Proc. Indian Acad. Sci., Vol. 88 B, Part II, Number 3, May 1979, pp. 213–217,
© printed in India.

Lentibulariaceae 11. The development of endosperm and embryo in *Utricularia cornuta* Mixch.

SAEED A SIDDIQUI
Department of Botany, Aligarh Muslim University, Aligarh 202 001

MS received 24 November 1977; revised 26 June 1978

Abstract. The development of endosperm conforms to the Scutellaria type of Schnarf. Variations in the plane of early cell divisions in the development of endosperm have been recorded. The embryogeny usually conforms to the Capsella variation of Onagrad type, sometimes Chenopodiad type and rarely Ruta variation of Onagrad type.

Keywords. *Utricularia cornuta*; endosperm; embryogeny.

1. Introduction

The development of male and female gametophytes of *Utricularia cornuta* Mixch. has been described by Siddiqui (1978c). The other aspects of the life-history of this taxon are now described.

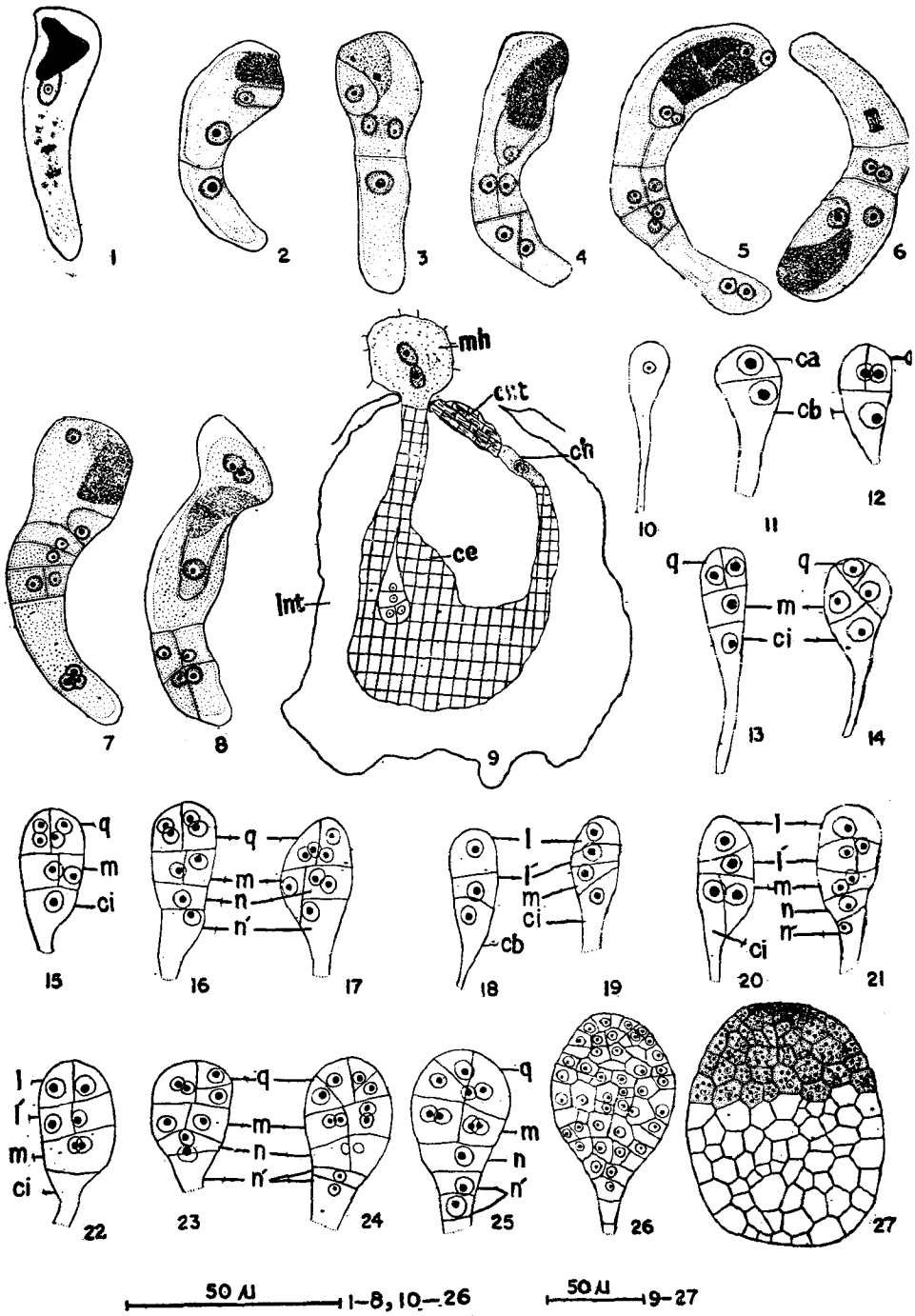
2. Material and methods

The material of *U. cornuta* was kindly sent by Dr Umesh C Banerjee, Department of Biology, Harvard University, Mass., USA. Conventional methods of dehydration and embedding were used. The sections were cut at 8–12 μm and stained with safranin and fast green.

