T. PULLAIAH*: Embryology, seed coat and fruit wall of *Parthenium hysterophorus* L. (Compositae)

T. プライア: *Parthenium hysterophorus* L.
(キク科) の胚発生学の研究

The Heliantheae, one of the largest tribes of Compositae, is of special interest to embryologists because of the occurrence of a number of variations (Pullaiah 1981a). A search of the available literature reveals that the development and structure of endosperm, embryo, seed coat and pericarp have not been studied in *Parthenium hysterophorus* L. Deshpande (1960) reported few aspects of development of male and female gametophytes in *P. hysterophorus*. Hence the present investigation is undertaken to study the embryology and structure and development of seed coat and fruit wall in *P. hysterophorus* belonging to the tribe Heliantheae.

Material and methods Heads at different stages were collected from plants growing along the railway track near Guntur, India. They were fixed in formalin-acetic acid-alcohol (F.A.A). Dehydration, infiltration, embedding and sectioning were done by the customary methods (Johansen 1940). The sections were stained in Delafield's haematoxylin.

Observations Microsporangium, microsporogenesis and male gametophyte. The anthers contain two microsporangia (Fig. 1A). Besides epidermis anther wall consists of endothecium, middle layer and tapetum (Fig. 1A). Cells of the epidermal layer are much stretched and persist at maturity. Hypodermal layer develops fibrous thickenings and functions as fibrous endothecium (Fig. 1C). The middle layer becomes distorted and crushed. Anther tapetum is of the periplasmodial type (Fig. 1B). Its cells undergo nuclear divisions and fusions resulting in multinucleate and polyploid cells.

The primary sporogenous cells undergo a few mitotic divisions resulting in a moderately extensive mass of pollen mother cells (Fig. 1A), which undergo meiotic divisions to produce tetrahedral (Fig. 1D) or isobilateral tetrads, the former arrangement being more prevalent. The pollen grains at the time of

* Department of Bio-sciences, Sri Krishnadevaraya Univ. Anantapur 515003, India.

