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ORGANOGENY AND VASCULAR ANATOMY OF THE OVULE OF *GNETUM GNEMON* L.

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The present investigation has revealed certain facts about the organogeny and anatomy of the ovule of *Gnetum*. The ovules are appendicular organ since they originate from the dorsal base of the collar. The cushion arises from the primordia for reproductive organs. Due to intercalary growth, displacement of ovule in the axil of next lower collar takes place. The integuments show acropetal origin. The developmental and antomical studies have little doubt that the integuments belong to the ovule. Glandular cells lining micropylar tube seem to be like micropylar cells of other Gymnosperm to facilitate fertilization.

Keywords : *Gnetum gnemon;* Ovule; Organogeny; Vascular anatomy.

Introduction

The morphological nature of reproductive organs of *Gnetum* has remained a point of discussion in the earlier communications, because they show structural features common to both Gymnosperm and Angiosperm. The ovule of *Gnetum* has also been compared with the carpel of Angiosperm. However, detailed studies have revealed more differences than similarities[1,2]. Vasil[3] in a comprehensive study of *Gnetum ula* has remarked "further anatomical work of a comparative nature is necessary before definite suggestions can be given on the nature of the three envelopes." Maheshwari and Vasil[1] in their monograph, have reviewed earlier work on the genus *Gnetum*. While compiling the work on female reproductive organs they have mentioned that their ontogeny, vascular anatomy and morphological nature need more detailed studies.

Material and Methods

The fixed and dried material of *Gnetum gnemon* was obtained through the courtesy of Dr. Holtum from Singapore botanical garden. The material was dehydrated and cleared in tertiary butyl alcohol series and embedded in wax. Serial longitudinal and transactions (10–12 microns in thickness) were stained with crystal violet-erythrosin or safranin-fast green combinations. Camera lucida sketches were drawn.

Observations

It would suffice here to mention that the female strobilus of *Gnetum* is differentiated into nodes and internodes. Each node has circular bract or collar. The ovules are arranged on the upper part of hairy hump (cushion) like structure, present in the axil of each collar. There is a ring of 4–10 ovules. The uppermost collars are devoid of ovules. The ovule consists of a nucellus surrounded by three envelopes. The innermost elongates to form the micropylar tube.

