Ontogeny of the ovule, seed coat and fruit wall of *Dicoma tomentosa* Cass., Asteraceae

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MS received 5 March 1980; revised 31 December 1980

Abstract. Ovule ontogeny and the structure of seed coat and fruit wall in *Dicoma tomentosa* are described. Ovules are anatropous, unigemig and tenuinucellate. Integument develops from a group of initials and it is dermal in origin. Ovary wall shows zonal differentiation, as an outer zone and inner zone. Zonal demarcation will be completely obliterated after fertilization. An air space around the endothelium, a common feature in the ovules of the Asteraceae, is absent. At early stage, the integument does not exhibit any demarcation of zones. As the seed develops tannin-like substance accumulates around the cells, fruit is ribbed and hairy. Pappus is plumose and found in two whorls.

Keywords. Asteraceae; ontogeny; seed coat; fruit wall.

1. Introduction

In recent years, increasing importance is being given to the study of the structure of seed coat and fruit wall, as these are considered to be of value in understanding the systematic relationships of the taxa concerned. Singh (1964) has reviewed the work done in India in this regard and Corner (1976) in his latest review of the subject has given an overall picture of the seed structure in the dicotyledons. The number of species investigated from the tribes like Mutiseae of the Asteraceae is particularly small. The earliest investigation of this subject is that of Lavialle (1912) who studied extensively members of the tribes, Cichorieae, Cynareae and Mutiseae and established close relationships among them. The latest publication is the one by Pandey et al. (1979) on the structure of seeds and fruits in some members of the tribe Cichorieae and of Rajashekar (1980) on *Blumea mollis* of the tribe Inuleae. The present paper gives an account of these structures in *Dicoma tomentosa* Cass.; of the tribe Mutiseae.

*Dicoma tomentosa* is a common annual of waste places in and around Mysore. It bears large, subsessile, spinescent heads. The cypsels are turbinate, densely silky and 5–10 ribbed.
2. Material and methods

The material was fixed in formalin-acetic-alcohol and processed through tertiary butyl alcohol-paraffin series. The mature fruits were softened by treating them with an aqueous solution of potassium hydroxide. Sections cut at 10-14 μ were stained in Heidenhain's iron-alum haematoxylin and safranin.

3. Observations

3.1. Ovule ontogeny

The ovary is bicarpellary, syncarpous and unilocular with a single anatropous, unitegmic and tenuinellate ovule on the basal placentum. The ovular primordium appears as a slight bulge in the locule of the ovary (figures 1 and 2) and soon becomes dome-shaped. Due to differential growth, the dome curves on the side. To begin with, a ring of cells in the epidermal layer becomes distinct by the enlarged size, prominent nucleus and dense cytoplasm (figure 3). Thus a layer of cells divides periclinally, to be followed by the periclinal divisions on the adjacent cells in the epidermal layer (figure 4). This group of meristematic epidermal cells forms the integumentary initials. Thus the integument is dermal in origin. Initially the integument is made up of only 2-3 layers of cells (figure 5). The archesporial cell functions directly as the megaspore mother cell, which becomes club-shaped with a distal broader part enclosed by a prominent nucellar epidermis. When the megaspore mother cell is fully developed, the integument reaches almost the level of the nucellar epidermis, and comprises 4-6 layers of cells (figure 6).

3.2. Pre-fertilization changes in the ovary wall and integument

The ovary wall at the stage of ovule initiation consists of 12-14 layers of homogeneous parenchymatous cells (figure 2), but become 16-18 layered at the time of integument initiation in the ovule primordium (figure 7). By now two regions could be differentiated: an outer zone with compactly arranged smaller cells containing prominent nuclei, and an inner zone made up of elongated and loosely arranged parenchymatous cells. The ovary wall at megaspore mother cell stage consists of 18-20 layers of cells (figure 8), of which the inner zone becomes loosely arranged, by the origin of schizogenous intercellular air spaces, due to its not keeping pace with the rapid growth of the outer zone through cell enlargement.

At the organised female gametophyte stage, the ovary wall consists of about 25 layers of cells (figure 9) with a clear demarcation of the two zones. The outer tangential wall of the outer epidermis becomes thick and the cells of the outer zone elongate. The cells of almost all the layers of the inner zone break down by unequal disintegration of cells.

At the organised female gametophyte stage the integument consists of 16-18 layers of parenchymatous cells (figure 10), of which the innermost layer elongates radially and differentiates into an integumentary tapetum or endothelium.