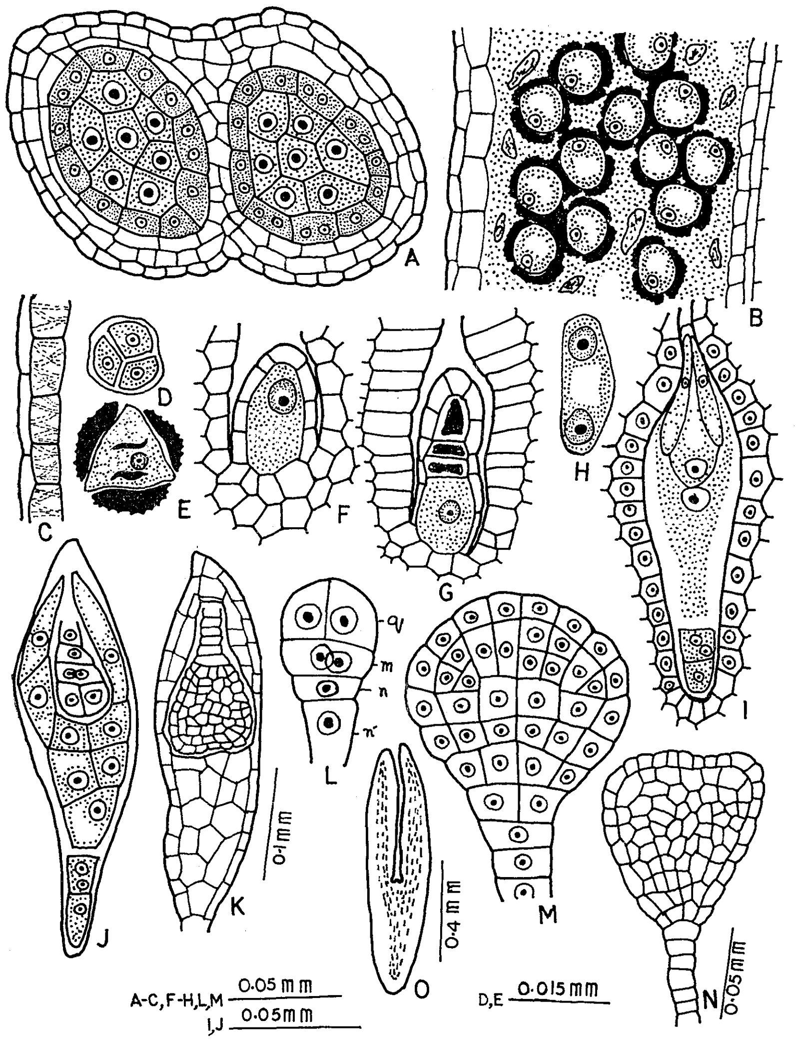

Fig. 1. *Parthenium hysterophorous*. A. T. S. of bisporangiate anther at pollen mother cell stage. B. L. s. part of anther lobe showing periplasmodium and one-nucleate pollen grains. C. Fibrous endothecium. D. Tetrahedral pollen tetrad. E. Mature pollen grain. F. Megaspore mother cell. G. Megaspore tetrad. H. Two-nucleate embryo sac. I. Mature embryo sac. J, K. Development of endosperm. L-D. Various stages in the development of the embryo.

shedding are 3-celled with three germ pores (Fig. 1E).

Ovary and Ovule. The ovary as characteristic of Compositae is bicarpellary syncarpous, unilocular and inferior with a single basal, anatropous, unitegmic and tenuinucellate ovule. At about the time of megaspore tetrad formation the cells of the inner layer of the integument become enlarged, accumulate abundant cytoplasm and develop into the integumentary tapetum (Fig. 1G). It remains uniseriate with uninucleate cells throughout further development (Fig. 1I).

Megasporogenesis and female gametophyte. The single female archesporial cell directly functions as the megaspore mother cell (Fig. 1F). It undergoes two meiotic divisions resulting in a linear tetrad of megaspores. Of the four megaspores the upper three degenerate and the functional chalazal megaspore after undergoing three successive nuclear divisions forms an 8-nucleate embryo sac of the Polygonum type (Figs. 1G–I). The newly formed 8-nucleate embryo sac is spindle shaped. After the formation of secondary nucleus in it, the embryo sac widens considerably near the regions of the egg apparatus, so that the extreme apex of it appears as a beak like protuberance. The synergids are beak-shaped (Fig. 1I). The antipodal cells are two in number, of which the upper is binucleate. They remain persistent till a heart-shaped embryo is formed.

Fertilization, endosperm and embryo. Fertilization is porogamous. Tripl fusion completes earlier than syngamy. Endosperm development is of the cellular type. The first division of the primary endosperm nucleus is followed by a transverse wall and two cells are formed. Further divisions in these two cells take place in all directions and a massive tissue is formed filling the embryo sac with cellular tissue (Fig. 1J, K). At about the globular stage of the embryo, the peripheral cells of the endosperm become differentiated as the jacket layer (Fig. 1K). These cells resemble the integumentary tapetal cells in their glandular nature, but the difference being that the integumentary tapetal cells are elongated longitudinally. The glandular nature of the cells of the jacket layer becomes more pronounced as the integumentary tapetal cells start degenerating. The growing embryo consumes the entire endosperm but this jacket layer (Fig. 2F).

The zygote divides transversely resulting in two cells, the basal cell *cb* and the terminal cell *ca*. The terminal cell *ca* divides vertically and the basal

