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Short Communication

Embryology of *Saussurea albescens*: An Arid Himalayan Plant of Asteraceae

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Endospermous tissue and its haustorial branches bring about the nourishment of developing embryo. These branches differentiate either from the micropylar or chalazal region, or from both the ends of endosperm (Maheshwari, 1950). Although the works of Sood and Tandon (1992) and Sood and Sud (1992) described the occurrence of only chalazal endospermous haustoria in *Galinsoga parviflora* and *Taraxacum officinale*, the development of both the micropylar and chalazal endospermous haustoria in one and the same species is not reported in any of the asteraceous taxa studied so far. The present study delineates this in *Saussurea albescens* (subtribe Carduineae, tribe Cynaroideae), a plant of common occurrence in cold desert areas, at an altitude of 3100 m in north-west Himalayas.

Young floral heads of *Saussurea albescens* were collected from Sumnam in Lahoul and Spiti district, an area which remains snow-bound for more than seven months in a year. The material was fixed in FAA and dehydrated in TBA series. Microtome sections, cut between 10 and 12 μm, were stained with safranin and fast green.

Anther wall development, microsporogenesis and male gametophyte: Anther wall development corresponds to the dicotyledonous type (Fig. 1A). At uninucleate stage of the pollen, the anther wall is constituted by an epidermis and an endothecial layer and the developing pollens are surrounded by the periplasmodial fluid (Fig. 1D). Endothecial cells develop fibrous thickenings at the shedding stage of pollen (Fig. 1C). The primary sporogenous cell enlarges to function as microspore mother cell which undergoes meiotic divisions, followed by simultaneous cytokinesis to produce tetrahedral and decussate tetrads. Mature pollen grains are 3-celled and triporate.

Megasporogenesis and female gametophyte: A single hypodermal archesporial cell directly functions as the megaspore mother cell (Fig. 1H). It undergoes meiotic divisions to form a linear tetrad of megaspores, of which the chalazal megaspore is large-sized and functional (Fig. 1D). Development of the female gametophyte corresponds to the monosporic type.

Fertilization, endosperm haustoria and embryology: The entry of the pollen tube is through the micropyle. Double fertilization occurs. However, the primary endosperm nucleus divides earlier than the zygote (Fig. 1E).

Endosperm is *ab initio* cellular (Fig. 1E). Cells of the endosperm are polygonal, densely cytoplasmic and uninucleate. A feature of unique interest is the development

