CHAPTER - 6

TRIBE : CICHOREAE

INTRODUCTION

Cichoreae, the only tribe of the sub family Liguliflorae, is characterised by the presence of homogamous heads with all ligulate florets and anastomosing laticiferous vessels. The tribe comprises 63 genera (Hofmann, 1894). Embryological investigations in the tribe are extensive. They include Rosenberg (1906), Dahlgren (1920), Jones (1927), Gerassimova (1933), Poddubnaja-Arnoldi (1931, 1933, 1944), Venkateswarlu (1939), Warmke (1943), Battaglia (1948), Vernin (1952), Venkateswarlu and Maheswari Devi (1955a), Beruti (1961), Walter and Kuta (1971), Singh and Kaul (1974), Kaul *et al* (1975), Gill and Iqbal (1981), Kaul and Singh (1982), Pullaiah (1982b) and Chikkannaiah and Hiremath (1982).

The genus *Lactuca* includes 100 species which are chiefly distributed in temporate regions (Willis, 1973). Embryological studies in the genus *Lactuca* are scanty. Dahlgren (1920) reported Polygonum type of embryo sac development and Cellular type of endosperm development in *Lactuca muralis* and *L. scariola*. While Vernin (1952) reported Senecio variation of Asterad type of embryo

development in L. perennis and L. virosa. Details of microsporogenesis and male gametophyte are not known in the genus Lactuca. Hence the present investigation has been taken to study the embryology of L. leucophaea A.Gray. (=Cicerbita alpina Wallr.) and Lactuca runcinata DC.

OBSERVATIONS

Microsporangium, Microsporogenesis and Male gametophyte:

The anthers are tetrasporangiate (Fig. 5 A). The youngest anther available in the material showed single row of microspore mother cell in each anther lobe surrounded by anther wall which consists of epidermis, endothecium, middle layer and tapetum (Figs. 5 A & B and 6 A). 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. 5 D). The middle layer gets crushed during the meiotic divisions of pollen mother cells.

The inner most layer of the anther wall is the anther tapetum. It's cells show many variations. The nucleus of the tapetal cell undergoes two nuclear divisions resulting in four nuclei arranged in a linear row (Figs. 5 E and 6 C & D). They enter next mitotic division and the spindles are arranged at right angles to the axis of

Fig. 5 A - Q

Fig. 5 A - Q : *Lactuca runcinata*

Fig. 5 A : T.S. of tetrasporangiate anther at pollen mother cell stage.

