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# FOLIAR EPIDERMAL FEATURES OF VITACEAE AND TAXONOMIC POSITION OF LEEA

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The present investigation brings out the foliar epidermal features of 10 species belonging to 5 genera of Vitaceae. Leaves of 5 species are amphistomatic whereas those of the remaining species are hypostomatic. Four stomatal types viz. aniso-, anomo-, cyclo- and tetracytic, are encountered in the study. Predominance of tetra-, anomo- and cyclocytic stomata and low frequency of stomata characterise all the species except *Leea*. On the contrary, *Leea indica* is distinguished by higher stomatal frequency and predominance of anisocytic stomata. Druse idioblasts occur in *L. indica* (both surfaces) and *Cissus repanda* (adaxial). *C. rotundifolia* possesses the druse and raphide idioblasts in the inner layer of biseriate epidermis. Mucilaginous idioblasts are seen only in *C. setosa*. Eight types of hairs have been reported in the present study. Separation of *Leea* from Vitaceae is justified by the evidences from epidermal morphology and other disciplines of analysis.

Key words : Vitaceae; foliar epidermis; taxonomic position of Leea.

A number of species of Vitaceae have been subjected to the studies pertaining to anatomy (Metcalfe & Chalk, 1950), floral anatomy (Kashyap, 1957), floral morphology and embryology (Nair, 1968), cytology (Cody & Horner, 1983) and palynology (Erdtman, 1952; Tarnavschi & Petria, 1960). Shah (1954) reported septate epidermis in the tendrils of Vitis repens and Janardhanan et al. (1981) recorded a number of stomatal abnormalities in C. quadrangularis, yet another species. Farooqui (1982) justified the separation of Leea from Vitaceae on the basis of stomatal ontogeny. However, there appears to be no other publication on the foliar epidermis; hence the present study has been taken up to investigate the epidermal morphology of 10 species viz. Cayratia carnosa, C. pedata, Cissus pallida, C. quadrangularis, C. repanda, C. rotundifolia, C. setosa, Leea indica, Tetrastigma lanceolarium and Vitis vinifera, with a view to bring out the diversity in its organisation and taxonomic significance.

## **MATERIALS AND METHODS**

Mature and young leaves (to study the caducous hairs in some species) of 10 species were collected and fixed in FAA. The epidermal peels of fresh and fixed leaves (base, middle and tip) were removed by making an oblique cut in them. In such taxa where peels could not be obtained by the above method, the leaf bits were treated with NaOH (2.5%) and chloral hydrate (30%) solutions respectively. The peels/cleared bits were washed in water, stained in 1% aqueous safranin, mounted in 50% glycerine and sealed with DPX. Free hand vertical sections of leaves were also taken simultaneously to supplement the information.

## **OBSERVATIONS**

Costal cells of both the surfaces of all species studied are almost similar in being axially elongated, narrow, longer than broad, rectangular to rhomboidal and straight-walled. However, those of *Cissus rotundifolia* and *T. lanceolarium* are sometimes broader than long.

The abaxial, non-costal cells are isodiametric to rectangular with thin and straight, slightly arched or sinuous walls; however, in *T. lanceolarium* these are thick and arched. These are small and more frequent in all the species except in *C. rotundifolia* which is distinguished by low frequency and comparatively larger size of abaxial cells.

The adaxial, non-costal cells are generally large with thin and straight or slightly sinuous walls in most of the species; however, these are thick and straightwalled in *C. repanda* and *T. lanceolarium*. The leaves of *C. rotundifolia* and *L. indica* are distinguished by high frequency and small size of adaxial cells. Cuticular striations have been observed in both surfaces in six species, being prominent in *Cayratia carnosa*, *Cissus pallida* (Figs. 10,11), *C. repanda* and

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#### Table 1: Foliar epidermal features of Vitaceae and Leea

