Embryology of *Paracalyx* (Fabaceae)

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ABSTRACT – Embrylogy of *Paracalyx scariosus* (Roxb.) Ali has been investigated. Anthers are tetrasporangiate and anther wall comprises of epidermis, endothecium, one middle layer and glandular tapetum. Cytokinesis is of the simultaneous type and pollen tetrads are tetrahedral, decussate and isobilateral. Pollen grains are shed at two-celled stage. Along with normal microspores abnormal spores with variable number of supernumerary nuclei have been met with. The ovule is compylotropous, bitegmic and crassinucellate. Megaspore tetrad is linear and embryo sac development is of the *Polygonum* type. Endosperm development follows Nuclear type. Embryo development follows Onagrad type.

INTRODUCTION

The Fabaceae (*nom. alter*. Leguminosae) comparises 650 genera and 18000 species (Polhill and Raven, 1981). Prakash (1987), who gave an excellent review on the embryology of the family, remarked that reasonably complete embryological data are available for 35 genera studied or about 5% of the total leguminous genera. No study has been made on any embryological aspect in roughly 83% of the genera. Hence the present study was undertaken and the present report deals with the embryology of *Paracalyx scariosus* (Roxb.) Ali (= *Cylista scariosa* Roxb.).

MATERIAL AND METHODS

Buds, flowers and fruits at different stages of development were collected from Vikarabad forests in Ranga Reddy District in Andhra Pradesh and fixed in formalin-acetic-alcohol (F.A.A.). Dehydration and infiltration was done in Tertiary butyl alcohol and embedded in paraffin wax. The material was sectioned at a thickness of 4-8 μm and stained in Delafield's hematoxylin. Voucher specimen has been deposited in the herbarium of the Department of Botany, Sri Krishnadevaraya University.

Results

Microsoporangium, microsporogenesis and male gametophyte

There are four microsporangia in each anther (Fig. 1 A). Anther wall consists of epidermis, endothecium, middle layer and tapetum (Fig. 1 B, C). The epidermal cells undergo only anticlinal divisions to keep pace with the growing anther. These cells get much stretched and flattened at maturity. The endothecium develops fibrous thickenings and forms fibrous endothecium (Fig. 1 E). The cells of the middle layer get degenerated during meiosis in the pollen mother cells (Fig. 1 D). Anther tapetum, the inner-most layer of the anther wall, encloses the pollen mother cells completely. Tapetum is of the Glandular type (Fig. 1 B, C). It remains uniseriate and cells remain uninucleate.

The sporogenous cells undergo divisions in all planes resulting in a moderately extensive mass of pollen mother cells (Fig. 1 B, C). The pollen mother cells round off and produce microspore tetrads by undergoing meiosis and simultaneous cytokinesis (Fig. 1 F-L). All the three types of tetrads – tetrahedral, decussate and isobilateral – occur (Fig. 1 M-O). The four microspores separate off from the tetrad before shedding and acquire thick exine (Fig. 1 P). The nucleus divides mitotically and gives rise to a large vegetative cell and a small generative cell (Fig. 1 Q). The later separates itself and enters the cytoplasm in the vegetative cell (Fig. 1 R, S). Polllen grains are 2-celled with 3 germ pores at the time of shedding.

Along with normal microspore tetrads and normal pollen grains, abnormal microspore tetrads and abnormal pollen grains are met with. These abnormal spores have variable number of supernumerary nuclei which may vary from 1-4 (Fig. 1 T-Z^3).

Ovule, megasporogenesis and female gametophyte

The ovule is campylotropous, bitegmic and crassi-nucellate (Fig. 2 H). Both the integuments participate in the formation of micropyle. Both the integuments are two cell layered, but the micropylar region of the outer integument is more than two cells thick. The single hypodermal archesporial cell undergoes a periclinal division to form a parietal cell towards outside and megaspore mother cell towards inside. The parietal cell divides anticlinally and periclinally to form 2-4 layered parietal tissue (Fig. 2 A-D). The megaspore mother cell undergoes meiotic divisions resulting in a linear (Fig. 22 C, E) or T-shaped megaspore tetrad (Fig. 2 D). The chalazal megaspore is functional while the three micropylar megaspores degenerate (Fig. 2 D, E). The functional megaspore elongates and undergoes mitotic division resulting in two nuclei which move to the opposite poles as they are separated by a vacuole (Fig. 2 E). The two nuclei undergo two more mitotic divisions resulting in the 4-nucelate (Fig. 2 F) and 8-nucleate embryo sac (Fig. 2 G) of the monosporic *Polygonum* type. The organised embryo sac shows typical 8-nucleate, 7-celled