5 B : L.S. of anther lobe showing wall layers and pollen mother cells.

5 C : L.S. part of anther lobe showing one-nucleate pollen grain and periplasmodial tapetum.

5 D : Fibrous endothecium.

5 E : Anther tapetal cell showing four nuclei.

5 F : Anther tapetal cell showing nuclear divisions.

5 G & H : Polyploid anther tapetal cells.

5 I - L : Meiotic divisions in the pollen mother cells.

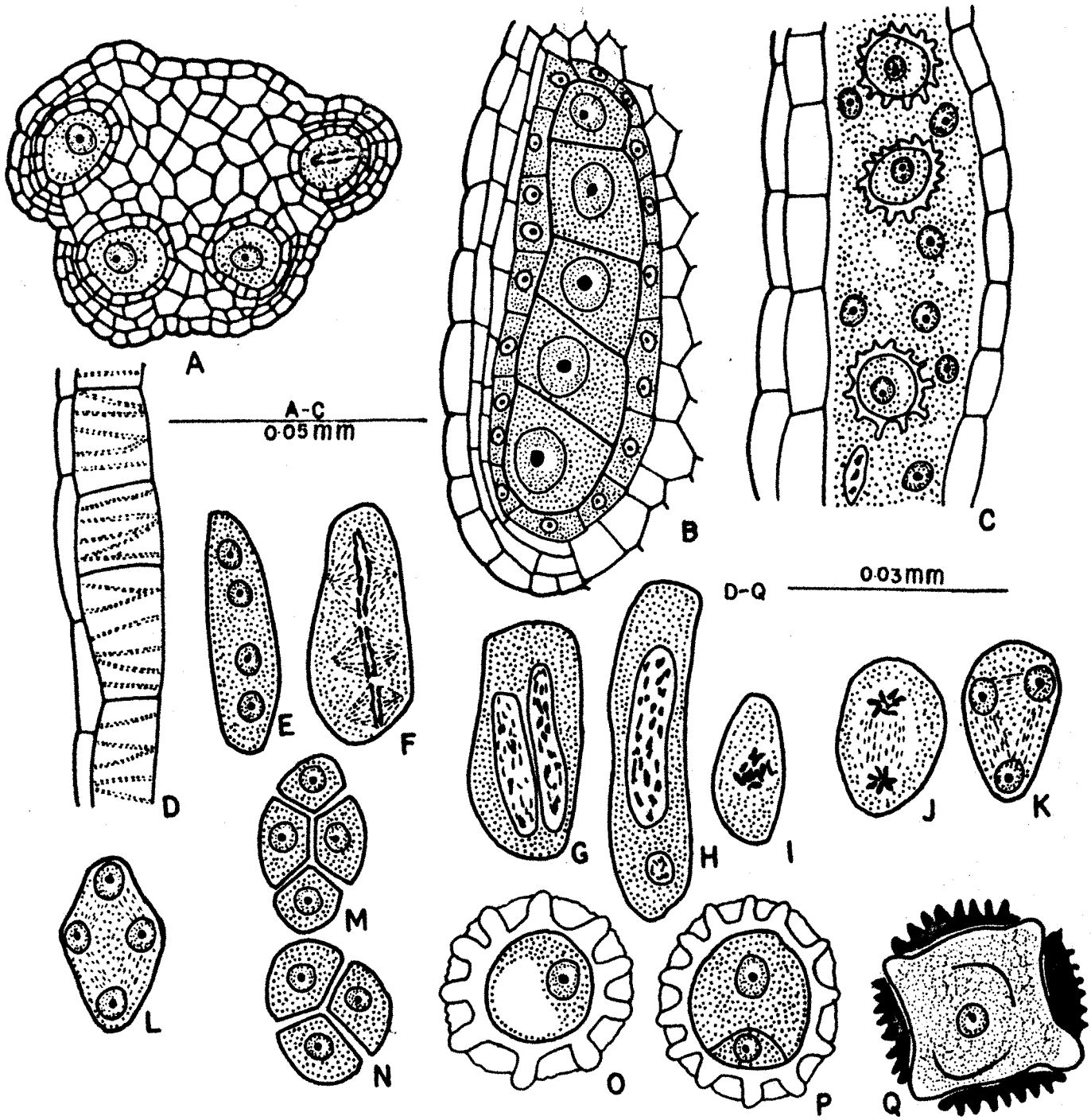
5 M : Decussate pollen tetrad.

5 N : Tetrahedral pollen tetrad.

5 O : One-nucleate pollen grain.

5 P : Two-celled pollen grain.

5 Q : Three-celled pollen grain.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the cell (Fig. 5 F). The spindles are so closely packed that at metaphase, the spindles fuse resulting in two octoploid nuclei at the end of division (Figs. 5 G & 6 E). In some cases a cell with one large and one small nucleus was observed (Fig. 5 H) and these might have been formed by the fusion of the nuclei. The tapetum is of the Periplasmodial type. The walls of the tapetal cells break down at the one-nucleate stage of the pollen grain and cytoplasm coalesces in the anther locule forming a Periplasmodium (Figs. 5 C and 6 B). The life of the periplasmodium is very short. It is consumed by the growing pollen grains and no trace is left at maturity.

The pollen mother cells in longitudinal section are six in number in Lactuca runcinata while in L. leucophaea they are 8 in number. In transverse section in both the species only one cell is seen in each sporangium and hence pollen mother cells are only in one row. Pollen mother cells undergo meiotic divisions (Figs. 5 I-L and 6 F) resulting in decussate and tetrahedral tetrads (Figs. 5 M & N and 6 G & H).

Microspore, here after called as pollen grain enlarges, gradually becomes spherical and develops a thick exine and a thin intine. Due to the appearance of a large vacuole, the nucleus is displaced towards one side (Figs. 5 O and 6 I). The pollen grain procreates a

Fig. 6 A - M

Fig. 6 A - M : *Lactuca leucophaea*

Fig. 6 A : L.S. part of anther lobe showing wall layers and pollen mother cells.

