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Abstract. The leaves are hypostomatic bearing the dia-mesogenous and diallelo-mesoperigenous stomata on the lower epidermis only. Less frequently occurring dia-mesogenous stomata have 2 subsidiaries of mesogenous origin, lying at right angles to long axis of the stomatal pore. The other type is more common and characterised by 4 or sometimes 3 subsidiaries of dual origin. Those two of the inner ring are mesogenous and the remaining two or one subsidiary cell of the outer ring, as the case may be, are of perigenous origin. However, the meristemoids of both types are dolabrate and the difference in the adult stomata is found to be dependent on the number of the cells encircling the meristemoid and the nature of the placement of the cross wall laid by the meristemoid producing protodermal cell.

Keywords. Ecbolium linneanum Kurz.; Acanthaceae; stomatal ontogeny; dia-mesogenous and diallelo-mesoperigenous types.

1. Introduction

The stomata, in the members of Acanthaceae, are generally of diaecytic type (Metcalf and Chalk 1957). In view of the mesogenous origin of the two subsidiaries, these stomata are regarded as dia-mesogenous type (Paliwal 1966; Inamdar 1970; Fryns-Claessens and Van Cotthem 1973). Recently, Rohweder and his co-workers (Rohweder et al 1971) have reported the occurrence of one more type of stomata viz., diallelo-mesogenous type, in some members of the above family. This stomatal type has at least three subsidiaries, lying at right angles to the long axis of the guard cells. However, there is no report available on the stomatal development in Ecbolium linneanum. The present paper deals with the stomatal ontogeny in this taxon.

2. Materials and methods

Leaves of various stages were collected from the plants growing in the Institute Campus. They were fixed in FAA. Customary procedures were followed for the preparation of epidermal peels. The young leaves were cleared with chloral hydrate solution and NaOH solution successively and stained with acetocarmine.
3. Observations

3.1. Mature epidermis

The costal cells of both surfaces are alike in that they are straight-walled and axially elongated bearing only non-glandular hairs. But, the intercostal cells of lower epidermis are deeply sinuous and thick-walled (figure 1) while those of upper side are straight-walled or sometimes slightly arched and thick-walled. The cystolith idioblasts and the hairs of both glandular and non-glandular types occur on both the surfaces where as the stomata are confined to the lower epidermis only (hypostomatic). However, the idioblasts are of frequent occurrence on the upper side while the hairs are abundant on the other side. The idioblasts are larger than the ordinary epidermal cells. They have a narrow and elongated surface and a swollen base, encircled by 6-8-smaller neighbouring cells (figure 1). Among the two types of hairs the glandular ones are distributed only on the intercostal areas. They possess a short, single-celled stalk and a spherical head composed of 4-8 cells with denser cytoplasm and a few oil droplets. Non-glandular hairs are uniseriate, and unbranched. They are made up of 2-4 thick-walled and warty cells, of which the terminal cell is tapering. In both the stomatal types, the subsidiaries are placed at right angles to the long axis of the stomatal pore. However, the dia-mesogenous stomata have two such subsidiaries of mesogenous origin while the diallelo-mesoperigenous ones possess four or some times three subsidiaries of dual origin. The stomata of former type are infrequent compared to those of other type. Among the latter those with four subsidiaries are more common than those with three subsidiaries.

Figures 1-6. Foliar epidermis (lower) of Ecbolium linneanum. 1. Mature epidermis. 2. Triangular meristemoid with a dia-mesogenous stoma. 3. Lenticular meristemoids at various developmental stages. 4. Diallelo-mesoperigenous stomata: note the stoma at right hand top corner with three subsidiaries. 5. Dia-mesogenous stoma; note the mesogenous subsidiaries encircled by more than four neighbouring cells. 6. Mature stomata of diallelo-mesoperigenous and dia-mesogenous type. (id, cystolith idioblast; m, meristemoid; ps, perigenous subsidiary cell; sc, sistercell; s1, first mesogenous subsidiary cell; s2, second mesogenous subsidiary cell).
3.2. Ontogeny of stomata

