

EMBRYOLOGY OF *PLUCHEA TOMENTOSA* DC.¹

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ABSTRACT

In *Pluchea tomentosa* the anther is tetrasporangiate and its wall development conforms to the Dicotyledonous type. Endothecium is non-fibrous. Tapetum is periplasmodial. Microspores are both tetrahedral and isobilateral. Pollen grains are shed at three-celled stage. Ovule is anatropous, unitegmic and tenuinucellate. Development of the female gametophyte is of Polygonum type. Antipodal cells are two to three in number. Fertilization is porogamous. Endosperm development is of Cellular type. The embryogeny conforms to the *Senecio* variation of the Asterad type.

INTRODUCTION

A perusal of the available literature on the embryological work of one of the largest tribes, Inuleae of the family Compositae reveals not only interesting information but also inadequacies which indicate that much more remains to be done. The present investigation therefore, is an attempt in this direction and deals with the embryology of *Pluchea tomentosa*, a large pubescent shrub.

MATERIAL AND METHODS

Material collected at Lalbagh, Bangalore in Karnataka was fixed in Nawashin's fluid after a prefixation in Carnoy's fluid for ten minutes and preserved in 70% ethanol. The capitula were infiltrated and embedded in paraffin. Serial transections and longisections were cut at 8-14/ μ m thickness and stained in Heidenhan's iron-alum haematoxylin. Orange G was used as a counter stain.

OBSERVATIONS

Microsporogenesis and Malegametophyte :

The anthers are tetrasporangiate. The archesporium is hypodermal (Fig. 1) and consists of a single vertical row of six to eight cells. The development of the anther is of the Dicotyledonous type (Davis, 1966). The sporangial wall is three layered. Fibrous thickenings of the endothelial cells are not observed (Figs. 2, 3, 6). The middle layer is ephemeral. The tapetal cells are initially uninucleate though some become binucleate later (Figs. 2, 3). Periplasmodium is formed at uninucleate pollen grain stage (Fig. 6).

Simultaneously with the changes taking place in the wall of the anther, primary sporogenous cell which functions directly as the microspore mother cell undergoes meiosis. Simultaneous cytokinesis by forrowing results in the formation of tetrahedral and isobilateral tetrads of microspores (Figs. 4, 5). The

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microspores soon after liberation from the tetradal wall undergo a division resulting in a large vegetative nucleus and a small generative nucleus which in turn divides giving rise to two small male gametes. The pollen grain is shed at this stage and has a thick echinate exine. The spines have broad base (Fig. 7.)

Ovary and Ovule :

The bicarpellary, syncarpous gynoecium has inferior unilocular ovary with a single basal, anatropous unitegmic and tenuinucellate ovule. The nucleolar epidermis degenerates gradually and disappears completely at mature female gametophyte stage (Figs. 11, 12). The endothelium is differentiated at about megaspore dyad stage. Its cells are uninucleate. The endothelium remains uniseriate throughout the development though at some places it becomes biseriate (Fig. 13). The endothelium persists as a thin non-cellular pellicle in the mature seed.

Megasporogenesis and female gametophyte :

Single hypodermal archesporial cell functions directly as the megaspore mother cell (Fig. 8), which undergoes meiosis to result in a linear tetrad of megaspores (Figs. 9). The chalazal functional megaspore (Fig. 10) undergoes three successive mitotic divisions to form eight nucleate female gametophyte of polygonum type (Fig. 11, 12). The female gametophyte is spindle shaped. The two polar nuclei fuse before fertilization forming the secondary nucleus. The number of antipodals is two or three. When the antipodals are two, one of them is usually binucleate and larger in size and the other is uninucleate and small. the antipodals persist upto proembryonal stages.

