Bull. Mar. Sci. Fish., Kochi Univ.
No. 14, pp. 23-26, 1994

Proceedings of the Concluding Workshop on Coral Reef Studies, Kochi, November 1993

Bacteria and Suspended Matter in Heron Reef

Hideo MIYOSHI

Usa Marine Biological Institute, Kochi University Usa-cho, Tosa, Kochi 781-11, Japan

Abstract: Preliminary surveys on bacterial density, ATP concentration and size fractionation of bacteria-associated particles were carried out, in October 1992, using water samples from Heron Reef, Queensland. The results are summarized as follows: bacterial counts tended to be almost uniform but, upon closer observation, a little lower at low tide as compared with those obtained at high tide; a large population of water bacteria was associated with particulate matter. Proteolytic potential was also examined *in situ* by using hide powder azure as a model substrate. Higher activity was measured on the sediment surface. The possible involvement of bacteria for these phenomena is discussed.

Key words: Bacterial count, Great Barrier Reef, ATP concentration, ETS activity, size fractionation

Introduction

The concentration of organic matter varies considerably in coral reefs.

Microorganisms, especially bacteria, probably play a substantial and some times dominating role in these processes.

With the aim of elucidating the contribution of bacteria to these processes, a preliminary survey was carried out on Heron Reef in the Great Barrier Reef, Australia in October 1992.

This report gives the outline of the results obtained in the survey.

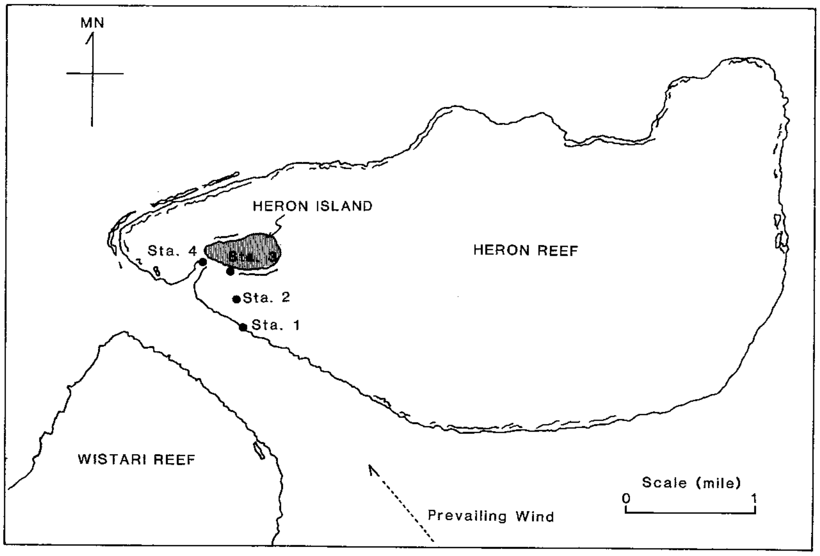

Fig. 1. Map showing the survey stations.

Abundance of bacteria

Seawater samples were collected at three stations along a transect crossing through shore channel (Sta. 3), reef flat (Sta. 2), and fore reef on the West (Sta. 1) in Heron Reef (Fig. 1).

The samples were fixed with acidified Lugol iodine solution (Nishino, 1986) and the bacterial population in the preserved sample was determined by epifluorescence microscopy (Porter and Feig, 1980).

The bacterial counts obtained here (Table 1) were almost equal to those detected previously in coral reefs (Ducklow, 1990; Sorokin, 1993). However, upon closer observation, the counts tended to be a little smaller at low tide as compared with those obtained at high tide. This tendency might reflect active grazing of bacteria by corals and other benthic fauna because the grazing pressure at low tide might be enhanced significantly by the decrease of water column over the reef.

Table 1. Epifluorescence counts of bacteria in water (Nov. 7-8, 1992).

Location	Depth (m)	Bacterial counts (cells/ml)	
		High tide	Low tide
Sta. 1	0	3.8×10^5	2.1×10^5
	2		
Sta. 2	0	2.6×10^5	1.2×10^5
	2	2.7×10^5	
Sta. 3	0	2.7×10^5	1.9×10^5

Table 2. Concentration of adenosine-tri-phosphate in water (Nov. 7, 1992).

Location	Depth (m)	Concentration of ATP (m μg/l)	
		High tide	Low tide
Sta. 1	0	356	344
	2	344	346
Sta. 2	0	374	350
	2	372	-
Sta. 3	0	414	360

Concentrations of adenosine-tri-phosphate (ATP) have given by far the best indication of living biomass in the marine environment. ATP concentrations of water samples collected from Stations 1, 2, and 3 were determined by the firefly luciferine-luciferase bioluminescence method (Jones, 1979). The concentrations obtained were almost the same level, but a little lower at low tide, as well as to bacterial counts (Table 2). Therefore, it seems reasonable to suppose that bacteria might enter into the reef food-web via the "detritus chain."

As already pointed out by Sorokin (1993), bacterial aggregates were grazed more efficiently than free bacteria by coarse filter-feeders. Size fractionation of bacteria and bacteria-associated particles in the seawater from Station 1 was carried out using Nylon mesh filters of 1 to 40 μm mesh size. About 80% of bacteria in seawater samples were retained on a 5-μm filter (Table 3). The observation that attached bacteria were dominant in the seawater samples was helped to explain the rapid decrease of bacteria during a relatively short period of time. Sorokin (1973), Moriarty *et al.* (1985) and Linley *et al.* (1986) already have pointed out that grazing is a very important mechanism for removal of bacteria in coral reef waters.

Table 3. Epifluorescence count of bacteria in seawater after size-fractionating with Nylon-mesh filters.

