CHAPTER - 4

TRIBE : CARDUEAE

INTRODUCTION

The tribe Cardueae otherwise known as Cynareae which comprises of 34 genera is characterised by the presence of homogamous heads and receptacles which are covered by numerous bristles. Embryological studies in this tribe are quite extensive. Poddubnaja - Arnoldi (1931) studied complete life history of *Carduus acanthoides*, *Onopordon acanthium*, *Cirsium arvense*, *Jurinea arachnoidea*, *Sassurea amara*, *Centaurea scabiosa*, *Cnicus benedictus*, *Serratula coronata*, *Crupina crupinastrum*, *C. vulgaris*, *Xeranthemum squarrosum*, *X. cylindricum*, *X. annuum*, and *Echinops sphaerocephalus*. Lavielle (1911) reported Polygonum type of embryo sac development in *Centaurea cirrhata*. Banerji (1940) investigated the embryology of *Carthamus tinctorius*. Maheswari Devi and Pullaiah (1976b, 1977a) reinvestigated the embryology of *C. tinctorius* and corrected the observations of Banerji. Deshpande (1964a) studied the embryology of *Voluterella ramosa*, while Renjoni (1970) gave an account of embryo sac development in *Centaurea cineraria*. Vernin (1952) studied the development of embryo in *Centaurea jacea* and C. cyamus, While Mestre (1963-64) reported an Asterad type of embryo development in Carlina acaulis, Carduus nutans, C. defloratus, C. crispus, C. tenuiuflorus, Silybum marianum, Galactites tomentosa, Cirsium acaule, C. lanceolatum, C. palustre, Centaurea aspera, C. collina, C. montana, Kentrophyllum lenatum and Serratula tinctoria.

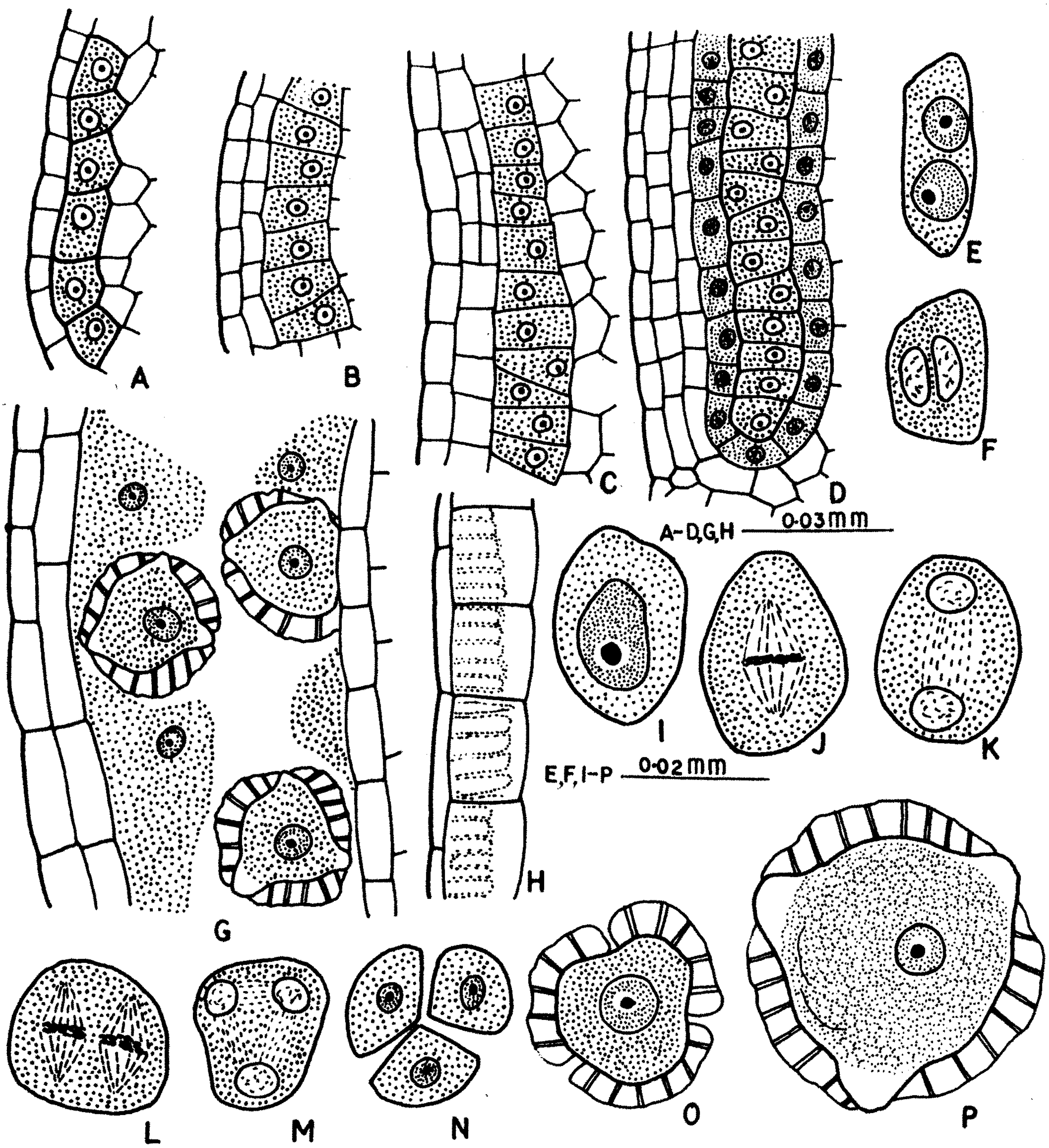
Cirsium, a large genus of about 150 species is mainly distributed in the North temporate region. Out of the 150 species, only 5 species have been investigated of which only C. arvense is known in detail. Cirsium acaule Scop. was chosen for embryological investigation in view of the paucity of the literature on the genus.