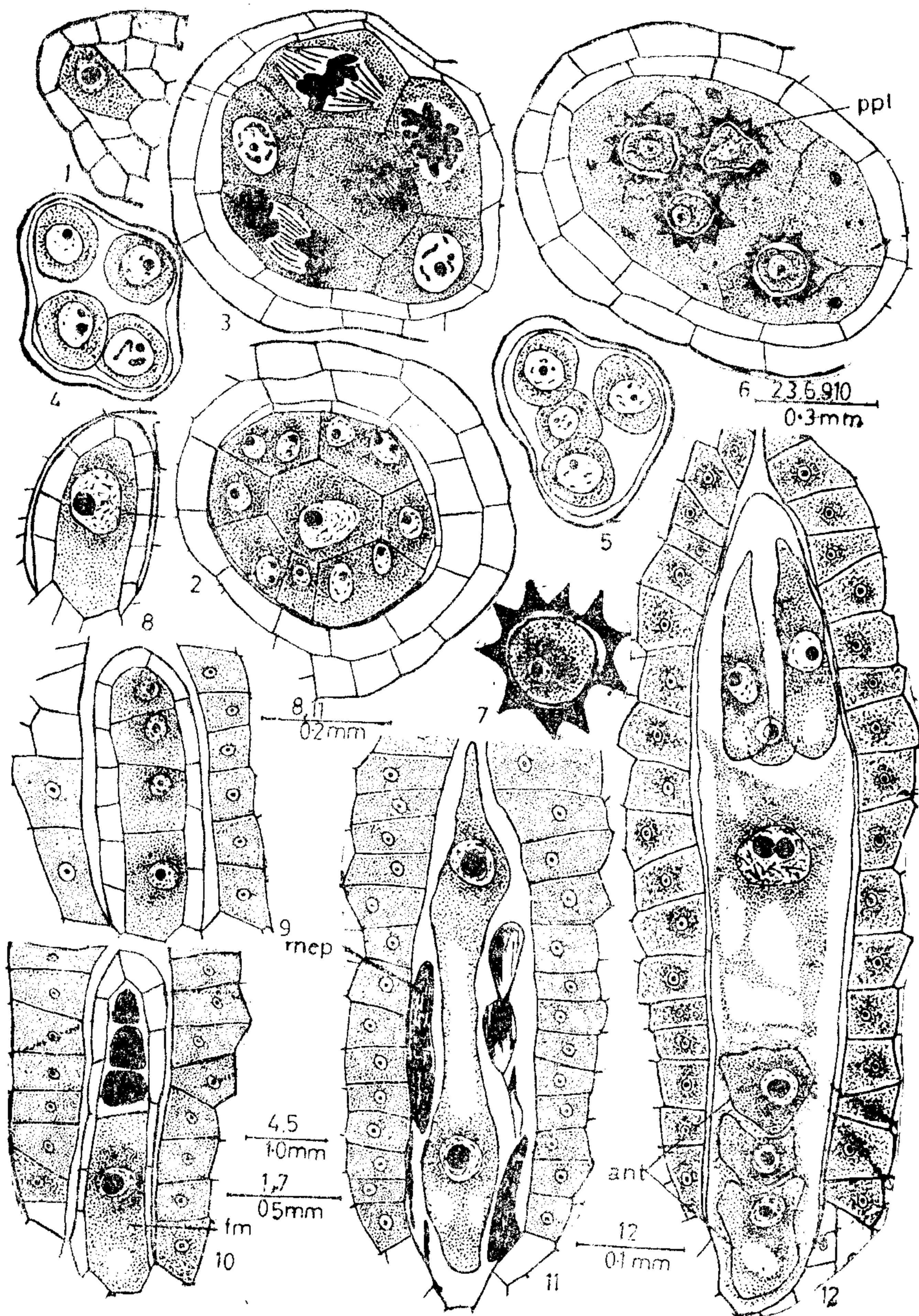
Fertilization, Endosperm and Embryo

Fertilization is porogamous type. The pollen tube enters the female gametophyte through one of the synergids and discharges its contents. The synergid which receives the pollen tube degenerates after fertilization (Fig. 13). Syngamy and triple fusion take place almost simultaneously.

The development of the endosperm is cellular. The primary endosperm nucleus divides vertically. Repeated transverse and vertical divisions followed by cytokinesis result in the formation of endosperm tissue around the growing embryo (Fig. 14). Most of the endosperm tissue is consumed by the growing embryo and few layers of the endosperm cells persist around the mature embryo.

