THE GAMETOPHYTE OF *ALEURITOPTERIS GRISEA* (BLANFORD) COMB. NOV.

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INTRODUCTION

The genus *Aleuritopteris* was originally founded by Fée (1852) on the type species, *Pteris farinosa* Forsk. Kaulfuss (1824) considered *Aleuritopteris* synonymous with *Cheilanthes* Sw. and published the new combination, *C. farinosa* (Forsk.) Kaulf. Blanford (1886), however, recognised *C. farinosa* as a species complex and published *C. grisea* Blanford from Simla as a species distinct from *C. farinosa* (Forsk.) Fée sensu stricto. Ching (1941) and Copeland (1947) have, on the other hand, maintained that *A. farinosa* (Forsk.) Fée be re-established on the authority of the 'Type method'. Ching (l.c.) treats *C. grisea* as a variety of *A. farinosa* (Forsk.) Fée. Available evidences, both morphological and cytological (Manton and Panigrahi, unpublished), shall be utilised to show that *A. farinosa* (Forsk.) Fée complex comprises at least three taxonomic species of which *A. grisea* (Blanford) comb. nov. is one. The present investigation which deals with the haploid gametophyte of *A. grisea* was incidental to the studies in cytotaxonomy of *A. farinosa* (Forsk.) Fée complex under the supervision of Professor I. Manton of Leeds (cf. Manton and Sledge, 1954), to whom I am indeed grateful.

MATERIAL AND METHODS

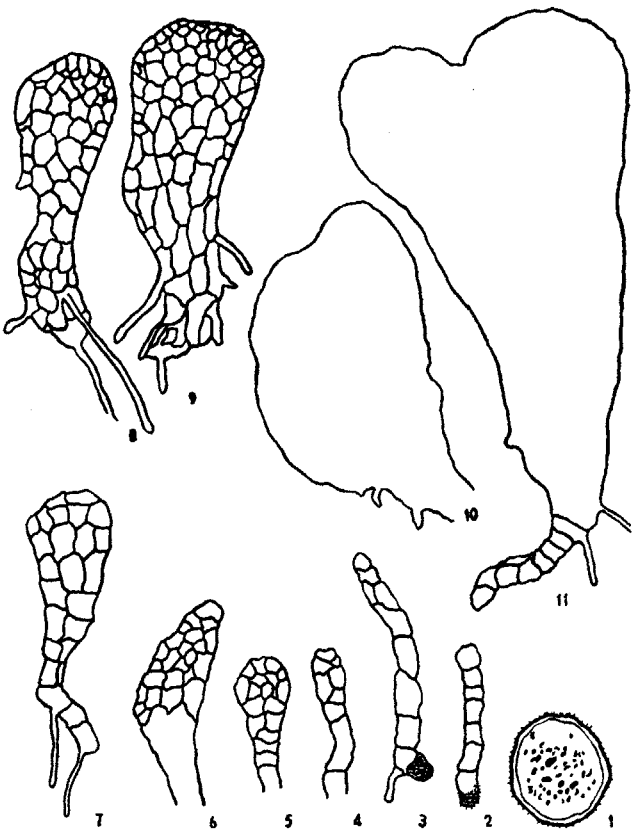
Spores of *A. grisea* were collected from plants which came from Ceylon and were kept in cultivation in one of the tropical fern houses in the Royal Botanical Garden, Kew.

Spores were sown in pots (2″) containing a sterilised soil mixture made up of peat: loam: and silver sand in proportions of 3 : 2 : 1 and was sterilised in a steam steriliser at 180°F. for 20 minutes. The mixture was cooled immediately by spreading it out and was left for at least three days before using it in porous earthern-ware pots for sowing. The spores sown, the pot was soaked with water from below by standing it in a tray of water.

The account is based mostly on the study of fresh material, but for sex organs sections were cut from prothalli embedded in paraffin after fixation with half-strength Chromo-acetic-formalin (cf. Manton, 1950). Sections were cut at 10μ and stained with Haidenhain's haematoxylin counterstained with Bismark Brown.