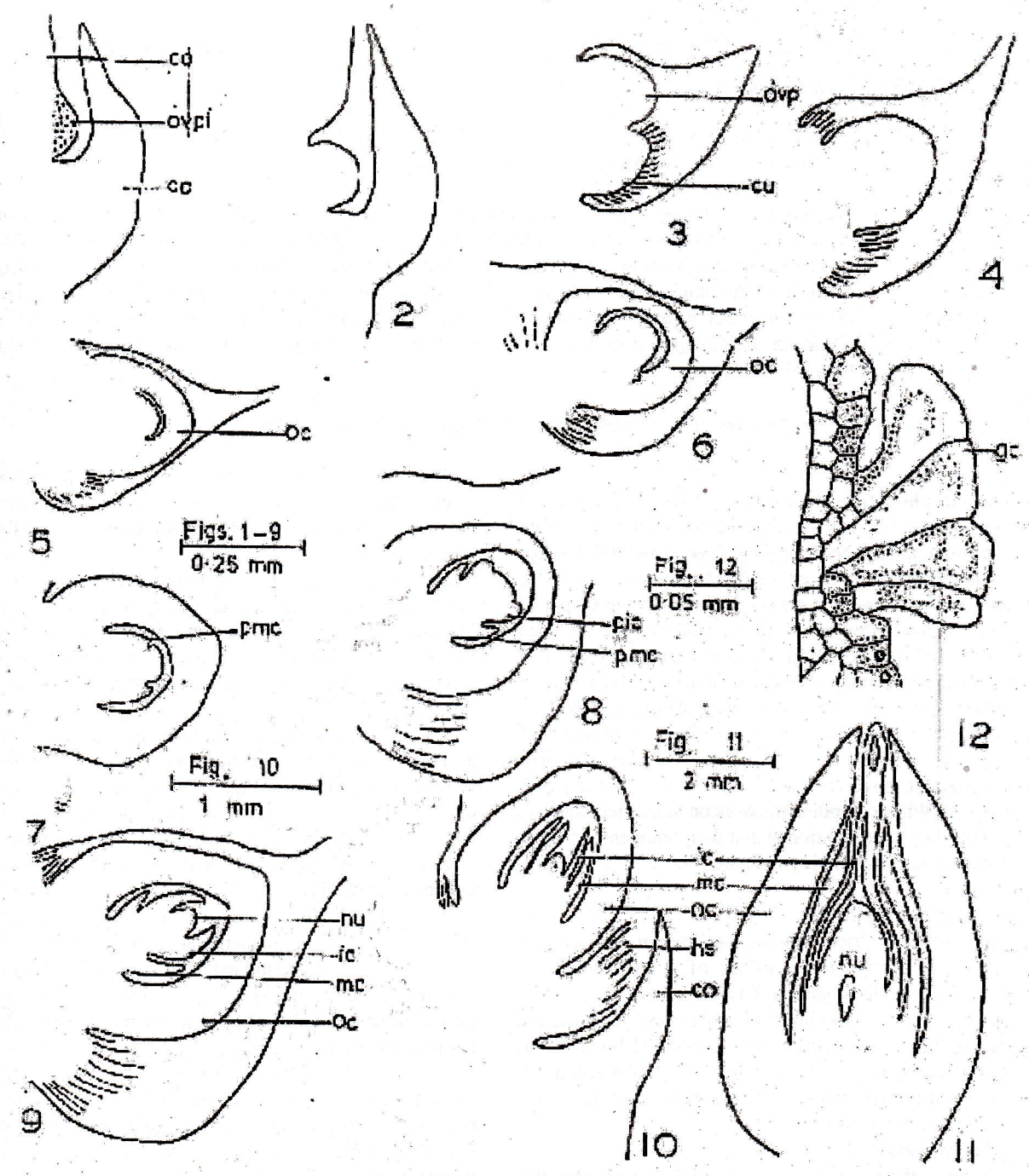
Organogeny of Ovule- The ovular primordium arises as a small outgrowth on the abaxial side of the collar (Figs. 1, 2). Each primordium consists of a large number of small compactly arranged parenchymatous cells. At a later stage cushion (hump) develops from base of ovular primordium (Fig. 3).

The ovular primordium increases in size by division in all planes and becomes a prominent dome shaped structure. The cushion begins to develop multicellular hairs from its epidermal cells. The hair in the vicinity of ovule are longer than those which are away (Fig. 4). A few epidermal cells on the abaxial side of ovule enlarge considerably (Fig. 12).

The outer covering is initiated near the apex of ovular primordium from superficial cells (Figs. 5, 6). There is a conspicuous lag period in the initiation of the middle and the inner coverings (Figs. 6, 8). Like outer covering the middle covering also develops from a ring of superficial peripheral cells near the apical end.

In longitudinal section of the ovule these coverings appear on either lateral side. After initiation of middle covering the central core of tissue increases lengthvise due to the activity of meristematic cells in micropylar region (Figs. 7, 8), closely following it the inner covering differentiates towards apical end (Figs. 8, 9). The meristematic activity in the chalazal region of the ovule results in broadening of its base (Fig. 9).

Thus the three coverings arise acropetally. In a



Figures 1–12; *Gnetum gnemon*

Figs. 1–10. Outline diagrams of the median longitudinal sections of the strobilus showing successive stages of development of the ovule and associated structures.; **Fig.11.** Longitudinal section of the ovule.; **Fig.12.** Showing enlarge glandular cells on the abaxial side. (co - collar; cu - cushion; gc - glandular cells; ic - inner covering; hs - hairs; mc - middle covering; nu - nucellus; oc - outer covering; ovp - ovular primordium; ovpi - ovular primordium initial; pic - primordium of inner covering; pmc - primordium of middle covering).

young ovule all the coverings remain free from each other (Figs. 8–10). In a mature ovule broadening of chalaza results in fusion of basal portion of inner covering with nucellus. The inner covering though last to be initiated develops faster and protrudes out in the form of micropylar tube (Fig. 11).

Vascular Supply of the Ovule- At the base of the ovule there is a ring of 16–18 vascular bundles (Fig. 2). Higher up these bundles divide into a large number of bundles and as many as 23–26 traces diverge out into the outer fleshy envelope (Figs. 3,4). The remaining bundles anastomose together to form a plexus of vascular tissue.

