EMBRYOLOGICAL INVESTIGATIONS IN *GONIOCAULON GLABRUM* L.

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Abstract: Anthers are 4-lobed. Anther wall development is of the Dicotyledonous type. Periplasmodial tapetum is formed when pollen grains are uni-nucleate. Pollen tetrads are decussate and tetrahedral. Pollen grains are 3-celled at the time of anther dehiscence. Ovule is anatropous, unitegmic and tenuinucellate. The development of embryo sac conforms to the Polygonum type. Synergids are pearshaped and antipodals are three in number. Endosperm is of the Nuclear type and embryo development resembles Asterad typed.

INTRODUCTION

Embryological studies in the tribe Cardueae of the family Asteraceae are extensive (see Pullaiah, 1984). Lavielle (1911) reported Polygonum type of embryo sac development in *Centaurea cirrhata*. Poddubnaja-Arnoldi (1931) studied the embryology of several genera such as *Carduus*, *Onopordon*, *Cirsium*, *Jurinea*, *Sassaurea*, *Centaurea*, *Cnicus*, *Serratula*, *Crupina*, *Xeranthemum* and *Echinops*. Banerji (1940) investigated the embryology of *Carthamus tinctorius*. Maheswari Devi and Pullaiah (1976, 1977) reinvestigated the embryology of *C. tinctorius* and corrected the observations of Banerji (1940). Deshpande (1964) studied the embryology of *Voluterella ramosa* while Renzoni (1970) gave an account of embryo sac development in *Centaurea cineraria*. Vernin (1952) studied the development of embryo in *C. jacea* and *C. cyamus* while Mestre (1963-'64) reported Asterad type of embryo development in *Centaurea*, *Onopordon*, *Cnicus*, *Xeranthemum*, *Carlina*, *Carduus*, *Silybum*, *Galactites*, *Cirsium*, *Kentrophyllum* and *Serratula*. Yurukova-Grncharova (1979) studied the embryo sac development in *Leontodon hispidus* and *L. crispus*. She reported the occurrence of somatic apospory in the former species. Pullaiah and Swarajya Lakshmi (1984) studied the embryology of *Cirsium acaule*. In spite of such extensive studies the genus *Goniocaulon* remained uninvestigated embryologically and hence the present investigation has been undertaken.

MATERIAL AND METHODS

Heads at different stages of development were collected by Dr. T. Pullaiah from Kammavaripalli, in Kurnool district of Andhra Pradesh and fixed in formalin-aceti acid-alcohol (F. A. A.). Dehydration, embedding and sectioning were followed adopting the procedure given by Johansen (1940) and Delafield's haematoxylin was used to stain the sections. Diagrams are drawn by using a camera lucida at bench level. Voucher specimen no. TP 2779 has been deposited in the Herbarium of Department of Botany, Sri Krishnadevaraya University.

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OBSERVATIONS

Microsporangium, microsporogenesis and male gametophyte

In a transverse section, the anther is four-lobed (Fig. 1T). A hypodermal row of male archesporium of 4-6 cells (Fig. 1A) divides periclinally to form a primary sporogenous layer and primary parietal layer (Fig. 1B). The primary parietal layer undergoes another periclinal division giving rise to an inner layer of anther

