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THE DISTRIBUTION OF *GAMBIERDISCUS TOXICUS* IN THE NORTHERN COAST OF PAPUA NEW GUINEA

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Introduction

A toxic dinoflagellate, *Gambierdiscus toxicus*, has been known to cause ciguatera, an intoxication brought about through the ingestion of a variety of coral reef fishes in tropical and subtropical areas (YASUMOTO *et al.*, 1977). A simple and practical field survey method was established on the dinoflagellate distribution (YASUMOTO *et al.*, 1980). Adopting the method, or the partly modified method, several surveys have been carried out in French Polynesia (INOUE, 1983), Fiji (INOUE and RAJ, 1985) and Micronesia (INOUE and GAWEL, 1986 ; INOUE *et al.*, 1987). The growth was also confirmed in several other places such as Papua New Guinea (INOUE *et al.*, 1990 ; INOUE, 1991) and New Caledonia (INOUE, 1979 unpublished). Throughout these surveys, it was demonstrated that the population density of *G. toxicus* changed, even during a rather short period, and showed remarkable differences from place to place, even within a small area. It was also shown that the dinoflagellate usually lived on the surface of growing macroalgae and scarcely on the bottom sand or rocks or swimming freely. Among macroalgae as attaching substrates, there was clear preferency on some special species as *Jania* sp., a red alga, and *Turbinaria* sp., a brown alga. The maximum population density was found in the samples collected on Mangareva Island of the Gambier Islands, French Polynesia. It reached to about 500,000 cells of the dinoflagellate on 1 g of macroalgae, and no fishes had been consumed without the dangers of intoxication for nearly 10 years. Paralytic shellfish poisoning was reported (WORTH *et al.*, 1975), however, the situation of intoxication by *G. toxicus* in Papua New Guinea has not yet been systematically studied and no statistical data of ciguatera occurrences are available. This study aims at getting some detailed information on the distribution of the dinoflagellate on the coast of Madang, which may help in preventing or lessening the intoxications in the area.

Methods

The survey was carried out at 13 stations along the coastline and inside the lagoon of Madang as shown in Fig. 1. Three stations (St. 1 to St. 3) were located at the coral reef edge in the lagoon and another ten stations (St. 4 to St. 13) were placed along the shore line of the site where the Christensen Research Institute (CRI) is situated. A rich population of benthic macroalgae was recognized through the shore stations, while very poor algal communities were seen at the offshore stations. At each station, benthic macroalgal samples were collected in order to count the number of dinoflagellates attached, and seawater samples were taken for determining the contents of some inorganic nutrients. The collected algal samples were shaken vigorously in plastic bags containing sea water. The contents were then passed through two different sized mesh sieves. The residues on a 37 μ mesh sieve were washed with seawater to make a volume of 25 ml, the aliquot of which was served to count

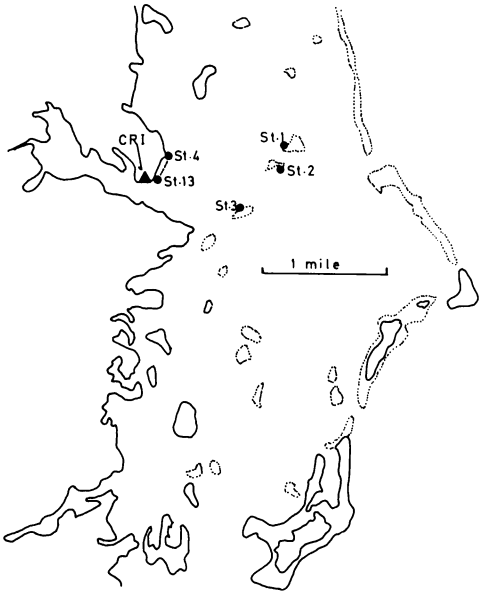

Fig .1 Sampling stations at Madang

the number of the dinoflagellates. The investigated dinoflagellates here were *G. toxicus*, *Ostreopsis lenticularis* and *O. ovata*. The latter two species were usually found together with *G. toxicus* on macroalgae through our surveys. The seawater samples obtained were carried to the laboratory of CRI as soon as possible after sampling where filtration by 0.45 μ millipore filters was applied immediately. The filtered seawater samples were stored at -20℃ until used for further analysis. The measurements of inorganic nutrients were carried out on NO_3-N, NO_2-N, NH_3-N, PO_4-P and salinity by colorimetry using a DREL-2000 analyzer without any modifications as indicated in the manual.

