THE EMBRYO-SAC AND EMBRYO OF *GEISSOLOMA MARGINATA*.

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[Plate VI.]

GEISSOLOMA MARGINATA is a small shrub, of an ericoid habit, confined to the South-West region of South Africa, and of very rare occurrence within that region. Material for the present investigation was obtained from a small patch growing on Garcia's Pass in the Langeberge Mountains, in the south of Cape Colony, during a vacation botanical expedition from the South African College, Cape Town,

The systematic position of this plant has been disputed, but it is usually regarded either as an anomalous genus of the Penæaceæ[1] or as the sole representative of a separate order—the Geissolomaceæ[2] or Geissolomataceæ[3]. The present investigation was undertaken to see whether the structure of its embryo-sac resembled in any way that found in the former order.

A single sporogenous cell is differentiated in the young ovule, but as no satisfactory preparations of the stages in its division have been obtained, it cannot be said whether or not the usual row of megaspores is formed. There is, however, strong presumptive evidence that it does occur. Thus, in Fig. 1, which shows the youngest stage of the embryo-sac seen, the developing megaspore is crowned by a deeply-staining mass which probably represents the remains of the megaspore row, and a similar appearance has been seen in several other preparations at the same stage. Moreover, the appearance of the first four nuclei formed in the embryo sac (Figs. 1—3), suggests that they are the results of ordinary nuclear divisions, and not of meiosis.

The eight-nucleate is reached in the usual manner (Figs. 1—4). As soon as the eight nuclei are formed they begin to show differences in size and staining properties, and this differentiation rapidly becomes very marked. The upper polar nucleus at once

[1] Bentham and Hooker. Genera Plantarum III. London, 1880. p. 203.

[2] Sonder, W. Beiträge zur Flora von Sudafrica. Linnæa, XXIII. (Halle, 1850), p. 105.

De Candolle. Prodromus XIV. Paris, 1856, p. 491.

[3] Engler. Syllabus der Pflanzenfamilien. Berlin, 1909, p. 177.

moves to the lower end of the sac to fuse with the lower one (Figs. 4 and 5); in several cases the nuclei were found to have completely fused before fertilisation (Fig. 8). The three antipodal nuclei decrease in size and quickly lose their staining properties. Ill-defined cells are formed around them (Fig. 5), completely filling the narrow lower end of the embryo-sac, and whilst the rest of the sac grows rapidly, this end remains small. It consequently can be recognised, at a slightly later stage, only as a small pocket at the antipodal end of the sac; while as the sac increases still more in size, at the expense of the antipodal nucellar tissue, it disappears along with this tissue (Fig. 6A). Even before this happens, the nuclei have degenerated, so that they are rarely recognisable at later stages than that of Fig. 5. The antipodal cells thus apparently take no part in the activities of the embryo-sac. The egg-apparatus is of the usual type. The nuclei of the synergids, with the surrounding protoplasm, take up stains very deeply, each synergid thus usually forming a deeply-staining mass with a small clear apical portion (Figs. 5, 6A).

The nucellus is composed of a central strand of elongated cells surrounded by starch-filled parenchyma. The embryo-sac, elongating laterally downwards, digests this parenchyma, and simultaneously large grains of starch begin to appear in the protoplasmic layer lining the sac (Figs. 5, 6A). These grains again begin to disappear as the embryo-sac attains its maximum development before fertilisation and the starch-bearing tissue becomes used up (Fig. 7).

A copious endosperm is formed after fertilisation, filling up the embryo-sac. It is only partly resorbed by the developing embryo, which lies in a sap-containing cavity closely surrounded by it (Figs. 9—11).

As in the Penæaceæ, there is no suspensor. The pro-embryo is at first pear-shaped (Fig. 9), but later becomes spherical (Fig. 10), the whole of it entering into the composition of the embryo. The cotyledons, which are long and linear, become differentiated at a much earlier stage (Fig. 11), and are much better developed than is the case in the Penæaceæ.