Species	Sur-	Non-	Stomata/		% of stomatal types			Hair types (both surfaces)
	face	costal cells/mm <sup>2</sup> .	mm²	Aniso-	Алото-	Cyclo-	Tetra-	
Cayratia carnosa Gaenep.	ab	1209	94	2	30		68	Unicellular conical and
	ađ	517	27	-	14	-	86	uniseriate conical (ng)
C. pedata Jusc.	ab	1422	273	18	58		24	Uniseriate conical
	ad	618	-	-		-	-	tubercled (ng)
Cissus pallida Planch.	ab	1397	123	-	-	55	45	Uniseriate uncinate (ng)
	ad	858	35	-	-	37	63	
C. quadrangularis L.	1b	999	40	-	48	-	52	
	ad	670	21		31	-	69	
C. repanda Vahl.	ab	670	55	-	81		19	Unicellular bi-armed (ng)
	ad	364	-	-	2.4	-	-	
C. rotundifolia (Forsk.) Vahl.	ab	1763	32	-		100	-	UniceIlular bi-armed (ng)
	ad	2172	27	-		100		encentital or annea (ng)
. setosa Roxb.	ab	604	109		39		61	Multiseriate (gl)
	ad	513	58		31		69	
Tetrastigma lanceolarium	ab	2028	169	-		100		Uniseriate short conical
Planch.	ad 1729 - and uniceriate lo	and uniseriate long warty (ng						
ab 1293 82 - 87 -	13	unicellular long coiled						

Vitis vinifera L.	ad	843			-	-	-	and uniseriate conical (ng)
Leea indica Merr.	ab	1823	263	79	2		19	
X X	ad	1910		-		-	-	

-, Absent; ab, abaxial; ad, adaxial; gl, glandular, ng. non-glandular.

V. vinifera; inconspicuous in C. quadrangularis and C. setosa. These arise either from the outer walls of guard cells (C. quadrangularis and C. pallida; Fig. 10) or from hair bases (C. carnosa) or from the centre of the cells (C. pallida; Fig. 11 and C. repanda).

As seen in a v.s., both the epidermis are uniseriate in the leaves of all the species except those of C. *rotundifolia* which are biseriate (Fig. 27) with small cells of outer layer and large cells of inner layer. The adaxial epidermis of C. *rotundifolia* is septate whereas that of C. *pallida* is septate and papillate (Fig. 23).

Mucilaginous idioblasts have been encountered on the adaxiao surface of *C. setosa* whereas druse idioblasts are seen on both the surfaces of *L. indica* (Fig. 28) and in the adaxial surface of *C. repanda* (Fig. 25). Druse and raphide idioblasts occur in the inner layer of adaxial epidermis in *C. rotundifolia* (Fig. 27). Leaves of five species viz. *Cayratia carnosa*, *C. pallida*, *C. quadrangularis*, *C. rotundifolia* and *C. setosa* are amphistomatic. Amongst the remaining five species which are hypostomatic, the leaves of *Cayratia pedata* (Fig. 19) and *L. indica* show a few stomata on the adaxial surface as well, especially in the vicinity of major veins. Of the four stomatal types, viz. tetra-, anomo-, cyclo- and anisocytic, the first two are predominant in seven species occurring in combination with one or more of the other types of stomata (Table I). The leaves of *C. rotundifolia* (Fig. 12) and *T. lanceolarium* (Fig. 8) show only cyclocytic stomata, whereas those of *L. indica* possess anisocytic type predominantly. In some species anomo- and tetracytic stomata become cyclocytic by the tangential supplementary divisions in some or all the subsidiaries. However, in the leaves of *L. indica* anisocytic type is predominant without any supplementary division. The stomatal frequency is higher in *C. pedata* and *L. indica* while it is low in *Cissus rotundifolia* (Table I). Usually stomata are in level with epidermis but in two succulent species (*C. quadrangularis* and *C. setosa*) some stomata are slightly sunken (Fig. 6).

A number of stomatal abnormalities have been encountered infrequently in the leaves of all the species (both the surfaces) except those of *C. rotundifolia*, *T. lanceolarium* and *V. vinifera*. These include stomata with single guard cell (Fig. 15), stomata with one guard cell divided (Fig. 16), degenerated stomata with occluded pore (Fig. 3), shrivelled stomata, contiguous stomata (oblique; Fig. 17 and juxtoposed; Fig. 19), stomata with one undulated guard cell (Fig. 20) and stomata with cytoplasmic connection (Fig. 18). These abnormalities are found to be more common in two succulent species (*C. quadrangularis* and *C. setosa*). Foliar epidermal features of Vitaceae and Leea