Results and Discussion

The numbers of *G. toxicus* and two other dinoflagellates found on benthic macroalgae are shown in Table 1. As seen in this table, the algae collected for the observation throughout the sampling stations were mostly two species of *Turbinaria*. These algae were chosen mainly because previous surveys indicated that *G. toxicus* preferred *Turbinaria* sp. to other algal species as attaching substrates and partly because the species were common at most sampling stations. Other algae were taken instead at those stations where *Turbinaria* was not found. All samples were collected at about a 4 m depth at the lagoon stations and at about a 1 m depth at the shore stations. Shore stations were situated at a distance of 10−15 m from the shoreline of CRI and each station was 40−50 m apart for each other. The biggest number was found at St. 10, reaching to 62 cells per 100 g of benthic macroalgae. This number is not so remarkable as that found in the survey of Mangareva Island, but rather abundant when compared to those of Micronesia and some other places of Papua New Guinea such as Port Moresby and Lae. The number of *G. toxicus* changes greatly even in a short period, but from the rather dense population recognized here, it can be understood that there is the possibility of its bloom leading to the ciguatera

Table 1. Distribution of *Gambierdiscus toxicus* and two other related dinoflagellates at the Madang coast

Sampling Station	Sp. of Macro algae	No. of *G. toxicus*	No. of *O. lenticularis*	No. of *O. ovata*
1	Turbinaria sp.	0	9	6
2	Halimeda sp.	1	8	2
3	Halimeda sp.	0	3	5
4	Turbinaria sp.	0	9	31
5	Turbinaria sp.	0	0	7
6	Turbinaria sp.	6	33	65
7	Turbinaria sp.	17	2	0
8	Turbinaria sp.	16	70	5
9	Turbinaria sp.	0	1	24
10	Turbinaria sp.	62	8	0
11	Turbinaria sp.	4	0	0
12	Turbinaria sp.	0	0	0
13	Turbinaria sp.	0	8	54

No. of dinoflagellates : No. per 100 g of macro algae

Table 2. Inorganic nutrient contents at the Madang coast

Sampling Station	NO_3-N	NO_2-N	NH_3-N	PO_4-P	Salinity
1	0.002mg/ l	0.003mg/ l	0.06mg/ l	0.03mg/ l	36.12‰
2	0.003	0.003	0.04	0.03	36.13
3	0.005	0.002	0.04	0.03	35.97
4	0.006	0.009	0.32	0.05	35.28
5	0.008	0.004	0.22	0.05	36.16
6	0.004	0.004	0.07	0.03	36.05
7	0.003	—	0.06	0.01	36.00
8	0.003	0.007	0.04	0.05	35.94
9	0.003	0.002	0.04	0.15	36.09
10	0.007	0.004	0.04	0.08	36.11
11	0.004	0.003	0.04	0.11	36.36
12	0.008	0.005	0.02	0.09	35.23
13	0.003	0.006	0.08	0.01	36.54

occurrences by the fishes inhabiting the place. Except for this one station there was found a low number of *G. toxicus*, less than 20 cells per 100 g of substrate macroalgae. The other two dinoflagellates sometimes exceeded the *G. toxicus* in number, but no blooms were observed at any of the stations.

Inorganic nutrient contents were shown in Table 2. Ammonia-N and phosphate-P concentrations were rather high at some stations suggesting discharges of domestic wastes which flowed into the sea around St. 4 and St. 9. Except for these stations, the concentrations of nutrients investigated in this study stayed at ordinary levels for tropical shore water. No direct relation was observed between either the number of *G. toxicus* or that of other dinoflagellates and the concentration of individual nutrients.

People at Madang told us that there had been intoxication cases by fishes, but the details were unknown. Ciguatera there has not been recorded officially at all. The confirmation of growth of *G. toxicus*, however, suggests the possibility of its occurrences in the past and in the future when the bloom of the dinoflagellate lasts long enough to make fishes toxic.

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