CHAPTER V

FAMILY - NYCTAGINACEAE

INTRODUCTION

Nyctaginaceae is a small family of approximately 30 genera and 250-300 species. Plants of this family are mostly distributed in the tropical and sub-tropical regions of both the hemispheres. Members of this family show considerable variation in their habit in having herbs, shrubs and even trees. Economically the family is of little importance except for few ornamentals.

Although the genus Boerhavia comprises of forty species, embryology of this species is only studied in two species, i.e., B. diffusa (Maheshwari, 1929; Bhargava 1932, Kajale 1936, 1937), B. repanda (Kajale, 1936, 1937). B. erecta Linn. has not been investigated and hence the present investigation has been undertaken.

REVIEW OF PREVIOUS LITERATURE

Embryological studies in this family is rather scanty. Of the 250-300 species of the family only fifteen species have been investigated embryologically.
The earliest embryological studies in the family is that of Hofmeister (1856) on *Mirabilis jalapa*, who reported that the antipodals are large and elongated and there is a short suspensor. Fisher (1880) described the origin of the embryo sac in *Oxybaphus nyctagineus* and pointed out the occurrence of three megaspores of which the basal one develops into embryo sac. Other reports include Heimerl (1887) was death with the development of ovule in *Mirabilis jalapa*, *M. longiflora* and *Oxybaphus nyctagineus*. Guinard (1882) reported late fusion of the polar nuclei in the family Nyctaginaceae. Tischler (1903) studied the development of pollen in some hybrid species of *Mirabilis* and also touched upon the origin and development of the tapetal cells. Fiedler (1910) gave an account of the pollen grains and development of embryo sac. Dahlgren (1916) described monosporic polygonum type of embryo sac development in *Mirabilis jalapa*. Rocen (1927) studied the embryology of *Mirabilis jalapa*, *M. multiflora*, *M. longiflora*, *Oxybaphus nyctagineus*, *O. microanthus*, *O. viscosus*, *Abronia umbellata* and *Rougainvillea glabra*. Maheshwari (1929) has described the embryology of *Boerhavia diffusa* while Bhargava (1932)
has given an account of the embryology of Boerhavia repanda. Other embryological studies in this family include Venkateswarlu (1947) on *Pisonia aculeata*, Soueges (1938) on *Oxybaphus viscosus* and Cooper (1931, 1949) on *Rougainvillea glabra* and *Oxybaphus nyctaginosus*. Kajale (1936, 1937, 1938) has reported that the development of embryo in *Boerhavia diffusa* and *B. repanda* is of Asterad type. Embryology of Nyctaginaceae has earlier been reviewed by Schnarf (1931) Davis (1966) and recently by Anisimova (1983).

**OBSERVATIONS**

Microsporangium, Microsporogenesis and Male gametophyte:

Anther is tetrasporangiate (Fig. 13 A). The young anther is at first a homogenous mass of meristematic cells surrounded by epidermis. When the anther becomes lobed, a single row of archesporial cells get differentiated in each anther lobe. In longitudinal section the archesporial cells are 2-celled (Fig. 13 B). Thus there are only eight archesporial cells per anther.
The archesporial cells divide periclinaly forming primary parietal cells and primary sporogenous cells (Fig. 13 C). The cells of the primary parietal layer divide periclinaly to form two layers (Fig. 13 D). The outer layer functions as endothecium while the one adjacent to the spore mother cells divide once again periclinaly (Fig. 13 E) forming middle layer and tapetum (Fig. 13 F). This type of anther wall development according to Davis (1966) is known as Monocotyledonous type.

The epidermis persists in the mature anther as flattened layer. The hypodermal layer develops fibrous thickenings forming fibrous endothecium. The middle layer divides periclinaly forming two middle layers (Fig. 13 G). Anther tapetum is of the Glandular type. Its cells become two nucleate during later stages (Fig. 13 H).

The sporogenous cells function directly as pollen mother cells without any increase in the number. The pollen mother cells undergo meiotic division (Fig. 13 I) resulting in pollen tetrads (Fig. 13 J-L). Quadripartition of the microspores is by furrowing.
Isobilateral pollen tetrads are more common (Fig. 13K, L) but tetrahedral tetrads are also met with occasionally (Fig. 13 J).