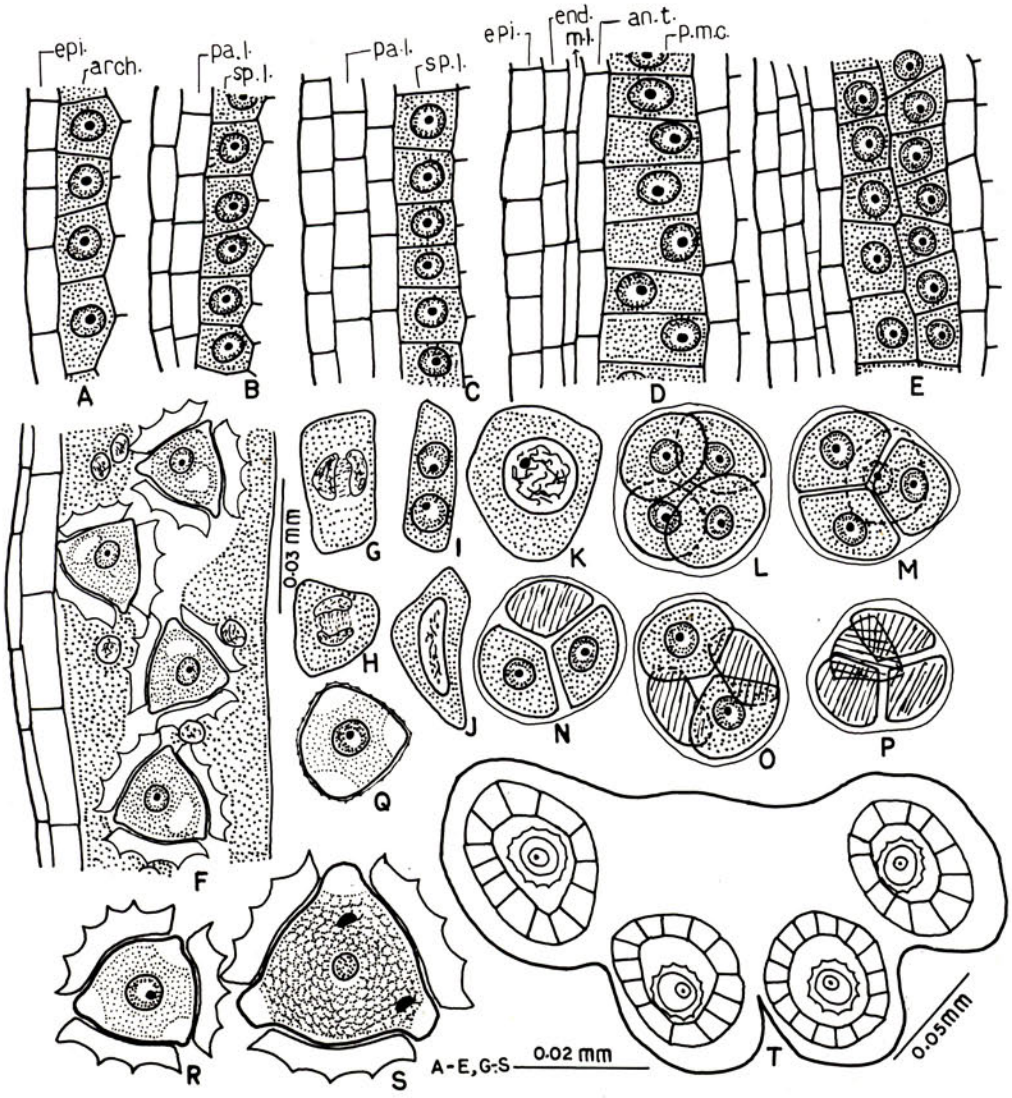

Fig. 1. A-E. Longitudinal section of part of anther lobes showing development of wall layers. F. Longitudinal section of part of anther lobe showing periplasmodial tapetum. G-J. Tapetal cells. K. Pollen mother cell. L, M. Pollen tetrads. N-P. Pollen tetrads showing degenerating microspores. Q, R. Uninucleate pollen grains. S. Mature pollen grain. T. Transverse section of anther. (an. t.—anther tapetum; arch.—archesporium; end.—endothecium; epi.—epidermis; ml—middle layer; pa. t.—parietal layer; pmc—pollen mother cells; sp. l.—sporogenous layer).

tapetum and outer parietal layer (Fig. 1C). The latter again divides periclinally forming hypodermal layer below the epidermis and a middle layer above the tapetum (Fig. 1D) thus resulting in Dicotyledonous type of anther wall development.

