T. PULLAIAH* & P. S. LAKSHMI*: **Embryology of *Lactuca runcinata* DC. (Compositae)**

T. プライア*・P.S. ラクシュミ*: アキノノゲシ属の1種 *Lactuca runcinata* DC. の胚発生

Embryological investigations in the tribe Cichoreae of the family Compositae are quite extensive. They include Rosenberg (1906, 1907), Dahlgren (1920), Jones (1927), Gerassimova (1933), Poddubnaja-Arnoldi (1931, 1933, 1944), Venkateswarlu (1939), Warmke (2943), Battaglia (1948), Vernin (1952), Venkateswarlu & Maheswari Devi (1955), Beruti (1961), Walter & Kuta (1971), Singh & Kaul (1974), Kaul et al. (1975), Gill & Iqbal (1981), Kaul & Singh (1982) and Pullaiah (1982). A perusal of the literature reveals that embryology of *Lactuca runcinata* DC. has not been investigated and hence the present investigation was undertaken.

Material and Methods Capitula at various stages of development have been collected from the plants growing in the University campus and fixed in formalin-acetic acid-alcohol. Usual methods of dehydration, embedding and sectioning are followed (Johansen 1940). The sections are stained in Delafield's haematoxylin. The voucher specimens, T. Pullaiah and P. S. Lakshmi No. 698, has been deposited in the Herbarium of Sri Krishnadevaraya University, Madras Herbarium (MH, Coimbatore) and Central National Herbarium, Howrah (CAL).

Observations

Microsporangium, microsporogenesis and male gametophyte. The anthers are tetrasporangiate (Fig. 1A). The anther wall consists of an epidermis, hypodermal layer, middle layer and tapetum (Fig. 1, A, B). The cells of the epidermis undergo only anticlinal divisions keeping pace with the growing anther. They become much stretched, elongated and flattened at maturity. The cells of the hypodermal layer develop fibrous thickenings and form fibrous endothecium (Fig. 1, D). The middle layer gets crushed during meiotic divisions of pollen mother cells. Anther tapetum is of the Periplasmodial type (Fig. 1, C). Its cells show many variations. The nucleus of the tapetal cell undergoes two

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nuclear divisions resulting in four nuclei arranged in a linear row (Fig. 1, E). They enter next mitotic division and the spindles are arranged at right angles to the long axis of the cell (Fig. 1, F). The spindles are so closely packed that at metaphase the spindles fuse resulting in two octoploid nuclei at the end of the division (Fig. 1, G). In some cases a cell with one large and one small nucleus was observed (Fig. 1, H) and these might have been formed by the fusion of the nuclei. The walls of the tapetal cells break down at the one-

