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INORGANIC NUTRIENT CONTENTS AND *Gambierdiscus toxicus* DISTRIBUTION IN THE COASTAL WATERS OF PAPUA NEW GUINEA

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Introduction

Papua New Guinea is endowed with a long coastline and coral reef regions suitable for the aquaculture of marine organisms for food or industrial uses. The high rainfall suggests a sufficient nutrient supply through rivers to maintain the high primary production in the vast coastal and estuarine areas.

The assessment of coastal and coral reef waters is essential to develop the aquaculture of fish and sea weed, but the general characteristics of sea water in PNG are not well understood. In this paper the results of an inorganic nutrient analysis on water samples collected around Madang, Lae and Port Moresby are presented. The distribution of *Gambierdiscus toxicus*, a toxic dinoflagellate which is responsible for ciguatera (YASUMOTO et al., 1978), an intoxication by coral reef fishes, was also investigated in some selected places.

Results and Discussion

To understand the general features of shore and coral reef waters in Papua New Guinea the concentrations of the following inorganic nutrients NH_3–N, NO_3–N, NO_2–N, PO_4–P and Silicate–Si were measured in November and December of 1989. The water samples were taken in plastic bottles and then carried to the research vessel, Keiten-maru, in a cooler and then were immediately analyzed for these nutrients. The inorganic nutrient analysis on board was done by a HACH DR-2000 auto-analyzer following the manual without any special modifications. The number of *G. toxicus* in the benthic macroalgal samples was counted after being concentrated according to the method adopted in the previous surveys (YASUMOTO et al., 1979). The sampling stations where water samples were collected are shown in Fig. 1 (Huon Gulf and Salamaua Peninsula, near Lae), 2 (Madang) and 3 (Motupore Island, near Port Moresby).

1) Huon Gulf and Salamaua Peninsula

In the vicinity of Lae twelve water samples were taken among which nine were from the coral areas along the east coast of Salamaua Peninsula. The flora was very poor throughout the sampling station whose depth was about 5 m. The three other samples were from the estuarine part of Huon Gulf where the discoloration of the sea water effected by the influx of particulate materials through the Markham River was visually observed. The sampling places are shown in Fig. 1 and the results obtained in Table 1. The concentrations of inorganic nutrients in the coral areas were comparatively low when compared to those obtained in other tropical regions (YASUMOTO et al., 1980). However the concentration of Si was high especially at St. 8, reflecting

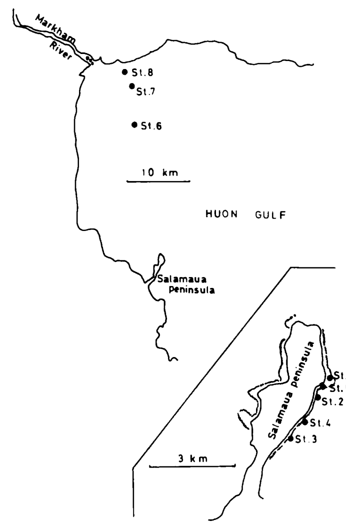

Fig. 1. Sampling stations around Lae.

Table 1. Inorganic nutrient contents at Salamaua peninsula.

Station		NH_3–N	NO_2–N	NO_3–N	PO_4–P	Sel.–Si
St.1	S	0.08 mg/1	0.001 mg/1	0.001 mg/1	0.01 mg/1	0.433 mg/1
	B	0.11	0.002	0.001	0.01	0.437
St.2	S	0.15	–	0.002	0.03	0.922
	B	0.11	0.003	0.003	0.01	0.347
St.3	S	0.09	–	0.001	0.03	1.166
	B	0.10	–	0.001	0.01	0.374
St.4	S	0.09	–	0.002	–	0.845
St.5	S	0.09	–	0.003	–	0.833
	B	0.07	–	–	0.04	0.921
St.6	S	0.07	0.002	0.004	0.02	0.480
St.7	S	0.04	0.003	0.003	0.02	1.563
St.8	S	0.09	0.003	0.004	0.04	9.510

S: Surface, B: Bottom
–: Not detected

the input from the river. The differences of inorganic nutrient concentration both among stations and among layers, either of surface or bottom, were not significant.

2) Madang

Water samples were collected near Madang Harbour as shown in Fig. 2. The bottom consisted of coral on which a meager population of benthic macroalgae, principally of brown algae, was observed. All these stations were of less than 5 m deep. Pollution from domestic waste was observed visually around Madang Harbour that had not been recognized in 1983 (unpublished). The results are shown in Table 2. Nitrite–N concentrations exceeded those obtained around Lae suggesting the accelerated oxidation procedure of inorganic nitrogen compounds. The Si

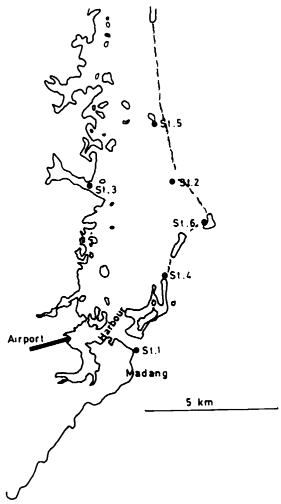

Fig. 2. Sampling stations around Madang.

Table 2. Inorganic nutrient contents near Madang Harbour.