Particle size (μm)	Bacterial counts (cells/ml)	Recovery (percentage)
(Whole)	5.1×10^5	100
40<	4.0×10^4	7.8
20-40	4.5×10^4	8.8
10-20	5.5×10^4	10.8
5-10	4.0×10^4	7.8
1-5	1.0×10^5	19.6
<1	2.0×10^4	3.9
(Subtotal)	3.0×10^5	58.8

The water sample was collected from the surface of Station 1 at high tide on Oct. 6, 1992.

Microbial removal of particulate organic matter

As shown above, some of the particulate organic matter was directly taken up by grazers. The remaining part may have been subjected to decomposition by microbial activity. A large part of particulate matter in this reef seemed to consist of proteinous substances as is the case in other areas of coastal sea (Miyoshi *et al.*, 1981). Decomposition of particulate organic matter was traced with hide powder azure as a model substrate. Assay bags were immersed in water or placed on coral sand surfaces at Stations 1, 3, and 4 (Fig. 1). The details of this method were reported by Miyoshi *et al.*, 1985. As the decomposition proceeded roughly according to the first order reaction, the result can be described by the following formula: $ln\ W_t/W_0 = -kt$, where W_t is the remaining amount of hide powder azure after t day's immersion, W_0 is the initial weight of hide powder azure, k is the decomposition coefficient. The decomposition coefficients obtained show that considerable variations of proteolysis did not occur in the seawater over the reef, but a higher level of decomposition occurred on the sediment surface (Table 4). This may reflect the difference of bacterial density between the water and the sediment surface. Anyway, particulate organic matter settled on the lagoon bottom may have a relatively short residence time.

Table 4. Electron transport activity of water and sediment samples.

Location	Sample	Depth(m)	ETS activity (μg O_2/h/l or g)	
			High tide (Oct. 6, 1992)	Low tide (Oct. 7, 1992)
Sta. 1	Water	0	0.19	0.20
	Water	2	0.20	0.25
Sta. 2	Water	0	0.21	0.21
	Water	2	0.21	
Sta. 3	Water	0	0.21	0.21
	Sediment	-	117.7	

ETS (electron transport system) activity is closely related to respiration rate of planktonic organisms in water (Packard, 1985). That is, the ETS is mainly involved in the process by which the organisms oxidized soluble organic matter into carbon dioxide and water. The ETS activities in water and mud samples collected from Stations 1, 2, and 3 were determined at ambient temperatures by the tetrazolium reduction technique (Jones and Simon, 1997). The mud sample showed, as was expected, higher ETS activity than that of the water sample, but ETS activities in the water samples remained practically equal for both local and tidal variations (Table 5).

Table 5. Decomposition coefficient (*k*) of hide powder azure (Nov. 3-11,1992).

Location	Depth (m)	-*k* (day/ ℓ)	Remarks
Sta. 1	0	0.17	
	2	0.19	
Sta. 3	0	0.20	Coral sand surface
Sta. 4	0	0.21	
	2	0.20	

In order to substantial the conjecture described above it is important to carry out more detailed, large-scaled surveys.

References

DUCKLOW, H. W., 1990. The biomass, production and fate of bacteria in coral reef. In, *Ecosystems of the world -Coral reefs-*, edited by H. W. Dublinsky. Elsevier Sci. Pub., Amsterdam, pp 265-289.

JONES, J. G., 1979. A guide to methods for estimating microbial numbers and biomass in fresh water. *Freshwater Biological Association, Scientific Publication*, No. **39**, pp 65-71.

JONES, J. G. and B. M., SIMON, 1979. The measurement of electron transport system activity in freshwater benthic and planktonic samples. *Appl. Bacteriol.*, **46**, 305-315.

NISHINO, S. F., 1986. Direct acridine orange counting of bacteria preserved with acidified Lugol iodine. *Appl. Environ. Microbiol.*, **52**, 602-604.

LINLEY, E.A.IS. and K., KOOP, 1986. Significance of pelagic bacteria as a trophic resource in a coral reef lagoon, One Tree Island, Great Barrier Reef. *Mar. Biol.*, **92**, 457-464.

MIYOSHI, H., T. HANDA and Y. HATA, 1981. Aerobic heterotrophic bacteria and the decomposition of dead organisms in Uranouchi Bay. *Bull. Jap. Soc. Sci. Fish.*, **47**, 1355-1359.

MIYOSHI, H., M., YAMAMOTO and Y. HATA 1986. Methods for determining *in situ* activities of proteolysis, amylolysis, and cellulolysis in coastal seawater. *Res. Rep. Kochi Univ. (Agri. Ser.)*, **34**, 79-91.

MORIARTY, D. J. W., P. C. POLLARD, W. G. HUNT, C. M. MORIARTY and T. J. WASSENBERG, 1985. Productivity of bacteria and microalgae and the effect of grazing by holothurians in sediments on a coral reef flat. *Mar. Biol.*, **85**, 293-300.

PACKARD, T.T., 1985. Measurement of electron transport activity of microplankton. *Adv. Aqu. Microbiol.*, **3**, 207-261.

PORTER, K. G. and Y. S. FEIG, 1980. The use of DAPI for identifying and counting aquatic microflora. *Limnol. Oceanogr.*, **25**, 943-948.

SOROKIN, Y. I., 1973. Micrological aspect of the productivity of coral reefs. In, *Biology and geology of coral reefs*, 2, edited by O. A. Jones and R. Endean, Academic Press, New York, pp. 17-45.

SOROKIN, Y. I., 1993. *Coral reef ecology*. Springer-Verlag, Berlin, 465 pp.

(Received 30 November, 1994)