The chief point of interest in connection with the embryology of this plant lies in a comparison with the closely allied Penæaceæ, there having been some discussion[1] as to whether the peculiar type

[1] *see* Stephens, E. L. The Embryo-Sac and Embryo of certain Penæaceæ. Ann. Bot., 1909, XXIII., p. 363—378.

of embryo-sac found in that order can be considered as more primitive than the normal Angiospermous type, or as derived from it. In the Penæaceæ, both the structure of the embryo, apparently highly adapted to xerophytic conditions,[1] and the comparatively feeble development of the endosperm, probably point to a higher degree of specialisation than is the case in *Geissoloma*. The embryo-sac of the Penæaceæ then might be expected to show a correspondingly higher degree of development. As the embryo-sac of *Geissoloma* is, if anything, rather specialised from the normal type (as is shown by the marked differentiation in the egg-apparatus, and the evanescence of the antipodals), it may be inferred that the Penæaceæ probably show a still further specialisation. Thus the evidence derived from the study of this form supports the conclusion that in the embryo-sac of the Penæaceæ we have, not a relatively primitive type, but rather one which is derived from the normal by the inclusion of four megaspores in its development.

SUMMARY.

Geissoloma marginata is the only representative of the order Geissolomaceæ, which is closely allied to Penæaceæ. The embryo-sac is probably derived from one of a row of megaspores. Its development is that of a typical Angiosperm, but the antipodal cells are very evanescent. It contains much starch. The pro-embryo is at first pear-shaped, later spherical, with no suspensor. The embryo lies in a copious endosperm.

The fact that this close ally of the Penæaceæ has a normal embryo-sac tends to uphold the view that *Geissoloma* is to be regarded as a representative of a separate order rather than as an anomalous genus of the Penæaceæ.

This investigation has been carried out in the Cambridge Botany School, by kind permission of Professor Seward.

[1] Stephens, E. L. *loc. cit.*, p. 369.

EXPLANATION OF PLATE

ILLUSTRATING MISS STEPHENS' PAPER ON THE EMBRYO-SAC AND EMBRYO OF *GEISSOLOMA MARGINATA*.

Fig. 1. Binucleate embryo-sac; the disintegrating mass above may represent the remains of the other megaspores. × 430.

Fig. 2. Three nucleate embryo-sac. × 430.

Fig. 3. Four nucleate embryo-sac. × 430.

Fig. 4. Eight nucleate embryo-sac. × 430.

Fig. 5. Later stage; the sac has begun to broaden near the base and starch has appeared in it. × 430.

Fig. 6. Longitudinal section through an ovule at a stage later than Fig. 5, showing the growing embryo-sac. × 66.

Fig. 6A. Embryo-sac of Fig. 6. × 430.

Fig. 7. Mature embryo-sac, showing axial cone of nucellar cells projecting into the base; much of the starch has disappeared. × 172.

Fig. 7A. Polar nuclei of Fig. 7. × 860.

Fig. 8. Base of another mature embryo sac, showing definitive nucleus. × 430.

Fig. 9. Young embryo. × 280.

Fig. 10. Later stage; the embryo-lies in a sap-containing cavity surrounded by endosperm × 280.

Fig. 11. Longitudinal section through ovule at a later stage than Fig. 10, showing endosperm, and embryo with developing cotyledons, × 15.

NOTES ON *POLYPORUS SQUAMOSUS*, HUDS.

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[Text-Fig. 44.]

THE following notes were made last summer in regard to some sporophores of *Polyporus squamosus* which developed under conditions particularly favourable for observation. In regard to the liberation of spores, these remarks are confirmatory of Buller's extensive work[1] (reviewed in the present issue) on this portion of the general biology of certain groups of the Hymenomycetes.

A cylindrical block of *Acer Negundo* about a foot in diameter had been brought into a room during the early part of May for the use of the Department of Forestry at Cambridge. On May 18th two groups of fungus fructifications which evidently belonged to *Polyporus squamosus* were seen to be arising from the bark. When enquiries were made at the Botanic Gardens whence the block had come I learnt that the specimen had been cut from a tree which had been attacked *in situ* by this fungus. One group of fructifications consisted of a bulbous base from which three stalked sporophores of different sizes arose, the other comprised a similarly swollen base and a single rudimentary pileus. During the three weeks that the fructifications were kept under observation the

[1] Buller, A. H. R. "Researches on Fungi," Longman & Co., 1909.