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SURFACE STRUCTURE OF THE FRUITS OF *IPOMOEA* SPECIES (CONVOLVULACEAE)

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Epidermal features of the fruits of five species of *Ipomoea* have been studied. All the species have variations in their epidermal cell frequency, stomata type, stomatal frequency, stomatal index and trichomes. All these epidermal structures and several stomatal abnormalities have been discussed in detail.

Keywords: Ipomoea; Stomata; Trichome; Striation.

Introduction

Ipomoea is one of the most natural and distinctive genus belonging to the family Convolvulaceae. Patel and Inamdar (1971), Patel *et al.*, (1982) worked out different organs of the Convolvulaceae for the epidermis, but these reports do not bring out any details of outer epidermis of the fruit wall of *Ipomoea*. The present investigation, therefore, has been initiated with a view to check up the plasticity of these characters in different species of the same genus *Ipomoea* available in local areas.

Materials and Methods

Mature fruits of the following five species of *Ipomoea* (*I. obscura* (L.) Kergawl., *I. sinensis* (Desr.) Choisy, *I. sepiaria* Roxb., *I. eriocarpa* R.Br. and *I. hederifolia* (L.) were collected from the University Botanical Garden and from different parts of Vallabh Vidyanagar.

Epidermal peels from basal, middle and terminal parts of the mature fruits were taken from F.A.A. fixed material. Drawings were made from the fresh preparations of epidermal peels under Visopan Microscope. The peels were stained with Delafield's hematoxylin and mounted in pure glycerin. Measurements were taken on Visopan Microscope and frequency of epidermal cells, stomata and trichomes was noted under 400 X Olympus Microscope.

Results and Discussion

Outer epidermis : The outer epidermis is covered with an uniform, thick and striated cuticle. The size of the epidermal cells varies in different species. The maximum epidermal cell frequency is noted in the basal, middle and terminal parts of *I. sinensis* and the minimum in basal part of *I. hederifolia* and middle and terminal parts of *I. obscura*. The highest epidermal cell frequency number amongst all the species is found in

the basal part of *I. sinensis*, while lowest one in the terminal part of *I. obscura* (Table 1) under field area of 400 X Olympus Microscope. These cells are polygonal, isodiametric, sometimes elongated and irregularly arranged in all the species. The cell walls are thin, straight and arched (Figs. 1,3–6), while thin and sinuous in middle and terminal parts of *I. obscura* (Fig. 2).

Trichomes : Two types of trichomes are observed on the fruit wall of *I. eriocarpa* and only one type on *I hederifolia* in its middle and terminal parts, whereas in the basal parts of *I. eriocarpa* and *I. hederifolia*, there are no trichomes. The fruits of *I. obscura*, *I. sinensis* and *I. sepiaria* are atrichomatous. The trichomes are unicellular, straight, long celled, thick walled with acute tip and smooth surface in the middle and terminal parts of *I. hederifolia* and in middle part of *I. eriocarpa* (Figs. 51,52). The frequency of the trichomes increase from middle to terminal part in *I hederifolia* (Table 1). The similar trichomes, but with verrucose thickenings are found in the middle and terminal parts of *I. eriocarpa* (Fig. 53) These trichomes are straight, and their verrucose thickenings are less in the middle part, while verrucose thickenings and frequency of trichomes gradually increase from middle to terminal parts. These trichomes are 2–3 times longer than the former type in the same species of *I. eriocarpa* (Table 1).

Striations : Cuticular striations have been observed in all the species. These striations flow out (in two lateral groups) from the stomata i.e. at right angles to the pore (Fig. 8); at long axes to the pore (Fig. 9); they extend in all directions from the stomata (Fig. 10); and are found extending in all directions from the base of the trichome (*I. eriocarpa, I. hederifolia)* (Fig. 7). These striations are mostly linear while corrugating are seen in middle and terminal parts of *I. obscura* (Fig. 11).

