P.S. Prakasa Rao* & B. Hanumantha Rao*: Embryo development in *Cleome aspera* L. (Capparidaceae)

Taxonomically the Capparidaceae comprise approximately 700 species spread over 64 genera (Lawrence, 1965). Compared to the extensiveness of the family, embryological studies in the family are still scanty and fragmentary (see Davis, 1966). For example, the information on the development of embryo, though restricted to a few species (Mauritzon, 1934; Tiwary, 1936; Raghavan, 1937; Rao, 1938a; Sachar, 1956b; Narayana, 1962, 1965), manifests variation, conforming to the Onagrad, the Solanad and the Caryophyllad types. In view of this diversity in the embryogeny and paucity of embryological information, the authors consider worthwhile to extend studies to some more capparidaceous taxa so as to fill in some gaps in the existing data as also to enrich our embryological knowledge of this family. The present paper presents the results of investigation on the development of embryo in an indigenous herbaceous annual, *Cleome aspera* Linn.

**Material and methods** Pollinated flowers and fruits of different stages were collected from plants growing locally and from Machilipatnam, Andhra Pradesh. The material was transferred to Formalin-acetic-alcohol after prefixing in Carnoy's fluid for a few minutes and stored in 70% ethanol to which a few drops of glycerine were added. Tertiary-butyl-alcohol series were used for dehydration. Infiltration and embedding were done in the usual way and the serial longitudinal sections were cut between 10-12 microns and were stained in Delafield's haematoxylin or safranin fast green combination.

**Observation and discussion** The zygote, which is gorged with starch grains, after a period of quiescence, increases in size and after at last six endosperm nuclei are formed begins to divide and completes it by about...

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20 endosperm nuclei are formed resulting in an apical cell \( ca \) and a basal cell \( cb \) (Figs. 1-6). During the entry of the pollen tube one or both the synergids are destroyed (Figs. 1-5). The persistent pollen tube could be discernible up-till the two-celled stage of the proembryo (Figs. 1-5).

The cell \( ca \) divides longitudinally into two juxtaposed cells while \( cb \) divides transversely into \( m \) and \( ci \) (Figs. 7, 8). However, in a few instances it has been observed that either of the cells of the two-celled proembryo may divide earlier than the other (Figs. 7, 9, 10). Thus at the second cell generation, a T-shaped proembryonal tetrad with the cells disposed in three tiers designated as \( ca \), \( m \), and \( ci \), is organized (Fig. 8). The apical tier \( ca \) comprises two cells, while the other two tiers, \( m \) and \( ci \) represented by one cell each (Fig. 8). The derivatives of \( ca \) from a quadrant in consequence of second longitudinal division at right angles to the first (Fig. 11). The starch grains could be seen up to this stage but they disappear subsequently (Figs. 1-12). At this stage the proembyo is 6-celled disposed in three tiers (Fig. 11). Each cell of the quadrant becomes partitioned transversely leading to the formation of an octant with two tiers \( l \) and \( l' \) each comprising four cells (Fig. 12).

The formation of quadrant and octant stages in Cleome aspera suggest that the embryo development in this species conforms to the Onagrad type. The tier \( l \) ultimately engenders cotyledons and stem tip, while \( l' \) produces the hypocotyl. Cell \( m \) derived from \( cb \) of the 2-celled proembryo divides by a transverse wall to beget two superposed cells \( d \) and \( f \), of which the former behaves as an hypophysis and the latter together with \( n \) and \( n' \), the derivatives of \( ci \), organizes into a short uniseriate (Figs. 18-21) to partly biseriate suspensor (Figs. 22-25) which persists during later stages of embryo development.

The origin, disposition, ultimate destination and histogenic behaviour of the proembryonal cells during the first four cell generations and the relationship of these cells to the different parts of the mature embryo in Cleome aspera Linn. are rendered in the scheme (p. 114).

