

V. RANGASWAMY* & T. PULLAIAH*: **Studies in the embryology
of *Erigeron canadensis* L. (Compositae)**

V. ランガスワミ*・T. プライア*: ヒメムカンヨモギの
花粉・胚珠の初期発育

The genus *Erigeron* of the tribe Astereae of the family Compositae, comprising about 200 species (Willis 1973), is cosmopolitan in distribution, especially occurring in North America. Embryologically this genus is better known than other members of Compositae because of its diversity in the development of embryo sac (Harling 1951). Most of the investigations are concerned with the embryo sac development only, while the microsporogenesis and male gametophyte have not been studied but for two species, i.e., *E. bonariensis* (Sehgal 1966) and *E. asterooides* (Desai 1982). Hence the present investigation has been undertaken to study the embryology of *Erigeron canadensis* L. Harling (1951) has reported monosporic type of embryo sac development, while Vernin (1952) has reported Asterad type of embryo development in this species.

Material and methods The material has been collected by the Junior author at Doddabetta in Nilgiris. Capitula at various stages of development are fixed in Formalin-Acetic acid-Alcohol (F.A.A.). Infiltration was done in tertiary butyl alcohol series and embedded in paraffin wax of melting point 58-60°C. Sections were cut at a thickness of 5-8 μm and stained in Delafield's Haematoxylin. Voucher specimen No. TP. 1280 has been deposited in the Herbarium of Sri Krishnadevaraya University, Anantapur.

Observations Microsporangium, microsporogenesis and male gametophyte. The anthers are bisporangiate (Fig. 1A). The archesporium is hypodermal and consists of a single row of 5-7 cells. The archesporial cells undergo periclinal division giving rise to primary parietal cells and primary spogogenous cells. The primary parietal cells undergo periclinal division resulting in two layers (Fig. 1C), of which the inner functions as the tapetum while the outer undergoes one more periclinal division resulting in a hypodermal layer and a middle layer (Fig. 1A). This type of wall development according to Davis (1966) is

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known as dicotyledonous type. The hypodermal layer develops fibrous thickenings and functions as fibrous endothecium (Fig. 1E). Anther tapetum is of the periplasmodial type. Tapetal cells remain one-nucleate. At one-nucleate stage of the pollen grains, the walls of the tapetal cells break down and the cytoplasm flows into the anther locule forming periplasmodium (Fig. 1D). It is consumed

