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STRUCTURE AND ONTOGENY OF STOMATA ON FLORAL PARTS OF *NICOTIANA TABACUM* L. AND *SOLANUM XANTHOCARPUM* SCHRAD. AND WENDL.[1]

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ABSTRACT

Developme tal studies of floral stomates in the two members of Solanaceae have been made. Three types of stomata: anisocytic, anomocytic and paracytic, have been recorded. However, no stomates of the diacytic type are noticeable. Development of anomocytic stomata is haplocheilic and that of the other types is syndet ocheilic. A normal stomtes with o e guard cell and with both guard cells degenerated are noticed occasionally. Contiguous stomata are frequent in *N. tabacum* and rare in *S. xanthocarpum*. While on the pericarp of *N. tabacum* all the aforesaid type are present, none could be seen on that of *S. xanthocarpum*.

INTRODUCTION

Stomatal apparatus in various families has been discussed by several workers during the last two decades. Literature regarding stomata on vegetative parts in Solanaceae is available in abundance (Ahmad, 1962, 64a, 64b, 64c, 64d ; Inamdar and Patel, 1969 ; Patel and Inamdar, 1971b etc.). However, information concerning pericarpic stomata in Solanaceae is meagre. Patel and Inamdar (1971) reported stomata on the pericarp of *Physalis minima* while Patel and Dave (1976) described stomata on the pericarp of *Datura innoxia* and *Datura metel*. The present paper deals with the structure and ontogeny of stomata on the calyx, corolla and pericarp of *N. tabacum* and *S. xanthocarpum*.

MATERIAL AND METHODS

The material of *N. tabacum* was collected from the University Botanical Garden and that of *S. xanthocarpum* from the plants growing wild in the campus. Various developmental stages of flowers and fruits were fixed in formalin-acetic-alcohol and preserved in 70% ethanol. The material under investigation was treated with 5% KoH solution for 4-6 hours and subesquently macerated by Jeffery's technique (1928). Peels were mounted in 50% glycerine after staining with haematoxylin.

OBSERVATIONS

In the case of *Nicotiana tabacum*, stomata have been recorded on the calyx, corolla and pericarp. However, in *Solanum xanthocarpum*, they are totally absent on the pericarp, being present only on the calyx and corolla. Epidermal cells are uninucleate, polygonal or elongated in various directions, with straight or sinnuous anticlinal walls (Figs. 1-10). Majority of stomata in *N. tabacum* and *S. xantho carpum* are anisocytic and anomocytic (Figs. 1 & 8). Paracytic stomata are

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of occasional occurrence (Fig. 2). No diacytic stomata are observed. In both the species, the different developmental stages are mixed in mosaic fashion so that the mature stomates occur side by side with immature ones. Anisocytic stomata are having three unequal subsidiary cells which surround the kidney-shaped guard cells (Fig. 1). Stomata comprising 4-6 subsidiary cells resembling the epidermal cells appear to be anomocytic (Figs. 1-3 and 7-10). Contiguous stomata occur frequently in *N. tabacum* (Fig. 7), but are absent in *S. xanthocarpum*. Abnormal stomates with a single guard cell each (Fig 4) and degenerated stomata with remnants of the two guard cells (Fig. 6) have been noticed in the pericarp of *N. tabacum*.

In mature stomata the inner concave wall of the guard cells surrounding the aperture is thicker than the outer wall. Guard cells possess reserve food material in the form of starch grains.

The stomatal meristemoids lie amongst the epidermal cells which are having thin walls, densely stainable cytoplasmic contents and conspicuous nuclei (Fig. 8). Each meristemoid enlarges and divides by a curved wall to give rise to a small triangular cell and a flat more or less rectangular cell. While the latter becomes the first subsidiary cell, the former increases in size and divides by a curved wall perpendicular to the first, giving rise to the second subsidiary cell. The residual triangular middle cell once again divides to produce the third subsidiary cell which happens to be the smallest of the three (Fig. 9). The three subsidiary cells consequently surround a central small cell which undergoes division by a straight wall resulting in a pair of guard cell initials (Fig. 5). Eventually, these cells enlarge and assume the characteristic crescentic shape.

In the case of anomocytic stomata the meristomoid cuts off no subsidiary cell but metamorphoses directly into a guard mother cell. The latter undergoes a vertical division giving rise to two guard cells (Fig. 14). This is followed by the formation of an aperture between the two ellipsoidal guard cells which in their turn are surrounded by 4-6 subsidiary cells (Figs. 1-3 and 7-10).

