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# CIGUATERA AND ITS CAUSATIVE ORGANISM DISTRIBUTION IN PALAU

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## Introduction

Ciguatera is induced both by herbivorous and carnivorous fish inhabiting mainly coral reefs in tropical and subtropical regions. The toxins are exogenous, produced by a dinoflagellate (*Gambierdiscus toxicus*) and are transferred subsequently to other organisms at higher trophic levels through food chains (YASUMOTO et al., 1977). The alga grows by preference on the surface of macro-benthic algae in the coral reef (YASUMOTO et al., 1979). The growth of *G. toxicus* has been confirmed in some islands of French Polynesia (INOUE, 1987), Fiji (INOUE and RAJ, 1985), the Federated States of Micronesia (INOUE and GAWEL, 1986; INOUE and Enouedward, 1995) and Papua New Guinea (INOUE et al., 1990; INOUE, 1991). The maximum population density, reaching to 500,000 cells of the dinoflagellate on 1 g of macro algae, was found on benthic algal samples, *Jania* sp., obtained from Mangareva Island, Gambier Islands, French Polynesia where no fishes had been consumed without the dangers of intoxication for nearly 10 years. It has been 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. The distribution in Palau Islands was also reported previously (INOUE et al., 1987) in which the authors warned of the possibility of ciguatera occurrences and proposed the necessity of periodical surveys on the dinoflagellate growth at selected sampling places to prevent or lessen the intoxication in the area. Ciguatera there, however, have been very rare since the survey fortunately (SPC, 1993). In 1995 the authors had another chance to survey with similar objectives in the same areas, aiming at understanding the present situation and knowing the changes of the growth patterns of the organism after about eight years. The benthic macroalgal growth, one of the most suitable substrates for the dinoflagellate attachment, was found rather poor through the surveyed areas. Therefore it was almost impossible to survey in the same sampling sites as the previous time. This study deals with the distribution of *G. toxicus* and another unicellular alga, *Ostreopsis renticularis*, that was elucidated to contain a different kind of toxin from that of *G. toxicus* (USAMI et al., 1995) with which it grows together in the natural environment.

## Methods and Sampling Sites

At each sampling site, benthic macroalgal samples were collected in order to count the number of dinoflagellates attached. The collected macroalgal 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 mesh sieve were washed with seawater to make a volume of 25 ml, 1 ml of which was served to count the dinoflagellates. The count was repeated at least five times whose mean number was used to represent the population density of a sample. When the number of the dinoflagellates was very small, whole prepared samples were counted.

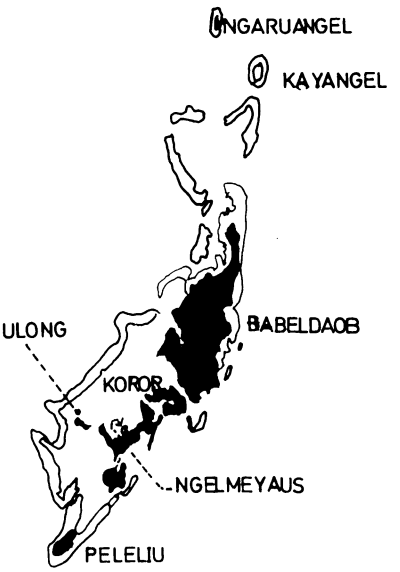


Fig. 1. Sampling sites

The 36 macroalgal samples were collected around four islands. The sampled sites are demonstrated in Fig. 1. *Turbinaria* sp., a favorable substrate for *G. toxicus*, was taken at Ulong Island. Other algal species, *Halimeda* sp., *Padina* sp. and *Caulerpa* sp., were selected instead at other islands, because no *Turbinaria* was found at all or not enough to test in quantity even when found.

1) Ngermeaus Island

This island was situated about one hour by boat from Koror. No people live there but tourists and Palau people often visit to spend half a day for pleasure. The macroalgal samples were picked up on coral reef developing at its southern shoreline. The algal growth was rather good, however, most of which was covered with a quantity of silts that might have disturbed attaching of epibenthic microalgae.

2) Peleliu Island

Three samples were taken at less than 1 m depth very near the island where abundant growth of both benthic algae and phanerogamic plants was observed including a surveyed site where the first survey was carried out in 1986. Five other samples were collected near a passage situated 4 km off the island at about 2 m depth showing poor benthic algal population affected either by rapid current at tidal changes or by much suspended particulate matter.

3) Augulpelu (Koror)

Ten samples of *Halimeda* sp. were collected about 3 m deep on the sandy bottom at Augulpelu, the barrier reef of Koror Island. Other kinds of algae were very scarce except *Caulerpa* sp. that was not enough for the study.

4) Ulong Island

Twenty-one samples were collected near the shore of the Island along four lines parallel to

the shore line as shown in Fig. 2. The depth was about 4 m at the line of St.1 to St.7, 3 m at that of St.8 to St.11, 2 m at that of St.12 to St.14 and 1.5 m at that of St.15 to St.21, respectively. To know the changes of *G. toxicus* population in a small area, only one macroalgal species of *Turbinaria* sp. was selected as substrate alga. Massive growth of other kinds of macroalgae was found on all the sampled area. The growth of corals was rather good throughout this area. The bottom of the area was of rock and the quantity of sediments was rather few.

