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BACTERIAL COUNTS IN SURFACE OPEN WATERS OF ENIWETOK ATOLL,  
MARSHALL ISLANDS

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# BACTERIAL COUNTS IN SURFACE OPEN WATERS OF ENIWETOK ATOLL, MARSHALL ISLANDS

by Louis H. DiSalvo<sup>1</sup>

## INTRODUCTION AND METHODS

During my investigations of coral reef microbiology at Eniwetok Atoll, Marshall Islands in 1968, large numbers of bacteria were found inhabiting coral reef internal sediments ( $10^7$ - $10^8$  colonies/g; DiSalvo, 1969). With the high level of metazoan activity on reefs it was expected that sediment processing and disturbance might cause the release of bacteria, contributing to the organic particulate enrichment of lagoon waters (Marshall, 1965; Johannes, 1967). To my knowledge, no bacteriological data were available which compared oceanic counts to lagoonal counts near an atoll, and therefore the following measurements were made both in reference to the work at hand and as a general contribution to atoll ecology.

Open water sampling for aerobic heterotrophic bacteria was carried out on six bi-weekly dates in June and July 1968. A total of 24 samples of surface seawater were obtained at oceanic and lagoonal stations. In addition, a total of 14 samples were obtained downstream from the Japtan reef at the surface and at 2 meters depth. Sample locations are shown in Figure 1. Surface (top 5 cm) water samples were obtained in sterile 200 ml prescription bottles from a boat. Skin diving was employed to obtain the 2 m samples. Samples were kept on ice for return to the laboratory, and plated for bacterial counts within five hours of collection. The plating medium was ZoBell 2216e (Oppenheimer and ZoBell, 1952) solidified with 1.5% (w/v) agar. Duplicate pour plates were made using 0.1 ml raw seawater inocula and 10 ml medium which had been cooled to 40-45°C. Plates were incubated at ambient temperature (30°C) for 48 hours and then counted for total colonies.

## RESULTS AND DISCUSSION

Bacterial counts for numbered samples located by Figure 1 are listed in Table 1. These counts are within order of magnitude limits established by other investigators using similar methods on waters near non-atoll reefs (Table 3). Table 2 lists counts for two depths immediately behind the Japtan Reef. Summarized results in Table 3 suggest there was no significant difference between oceanic and back-reef counts.

Conclusions from these data are tentative and preliminary. Comparisons with plate counts of other workers in Table 3 have been made for convenience, although they may be invalidated by slight differences in methodology and materials. The limitations of the plate count technique in obtaining "true counts" are well known (ZoBell, 1946; Jones and Jannasch, 1959) and present results can only be considered as a measure of relative microbial activity. The counts are

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within higher ranges expected for clear tropical pelagic waters, and it may therefore be hypothesized that the waters surrounding the atoll are enriched in some way, perhaps by local upwelling or organic enrichment from the reefs.

The small numbers of sample platings preclude rigorous statistical interpretations of the data. More seriously, I was unable to sample the same water mass flowing from ocean to lagoon over the Japtan Reef for the before-after measurements. Both these factors were the result of logistical problems, helping to explain why there are essentially no microbiological data available for atoll waters. Since it has previously been suggested that the Japtan Reef was in a steady state with regard to the import and export of matter and energy (Odum and Odum, 1965), it is not unreasonable to deduce from the available data that this reef is in equilibrium with regard to input and output of heterotrophic bacteria.

Future studies should attempt to confirm present results under various seasonal and tidal regimes, and extend the measurements to representative depths within and outside the atoll. Such measurements might be useful in studies of outer slope upwelling and local enrichment due to the coral reefs.

#### ACKNOWLEDGEMENT

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Table 1. BACTERIAL COUNTS FOR ENIWETOK ATOLL OPEN WATERS

Date 1968	Sample* #	Colonies/ml**	Date 1968	Sample #	Colonies/ml
6/16	1	780	6/23	13	70
"	2	720	"	16	140
"	3	40	"	18	50
"	4	600	"	21	80
"	5	130	"	24	160
"	9	100	6/30	12	180
"	15	800	"	14	100
6/23	6	100	"	17	500
"	7	60	"	19	50
"	8	130	"	20	100
"	10	30	"	22	150
"	11	130	"	23	30

\*For sample location, see Fig. 1.

\*\*Colonies/ 0.1 ml plated x 10.

Table 2. BACTERIAL COLONY COUNTS FOR JAPTAN I. BACK-REEF WATERS\*

Date 1968	Surface samples		Samples from 2m depth**	
	Sample #	Colonies/ml	Sample #	Colonies/ml
7/15	1	150	1d	250
	2	250	2d	500
	-	-	3d	350
7/17	3	50	4d	160
	4	330	5d	150
	5	550	-	-
7/19	6	80	6d	300
	-	-	7d	330
	-	-	8d	250
Mean values		235	$\bar{x}$	285

\* Water depth approximately 4 meters.

