

GAMETOPHYTES IN *HOPPEA DICHOTOMA* WILLD.

ALTHOUGH Gentianaceae have received the attention of several embryologists in the past (Stolt¹¹, Guerin⁶, Schnarf⁹, Srinivasan¹⁰, Crete¹⁻³, Arekal⁵, Maheswari Devi⁷⁻⁸, Vijayaraghavan¹²), information on the subtribe Erythraeinae remained meagre. *Hoppea* Willd., a genus endemic to the Indian subcontinent, is incompletely known. Arekal⁵ studied the post-fertilization embryology of *H. dichotoma* Willd. To complete the data on this species, a detailed study of its pre-fertilization embryology is presented.

Hoppea dichotoma is a tiny much-branched herb with pale yellow flowers in 2-3-chotomous cymes. Flowers are tetramerous, hypogynous, bisexual and zygomorphic with one perfect stamen. Material was collected from the National Park, Bannerghatta, Bangalore District. Flower buds were fixed in acetic alcohol and dehydrated and embedded from *n*-butanol series. Paraffin sections were cut at 8-12 μ m thickness and stained in Heidenhain's haematoxylin and counterstained in erythrosin.

Flowers are protandrous. Anthers are tetrasporangiate. Development of the microsporangium commences with the differentiation of a hypodermal plate of four to five archesporial cells in each of the four prominences of a young anther (Fig. 1). The archesporial cells are characterised by their dense cytoplasm and prominent nuclei. The cells of the archesporial layer divide periclinally to produce an outer primary parietal layer and an inner primary sporogenous layer (Fig. 1). The primary sporogenous layer gives rise to pollen mother cells which are recognisable by their polygonal shape, dense cytoplasm and large nuclei. These cells extend in five to six vertical rows in each loculus and are disposed in an irregular arc as seen in transection of the anther (Fig. 3).

The primary parietal layer divides periclinally (Fig. 2). Of the two layers thus formed, the inner contributes to the tapetum on the distal face of the sporogenous tissue. The outer parietal layer by one more periclinical division cuts off an outer subepidermal fibrillar endothecium and an ephemeral middle layer (Figs. 3, 4 and 9). Tapetum bordering the proximal face of the sporogenous tissue is differentiated from among the cells of the ground tissue near the connective. The cells of the glandular tapetum protrude into the anther loculus, especially from the direction of the septum between the two microsporangia (Fig. 4). These cells are uninucleate and vacuolated. They remain persistent till the microspores dissociate from the tetrad and are eventually absorbed *in situ* by the developing microspores.

Division of the pollen mother cells is of the simultaneous type (Figs. 5-8). Quadripartition of the pollen

mother cell is accomplished by centripetal furrowing. Microspore tetrads are tetrahedral (Fig. 8). The pollen grains are more or less spherical and tricolporate (Fig. 10). They have a radially striate thick exine and a thin intine. Certain hyaline capitate processes develop from the pollen grains as they mature (Figs. 9 and 10). These processes are located at the germ pore region and drop off before the pollen grains are shed. At the shedding stage, the pollen grain is two-celled (Fig. 10).