3. Observations

3.1. *The endosperm*

The first division of the primary endosperm nucleus divides the embryo sac into primary micropylar and primary chalazal endosperm chambers (figures 1, 2). The division in both the chambers is longitudinal (figures 3, 4). The division in the micropylar chamber usually precedes that in the chalazal one (figure 3). The vertical wall laid down in the micropylar chamber appears to be incomplete (figure 4). Perhaps the zygote and the remains of the pollen tube obstruct the view of the micropylar end of the cell wall, therefore, the two cells of the micro-



Figures 1–27. (Captions in p. 217)

pylar chamber appear to be incompletely partitioned (figure 4), while the chalazal chamber is completely partitioned into two cells (figure 4). The second division in both the chambers is transverse producing 8-celled endosperm. At this stage the cells are arranged in four tiers of two cells each. The middle two tiers give rise to the endosperm proper, while the micropylar and chalazal tiers differentiate as micropylar and chalazal endosperm haustoria (figure 5). Variations in the plane of early cell divisions in the development of the endosperm have been observed. Rarely, the chalazal endosperm chamber may divide transversely (figure 6). In an abnormal case, the chalazal chamber of an eight-nucleate endosperm stage may be 3-nucleate (figure 7). In another exceptional case it appears that the micropylar chamber has directly differentiated as a 2-nucleate micropylar haustorium, while the chalazal chamber has divided vertically and transversely into four cells (figure 8). The micropylar haustorium is aggressive. It encroaches upon the placental nutritive tissue, which is consumed during the seed development. It remains 2-nucleate throughout. The chalazal haustorium is not very aggressive. The endosperm proper becomes almost U-shaped due to the curvature of the ovule (figure 9).

3.2. *Embryogeny*

The zygote elongates and divides transversely producing *ca* and *cb* (figures 10, 11). The cell, *ca* divides vertically and *cb* transversely to produce a T-shaped proembryonic tetrad (figure 13). The division in *ca* precedes that in *cb* (figure 12). In one exceptional proembryonic tetrad the arrangement of cells is peculiar. The first division in the zygote has taken place obliquely, so that the two cells almost come to lie side by side. Both the cells divide resulting in an almost isobilateral tetrad (figure 14). The two daughter cells of *ca* undergo another vertical division to produce the quadrants (figure 15). Meanwhile the cell, *m* divides vertically, and *ci* transversely producing the cells, *n* and *n'* (figure 16). In one case the cell *m* has been cut off laterally (figure 17). The division in *ci* has been transverse and the cell *n* has divided vertically (figure 17). Further stages of this type of embryo development could not be observed. However, the early developmental stages of the embryo suggest that the embryogeny in the species conforms to the Capsella variation of the Onagrad type.

Sometimes the proembryonic tetrad may be linear, consisting of *l*, *l'*, *m* and *ci* (figures 18, 19). Rarely the cells, *m* and *ci* are lateral in position (figure 20). The division in the tier *l'* precedes that in *l* (figure 21). The tiers *l* and *l'* divide vertically and the quadrant cells are arranged in two tiers of two cells each (figure 22). The cell, *m* divides vertically and *ci* transversely producing *n* and *n'* (figure 21). Thus the early developmental stages reveal that the embryogeny sometimes conforms to Chenopodiad type.

Rarely the T-shaped proembryonic tetrad develops according to the Ruta variation of the Onagrad type. One of the daughter cells of *q* divides vertically while the other transversely (figures 23, 24). The cell, *m* divides twice vertically (figures 23–25). The cell, *ci* undergoes transverse divisions (figures 24, 25). The cell, *n* may divide vertically (figure 24). The young embryo is pear-shaped with uniseriate suspensor (figure 26). The mature embryo rounds off at both ends. The only differentiation in the mature embryo is a group of small cells which consti-

tute the apical growing region. Rest of the cells of the embryo are larger in size (figure 27). Starch grains accumulate in the cells of the mature embryo.

