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REPORT

Ambariyanto · O. Hoegh-Guldberg

Net uptake of dissolved free amino acids by the giant clam, *Tridacna maxima*: alternative sources of energy and nitrogen?

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Abstract The role of dissolved free amino acids (DFAA) in nitrogen and energy budgets was investigated for the giant clam, *Tridacna maxima*, growing under field conditions at One Tree Island, at the southern end of the Great Barrier Reef, Australia. Giant clams (121.5–143.7 mm in shell length) took up neutral, acidic and basic amino acids. The rates of net uptake of DFAA did not differ between light and dark, nor for clams growing under normal or slightly enriched ammonium concentrations. Calculations based on the net uptake concentrations typical of the maximum concentrations of DFAA found in coral reef waters (~ 0.1 μM) revealed that DFAA could only contribute 0.1% and 1% of the energy and nitrogen demands of giant clams, respectively. These results suggest that DFAA does not supply significant amounts of energy or nitrogen for giant clams or their symbionts.

Introduction

Many coral reefs are renowned for their low concentrations of both particulate and non-particulate nutrients (Odum and Odum 1955). The high productivity of these diverse communities has been paradoxical to workers who have sought to explain how the nutrient-impoverished waters of the tropics can sustain their high rates of productivity (Muscatine and Porter 1977). Partial resolution of this "paradox" has come from the idea that symbioses, like those between corals and clams, and dinoflagellates of the genus *Symbiodinium* (Freudenthal 1962), recycle nutrients within the tissues of the association.

Utilisation of dissolved organic nutrients has also been suggested as a solution to the general problem of the scarcity of nutrients in tropical waters (e.g. Lucas 1982). Uptake of dissolved free amino acids (DFAA) has been reported for a wide range of marine invertebrates including brittle stars (*Amphipholis squamata* and *Ophiopholis aculeata*; Lesser and Walker 1992), mussels (*Mytilus californianus* and *M. edulis*; Wright et al. 1984; Silva and Wright 1992), oysters (*Crassostrea gigas*; Manahan 1983a, b, 1989), abalone (*Haliotis rufescens*; Jaeckle and Manahan 1989a), and echiuran worms (*Urechis caupo*; Jaeckle and Manahan 1989b) and may, therefore, play an important role in providing metabolic energy, especially when particulate food is scarce. Most of these organisms are from temperate oceans, however, and the relevance of DFAA to the nutrition of animals typical of tropical oceans has not been assessed to any great extent.

The concentrations of dissolved free amino acids in coral reef waters are similar to those of temperate oceans, and range from the limit of detection to about 1 μM (0.05–0.22 μM: Bermuda, Ferrier 1991; 0.86–1.08 μM: Mombasa, Schlichter and Liebezeit 1991; and 0.05–0.17 μM: Great Barrier Reef, Hoegh-Guldberg and Welborn 1992; Hoegh-Guldberg et al. 1997). Dissolved molecules like DFAA may play a role in the nutrition of many tropical marine organisms (*Acanthaster planci*, Hoegh-Guldberg 1994a; *Tridacna gigas*, Klumpp and Griffiths 1994; see also Stephens 1981), but experimental evidence is restricted to a few studies. The role of DFAA as a source of energy or nitrogen for corals and tridacnid clams has not been assessed experimentally.

This study explores the role of DFAA in the nutrition of the giant clam, *Tridacna maxima*, and its symbiotic zooxanthellae. Giant clams take up dissolved

Ambariyanto[1] (✉) · O. Hoegh-Guldberg
School of Biological Sciences, AO8, The University of Sydney, NSW 2006, Australia

[1] *Present address*:
Faculty of Fisheries and Marine Science, Diponegoro University
Kampus Tembalang, Semarang 50241 Indonesia
email: ambari@indosat.net.id (OVEH@Bio.USYD.EDU.AU)