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Figs. 21-30. V.s. of lamina. 31 - 38. Hairs. 21, 35. Cayratia carnosa 22, 34. Cayratia pedata 23, 37. Cissus pallida 24. Cissus quadrangularis 25. Cissus repanda 26, 38. Cissus setosa 27, 36. Cissus rotundifolia 28. Leea indica 29, 31, 32. Tetrastigma lanceolarium 30, 33. Vitis vinifera (al. anisocytic stoma; ao, anomocytic stoma; pp. papillate epidermal cell; sd. supplementary tangential division; se, septate epidermal cell : ss, sunken stoma; tc, tetracytic stoma; th, tubercled hair; uc, undulated guard cell; wh, warty hair)

#### Foliar epidermal features of Vitaceae and Leea

Table 2: Differences between other members of Vitaceae and Leea

Features	Vitaceae	Leea			
Habit	Tendril climbers	Shrubs or small trees without tendrils			
Leaf	Simple or palmate	Pinnate with sheathing leaf bases			
Stipule	Small and caducous	Large and adnate to the petiole			
Diameter of vessels (Metcalfe & Chalk, 1950)	Large (more than 200 µ)	Small (less than 100 u)			
Inflorescence	Leaf opposed	Terminal or axillary			
Disc	Present	Absent			
Androecium	Stamens free, antipetalous	Synandrous, obdiplostemonous			
Staminodes	Absent	Present in the inner whorl			
Microspores (Erdtman, 1952)	Subprolate	Spheroidal			
Ovary	Bicarpellary, bilocular	Polycarpellary, multilocular			
Ovule	One in each locule	More than one in each locule			
Fruit	1-3 seeded	4-6 seeded			
Seed coat (Nair, 1968)	Crystalliferous with raphides	Non-crystalliferous			
Foliar epidermis (Present study)					
Non-costal cells/mm <sup>2</sup>	a leader to be a second to be a				

Abasial Adaxial
Stomatal frequency Abaxial Adaxial
Stomatal/Size Abaxial
Predominant stomatal types
Cyclocytic type
Hairs
Stomatal ontogeny (Parveen Farooqui, 1982)

Mostly low Mostly low

Mostly low

Mostly large Tetra-, cyclo- or anomocytic Mostly present Mostly present Mesoperigenous Unilabrate High High

High

Small Anisocytic Absent Absent or rare Mesoperigenous trilabrate

Leaves of C. quadrangularis and L. indica are glabrous whereas the other species show hairs of one or more types. The latter are caducous and found only in the young leaves in C. repanda, C. rotundifolia and C. *pallida* and persistent in the remaining five species. These are more frequent in C. carnosa, C. pedata and C. setosa and infrequent in T. lanceolarium and V. vinifera. Two types viz. unicellular, conical and uniseriate conical (Fig. 35) hairs are recorded in C. carnosa; uniseriate, conical tubercled type in C. pedata (Fig. 34); long, multiseriate, glandular type in C. setosa (Fig. 38); unicellular, bi-armed type in C. repanda and C. rotundifolia (Fig. 36); uniseriate, conical curved (uncinate) type in C. pallida (Fig. 37); uniseriate, short conical and uniseriate long, conical, warty hairs in T. lanceolarium (Figs. 31,32); unicellular long coiled flat ribbon-like hairs (Fig. 33) which give spider web-like appearance to the lamina and

uniseriate conical type in V. vinifera. DISCUSSION

The epidermis is uniseriate in all the species except C. rotundifolia (biseriate on both the surfaces) where the cells of the outer layer are small and differentiated into ordinary cells, hairs and stomata whereas those of the inner layer are differentiated into very large cells and idioblasts. Most of the adaxial cells in the leaves of C. pallida are papillate; this is considered as a device to scatter the light (Juniper & Jeffree, 1983). Metcalfe & Chalk (1950) have described the occurrence of mucilaginous idioblasts in the mesophyll of leaf and cortex of the stem but not in the epidermis. On the other hand, Farooqui (1982) has reported druse idioblasts in the leaves of L. macrophylla. The present study reports the occurrence of foliar epidermal mucilaginous idioblasts in C. setosa and druse idioblasts in C. repanda and C. rotundifolia for the first time.

Occurrence of septate epidermis in the leaves of C. pallida and C. rotundifolia (present study) and in the stem epidermis of C. quadrangularis (Farooqui, 1982) does not support the view of Shah (1954) and Chavan & Shah (1955) that the presence of septate epidermis on the concave side of tendrils of V. repens and V. pallida is a structural adaptation for their climbing habit.