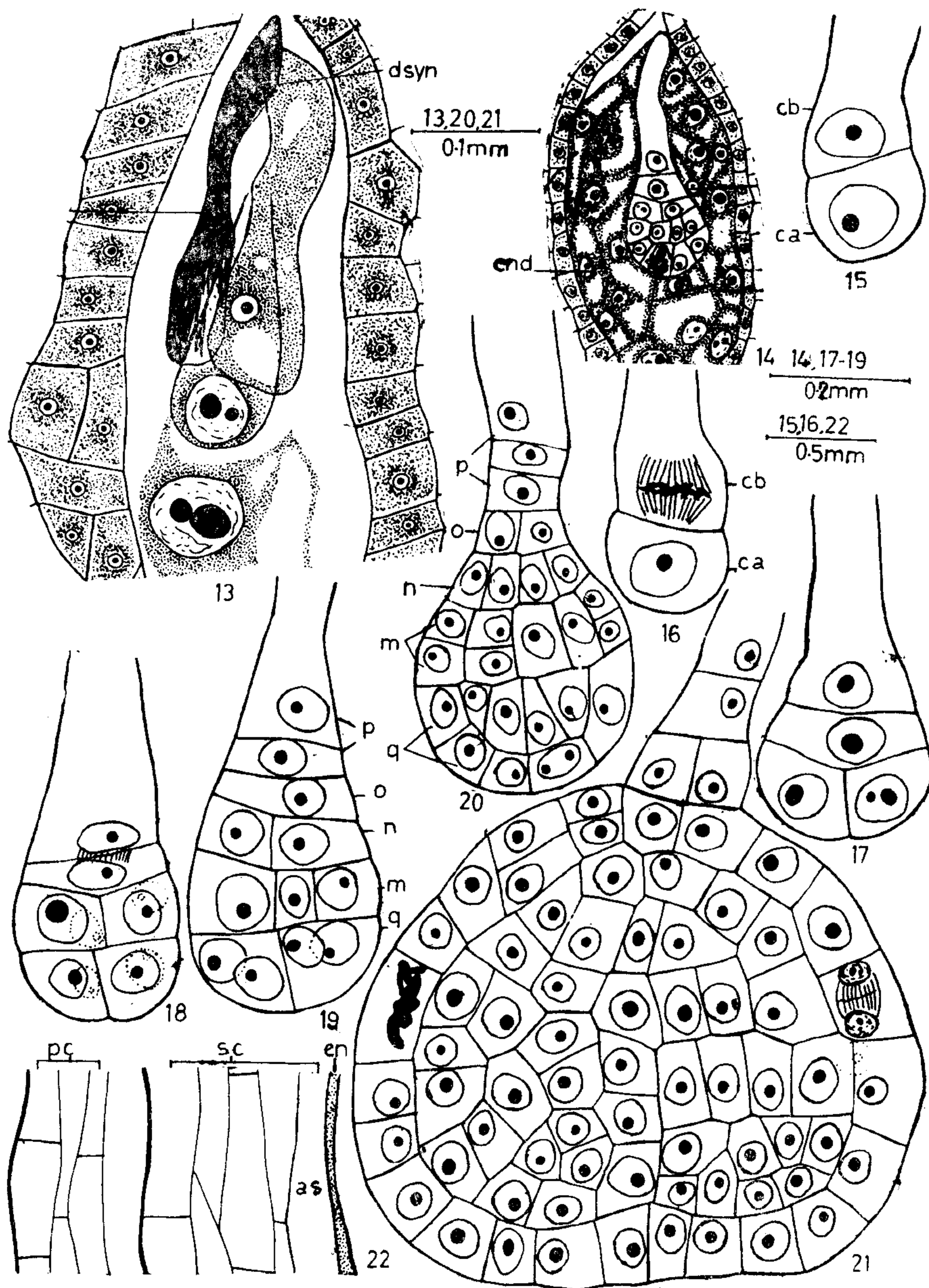
Transverse division in the zygote results in the terminal cell *ca* and the basal cell *cb* (Fig. 15). The cell *cb* undergoes a transverse division giving rise to *m* and *ci* (Figs. 16, 17). The cell *ci* divides transversely and cells *n* and *n'* are formed. A transverse division in the cell *n'* gives rise to *o* and *p*. The cell *p* undergoes one or two transverse divisions resulting in a uniseriate suspensor (Figs. 17-21). Meanwhile *ca* undergoes two vertical divisions at right angles to each other, as a result quadrant *q* is formed, which by oblique divisions gives rise to an octant (Figs. 17-19).

The derivatives of *q* give rise to the cotyledons and stem tip, *m* contributes to the hypocotyledonary region and plerome initials of the root and *n* and *o* to initials of root cortex, root cap and dermatogen (Figs. 20, 21). The mature embryo is dicotyledonous and straight and is surrounded by few layers of endosperm cells. The development of the embryo thus conforms to the *Senecio* variation of the Asterad type (Johanson, 1950).



Figs. 1-12. Figs 1-7. Microsporogenesis and development of male gametophyte, Fig. 1. T. S. of anther lobe showing archesporial cell. Fig. 2. T. S. of anther lobe showing epidermis, endothecium, degenerating middle layer and binucleate tapetal cells. Fig. 3. T. S. of anther lobe showing tapetal cells and pollen mother cell in division. Figs. 4, 5. Tetrahedral and isobilateral microspore tetrads, Fig. 6. T. S. of anther lobe showing uninnucleate pollen grain and periplasmodium. Fig. 7. Three-celled pollen grain. Figs 8-12 megasporogenesis and development of female gametophyte Fig. 8 L. S. of ovule showing megaspore mother cell. Fig. 9. Linear tetrad of megaspores Fig. 10. Chalazal functional megaspore. Fig. 11. Two-nucleate embryo sac. Fig. 12. mature embryo sac.