OBSERVATIONS

The spores of *A. grisea* are spherical, more or less smooth, brown with a thin exospore and average 45μ in diameter (Fig. 1). Germination begins in 3-4 weeks time with the cracking of the exospore when a papilla emerges, which soon cuts off a filament of 6–8 cells (Figs. 2-3). The first rhizoid is formed from the basal cell of the filament (Fig. 3). The apical cell, at this stage, enlarges and cuts off cells by oblique cell walls (Figs. 4-5). In some cases division may initiate in cells one or two removed from the apical cells (Fig. 3), which, in its turn, develops a papillate



TEXT-FIG. 1.

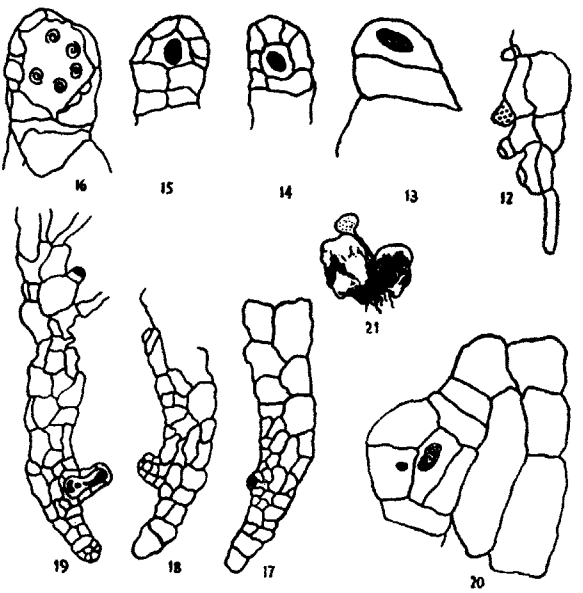
FIGS. 1–11. Fig. 1. Spore. × 350. Figs. 2-3. Early stages of the filamentous thallus with a basal rhizoid; Figs. 4-5. Young plate stage; Figs. 6–10. Asymmetrical development of the prothallus, with apical cell of the filament pushed to a lateral position; Fig. 11. Cordate shaped prothallus, 5 months old with a filamentous base. Figs. 2–11 × 87.

outgrowth (Fig. 6). Pronounced meristematic activity posterior to the apical cell results in asymmetrical development of the cell plate pushing the papillate apical cell to a lateral position (Fig. 8). The broadening of the filament into a plate is brought about by division of the cells from the apex. But the basal cells do not divide, so that even in large prothalli one can see a filamentous base (Fig. 11) except in old prothalli where only the basal cell remains undivided.

Cells in the plate towards the base and centre are much larger than the peripheral cells (Fig. 9), some of which at the central region differentiate into an apical meristem and cut off cells laterally resulting in a deep notch along the longitudinal axis of the plate (Fig. 10). Gradually, a cordate shaped symmetrical prothallus is formed with well developed wings of only one layer of cells (Fig. 11). The prothallus consists of 4-5 layers of cells at the sexually mature stage (Figs. 17–19), although a thick midrib is differentiated in very old prothalli prevented from fertilisation. The margin and surface of the prothallus is devoid of any emergence, such as hairs, setae or glands (Figs. 2–11 and 19).

The young rhizoids are colourless, but older ones are brownish. The basal cell of the filament bears only one rhizoid (Figs. 7-8), but these soon develop from the marginal cells of the gametophyte, particularly from its basal region (Figs. 8, 9 and

11). In very old prothalli, copious rhizoids, woolly in appearance develop from the midrib, sometimes on both the surfaces (Fig. 21).



TEXT-FIG. 2.

FIGS. 12–16. Antheridia median section. Figs. 12–15. Early stages. Fig. 16. Mature antheridium with spirally coiled antherizoids. ×87. Figs. 17-18. Archegonium, stages in development. ×87. Fig. 19. Mature archegonium. ×90. Fig. 20. A magnified view of the developing archegonium. ×350. Fig. 21. An old prothallus, woolly in appearance, with a young sporeling whose surfaces are covered with palish yellow ceraceous covering, one year old. ×2.