Mature stomata : There is no definite pattern of orientation of stomata on the epidermis. They are oriented irregularly in various directions. Frequency of stomata gradually decreases from basal to terminal parts in all the species. It is found to be highest in the basal and terminal parts of *I. hederifolia* and in the middle part of *I. obscura*. The lowest stomatal frequency is observed in the basal and middle parts of *I sepiaria* and in the terminal part of *I. sinensis*. The maximum stomatal frequency number amongst all species is recorded for the basal part of *I. hederifolia* (23–25), while the minimum for terminal part of *I. sinensis* (2.1) under the field area of 400 X Olympus Microscope. The largest size of the stomata amongst all species is found in the middle part of *I. sepiaria* (36.62 X 25.20 m), while the smallest stomata in the middle part of *I. eriocarpa* (26.54 X 19.42 m). Stomatal index is highest in the basal part of *I. hederifolia* (18 72) and lowest in the terminal part of *I. sinensis* (1.34).

Seven types of stomata namely, anomocytic, anisocytic, paracytic, diacytic, laterocyclic, hemiparacytic and staurocytic have been recorded in *Ipomoea*. Paracytic type is invariably found in all the species investigated

and thus it seems to be dominant on *Ipomoea* fruits.

The anomocytic stomata are monocyclic surrounded by three to five epidermal cells (Figs. 5,25,27), while six epidermal cells are also observed in *I. obscura* (Fig. 19). More than one cycles of subsidiary cells are also noted in *I. sinensis* (Fig. 26). The anisocytic stomata are monocyclic and are surrounded by a ring of three subsidiary cells of which one is distinctly smaller than the remaining two (Figs. 15,28). The paracytic stomata are either monocyclic or partly or completely amphicyclic. The monocyclic paracytic stomata are flanked by two subsidiary cells parallel to the long axis of the guard cells (Fig. 29). The subsidiary cells may be contiguous at both the ends (Fig. 17) as in *I. eriocarpa, I. obscura, I. sinensis* and *I. hederifolia;* or non contiguous at one end (Fig. 16) as in *I. obscura, I. eriocarpa, I. sinensis* and *I. hederifolia;* or non-contiguous at both the ends (Fig. 29) as in all the species. The completely amphicyclic paracytic stomata are flanked by three subsidiary cells, two on one side and the third one on the other side of the guard cell (Fig. 12) as in *I. eriocarpa, I.sinensis* and *I. sepiaria* three subsidiaries on one side and the fourth one on other side are also noticed as in *I. eriocarpa* (Fig 13) The completely amphicyclic stomata are flanked by four to five subsidiary cells, two on each side of the guard cell placed parallel to the pore (Fig 24) as in *I. eriocarpa* and *I. sinensis;* two on one side and three on the other side (Fig. 14) as in *I. sepiaria* and *I. eriocarpa.* The subsidiary cells of amphicyclic stomata are usually semilunar, equal or unequal in size and contiguous or non-contiguous at one or the two ends of the stomata. In paracytic stomata one subsidiary cell may be horse-shoe shaped (Fig. 18) as in *I. obscura* and *I. eriocarpa.*

Laterocyclic stomata are similar to paracytic stomata, in which the two lateral subsidiary cells surround the guard cells completely (Fig. 21). The diacytic stomata are also surrounded by two subsidiary cells, but at right angle to the pore (Fig. 20). The staurocytic stomata with four subsidiary cells oriented in a crossed position to the pore, depending on whether one arm of the cross formed by the radial wall of the subsidiary cells is in line with the line of closure of the guard cells (Figs. 10,22) or at 45° to it (Fig. 23). The hemi-paracytic stomata have only a single subsidiary cell placed parallel to the long axis of the pore (Fig. 30). It may be longer or shorter than the guard cells. Sometimes stomata are found in groups in *I. hederifolia* (Figs. 37,38).