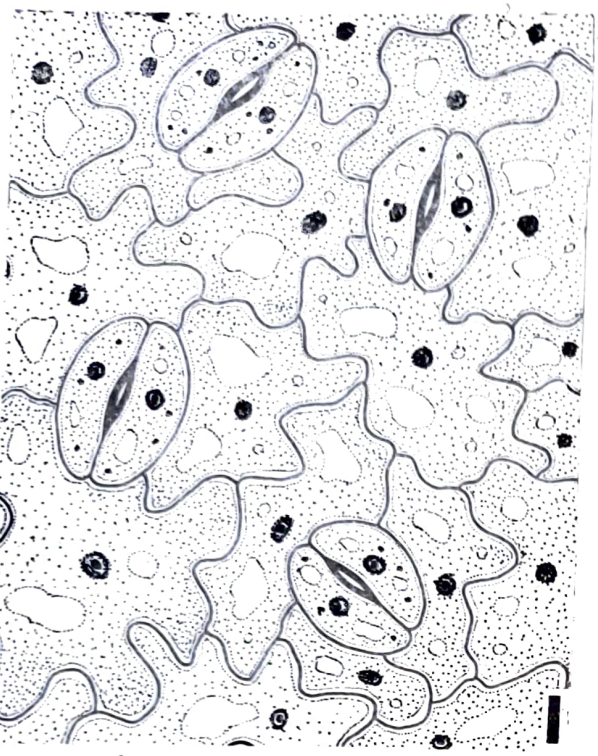
Paracytic stomata are having two guard cells with two flanking subsidiary cells (Fig. 2). The meristemoid, which is more or less rhomboidal in shape undergoes division by a slightly curved wall resulting in two cells, one smaller and

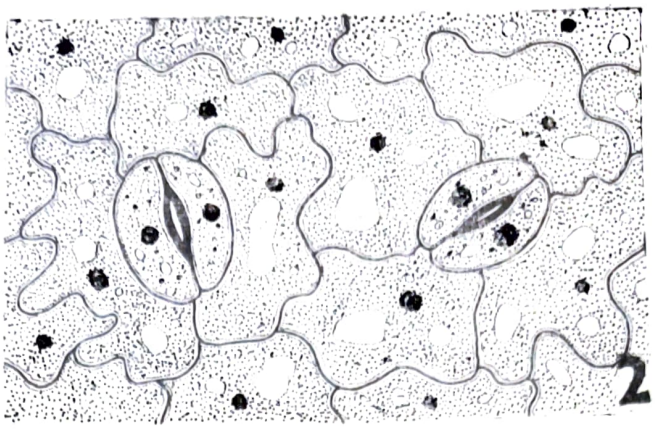
TABLE I

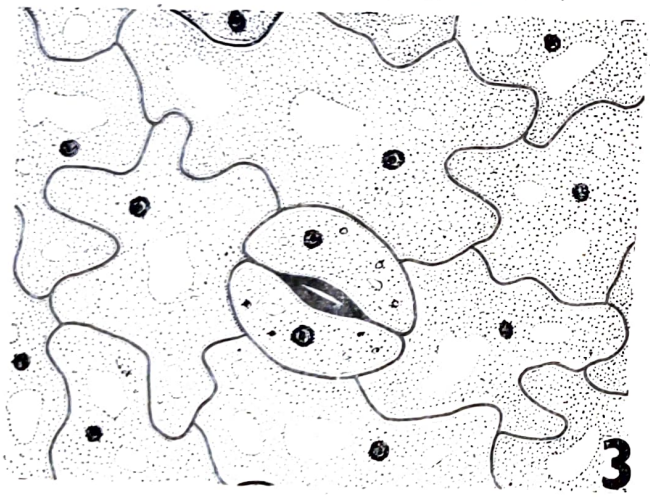
STOMATAL INDEX, STOMATAL FREQUENCY AND FREQUENCY OF CONTIGUOUS STOMATA ON DIFFERENT FLORAL PARTS*

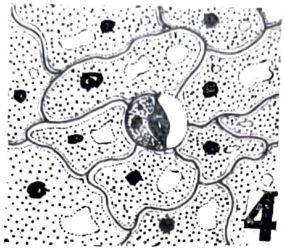
S. No.	Name of the plant	Name of the floral organ	Stomatal index	Stomatal frequency/mm²	Contiguous stomata/mm²
1.	*Nicotiana tabacum*	Sepal	27.30	24.00	Absent
		Petal	14.30	8.00	Absent
		Pericarp	20.00	16.00	6.00
2.	*Solanum xanthocarpum*	Sepal	4.40	48.00	Absent
		Petal	3.90	16.00	Absent
		Pericarp	Absent	Absent	Absent

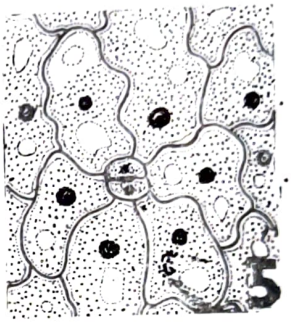
*Average of 15 replicates.