6 B : L.S. part of anther lobe showing protruding periplasmodial tapetal cells and one-nucleate pollen grains.

6 C & D : One-nucleate and four-nucleate anther tapetal cells.

6 E : Anther tapetal cells showing two polyploid nuclei.

6 F : Pollen mother cell in meiotic division.

6 G & H : Decussate and tetrahedral pollen tetrads respectively.

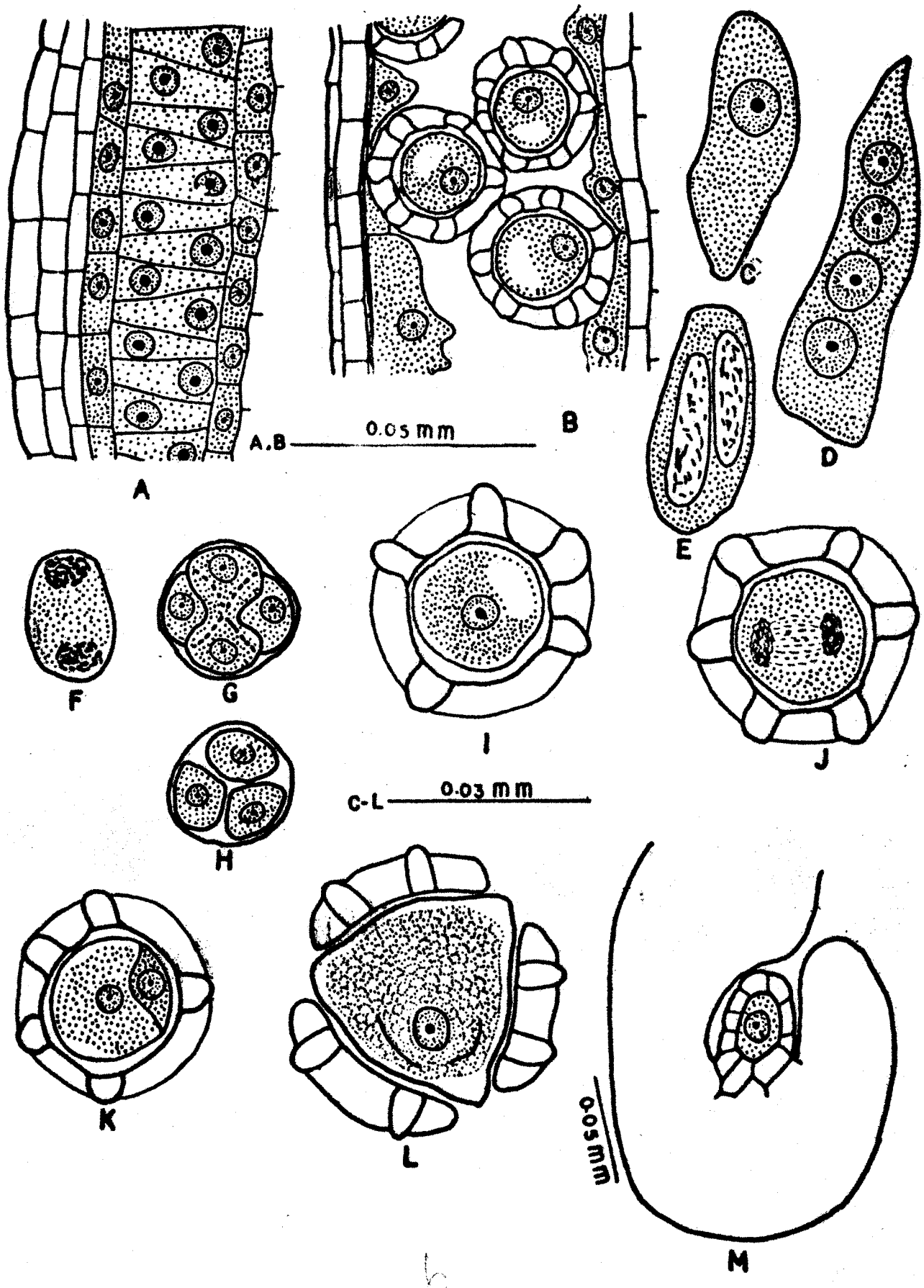
6 I : One-nucleate pollen grain.

6 J : Pollen grain undergoing mitotic division.

6 K : Two-celled pollen grain.

6 L : Mature pollen grain.

6 M : Anatropous ovule with megaspore mother cell.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small generative and a large vegetative cell, the former is closely appressed to the intine (Figs. 5 P and 6 J & K). Soon afterwards 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 three germ pores in Lactuca leucophaea (Fig. 6 L) and with four germ pores in L. runcinata (Fig. 5 Q). The sperm cells are much elongated and filiform.

Ovary and Ovule:

The ovary as characteristic of Compositae is bicarpellary syncarpous and unilocular with a single basal ovule. The ovule arises as a papillate out growth from the base of the ovary but during subsequent development it curves and attains anatropous condition during megasporogenesis stage (Figs. 6 M and 7 A & B). The ovule is unitegmic and tenuinucellate. The cells of the inner epidermis of the integument during megaspore tetrad formation elongate radially acquire dense cytoplasm and function as integumentary tapetum (Figs. 7 E & F and 8 A). It remains uniseriate with unimucleate cells throughout its further growth (Figs. 7 J and 8 D). In Lactuca leucophaea the epidermal cells lining the micropylar canal are very much elongated and appear glandular in nature. These can be refered to as the

Fig. 7 A - J

Fig. 7 A - J : *Lactuca runcinata*

Fig. 7 A : Young ovule showing archesporial cell.

