J. Indian bot. Soc. 62 : 44—47, 1983

EMBRYOLOGY OF *ACHILLEA SQUARROSA* AIT. (ANTHEMIDEAE: COMPOSITAE)[1]

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ABSTRACT

Embryology of *Achillea squarrosa* Ait. has been studied. The disc floret contains either four or five stamens. The anther is tetrasporangiate and its wall development corresponds to the Dicotyledonous type. Anther tapetum is of the Periplasmodiae type. Simultaneous cytokinesis results in tetrahedral or isobilateral microspore tetrads. Pollen grains at the time of shedding are tricolpate and 3-celled. The ovule is anatropous, unitegmic and tenuinucellate. The embryo sac development is of the Polygonum type. The antipodal cells are either two or three in number. Endosperm development is of the Cellular type and embryogeny follows the Senecio variation of the Asterad type.

INTRODUCTION

Although considerable literature is available on the embryology of the tribe Anthemideae information on the genus *Achillea* is inadequate (Chiarugi, 1927; Harling, 1950). Detailed information on microsporogenesis and male gametogenesis is not available in *Achillea* as well as in other genera of the tribe excepting in *Cotula australis* (Davis, 1952). The present investigation on *Achillea squarrosa* is undertaken to bridge the gap in our present knowledge on the embryology of the tribe.

The genus *Achillea* consists of about 200 species mostly occurring in the north temperate zone (Willis, 1966). *Achillea squarrosa* occurs sparsely in India. The plant is a herb with heterogamous heads and consists of ray florets which are female fertile and disc florets which are female sterile.

MATERIAL AND METHODS

Capitula of *Achillea squarrosa* at different stages of development were collected from the Anantagiri hills in Visakhapatnam district in Andhra Pradesh. The material was fixed in Formalin-acetic-alcohol (FAA). Usual methods of dehydration, embedding and sectioning were followed (Johnsen, 1940). The sections were stained in Delafield's haematoxylin.

OBSERVATIONS

Microsporangnium, Microsporogenesis and *Male gametophyte :*

The number of stamens in a disc floret is either four of five (Fig. 1, 2). The anther is tetrasporangiate. The archesporium in the anther lobe consists of a row of 6-8 cells. The anther wall development is of the Dicotyledonous type. The epidermal cells persists upto the maturity of of the anther. The hypodermal layer develops fibrous thickenings and forms the fibrous endothecium. The middle layer is ephemeral. The tapetum is of the periplasmodial type. Its cells later on become binucleate (Fig. 3). The cytoplasm of