3.3. Post-fertilization changes in the pericarp and seed coat

At the globular stage, almost all the cells of the inner zone of the fruit wall degenerate, so that the zonal differentiation is completely obliterated. One to two layers
of the cells towards the outer surface (including the outer epidermis) become very much enlarged in size and exhibit a prominent nucleus and peripheral cytoplasm. The cytoplasmic contents inside these cells impart a network-like configuration (figure 11). By the time the embryo differentiates cotyledons, a few layers of cells towards the inner region are utilized and the remaining layers breakdown due to excessive elongation. Later the cell contents of the outer layers are almost completely depleted and the remnants are found shrunk in cells with a nucleus in the centre. As the embryo attains maturity, the pericarp becomes differentiated into three zones. An outermost sclerosed layer, the epicarp, a zone of thin-walled and irregularly stretched cells constituting the mesocarp and the innermost zone with the compactly arranged, degenerated cells (pellicle-like non-cellular portion) the endocarp (figure 12). Vascular supply is confined to the endocarp only.

In mature seed the seed coat consists of six layers of much elongated cells (figure 16), along the sides. No air space due to degeneration of cells has been noticed (figure 14). Tannin-like substances accumulate in cells of the inner layer of the seed coat. The seed coat which comprises 25 layers thick after fertilization (figure 13) is utilized and reduced to 10 layers only at the heart-shaped stage of the embryo (figure 15) and as the embryo attains maturity still four layers are utilized for the development.

In a mature seed generally 1-2 layers of the endosperm persist except on the radicular side, where more layers are seen. The mature embryo extends more or less throughout the entire length of the seed (figure 17).

4. Discussion

Although an impressive number of Asteraceae have been studied embryologically, the ontogeny of the ovule, the structure of the seed coat and fruit wall have not received sufficient attention. The integument is dermal in origin, as reported in other families such as Winteraceae and Scrophulariaceae (Bhandari et al 1976; De Bocq and Bouman 1974).

The differentiation of the ovary wall in its early stages, into two zones, of which the inner zone is completely lost during its development has also been observed by Misra (1972) in the Asteraceae except in Calendula officinalis and Dimorphotheca pulvialis in which the ovary wall remains intact throughout its development into the pericarp. At the megaspore mother cell stage, the schizogenous cavities are observed in the inner zone of the ovary wall. But such cavities are also observed by Misra (1972) in members belonging to the tribe Heliantheae, Heleniumeae and Eupatorieae. These schizogenous cavities are found between two zones. Misra (1972) has also reported such an initial demarcation of two zones in Vernonioa anthelmintica (Vernonieae) and in Verbesina encelioides (Heliantheae). In the latter taxon, the outer zone comprises the epidermis and hypodermis and the inner includes the rest of the ovary wall. The hypodermis is made up of radially elongated cells with comparatively dense cytoplasm. The network-like configuration of the cell contents, in the outer layers of the pericarp, is a rare phenomenon not reported in any other taxon of the family so far studied. The number of cell layers of the integument at the organised female gametophyte
Figures 11-17. 11. Pericarp at globular stage of the embryo (x 1,500). 12. Pericarp at mature embryo stage (x 1,500). 13. Seed coat at globular stage of the embryo (x 1,500). 14. L.S. of fruit at globular embryo stage (x 90). 15. Structure of seed coat at heart-shaped stage of the embryo (x 1,500). 16. Seed coat at mature embryo stage (x 1,500). 17. L.S. of fruit (x 90).

AS—Air space; EC—Epicarp; End—Endothelium; EnC—Endocarp; Endo—Endosperm; EL—Epidermal layer; FW—Fruit wall; GE—Globular embryo; IE—Inner epidermis; II—Integumentary initials; IZ—Inner zone; MC—Mesocarp; OE—Outer epidermis; OP—Ovule primordium; OW—Ovary wall; OZ—Outer zone; SC—Seed coat; Vas—Vasculature.
stage is 18 layers thick. But it differs in other taxa; for example, in *Eclipta alba* 6–10 layers and in *Youngia*, 6–8 layers (Pandey 1976; Pandey *et al* 1979) are noticed. In contrast to the single-layered endothelium more than one layer is observed in *Vernonia anthelmintica* by Misra (1972a). Pandey and Sharma (1978) observed a multilayered structure in *Dimorphotheca sinuata*. The gelatinization of cells around the endothelium and the formation of an air space called as “zone internae” by Lavialle (1912) and “periendothelial zone” by Misra (1972b) is absent. However, Lavialle (1912) states that the presence of an air space around the endothelium appears to be a constant feature in the ovules of the Asteraceae. In mature seed, the seed coat consists of 6–8 layers of cells, but it is represented by 1–2 layers in *Eclipta alba* (Pandey 1976). The present author has also observed the complete utilization of seed coat in *Blumea mollis* (Rajashekar 1980). Complete lack of seed coat is also reported by Tiagi and Taimini (1963) in *Vernonia cinerea*.

**Acknowledgements**

The author is deeply indebted to Dr. M A Rau for guidance. He is thankful to Dr. D A Govindappa for encouragement and facilities and to the University Grants Commission for a teacher fellowship.

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