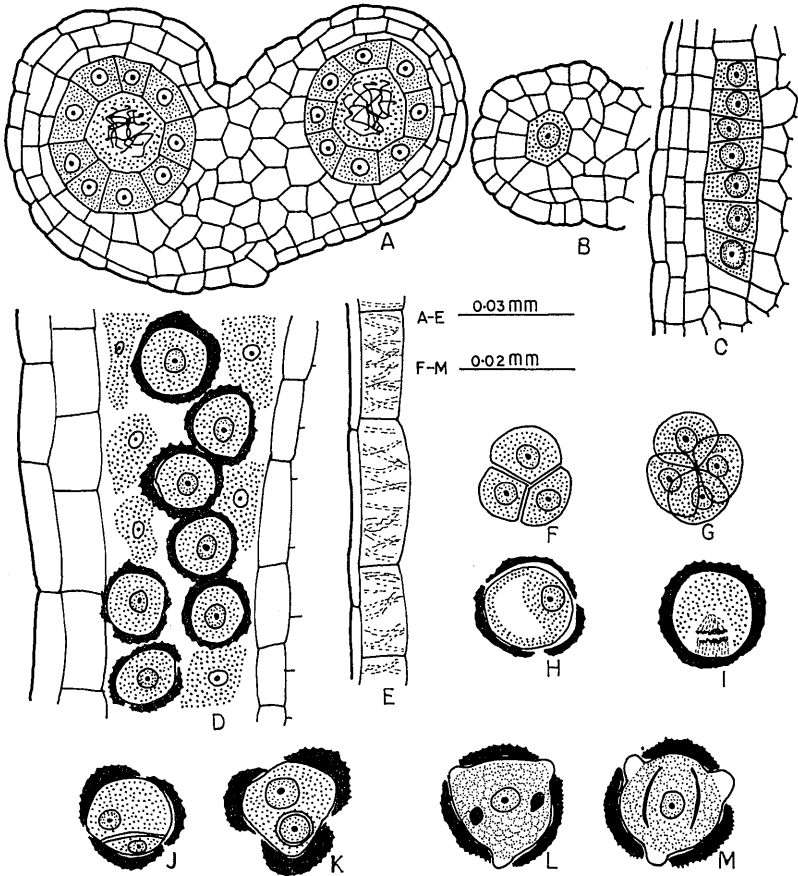


Fig. 1. *Erigeron canadensis*. A. T. s. of bisporangiate anther showing pollen mother cells and wall layers. B. T. s. of part of anther lobe showing sporogenous cell and primary parietal cells. C. L. s. of part of anther lobe showing sporogenous cells and two parietal layers. D. L. s. of part of anther lobe showing one-nucleate pollen grains and periplasmodial tapetum. E. Portion of fibrous endothecium. F, G. Tetrahedral and isobilateral pollen tetrads respectively. H-M. Stages in the development of pollen grain.

by the growing pollen grains and no trace of it is left at maturity. The cells of the middle layer gets crushed and degenerated at the time of meiosis of pollen mother cells.

The sporogenous cells undergo only transverse division resulting in a single row of pollen mother cells (Fig. 1A). The pollen mother cells undergo meiotic divisions resulting in tetrahedral or isobilateral pollen tetrads (Fig. 1F, G). Quadripartition occurs by furrowing. Microspore after its release from the tetrad enlarges considerably and develops a vacuole while the nucleus is situated towards one side (Fig. 1H). Pollen grain undergoes division resulting in a large vegetative cell and a small lenticular generative cell (Fig. 1I, J). The generative cell divides and forms two sperms (Fig. 1K, L, M). The mature pollen grain is three-celled with three germ pores (Fig. 1M). The sperms are either ovoid (Fig. 1L) or linear and filiform (Fig. 1M).

Ovary and ovule. Ovary as in other members of Compositae is bicarpellary, syncarpous and unilocular with single basal anatropous ovule, which is unitegmic and tenuinucellate. Ovule arises as a papillate outgrowth from the base of the ovary (Fig. 2A). Due to anti- and periclinal divisions on only one side, the ovule gets curved and becomes anatropous (Fig. 2B, C). At about the megaspore tetrad stage the cells of the inner epidermis of the integument become enlarged, elongate radially, acquire dense cytoplasm forming integumentary tapetum (Fig. 2E). It remain uniseriate with uninucleate cells throughout its further growth (Fig. 3A, C, E), and surrounds embryo sac completely but for the micropylar and chalazal regions (Figs. 2K, 3A, C, E).

Megasporogenesis and female gametophyte. The female archesporium is single-celled (Fig. 2A). It functions directly as megaspore mother cell (Fig. 2B, D) and undergoes meiotic divisions resulting in linear tetrad of megaspores. Usually the chalazal megaspore is functional but some times the sub-micropylar is functional (Fig. 2E). The functional megaspore undergoes three nuclear divisions resulting in an 8-nucleate embryo sac of the monosporic Polygonum type (Figs. 2D, E, 3A). The mature embryo sac is spindle-shaped. The two synergids are pyriform. The nucleus in the synergid is at micropylar end while the lower half is having a vacuole. The egg is flask-shaped. The nucleus in the egg is at the lower end while the upper part is occupied by a large vacuole. The antipodals are initially two in number (Fig. 2G). The behaviour of the antipodal cells vary. The number of antipodal cells increase up to eight by