7 B : Anatropous ovule showing megaspore tetrad.

7 C : Megaspore mother cell.

7 D : Megaspore dyad.

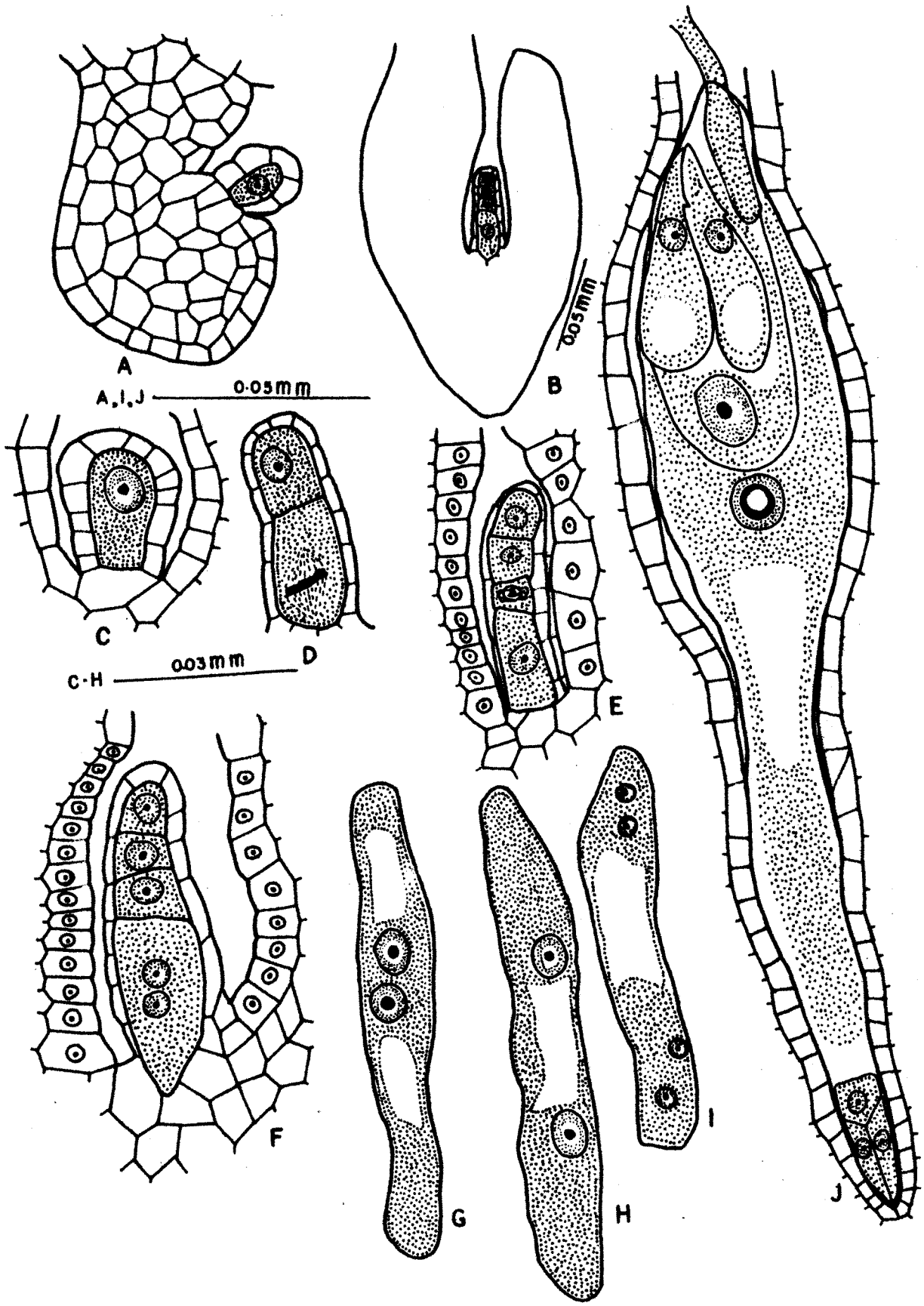
7 E : Megaspore tetrad.

7 F : Megaspore tetrad. Note the chalazal functional megaspore which is at two-nucleate embryo sac stage.

7 G & H : Two-nucleate embryo sacs.

7 I : Four-nucleate embryo sac.

7 J : Mature embryo sac.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E
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G
H
I
J

obturatory cells. These cells probably guide the pollen tube to reach the embryo sac.

