THE OVULE AND EMBRYOSAC DEVELOPMENT IN BROWALLIA DEMISSA LINN.

BY K.M. KARUNA MOHAN
(National Botanic Gardens, Lucknow)
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ABSTRACT

1. The ovule is anatropous, unitegmic, tenuinucellate.
2. A single hypodermal archesporial cell functions as megaspore mother cell.
3. Nucellus is consumed at an early stage of development.
4. The female gametophyte conforms to the "Polygonum type" of development.
5. At the organised embryosac stage, the integument is seven-layered thick, its inner epidermis serving as the endothelium.
6. Abnormal embryosacs with six nuclei, four at the micropylar and two at the chalazal side, have also been observed.

INTRODUCTION

Solanaceae is a family consisting of about 85 genera and more than 2,200 species. Its origin is said to be primarily in tropical and South America (Lawrence, 1951).

It serves as an important source of vegetable, ornamental, medicinal and other economic plants.

Literature on its embryology and seed structure is meagre and therefore some genera of economic importance have been taken up by the author for investigation. Browallia demissa Linn., earlier known as B. elata Linn. (Index Kewensis, I Ed., 1946, p. 345), a small winter annual, reaching a height of about 6" to 18", bearing blue-violet flowers, forms the first of the series whose embryological investigations are presented in this paper.


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**Previous Work**

Hofmeister (1858) made a study of the embryosacs of three solanaceous plants, *Hyoscyamus orientalis*, *Scopolina atropoides*, and *Salpiglossis picta*, and gave a brief description of them. Jönsson (1881), however, was the first to make a study of the development of the embryosac in this family. In *Saracha jaltomato*, he found that the macrospore mother cell forms four daughter cells. The inner cell develops into a normal eight nucleate embryosac.

Guignard (1882), who worked out the embryosac development in *Nicotiana tabacum* and *Cestrum splendens*, concluded that the embryosac development in these plants follows the “Polygonum type”.

Souèges (1907), Palm (1922) and Sevensson (1926), working respectively with *Atropa belladonna*, *Nicotiana* and *Hyoscyamus niger*, came to the same conclusion as Jönsson and Guignard, but Nanetti (1912) found the development of the female gametophyte in *Solanum muricatum* to be tetrasporic after the “Lilium type”. Young (1922) stated that in *Solanum tuberosum*, the archesporial cell, which functions as megaspore mother cell, undergoes three successive divisions. The cellular organization takes place only at the end of the third division to form an organised eight nucleate embryosac.

Cooper (1931) reported a monosporic eight nucleate embryosac in *Lycopersicon esculentum*.

Bhaduri (1932) has criticised Nanetti (1912) and Young (1922) for recording the “Lilium type” of embryosac development, for he finds it to be of “Polygonum type” in *Solanum nigrum*. In his later work, he (Bhaduri, 1935) emphasizes that “Polygonum type” of development of female gametophyte is a common feature in the genus *Solanum*.

He has also reported more than one archesporial cell in the same nucellus and the development of the chalazal nucellar cell or integumentary cells as a megaspore mother cell (*see also* Maheshwari, 1950, Fig. 50 D, p. 72). Bhaduri further states that the nucellar megaspore mother cells develop up to the linear tetrad of megaspore stage. In *Brunfelsia*, it seems that the nucleus of this megaspore mother cell undergoes two divisions but no walls are formed between the four megaspore nuclei on account of which a four nucleate embryosac results. This embryosac does not show further growth.

Rees-Leonard (1935) reports one to multiple archesporial cells in *Solanum tuberosum*. Only one of these archesporial cells, however, ultimately
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develops to a mature embryosac. In some cases irregularities in meiosis have been observed leading to the degeneration of embryosacs and consequent failure of seed formation.

Mohan Ram and Isha Kamini (1965) state that the embryosac of Withania somnifera is usually monosporic; one instance of a tendency towards a bisporic development has also been noticed by them.

MATERIAL AND METHODS

The material of Browallia demissa, earlier collected at the National Botanic Gardens, was passed on to me by the department.

It was dehydrated by me in Tertiary Butyl Alcohol series and embedded in paraffin (56°-58° C.). Serial transverse and longitudinal sections were cut at 6-12 μ according to the need, and stained with safranin and fast green.