Further details of development of the diverse parts of the embryo are detailed out in the following paragraphs:

About the time the octant is engendered, the embryo comprises four tiers: the two terminal tiers \( l \) and \( l' \) of four cells each, the next one \( m \) of
Figs. 1-26. 1: Longitudinal section of micropylar region of ovule showing integuments, nucellus and embryo sac x 100; note zygote, persistent pollen tube and degenerating synergid. 2: Mature embryo sac showing zygote in division, persistent pollen tube, degenerating synergid and endosperm nuclei, × 130. 3: Mature embryo sac with zygote in division, degenerating synergid, persistent pollen tube and endosperm nuclei. × 130. 4: Mature embryo sac showing the 2-celled proembryo, persistent pollen tube, degenerating synergid and 20 endosperm nuclei. × 130. 5: L.s. nucellus showing a part of mature embryo sac with 2-celled proembryo, persistent pollen tube and a few endosperm nuclei; note starch grains in the proembryo. 6-25: Stages in the development of embryo (6-24: × 300; 25: × 120.). 26: L.s. mature embryo. × 30. (cot, cotyledon; dsy, degenerating synergid; end, endosperm; es, embryo sac; ii, inner integument; oi, outer integument; pem, proembryo; pt, persistent pollen tube; vs, vascular supply; zy, zygote.)
one cell and the lower tier \( ci \) of one cell (Fig. 12). Each cell of the terminal tier \( l \) divides by an oblique wall cutting of two cells (Fig. 13). The inner cells by transverse and longitudinal divisions give rise to the plumule while the peripheral cells, two on each side, form the initials of the cotyledons (Figs. 17-22). Hand in hand with these developmental changes in the tier \( l \), cells of \( l' \) divide periclinally to initiate the dermatogen (Figs. 13-16). After completion of dermatogen in \( l \) and \( l' \), the inner cells in these tiers divide in diverse planes in consequence of which the embryonal mass becomes globular (Figs. 17-22); the dermatogen, however, always remains single-layered. The central cells of \( l \) form the plumule, while those of the periphery constituting two groups, on either side of the plumule, form the two cotyledons (Figs. 24, 25).

As a sequel to the aforesaid changes in \( l \) and \( l' \), each of the cells \( m \) and \( ci \) undergoes a transverse division forming \( d, f, n \) and \( n' \) (Fig. 18). The first division of \( d \) is transverse, while the second one is vertical resulting in four cells in two tiers designated as \( iec \) and \( co \) (Figs. 18-20), which contribute to the central cylinder of the root and the root cap respectively (Figs. 19-24). Other derivatives of \( cb \) (viz., \( f, n \) and \( n' \)) constitute filamentous suspensor (Figs. 18-25) which degenerates gradually as the embryo matures (Fig. 26). The development of cotyledonary primordia from the distal region of the globular proembryo results in the heart-shaped stage of the embryo (Figs. 24, 25).

The mature embryo extends from the micropylar part to the chalazal region and is fleshy, curved and dicotyledonous with the discernible shoot apex, root, root cap and vascular supply to the cotyledons (Fig. 26).

Mauritzon (1934) gave a succinct account of the development of embryo in *Capparis frondosa*, *Cleome monophylla*, *Cleome serrata*, *Gynandropsis pentaphylla*, *Polanisia graveolens* and *Polanisia trachysperma* and observed that there has been considerable variance in embryogenesis within the family, despite further course of development of the embryo tracking uniform pattern in these members. Based on the findings of Mauritzon (1934), Johansen (1950) regarded ‘all of these species appear to follow the Alyssum variation, Onagrad Type, very closely’. Raghavan (1937) gave a detailed description of the embryogeny of *Cleome chelidonii*. According to him the hypophysis is derived by a single cell division of the intermediate cell of
Developmental history of the embryo of *Cleome aspera* L.