Megasporogenesis and Female gametophyte:

The nucellus consists of a single layer of epidermal cells surrounding a single archesporial cell (Fig. 7 A). It functions directly as the megaspore mother cell (Figs. 6 M and 7 C) and undergoes 2 meiotic divisions resulting in a linear tetrad of megaspores (Figs. 7 C-E and 8 A). The chalazal megaspore is functional while micropylar three degenerate (Fig. 7 E & F). In some cases of Lactuca runcinata the chalazal functional megaspore undergoes first mitotic division even while the three micropylar megaspores are still in healthy condition (Fig. 7 F). The functional megaspore undergoes the first mitotic division resulting in two nuclei (Figs. 7 G and 8 B). The embryo sac pierces the nucellar epidermis which is already in the degenerating condition. The two nuclei move to each pole and they are separated by a large vacuole (Fig. 7 H). The two nuclei undergo two more mitotic divisions resulting in 8-nucleate embryo sac of the Polygonum type (Figs. 7 I & J and 8 C&D). The mature embryo sac is spindle shaped in Lactuca leucophaea (Fig. 8 D) while it is much elongated in L. runcinata (Fig. 7 J). The synergids are hooked in both the species. The nucleus of the synergids is at the

Fig. 8 A - E

Fig. 8 A - E : *Lactuca leucophaea*

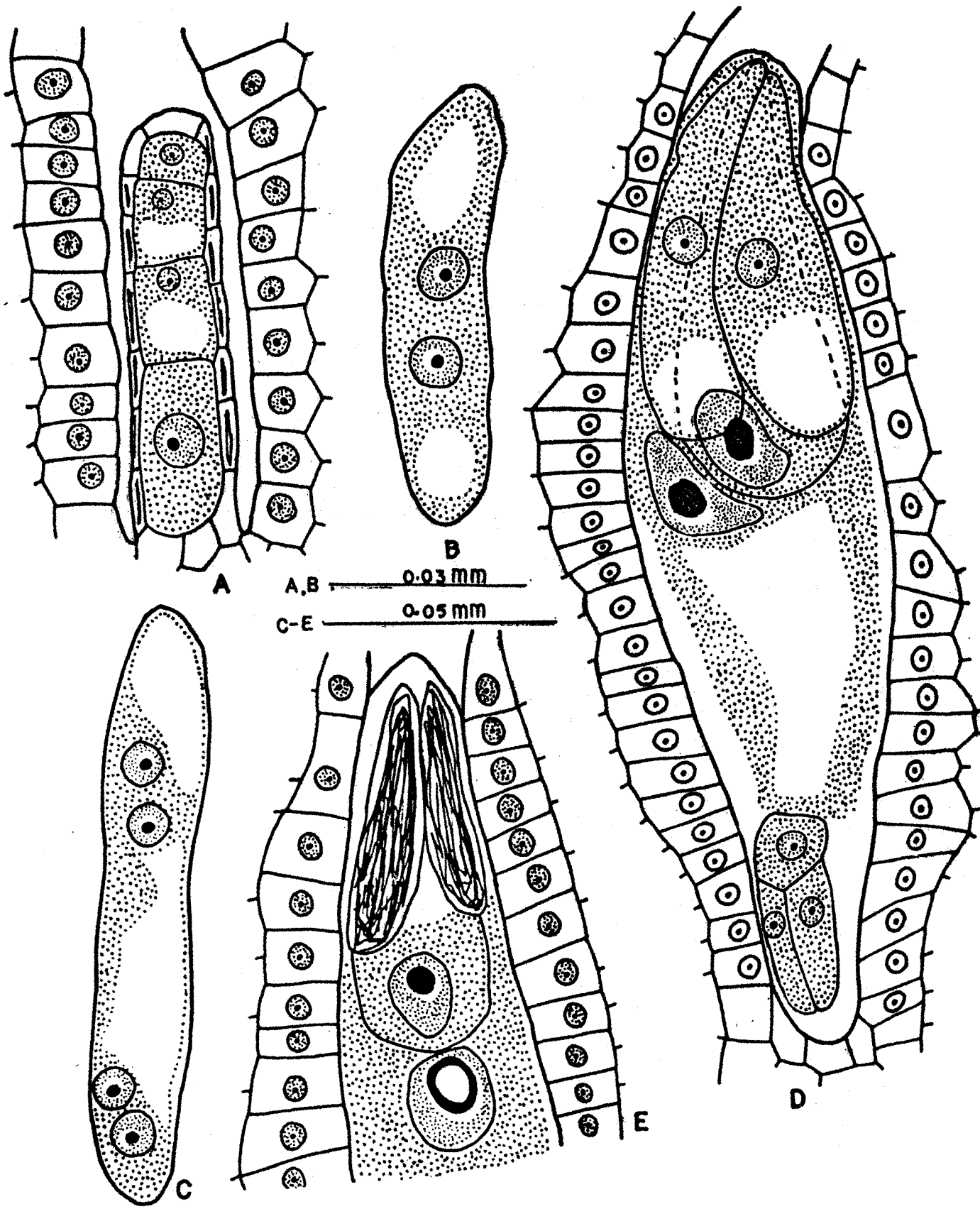
Fig. 8 A : Linear megaspore tetrad.

