EMBRYOLOGICAL STUDIES IN CLEOME MONOPHYLLA LINN.*

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ABSTRACT

In Cleome monophylla Linn. calyx, stamens, corolla and carpels arise in acropetal succession. The wall of the anther has four layers of cells. The tapetum is binucleate and is of the glandular type. The cells of the endothecium have fibrillar thickenings. The microspores are tetrahedral, isobilateral and decussate in arrangement. The pollen-grains remain uninucleate mostly but rarely become binucleate at the time of shedding. Development of the female gametophyte in the bitegmic crassinucellate, campylotropous ovules conforms to the polygonum type. The embryo-sac becomes filled with starch-grains during later stages. The differentiation of testa and tegmen in the seed are described. The present observations are evaluated in the light of earlier investigations in the family.

INTRODUCTION

Interest in embryological investigations in Capparidaceae began with the studies of development of ovular integument in Polanisia graveolens (Guignard, 1893) referred to by Schnarf (1931). Then followed the studies in seed structure of Steriphoma cleomoides, Cleome and Isomeris (Orr, 1921).

Extensive embryological studies were undertaken by Mauritzon (1934) in four species of Cleome, two species in each of Capparis and Polanisia, Dactylena micrantha and Gynandropsis pentaphylla. Further V. S. Rao studied embryology in Maerua arenaria (1936), Gynandropsis pentaphylla (1936) and three species of Capparis (1938); N. K. Tiwary in Cleome viscosa (1936); T. S. Raghavan in Cleome chelidonii (1937) and Gynandropsis pentaphylla (1938). Billings' observation on Isomeris arborea (1937) stimulated

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interest for re-investigation in the member by Maheshwari and Khan (1953), Maheshwari and Sachar (1954) and Sachar (1956).

Embryological studies in the genus Cleome confine to C. monophylla, C. serrata, C. spinosa, C. violacea (Mauritzon, 1934), C. viscosa (Tiwary, 1936) and C. chelidonii (T. S. Raghavan, 1937). Embryological studies in C. monophylla is undertaken as earlier studies by Mauritzon (1934) are meagre.

**Observations**

Flower.—Figs. 1–3 represent the disposition of the floral parts. Flowers are pink, bracteate, ebracteolate, actinomorphic, bisexual, hypogynous, protandrous and are in axillary racemes. Stamens are usually six in number, although five are not uncommon, in a single whorl with dithecous anthers. Ovary is bicarpellary, syncarpous, unilocular and is continued into a short solid style which ends in a bilobed glandular stigma (Figs. 4, 5). The wall of the ovary has epidermal glandular protrusions (Fig. 6).

The floral primordium becomes differentiated into a dome-shaped structure. Calyx initials are the first to appear and then the stamens after which the initials of the corolla arise. The sepals then differentiate and grow overarching the corolla displaying epidermal glandular outgrowths. The carpellary initials are last to be differentiated (Figs. 7–10).

Microsporangium and the pollen development.—The transection of an young anther lobe consists of a group of microspore mother cells surrounded by tapetum, one middle layer, endothecium and epidermis. Cells of the tapetum are uninucleate at first but later become binucleate and are of the glandular type (Fig. 11). The epidermis finally becomes stretched and wavy; endothecium exhibits fibrous thickenings; middle layer and tapetum become disorganised (Fig. 12). The tetrads of microspores formed by the meiotic divisions of microspore mother cells are usually tetrahedral, but occasionally decussate and isobilateral in arrangement (Figs. 13–15). The trirporate pollen-grains have a thick smooth exine all over except at the pores where only a thin intine is seen. Most of the mature pollen-grains remain uninucleate and two-nucleate grains also occur, though very rare (Figs. 16–18).

Ovule.—Ovule arises as a mound of tissue on a parietal placenta and finally becomes campylotropous owing to the pronounced growth of the nucellus at the chalazal end. Ovules are bitegmic and crassinucellate. The inner integument develops first followed by the outer integument. The
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micropylar canal is formed by the pronounced growth of the outer integument over the inner and is zigzag (Figs. 19–22).

