D. SARADA* & T. PULLAIAH*: **Embryology of *Helichrysum bracteatum* Andr. (Compositae)**

D. サラダ*・T. プライア*: *Helichrysum bracteatum* (キク科) の胚学的研究

Although the genus *Helichrysum* comprises 500 species, embryology of only two species has been worked out and that too is concerned with one aspect each only. Tongiorgi (1942) reported *Drusa* type of embryo sac development in *Helichrysum bracteatum*, while Mestre (1963-64) studied the embryo development of *H. staechas*. Complete life history of even a single species is not known and hence the present study is undertaken.

Material and methods Flower heads at different stages of development were collected from the vicinity of Ooty in Tamilnadu and fixed in formalin-acetic-alcohol. Dehydration and clearing were done in tertiary butyl alcohol series. Embedding was done in paraffin wax of 58-60°C. Serial longi- and transections were cut at a thickness of 3-5 μm. The voucher specimen no. TP 1284 has been deposited in the Herbarium of Sri Krishnadevaraya University and Madras Herbarium, Coimbatore.

Observations Microsporangium, microsporogenesis and male gametophyte. The male archesporium is hypodermal and consists of a row of 6-8 prominent cells (Fig. 1A). The primary archesporial cells undergo a periclinal division giving rise to primary parietal cells on outside and primary sporogenous cells on inside (Fig. 1B). The primary parietal cells undergo a periclinal division resulting in two layers (Fig. 1C), of which the inner functions as tapetum while the outer undergoes one more periclinal division forming a hypodermal layer and a middle layer (Fig. 1D). Thus the development of anther wall corresponds to the dicotyledonous type.

Anther tapetum is of the periplasmodial type (Fig. 1E). Tapetal cells undergo nuclear divisions resulting in multinucleate cells (Fig. 1F-I). The number of nuclei may vary up to six (Fig. 1I). Sometimes tapetal cells with polyploid nuclei of various shapes have been observed (Fig. 1J, K). Periplas-

*Department of Bio-Sciences, Sri Krishnadevaraya University, Anantapur 515 003, A. P., India.

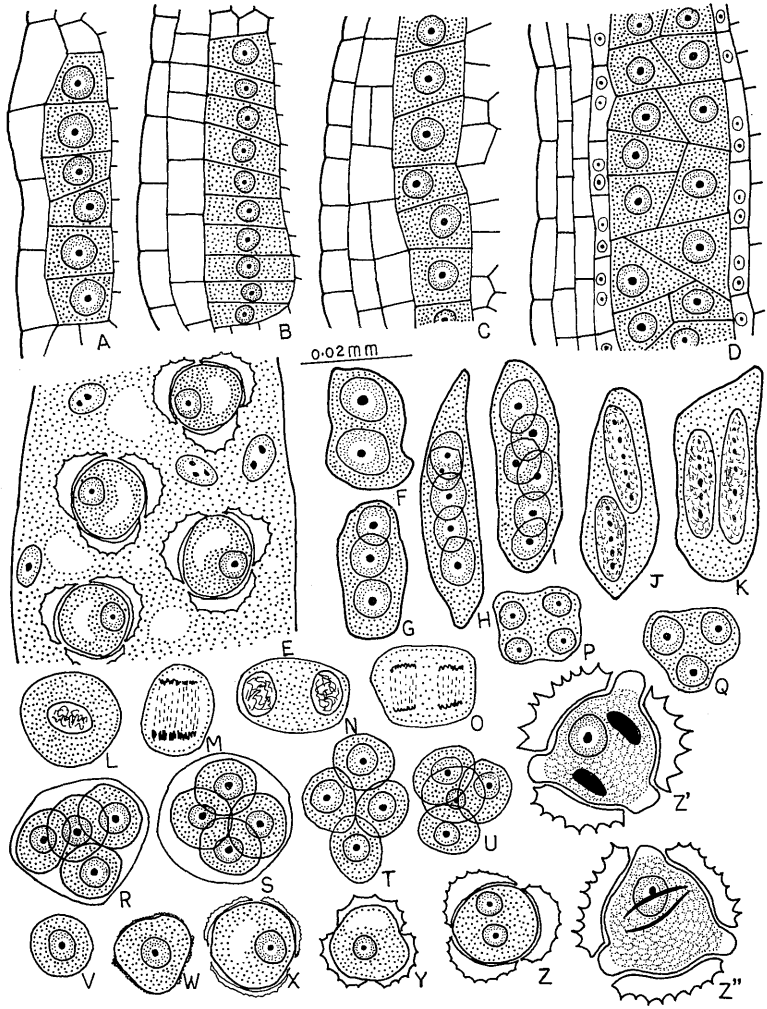


Fig. 1. *Helichrysum bracteatum.* A. Longitudinal section of anther lobe showing male archesporium. B-D. Logitudinal sections of anther lobe showing anther wall development. E. Logitudinal section of anther lobe showing periplasmodium and one-nucleate pollen grains. F-K. Anther tapetal cells. L-Q. Meiosis in pollen mother cells. R, S. Pollen tetrads in sheath. T, U. Tetrads released from sheath. V-Z′. Stages in the development of pollen grain. Z″. Mature pollen grain.

