

Identification and modification of the symbiotic algal carbon fixation-enhancing factor in *Paramecium bursaria*

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SUMMARY

We previously reported that an extract of the Japanese *Paramecium bursaria* enhanced carbon fixation in symbiotic algae. In our studies to identify the enhancing factor, we found that the enhancing activity remained even when the organic compounds in the *Paramecium* extract were completely removed by burning. We then measured the concentration of major inorganic cations (K^+ , Ca^{2+} and Mg^{2+}) in the extract and prepared an artificial cation mixture (Artificial Host Factor; AHF) according to the results. We found that AHF enhanced algal carbon fixation in the same way as the *Paramecium* extract, and that modification of the cation concentrations caused higher carbon fixation. To reveal the mechanism of the enhancement of carbon fixation, we studied the reaction to light, which provides energy for carbon fixation. We found that oxygen evolution by symbiotic *Chlorella* F36-ZK decreased in a sodium phosphate buffer without AHF, while oxygen evolution by free-living *Chlorella* was stable in the same buffer. When AHF was added, the decrease in oxygen produced by symbiotic algae did not occur and the algal oxygen evolution rate remained unchanged. The sensitivity of symbiotic *Chlorella* F36-ZK to an external cation concentration suggests that the symbiont cannot regulate its own cation balance in the cell. The ability to regulate cation balance may have been lost through the endosymbiosis, because the *Paramecium* host provided a suitable cation balance to the symbiotic *Chlorella*.