OBSERVATIONS

Microsporangium, Microsporogenesis and Male gametophyte:

The young anther in cross section shows an oval mass of meristematic cells surrounded by the epidermis. When the anther becomes tetralobate, a row of six hypodermal archesporial cells are differentiated in each of the four lobes. They become prominent with their larger size and conspicuous nuclei (Fig. 1 A). These archesporial cells expand radially and undergo periclinal divisions which result in the formation of a primary parietal layer towards outside and primary sporogenous layer towards inside (Fig. 1 B). The primary parietal layer undergo periclinal division resulting in the inner and the outer layers (Fig. 1 C). The inner one forms the tapetum while the outer divides forming a hypodermal layer and a middle layer (Fig. 1 D). Thus the wall consists of three layers below the epidermis. This type of anther wall development is classified as the Dicotyledonous type by Davis (1966).

The epidermal cells undergo only anticlinal divisions and keep pace with the expanding anther. Later on these cells get much stretched and flattened and persist in the mature anther. The sub epidermal layer develop fibrous thickenings at about the time of formation of 3-celled pollen grains and forms the fibrous endothecium (Fig. 1 H). The middle layer gets crushed and degenerates during meiotic divisions in the pollen mother cells. The tapetum shows a dual origin. The peripheral tapetal cells of the anther develop from the parietal layer while the tapetal cells towards the connective side develops from the cells of the connective tissue. The tapetal cells undergo nuclear division resulting in 2-nucleate cells (Fig. 1 E). In some cases, tapetal cells with two polyploid nuclei have been



A
B
C
D
E
F
G
H
A-D,G,H 0·03mm
I
J
K
E,F,I-P 0·02mm
L
M
N
O
P

met with (Fig. 1 F). The tapetum is of the Periplasmodial type (Fig. 1 G). When one-nucleate pollen grains have already started developing exine, the walls of the anther tapetum break down and the cytoplasm flows in to the anther locule. The periplasmodium gets absorbed even before the cytoplasm of the different cells fuse.

The primary sporogenous cells undergo only transverse divisions and form a single row of pollen mother cells (Fig. 1 D). The pollen mother cells undergo meiotic divisions (Fig. 1 I-M) forming microspore tetrads. Cytokinesis is simultaneous. The tetrads are of the tetrahedral type (Fig. 1 N). The microspore after its release from the pollen tetrad enlarges, gradually becomes spherical and develops a thick exine (Fig. 1 O & P). The pollen grains are three-celled at the shedding stage with three germ pores. The sperm cells are filiform and much elongated (Fig. 1 P).