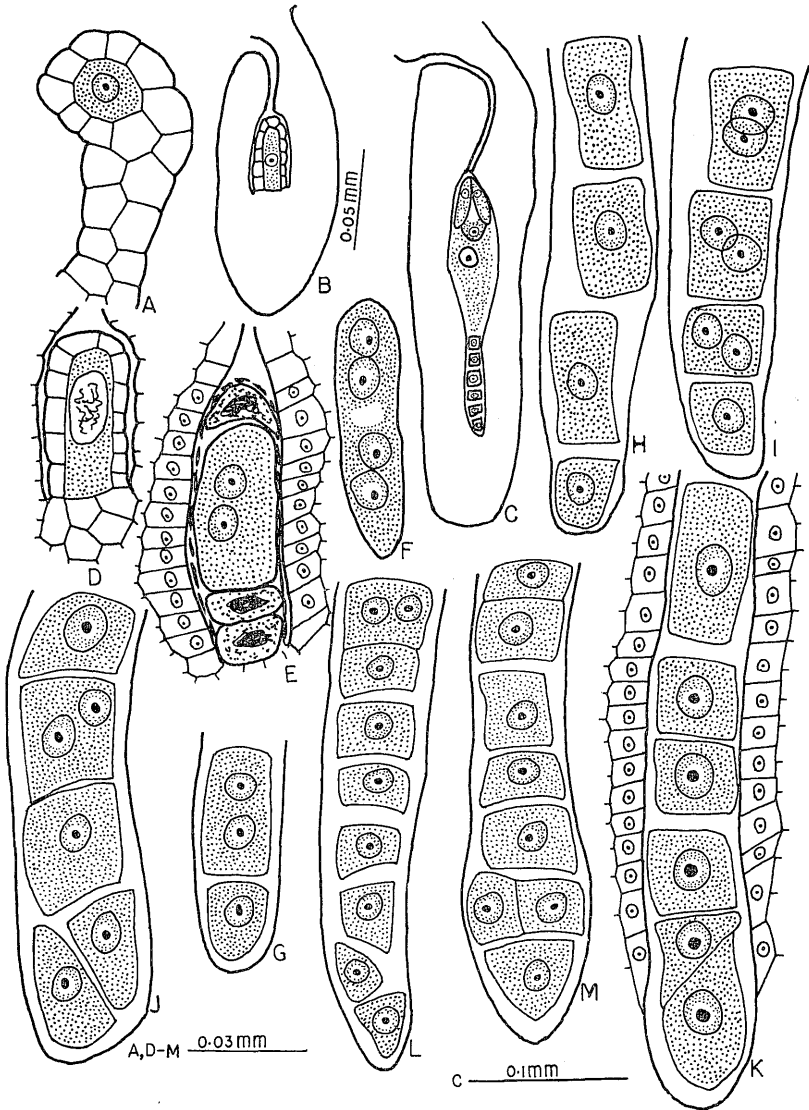


Fig. 2. *Erigeron canadensis*. A. Young ovule with archesporial cell. B, C. Anatropous ovule at megaspore mother cell stage and embryo sac stage respectively. D. Megaspore mother cell in meiosis. E. Tetrad of megaspores; note submicropylar megaspore is functional. F. Four-nucleate embryo sac. G-M. Antipodal cells.