The common stomatal type described in this family is ranunculaceous (Metcalfe & Chalk, 1950). Farooqui (1982) reported tricytic (anisocytic) stomata in L. macrophylla and amphicyclic (cyclocytic) stomata (incompletely or completely) in C. quadrangularis. This is contary to the report of Janardhanan et al. (1981) who have reported anomocytic stomata in the leaves of C. quadrangularis. During the present study, one more type, viz. tetracytic, has been added to this family. C. rotundifolia and T. lanceolarium possess only cyclocytic stomata whereas the other species bear three types of stomata. Among the latter species, L. indica is characterised by the predominance of anisocytic stomata and the other seven species are distinguished by the predominance of anomo- and tetracytic types. Some anomo- and tetracytic stomata in the leaves of C. quadrangularis show a tendency to become cyclocytic due to supplementary tangential divisions in the subsidiaries. Cyclocytic (dicyclic) stomata have been reported earlier in xerophytes such as Gnetum, Eucalyptus and some members of Magnoliaceae and Rhizophoraceae (Fryns-claessens & Van Cotthem, 1973) and Coccoloba uvifera (Kannabiran & Ramassamy, 1985). Observation of the cyclocytic (dicyclic) stomata in the xerophytic members viz. C. quadrangularis, C. rotundifolia and T. lanceolarium of the present study supports the view that these subsidiaries may play an effective role in reducing the rate of transpiration. The higher frequency of stomatal abnormalities, observed in the succulent species such as C. quadrangularis and C. setosa suggests that this may be a device to reduce the transpiration rate by

tubercled type (C. pedata); iii. uniseriate, uncinate type (C. pallida) and iv. uniseriate, conical, long, warty hairs (T. lanceolarium).

The earlier studies on palynology (Erdtman, 1952; Tarnavschi & Petria, 1960), wood anatomy (Metcalfe & Chalk, 1950), floral morphology and embryology (Nair, 1968), stomatogenesis in the leaves of Vitaceae including *Leea* (Farooqui, 1982) advocated that the genus *Leea* may be separated from the family Vitaceae and placed in its own family, Leeaceae (Table II). This is substantiated by the present observations of high frequency and smaller size of epidermal cells and predominance of anisocytic stomata in the leaves of *L. indica*.

### REFERENCES

Chavan A R & J J Shah 1955 Septate epidermis and stomata in the tendril of *Vitis pallida* W. & A. : *Curr Sci* **3** 84-85.

Cody A M & H T Horner 1983 Twin raphides in the Vitaceae and Araceae and a model for their growth. *Bot Gaz* 144 318-330.

Erdtman G 1952 Pollen morphology and Plant Taxonomy : Angiosperms. An Introduction to Palynology I Almqvist Wiksells, Stockholm.

Farooqui Parveen F (NEE Kidwai) 1982 Epidermal structure and stomatal ontogeny in some Vitaceae. *Indian J For* **5** 115-119.

Fryns Claessens E & Van W Cotthem 1973 A new classification of the ontogenetic types of stomata. *Bot Rev* 39 71-138.

Janardhanan K, V Gopai & K K Lakshmanan 1981 Little known features in the epidermology of Cissus quadrangularis L. Curr Sci 50 774-775.

Juniper B E & C E Jeffree 1983 Plant Surfaces Edward Arnold, London.

Kannabiran B & V Ramassamy 1985 Morphology and development of foliar epidermis in Coccoloba uvifera L. Phytomorphology 35 3-4/233-237.

### decreasing the area of stomatal opening.

In addition to the four types of hairs recorded by Metcalfe & Chalk (1950) we report the following additional types of hairs for the first time in this family : 1. unicellular, conical, smooth-walled type (C. carnosa); ii. unicellular, conical, straight or curved, Kashyap G 1957 Studies in the family Vitaceae II Floral anatomy of Vitis trifolia Roxb. and V. himalayana Brandis. J Indian bot Soc 36 317-323.

Metcalfe C R & L Chalk 1950 Anatomy of the Dicotyledons Vols I, II, Clarendon Press, Oxford. Foliar epidermal features of Vitaceae and Leea

Nair N C 1968 Contributions to the floral morphology and embryology of two species of *Leea* with a discussion on the taxonomic position of the genus. *J Indian bot Soc* 47 193-205.

Shah JJ 1954 Septate epidermis and collenchyma cells

in the tendrils of Vitis repens W & A. Curr Sci 8 70.

Tarnavschi J & Petria 1960 Contributions to the knowledge of the microsporal structure in the Leeaceae. *Pollen et Spores* 10 221-249.