The microspores soon after separation from the tetrads enlarge in size considerably (Fig. 13 M-Q). The nucleus in the pollen grain divides and two unequal cells are formed (Fig. 13 R). The smaller cell is the generative cell which during later stage gets pinched off into the pollen grain. Pollen grain at the shedding stage is 2-celled (Fig. 13 S). The exine is thick with minute projections while the intine is thin.

Ovary and Ovule:

The ovary is superior and unilocular with a single basal ovule which is unitegmic and crassinucellate. The ovule arises as a papillate outgrowth from the base of the ovary. Due to divisions on only one side of the ovule it gets curved and becomes anatropous (Fig. 14 A, B). The ovule remains in the anatropous condition even at about 2-celled embryo stage. But later on the nucellus grows backwards and gets curved so that the ovule becomes campylotropous (Fig. 14 C). The single integument is 3-6 layered in thickness.
Megasporogenesis and Female Gametophyte:

Female archesporium is hypodermal and single-celled. It undergoes periclinal division forming a parietal cell towards the surface and megaspore mother cell towards inside. The parietal cell undergoes periclinal and anticlinal divisions forming a massive parietal tissue. The deep seated megaspore mother cell (Fig. 14 D), undergoes meiosis resulting in a linear tetrad of megaspores (Fig. 14 E). The chalazal megaspore is functional while the micropylar three megaspores degenerate.

The functional megaspore elongates and enlarges and its nucleus which is centrally located undergoes mitosis to produce a binucleate cell. The nuclei separate and move to the ends of the cell and there undergo division to form a 4-nucleate embryo sac (Fig. 14 F). A large central vacuole is present at this 4-nucleate embryo sac stage. The nuclei divide once again to produce eight nuclei which organised into 3-celled egg apparatus and 3 antipodal cells while remaining two fuse in the centre forming secondary nucleus (Fig. 14 G). This type of embryo sac development is known as Monosporic Polygonum type.
The egg is vacuolate at the upper side, the cytoplasm being aggregated round the nucleus at the lower end. The synergids are pyriform in shape and are hooked. The nucleus lies towards the upper end of the synergid and at the lower side a vacuole is present. Secondary nucleus lies near the egg apparatus. Antipodals are three in number and are persistent up to the globular stage of embryo (Fig. 15 C, D).

Fertilisation, Endosperm and Embryo:

Fertilisation is porogamous. The primary endosperm nucleus divides earlier than the sygote forming two nuclei. They undergo further divisions forming large number of nuclei which are scattered in the thin layer of cytoplasm around the periphery of the greatly enlarged embryo sac (Fig. 15 A, B). Cellularization starts at the 4-celled embryo stage and it is confined only to the micropylar region around the embryo (Fig. 15 C, D) while the chalazal portion remains free nuclear.

The first division in the sygote is by a transverse wall and leads to the differentiation of an apical cell $oa$ and a basal cell $ob$ (Fig. 15 E).
next division takes place in the basal cell and is again transverse resulting in $m$ and $q_1$. Thus a filamentous proembryo of three cells is formed (Fig. 15 F). Another transverse division occurs in the cell $q_1$ resulting in $n$ and $n'$ and the proembryo becomes four-celled (Fig. 15 G).

The terminal cell $q_2$ undergoes two vertical divisions at right angles to each other forming quadrants $q$. This tier undergoes transverse division resulting in two tiers $l$ and $l'$.

The destination of the tiers are as follows:

The tier $l$ gives rise to cotyledons and plumule, $l'$ forms upper part of hypocotyl, $m$ gives rise to the lower part of hypocotyl and major part of root, $n$ forms root apex and root cap and $n'$ develops into a suspensor which is 8-12 cells in length (Fig. 15 H-J).