Stomatal abnormalities : The general abnormalities observed include stomata with a single guard cell and pore (Fig 32); one guard cell smaller than other (Fig.31); contiguous stomata juxtaposed (Figs. 46,49); juxtaposed over-lapped (Figs. 39,50); superimposed displaced (Figs. 44,48); at right angles to each other (Fig.42); obliquely placed

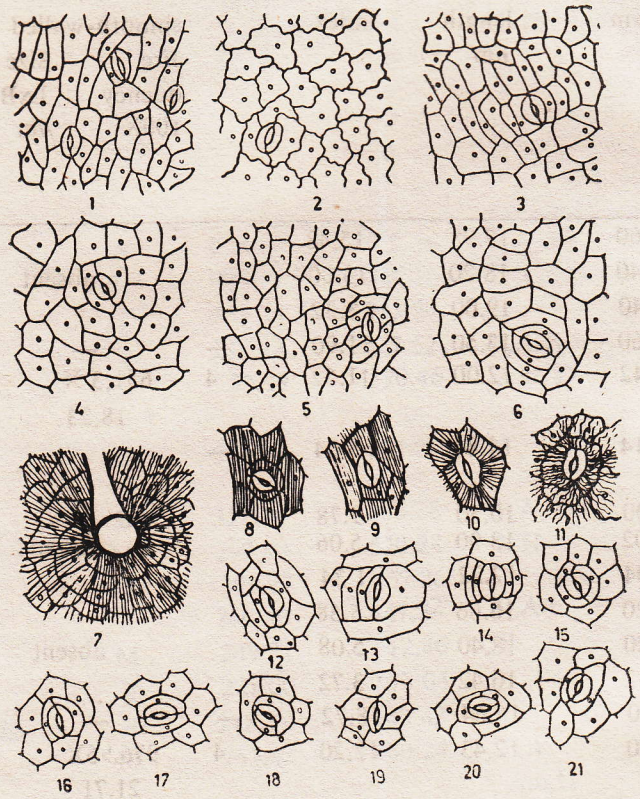
Table 1. Outer epidermal features of the species of I*pomoea*.

Sl. No.	Name of species	Parts	Epidermal cells Frequency 400 X	Area um	Types of stomata	Stomatal frequency 400 X
1.	I. *obscura* (L.) Ker-Gawl	B	258.19	438.48	P,A,Am	21.70
		M	223.21	550.56	D,L,S,H	18.10
		T	164.47	733.60		8.20
2.	I. *eriocarpa* R Br.	B	255.23	427.52	P,A,H	16.16
		M	289.19	390.46	Am, D	11.50
		T	215.17	514 2		5.16
3.	I. *sinensis* (Desr.) Choisy	B	311.00	383.38	P,A,Am	16.00
		M	297.40	520.24	L,H	7.75
		T	305.27	452.26		2.10
4.	I. *sepiaria* Roxb.	B	260 80	447.22	P,Am	7.50
		M	249 21	512.86	S	6.50
		T	221.00	573.04		4.20
5.	I *hederifolia* L.	B	248.34	540 42		23.25
		M	265.42	480.24	P,A Am,H	16 20
		T	281.12	379.50		12.33

B: Basal; M. Middle; T: Terminal, P : Paracytic; Am: Anomocytic; L: Laterocyclic; S: Staurocytic; H: Hemiparacytic; —Not observed.

Stomatal size				Trichomes			
Length μm	Breadth μm	Pore length μm	Stomatal index	Filiform, smooth-walled Frequency 100X	Size LxB μm	Filiform with verrucose thickenings Frequency 100X	Size LxB μm
30.00	19.60	17.98	15.48				
29.60	19.40	18 20	13.00	absent			
32.40	23 40	19.00	8.32				
30.40	20.60	13.50	11.90	—	—	—	—
26.54	19.42	12.00	11.52	4	651.3 X 18.23	10	1302.6X 21.71
30.40	19.14	14.84	5.04	—		41	1953.9X 21.71
27.00	21.00	10.50	9.78				
31.02	17.02	13.00	5.06	absent			
29.04	17.04	12.22	1 34				
32.00	23.20	16.66	5.58				
36.62	25.20	18.40	5.08	absent			
30.24	20.42	16.42	3.72				
30.20	24.40	16.64	18.72	—	—		
30.40	22.10	12.43	12.20	4	976.95X 21.71		absent
30 41	24.20	16.04	8.40	16	976.95X 21.71		