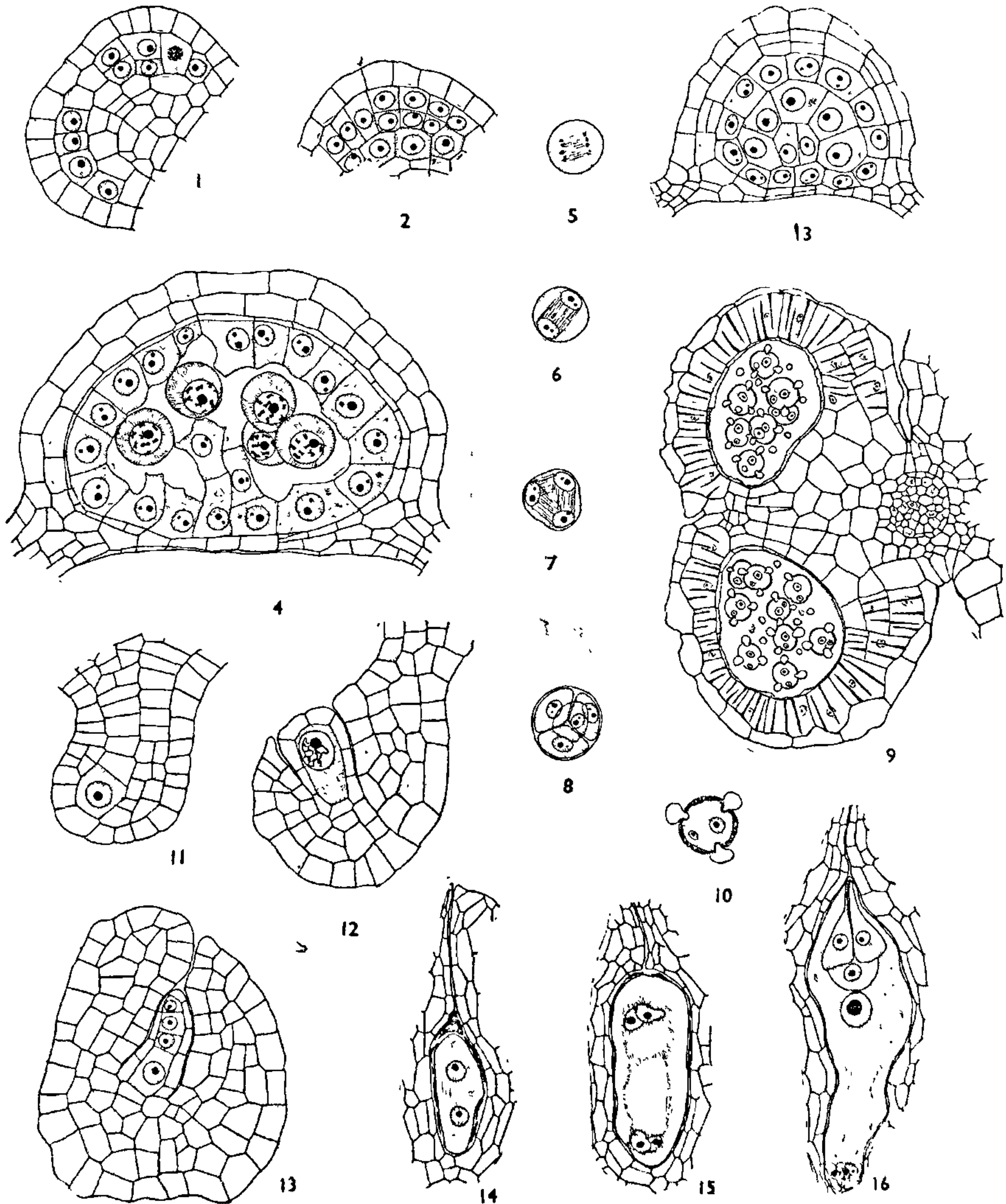
The ovary is superior, bicarpellary, syncarpous and unilocular with two parietal placentae which are formed along the fused margins of the carpels. The placental tissue forks at the base, the branches protruding into the ovarian loculus. Each branch of the placenta bears three vertical rows of ovules. Ovules are numerous, anatropous, tenuinucellate and unitegmatic. They develop as small protuberances on the placenta and start curving at an early stage to assume an anatropous configuration (Figs. 11-13). The integumentary primordium appears shortly after the differentiation of the female archesporium in the young nucellus (Fig. 11). Growth of the massive integument around the nucellus is complete by the time the megaspore mother cell is organised (Fig. 12).

The female archesporium is a single hypodermal cell which directly functions as the megaspore mother cell (Figs. 11 and 12). Preparatory to the division that follows, the megaspore mother cell enlarges. Through meiosis, the megaspore mother cell produces a linear tetrad of megaspores (Fig. 13). The chalazal megaspore of the tetrad always develops into the embryo sac while the three upper megaspores degenerate (Fig. 14). An eight-nucleate embryo sac of the Polygonum type is formed following three successive free nuclear divisions of the functional megaspore (Figs. 14-16). The organised embryo sac is more or less spindle-shaped and is slightly curved (Fig. 16). The synergids are long, flask-shaped with tapered upper ends and basal vacuoles. The egg is a large pear-shaped cell. The polar nuclei fuse before fertilization and the secondary nucleus lies immediately below the egg cell. The antipodals are organised into cells with their pointed ends directed towards the chalaza. These cells remain healthy at the time of fertilization. During the first phase of embryo sac formation, the epidermal cells of the nucellus covering the enlarging megaspore are crushed and absorbed, and the developing embryo sac comes to lie next to the integument. An integumentary tapetum is not organised around the embryo sac.

Erythraeinae (Gilg⁴) show in their flowers a reduction in the male complement to varying degrees. One of the four stamens is larger than the rest in *Canscora decussata*. Flowers of *Hoppea dichotoma* have a single functional stamen. Pollen mother cells in pollen sacs

with healthy tapetum degenerate in *Centaurium ramosissimum*. Pollen grains and pollen sacs show degenera-

tion in *Canscora diffusa* and *C. decussata*. Anther development is of the dicotyledonous type throughout



FIGS. 1-16. Figs. 1-3. Transection of young anther lobes showing the development of wall layers and sporogenous tissue, $\times 1,600$. Fig. 4. Transection of young anther lobe showing wall layers, tapetum and pollen mother cells, $\times 1,600$. Figs. 5-8. Formation of pollen tetrad, $\times 1,600$. Fig. 9. Transection of anther showing the hypodermal fibrillar endothecium and pollen sacs, $\times 240$. Fig. 10. Two-celled pollen grain, $\times 1,600$. Fig. 11. Young nucellus showing female archesporium, $\times 1,600$. Fig. 12. Young ovule with megaspore mother cell, $\times 1,600$. Fig. 13. Ovule with tetrad of megaspores, $\times 1,600$. Figs. 14-16. Two-four-nucleate and organised embryo sacs, $\times 1,600$.