ANTHERIDIUM

Antheridia first appear in prothalli, 3-4 weeks old and are never very abundant even on adult prothalli. There is usually zonation in the development of sex organs and the formation of antheridia is checked when archegonia are formed near the notch. But in prothalli, a year old, antheridial formation again takes place not only on the ventral surface but on the dorsal surface as well.

The antheridium initial arises as a protuberance from the superficial cell (Fig. 12) and is soon cut off by a transverse wall into a basal cell and an antheridial initial proper. The basal cell may divide again transversely to form the stalk of the antheridium (Figs. 13–15). The antheridium initial proper divides into an outer wall cell and an inner dome-shaped cell. The outer cell divides anticlinally into a layer of 5–8 cells (Figs. 14–16), of which one is cap cell. These constitute the antheridial wall. The inner dome-shaped cell divides several times mitotically to produce androcytes which transform into the ciliated antherozoids (Fig. 16). The antherozoids, when liberated by the dehiscence of the antheridium in contact with water, can be seen actively swimming about, under the microscope. These retain their motility up to half an hour after which these become inactive. The antherozoids, when fixed and stained, appear as coiled bands inside the antheridia (Fig. 16). The antheridia are globular or very slightly elongated.

ARCHEGONIUM

The archegonium develops from one of the superficial cells on the ventral side, usually 4–8 cells removed from the apical growing cell (Fig. 17). It divides

transversely into an outer primary neck cell and a larger inner cell (Fig. 20). The former as usual divides successively into 4 surface cells, from which differentiate the neck of 4 rows of cells, with 4-5 cells per row. The inner cell divides transversely into a ventral cell and a neck canal cell (Fig. 19). The nucleus of the latter divides again to form a binucleate neck canal cell. The ventral cell divides into a large egg and a small ventral canal cell (Fig. 19), both of which are surrounded by the cells of the venter formed from the surrounding prothallial cells. Thus, a fully developed archegonium is formed. Later, the ventral canal cell disorganise and are exuded out of the archegonium through the opening between the cover cells, thus establishing an open canal for the entrance of the ciliated antherozoids.

The first juvenile frond of the sporeling is produced in 3-4 weeks from the date of fertilisation of the egg. The sporeling develops greyish yellow ceraceous covering on both the surfaces of the frond and the stipe, which retards the rate of transpiration (Fig. 21).

Discussion

Stokey (1951) has shown that the contribution of the gametophyte is of taxonomic significance and may be utilised for the classification of homosporous ferns. We have seen earlier that there has been serious disagreements not only over the definition of the specific boundaries between *grisea* (Blanford) and *farinosa* (Forsk.), but also at the generic level, as to whether these species be referred to *Cheilanthes* Sw. or *Aleuritopteris* Fée. Copeland (1947) separates a group of 15 species from *Cheilanthes* Sw. and includes them in *Aleuritopteris* Fée on the basis of the shape of frond, ceraceous covering of the lamina and number of sporangia per sorus. These are all characters of the sporophyte. The naked gametophyte with a lateral meristem and asymmetrical development of the prothallus in the early stages becomes cordate shaped and prostrate in adult condition in *A. grisea*. These characters are shared more or less by the gametophytes of some of the other genera of the Gymnogrammoideae of Christensen (1938), (cf. Stokey, 1951 for reference).

Considering the role of the gametophyte in elucidating taxonomic problems, the present account of *A. grisea* is of significance. It is very much desired that study of the gametophyte of some related species of *Cheilanthes* Sw. be undertaken for purposes of comparison.

Summary

A method for the culture of fern prothalli in an extensive scale is described. The gametophyte of *Aleuritopteris grisea* (Blanford) comb. nov. is naked without any setae, hairs, or glands and differentiates a lateral meristem which produces a somewhat asymmetrical prothallus at early stages, but the adult prothallus is cordate shaped and dorsiventral. The ontogeny of the sex organs has been outlined with more important details.

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