STUDIES IN THE FAMILY ALISMACEÆ.

III. Sagittaria guayanensis¹ H.B.K. and S. latifolia Willd.

BY B. M. JOHRI,
Department of Botany, Agra College, Agra.

Received May 17, 1935.
(Communicated by Dr. P. Maheshwari, D.Sc.)

Introduction.

A review of the work on the family Alismaceæ has already been given in the first paper of the series (Johri, 1935). Of the genus Sagittaria, three species have so far been investigated. The earliest work is that of Schaffner (1897) on S. variabilis, who found an eight-nucleate embryo sac with three antipodal cells. Cook (1907) also reported an eight-nucleate embryo sac with ephemeral antipodal cells in S. lancifolia. The fullest and the most recent account is that of Dahlgren (1934) on S. sagittifolia. This has a megaspore mother cell which undergoes the heterotypic division and produces two cells, of which the upper degenerates and the nucleus of the lower undergoes two divisions to produce a four-nucleate embryo sac. The two micropylar nuclei divide once again but the chalazal nuclei remain undivided, so that the mature embryo sac is six-nucleate. These findings agree with Dahlgren's earlier report on a few other members of the Alismaceæ (Dahlgren, 1928). I have also made some observations myself on S. sagittifolia (Johri, 1935), calling attention to the occasional occurrence of seven- and eight-nucleate embryo sacs in this plant.

Material and Methods.

The material of S. guayanensis was collected at Bharatpur in November 1933. Formalin-acetic-alcohol, Allen's modification of Bouin's fluid and Nawaschin's fluid were used for fixation. Of these, the last gave the best results. Flowers of S. latifolia were fixed in Nawaschin's fluid and very kindly sent by Dr. Norma E. Pfeiffer of The Boyce Thompson Institute, Yonkers, New York, in January 1934. The usual methods of infiltration and embedding were followed. Sections were cut 4–25 microns thick. The

¹ A preliminary report of the work on S. guayanensis has already been published (Johri, 1934).
² This was really S. latifolia and will be referred to as such in the course of the paper. See Schaffner's later paper (1908), where the mistake is acknowledged.
slides were stained with Haidenhain's iron-alum haematoxylin and differentiated in a saturated aqueous solution of picric acid. A very dilute solution of fast green in alcohol was sometimes used as a counter-stain. A combination of crystal violet and erythrosin was also used with satisfactory results.

**Sagittaria guayanensis.**

*Microsporogenesis.*—The young anther is oval and consists of a mass of meristematic cells. Later it becomes four-lobed, and simultaneously with the appearance of these lobes there appears in each corner a group of hypodermal archesporial cells which are distinguishable from the other cells by their large nuclei and dense contents. The peripheral cells by periclinal divisions cut off a primary parietal layer which divides to form two layers. Of these the one adjacent to the epidermis is the endothecium, while the inner divides again producing the middle layer and the tapetum (Fig. 1). The endothecium develops the usual fibrous thickenings when the anther is mature. The middle layer degenerates early and practically disappears by the time the reduction divisions are over. The microspore mother cells stay for a long time in the synizesis stage and round up soon after. The walls swell and become mucilaginous. There are two successive divisions and the arrangement of the microspores is isobilateral (Fig. 2).

*Tapetum.*—As in *Limnophyton* (Johri, 1935), the tapetal cells always remain uni-nucleate. During the time the mother cells are undergoing reduction, their walls become indistinct and the nuclei enlarge and stain deeply. As soon as the microspores separate, the tapetal protoplasts become amöeboid and project into the anther lobe, their deeply staining nuclei soon following. A little later the microspores are seen embedded in a mass of periplasmodium with the tapetal nuclei scattered here and there (Fig. 3). A certain amount of fusion of the protoplasts of individual tapetal cells may sometimes occur even before their migration in between the microspores. The periplasmodium is completely used up during the growth of the pollen grains.

Tischler (1915) and Clausen (1927) have made similar observations in several members of the Helobiales. The last author has described four types of amöeboid tapetum in monocotyledons:—

(i) **The Sagittaria-type.**—The tapetal cells lose their walls by the time the tetrads are formed and their protoplasts begin to project inwards as soon as the microspores have separated. Later the periplasmodium becomes continuous. **Examples:** *S. sagittifolia, S. montevidensis, Alisma plantago, Limnocharis humboldti* and *Hydrocharis morsus rana.* The same type is seen in *Limnophyton obtusifolium* (Johri, 1935) and *S. guayanensis.*