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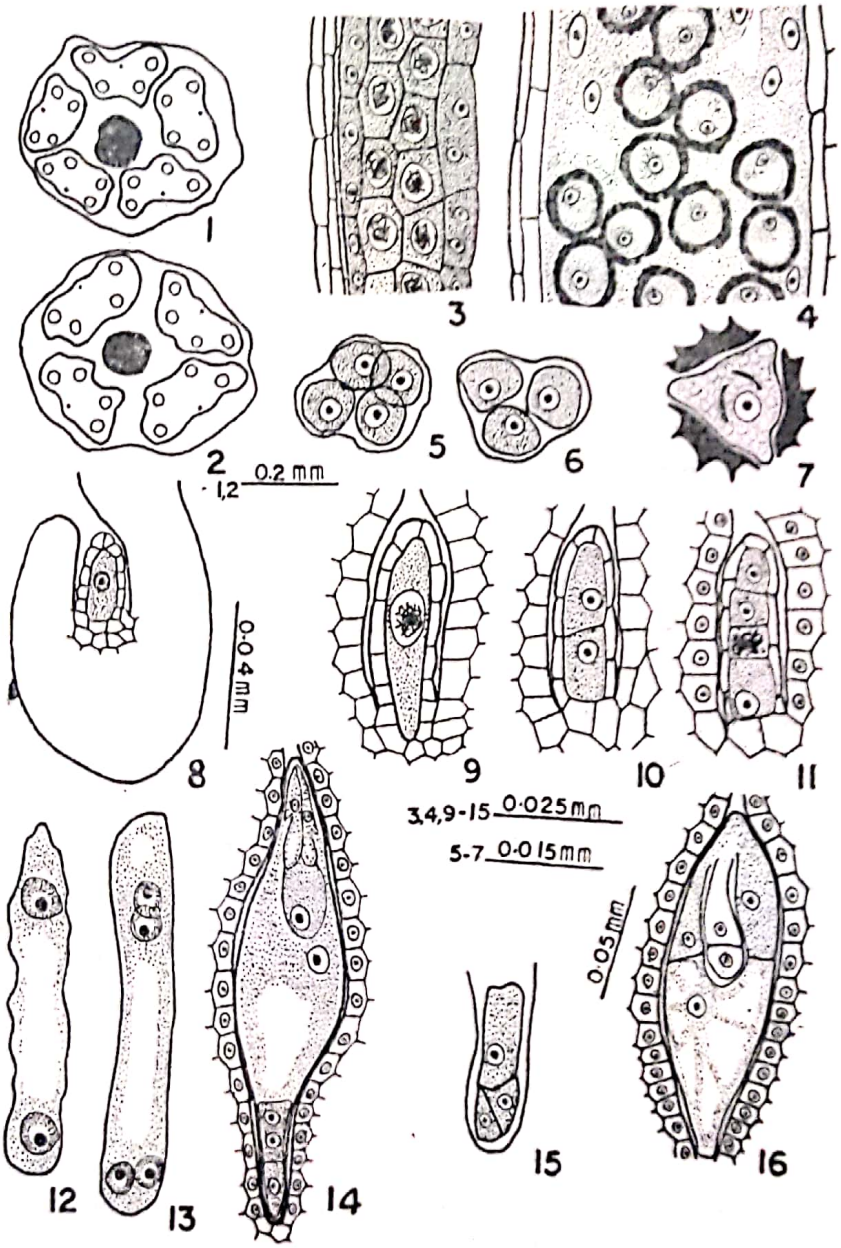
the tapetal cells flows into the anther locule slightly after the initiation of the exine of the uninucleate pollen grains (Fig. 4). The periplasmodium is completely consumed by the growing pollen grains.

The primary sporogenous cells undergo a few mitotic divisions in all planes resulting in a moderately extensive mass of pollen mother cells (Fig. 3). They undergo meiotic divisions and cytokinesis of simultaneous type results in



Figs. 1-16. *Achillea squarrosa*. Figs. 1, 2 T.S. of flowers showing five and four stamens respectively. Fig. 3 L.S. part of anther lobe showing epidermis, wall layers and pollen mother cells. Fig. 4 L.S. part of anther lobe showing periplasmodium and one-nucleate pollen grains. Figs. 5, 6 Isobilateral and Tetrahedral pollen tetrads respectively. Fig. 7 Mature pollen grain. Fig. 8 L.S. of ovule showing primary female archesporium. Fig. 9 Megaspore mother cell in meiotic prophase. Fig. 10 Megaspore dyad. Fig. 11. Megaspore tetrad. Figs. 12, 13. Two and four nucleate embryo sacs respectively. Fig. 14. Mature embryo sac. Fig. 15. Chalazal portion of the embryo sac showing antipodal cells. Figs. 16 Embryo sac showing two-celled embryo and cellular endosperm.

tetrahedral microspore tetrads (Fig. 6). Occasionally isobilateral tetrads are also formed (Fig. 5). The exine is spinous. At the time of shedding the pollen grains are three-celled with three germ pores (Fig. 7).

Ovary and Ovule :

The gynoecium is bicarpellary and the ovary is inferior, syncarpous and unilocular with a single basal ovule. The ovule is anatropous, unitegmic and tenuinucellate (Fig. 8). An ovular vascular strand traverses and reaches the tip of the integument. The innermost layer of the integument differentiates into endothelium (Fig. 11).

