjacent

stomata abut each other laterally or polaro-laterally. The former is recorded in case of *Calystegia affinis, Ipomoea biloba, I. clarkei* and *I. triloba*. The latter is observed in case of *Hewittia sublobata, Hildebrandtia valo, Ipomoea illustris and I. mauritiana*. Stomatal abnormalities are by now are thought to be frequent in Angiosperms. They are conceived to be freaks during stomatal ontogeny.

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