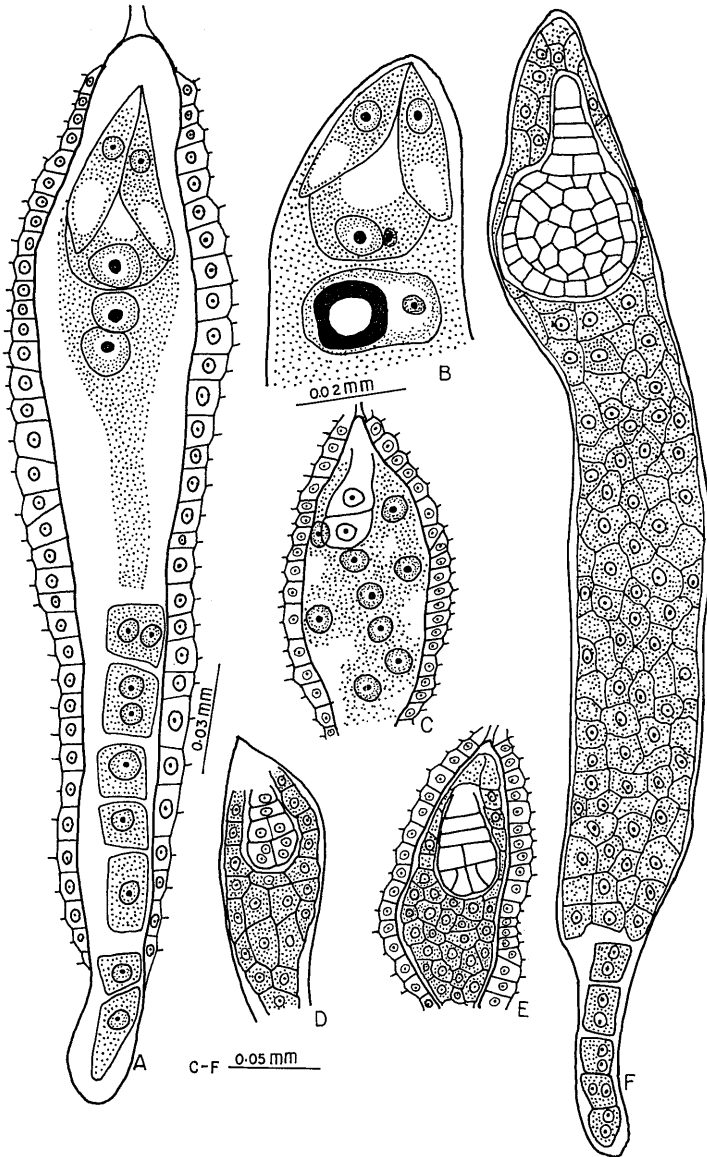


Fig. 3. *Erigeron canadensis*. A. Organised embryo sac. B. Micropylar part of the embryo sac showing syngamy and triple fusion. C-F. Stages in the development of endosperm.

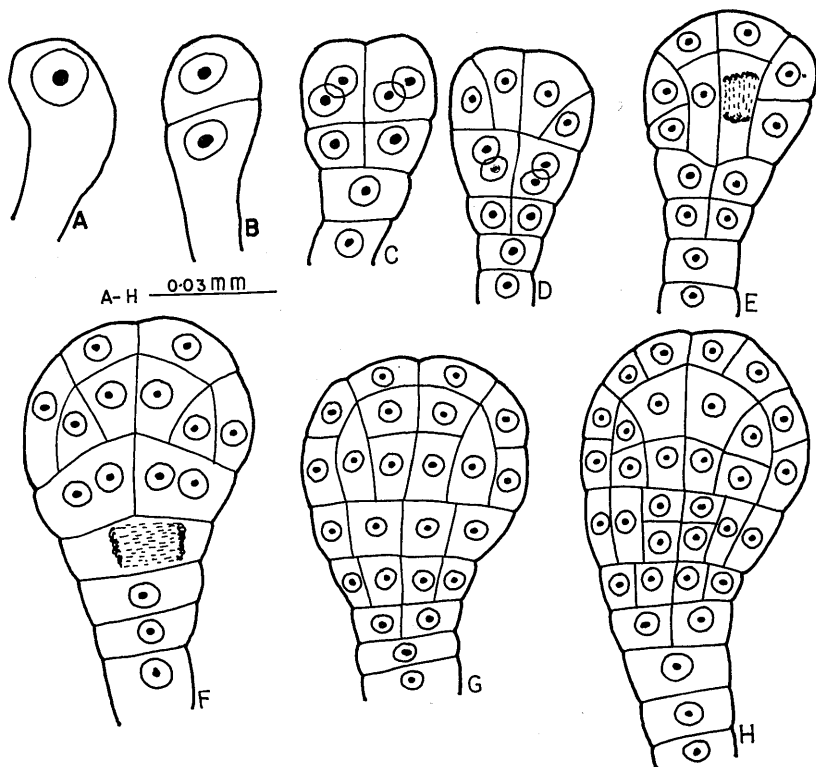


Fig. 4. *Erigeron canadensis*. A-H. Stages in the development of embryo.

nuclear divisions followed by cell wall formations (Fig. 2H-M). These antipodals may be arranged linearly (Fig. 2H, I, L), but in some cases the antipodals are situated side by side (Fig. 2J, M). The antipodals are persistent and are seen even at globular embryo stage (Fig. 3F). The polar nuclei fuse near the egg forming a secondary nucleus.

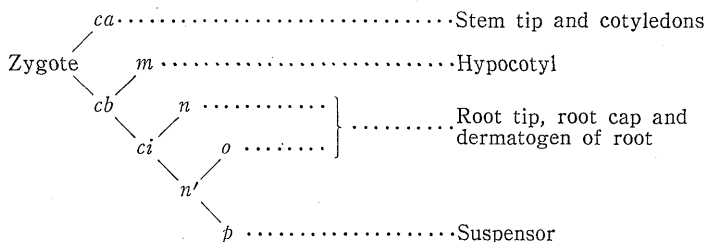
Fertilisation, endosperm and embryo. Entry of the pollen tube is porogamous. Fertilisation is normal. Syngamy and triple fusion occur more or less simultaneously (Fig. 3B).

