Cell Division in the Marine Slime Mold, *Labyrinthula* sp., and the Role of the Bothrosome in Extracellular Membrane Production

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With 25 Figures

Received November 22, 1971

Summary

Electron microscopic observations of vegetative cell division in *Labyrinthula* indicate that the specialized invaginations of the cell surface called bothrosomes arise *de novo* between newly divided daughter cells and function in the production of the membrane-bound extracellular matrix or slimeways. Protocentrioles are formed before each division and persist through cell separation but are not found in interphase cells. Cytokinesis begins after the completion of mitosis and occurs by vesicle accumulation and fusion, an unusual cytokinetic mechanism reminiscent of zoospore cleavage. Cell elongation after cytokinesis is accompanied by elongation of the Golgi apparatus and the appearance of non-spindle microtubules.

1. Introduction

The genus *Labyrinthula*, placed in the slime molds out of convenience rather than by a true phylogenetic affinity with the Mycetozoa (Bonner 1967, Pokorny 1967, Osler 1970), is a group of predominantly marine organisms which, based on frequency of observation, constitute important members of the marine littoral community (Porter 1967). They are characterized by having a primitive colonial organization of small fusiform cells all capable of gliding movement in a continuous filamentous network, the “slimeways” (Watson 1957). Several previous ultrastructural studies (Hohl 1966, Porter 1969, Stey 1969) have demonstrated that the vegetative cells of the colony are completely enclosed by a predominantly electron lucent network which has been described as extracellular (Valkanov 1929, Holland and Enjumet 1955, Hohl 1966, Porter 1969, Bartsch 1971) or ectoplasmic (Zopf 1892, Jepps 1931, Schmoller 1960, Stey 1969). The network itself is bounded by membranes both externally and adjacent to the cell membrane. The cells are thus separated from the matrix of the network by a double mem-
brane complex composed of the cell membrane and the inner membrane of the network. This membrane complex is interrupted only at specialized invaginations of the cell surface, which have been previously described (Stey 1968, 1969, Porter 1969, Bartsch 1971) and called bothrosomes (Porter 1969).

The importance of the network to the biology of the organism is exemplified by its role in protection, nutrition, locomotion, and intercellular communication. The network affords protection to the cells of the colony not only in the active stage, but also by modification as a covering of the encystment and aggregate stages that have been described for various species (Valkanov 1929, Jepps 1931, Watson 1957, Stey 1969). Nutrition in the labyrinthulas is osmotrophic (Young 1943, Hollande and Enjumet 1955, Watson 1957, Klie and Mach 1968). Decomposition of cells of food organisms such as yeast, bacteria, and diatoms occurs extracellularly (Watson 1957, Klie and Schwartz 1963, Klie and Mach 1968) but only when the network is in contact with the food cell (Jepps 1931, Watson 1957, Klie and Mach 1968). Lytic enzymes capable of such activity are presumed to be localized in the extracellular network (Klie and Mach 1968, Porter 1969). The characteristic gliding movement of the cells, which may attain speeds of 150–200 μ/min in some isolates (Young 1943, Porter 1969, Stey 1969, Bartsch 1971), only occurs within the network which must be preformed ahead of an expanding colony (Cienkowski 1867, Young 1943, Porter 1969). A vegetative cell is unable to move when isolated from the network (Porter 1967, Stey 1969). The actual role of the network matrix, however, in the mechanism of movement is not known. Finally, the network has been suggested as the medium for the transmission of stimuli affecting movement patterns in a colony (Aschner and Kogan 1959, Porter 1967).

A better understanding of the relationship between the cells and the surrounding network is obviously necessary for a better understanding of various aspects of the biology of Labyrinthula. The first step in the investigation of the network matrix is necessarily morphological. How do the cells produce the material of the network? From their structure alone, the bothrosomes have been suggested as the sites of network matrix production (Stey 1968, 1969, Porter 1969, Bartsch 1971). The present study of fine structure observations during the cell division and subsequent cell separation within the matrix of the network demonstrates that in fact the bothrosomes do function in matrix production.

2. Materials and Methods

Labyrinthula strain L65-8 was used in this study. The isolation and cultivation of this organism has already been described (Porter 1969). Cultures to be fixed for electron microscopy were prepared by inoculating polystyrene petri dishes (60 × 15 mm) containing 1% horse serum in sea water with cells from an active culture. Fixation for electron micros-