The epidermal cells undergo anticlinal divisions to keep pace with the enlarging anther. The hypodermal layer develops fibrous thickenings at maturity forming endothecium. The middle layer gets dissolved during meiosis in pollen mother cells (Fig. 1E). The tapetal cells are 2-nucleate (Fig. 1G-I). Some times these nuclei fuse forming polyploid tapetal cells (Fig. 1J). At one-nucleate stage of the pollen grains, the walls of the tapetum break down and the cytoplasm (Fig. 1F) finally coalasces in the centre forming periplasmodium. It gets absorbed by the developing pollen grains.

The pollen mother cells which result from the primary sporogenous cells undergo one more periclinal division resulting in two rows (Fig. 1E). Pollen mother cells round off, undergo meiosis resulting in decussate and tetrahedral

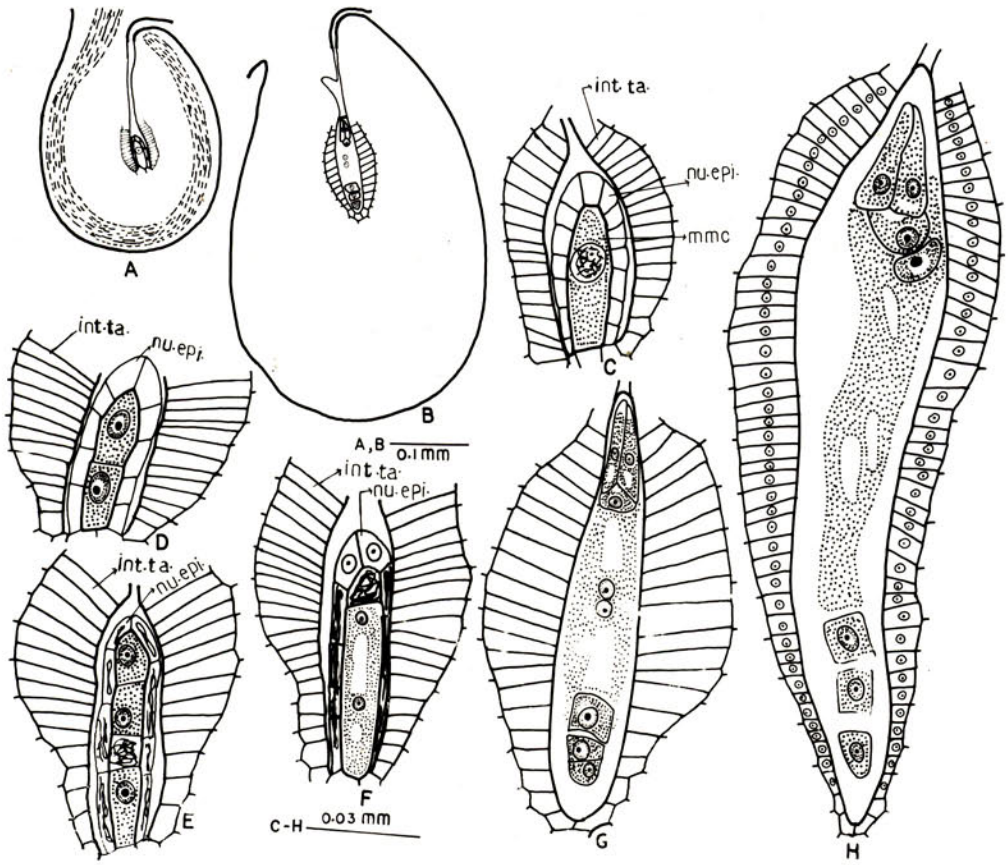

Fig. 2. A, B. Ovules at megaspore mother cell and young embryo sac stages respectively. C. Megaspore mother cell. D. Megaspore dyad. E. Megaspore tetrad. F. Two-nucleate embryo sac. Note degenerating megaspores. G, H. Young and mature organised embryo sacs respectively. (int. ta.—integumentary tapetum; mmc—Megaspore mother cell; nu. epi.—nucellar epidermis).