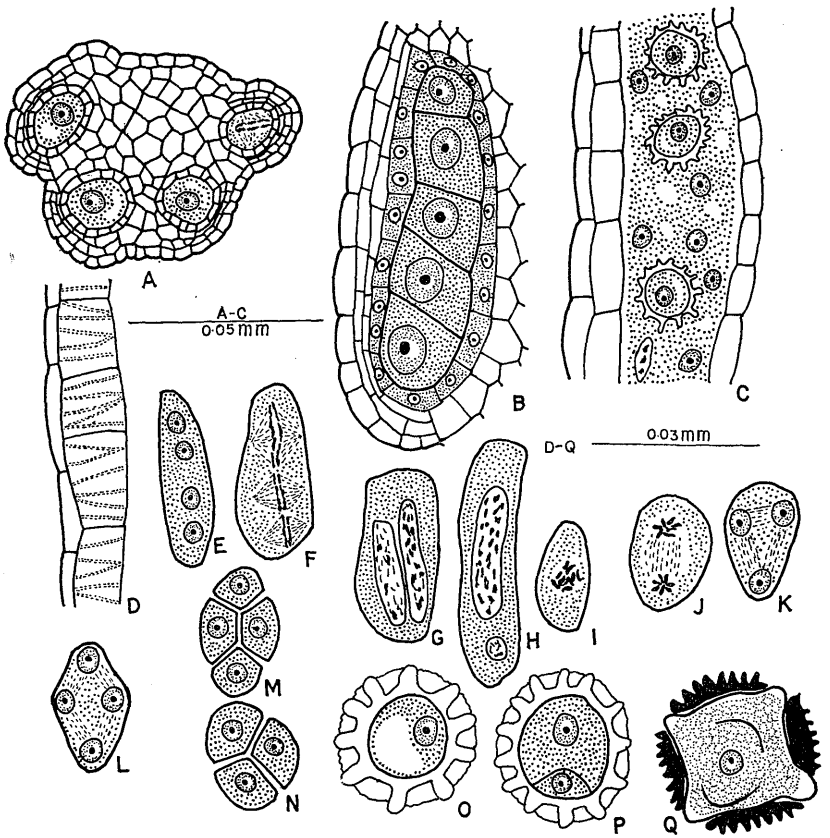

Fig. 1. *Lactuca runcinata*. A. Transverse section of anther at pollen mother cell stage. B. Longitudinal section of anther lobe showing wall layers and pollen mother cells. C. Longitudinal section of the part of anther lobe showing periplasmodium and one-nucleate pollen grains. D. Fibrous endothecium. E–H. Anther tapetal cells. I–L. Meiotic divisions in the pollen mother cells. M. Decussate pollen tetrad. N. Tetrahedral pollen tetrad. O. One-nucleate pollen grain. P. Two-celled pollen grain. Q. Three-celled pollen grain.

nucleate stage of the pollen grain and the cytoplasm coalesce in the anther locule forming the periplasmodium. The life of the periplasmodium is very short.

In longitudinal section pollen mother cells are six in number (Fig. 1, B) and in transverse section only one pollen mother cell is seen in each sporangium (Fig. 1, A) and hence there are only six pollen mother cells per sporangium. These pollen mother cells undergo meiotic divisions resulting in tetrahedral or decussate pollen tetrads (Fig. 1, I-N). Cytokinesis is of the simultaneous type.

The microspore (hereafter called as pollen grain) after its release from the tetrad enlarges considerably and develops its own wall. The vacuole occupies major portion of the pollen grain while the nucleus is displaced towards one side (Fig. 1, O). The nucleus then undergoes the mitotic division followed by wall formation resulting in a large vegetative cell and a small generative cell (Fig. 1, P). The generative cell rounds off and gets pinched off into the vegetative cell, where it undergoes one mitotic division resulting in two sperm cells. Pollen grains at the time of shedding are 3-celled with four germ pores (Fig. 1, Q). The sperms are much elongated and filiform. Pollen wall is very thick and spinous.

Ovary and ovule. The ovary is bicarpellary syncarpous and unilocular with a basal ovule which is anatropous, unitegmic and tenuinucellate (Fig. 2, A, B). The ovule arises as a papillate outgrowth from the base of the ovary. Later on due to anticlinal and periclinal divisions of the cells of the integument on only one side of the ovule, it gets curved and becomes anatropous (Fig. 2, A, B). The cells of the inner epidermis of the integument during megaspore tetrad formation elongate radially, acquire dense cytoplasm and function as integumentary tapetum (Fig. 2, E, F). It remains uniseriate with uninucleate cells (Fig. 2, J) through out its further growth till it is completely absorbed by the growing embryo.

Megasporogenesis and female gametophyte. The female archesporium is hypodermal and single-celled (Fig. 2, A). It functions directly as the megaspore mother cell (Fig. 2, C). The megaspore mother cell undergoes two meiotic divisions resulting in a linear tetrad of megaspores (Fig. 2, C-I). The chalazal functional megaspore undergoes first mitotic division even while the three micropylar megaspores are still in healthy condition (Fig. 1, F). The functional megaspore undergoes mitotic division resulting in two nuclei (Fig. 2, G). The embryo sac pierces the nucellar epidermis which is already in a degenerating con-