Megasporogenesis and female gametophyte :

The archesporium is hypodermal and is single-celled (Fig. 8). It directly functions as the megaspore mother cell and undergoes meiotic divisions resulting in a linear tetrad of megaspores (Figs. 9-11). The megaspore at the chalazal end develops further while the other three megaspores degenerate (Fig. 11). The functional megaspore enlarges considerably, undergoes the three mitotic divisions and produces an 8-nucleate embryo sac of the polygonum type. (Figs. 12-14). The synergids are hooked (Fig. 77). The two polars fuse to from the secondary nucleus which lies near the egg cell. The antipodal cells are either two or three in number. If three, they are uninucleate (Fig. 15) and if two, usually the upper one is binucleate (Fig. 14). They persist up to the time of the formation of a globular embryo.

Fertilisation, Endosperm and Embryo :

Fertilisation is porogamous. Triple fusion completes earlier than syngamy. The synergids degenerate immediately after fertilisation.

Endosperm development is *ab initio* Cellular (Fig. 16). The primary endosperm nucleus divides long before the zygote and is accompanied by a transverse wall. These two cells undergo divisions in all planes and produce a massive tissue of endosperm. But for one or two layers of cells, the entrire endosperm is used up by the growing embryo.

The embryo development is of the Asterad type and keys out to the Senecio variation. The development of the embryo closely resembles that of the members reported in the earlier papers (Pullaiah, 1978a, b, 1979) and hence a detailed account is omitted.

DISCUSSION

In the general structure and development of the anther and male gametophyte the two hitherto investigated members of the tribe- *Cotula australis* (Davis, 1962) and *Achillea squrrosa* (present data)—show greater uniformity. The development of anther wall follows the Dicotyledonous type, a true periplasmodium is formed at the uninucleate stage of the pollen grains, the exine of the pollen grains is spinous. However, they show some variation in nuclear divisions and fusions of nuclei of the tapetal cells of the anther. In *Cotula australis* (Davis *op. cit.*,) occurrence of multinucleate and polyploid tapetal cells is a common feature whereas in *Achillea squarrosa* (present study) the tapetal cells are binucleate and show no nuclear fusions.

Occurrence of both uni-and multicelled female archesporium is a common feature of this tribe. Both these conditions are present in *Achillea*. In. *A. clavenae, A. oxyloba* (Chiarugi, 1927) and in *A. millefolium* (Harling, 1950) the archesporium is multicelled while in *A. squarrosa* (present account) it is unicelled.

The tribe Anthemideae is of great

interest to embryologists. As many as four different types of embryo sac development namely-Polygonum, Allium, Drusa and Peperomia-occur within the tribe (Harling, 1950, 1951, 1960; Borgen, 1972). Besides these, some unclassified types occur in plants like *Balsamita vulgaris* (Fagerlind, 1939) and *Chrysanthemum cinerariaefolium* (Martinoli, 1939). For instance in the same genus *Chrysanthemum* all the three major types-Mono-, Bi- and tetrasporic types of embryo sac development are reported (Harling, 1951). In the presently investigated member *Achillea squarrosa*, the development of the embryo sac follows the Polygonum type as in other species of the genus like *Achillea clavenae* and *A. oxyloba* (Chiarugi, 1927) and *A. millefolium* (Harling, 1950).

The antipodal cells show some variation in the genus *Achillea*. In *Achillea squarrosa* (present data) 2 or 3 antipodal cells are present. Neither nuclear divisions nor increase in the number of cells is observed as in *A. millefollium* (Harling, 1950). However, Chiarugi (1927) in *A. oxyloba* reported 20-30 antipolal cells by multiplication of the original antipoal cells. Even in this species nuclear fusions of the antipodal cells resulting in polyploid nuclei are not recorded.

The development of enosperm in the tribe follows both Nuclear and Cellular types. In *Achillea squarrosa* it is of the Cellular type as in *Anthemis tinctoria, Matricaria discoidea* (Vernin, 1952) and *Cotula australis* (Davis, 1962), whereas in *Chrysanthemum indicum, C. segetum* and *C. pinnatifidum* (Vernin, 1952) it is of the Nuclear type.

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