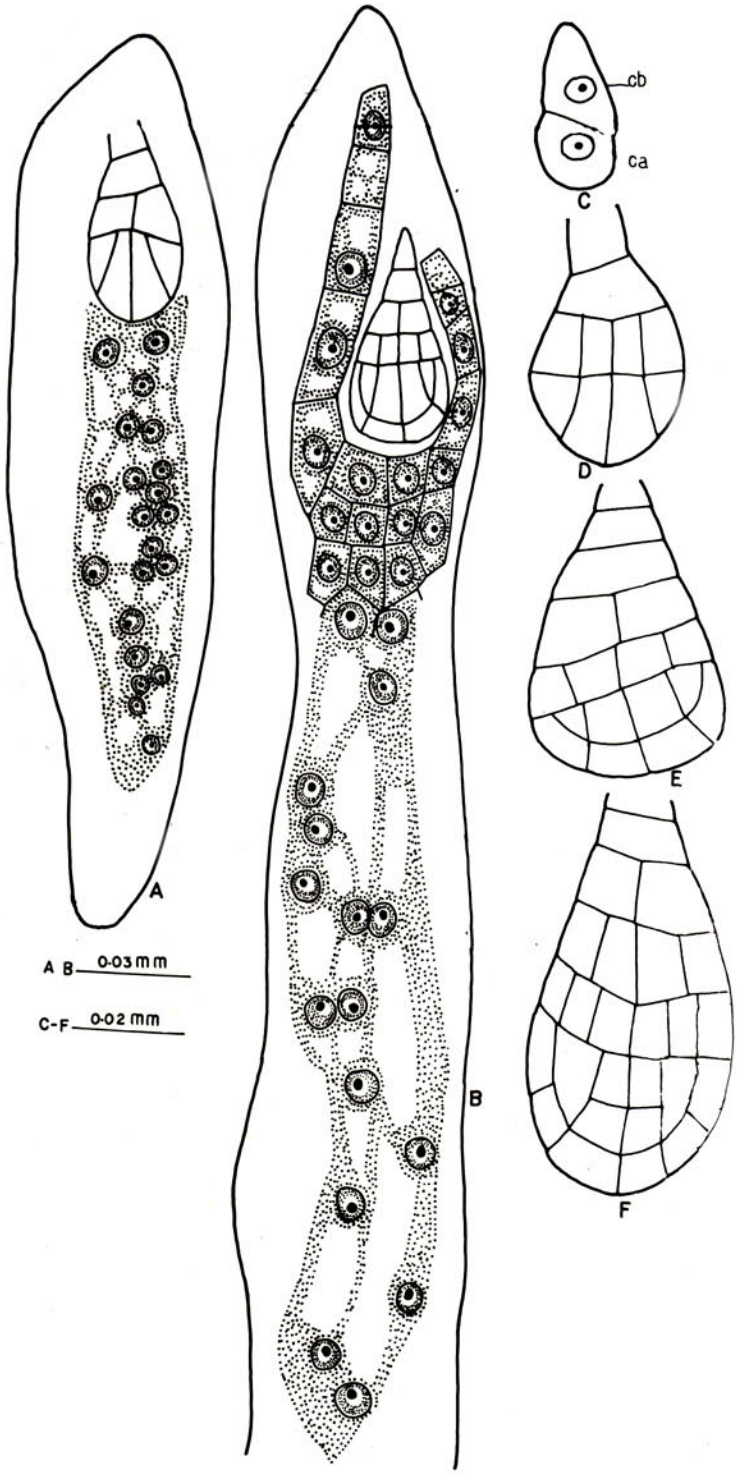

Fig. 3. A, B. Stages in endosperm development. C-F. Stages in the development of embryo.

microspore tetrads (Fig. 1K-M). Microspores after seperation from the tetrad enlarge and develop thick exine (Fig. 1Q, R). Pollen grains at the time of anthesis are three-celled with three germ pores (Fig. 1S). Pollen degenerations are not infrequent at the tetrad stage. One, two or all the four microspores are found degenerating (Fig. 1N-P).