\*\* Obtained by diving.

Table 3. SUMMARY OF COLONY COUNTS FOR ENIWETOK  
ATOLL OPEN WATERS

Stations	Number of samples	Colonies/ml
Ocean (nos. 1-5, 7-11)	10	272 ± 100
Lagoon (all Japtan*, nos. 20-24)	19	222 ± 10
<u>Previous data, near reefs</u>		
Gee (1932) <sup>1</sup>	3	100,150,700**
Sisler (1962) <sup>2</sup>	nd	< 10-10 <sup>3</sup>
Gundersen and Stroupe (1967) <sup>3</sup>	(a) 5 (b) 3	50,60,1360,12,42** 13,2,5**
Sieburth (unpub.) <sup>4</sup>	4	215,235,250,700**

\*See table 2.

\*\*Individual results.

<sup>1</sup> Open water near Florida reef tract (Gulf Stream, Bird Key Harbor, Marquesas lagoon).

<sup>2</sup> Water over Great Bahama Bank west of Andros I.

<sup>3</sup> (a) immediately outside northern Kaneohe Bay, Hawaii.  
(b) Kauai I., Hawaii, 1.5-2.5 miles offshore.

<sup>4</sup> unpolluted lagoon stations, Majuro Atoll, Marshall Is., Feb-Apr. 1970. Unpub. data of J.McN.Sieburth, U.Rhode I. Narragansett Marine Laboratory, Kingston.

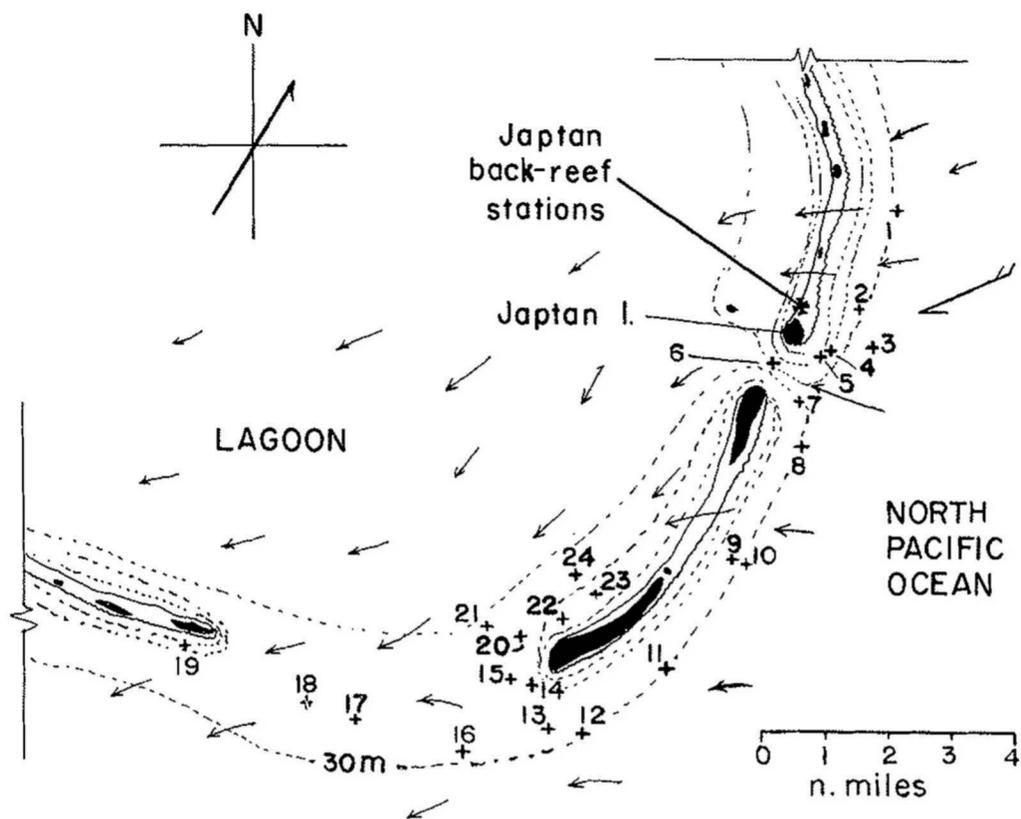


Figure 1. Southeast quadrant of Eniwetok Atoll, Marshall Is. ( $11^{\circ}30'N$ ,  $165^{\circ}15'W$ ), to show sampling stations. Approximate current pattern is designated by small arrows. Contour interval 10 meters.