Endosperm development is of the nuclear type. The primary endosperm nucleus divides earlier than zygote and they are not accompanied by wall formation. Cellularization occurs at two-celled embryo stage when 8-16 nuclei are

formed (Fig. 3C-F). These endosperm cells undergo repeated divisions in all planes resulting in a massive cellular tissue (Fig. 3F). The endosperm is absorbed by the growing embryo, but for one or two layers.

The zygote divides transversely forming a terminal cell *ca* and a basal cell *cb* (Fig. 4A, B). The terminal cell *ca* undergoes vertical division while the basal cell *cb* undergoes transverse division resulting in a four-celled 'T'-shaped pro-embryo. The derivatives of cell *ca* undergo one more vertical division at right angles to the previous one resulting in quadrants *q* (Fig. 4C). The derivatives of the cell *cb* are designated as *m* and *ci*. The cell *m* undergoes two vertical divisions at right angles to each other while the cell *ci* divides transversely forming *n* and *n'* (Fig. 4C). The cell *n'* undergoes another transverse division resulting in *o* and *p* (Fig. 4D).

Further development of embryo (Fig. 4E-H) is represented in the following schematic representation.



The embryo development (Fig. 4A-H) thus corresponds to the Senecio variation of the Asterad type of Johansen (1950) and Grand period I, Megarcho-type II series A, sub series A₂ in first group according to Souèges system (Crête 1963).

Discussion The anther of *Erigeron canadensis* is bisporangiate (present study). In the family Compositae bisporangiate anthers are very rare and have been reported in *Parthenium hysterophorus* (Deshpande 1960, Pullaiah 1982a), *Cotula australis*, *C. coronopifolia*, *Calotis hispidula*, *C. squammigera* (Davis 1962, 1966), *Spilanthes acmella* (Sundara Rajan 1974), *Blumea membranacea*, *Ageratum conyzoides* and *Gynura nitida* (Pullaiah 1979, 1982b, 1983).

Anther tapetum in *Erigeron canadensis* (present study), *Conyza stricta* (Pullaiah 1978), *Erigeron bonariensis* (Sehgal 1966) and *E. asteroides* (Desal 1982) is of the periplasmoidal type. However, Snow (1945) and Anderson (1970)

reported glandular type and this appears questionable since Compositae is characterised by the periplasmodial tapetum (see Pullaiah 1984).

The antipodal cells in the tribe Astereae show much variation. In many species the antipodal cells increase in number (Tahara 1921, Harling 1951, Davis 1964, Howe 1975, Pullaiah 1978, Murthy & Sharma 1978 and Desai 1982). In all these species the antipodal cells are persistent till the initiation of the cotyledons.

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ヒメムカシヨモギの蒴は bisporangiate であり、その壁のでき方は dicotyledonous
 type である。タベタムの形成は周辺変形体型である。腺体形型だとする報告があるが
 それは誤りである。胚珠は倒生、珠皮は1枚で、薄層珠心である。胚嚢形成は *Poly-*
gonum type で、反足細胞は初め2細胞であるが、分裂によって数を増し、胚嚢完成時
 には8細胞にまでなり、ときに2核細胞も見られる。これらは多くは1列に並んでい
 る。胚乳形成は多核型であり、8-16個の遊離核ができた後細胞膜が作られる。反足細
 胞は分裂して8細胞にまでなり、胚が球形に発達する頃まで残っている。胚形成は
 Asterad 型である。

○ヤブマオの学名訂正 (矢原徹一) Tetsukazu YAHARA: A correction for a
 combination of *Boehmeria* published on p. 134

本巻 134 ページに発表したヤブマオに対する新組合せ名は国際命名規約の最新版
 (1983) で挿入された57条3項 (autonym はそれが自動的に作られるもとなった同じ
 分類階級の同時に発表された他の名に対し優先権をもつ) に反するものであったので訂
 正する。

Boehmeria japonica (L. f.) Miq. var. ***longispica*** (Steud.) Yahara, comb. nov.

B. longispica Steud., Fl. Regensb. 33: 260 (1850).

B. longispica Steud. var. *appendiculata* Bl., Mus. Bot. Lugd.-Bat. 2: 221
 (1856).

B. japonica (L. f.) Miq. var. *appendiculata* (Bl.) Yahara, Journ. Jap. Bot.
 59: 134 (1984).

A new combination is proposed based on International Code of Botanical
 Nomenclature 1983, Art. 57. 3. (東京大学 理学部付属植物園)