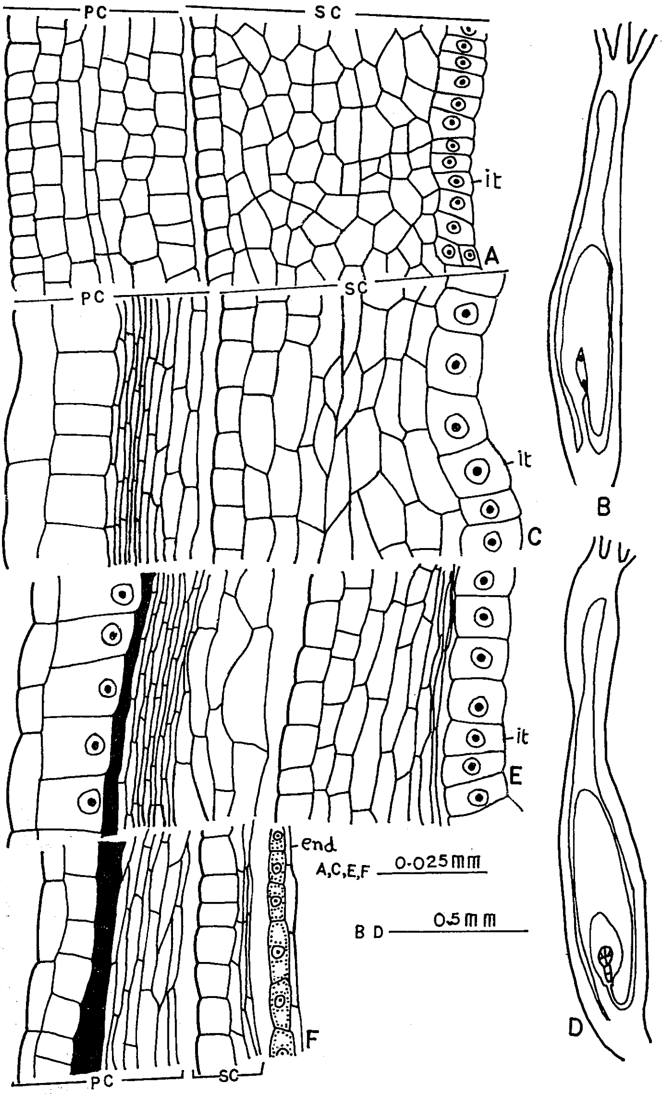

Fig. 2. *Parthenium hysterophorus*. A. L. s. portion of seed coat and pericarp at the megaspore tetrad stage. C. Portion of seed coat and pericarp enlarged from B. D. L. s. ovary at globular embryo stage. E. Portion of seed coat and fruit wall enlarged from D. F. Seed coat and pericarp at mature embryo stage. (end, endosperm; it, integumentary tapetum; pc, pericarp; sc. seed coat).

cell *cb* divides transversely resulting in a four-celled 'T'-shaped proembryo. Further development resembles those investigated earlier (Pullaiah 1978, 1981a, 1981b) and hence a detailed description is omitted. The embryogany conforms to the Senecio variation of the Asterad type (Fig. 1L–O) (Johansen 1950).

Seed coat and pericarp. The integument at the megaspore tetrad stage consists of about 9–11 layers of parenchymatous cells including the integumentary tapetum (Fig. 2A). After fertilization a few layers of cells of the integument next to the endothelium become enlarged, lose their contents and get obliterated (Fig. 2B–E). This zone forms the periendothelial zone (Fig. 2E). In a mature seed excepting a few layers of cells and epidermis all the layers of the integument become crushed and absorbed by the growing embryo. Thus the seed coat consists of the epidermis and a few layers of the integument (Fig. 2F).

The ovary wall which consists of similar parenchymatous cells at the megaspore mother cell stage, becomes differentiated into three zones by the time a mature embryo sac is formed in the ovule (Fig. 2A–C). The outer zone consists of epidermis and hypodermis. The cells of the hypodermis are larger. The middle zone consists of a few layers of elongated fibrous cells and the inner zone of a few layers of parenchymatous cells. After fertilisation schizogenous cavities develop between the hypodermis and the inner layers of cells (Fig. 2D, E). A brown resinous substance exudates into this space. This dark cementing substance also penetrates the tissue of the outer zone intercellularly forming characteristic patterns. Finally this substance becomes hardened and forms a dark cementing layer. Meanwhile the inner parenchymatous zone becomes obliterated. In a mature achene the epidermis, hypodermis and a few fibrous layers take part in the formation of the pericarp (Fig. 2F).

Discussion The taxon studied fits in well with the picture obtained from previous studies of the embryology of other representatives of the tribe. However, Deshpande's (1962a, 1962b, 1964) statement that in *Tridax procumbens*, *Glossocardia bosvallea* and *Bidens biternata* the endosperm is completely consumed and the endothelium persists forming a storage tissue appears questionable, since in *Parthenium hysterophorous* studied here and other species investigated by earlier workers (Harris 1935; Maheswari & Roy 1952; Pullaiah 1978, 1981a, 1981b) a single layer of endosperm persists in the mature seed.

In the ovary wall of the tribe Heliantheae schizogenous cavities are formed in between the hypodermis and inner layers of the ovary wall. Tannin-like substance oozes into this cavity which later on becomes dark cementing layer (Misra 1972; Pullaiah 1981a). This character is also met with in the tribes Eupatorieae and Helenieae (Misra 1964, 1972; Pandey & Chopra 1979). This feature supports Cronquist's (1955, 1977) argument that Helenieae and Heliantheae should be united into one tribe.