modium formation occurs at 1-nucleate stage of pollen grains. The hypodermal layer develops thickening forming fibrous edothecium. The middle layer gets crushed and degenerated during meiotic division in the pollen mother cells.

The primary sporogenous cells undergo one vertical division and transverse divisions forming two rows of pollen mother cells (Fig. 1D). The pollen mother cells undergo meiosis (Fig. 1L-Q) forming tetrahedral (Fig. 1R, U) and isobilateral tetrads (Fig. 1S, T). Quadripartition of the microspores is by furrowing (Fig. 1P, Q). Microspores after their release from the tetrad (Fig. 1T-V) enlarge and develop a thick exine and a thin intine (Fig. 1W-Z″). Pollen grains at the time of shedding are 3-celled with 3 germ pores. The sperms which are oval in the beginning (Fig. 1Z′) later become filiform (Fig. 1Z″).

Ovary and ovule. The ovary as in other Compositae is bicarpellary syncarpous and unilocular with basal anatropous, unitegmic and tenuinucellate ovule (Fig. 2A-E). Integumentary tapetum is differentiated at megaspore tetrad stage. (Fig. 3A). It remains uniseriate with uninucleate cells during further development (Fig. 3B-E).

Megasporogenesis and female gametophyte. The female archesporium is hypodermal, single-celled (Fig. 2A, F) and functions as the megaspore mother cell (Fig. 2G). The megaspore mother cell undergoes meiosis resulting in a coenomegaspore (Fig. 2H) and the nuclei are arranged in a linear fashion. Later on the coenomegaspore elongates considerably and pushes through the nucellar epidermis (Fig. 3A). Nuclei at this stage are arranged in 1+2+1 manner. These nuclei undergo one more division resulting in 8 nuclei. These nuclei undergo one more division, but usually the chalazal nuclei of the 8-nucleate embryo sac fail to divide and consequently only 11-13 nuclei are formed. Of these, three at the micropylar end organise into an egg apparatus, two nuclei fuse near the egg appartus to form the secondary nucleus, while the remaining nuclei form antipodal cells (Fig. 3B). Thus the development of embryo sac follows the tetrasporic *Drusa* type. This is in conformity with the earlier report of Tongiorgi (1942). The embryo sac is spindle-shaped. The synergids are hooked (Fig. 3B). Antipodals vary in number from 6-8 (Fig. 3B-E). The cells are arranged in a linear fashion though some of them may be arranged side by side. Antipodals are persistent (Fig. 3C, E).