*Megasporogenesis and female gametophyte.*—The hypodermal archesporial cell differentiates before initiation of the inner integument (Fig. 23). It cuts off an outer primary parietal cell and an inner megaspore mother cell before the initiation of the outer integument (Fig. 24). The parietal cell gives rise to a three-layered parietal tissue causing the megaspore mother cell deep-seated (Fig. 25). Occasionally two megaspore mother cells differentiate within the ovule (Fig. 26). The megaspore mother cell by meiosis gives rise to a tetrad of megaspores which are linear and T-shaped (Figs. 27, 28).

The single basal functioning megaspore by three successive nuclear divisions produces an eight-nucleate embryo-sac of the Polygonum type (Maheshwari, 1948) (Figs. 29–31). As the embryo-sac is becoming fully organised it becomes filled with starch-grains. Synergids are neither hooked nor beaked nor do they exhibit filiform apparatus. The antipodal cells are ephemeral (Fig. 32).

*Seed-coat.*—The outer and the inner integuments are two-layered at first. The outer integument remains two-layered even when it differentiates into testa. The outer layer of the testa becomes thick-walled while the cells of the inner layer enlarge and become vacuolate. The two-layered tegmen which arises from the inner integument subsequently becomes multilayered. The epidermal layer becomes conspicuous with rich cytoplasmic contents. During further development the outer epidermal cells at the micropylar end become vacuolate, enlarge finally and develop conspicuous striations. The innermost layer of the tegmen becomes transformed into heavy walled sclereids (Figs. 33–36).

**Discussion**

The embryological features in *Cleome monophylla* show differences and similarities with the allied species and other members of the family. While the tapetum of the anther wall remains binucleate and glandular in *Cleome monophylla* different degrees of nuclear fusions in tapetal cells are reported in *Gynandropsis pentaphylla*. The fibrillar endothecium of *Cleome monophylla* is as in *Gynandropsis pentaphylla* (Raghavan, 1938). Tetrahedral, isobilateral and decussate microspores are seen in *Cleome monophylla* while they are only tetrahedral in *Maerua arenaria* and *Gynandropsis pentaphylla* (V. S. Rao, 1936). The pollen-grains in *Cleome monophylla*
remain mostly uninucleate but occasionally become binucleate. In *Gynandropsis pentaphylla* the pollen grains as reported by V. S. Rao (1936) are uninucleate throughout. However, this observation is not in agreement with those of Raghavan (1938) who records the presence of two-celled pollen-grains at the time of shedding.

Variations are noticed in the developmental sequence of the two integuments of the ovule in the members of this family. In *Cleome monophylla* the inner integument develops earlier than the outer integument. The micropyle has a zigzag course as the endostome and exostome do not lie in the straight line. This is seen in *Isomeris arborea* (Maheshwari and Khan, 1953) and in *Cleome viscosa* (Tiwary, 1936; V. S. Rao, 1936). In *Gynandropsis pentaphylla* and *Capparis galeata* (V. S. Rao, 1936, 1938) the development of the two integuments is simultaneous. The micropyle in *Cleome monophylla* is formed by both the integuments while in *Capparis galeata* and *C. horrida* it is formed only by the inner integument (V. S. Rao, 1938).

The arrangement of megaspores is linear and T-shaped in *Cleome monophylla* as in *Capparis horrida* (V. S. Rao, 1938), while in *Gynandropsis pentaphylla* (Raghavan, 1938) and *Isomeris arborea* (Maheshwari and Khan, 1953; Sachar, 1956) the upper diad degenerates and two megaspores are formed from the lower diad. The Polygonum type of development of the embryo-sac appears to be common in all members of the family so far studied. Synergids are neither hooked nor beaked nor do they exhibit filiform apparatus in *Cleome monophylla*. However, in *Maerua arenaria, Capparis galeata, C. sepiaria* and *C. horrida* (V. S. Rao, 1936, 1938) the synergids show filiform apparatus. In *Capparis galeata* (V. S. Rao, 1938) in addition, they are beaked. Among the species of *Cleome* investigated only in *Cleome monophylla* the embryo-sac is filled with starch-grains.

The presence of sclerotic layer and steroid cells in the inner integument appears to be characteristic feature of the seeds of *Cleome monophylla*. No layer corresponding to the inner sclerotic layer is reported in any other member investigated.

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REFERENCES


EXPLANATION OF FIGURES

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(O.I. = Outer integument; I.I. = Inner integument; N = Nucellar cells)