Erythraeinae Anther tapetum is generally of the glandular type. In *C. diffusa* and *C. decussata*, it is of the amoeboid type. Cytokinesis in pollen mother cells is of the simultaneous type. Pollen grains are usually tricolporate. But in *Centaurium ramosissimum*, tetracolporate pollen grains occur in addition to tricolporate ones. They are usually two-celled at the shedding stage. But 2- and 3-celled pollen grains are found in the same pollen sac in *Canscora diffusa*.

The parietal placentae protrude deep into the ovarian cavity to varying degrees. The female archesporium is usually single-celled. In *Canscora decussata* and *Centaurium ramosissimum*, however, it is multiple. Megaspore tetrads are linear while in *Erythraea roxburghii* (*Centaurium roxburghii*), T-shaped tetrads are found. Embryo sac development is consistently of the Polygonum type in all the members. Fusion of the polars in all the cases is before fertilization. Synergids are smooth in all except in *Centaurium ramosissimum* where they are hooked. Antipodal cells remain healthy at the time of fertilization in *H. dichotoma* and persist till the 2-nucleate stage of the endosperm in *Centaurium ramosissimum* while they are ephemeral in all the other members. Endosperm development (Nuclear) and embryogeny (Solanad type) are uniform throughout the taxon. Polyembryony is observed in *Erythraea centaurium*.

The author is thankful to the Principal, St Joseph's College, Bangalore, for providing facilities.

Department of Botany,
St. Joseph's College,
Bangalore 560 001, India,
April 17, 1978.

K. SANKARA RAO.

1. Crete, P., *C.R. Acad. Sci.*, 1949, 228, 1448.
2. —, *Bull. Soc. bot. France*, 1949, 96, 113.
3. —, *C.R. Acad. Sci.*, 1955, 241, 1825.
4. Gilg, E., *Gentianaceae in Die natürllichen Pflanzenfamilien*. Leipzig, 1895.
5. Arckal, G. D., *Can. J. Botany*, 1961, 39, 1001.
6. Güerin, P., *Bull. Soc. Bot. France*, 1926, 73, 5.
7. Maheswari Devi, H., *Proc. Indian Acad. Sci.*, 1962, 56 B, 195.
8. — and Satyanarayana, P., *Plant Science*, 1971, 3, 61.
9. Schnarf, K., *Vergleichende Embryologie der Angiospermen*. Berlin, 1931.
10. Srinivasan, A. R., *Proc. Indian Acad. Sci.*, 1941, 14 B, 529.
11. Stoll, K. A. H., *Kgl. Svenska. Vetensk. Acad. Handlingar*, 1921, 61, 1.
12. Vijayaraghavan, M. R. and Usha Padmanabhan, *Beitr. Biol. Pflanzen*, 1969, 46, 15.

OBSERVATIONS ON TISSUE CHANGES CAUSED AT THE SITES OF ATTACHMENT OF THE NEMATODES, *TANQUA ANOMALA* AND *DISPHARYNX NAUSTA*

Tanqua anomala (Linstow, 1904) Baylis, 1916; without exception, occurs embedded in a pit on the stomach wall. As soon as the body of the water-snake *Tropidonotus piscator* is opened the infection of these worms is noticeable from outside due to pit formation. Every worm forms a pit (Fig. A) for itself. In section (Fig. B) the pit appears to be well-defined and the mucosa and submucosa of the pit are seen eroded. However, the circular muscles are not affected.



FIGS. A-C. Fig. A. *Tanqua anomala* (Linstow, 1904) Baylis, 1916. Worms *in situ*. Note the pits on the stomach wall. Fig. B. *Tanqua anomala* (Linstow, 1904) Baylis, 1916. The head bulb in the pit, Sagittal section. Note the erosion of the mucosal and submucosal layer of the stomach. A patch of the inflammatory tissue seen in the region of the attachment of head bulb to the wall of stomach. Fig. C. *Dispharynx nausta* (Rud., 1819) Railliet, Henry and Sisoff, 1912. Anterior end in the pit, Sagittal section. Note the erosion of the mucosal and submucosal layer of the duodenum. Heavy infiltration of macrophages, lymphocytes and eosinophils seen.

The worm is intimately fastened to the pit wall and specifically all round the head is visible a very thin layer of matrix. The worm has hooks and transverse striations on the head bulb, an adaptation for attachment to the host tissue. The Pits ($n = 10$) vary