Zygote

Apical cell

- ca
  - (pcoc + pvt + phy + icc)
  - c

Basal cell

- cb
  - (iec + co + s)
  - m
  - ci

First cell generation

Second cell generation

Third cell generation

Fourth cell generation

Destination

- Central cylinder of the root
- Root cap
- Suspensor

Cotyledonary region
- Stem apex
- Hypocotyl and Root
- Central cylinder of the stem
the four-celled proembryo, a condition intermediate between the Ranunculaceae and the Capsella type. From a critical examination of the illustrations given by Raghavan (p. 59) for the development of embryo in *Cleome chelidonii*, it is obvious that the embryo development can be referable to the Onagrad type only. In this regard it is worthwhile mentioning Johansen's (1950) statement (p. 142): 'A later and more accurate investigation of *Cleome chelidonii*, however, reveals that this species follows the Lythrum variation, Onagrad Type, precisely'. V.S. Rao (1938a) reported 7 or 8-celled proembryos in *Capparis galeata* and inferred that the three terminal cells undergo vertical division resulting in a bunch of cells. He further observed that the cells of the suspensor nearest to the embryonal mass also divide vertically and contribute to the formation of embryonal sphere. Phouphas (1952) expressed that the proembryo of *Gynandropsis pentaphylla* and the disposition of the different tiers are in agreement with those of *Myosurus minimus*. The observations of Billings (1937) that the embryo in *Isomeris arborea* arises from the endosperm nodule has since been confuted by Sachar (1956b) who showed that the embryo is zygotic and its development conforming to the Solanad type. Narayana (1962b) reported that the embryogeny in *Capparis decidua* displays points of resemblance with the Solanad, Onagrad and Caryophyllad types. He (1965) reported the occurrence of Solanad type in *Crataeva nurvula* and Caryophyllad type in *Cadaba indica*. The embryo development in *Cleome tenella* (Hanumantha Rao and Prakasa Rao, 1975) and *Cleome aspera* (present report) follows the Onagrad type of Johansen (1950) and keys out to the Lythrum variation or to the Megarchetype IV, series A of the First Period of Souèges (vide Crété, 1963a). Further, the embryogeny in the two species is in conformity with the account given by Raghavan (1937) for *Cleome chelidonii* except that the suspensor is 4-celled in the species of *Cleome* studied by the authors as against 7-celled condition in *Cleome chelidonii* (Raghavan, 1937) and 3 or 4-celled in *Cleome viscosa* (Tiwary, 1936). Nucellar embryony reported in *Capparis frondosa* (Mauritzon, 1934) and suspensor haustorium in *Polanisia trachysperma* (Mauritzon, 1934) and *Isomeris arborea* (Sachar, 1956) were not recorded in *Cleome tenella* and *Cleome aspera* investigated by the authors.

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**Literature cited**


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フウチョウソウ科の胚形成の情報はまだ貧弱で断片的であり、また色々に異った胚形成の型が報告されている。情報を増すことを目的としてセイヨウフウチョウソウ属の一種 *Cleome aspera* の胚形成を報告する。

受精卵は上下に分裂して ca, cb 細胞を作り、ca 細胞は縦に 2 回分裂して 4 細胞となり、さらにそれぞれの細胞が横に分裂して上下に 4 細胞づつ 2 層 l, l' となる。cb 細胞は横に分裂して m, ci の 2 細胞となる。このような分裂様式は Johansen の
Onagrad type にあたる。m 細胞は横に分裂して d, f 細胞を作り, d 細胞から根の生長点組織と根冠が分化してくる。これは Onagrad type の Lythrum variation にあたる。この観察と今までの報告とを比較した。


この本の一大特色は, 生殖細胞やその発育過程などを光顕, 電顕, さらに走査電顕によりとらえた, 800 以上および膨大な数の写真の, 視覚に訴えた効果的な配列にあるといってよい。紙芝居を見るように楽しく, しかもそれぞれがストーリーを物語るようで, いつしか緑藻の微細の世界に誘い込まれるといった感じである。総章の「系統と細胞構造」には, Marchantia, Sphaerocarpos, Equisetum, Zamia など, 有胚植物の精子形成過程の微細構造写真が認められている。文献は豊富で, 綠藻のこの方面的ものはほとんど収録されているというよい。（千原光雄）

□堀内克明訳：アメリカ俗語辞典 Eugene E. Landy: The Underground Dictionary. 1975 研究社。本書は書名通り米国俗語の和訳辞典であるが, 巻末に多少参考になるものが収録してある。その内に Harrison Act (1914), すなわち Laws relating to the Control of Drugs と, その後の 4 回にわたる修正条項の概略がのである。この法律は麻薬類の取締に関するものであるから, アヘンやその原料植物であるケシや, 近頃よく問題を起こす大麻（アサ）や, それに栽培並に同法に違反した場合の罰則などが規定してあって, 我国の取締に似たものであるけれども, 他国のもものを心得ておくのもあらかじめ無用でもなさそうなので, 紙面を借用することにした。

（久内清孝）

—21—