References

Cronquist, A. 1955. Phylogeny and taxonomy of Compositae. Amer. Midl. Nat. **53**: 478–511. —— 1977. The Compositae revisited. Brittonia **29**: 137–153. Deshpande, P.K. 1960. Studies in the family Compositae. Male and female gametophytes of *Parthenium hysterophorus*. J. Biol. Sci. **3**: 26–27. —— 1962a. A reinvestigation of the endosperm in *Tridax procumbens*. Curr. Sci. **31**: 113–114. —— 1962b. Studies in the life history of *Glossocardia bosvallia*. Bull. Bot. Soc., Cell. Sci., Nagpur **3**: 84–91. —— 1964. A contribution to the embryology of *Bidens biternata*. J. Indian Bot. Soc. **43**: 149–157. Harris, C.J. 1935. The development of the flower and seed in *Galinsoga ciliata*. Univ. Pittsb. Bull. **32**: 131–137. Johansen, D.A. 1940. Plant microtechnique. McGrow Hill, New York. —— 1950. Plant embryology. Waltham, Mass. Maheshwari, P. & S.K. Roy 1952. The embryo sac and embryo of *Tridax procumbens*. Phytomorphology **2**: 245–252. Misra, S. 1964. Floral morphology of the family Compositae. II. Development of the seed and fruit in *Flaveria repanda*. Bot. Mag. Tokyo **77**: 290–296. —— 1972. Floral morphology of the family Compositae. V. The seed coat and pericarp in *Verbesina enceloides*. J. Indian Bot. Soc. **51**: 332–341. Pandey, A.K. & S. Chopra 1979. Development of seed and fruit in *Gerbera jamesonii*. Geophytology, **9**: 171–174. Pullaiah, T. 1978. Embryology of *Tithonia*. Phytomorphology, **28**: 437–444. —— 1981a. Studies in the embryology of Heliantheae (Compositae). Pl. Syst. Evol. **137**: 203–214. —— 1981b. Embryology of *Acanthospermum hispidum*. Curr. Sci. **50**: 992–994.

* * * *

キク科のメナモミ連に属する *Parthenium hysterophorus* の胚発生，種皮，果皮の形成を調べた。大胞子形成は一般的なタデ型である。胚嚢の反足細胞は 2 細胞からな

り，その上側の1細胞は2核からなる。胚乳形成は造膜型であり，胚形成はコンギク型のキオン変型である。種皮は珠皮の表皮層のみが発達して残り，他の層は消失する。果皮形成の初期の段階では表皮層，下皮層，その内側の数層からなる柔組織が認められる。下皮層と柔組織との間に樹脂状の物質が分泌され，暗色の堅いセメント層を作る。この層はヒヨドリバナ連とメナモミ連とに見られるものである。

○キミノクロガネモチについて (新　敏夫) Toshio SHIN: On *Ilex rotunda* f. *xanthocarpa*

本品種について私は本誌 57(2):40 (1981) に新品種として発表しましたが原 寛先生等の御注意により，すでに本誌 41:100 (1966) に *Ilex rotunda* Thunb. f. *xanthocarpa* Uyeki et Tokui として発表されていることを知りましたので，私の発表を取消さして戴きます。尚本品種については林 弥栄氏も「北陸の植物」25(3):55 (1978) で全く同じ学名で発表されていますがこれも無効となります。

Ilex rotunda Thunb. f. **xanthocarpa** Uyeki et Tokui in Journ. Jap. Bot. 41: 100 (1966).

Ilex rotunda Thunb. f. *xanthocarpa* Hayasi in Journ. Geobot. 25: 55 (1977), syn. nov.

Ilex rotunda Thunb. f. *xanthocarpa* Shin in Journ. Jap. Bot. 57: 40 (1981), syn. nov.

(鹿児島大学教養部)

□Young, D. A. & D. S. Seigler: **Phytochemistry and angiosperm phylogeny** 295 pp. 1981. Praeger ¥11,650. これは1979年8月15日に Oklahoma State University で開かれた表記のシンポジウムで述べられた論文を集めたものである。主として米国とデンマークの研究者による8論文を収めている。ベタレーンがナデシコ科を除く大部分とサボテン科にみつかって後者が前者に包含されるにいたったことは1966年以来明らかだが，近年じつにたくさんの化合物の存在が明らかになっている。DNA，アミノ酸，Glucosinolato-myrosinase，テルペン，iridoids，Ellagic acid 其他じつに多い。それらに関連する討論は多岐に亘っており一致したとは言い兼ねる。中でも Dahlgren (デンマーク) と Thorne (カリフォルニア) の両氏は顕花植物を一瞥できる類縁図と分類表とを掲げ，前者ではその類縁図の概当する部門に点を打って沢山の図でそのよって来たる処の確実性を示している。前者では双子葉が79目，単子葉が27目，後者では40目と12目と少ないが分類表には亜科迄を網羅している。最近 Cronquist の分類表も出たのでこれからはこの分野の議論に一層の熱がかかると思われ，大いに期待が持てるところである。

(前川文夫)