Fertilisation, endosperm and embryo. Entry of the pollen tube is poro-

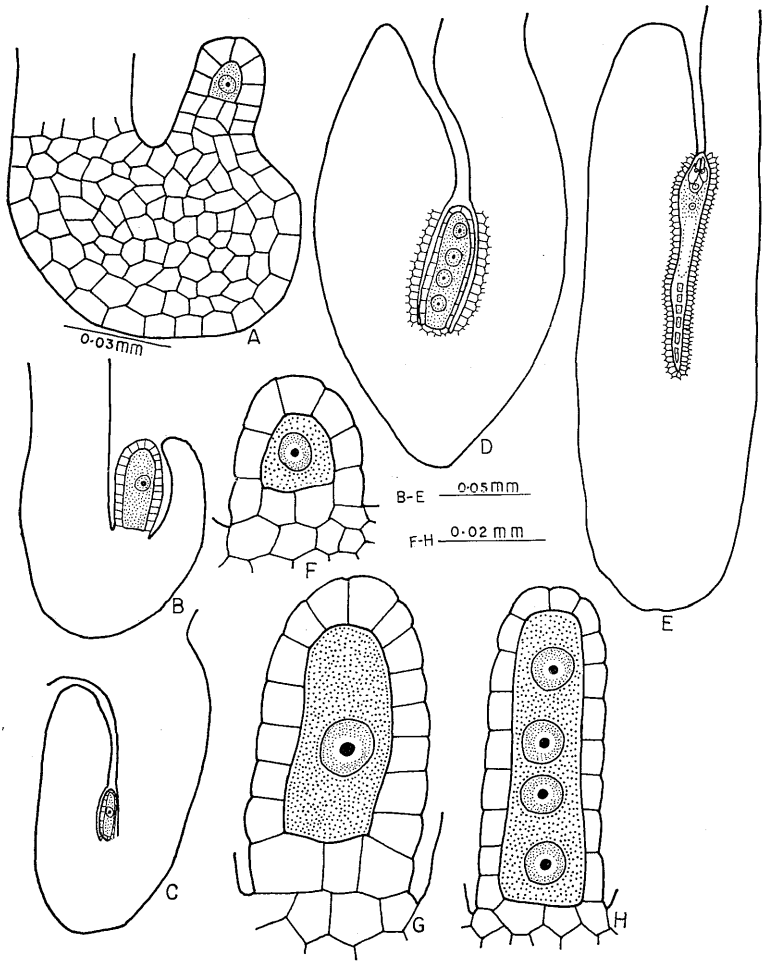


Fig. 2. *Helichrysum bracteatum.* A–E. Stages in the development of ovule. F. Female archesporial cell. G. Megaspore mother cell. H. Coenomegaspore.

gamous. Syngamy and triple fusion occur simultaneously.

Endosperm development is of the Nuclear type. The primary endosperm nucleus divides before the zygote. The endosperm nuclei are distributed to the periphery of embryo sac (Fig. 3C). Cellularization occurs at sixteen-celled stage of the embryo (Fig. 3D). The cells undergo repeated divisions in varied

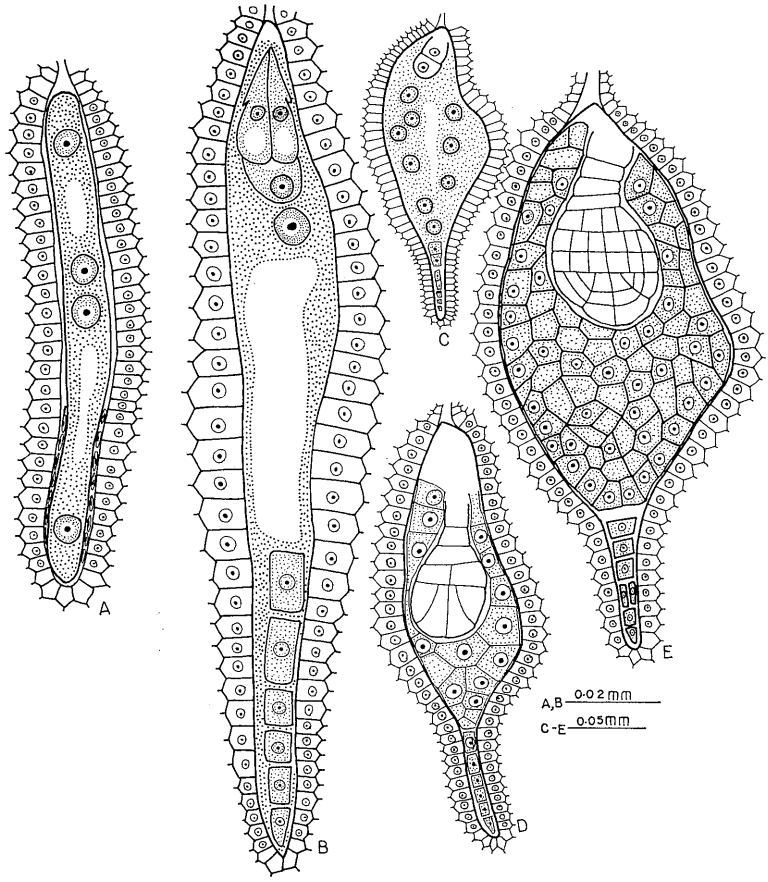
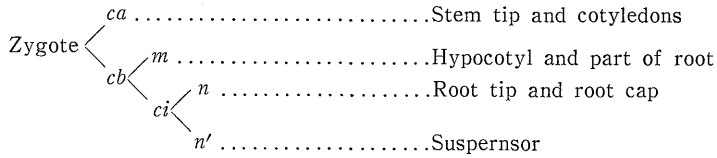


Fig. 3. *Helichrysum bracteatum.* A. Four-nucleate embryo sac. B. Organised embryo sac. C-E. Stages in the development of endosperm.

planes resulting in a massive cellular endosperm (Fig. 3E).

The zygote divides transversely giving rise to a terminal cell *ca* and a basal cell *cb* of 2-celled embryo (Fig. 4A). The *ca* divides longitudinally and *cb* transversely resulting in a 4-celled T-shaped proembryo. Further development of the embryo (Fig. 4B-E) is represented below.