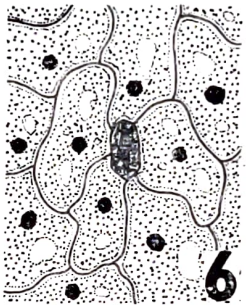


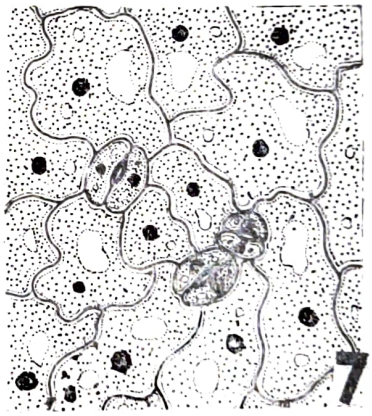


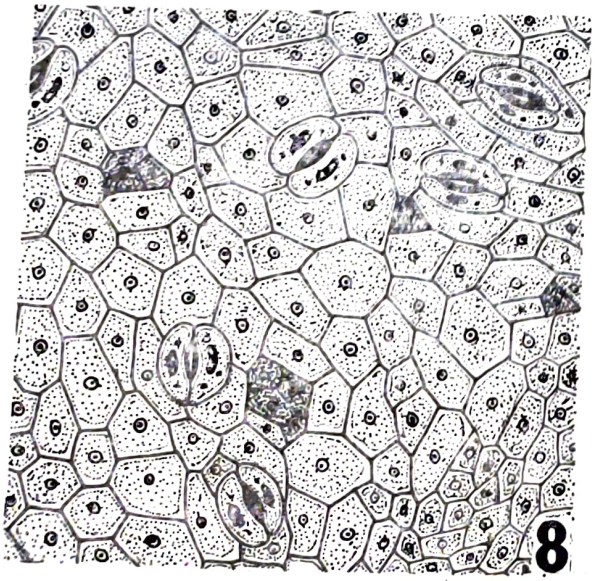


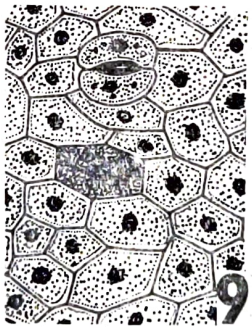


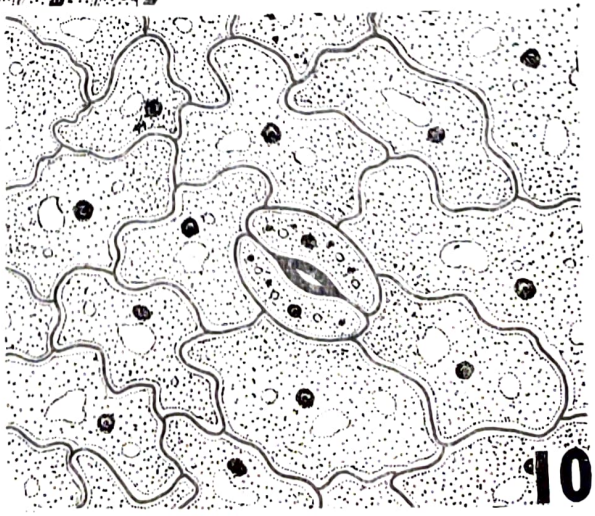






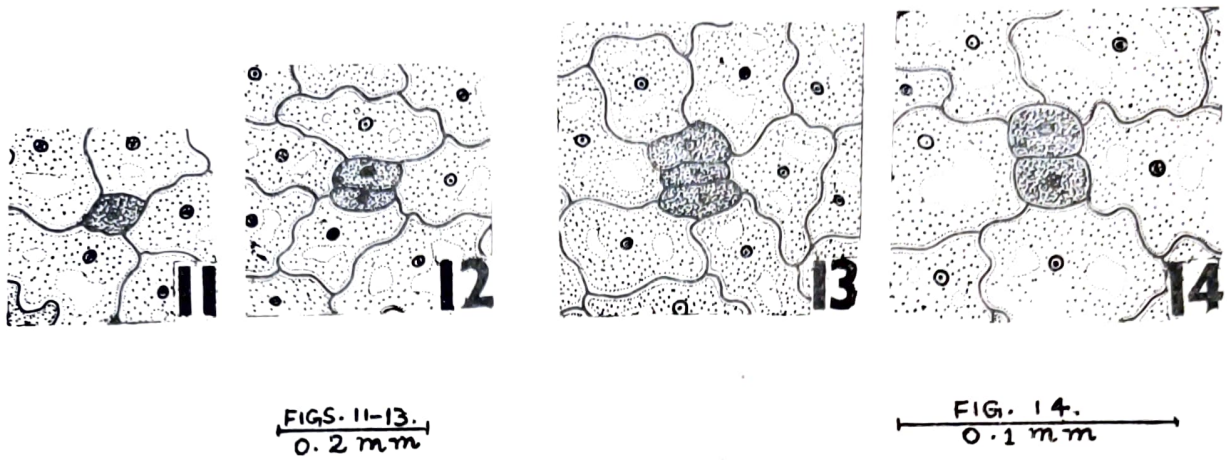






FIGS. 1–3, 8–10.
0.1 mm

FIGS. 4–7.
0.2 mm



Figs. 1—14.

Figs. 1, 7, 11-14. *Nicotiana tabacum*. Figs. 1-3. Various types of stomata on sepal and petal. Figs. 4-7. Single guard cell, guard cell initials, degenerated guard cells and contiguous stomata respectively. Figs. 11-13. Various developing stages of Paracytic stoma on pericarp. Fig. 14. A developing anomocytic stoma. Figs. 8-10. *Solanum xanthocarpum*. Figs. 8 & 9. Various developing stages of stomata on sepal. Fig. 10. Stoma on petal.

the other larger (Figs. 11, 12) and while the larger cell is the first subsidiary cell, the smaller one divides again by a curved wall giving rise to the second subsidiary cell and the central guard mother cell (Fig. 13). The guard mother cell subsequently divides by a vertical division to give rise two guard cells, in the centre of which develops a stomatal aperture. The division is oriented parallel to the subsidiary cells. Table-I indicates the stomatal index, stomatal frequency and frequency of contiguous stomata on different floral parts.

DISCUSSION

Various workers have studied stomata on vegetative as well as floral organs of solanaceous plants from time to time. Ranunclaceous (anomocytic) and cruciferous (anisocytic) stomata are described by Metcalfe and Chalk (1950) in the vegetative parts of *Datura, Duboisea, Hyoscyamus, Solanum, Withania* and Caryophyllaceous (diacytic) stomates in those of *Dyssochroma, Juanulloa, Jaborosa, Melananthus* etc. Similarly, anomocytic and anisocytic stomata are