AN EMBRYOLOGICAL STUDY OF *LINUM MYSORENSE* HYENE

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Literature on the embryological studies of the family Linaceæ is restricted to a few members of the genus *Linum*, particularly *L. usitatissimum*, *L. perenne*, *L. Flavum* (Schürhoff, 1924), *L. catharticum* (Souèges, 1924), etc. *L. mysorense* Heyne, which is indigenous to South India, grows in a wild state in marshy regions, specially on hill tops in association with species of *Eriocaulon*, *Lobelia* and others. A comparative account of the developmental stages of the female gametophyte and embryogeny of *L. mysorense* and some of the other species of *Linum* already known is presented in this paper.

Material for the present study was collected partly on the Nandi Hills, Mysore State, and the rest secured through the courtesy of Professor L. S. S. Kumar to whom our grateful thanks are due. For microscopic studies the material was fixed in Allen's modification of Bouin's fluid and formalin-acetic-alcohol. The sections were cut from 12-14 μ in thickness and stained in Heidenhain's iron-hæmotoxylin with eosin in clove oil as counter-stain.

Development of the Female Gametophyte

The ovary is superior and is 10 locular with a single anatropous ovule in each locule. The primordia for the ovule starts as a protuberance from the placenta and simultaneous with this the initials for the two integuments are formed. The initials for the obturator become differentiated early on the funiculus (Fig. 1). In later stages, the obturator composed of a pad of tissue arches over the micropylar end of the ovule. The archesporium is hypodermal and cuts off a parietal and a megaspore mother cell. Cases of occurrence of more than a single archesporium are met with (Fig. 2) but further development is confined to one archesporial cell only. There is a thin layer of nucellus surrounding the megaspore. As the embryo-sac enlarges in size following development, nucellar cells on the sides break down contributing nutrition, with the result the embryo-sac becomes lined with the epidermis of the inner integument. The rich cell contents and the presence of deeply staining nuclei in the epidermal cells point out the fact that the inner integument might well be considered as constituting the integumental tapetum. The megaspore mother cell undergoes the usual divisions (Figs. 3 and 4) and forms a linear tetrad of megaspores. The

division in the lower dyad cell is sometimes belated. The chalazal megaspore is functional and the rest degenerate (Fig. 5). The mature embryo-sac conforms to the monosporic 8-nucleate type.

The egg apparatus organised at the micropylar end consists of a small egg and two synergids which show conspicuous striations characteristic of filiform apparatus (Fig. 8). The antipodals degenerate by the time the egg apparatus is organised. The polars remain without fusion for a very long time (Fig. 7).

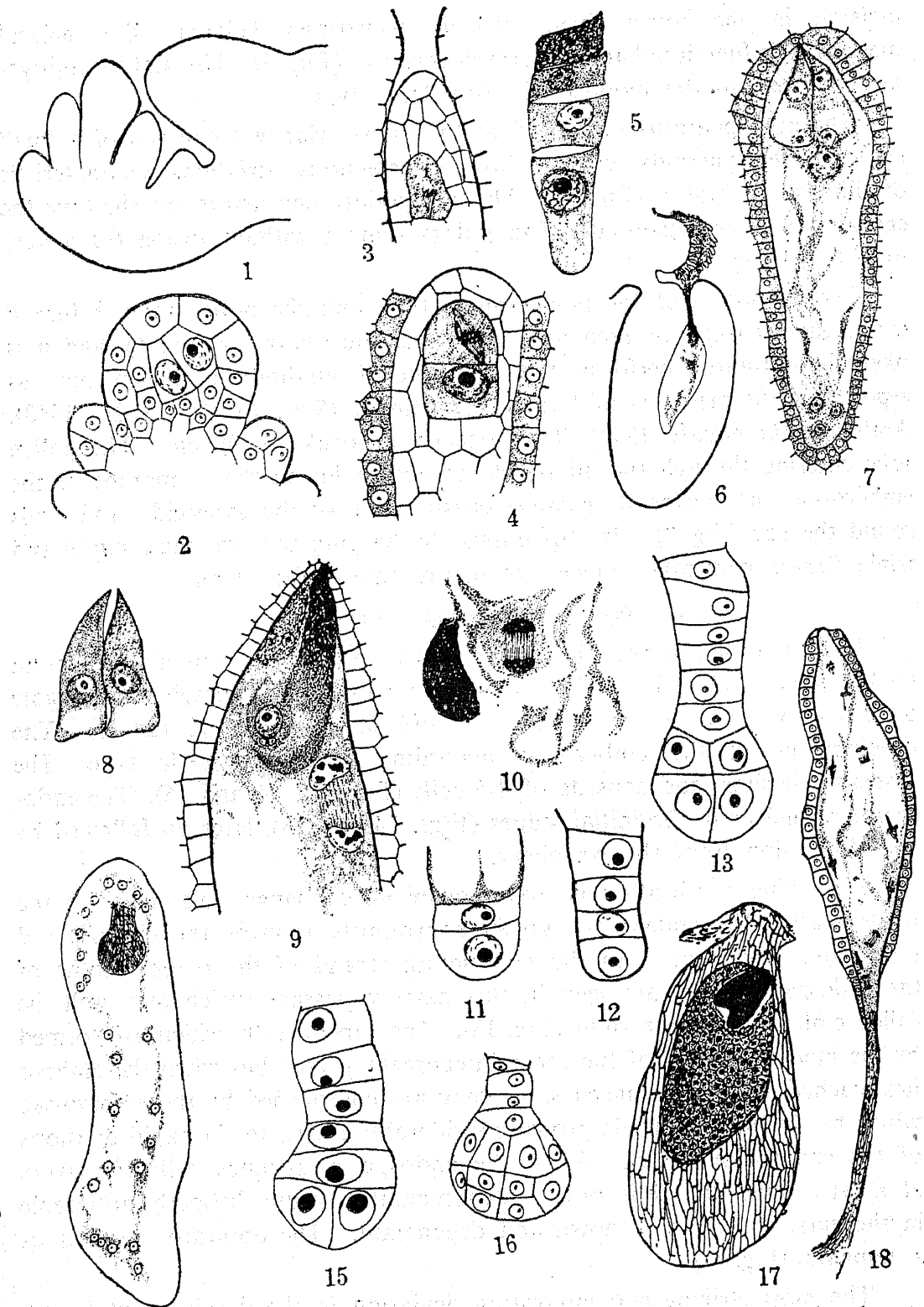
Fertilisation is of the porogamous type and the pollen tube, before it enters the micropyle is seen to grow along the obturator (Fig. 6), and it is likely the obturator performs the function of guiding the pollen tube as reported in the members of Labiatæ (Bushnell, 1936; Murthy, S. N., 1940), Araliaceæ (Gopinath, 1944), Thymeleaceæ (Kausik, 1940), etc. The pollen tube entering through the micropyle comes to lie on the membrane of the embryo-sac and during its passage crushes one of the synergids and coils round the egg (Fig. 9). Its tip bursts discharging the two male nuclei and triple fusion first takes place. Syngamy takes place later.