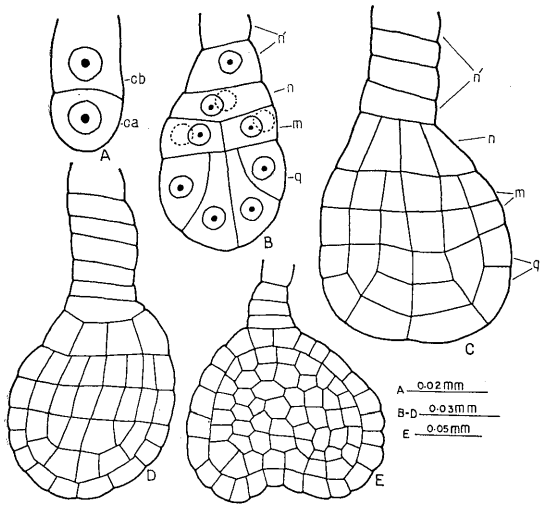


Fig. 4. *Helichrysum bracteatum.* A-E. Stages in the development of embryo.

Thus development of embryo follows *Senecio* variation of Asterad type (Johansen 1950) and Grand period I, Megarche-type II, series A, sub-series A_2 in the first embryonic group according to Souèges system (Crété 1963).

The suspensor in *H. bracteatum* is formed from the tier *n′*. On the basis of this character the development of embryo has been included in *Calendula* sub-type of Mestre (1963-64).

Discussion Endosperm development in *Helichrysum* is not known so far. In *H. bracteatum* endosperm is of Nuclear type. In the tribe Inuleae to which *Helichrysum* belongs both Nuclear and Cellular endosperm have been recorded (Pullaiah 1979, 1984).

Embryo development in *Helichrysum bracteatum* (present study) differs from most other Compositae in that the suspensor is formed by tier *n′* while in most other Compositae the suspensor is formed by the tier *p*, i.e., part of *n′*. Such a type of embryo development according to Mestre (1963-64) is known as *Calendula* type and it occurs in *Eupatorium ayapana, Calendula officinalis, Dimorphotheca pluvialis* and *Cnicus benedictus.*

References

Créte, P. 1963. Embryo. *In* Maheshwari, P. (ed.): Recent advances in the embryology of Angiosperms. Delhi. Johansen, D. A. 1950. Plant embryology. Mass. Mestre, J. C. 1963-64. Recerche d'embryogenie comparee: les rapports phylogenetiques des Composées. These, Univ. Paris. Pullaiah, T. 1979. Studies in the embryology of Compositae IV. The Tribe Inuleae. Amer. J. Bot. **66**: 1119-1127. —— 1984. Embryology of Compositae, Delhi. Tongiorgi, E. 1942. Il gametofito tetramegasporiale di *Helichrysum bracteatum*. N. G. Bot. Ital. **49**: 205-220.

* * * *

Helichrysum bracteatum の花粉形成，胚嚢・胚形成を観察した。葯壁の形成は Dicotyledon type である。葯のタペート形成は Periplasmoidal type である。成熟した花粉は3細胞である。胚嚢形成は *Drusa* type，胚形成は Asterad type である。

□橋爪 真：**駒ケ根の鼓藻類と珪藻の増大胞子** 167pp. 1985. 精興社，東京. ¥7,000. 長野県下の高校にあって永年藻類を観察し，熱心に藻類の撮影を続けている橋爪真氏の成果の集成であり，鼓藻類358種と羽状珪藻類8種の顕微鏡写真が収録される。よく知られるように，これらの藻群は昔は二殻類 (Diatomaceae) と呼ばれ，ともに有性生殖はアメーバ運動をする配偶子の接合による。しかし，実際にこの接合現象をわれわれが見ることは多くなく，むしろ稀でさえある。著者は有性生殖に格別の興味をもった由で，たゆまない努力により80余種の接合現象と接合胞子の写真撮影に成功している。章の後半には，鼓藻類の分類・分布の研究史，有性生殖についての解説が挿入され，また著者が観察した羽状珪藻の有性生殖の特色が述べられている。本書は題名が示すように長野県の一地方から得た材料に基づいてつくられているが，様々な接合型の写真が収録され，接合藻類の有性生殖一般の知見も与えてくれる。これは本書の一つの特色でもある。3章から成り，1. 鼓藻類の種類，2. 生態，3. 羽状珪藻の有性生殖であるが，内容からいって2は生殖でよかった。珪藻とケイソウの統一も欲しかった。しかし，これらは細かい事である。生物進化の面で，また生態の面で頗る興味のあるツヅミモ類について，教科書にない，いわばナマの知識を与えてくれる労作である。なお著者は分類は平野実博士に，生殖や生活史については市村輝宜博士に師事している。 (千原光雄)