8 B : Two-nucleate embryo sac.

8 C : Four-nucleate embryo sac.

8 D : L.S. of mature embryo sac showing egg apparatus, antipodal cells and secondary nucleus.

8 E : Upper part of embryo sac showing zygote, primary endosperm nucleus and degenerating synergids.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C-E 0.05 mm
C
D
E

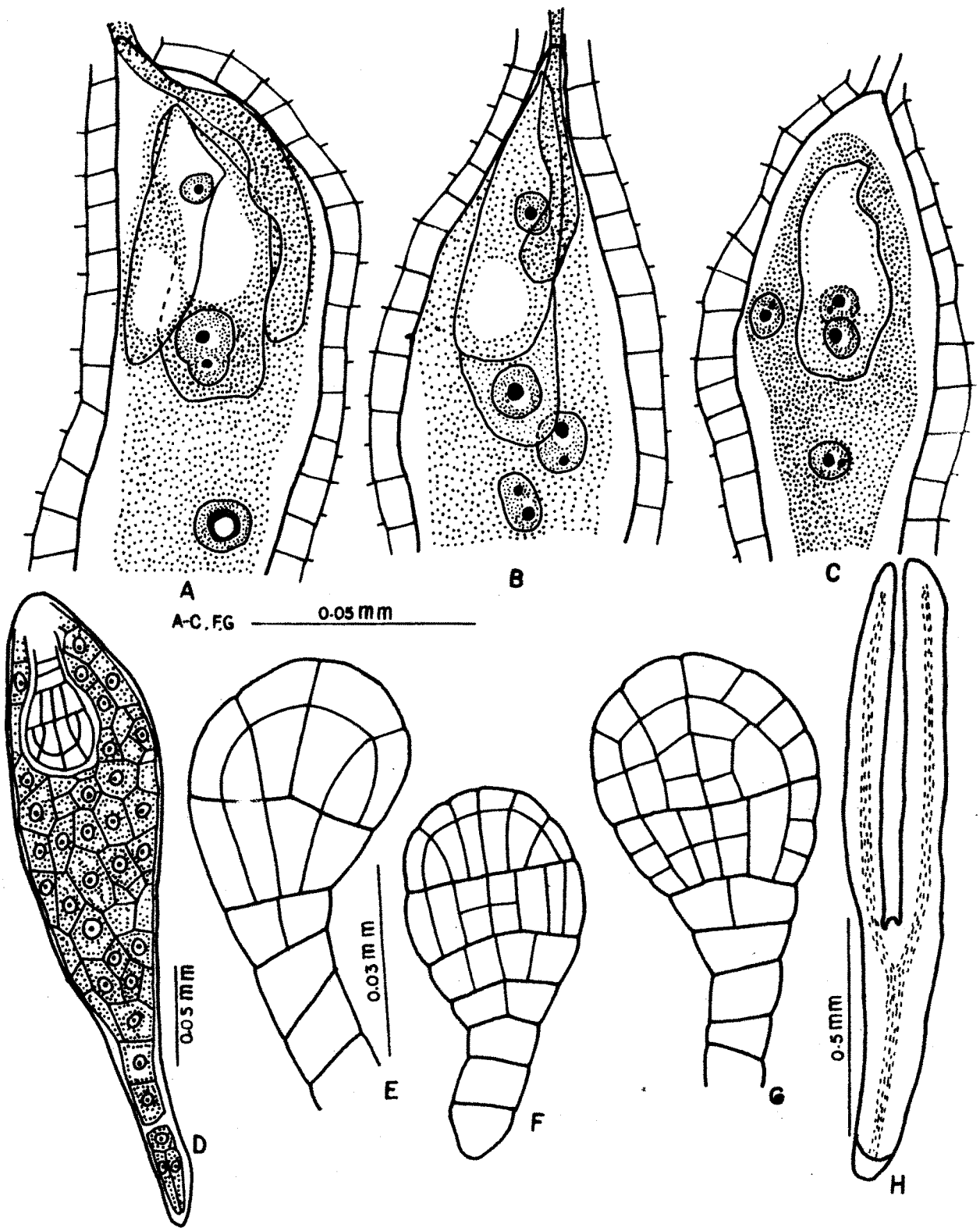
micropylar end while the chalazal portion is occupied by a large vacuole. The antipodal cells are three in number and are uni-nucleate. They simulate the egg apparatus in arrangement. The two polar nuclei fuse prior to fertilization resulting in a secondary nucleus which lies near the egg apparatus.