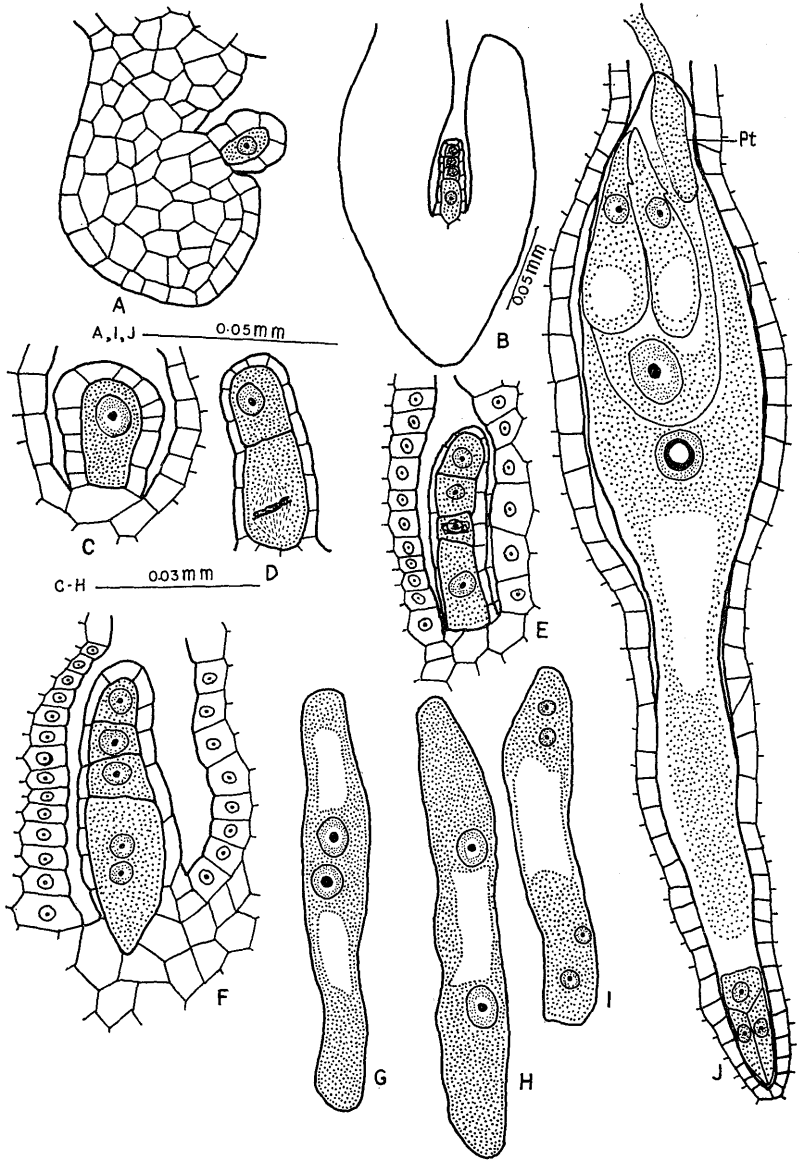

Fig. 2. *Lactuca runcinata*. A, B. Development of ovule. C. Megaspore mother cell. D. Megaspore dyad. E, F. Megaspore tetrads. G, H. Two-nucleate embryo sac. I. One-nucleate embryo sac. J. Mature embryo sac.

dition. The two nuclei move to each pole and they are separated by a large vacuole (Fig. 2, H). The two nuclei undergo two more mitotic divisions resulting in an 8-nucleate embryo sac of the *Polygonum* type (Fig. 2, I, J). The mature embryo sac is much elongated. The nucleus in the synergids is at the micropylar end while the chalazal part is occupied by a large vacuole. The antipodal cells are three in number and are uninucleate (Fig. 2, J). They are arranged in T-shaped manner. The two polar nuclei fuse prior to fertilization resulting in a secondary nucleus which lies near the egg apparatus.

Fertilization, endosperm and embryo. Fertilization is porogamous. The pollen tube enters through micropyle and discharges its contents near the egg apparatus. Triple fusion completes earlier than syngamy (Fig. 3, A).

Endosperm development is of the Nuclear type. The primary endosperm nucleus undergoes few free nuclear divisions (Fig. 3, B, C). Later on wall formation takes place forming cellular tissue. These cells undergo further divisions resulting in a massive tissue (Fig. 3, D). The growing embryo absorbs the endosperm completely except for one or two layers (Fig. 4, D).

The zygote undergoes transverse division resulting in two cells, terminal cell *Ca*, and basal cell *Cb*. Further development is essentially similar to those investigated earlier. The development follows (Fig. 3, E-H) the *Senecio* variation of Asterad type of Johansen (1950) and Grand Period I, Megarche type II, Series A and subseries A_2 in the first group according to Souèges system (Crété 1963). The mature embryo is straight (Fig. 3, H).