(*ant.* antipodal cells, *fm*- functional megaspore, *ppl*-periplasmodium *rnep*-remnants of nucellar epidermis)



Figs. 13-22. Fig. 13. A part of the embryo-sac showing double fertilization, degenerating and persistent synergids. Fig. 14. A part of the embryo-sac showing cellular endosperm and globular embryo. Figs. 15-21. different stages in the development of the embryo. Fig. 15. Two-celled proembryo Fig. 16, Proembryo with *cb* in division. Fig. 17. Four-celled proembryo. Figs 18-21 Advanced stages in the embryo development Fig. 22. L. S. of part of pericarp, seed coat and endothelium.

(*dsyn*- degenerating synergid, *en*- endothelium, *end*- endosperm, *as*- air space, *pc*- pericarp, *sc*- seed coat).

Seed coat and Pericarp:

The integument differentiates at the megaspore mother cell stage and usually consists of five to six layers of parenchymatous cells. At the organised female gametophyte stage it has seven to ten layers of cells, though at the micropylar and chalazal regions its thickness varies from twelve to sixteen cell layers. After fertilization the cells around the endothelium enlarge, lose their contents and constitute the periendothelial zone. When the embryo attains the globular stage, the cells of the periendothelial zone except the epidermis and three to four underlying layers of cells undergo asymmetric disorganisation involving more cells at the chalaza than at the micropyle. As a result, an air space appears more towards the chalaza than at the micropyle and at the lateral sides of the endosperm. The endothelium persists as a non-cellular pellicle closely adpressed to the layer of the endosperm. In the mature seed, the seed coat consists of four to five layers of cells (Fig. 22)

The ovary wall consists of six layers of parenchymatous cells at the mature female gametophyte stage. The pericarp at mature seed stage consists of three layers of elongated cells (Fig. 22.)

DISCUSSION

Female gametophyte development of different types are known to occur in the tribe Inuleae. In the present study, it is of Polygonum type as in the majority of the species. However, Allium type in *Ammobium alatum* (Davis, 1962), Drusa type in *Helichrysum bracteatum* (Davis 1966) both Polygonum and Allium type in *Blumea virens* (Lalitha, 1981), aneusporic in *B. oxydonta* and *B. deriantha* (Chennaveeraiah and Patil, 1971) have been reported.

The antipodals are of special interest

in Inuleae. The number of antipodals is three in *Casesulia axillaris* (Deshpande 1962), *Ammobium alatum*, *Epaltes australis* (Davis, 1962), *Blumea malabarica*, *Laggera pterodonta*, *Anaphalis busna* and *Vicoa auriculata* (Pullaiah, 1979) and *Blumea virens* (Lalitha, 1981). The antipodals are two to three in *Laggera aurita* (Lalitha, 1981) and *Blumea barbata* Lalitha Ram, 1983). The number of antipodals increase due to secondary multiplication. Four in *Blumea belangeriana*, five in *Anaphalis wightiana* (Lalitha, 1981), five to sixteen in *Antennaria*, *Gnaphalium*, *Inula lebenum* (Schnarf, 1931), *Podolepis jaccoides*, *P. canescens*, *P. longipedata* and *P. neglecta* and as many as fifty one in *P. arachinoides* (Davis, 1961), six in *Blumea lacera* and *B. mollis*, six to nine in *Anaphalis subdecurrens* (Lalitha, 1981) have been reported. The multiplication and persistence of antipodals suggest their haustorial nature. However, the antipodals degenerate soon in *B. virens* (Lalitha, 1981).

Both Nuclear and Cellular types of endosperm development have been reported in this tribe. Cellular endosperm occurs in *Antennaria*, *Gnaphalium*, *Helichrysum* (Schnarf, 1931), *Blumea laciniata* (Banerji, 1942), *Podolepis jaceoides* and species of this genus (Davis, 1961), *Caesulia axillaris* (Deshpande, 1962), *Ammobium alatum* (Davis, 1962), *Epaltes australis* (Davis, 1968), *Blumea membrancea*, *Laggera pterodonta* (Pullaiah, 1979), *Anaphalis subdecurrens*, *A. wightiana*, *B. belangeriana*, *B. lacera*, *B. mollis*, *B. virens* and *Laggera aurita* (Lalitha, 1981), *B. barbata* (Lalitha Ram, 1983) and is nuclear in *Antennaria alpina*, *A. porsilichi* (Davis, 1966), *B. oxydonta*, *B. eriantha* (Chennaveeraiah & Patil 1971) and *B. malabarica* (Pullaiah, 1979). Few layers of endosperm persists at mature seed stage including the present one but Deshpande (1962) is of the opinion that the endosperm gets completely

consumed by the growing embryo and it is the cells of endothelium which gets considerably stretched simulating the endosperm. The development of the embryo is of *Senecio* variation of the Asterad type (Johanson, 1950) in all so far investigated taxa including the present one.

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