The stomata of both types differentiate in a mixed sequence. The diacytic stomata develop, much earlier than those of other type, when the leaf is very young. Hence the meristemoids of diallelocytic type are seen along with a few fully developed diacytic stomata among the protodermal cells (figure 2). The meristemoids are cut off from the protodermal cells by a cross wall. Most of the times, the protodermal cell puts forth a slightly curved wall, intersecting one of its walls at two points. This results in the formation of a lenticular meristemoid, completely flanked by the sister cell and an adjacent cell on either side (figure 3). Occasionally the protodermal cell produces a cross wall extending between its two adjacent walls. Consequently a triangular meristemoid is formed, which is flanked by the sister cell on one side and 2-3 adjacent cells on the other side (figure 2). The sister cell becomes larger and assumes the hemispherical shape without any further division (figure 4). The meristemoid now enlarges to certain extent and produces a curved wall so as to form a smaller cell and the first subsidiary cell (figure 3). The smaller cell divides again by a slightly curved wall which intersects the first formed wall on both sides. This results in a GMC (guard cell mother cell) and another subsidiary cell (figure 4). After enlarging to some extent, the GMC divides vertically at right angle to the second partition to produce two guard cells which develop a pore later (figure 4). These guard cells are now completely encircled by two mesogenous subsidiaries whose common walls lie at right angles to the long axis of the stomatal pore (figures 4-6).

The subsidiaries are cut off in such a way that they lie parallel to the sister cell and the neighbouring cell whenever it is single in number (figure 4). The stomata, derived from the lenticular meristemoids, have an inner ring of two mesogenous subsidiaries and an outer ring of two perigenous ones, all of them lying at right angles to the pore (figures 3, 4). On the contrary, those, derived from triangular ones, have two inner mesogenous subsidiaries and only one perigenous subsidiary cell in the outer ring. The perigenous subsidiaries differ from the ordinary cells in their size, hemispherical shape and typical parallel orientation to the inner subsidiaries. As these four or three subsidiaries, as the case may be, are of mesogenous and perigenous origin these stomata are placed in a new category, viz., *diallelo-mesoperigenous* type, which obviously differs from the diallelo-mesogenous type (Fryns-Claessens and Van Cotthem 1973), where all the four or at least three subsidiaries are derived mesogenously.

The dia-mesogenous stomata follow the same sequence of differentiation as those of other type. But the meristemoid of dia-mesogenous type is encircled by more than three protodermal cells in an irregular manner. Sometimes the number of these encircling cells may increase by supplementary radial division in any one of them. Obviously the mature stomata become dia-mesogenous as there is not even a single adjacent cell or sister cell lying parallel to the mesogenous subsidiaries (figures 2, 5).

4. Discussion

The meristemoids of both dia-mesogenous and diallelo-mesoperigenous stomata are dolabrare irrespective of their mode of origin. The meristemoid of the former develops into the diacytic stoma as none of the three encircling cells is oriented parallel to the
mesogenous subsidiaries. On the other hand, the meristemoid of the latter, whose differentiation is postponed considerably, is always flanked by one sister cell on one side and one to three cells on the other side according to the placement of the cross wall produced at the time of the formation of meristemoid. Thus it results in the formation of diallelocytic stoma having four or three subsidiaries as the case may be.

Pant (1965) has reported earlier that diversity in the adult stomata is dependent on the number and planes of divisions of the meristemoid, intersection or non-intersection of its walls and the time lag between its divisions. Recently the present author (Kannabiran 1975) has shown that the formation of three types of stomata in *Zornia* depends on the intersection or intersection of the two consecutive walls of the meristemoid. The present study reveals that the difference in the stomatal types may also be dependent on the number of cells encircling the meristemoid and the nature of placement of the cross wall laid down by the meristemoid producing protodermal cell.

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