

Identification of an Algal Carbon Fixation-Enhancing Factor Extracted from *Paramecium bursaria*

Yutaka Kato^a and Nobutaka Imamura^{b,*}

^a Department of Bioscience and Biotechnology, Faculty of Science and Engineering,
Ritsumeikan University, 1-1-1 Noji-higashi, Kusatsu City, Shiga 525-8577, Japan

^b College of Pharmaceutical Sciences, Ritsumeikan University, 1-1-1 Noji-higashi,
Kusatsu City, Shiga 525-8577, Japan. Fax: +81-77-561-5203.
E-mail: imamura@ph.ritsumei.ac.jp

* Author for correspondence and reprint requests

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The green ciliate *Paramecium bursaria* contains several hundred symbiotic *Chlorella* species. We previously reported that symbiotic algal carbon fixation is enhanced by *P. bursaria* extracts and that the enhancing factor is a heat-stable, low-molecular-weight, water-soluble compound. To identify the factor, further experiments were carried out. The enhancing activity remained even when organic compounds in the extract were completely combusted at 700 °C, suggesting that the factor is an inorganic substance. Measurement of the major cations, K⁺, Ca²⁺, and Mg²⁺, by an electrode and titration of the extract resulted in concentrations of 0.90 mM, 0.55 mM, and 0.21 mM, respectively. To evaluate the effect of these cations, a mixture of the cations at the measured concentrations was prepared, and symbiotic algal carbon fixation was measured in the solution. The results demonstrated that the fixation was enhanced to the same extent as with the *P. bursaria* extract, and thus this mixture of K⁺, Ca²⁺, and Mg²⁺ was concluded to be the carbon fixation-enhancing factor. There was no effect of the cation mixture on free-living *C. vulgaris*. Comparison of the cation concentrations of nonsymbiotic and symbiotic *Paramecium* extracts revealed that the concentrations of K⁺ and Mg²⁺ in nonsymbiotic *Paramecium* extracts were too low to enhance symbiotic algal carbon fixation, suggesting that symbiotic *P. bursaria* provide suitable cation conditions for photosynthesis to its symbiotic *Chlorella*.

Key words: Carbon Fixation, Symbiosis, *Paramecium bursaria*