Fertilization, Endosperm and Embryo:

The pollen tube enters through the micropyle (Figs. 9 A & B and 7 J) and hence the entry of pollen tube is called as 'porogamous'. The synergids degenerate soon after fertilization (Fig. 8 E). Triple fusion completes earlier than syngamy (Fig. 9 A).

Endosperm and embryo development have been studied only in Lactuca runcinata. Endosperm development is of the Nuclear type. The primary endosperm nucleus divides much earlier than zygote resulting in two nuclei (Fig. 9 B). These two nuclei undergo further divisions (Fig. 9 C) resulting in about 8 nuclei when wall formation sets in. The cells undergo further divisions resulting in a massive cellular tissue (Fig. 9 D). The growing embryo absorbs the endosperm completely except for one or two layers (Fig. 10 D).

The zygote undergoes transverse division resulting in two cells, the terminal cell ca and the basal cell cb.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Further development follows the Senecio variation of Asterad type of Johansen (1950) and Grand period I, Megarchetype II, series A, sub series A_2 in the first group according to Souège's system (Crété, 1963) (Fig. 9 E-H). The mature embryo is straight (Fig. 9 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. 10 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. 10 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. 10 C). Finally, at the mature embryo stage the endothelium also gets absorbed and the seed coat consists of only three layers of cells (Fig. 10 D).

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

DISCUSSION

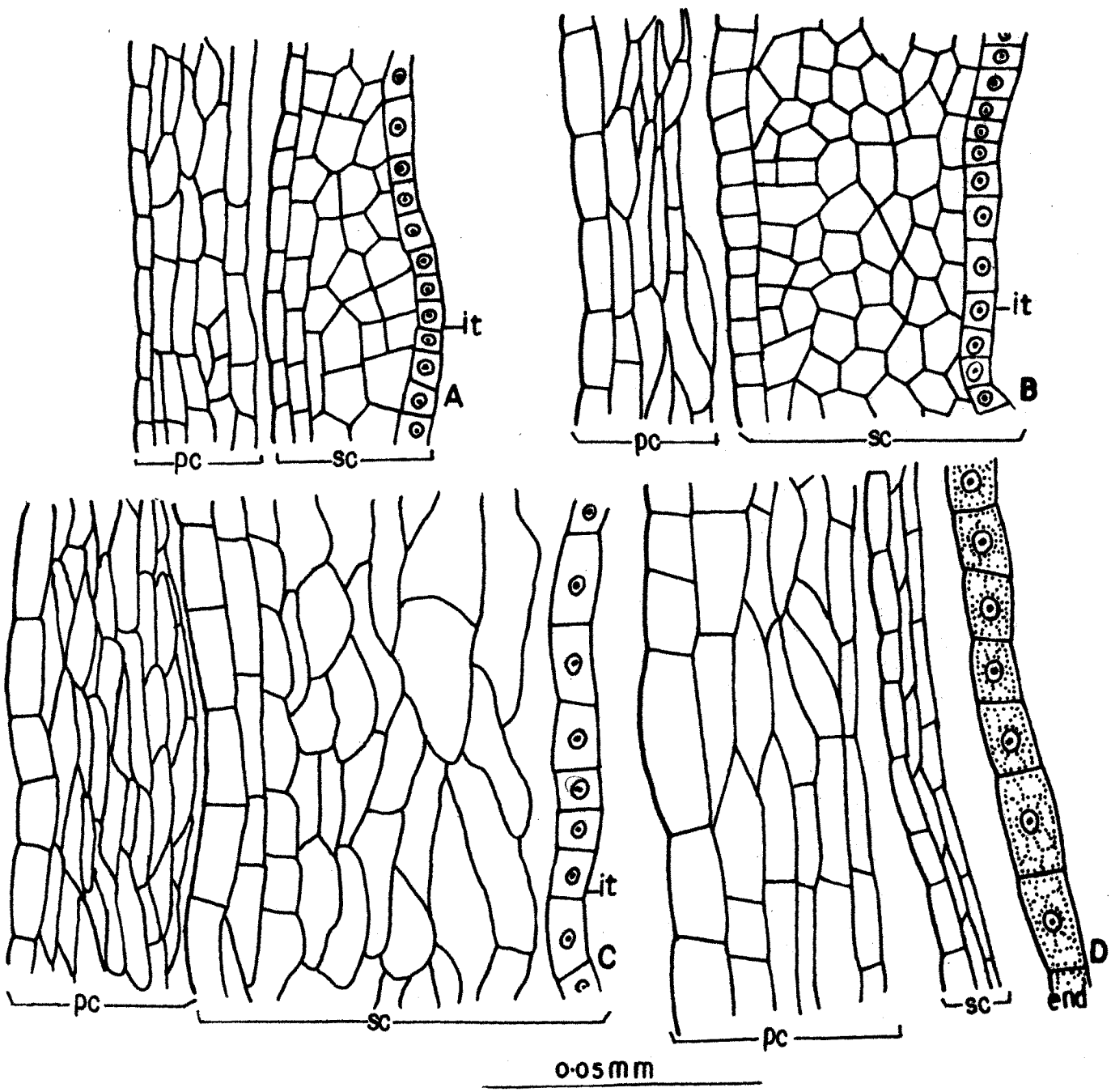
The anther tapetum in the family Compositae is of the Periplasmodial type which is also observed in Lactuca runcinata and L. leucophaea. However, in a few cases like