Ovary and Ovule:

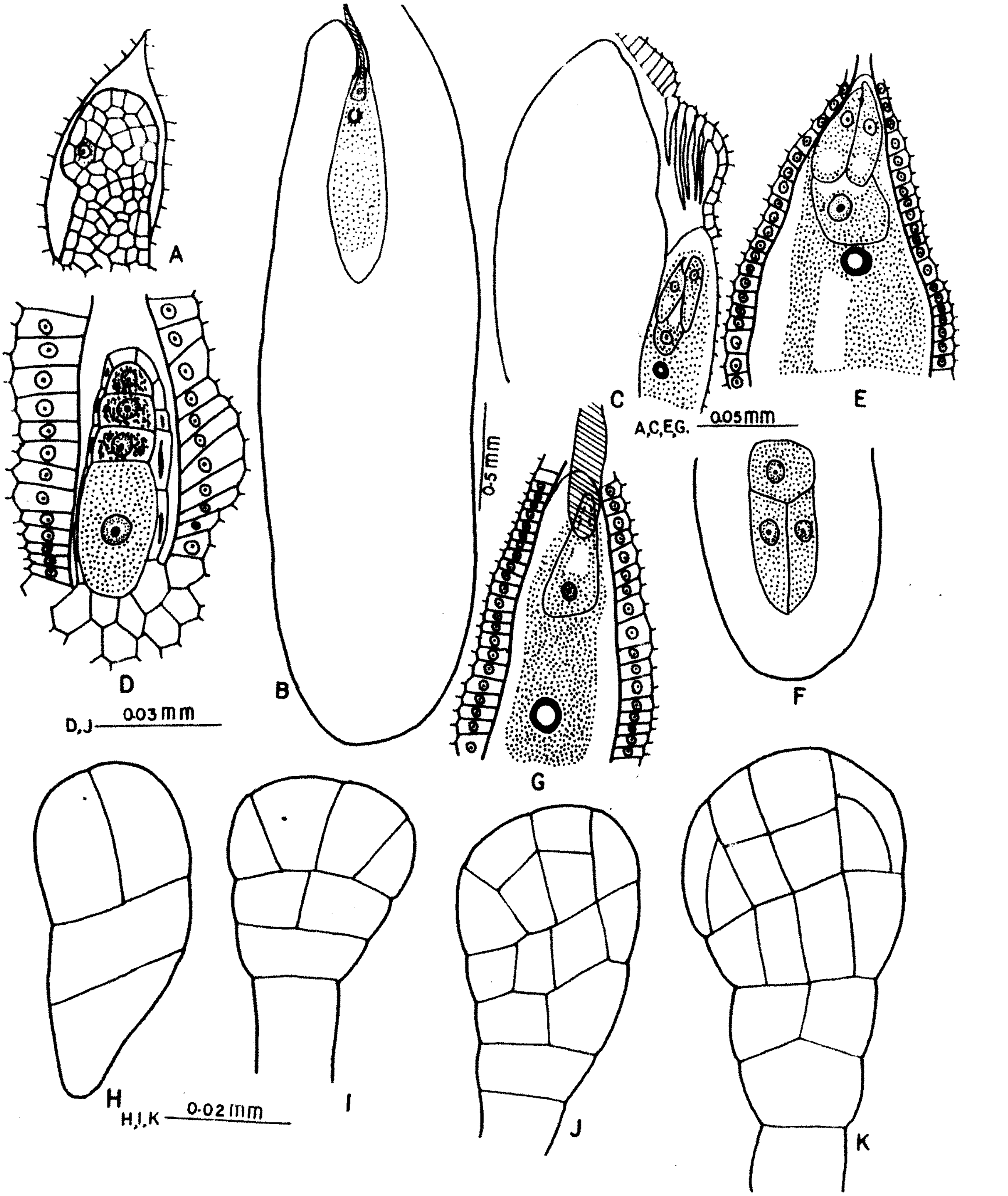
The ovary is inferior, bicarpellary syncarpous and unilocular with a single basal anatropous, unitegmic and tenuinucellate ovule. The ovule arises as a papillate outgrowth from the base of the ovary. During subsequent development due to the anticlinal divisions the ovule curves and attains an anatropous condition (Fig. 2 A & B).

The feature of special interest in Cirsium acaule is the occurence of obturator. The cells of the funicle lining the micropylar canal elongate radially acquire dense cytoplasm and function as obturatory cells (Fig. 2 C). As they are pointed towards the micropyle they may help in directing the pollen tube towards the micropyle.

