Light- and Electron-Microscopic Studies of Growth and Reproduction in *Cutleria* (Phaeophyta)

I. Gametogenesis in the Female Plant of *C. hancockii*

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Summary

Differentiation of the female gametangium in *Cutleria hancockii* Dawson is described. Four series of mitoses result in a 16-locule structure (four tiers of four cells each). The organelles in each locule become polarized after partitioning is complete, with the mitochondria lying near the longitudinal axis of the gametangium. The nucleus and plastids are centrally located, with abundant osmiophilic material present in the cytoplasm subjacent to the gametangial surface. Both electron density and Toluidine Blue O staining of the material increase. Two flagella are then produced: one becomes tightly appressed to the plasmalemma near its base, and the other is free. A prominent eyespot forms in the plastid nearest the developing flagella. Golgi and endoplasmic reticulum vesicles are prolific in this region and seem to be involved with mastigoneme production and deposition on the free flagellum. Immediately beneath the plasmalemma, flagellar rootlet tubules emanate from amorphous masses near the basal bodies. Some of these tubules are associated with the eyespot. Most of the osmiophilic material is then secreted into the extracytoplasmic spaces while the gametes are rounding up. Granular-cored vesicles may be involved with pore formation and gamete release.

1. Introduction

The order *Cutleriales* (Phaeophyta) has been of interest to phycologists for well over a century. The type genus, *Cutleria*, is characterized by having a trichothallic meristem (*i.e.*, cell divisions are at the base of the marginal rows of hairs), marked anisogamy and a putative alternation of heteromorphic generations (Fritsch 1952). Since the cytological and culture studies of the early part of the century, little additional work has been published on the group (see Fritsch 1952, for review). Most of these early investigations involved either *C. adpersa* or *C. multifida*. More recently, Müller (1974) has isolated a sex attractant from the female gametes of the latter species and Caram (1975, 1977 a, b) has done ultrastructural and culture work with
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C. adspersa. Also, Niklas (1977) applied finite element analysis to the morphology and growth of Cutleria. However, no investigations have been made with C. hancockii since Dawson (1944) first described the plant.

Detailed ultrastructural study of gametogenesis in the brown algae has been limited to the filamentous alga, Pilayella (= Pylaiella) littoralis (Markey and Wilce 1975, 1976 a). Some stages of gamete formation were reported in Macrocystis (Gherardini and North 1972), Zonaria (Liddle and Neushul 1969), Fucus and Ascophyllum (Bouck 1969). Sporogenesis has been studied in several brown algae including Chorda (Toth 1974), Ectocarpus (Baker and Evans 1973 a, b, Lofthouse and Capon 1975), Macrocystis (Chi and Neushul 1972, Gherardini and North 1972), Pilayella (Loiseaux 1973, Markey and Wilce 1976 b), Zonaria (Liddle and Neushul 1969), Elachista and Hecatonema (Loiseaux 1973). Caram (1975, 1977 b) reported the fine structure of some stages of male and female gametogenesis in Cutleria adspersa, and both Hori (1972) and Evans (1966) included Cutleria in their ultrastructural surveys of phaeophycean pyrenoids.

The genus Cutleria occupies a unique position among the brown algae. Members possess a basically filamentous construction initially with intercalary growth, which is characteristic of the least advanced orders. However, these filaments coalesce and longitudinal divisions produce a truly parenchymatous thallus. This feature coupled with their having anisogamous reproduction and a general alternation of morphologically dissimilar generations, allies the group with the more advanced orders (Fritsch 1952). Aside from these intriguing phylogenetic relationships, the trichothallic meristem is very poorly understood in general. Therefore, a comparative ultrastructural examination of growth, reproduction and mitosis was undertaken with Cutleria. This first paper is concerned with differentiation of the female gametangium and gametes in C. hancockii.

2. Materials and Methods

Female plant material collected from Puerto Peñasco (Sonora), Mexico (March 4, 1977), was fixed in the field (for 90 minutes at room temperature) with 2% glutaraldehyde and 1% paraformaldehyde in 0.15 M sodium cacodylate buffer. After rinsing briefly in a buffer series with decreasing salt concentrations, the tissue was postfixed overnight at 0 °C in 2% OsO₄ in the same buffer. Thorough rinsing in the cold buffer was followed by stepwise dehydration with acetone (in 10% increments), and slow infiltration and embedding with Mollenhauer's epon-aranlde mixture #1 (Dawe 1971). Ultramicrotomy and staining techniques were identical to those previously described (La Claire and West 1977). Thick (0.5 μm) sections were stained with Toluidine Blue 0 for light microscopy.

3. Results

3.1. Light Microscopy

Concentric bands of gametangial sori (Fig. 1) are present on both surfaces of the blade-like thallus. Each sorus is composed of fertile filaments and