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Symbiosis between foraminifer and red algae.

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Large benthic foraminifera and some planktonic foraminifera have photosynthetic endosymbionts in their cytoplasm. These symbionts are cyanobacteria, diatoms, green algae, dinoflagellates, red algae and haptophytes. Each taxonomic group of the host foraminifera has a different taxonomic group of algal endosymbiont, furthermore there are few algal symbiont species. The unicellular red alga *Porphyridium purpureum* was identified as an endosymbiont of a Peneroplidae foraminifer based on its color and ultrastructure (Lee 1990). Some symbionts can be isolated and maintained as clonal cultures. To evaluate the taxonomic and phylogenetic position of the *Porphyridium* symbionts, SSU rDNA sequences were done. All the *Porphyridium* symbionts were monophyletic and distinct from the clade of free-living *P. purpureum* collected from terrestrial habitats. Moreover, some physiological properties of the symbionts were also different from those of free-living isolates. These results suggested that symbionts of peneroplid foraminifers comprise an entity distinct from typical *P. purpureum*.

Phylogenetic analysis of the host foraminifera was performed using SSU rDNA sequences showed that all foraminifers having *Porphyridium* endosymbionts are monophyletic. Therefore I propose that the *Porphyridium*- foraminifer endosymbiosis arose only once.

Keywords: Foraminifer, Microalgae, Red algae, symbiosis, Peneroplidae, *Porphyridium*