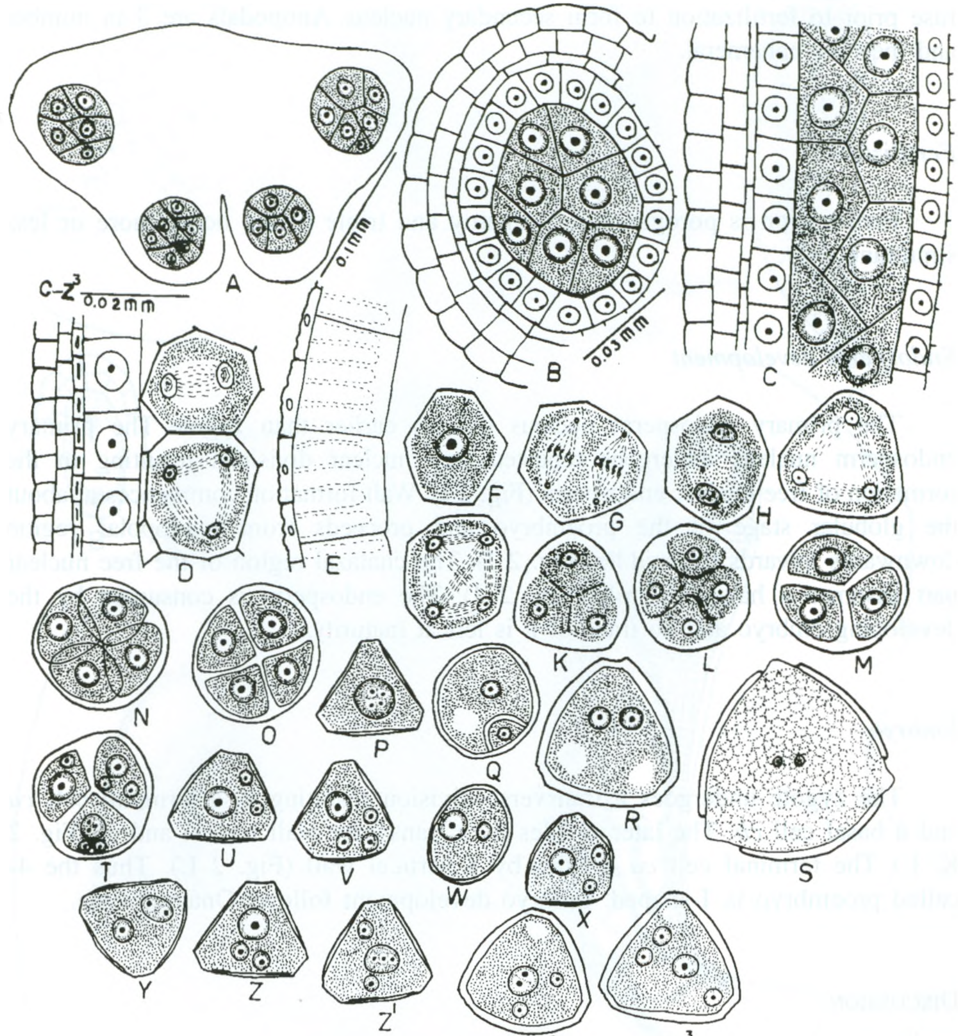

Fig. 1 – *Paracalyx scariosus* (Roxb.) Ali. A.T.s. of tetrasporangiate anther. B.C.T.s. and L.s. respectively of anther lobe showing wall layers and pollen mother cells. D.L.s. part of anther lobe showing anther wall and pollen mother cells in meiosis. E. Epidermis and fibrous endothecium. F-L. Pollen mother cells in meiosis. M. Tetrahedral microspore tetrad. N. Decussate microspore tetrad. O. Isobilateral microspore tetrad. P. Uninucleate pollen grain. Q-S. 2-celled pollen grains. T. Tetrahedral microspore tetrad with supernumerary nuclei. U-Z^1. Very young pollen grains with supernumerary nuclei. Z^2-Z^3. Mature pollen grains with supernumerary nuclei.

structure. Synergids are pear-shaped and beaked (Fig. 2 G). The two polar nuclei fuse prior to fertilization to form secondary nucleus. Antipodals are 3 in number and they are ephemeral.

