EPIDERMAL STRUCTURE AND DEVELOPMENT OF STOMATA IN SOME POLYGONACEAE

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Received December 3, 1969

(Communicated by Prof. V. Puri, F.A.Sc.)

ABSTRACT

In the present paper, epidermal structure and development of stomata are described in 15 species of the Polygonaceae. Epidermal cells of Polygonum species contain druses of calcium oxalate. Parallel cuticular striations are noticed. Six types of glandular, non-glandular trichomes and extra-floral nectaries are observed. The mature stomata are anisocytic, anomocytic and paracytic. The anisocytic and paracytic stomata may be monocyclic or amphicyclic. The anomocytic stomata are incompletely monocyclic. The increase in number of subsidiary cells in anisocytic and paracytic stomata is due to the divisions of the subsidiaries. The ontogeny of anisocytic and paracytic types is syndetocheilic or mesogenous, while that of anomocytic is haplocheilic or perigenous. Twin stomata are also noticed.

INTRODUCTION

Metcalfe and Chalk (1950) pointed out that the stomata are nearly always ranunculaceous (anomocytic), rarely rubiaceous (paracytic) in the members of the family Polygonaceae. The present author (1969 b) studied the epidermal structure and ontogeny of stomata in two species of the family and reported anisocytic (cruciferous), anomocytic and paracytic stomata. The present investigation, therefore, was undertaken, as there is no other report on the epidermal structure and development of stomata in the Polygonaceae. The present paper deals with the epidermal structure and ontogeny of stomata in 15 species of the Polygonaceae. Terminologies used here are as defined by Metcalfe and Chalk (1950) and Pant (1965).

MATERIALS AND METHODS

Material of the following 15 species was collected by me during botanical excursion to Dharampur forests, Mount Abu, Mahableshwar,

Epidermal peels of young and mature leaves and other organs were taken from fresh as well as fixed material (1:3 acetic-ethanol) and herbarium specimens. Camera lucida drawings were made from temporary whole mounts of epidermal peels stained with Delafield's hematoxylin.

**Observations**

*Mature Epidermis*

The leaves of all the species are amphistomatic except the floating leaves of *Polygonum amphibium* which are epistomatic. In case of amphistomatic leaves, the number of stomata on the lower epidermis are more than the upper. The cells of the epidermis are polygonal, isodiametric or elongated and not arranged in a definite pattern. The anticlinal epidermal walls are either sinuous, straight or arched. Sinuousities are more pronounced in *Polygonum dumetorum* (Fig. 8) and *P. nepalense* (Fig. 12). Druses of calcium oxalate are present in the epidermal cells of *Polygonum* species (Fig. 9). Surface of the cuticle shows parallel striations radiating from the trichome bases or guard cells (Figs. 7, 9).

Glandular and eglandular trichomes, some six types and extra floral nectaries are observed in the species investigated, they are:

(i) Peltate glandular trichome (Figs. 15–17);
(ii) Extra-floral nectary with a multiseriate stalk, from the stipule and perianth of *Polygonum glabrum* (Figs. 11, 19);
(iii) Simple uniseriate filiform trichome of *Polygonum amplexicaule* (Fig. 20);
(iv) Simple bicellular conical trichome of *Fagopyrum cymosum* (Fig. 21);
(v) Simple unicellular conical peg-like trichome of *F. cymosum* (Fig. 22);
(vi) Small shaggy trichome of *Polygonum barbatum* var. *gracile* (Fig. 23);
(vii) Bizarre shaggy trichomes are present in many *Polygonum* species (Fig. 24).

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*Mature Stomata*

The stomata are irregularly arranged on the leaf epidermis. The stomata are distributed in between the veins. The mature stomata are anisocytic (Figs. 2-18), anomocytic (Figs. 2-18) and paracytic (Figs. 2-18). The anisocytic and paracytic stomata may be monocyclic (Figs. 2-14, 16-18) or amphicyclic (Fig. 15). Twin stomata are also observed (Fig. 2).
some cases there are distinct stomatiferous and non-stomatiferous areas (Figs. 9–10, 15–16).

Figs. 11–24. Fig. 11. *P. glabrum* (perianth, note extra-floral nectary). Fig. 12. *P. nepalense*. Fig. 13. *P. recumbens*. Fig. 14. *Fagopyrum cymosum*. Fig. 15. *Meuhlenbeckia platyclada* (stem, note peltate gland). Fig. 16. *Meuhlenbeckia platyclada* (leaf, note peltate gland). Fig. 17. *Rumex dentatus* (note peltate gland). Fig. 18. *R. hastatus*. Fig. 19. Extra-floral nectary from stipule of *P. glabrum*. Fig. 20. Simple uniseriate filiform trichome of *P. amplexicaule*. Fig. 21. Simple bicellular conical trichome of *Fagopyrum cymosum*. Fig. 22. Simple unicellular conical trichome, peg-like, *F. cymosum*. Fig. 23. Small shaggy trichome of *P. barbatum* var. gracile*. Fig. 24. Bizarre shaggy trichome of *P. nepalense*.

Figs. 11–24, × 97.