Post-fertilisation Stages

It is interesting to note that even before syngamy the primary endosperm nucleus divides (Fig. 9). When however fertilisation is complete the zygote divides transversely to form a 2-celled pro-embryo (Figs. 10 and 11). The development of the embryo is according to the capsella type. The suspensor is short and consists of 4-5 cells (Figs. 13, 15 and 16). The endosperm is nuclear in the initial stages (Figs. 14 and 18), later on followed by wall formation from the periphery.

Soon after fertilization is over, conspicuous changes take place in the ovule itself. The embryo-sac grows enormously towards the chalaza and establishes connection with the conducting strand of the ovule. Some of the endosperm nuclei are seen in this narrow passage which may well be called embryo-sac haustorium (Fig. 18). The tapetal cells which are formed by the inner epidermis of the inner integument persist but when the embryo has reached a fairly advanced stage they are encroached by the embryo-sac which has in the meanwhile grown considerably owing to the rapid divisions of the endosperm nuclei. When the endosperm assumes cellular nature at a later stage, the cells of the integumental tapetum distinctly noticeable in the early stages break down and degenerate. The obturator persists as a remnant (Fig. 17).

The most striking and interesting deviation in the developmental morphology of *Linum mysorense* from those of other species so far investigated



FIGS. 1–18.—Fig. 1. Development of the integuments and the initial for the obturator. ×570. Fig. 2. Archesporial cells. ×760. Fig. 3. Megaspore mother cell in metaphase. ×420. Fig. 4. Dyad; upper cell in division. ×760. Fig. 5. Linear tetrad of megaspores; upper

three degenerating. ×570. Fig. 6. Pollen tube growing over the obturator. ×80. Fig. 7. Embryo-sac with the full complement. Antipodals degenerating. ×440. Fig. 8. Synergids showing the filiform apparatus. ×900. Fig. 9. Fertilization of the egg and the first division of the primary endosperm nucleus. ×760. Fig. 10. First division of zygote. ×950. Fig. 11. Two-celled pro-embryo. ×570. Fig. 12. Four-celled pro-embryo. ×570. Figs. 13, 15 and 16. Stages in embryogeny. ×760. Fig. 14. Free nuclear endosperm and the embryo. ×570. Fig. 17. Condition of the ovule at an advanced statge in embryogeny. ×440. Fig. 18. Extension of the chalazal region of the embryo-sac into an haustorium at the post-fertilization stage. ×570.

is in the nature of endosperm formation. Schürhoff reports in the three species of *Linum* he has investigated, *viz., L. usitatissimum, L. perenne* and *L. Flavum* Heleobiales type of endosperm formation. In *L. mysorense* the development of endosperm is characteristically nuclear. The primary endosperm nucleus divides even before syngamy and the resulting two nuclei are not separated by wall formation (Fig. 9). In fact, there is no migration of any of the nuclei towards the chalaza. After the first division of the primary endosperm nucleus, it is followed by quick successive divisions resulting in the formation of free endosperm nuclei.

So far as the other features in the development of the female gametophyte are concerned, *L. mysorense* closely resembles the other species. Thus the type of embryo-sac development in *L. catharticum* (Souèges), *L. usitatissimum* (Schürhoff) and *L. mysorense* is monosporic 8-nucleate. The breaking down of the nucellar cells and the consequent formation of an integumental tapetum termed by Schnarf as "mantle layer" is also seen in *L. mysorense.* Prolongation of the chalazal end of the embryo-sac into an embryo-sac haustorium during post-fertilisation stages is common to both *L. mysorense* and *L. usitatissimum.* There seems to be a very close similarity in the developmental stages of the embryo in *L. catharticum* (Souèges) and *L. mysorense.*

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