Fig. 10 A - D

Fig. 10 A - D : Lactuca runcinata

Fig. 10 A - D : Seed coat and pericarp at megaspore tetrad stage, 2-nucleate embryo sac stage, organised embryo sac stage and mature embryo stages respectively.

end: endosperm; it: integumentary tapetum; pc: pericarp; sc: seed coat.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pc
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it
B
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Chrysothamnus (Snow, 1945; Anderson, 1970), Vernonia cinerea, V. cinerascens (Tiagi and Taimni, 1963), Sonchus oleraceus (Walter and Kuta, 1971), S. asper (Walter and Kuta, 1971; Kaul et al, 1975), Hypochoeris radicata (Kaul, 1972), Youngia japonica (Kaul, 1973), Tragopogon gracile (Singh and Kaul, 1974), Sonchus arvensis (Kaul et al, 1975) it is reported that Glandular tapetum occurs. These reports appear questionable since Periplasmodial tapetum is a characteristic feature of Compositae, as reported by Poddubnaja-Arnoldi (1964, 1976), Venkateswarlu and Maheswari Devi (1955a,b), Maheswari Devi (1957, 1963), Davis (1962a,b, 1963, 1964a, b), Horner (1977), Pullaiah (1978a, b, 1979a, b, 1981, 1982a,b,c and 1983). In some species Periplasmodial formation commences only after the formation of 1-nucleate pollen grains and further the life of the Periplasmodium in these members is very short. Probably, the above authors might have missed the stages of formation of Periplasmodium and have mistaken the tapetum for Glandular type.

In the family Compositae, pollen grains are shed at 3-celled stage. However, Kaul (1972, 1973) in Hypochoeris radicata, Youngia japonica, Singh and Kaul (1974) in Tragopogon gracile, Kaul et al (1975) in Sonchus arvensis and S. asper, Prakash Rao et al (1979) in

Emilia flammea Sundara Rajan (1968) in E. sonchifolia reported that 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.

Diverse opinions exist regarding the fate of endothelium and endosperm in various genera of the family. Harris (1935) reported that in Galinsoga ciliata the endosperm in a mature seed persists as a single layer. The observations of Harris were contradicted by Popham (1938). Maheshwari and Roy (1952) recorded the occurence of endosperm as a single layer of cells in a mature seed. However, according to Deshpande (1962a,b, 1962c, 1964b) in Caesulia auxillaris, Tridax procumbens, Glassocardia bosvallia and Bidens biternata the endosperm is completely consumed and the endothelium persists forming a storage tissue. According to Kapil and Sethi (1962b) and Padmanabhan (1962), in Tridax trilobata and T. procumbens respectively, a single layer of endosperm persists in the mature seed. Misra (1964, 1972b) has also reported that one or two layers of endosperm persists in mature seed. Pullaiah (1978a, 1979a,b, 1981a, 1982b) has also reported

that one or two layers of endosperm persists in the mature seed. Hence, the reports of Popham (1938), Deshpande (1962a,b,c, 1964b) seems to be erroneous.

While studying the development of seed in Vernonia cinerea, Tiagi and Taimni (1960, 1963) reported that in the mature seed the integument is almost completely liquidated and absorbed by the embryo. Thus in their opinion, the seed coat is completely absent and embryo lie naked in the pericarp. Contrary to this few layers of the integument persists in the mature seed in Lactuca runcinata. In the light of these observations and also on the basis of earlier reports (Misra, 1972a; Pullaiah, 1978a, 1979a,b, 1981a, 1982a) the report of Tiagi and Taimni, (1963) stating that the seed coat is totally absent in V. cinerea appears to be doubtful.