

## NOTES.

**A CASE OF REVERSED POLARITY IN THE EMBRYO-SAC.**—A characteristic of the normal embryo-sac in the flowering plants is its marked polarity. The egg-apparatus lies at the micropylar end of the embryo-sac, and the antipodal cells at the chalazal end. Exceptions to this rule, that is, cases of reversed polarity in the embryo-sac, are very rare, and only four cases have been enumerated by Schnarf<sup>1</sup> in his recent book. In 1901, Lotsy<sup>2</sup> described an embryo-sac in *Rhopalocnemis phalloides* (Balanophoraceae), in which an antipodal cell lay at the micropylar end and the egg-apparatus was laterally situated. In 1915, Täckholm<sup>3</sup> observed many irregularities in the construction of the embryo-sac in *Fuchsia Marinka* (Onagraceae), and in one case observed an embryo-sac with the egg-apparatus lying at the chalazal end. In *Lindelofia longiflora* (Boraginaceae), according to Svensson,<sup>4</sup> the egg-apparatus is sometimes widely separated from the micropylar end of the embryo-sac, and in one instance lay in the chalazal region. The antipodals were not observed in this case, and perhaps had disappeared early. The largest number of such abnormal embryo-sacs has been seen by Pace<sup>5</sup> in *Atamosco* (= *Zephyranthes*) *lexana*, though the egg-apparatus in these cases was not situated exactly at the chalazal end. Out of 300 ovaries examined, she found in 56 ovaries 205 embryo-sacs with the antipodals in the micropylar end and the egg-apparatus on one side. Besides these four cases mentioned by Schnarf, only one more probable case of reversed polarity in the embryo-sac has been recorded recently in the sugar-cane by Dutt and Subba Rao.<sup>6</sup> They found an embryo-sac with three nuclei (believed to be the antipodal nuclei) in the micropylar region, and one cell (believed to be the egg, although in the figure illustrating it the vacuole is seen on the side facing the centre of the embryo-sac) and two nuclei (believed to be the polar nuclei) in the chalazal region. Two other cells, the synergidæ, were not seen, and are supposed to have degenerated.

In investigating the morphology of the family Lythraceae, we have found an instance of reversed polarity in the embryo-sac in *Woodfordia floribunda* Salisb. in material collected by us in Kumaon (Himalayas) in October 1933. This was from a single tree flowering at an unusual time, the usual flowering period of the species in this locality being February to April according to Osmaston.<sup>7</sup>

<sup>1</sup> Schnarf, K. : Embryologie der Angiospermen. Berlin, 1929.

<sup>2</sup> Lotsy, P. : *Rhopalocnemis phalloides* Jungh. A Morphological-systematical Study. Ann. jard. Buitenzorg. II ser. ii, 73-101, 1901.

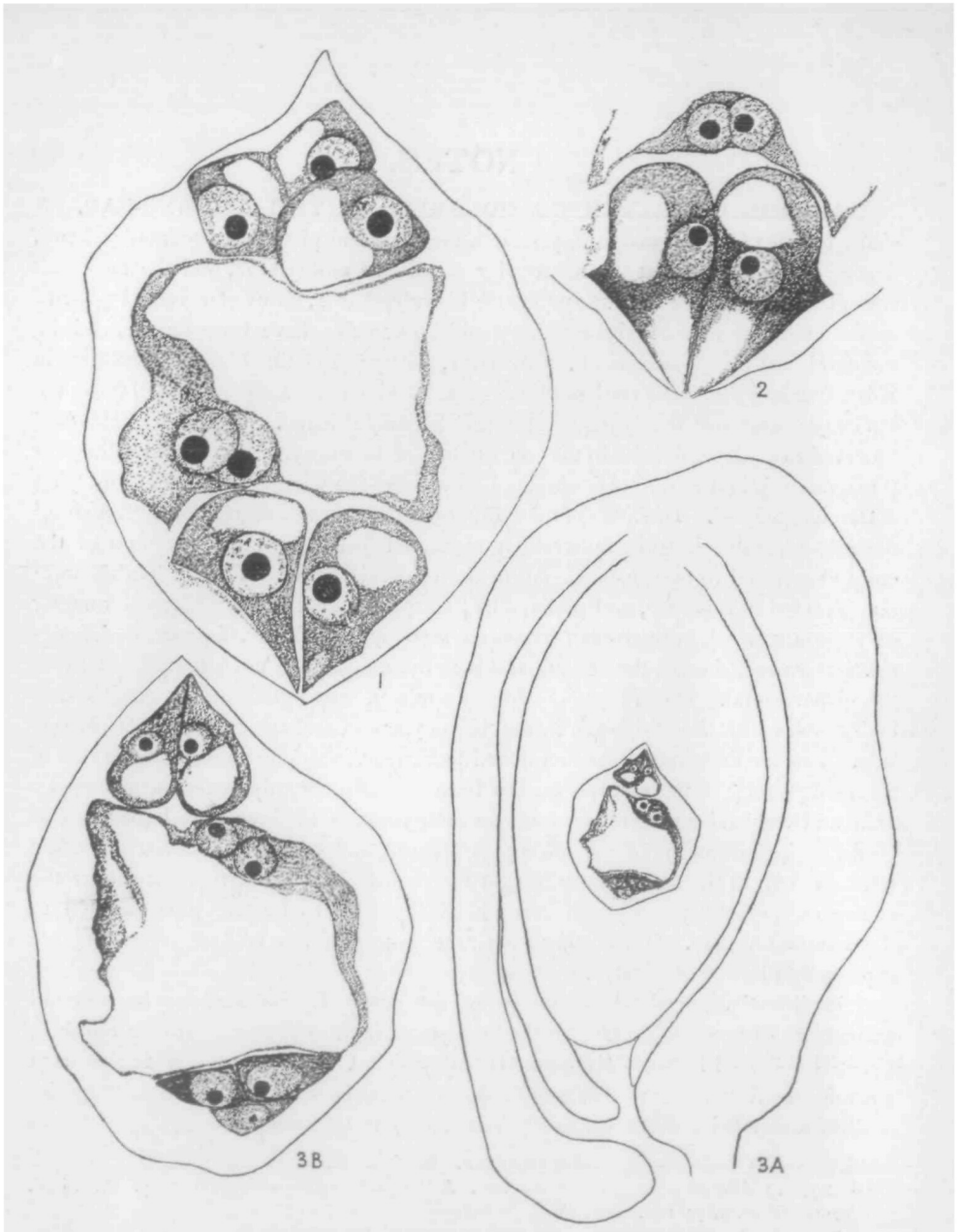
<sup>3</sup> Täckholm, G. : Beobachtungen über die Samenentwicklung einiger Onagraceen. Svensk. bot. Tidskr., ix, 294-361, 1915.