The inner layer of the integument becomes differentiated as the endothelium during megaspore tetrad formation (Fig. 2 D). During further development, this layer remains uniseriate, but at places it is two-celled thick (Fig. 3 A & C). The cells of the endothelium remain uninucleate.

Megasporogenesis and Female gametophyte:

A female archesporial cell is differentiated hypodermally in the ovule (Fig. 2 A). This cell directly functions as the megaspore mother cell and enlarges considerably. A linear tetrad of megaspores is formed consequent upon the two meiotic divisions. The chalazal megaspore is functional while the micropylar three degenerate (Fig. 2 D). The functional megaspore undergoes three mitotic divisions resulting in eight-nucleate embryo sac of the Polygonum type. The embryo sac is


A
B
C
D
E
F
G
H
I
J
K
0·5 mm
A,C,E,G. 0.05 mm
D,J 0.03 mm
H,I,K 0·02 mm

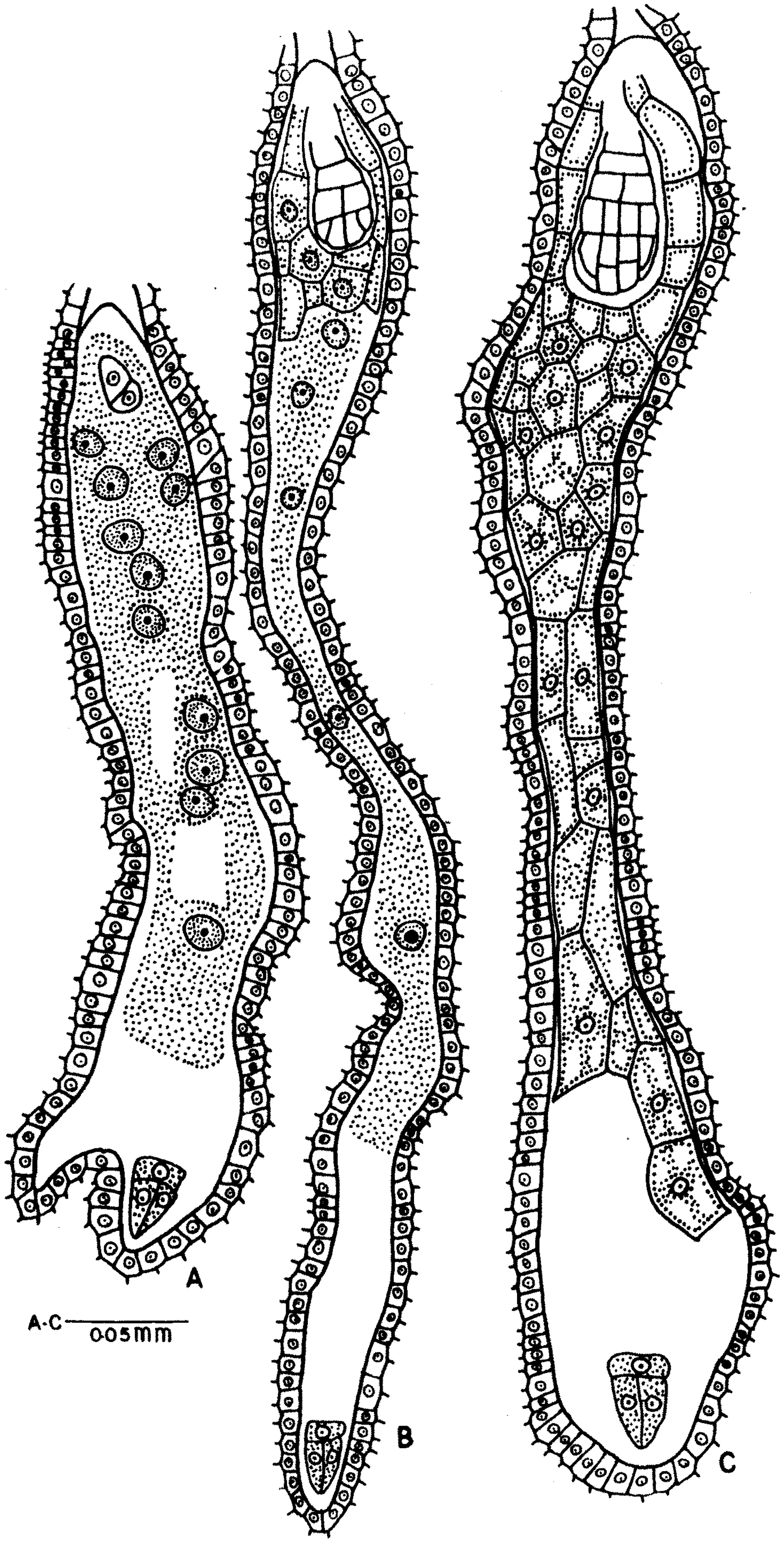
narrow. It elongates considerably after organisation and continues to elongate even during endosperm formation (Fig. 3 A-C). The synergids are hooked (Fig. 2 E). The antipodal cells simulate the egg apparatus in arrangement (Fig. 2 F). Antipodal cells are persistent and they are seen up to globular stage of the embryo (Fig. 3 A-C).