At a higher level it resolves into 12–14 vascular bundles, disposed of in a ring (Figs. 5, 6). These bundles continue up and traces for the second (middle) envelope depart from them. To begin with there are 7–8 traces for middle envelope but only 4–5 enter, while the remaining end at the base of it. These traces are feeble (Figs. 8–10).

The remaining central bundles migrate towards periphery at a level where the second envelope separates from the nucellus. The chalazal end of female gametophyte is also visible in this region (Fig. 11). The third envelope separates from the nucellus at a higher level. The vascular bundles end at the base of the free portion of this envelope (Figs. 12, 13).

The outermost integument is fleshy and has a large number of laticifers and sclereids distributed irregularly in it's tissue[4]. In this envelope some bundles are more prominent and are placed slightly inner to the numerous smaller bundles (Fig. 6). In the terminal region only a few bundles continue up to the tip.

The middle envelope is thin in lower 2/3 portion but in micropylar region it becomes thicker. This envelope consists of a single layer of parenchymatous cells below outer epidermis, followed by 2–3 layers of radially dongated cells in the middle region and 3–4 layers of small parenchymatous cells inner to the inner epidermis (Fig. 14).

The innermost envelope in the micropylar region, has inner layer of radially elongated cells with dense cytoplasm and prominent nuclei. In all probability they constitute glandular tissue. These cells enclose the micropylar canal filled with a darkly staining substance. The possibility that this substance is the secretion of glandular tissue can not be excluded (Fig. 15).

Higher up, the micropylar canal is very narrow and slit like resembling the stylar canal of certain Angiosperms. At the tip, the canal again widens and is enclosed by a conspicuous lining layer the cells of which are thickened on their inner tangential walls. The cells inner to this layer are radially elongated and have thickenings on their radial walls (Figs. 16, 17).

Discussion

Since the Gnetalean theory of angiosperm origin[5] many authors tried to discuss the reproductive structures of the members of Gnetales in terms of corresponding angiospermous structure or to interpret these structures in terms of various theories put forward from time to time.

The morphological nature of the ovule is interpreted as (1) The axillary bud and the coverings as foliage leaves[6-8]. Smith[9] has opinion that they are derived from fronds or part of fronds, so would be o foliar origin.

Fagerlind[10] explained morphological nature of ovule in terms of telome theory and compared it with a short reduced shoot.

According to studies of Maheshwari and Vasil[1] and present investigations the appendicular nature of the ovule is supported by its ontogeny and vascular supply. Further the cushion arises from base of ovular primordium and does not receive any vascular supply. This view is further strengthened by ontogeny of ovule in *Gnetum ula*.