Seed coat and fruit wall. The integument at the time of megaspore tetrad is 5- or 7-celled thick at the middle region of the ovule (Fig. 4, A). The cells are parenchymatous. The cells increase in number and by the 2-nucleate embryo sac stage the integument is 9-celled thick (Fig. 4, B). Later on the cells next to integumentary tapetum enlarge in size and loose their contents by passing the nutrients to the growing embryo sac (Fig. 4, C). Finally at the mature embryo stage the endothelium also gets absorbed and the seed coat consists of only three layers of cells (Fig. 4, D).

The ovary wall is 5-6 layered with parenchymatous cells traversed by vascular elements at the megaspore tetrad stage. During further growth they enlarge considerably and form the fruit wall.

Discussion The anther tapetum in the family Compositae is of the Periplasmodial or Amoeboid type (Poddubnaja-Arnoldi 1931, 1944; Venkateswarlu &

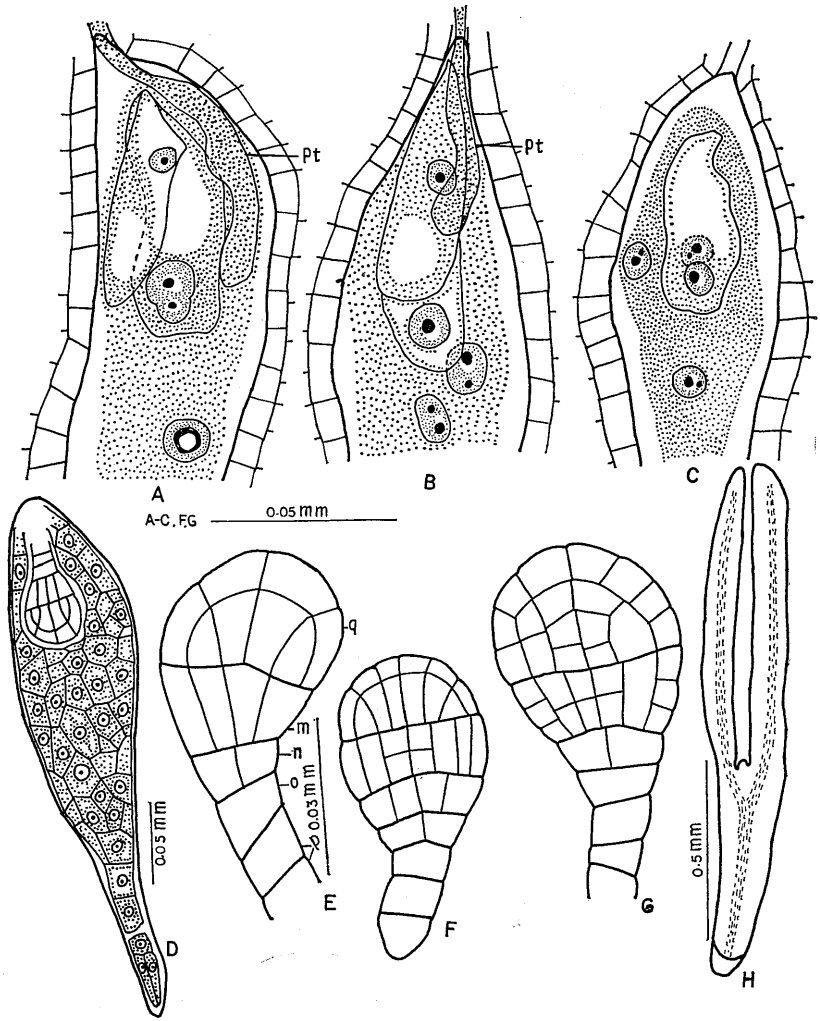

Fig. 3. *Lactuca runcinata*. A. Micropylar part of the Embryo sac showing syngamy and primary endosperm (triple fusion) nucleus. B–D. Development of Endosperm. E–G. Development of Embryo. H. Mature embryo (pt, pollen tube).