OBSERVATIONS

Megasporangium.—A large number of ovules appear as small protuberances on the axile placenta and begin to curve soon. A single integument, which is initiated in each ovule shortly after an archesporial cell is discernible, is only two-layered thick to start with (Figs. 1 and 2). The ovules become completely anatropous by the time a binucleate embryosac develops in it (Fig. 4).

At the time of megaspore mother cell formation, the integument becomes 3 or 4 layers thick of which the middle layer or layers are derived from the inner epidermis.

By the time a binucleate embryosac stage is reached in the ovule, the integument is found to have become seven layers thick. Its inner epidermis starts radial elongation and forms the endothelium. The cells are uninucleate and have dense cytoplasm. Within the outer and inner epidermal layers the cells are somewhat tangentially elongated with conspicuous nuclei.

By the time the ovule has reached the four nucleate embryosac stage, the cells of the integument stop dividing; the endothelium, however, becomes more prominent and distinct up to the micropyle.

Megasporogenesis and female gametophyte.—The archesporial cell directly functions as the megaspore mother cell (Fig. 1). The first meiotic mitosis is followed by cytokinesis forming a dyad (Fig. 2). The second division soon follows giving rise to a linear tetrad of megaspores, all of which are
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alike with a conspicuous nucleus and a prominent nucleolus in each. The upper three megaspores, however, degenerate while the chalazal megaspore

FIGS. 1-9 b. Fig. 1. L.s. of ovule showing megaspore mother cell, × 533. Fig. 2. L.s. of ovule showing dyad, × 500. Fig. 3. Megaspore tetrad with the chalazal megaspore functioning, × 767. Fig. 4. L.s. ovule showing bi-nucleate embryosac. Note.—The ovule has become completely anatropous at this stage, × 200. Fig. 5. Bi-nucleate embryosac, × 533. Fig. 6. Four-nucleate embryosac enclosed by the endothelium, × 533. Fig. 7. Eight nucleate embryosac, × 533. Fig. 8. Mature fully organised embryosac, × 533. Fig. 9. Abnormal six nucleate embryosac, × 533. Figs. 9 a and 9 b. Reconstructed to (as Fig. 9) showing abnormal six-nucleate embryosac, × 533.
functions (Fig. 3). The chalazal megaspore develops two prominent vacuoles on either poles. At the end of the first mitotic division both the nuclei lie side by side for some time; finally, however, a big central vacuole pushes them to the opposite poles in the two-nucleate embryosac (Figs. 4 and 5). The next two mitotic divisions take place one after the other, resulting a four- and eight-nucleate stage of the embryosac (Figs. 6 and 7).

The nuclei of the embryosac organise into two synergids and one egg at the micropylar end, and three antipodal cells at the chalazal end, while the polar nuclei occupy the middle of the embryosac. They fuse before fertilization to form a secondary nucleus which lies somewhat above the middle in the embryosac (Fig. 8).

Both the synergids have long and acute beaks, with a very conspicuous and big vacuole at the base and prominent nucleus in the upper part of the synergid. The egg has dense cytoplasm and its nucleus is smaller than the secondary nucleus. The three antipodal cells lie close together in the chalazal groove of the embryosac. They degenerate before fertilization. The egg apparatus is surrounded by dense cytoplasm but the antipodals sometimes appear to be separated from the cytoplasm of the embryosac. The rest of the mature embryosac has thin lining layer of cytoplasm.

Some embryosacs with six nuclei have also been observed (Figs. 9, 9 a and 9 b). In these embryosacs the chalazal pair of nuclei shows belated division, while at the micropylar end are seen organised synergids; no organisation of egg has yet taken place in these embryosacs. These embryosacs thus show two synergids along with two free nuclei at the micropylar end, and only two nuclei at the chalazal end. These cases show that sometimes division of the nuclei at the chalazal end is delayed. Figure 9 shows that the chalazal nucleus of the two-nucleate stage has divided but both the daughter nuclei are still connected with spindle fibres.

Remnants of large number of pollen tubes are often seen in the ovary but only one pollen tube could be made out inside an embryosac lying close to the egg. No synergids are observed in these embryosacs because of the denser cytoplasm of these embryosacs.

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REFERENCES


* Not seen in original.