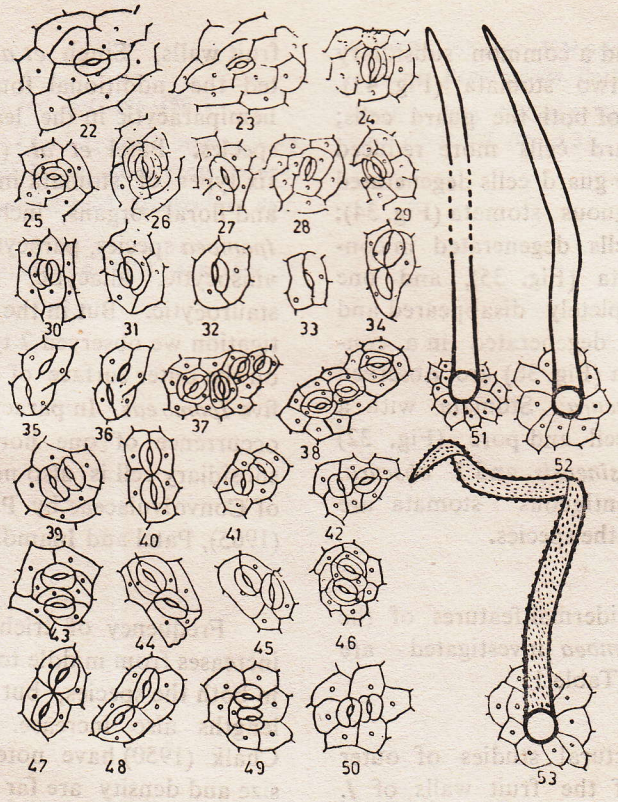
D: Diacytic;



Figs. 1-53. Epidermal structures of outer surface of pericarp in *Ipomoea* species (Figs. 1,2,9,11,16-20,22,23,31-36, 44,45. I. *obscura* (L.) Ker-gawl; 3 10, 27,47,48. I. *sepiaria* Roxb ; 4,28-30,37, 38,46,51. I *hederifolia* L.; 5,21 24-26, 49,50. I. *sinensis* (Desr.) Choisy.; 6-8, 12-15,39-43, 52,53. I. *eriocarpa* R.Br.,

Figs. 1-21 (500X)

Figs. 1-6. Epidermal structures; 7. Striations flowing out from all around the base of trichome; 8 Paracytic stomata and striations flowing out from the guard cells at right angle to the pore; 9. Diacytic stomata and striations flowing out from the guard cells parallel to the long axis of the pore; 10. Staurocytic stomata and striations extending in all directions of stomata; 11. Anomocytic stomata and corrugated striations; 12 14. Paracytic stomata; 15. Anisocytic stomata; 16,17 Paracytic stomata; 18. Paracytic stoma with one subsidiary cell horse-shoe shaped; 19. Anomocytic stomata with six surrounding cells; 20. Diacytic stomata; 21. Laterocyclic stomata.