Fertilization, Endosperm and Embryo:

The pollen tube enters the ovule through the micropyle and hence it is refered as porogamous (Fig. 2 B & G). Syngamy and triple fusion occur more or less simultaneously.

The primary endosperm nucleus divides much earlier than the zygote forming two nuclei. These two nuclei undergo many more divisions and the resulting nuclei are mostly distributed in the micropylar part of the embryo sac (Fig. 3 A). Wall formation sets in when there are about 32-64 nuclei in the embryo sac. Wall formation commences at the micropylar end and proceeds towards the chalazal end (Fig. 3 B & C). Finally the embryo sac is completely filled with cellular tissue. Endosperm is completely absorbed by the growing embryo but for one or two layers of cells.

The zygote undergoes a transverse division resulting in a 2-celled proembryo. The terminal cell



A
B
C
A-C
0·05 mm

ca undergoes two vertical divisions at right angles to one another resulting in the formation of quadrants (Fig. 2 H). The next division in this tier q results in the formation of octants and the walls are oriented obliquely (Fig. 2 I). Due to periclinal divisions in the octants, a single layer of dermatogen cells are formed (Fig. 2 J & K). The derivatives of the tier q give rise to the two cotyledons and the stem tip.

Meanwhile basal cell cb divides transversely and two superposed cells m and ci are formed (Fig. 2 H). The cell m divides vertically twice at right angles to one another resulting in quadrants. The tier m gives rise to the entire hypocotyledonary region and plerome initials of roots. The cell ci divides transversely resulting in n and n' (Fig. 2 I). The cell n divides transversely resulting in two cells o and p (Fig. 2 K). The derivatives of n and o contribute to the root cortex, root cap and dermatogen of root.

Thus embryo development is of the Senecio variation of Asterad type of Johansen and Grand period I, Megarchetype II, series A, sub series A_2 in the first group according to Souege's system (Crété, 1963). It is in complete conformity with that studied by Mestre (1963-64).

DISCUSSION

Banerji (1940) reported that pollen grains in *Carthamus tinctorius* at maturity are 1-celled. Maheswari Devi and Pullaiah (1976b) reinvestigated and found that pollen grains are shed at 3-celled stage. In fact 3-celled pollen grains at shedding stage is the characteristic feature of Compositae (Brewbaker, 1967) except for some apomictic species. In *Cirsium acaule* (present study) also pollen grains are 3-celled.

In *Cirsium acaule* obturatory cells have been observed (present data). In the family Compositae presence of obturatory cells is a rare feature and has been reported only in a few members like *Lactuca muralis*, *Mutisia candolleana* (Dahlgren, 1920, 1924), *Ainsliaea aptera* (Kapil and Sethi, 1962a), *Carthamus tinctorius* (Maheswari Devi and Pullaiah, 1976b) and *Gerbera jamesonii* (Pande and Chopra, 1979).

Embryo sac development in the tribe Cardueae is of the Polygonum type in all members so far investigated (Lavielle, 1911; Poddubnaja - Arnoldi, 1931; Banerji, 1940; Maheswari Devi and Pullaiah, 1976b; Deshpande, 1964a; Renjoni, 1970 and present data). Endosperm development in the Cardueae is of the Nuclear type while embryo development follows the Senecio variation of Asterad type.