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-
modium formation occurs at 1-nucleate stage of pollen grains. The hypodermal
layer develops thickening forming fibrous edothecium. The middle layer gets
brushed 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). Quadrupartition 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 syn-
carpous 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 appatus 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 synergid
gs 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. Megasporangium 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.
Thus development of embryo follows Senecio variation of Asterad type (Johansen 1950) and Grand period I, Megarchetype II, series A, subseries A$_8$ in the first embryonic group according to Souèges system (Crété 1963).

The suspensor in *Helichrysum 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

Helichrysum bracteatum の花粉形成, 胚囊・胚形成を観察した。葯壁の形成は Dicotyledon type である。葯のタベル形成は Periplasmoidal type である。成熟した花粉は 3 細胞である。胚囊形成は Drusa type, 胚形成は Asterad type である。