Fertilization

Fertilization is porogamous. Syngamy and triple fusion occur more or less simultaneously.

Endosperm development

The primary endosperm nucleus divides earlier than zygote. The primary endosperm nucleus undergoes repeated free nuclear divisions resulting in the formation of free nuclear endosperm (Fig. 2 I). Wall formation commences at about the globular stage of the proembryo and proceeds from micropolar region downwards towards the middle (Fig. 2 J). The chalazal region of the free nuclear part assumes a haustorial role (Fig. 2 J). The endosperm is consumed by the developing embryo and no trace of it is left at maturity.

Embryo

The zygote undergoes a transverse division resulting in a terminal cell *ca* and a basal cell *cb*. The later divides by a transverse wall into *m* and *ci* (Fig. 2 K, L). The terminal cell *ca* divides by a vertical wall (Fig. 2 L). Thus the 4-celled proembryo is T-shaped. Embryo development follows Onagrad type.

Discussion

The tapetal cells remain uninucleate in the present study in *Paracalyx*. While uninucleate tapetal cells are characteristic of all the investigated members of the Faboideae, a binucleate condition of the tapetal cells was reported by Latter (1926) in *Lathyrus odoratus*, Cooper (1938) in *Pisum sativum* and Prakash and Chan (1987) in *Glycine max*. Similarly Bharathi and Murthy (1984) also reported bi-, tetranucleate and polyploid tapeteal cells. In extensive survey of tapetal cells covering 89 genera and 167 species of the family Fabaceae, Buss (1971) and Buss and Lersten (1975) found that the tapetal cells are always uninucleate in Faboideae. Hence the observations of Latter (1926), Cooper (1938), Prakash and Chan (1976) and Bharathi and Murthy (1984) appear to be erroneous.

Ovules in the sub-family Faboideae have been reported to be anatropous, campylotropous, ana-campylotropous, amphitropous and ana-amphitropous.