also recorded in some members of Solanaceae by Ahmad (1962, 1964a, 1964b, 1964c, 1964d). However, Patel and Inamdar (1970) have studied stomatal structure and ontogeny on vegetative as well as floral organs of *Physalis minima*. Fryns-Claessens and Cotthem (1973) giving 'A New Classification Of The Ontogenetic Types of Stomata' have termed the anisocytic, anomocytic and paracytic stomata as aniso-mesoperigenous, aperigenous and para-meso-perigenous respectively.

Anisocytic, anomocytic and paracytic stomata have been observed in *N. tabacum* and *S. xanthocarpum*. Our observations are in accordance with those of the above-cited workers. Yarbrough (1934), Pant and Verma (1963) and Paliwal (1967) described the ontogeny of cruciferous (anisocytic) type of stomata. Behaviour of the meristemoid is just like that of an apical initial with three cutting faces. It gives rise to three subsidiary cells arranged in a spiral sequence. The sequence suggests an establishment of a centre with highly specialized cells (guard cells) surrounded by less specialized cells with gradation in the degree of specializa-

tion. Anomocytic stomata seem to arise by the periclinal division of the subsidiary cells or by a direct division of the meristemoid (Fig. 14). Our observations regarding degenerated stomata and stomata with a single guard cell lend support to the views of Ahmad (1964a). Stomates with single guard cells appear to have been derived by abortion of one of the two guard cells while the 'degenerated stomata' seem to result from the degeneration of both the guard cells. The view is in agreement with the work of Dehnel (1957) who has successfully induced (by wounding) similar degeneration in *Begonia aridicaulis*.

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