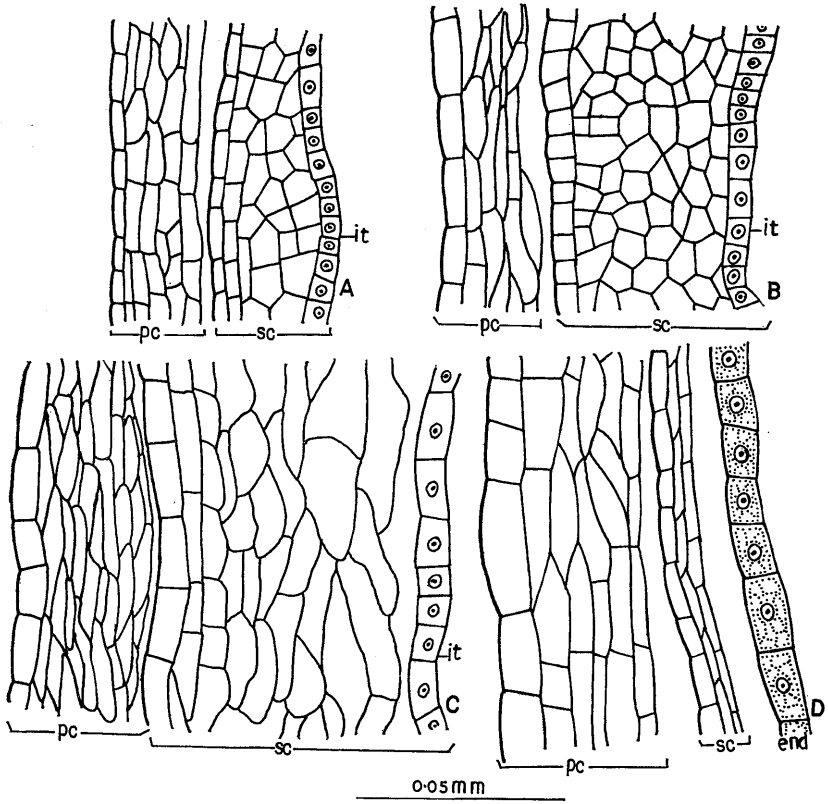

Fig. 4. *Lactuca runcinata*. A–D. Seed coat and pericarp at megaspore tetrad, 2-nucleate embryo sac, organized embryo sac and mature embryo stages respectively. (end, endosperm; it, integumentary tapetum; pc, pericarp; sc, seed coat).

Maheswari Devi 1955; Pullaiah 1978, 1979, 1982). However, in a few cases like *Chrysothamnus* (Snow 1945, Anderson 1970), *Vernonia cinerea*, *V. cinerascens* (Tiagi & Tiamni 1963), *Sonchus asper* (Walter & Kuta 1971; Kaul et al. 1975), *Hypochoeris radicata* (Kaul 1972) and *Youngia japonica* (Kaul 1973), it is reported that glandular tapetum occurs. From the present investigation it is found that periplasmodial formation commences only after one nucleate pollen grains are formed in the anther locule. Further, the life of periplasmodium in these members is very short. Probably, the above authors might have missed the stages of formation of periplasmodium and have mistakenly assumed it to

be of the Glandular type.

In the family Compositae pollen grains are shed at 3-celled stage. However, Kaul (1972, 1973) in *Hypochoeris radicata* and *Youngia japonica*, Singh & Kaul (1974) in *Tragopogon gracile*, and Kaul et al. (1975) in *Sonchus arvensis* and *Sonchus asper* reported pollen grains to be 2-celled at the shedding stage. Brewbaker (1967) has earlier studied the number of nuclei in pollen grains of angiosperms and concluded that the family Compositae is characterised by the 3-celled pollen grains and hence the above reports of 2-celled pollen grains at the shedding stage seems to be erroneous.

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キク科アキノノゲシ属の *Lactuca runcinata* の花粉と種子形成を報告した。4個の葯室には，それぞれ1列に並ぶ6個の花粉母細胞があり，各花粉母細胞は tetrahedral 型の分裂で4個の花粉を作る。葯のタペート組織のでき方は periplasmodial 型である。キク科ではこの他に Amoeboid 型が知られている。しばしば glandular 型が報告されることがあるが，これは，タペートの periplasmodium の出現期間は短いので，時期の違いにより glandular に見間違えたことによると思われる。花粉は3細胞期の状態で散る。胚嚢形成は *Polygonum* 型である。胚乳形成は nuclear 型で，後に細胞膜ができて多細胞になるが，胚が完成する頃は1～2層を除いて殆んど胚に吸収される。