**Development of Stomata**

In a young organ the epidermal cells are polygonal, isodiametric or elongated and uninucleate with straight or arched anticlinal walls (Fig. 1). The stomatal initial is cut off in a corner of any cell of the epidermis. The meristemoid can be easily distinguished from the adjacent epidermal cells by its smaller size, rather prominent nucleus and dense staining properties (Fig. 1). The ontogeny of the different types of stomata is as follows;
(1) *Anisocytic stomata.*—The triangular meristemoid divides unequally by a slightly curved wall forming a large more or less flat rectangular cell on one side and a small triangular cell in a corner (Fig. 1). The large rectangular cell differentiates into a first subsidiary cell, while the small triangular cell divides again by a curved wall perpendicular to the first so as to form a second subsidiary cell and a middle triangular cell (Fig. 1). The middle cell then divides on the third side by a straight or slightly curved wall perpendicular to the previous ones, so as to give rise to a third subsidiary cell and a small triangular central cell (Fig. 1). It now functions as a guard mother cell, becomes rounded and divides forming a pair of guard cells (Fig. 1). The guard cells become bean-shaped and develop an intervening pore. In majority of the cases the mature anisocytic stomata are surrounded by a ring of three unequal subsidiary cells of which one is distinctly smaller and arranged in a spiral fashion. In the stem of *Muehlenbeckia platyclada* all the three subsidiary cells divide once, so that the stomata are surrounded by six subsidiaries and become amphicyclic (Fig. 15).

(2) *Anomocytic stomata.*—The triangular meristemoid becomes rounded and directly functions as a guard mother cell without cutting off any subsidiary cells. The guard cells become bean-shaped and develop a lenticular pore in between. The mature stomata are anomocytic and surrounded by 3–5 ordinary epidermal cells. Sometimes, an anomocytic stoma in *Polygonum laginerum* (Fig. 10) may be flanked by a parallel subsidiary cell, thus making the stomatal apparatus incompletely monocyclic.

(3) *Paracytic stomata.*—The meristemoid divides by slightly curved wall forming two unequal cells (Fig. 1). The large cell differentiates as a first subsidiary cell while the smaller lenticular cell which increases in size and divides again by a curved wall intersecting the first so as to form a second subsidiary cell and a central guard mother cell (Fig. 1). Sometimes, the second wall intersects at one pole only or both the walls are straight and parallel to each other (Fig. 1). The guard mother cell divides by straight wall to form a pair of guard cells between which an intervening pore develops. Occasionally, as in the stem of *Muehlenbeckia platyclada*, both the subsidiary cells divide once, so that the mature stoma is flanked by 4 subsidiary cells and the stoma becomes amphicyclic (Fig. 15). The mature stomatal apparatus is paracytic, flanked by 2–4 subsidiary cells which are contiguous at both the poles (Figs. 2–5, 9, 16–18) or non-contiguous at one (Figs. 2, 5, 8, 12, 13) or both the poles (Figs. 6, 7, 10, 11, 14, 15).
As the subsidiary cells and the guard cells originate from the same meristemoid in anisocytic and paracytic stomata, the ontogeny of these types conforms to the syndetocheilic type of Florin (1931, 1933) or mesogenous type of Pant (1965). The development of anomocytic type is haplocheilic (Florin, 1931, 1933) or perigenous (Pant, 1965).

**Discussion**

According to Metcalfe and Chalk (1950) the stomata in the members of the family Polygonaceae are nearly always anomocytic except in *Coccoloba* which has distinct subsidiary cells; rubiaceous in *Oxytheca* and *Triplaris*. Inamdar (1969b) reported syndetocheilic or mesogenous anisocytic, paracytic and haplocheilic or perigenous anomocytic stomata in the leaves of *Antigonon leptopus* and *Polygonum glabrum*. As regards the structure and ontogeny of stomata in 15 species of the Polygonaceae, the present observations are in accordance with the previous ones of this author. Abnormality noticed here is twin stomata only. Observations on trichomes and extra-floral nectaries are also in accordance with Metcalfe and Chalk (1950).

The development of anisocytic stomata has been studied in the members of Crassulaceae (Strasburger, 1866; Yarbrough, 1934), Cruciferae (Tognini, 1897; Paliwal, 1967; Pant and Kidwai, 1967), Compositae (Pant and Verma, 1963), Verbenaceae (Pant and Kidwai, 1964; Inamdar, 1969a), Convolvulaceae (Pant and Banerji, 1965; Inamdar, 1969d), Malvaceae (Inamdar and Chohan, 1969), Araliaceae (Inamdar et al., 1969), some Centrospermae and Polygonales (Inamdar, 1969b), Violaceae (Inamdar, 1969c) and Solanaceae (Esau, 1965; Inamdar and Patel, 1969). As reported by these authors, here also the meristemoid behaves like an apical cell with three cutting faces and produces three subsidiary cells in a spiral sequence. Here, the meristematic activity is confined to the smaller cell always and the successive walls laid down are perpendicular to the preceding ones.

The occurrence of three types of stomatal apparatuses has been observed in the leaves of all the species as well as the stipule and perianth of *Polygonum glabrum*. Inamdar (1969b) also reported such a diversity in the leaves of *Antigonon leptopus* and *Polygonum glabrum*. A combination of diverse types of stomatal complexes on the same surface of the leaf has also been reported by several workers (Tognini, 1897; Pant and Kidwai, 1964; Paliwal, 1965; Inamdar, 1967, 1968, 1969a, 1969b, 1969c, 1969d; Inamdar and Chohan, 1969; Inamdar et al., 1969; Inamdar and Patel, 1969). Although the mature stomatal complexes are constant from
species to species, they show variation in number and orientation of the subsidiary cells as pointed out earlier.

The development of the anisocytic and the paracytic stomata resembles syndetocheilic (Florin, 1931, 1933) or mesogenous (Pant, 1965) type as the subsidiary cells and the guard cells originate from the same stomatal initial. The anomocytic stomata are haplocheilic (Florin, 1931, 1933) or perigenous (Pant, 1965).

ACKNOWLEDGEMENTS

The author's gratitude is due to Principal J. G. Chohan and Prof. V. Puri for their keen interest and encouragement. My thanks are due to Mr. R. C. Patel for his ever-willing help.

REFERENCES