Ovary and Ovule

The inferior ovary is bicarpellary, syncarpous and unilocular with a single basal ovule. The ovule is unitegmic, anatropous and tenuinucellate (Fig. 2A, B). A vascular bundle traverses from the funicle and runs to the tip of the the integument (Fig. 2A). The cells of the inner epidermis of the integument at the megaspore mother cell stage, elongate radially and function as integumentary tapetum (Fig. 2C). During further development this layer remains uniseriate with uninucleate cells (Fig. 2H) till it is completely absorbed by the growing embryo.

Megasporogenesis and female gametophyte

The female archesporium is hypoderrmal and single-celled. It functions directly as the megaspors mother cell (Fig. 2C) and undergoes meiotic division resulting in a linear tetrad of megaspores (Fig. 2C-E). Three micropylar megaspores degenerate whereas the chalazal one is functional (Fig. 2E, F) which later develops into an 8-nucleate Polygonum type of embryo sac (Fig. 2F, G). The synergids are pear-shaped. The antipodal cells are three in number, they are uni-nucleate and arranged in linear fashion. The two polar nuclei fuse prior to fertilisation resulting in a secondary nucleus which lies near the egg apparatus (Fig. 2H).

Fertilisation, endosperm and embryo

Fertilisation is porogamous. Endosperm development is of the Nuclear type. The perimary endosperm nucleus undergoes free nuclear divisions and the nuclei are distributed throughout the embryo sac (Fig. 3A). After undergoing many such divisions the wall formation starts at about 16-celled embryo stage and it takes place from micropylar to chalazal side (Fig. 3B). Endosperm is consumed by the growing embryo except for one of two layers.

The zygote undergoes transverse division resulting in two cells, the terminal cell *ca* and the basal cell *cb* (Fig. 3C). Further development follows the Senecio variation of Asterad type of Johansen (1950) and Grand period I, Megarchetype II, series A, subseries A_2 in the first embryonic group according to Souèges system (Crété, 1963) (Fig. 3D-F).

DISCUSSION

In structure and development of anther and male gametophyte, *Goniocaulon glabrum* (present study) shows greater uniformity with the other species of the tribe hitherto investigated (Poddubnaja-Arnoldi, 1931; Deshpande, 1964; Maheswari Devi and Pullaiah, 1976). However pollen degenerations at the tetrad stage are met with in the present study. Formation of well developed endothecium is seen at megaspore mother cell stage while in others, that have been investigated earlier in this tribe it's presence is observed at megaspore tetrad stage (Poddubnaja-Arnoldi, 1931; Deshpande, 1964; Maheswari Devi and Pullaiah, 1976). Both pear-shaped and hooked synergids occur in this tribe (Poddubnaja-Arnoldi, 1931;

Deshpande, 1964; Maheswari and Devi and Pullaiah, 1976). In *Carduus acanthoides Onopordon acanthium, Cirsium arvense* (Poddubnaja-Arnoldi, 1931), *Carthamus tinctorius* (Banerji, 1940; Maheswari Devi and Pullaiah, 1976) and *Goniocaulon glabrum* (present study) the synergids are pear-shaped while in *Cnicus benedictus* (Poddubnaja-Arnoldi, 1931) hooked synergids are reported. An increase in the number of antipodal cells is reported in only three species—*Centaurea scabiosa, Serratula coronata* (Poddubnaja-Arnoldi, 1931) and *Centaurea cineraria* (Renzonicela, 1970). But in the present species the antipodal cells are only three in number and are uninucleate.

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Goniocaulon glabrum Linn. 之胚研究

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摘　　要

花藥四瓣，藥壁之形成過程屬雙子葉植物型。花粉於單核期藥壁內層之原生體型營養層就形成。四分孢子期之花粉排列爲十字對生和四面體型。花粉粒釋出時含三個細胞。胚珠倒生、單珠被而發育過程爲薄珠心型。胚囊發育屬蓼型，助細胞梨形而反足細胞有三。胚乳屬遊核型，胚形成似菊科型。