Station		NH_3–N	NO_2–N	NO_3–N	PO_4–P	Sil.–Si
St.1	S	0.03 mg/l	0.002 mg/l	0.001 mg/l	0.15 mg/l	0.149 mg/l
St.2	S	0.05	0.002	0.001	0.06	–
	B	0.02	0.003	0.001	0.04	–
St.3	S	0.03	0.001	0.002	0.03	0.347
St.4	S	0.05	0.001	0.002	0.02	0.250
St.5	S	0.03	0.002	0.002	0.04	0.117
St.6	S	0.02	0.002	0.001	0.04	0.021

S: Surface, B: Bottom
–: Not detected

concentration was naturally low reflecting the low amount of fresh water supply to this area. Si was not detected at Station 2, neither at surface nor bottom layers, which might be the result of massive uptake by planktonic activities preceding the survey.

3) Motupore Island

In Port Moresby twelve samples were taken around Motupore Island where th Research Center of the Faculty of Science, the University of Papua New Guinea is situated. The sampling sites are indicated in Fig. 3. Most of these stations were located near the island and an abundant growth of brown algae was seen at Stations 1 and 2 dominated by *Turbinaria* sp. and *Sargassum* sp. respectively. Except for these two stations, there were far fewer benthic macroalgal communities observed. Five water samples were collected from deeper zones between 3 and 5 m, and another one from 20 m on the descending slope of the coral reef edge. The results of the water analysis are in Table 3. No significant differences of individual inorganic nutrient contents between two layers at each station were observed. Ammonia–N concentrations were comparable to those at Madang.

Throughout this survey the levels of inorganic nutrient such as nitrogen, phosphorus and

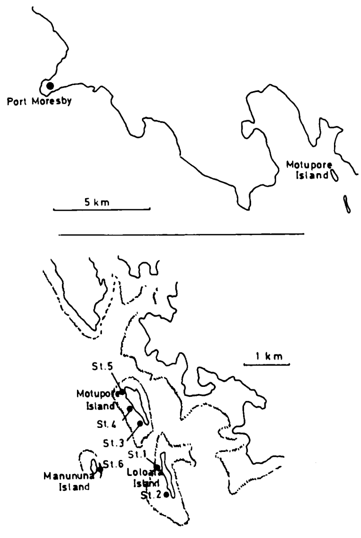

Fig. 3. Sampling stations around Port Moresby.

silicate–Si were lower than those of coral reef areas in general (RICARD, 1976; LEMASSON et al., 1980). This indicates that planktonic primary production in this area was less than that in other tropical coral reef regions and much less than those in several lagoons. The vegetation of both benthic macroalgal and phytoplanktonic communities varies either in quality or quantity depending on the changes of several environmental factors. Therefore no conclusion could be deduced from the survey at one time. But when taking into consideration the least seasonal changes of such governing factors as water temperature, solar irradiation and salinity in the tropical regions, the productivity in the surveyed areas is thought to be relatively low.

Ciguatera is one of the serious problems in fisheries and food hygienics throughout the

Table 3. Inorganic nutrient contents around Motupore Island.

Station		NH_3–N	NO_2–N	NO_3–N	PO_4–P	Sil.–Si
St.1	S	0.03 mg/1	0.002 mg/1	0.001 mg/1	0.14 mg/1	0.197 mg/1
	B	0.03	0.003	0.002	0.02	0.162
St.2	S	0.07	0.003	0.001	0.03	0.200
St.3	S	0.04	0.002	0.001	0.04	0.160
	B	–	0.003	0.002	0.05	0.292
St.4	S	0.04	0.002	0.002	0.04	0.105
	B	0.06	0.002	0.002	0.01	0.236
St.5	S	–	0.002	0.003	0.01	0.284
	B	0.03	0.002	0.001	0.01	0.141
St.6	S	–	0.002	0.002	0.03	0.224
	B	0.02	0.003	0.003	0.02	0.208
	20m	0.01	0.005	0.004	0.03	0.159

S: Surface, B: Bottom

–: Not detected

Table 4. Ciguatera occurrences in the South Pacific.

Year	Whole Oceania	French Polynesia	Fiji	Papua New Guinea
1981	2,105	1,145 (54.0%)	123 (5.8%)	–
1982	1,870	831 (44.4%)	71 (3.8%)	–
1983	1,689	789 (46.7%)	–	–
1984	1,866	999 (53.5%)	–	–
1985	3,376	901 (26.7%)	1,125 (33.3%)	–
1986	3,793	815 (21.5%)	1,318 (34.7%)	–

(Modified after the SPC statistics)

tropical areas especially in French Polynesia. Ciguatera occurrences from 1981 to 1986 were tabulated and are shown in Table 4. The annual intoxication cases reported increased gradually in this period. As seen in this table no records were described officially in Papua New Guinea. People around Lae and Port Moresby, however, often tell about the intoxication experienced by themselves through taking coral reef fishes near their villages. This suggests the inhabiting possibility of the culprit organism of ciguatera even in some restricted areas.

The distribution of a causative organism for ciguatera, *Gambierdiscus toxicus*, a dinoflagellate, was investigated in Lae and Motupore Island. Several benthic algae such as *Turbinaria* sp., *Sargassum* sp., *Boodlea* sp. and *Padina* sp. were picked up, and the number of the dinoflagellate attached was counted under microscope. Among fifteen samples tested three showed the presence of the organism. No existence of *G. toxicus* was noticed on the samples around Lae. The biggest number of the dinoflagellate was found on the samples collected at St. 2 at Motupore Island reaching 36 cells per 100g of benthic algae, *Turbinaria* sp. This number was not so great as to induce ciguatera at present (INOUE, 1983, 1985), but the number of *G. toxicus* fluctuates even during a short period and it differs from place to place even in locations which are situated very near to each other. Therefore the existence of the dinoflagellate indicates that there is a possibility of a ciguatera intoxication at any time when circumstances change to trigger a high population density. Caution should be taken incessantly to prevent or minimize the intoxication by coral reef fish in this area.

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