This type of embryo development is known as the Asterad type according to Johansen (1950). A suspensor is formed and no epiphysis is differentiated which characterizes the Polygonum variation of Asterad type.
DISCUSSION

Male archesporium in *Boerhavia erecta* (present study) consists of only two cells which are in a single row. Similar situation has earlier been reported in *B. diffusa* by Maheshwari (1929) while Bhargava (1932) reported that in *B. repanda* male archesporium consists of single row of 3-4 cells. Anther wall development in all the members of Nyctaginaceae so far investigated is of the Monocotyledonous type. Anther tapetum in *B. erecta* (present study) is of the Glandular type which is the case with other members of the family.

The ovule in the family Nyctaginaceae is quite variable. Woodcock (1929) describes single campyloptropous ovule as occurring in both *Mirabilis jalapa* and *Thelygonium cynocombrae*. Maheshwari (1929) reports that there is a single basal anatropous ovule in *Boerhavia diffusa*. Bhargava (1932) also reported anatropous ovules in *B. repanda*. But Kajala (1933) reported that the ovule in *B. diffusa* and *B. repanda* shows a distinct bend, pointing towards campylotropy. He says "The figures of Maheshwari and Bhargava also show this clearly".
According to Cooper (1932) the ovule of Bougainvillea glabra is intermediate between campylotropous and anatropous condition. Anacampylotropous ovules have also been recorded in *Pisonia aculeata* (Venkateswarlu, 1947) and *Oxybaphus nyctagineus* (Rocen, 1927; Cooper, 1949) while campylotropous ovules have been recorded in *Oxybaphus viscosus*, *O. micranthus* (Rocen, 1927), *Mirabilis multiflora*, *M. longiflora* and *Abronia umbellata* (Rocen, 1927). In *Boerhavia erecta* (present study) ovule is campylotropous.


Embryo sac development in the family Nyctaginaceae is of the Monosporic Polygonum type. Such a type has been reported in *Boerhavia diffusa* (Maheshwari, 1929) *Mirabilis jalapa*, *Oxybaphus nyctagineus*, *O. viscosus*. 
O. mieranthus, Mirabilis multiflora, M. longiflora, Abronia umbellata (Rooses, 1927), Pisonia spiculeata (Venkateswarly, 1947) and Boerhavia erecta (present study).

AN EMBRYOLOGICAL APPROACH TO THE SYSTEMATIC POSITION OF THE FAMILY NYCTAGINACEAE

Bentham and Hooker (1862–1883) included the family Nyctaginaceae in his series Curvembryae of the sub-class Monochlamydeae in Dicotyledones. Eichler (1878) first introduced the group Centrospermae consisting of Nyctaginaceae, Polygonaceae, Chenopodiaceae, Amaranthaceae, Caryophyllaceae, Phytolaccaceae, Portulacaceae, Aizoaceae and Cactaceae. Cronquist (1968), Takhtajan (1980) and others included family Nyctaginaceae in their order Caryophyllales along with Amaranthaceae, Phytolaccaceae, Chenopodiaceae, Aizoaceae, Cactaceae, Didieriacae, Molluginaceae, Basellaceae, Caryophyllaceae and Portulacaceae. Bentham and Hooker (1883) kept the families Caryophyllaceae and Portulacaceae in Polypetalae in the series Thalamiflorae and Cactaceae and Aizoaceae in the series Calyciflorae. Mabry (1976) who discussed the systematic position of the group...
Centrospermae said that Centrospermae are characterized by the chemical group Betalins (except the two families Molluginaceae, Caryophyllaceae) \( P_{III} \) sub type sieve element plastids. In addition to this the DNA - RNA hybridization data also supports the view that these families should be held together.

Embryologically the Centrospermae family are characterized by tetrasporangiate anthers, monocotyledonous type of anther wall development, secretory type of anther tapetum, occurrence of bitegmic and crassimucillate ovules (except in a few members of Nyctaginaceae), Polygonum type of embryo sac development and Nuclear type of endosperm development. Nyctaginaceae also shows all these characters and hence the opinion of Mabry (1976), Cronquist (1968), Takhtajan (1980) is justified on embryological grounds.
REFERENCES


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**Fig. 13 A - S**

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**Fig. 15 A - K**

**Fig. 15 A - K**: *Boerhavia erecta*

**Fig. 15 A - D**: Different stages in endosperm development

**Fig. 15 E - K**: Different stages in embryo development