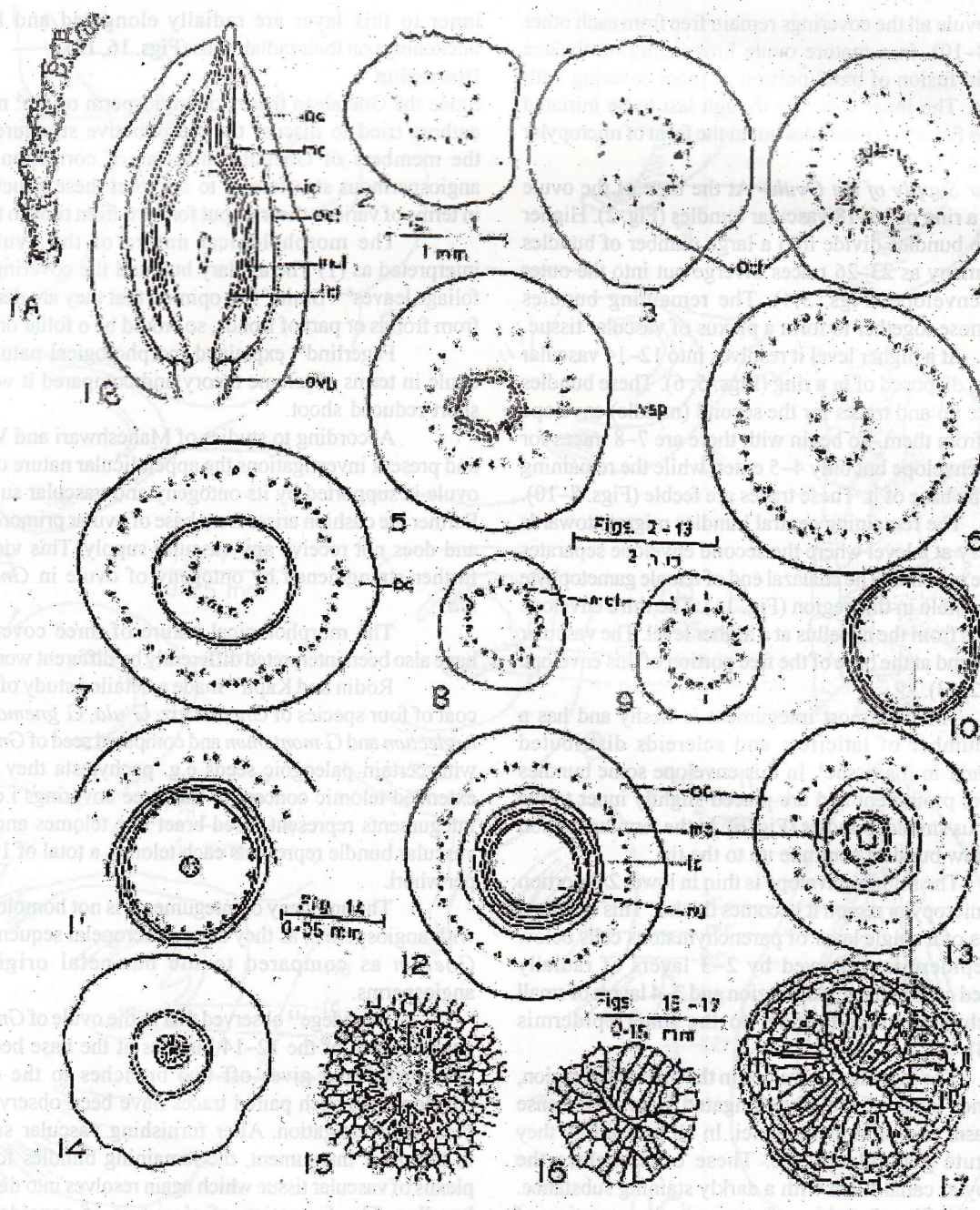
The morphological nature of three coverings have also been interpreted differently by different workers.

Rodin and Kapil[11] made a detailed study of seed coat of four species of *Gnetum* viz. *G'ula*, *G gnemon*, *G neglectum* and *G montanum* and compared seed of *Gnetum* with certain paleogoic seeds e.g. pachytesta they have extended telomic concept to the three coverings i.e. the integuments represent fused bract like telomes and one vascular bundle represents each telome, a total of 18–20 per whorl.

The antogeny of integuments is not homologous with angiosperms, as they arise in acropelal sequence in *Gnetum* as compared to the basipetal origin in angiosperms.

Berridege[12] observed that in the ovule of *Gnetum genmon* each of the 12–14 bundles at the base become very broad and gives off two branches to the outer envelope. No such paired traces have been observed in present investigation. After furnishing vascular supply to the outer integument, the remaining bundles form a plexus of vascular tissue which again resolves into discrete bundles. The formation of plexus is of considerable importance as such a condition is met with at the nodes of strobilus.

Detailed developmental and morphological studies by Negi[13] Madhulata[14] and the present investigations leave little doubt that the three coverings are part and parcel of the ovules.



Figures 1–17; *Gnetum gnemon*

Figs. 1A. A female strobilus; **Fig.2–13.** Serial transverse sections of the ovule from base upwards showing vascular supply of the coverings (Outer covering not shown in Figs. 8–10).; **Fig.14.** Transverse section of the ovule showing outer and inner coverings only. Note the radially elongated cells lining the micropylar canal.; **Fig.15–17.** Cellular details at different levels of micropylar tube from below upwards. (ic - inner covering; ict - inner covering trace; mc - middle covering; mct - middle covering trace; nu - nucellus; oc - outer covering; oct - outer covering trade; ovb - ovular bundles; vsp - vascular plexus).; **Fig.18.** Outline diagram of the ovule in L.S. showing its vesculature.

The glandular cells lining a part of micropylar tube have not been mentioned earlier[15]. However, Maheshwari and Vasil[1] have mentioned elongation of some cells in micropylar tube after fertilization.

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