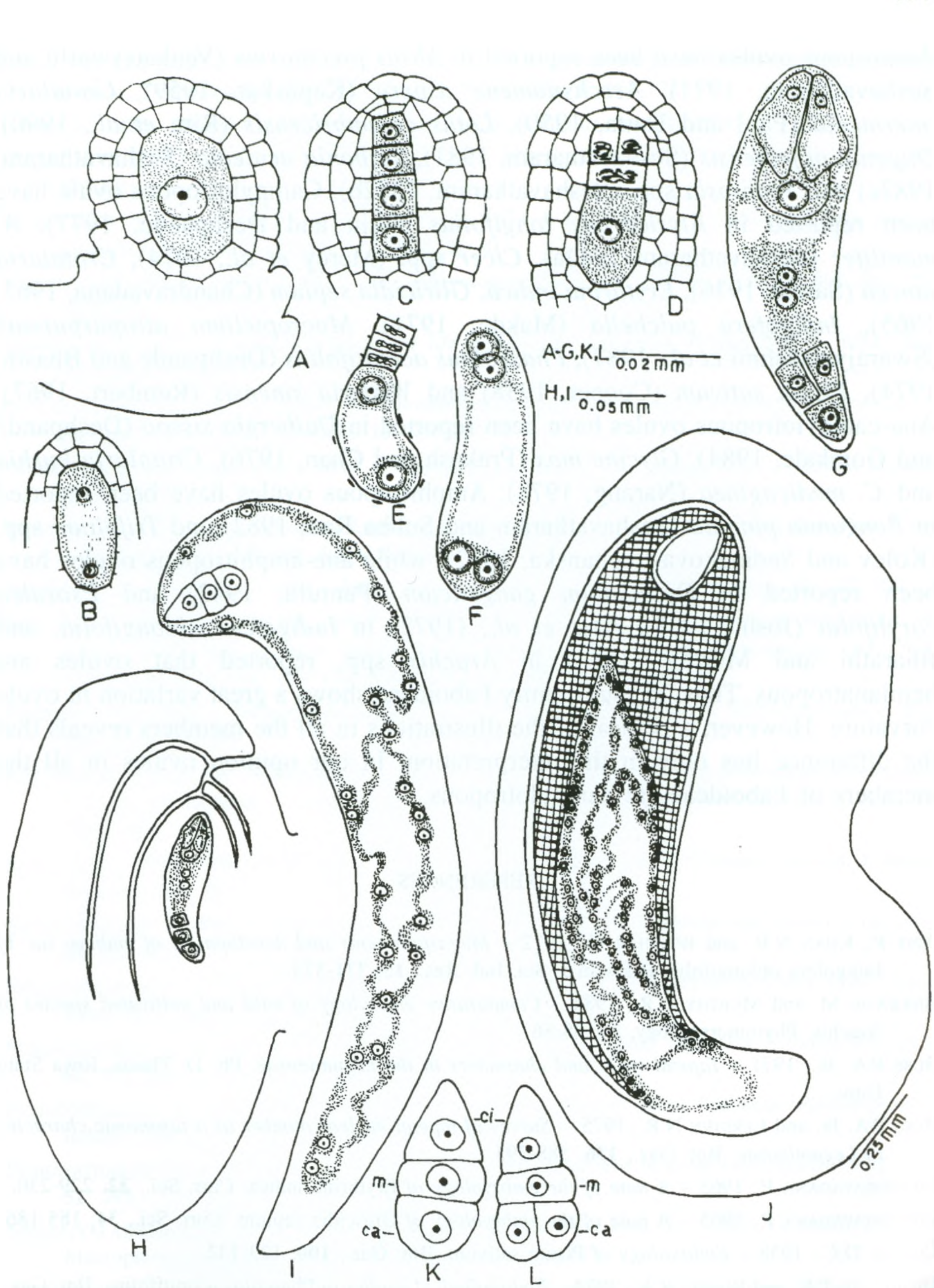

Fig. 2 – *Paracalyx scariosus* (Roxb.) Ali. A. Ovule with megaspore mother cell. B. Megaspore mother cell in meiosis. C. Linear megaspore tetrad. D. T-shaped megaspore tetrad. E. 2-nucleate embryo sac. F. 4-nucleate embryo sac. G. Organised embryo sac. H. Ovule with organised embryo sac. I,J. Stages in the development of endosperm. K,L. Stages in the development of embryo.

Anatropous ovules have been reported in *Abrus precatorius* (Venkateswarlu and Seshavatharam, 1971), *Aeschynomene aspera* (Kapuskar, 1959), *Crotalaria intermedia* (Paul and Datta, 1950), *Lotus conimbricensis* (Rim *et al.*, 1990), *Ougenia oojeinensis* (Seshavatharam, 1981), *Sesbania aculeata* (Seshavatharam, 1982c) and *Tephrosia* spp. (Seshavatharam, 1982b). Campylotropous ovule have been reported in *Alysicarpus longifolius* (Raju and Deshpande, 1977), *A. monilifer* (Seshavatharam 1982a), *Cicer* spp. (Mercy *et al.*, 1974), *Crotalaria juncea* (Samal, 1936), *Erythrina indica, Gliricidia sepium* (Chandravadana, 1963, 1965), *Indigofera pulchella* (Makde, 1971), *Macroptelium atropurpureum* (Swarajyalakshmi *et al.*, 1987), *Phaseolous aconitifolius* (Deshpande and Bhasin, 1974), *Pisum sativum* (Cooper, 1938) and *Wisteria sinensis* (Rembert, 1967). Ana-campylotropous ovules have been reported in *Dalbergia sissoo* (Deshpande and Gomkale, 1984), *Glycine max* (Prakash and Chan, 1976), *Crotalaria burhia* and *C. medicaginea* (Narang, 1978). Amphitropous ovules have been reported in *Pongamia pinnata* (Seshavatharam and Subba Rao, 1982) and *Trifolium* spp. (Kolev and Sedmakova-Luchanska, 1972), while ana-amphitropous ovules have been reported in *Desmodium gangeticum* (Pantulu, 1942) and *Psoralea corylifolia* (Joshi, 1938). Aziz *et al.*, (1972) in *Indigofera oblongifolia*, and Bharathi and Murthy (1984) in *Arachis* spp. reported that ovules are hemianatropous. Thus, the sub-family Faboideae shows a great variation in ovule curvature. However, a perusal of the illustrations in all the members reveals that the difference lies only in the interpretation. In our opinion ovules in all the members of Faboideae are campylotropous.

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