<sup>4</sup> Svensson, H. G. : Zur Embryologie der Hydrophyllaceen, Boraginaceen und Heliotropiaceen. Uppsala Univ. Årsskrift. 2, 1925.

<sup>5</sup> Pace, L. : Apogamy in *Atamosco*. Bot. Gaz., lvi, 376-94, 1913.

<sup>6</sup> Dutt, N. L. and Subba Rao, K. S. : Observations on the cytology of the sugar-cane. Ind. Journ. Agric. Sci., III, 37-56, 1933.

<sup>7</sup> Osmaston, A. E. : A Forest Flora for Kumaon. Allahabad, 1927.



FIGS. 1-3. *Woodfordia floribunda*. Fig. 1, a normal embryo-sac showing two synergids, two polar nuclei, and three antipodals. Fig. 2, a part of the same at a later stage showing two synergids and the two polar nuclei. Fig. 3 *a*, an ovule showing an embryo-sac with reversed polarity. Fig. 3 *b*, an enlarged sketch of the embryo-sac of the same. Figs. 1, 3 *a*, and 3 *b* are reconstructions from two adjacent sections. Figs. 1, 2, and 3 *b*,  $\times 1,575$ ; Fig. 3 *a*,  $\times 520$ .

The ovules of *Woodfordia floribunda* possess a many-celled primary archesporium. One of these cells cuts off a primary wall cell and develops into the megaspore-mother cell. The megaspore-mother cell gives rise to a linear tetrad of four megaspores, the chalazal one of which develops in the normal manner into an eight-nucleate embryo-sac. In form, the embryo-sac is broadly spindle-shaped (Fig. 1) and the egg has the usual form. The synergids while at an early stage develop small indentations towards the outside; these run in an oblique manner, and in different sections of the embryo-sac their distance from the micropylar tips of the synergids is found to vary. In the mature embryo-sac just before fertilization, these indentations on the synergids develop into prominent hooks (Fig. 2). Besides this peculiarity, the apices of the synergids develop prominent vacuoles. The beginning of this is seen in one of the synergids in Fig. 1, and in the fully developed condition these are seen in Fig. 2. The polar nuclei at an early stage in the history of the embryo-sac take up a position just below the egg-apparatus (Figs. 1 and 2), and unite together only about the time of fertilization. The antipodals, as in most other members of the Lythraceae (Tischler,<sup>1</sup>; Mauritzon,<sup>2</sup>), show a tendency to degenerate early. They are, however, always organized into cells, which often develop prominent vacuoles (Fig. 1). The mature embryo-sac, a part of which is shown in Fig. 2, is always without antipodals. The central cells of the nucellus in the chalazal half are elongated, different from the rest, and connect the chalazal end of the embryo-sac with the vascular supply of the ovule ending in the chalaza. The development of the embryo agrees with that of *Lythrum Salicaria* described by Souèges.<sup>3</sup>

The ovule with a reversed polarity in the embryo-sac is shown in Fig. 3a. In Fig. 3b the embryo-sac of the same is shown on a larger scale. It agrees in all essential respects with the normal embryo-sac, except that the antipodals are situated at the micropylar pole, and the egg-apparatus and the polar nuclei at the chalazal pole. The form of the embryo-sac is slightly different, in that the micropylar end is not pointed. The antipodals have not developed vacuoles. The synergids have reached a stage corresponding to that shown in Fig. 1. Small indentations have developed on them, but vacuoles have not yet appeared in their apices.

This is the first clear case of reversed polarity observed in an eight-nucleate embryo-sac. In *Rhopalocnemis* and *Atamosco*, the egg-apparatus was only laterally displaced, and was not situated in the chalazal end of the embryo-sac. In *Lindelfia longiflora*, Svensson did not observe the antipodals. In the sugar-cane also, all the parts of the embryo-sac are not clearly described. *Fuchsia Marinka* possesses only a four-nucleate embryo-sac.

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<sup>1</sup> Tischler, G.: Über die Entwicklung und phylogenetische Bedeutung des Embryosackes von *Lythrum Salicaria*. Ber. d. deutsch. bot. Ges., xxxv. 233-45, 1917.

<sup>2</sup> Mauritzon, J.: Zur Embryologie einiger Lythraceen. Meddelanden från Göteborgs Botaniska Trädgård, ix. 1-21, 1934.

<sup>3</sup> Souèges, R.: Embryogénie des Lythracées. Développement de l'embryon chez le *Lythrum Salicaria*. Compt. Rend. ac. Paris, clxxx. 949-50, 1925.