Figs. 22-50 (500x)

Figs. 22,23. Staurocytic stomata; 24 Paracytic stomata. 25. Anomocytic stomata with three surrounding cells; 26. More than one cycles of subsidiary cells; 27. Anomocytic stomata with five surrounding cells; 28. Anisocytic stomata; 29. Paracytic stomata; 30. Hemiparacytic stomata; 31. Stomata with a smaller guard cell; 32. Stomata with single guard cell and pore; 33. Stomata with both the guard cells. degenerated and one reduced; 34. Three guard cells degenerated in contiguous stomata; 35. All the guard cells degenerated in contiguous stomata; 36. Contiguous stomata with three guard cells degenerated and one disappeared; 37,38. Stomata in groups; 39,50. Juxtaposed overlapped contiguous stomata; 40,47. Super imposed contiguous stomata 41, 45. Obliquely placed contiguous stomata; 42. Contiguous stomata placed at right angle to each other; 43. A common subsidiary cell between two stomata; 44, 48. Superimposed displaced contiguous stomata; 46, 49. Juxtaposed contiguous stomata, 51,52. Unicellular, filiform and thick walled trichomes with acutetip and smooth surface. 125x; 53. Unicellular, filiform and thick walled trichome with verru cose thickening. 125x.

(Figs. 41,45) and a common subsidiary cell between two stomata (Fig. 43). Degeneration of both the guard cells; one of the guard cells more reduced (Fig. 33), three guard cells degenerated from the contiguous stomata (Fig. 34); all the guard cells degenerated in contiguous stomata (Fig. 35), and one guard cell completely disappeared and the rest three degenerated in a contiguous stomata (Fig. 36) are observed only in *I. obscura*. Stomata with a single guard cell and pore (Fig. 32) observed in *I. sinensis* and *I. obscura*, while the contiguous stomata are observed in all the species.

Various epidermal features of the species of *Ipomoea* investigated are summarized in Table 1.

From structural studies of outer surface view of the fruit walls of *I. obscura* (L.), *I. hederifolia* (L.), *I. eriocarpa* R. Br, *I. sepiaria* Roxb. and *I. sinensis* (Desr.) Choisy. it is found that the paracytic type of stomata on the fruit walls of *Ipomoea* is most common. But occasionally anomocytic anisocytic, hemiparacytic and rarely laterocyclic, diacytic and staurocytic stomata also occur.

According to Metcalfe and Chalk (1950), in the leaves of Convolvulaceae, the stomata are mostly of rubiaceous type, less frequently cruciferous type and occasionally of ranunculaceous type. Inamdar (1968) observed these three types of stomata in foliar and floral organs of *Ipomoea*, but not on the fruit walls. Singh *et al.* (1974) reported the additional fourth type viz., hemiparacytic in the leaves of *Ipomoea* species. Patel *et al.* (1982) observed six types of stomata in the vegetative and floral organs, including fruits of *Ipomoea* species, paracytic, anomocytic, anisocytic, diacytic, tetracytic and staurocytic. But in the present investigation we observed 7 types of stomata on the outer surface of the pericarps of five *Ipomoeas*. In paracytic stomata the occurrence of one horse-shoe shaped subsidiary cell is also noted in the leaf of Convolvulaceae by Pant and Banerji (1965), Patel and Inamdar (1971).

Frequency of trichomes generally increases from middle to terminal parts in both the species, but in I. *eriocarpa* lengths also increase. Metcalfe and Chalk (1950) have noted that length, size and density are far more variable in response to varied environmental conditions than are the types of trichomes. Two types of trichomes are observed; long,filiform, unicellular with thick walls and acute tip in I. *eriocarpa* and I, *hederifolia*; and these trichomes with verrucose wall thickenings in I. *eriocarpa*.

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References

Inamdar JA 1968, *Ind. Bot Soc.* 158 1

Metcalfe CR and Chalk L 1950, *Anatomy of Dicotyledons* Vol. I, Clarendon Press Oxford.

Pant DD and Banerji R 1965, *Senckenberg Biol.* 46 155.

Patel RC and Inamdar JA 1971 *Ann. Bot. 35* 389.

Patel RC, Shenoy KN and Inamdar JA 1982, *Feddes Reportorium*, Berlin, Marz. 93 99.

Singh V, Jain DK and Sharma Meena 1974, *Bangladesh J. Bot. 3* 31.