4. Discussion

The development of endosperm conforms to the Scutellaria type of Schnarf (1917) and is in conformity with the described species of the genus. In majority of the investigated species the partition walls laid down at the time of the first division in the primary endosperm chambers are incomplete towards their micropylar and chalazal ends, consequently the cells are not completely partitioned. However in *U. scandens* (Farooq and Bilquis 1966b), *U. coerulea* var. *filicaulis* (Siddiqui 1975) and *U. dichotoma* (Siddiqui 1978b) four completely partitioned cells are formed at the time of second division. *U. cornuta* is peculiar in this respect, where the two chalazal cells are completely partitioned, while the two micropylar cells are incompletely partitioned. A similar condition has been observed in *U. striatula* (Farooq 1966). Rare occurrence of transverse divisions in the early development of endosperm as described here has been reported in *U. flexuosa* (Khan 1954), *U. vulgaris* var. *americana* (Farooq and Siddiqui 1966) and *U. coerulea* var. *filicaulis* (Siddiqui 1975). Differentiation of the entire micropylar endosperm chamber as micropylar haustorium as described in the present material has also been recorded in *U. stellaris* var. *inflexa* (Farooq 1964).

The embryogeny in the genus *Utricularia* is inconsistent. Besides one normal type of embryogeny, sporadic variations which belong to the other principal type may also occur in the same species as described in the present material and in *U. scandens* (Farooq and Bilquis 1966a) and *U. dichotoma* (Siddiqui 1978b).

References

Farooq M 1964 Studies in the Lentibulariaceae 1. The embryology of *U. stellaris* Linn. f. var. *inflexa*. Part II. Microsporangium, male gametophyte, fertilization, endosperm, embryo and seed; *Proc. Natl. Inst. Sci. India* **30** 280–290

Farooq M 1966 Studies in the Lentibulariaceae 4. The embryology of *U. striatula* Sm.; *J. Indian Bot. Soc.* **45** 1–13

Farooq M and Bilquis S 1966a Studies in the Lentibulariaceae 7. The embryogeny in *U. scandens* Benj.; *Beitr. Biol. Pflanz.* **42** 127–131

Farooq M and Bilquis S 1966b Studies in the Lentibulariaceae 8. The life-history of *Utricularia scandens* Benj; *Beitr. Biol. Pflanzen* **42** 363–371

Farooq M and Siddiqui S A 1966 Studies in the Lentibulariaceae 5. The development of endosperm in *U. vulgaris americana* Gray (A reinvestigation); *New Phytol.* **65** 50–53

Khan R 1954 A contribution to the embryology of *Utricularia flexuosa* Vahl.; *Phytomorphology* **4** 80–117

Schnarf K 1917 Beitrage zur Kenntnis der Samenentwicklung der Labiateen; *Denkschr. Akad. wien. math-nat. Kl.* **94** 211–274

Siddiqui S A 1975 Studies in the Lentibulariacae 7. The development of endosperm and embryo in *Utricularia coerulea* var. *filicaulis* Clarke; *Bot. Not.* **128** 432–437

Siddiqui S A 1978a Studies in the Lentibulariaceae 8. The development of gametophytes in *U. dichotoma* Labill.; *Flora* **167** 111–116

Siddiqui S A 1978b Studies in the Lentibulariaceae 9. Pollination, fertilisation, endosperm, embryo and seed in *U. dichotoma* Labill.; *Bot. Jahrb. Syst.* **100** 237–245

Siddiqui S A 1978c Studies in the Lentibulariaceae 10. The development of gametophytes in *U. cornuta* Mixch.; *Plant Sci.* **8** 11–15

Captions

Figures 1–27. *Utricularia cornuta*, endosperm and embryo. 1. Primary endosperm nucleus dividing. 2. 2-celled endosperm. 3. Vertical division in the micropylar chamber. 4. 4-celled endosperm. 5. 8-celled endosperm, micropylar and chalazal endosperm haustoria. 6. 4-celled endosperm, the nucleus in the chalazal chamber is dividing transversely. 7. 8-nucleate endosperm, chalazal chamber three-nucleate. 8. 6-celled endosperm, the micropylar chamber has directly differentiated as 2-nucleate micropylar haustorium. 9. L.s. ovule showing U-shaped endosperm, proembryo. 10–13. T-shaped proembryonic tetrad. 14. 4-celled proembryonic tetrad, cells arranged isobilaterally. 15. 7-celled proembryo, quadrant. 16–17. 8-celled proembryo. 18–19. Linear proembryonic tetrad. 20. 4-celled proembryo. 21. 7-celled proembryo. 22. Proembryo, quadrant. 23. 8-celled proembryo. 24–25. Proembryos 12-celled. 26. L.s. pear-shaped embryo. 27. L.s. mature embryo. (ce, cellular endosperm; ch, chalazal haustorium; mh, micropylar haustorium; int, integument; cnt, chalazal nutritive tissue).