The Mechanism of Endosymbiosis of the Chlorella Species within the Cell of a Ciliate Paramecium Bursaria by Adjusting the Surrounding pH and Overcoming Digestion

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It has been thought that intracellular symbiosis evolved chloroplast and mitochondria, and understanding the mechanism is one of the major issues in biological science. Paramecium bursaria is a ciliate in which the unicellular green alga of Chlorella sp. coexists symbiotically. Because this symbiosis between Chlorella and Paramecium can be reproduced experimentally, this system has been applied to elucidate the symbiosis. It is essential for Chlorella coexisting in Paramecium that Chlorella must survive in a strong acidic environment by acidosome when it is taken into the phagosome of Paramecium, and overcome digestive action as well. These two questions have been addressed in this study. When yeast cells stained with a pH-indicating dye was taken up into phagosomes together with Chlorella cells and placed under the light, the pH in phagosomes rose. This experiment clearly showed that Chlorella increased the surrounding pH under the light in relation to photosynthesis. The cell number of Chlorella after incorporating into Paramecium decreased in the dark but increased in the light, which suggested a possible involvement of some excreted photosynthetic product(s). Based on the findings of previous research indicating maltose of a major photosynthetic product excreted from Chlorella, the cell number of Chlorella greatly decreased when maltose is degraded by maltase treatment, whereas the cell number was restored when maltase was removed by rinsing. It was then suggested that maltose excretion prevented Chlorella digestion by lysosomes.