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# An overview of cellular ultrastructure in benthic foraminifera: New observations of rotalid species in the context of existing literature

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## Abstract

We report systematic transmission electron microscope (TEM) observations of the cellular ultrastructure of selected, small rotalid benthic foraminifera. Nine species from different environments (intertidal mudflat, fjord, and basin) were investigated: *Ammonia* sp., *Elphidium oceanense*, *Haynesina germanica*, *Bulimina marginata*, *Globobulimina* sp., *Nonionellina labradorica*, *Nonionella* sp., *Stainforthia fusiformis* and *Buliminella tenuata*. All the observed specimens were fixed just after collection from their natural habitats allowing description of intact and healthy cells. Foraminiferal organelles can be divided into two broad categories: (1) organelles that are present in all eukaryotes, such as the nuclei, mitochondria, endoplasmic reticulum, Golgi apparatus, and peroxisomes; and (2) organelles specific to foraminifera, generally with unknown function, such as fibrillar vesicles or electron-opaque bodies. Although the organelles of the first category were observed in all the observed species, their appearance varied. For example, subcellular compartments linked to feeding and metabolism exhibited different sizes and shapes between species, likely due to differences in their diet and/or trophic mechanisms. The organelles of the second category were common in all foraminiferal species investigated and, according to the literature, are frequently present in the cytoplasm of many different species, both benthic and planktonic. This study, thus, provides a detailed overview of the major ultrastructural components in benthic foraminiferal cells from a variety of marine environments, and also highlights the need for further research to better understand the function and role of the various organelles in these fascinating organisms.

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