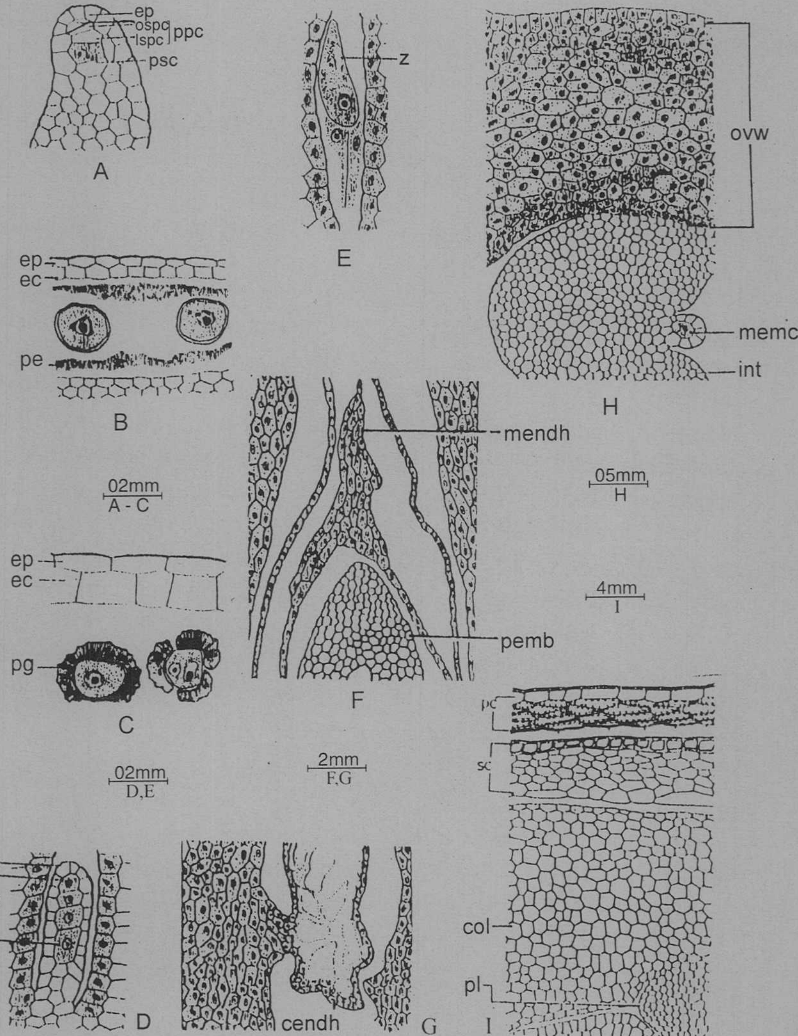

Fig. 1A-I. Saussurea albescens, male and female gametophyte, endosperm and pericarp. (A) differentiation of anther wall layers; (B) Periplasmodial tapetum; (C) Anther wall layers at 2-nucleate pollen grain stage; (D) Linear megaspore tetrad with functional chalazal megaspore. Note differentiation of the endothelium; (E) Zygote with 2-celled cellular endosperm; (F and G) Portions of l.s. achenes showing the development of micropylar and chalazal endospermous haustorium, respectively; (H) Structural details of seed-coat and pericarp prior to fertilization (megaspore mother cell stage); and (I) Same, at mature embryo stage (cendh, chalazal endospermous haustorium; cot, cotyledons; ec, endothecium; ep, epidermis; int, integument; ispc, inner secondary parietal cell (layer); me, megaspore; memc, megaspore mother cell; mendh, micropylar endospermous haustorium; ne, nucellar epidermis; ospc, outer secondary parietal cell (layer); pc, pericarp; pc, peripalasmodial tapetum; pemb, proembryo: pg, pollen grain; pl, plumule; ppc, primary parietal cell (layer); psc, primary sporogenous cell; sc, seed-coat; ovw, ovary wall; z, zygote).

of haustoria from both micropylar and chalazal regions of the endosperm (Fig. 1F, G). These haustoria are both active and functional. The mature embryo is orthorrhizal with two cotyledons, stem-tip, hypocotyledonary part and a radicle (Fig. 1F).

Seed coat: At the megaspore mother cell stage, the integument comprehends 10-15 layers of thin-walled cells (Fig. 1H). Nevertheless, the thickness increases to 24 layers, of which the inner 1 or 2 layers function as endothelium in the pre-fertilization stages. By the time globular embryo is differentiated, the outermost layer of the testa becomes sclerotic and some of its inner cell layers including the endothelium, disintegrate. Consequently, the testa shows 5 or 6 layers, besides the outer sclerotic layer in the mature achene (Fig. 1I).

Pericarp: Prior to fertilization, the ovary wall contains 16-21 layers of parenchyma, besides the outer and inner epidermis (Fig. 1H). In the maturing seed, the pericarp shows two distinct regions, two layer of thick-walled cells with the cuticle present on the outer layers, followed by 10 to 13 layers of thick-walled, pitted cells. Finally, when the embryo matures, the pericarp contains only 4 or 5 layers, whereas the inner few layers disintegrate (Fig. 1I).

One of the unique features of the present study is the differentiation of haustorium from both the micropylar and chalazal ends of the endosperm, a first report of its type for the Asteraceae and in angiosperms, so far recorded in Hydrophyllaceae (Svensson, 1925), Scrophulariaceae (Glisic, 1932), Acanthaceae (Mauritzon, 1934), Lobeliaceae (Hewitt, 1939; Subramanyam, 1949) and Globulariaceae (Rosen, 1940). These haustoria embed into the surrounding ovular tissue to form a very efficient absorptive system for providing additional nutrition to the developing embryo and ensure better seed set in such a harsh climatic condition. So far as the seed coat in *Saussurea albescens* (subtribe Centaureae) is concerned, it is 2-zonate with lignified epidermal layer and reaffirms the viewpoint of Singh and Pandey (1984) that the presence of lignified epidermal layer in the seed-coat was an established feature for the subtribe Carduinae and Centaurinae of tribe Cynaroide.

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