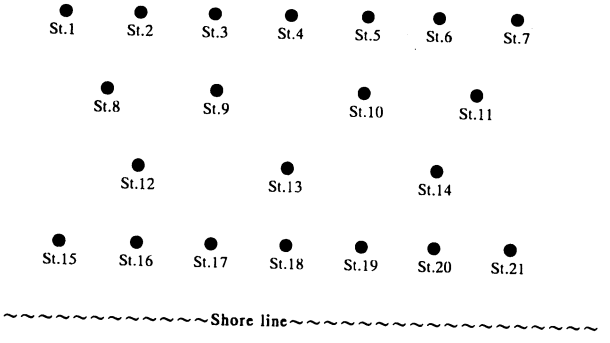


Fig. 2. Sampling sites at Ulong Island

## Results and Discussion

As far as the investigation of one of the authors (MADRAISAU) is concerned, ciguatera occurrences have never been reported in the past ten years in the Republic of Palau. It is said that *Lutjanus bohar* caught in the eastern half of a shallow region lying between Kayangel Atoll in Palau and Yap Island in the Federated States of Micronesia, were toxic sometimes. Palau fishermen said that this was known well to them and they used to discard the fish when caught in this area. On the contrary, all fish inhabiting the western half of the region are non-toxic and have been supplied to people without any problems of fish poisoning. Only one species of fish, *Siganus canaliculatus,* which inhabited the sea grass zone of a mangrove area located in the middle part of eastern shore line of Ngerard State, Babeldaob Island, gave a kind of drunkenness feeling when taken. This symptom differs greatly from that of ciguatera. Except for these two peculiar regions, no fish have been reputed to be toxic in the country.

The results of the survey at Ngermeaus Island on the distribution of two toxic species of epibenthic dinoflagellates, *G. toxicus* and *O. renticularis* , are indicated in Table 1. In this island only one sample was found to have three cells of *G. toxicus* per 100 g of Padina sp. among 7 macroalgal samples. The numbers of *O. renticularis* were also few, but they exceeded those of *G. toxicus* at all sampling sites. All the samples prepared contained a considerable quantity of small coral granules that should have resulted in fewer of the two dinoflagellates.

As indicated in Table 2, very few of the two dinoflagellates were observed on Peleliu samples even when found. *Padina* sp. collected near the passage gave the biggest number of *G. toxicus* and *O. lenticularis,* 8 and 5 cells per 100 g of substrate algae among others, respectively. At Augul-peru few of the two dinoflagellates are found (Table 3). *Halimeda, Padina* and *Caulerpa,* collected as substrate macroalgae in these three islands, are not favorable substrates for the dinoflagellates which might have been one reason why so few of the two dino-

flagellates tested here were found. Another reason is attributed to the fact that most benthic algae was covered with small granules of corals which should have prevented the attaching of epibenthic microalgae.

Table 1. Growth of *Gambierdiscus toxicus* and *Ostreopsis renticularisis* around Ngermeaus Island

| Sampling Sites | Species of Benthic Algae | Weight of Algae (g) | No. of *G. toxicus* | No. of *O. lenticularis* |
|---|---|---|---|---|
| 1 | *Halimeda sp.* | 78 | 0 | 9 |
| 2 | ibid | 106 | 0 | 9 |
| 3 | ibid | 93 | 0 | 11 |
| 4 | ibid | 64 | 0 | 12 |
| 5 | *Padina* sp. | 35 | 0 | 28 |
| 6 | ibid | 40 | 3 | 54 |
| 7 | *Caulerpa* sp. | 94 | 0 | 0 |

No. of *G. toxicus* and *O. Renticularis* is demonstrated by the total number found on 100 g(wet basis) of benthic macroalgae

Table 2. Growth of *Gambierdiscus toxicus* and *Ostreopsis renticularis* at Peleliu Island

| Sampling Sites | Species of Benthic Algae | Weight of Algae (g) | No. of *G. toxicus* | No. of *O. lenticularis* |
|---|---|---|---|---|
| 1 | *Halimeda* sp. | 55 | 2 | 3 |
| 2 | ibid | 47 | 0 | 3 |
| 3 | ibid | 88 | 0 | 0 |
| 4 | *Padina* sp. | 18 | 8 | 5 |
| 5 | *Halimeda* sp. | 65 | 0 | 0 |
| 6 | ibid | 68 | 0 | 0 |
| 7 | ibid | 70 | 0 | 0 |
| 8 | ibid | 42 | 2 | 0 |

Table 3. Growth of *Gambierdiscus toxicus* and *Ostreopsis renticularis* at Angul-peru, near Koror

| Sampling Sites | Species of Benthic Algae | Weight of Algae (g) | No. of *G. toxicus* | No. of *Olenticularis* |
|---|---|---|---|---|
| 1 | *Halimeda* sp. | 31 | 0 | 0 |
| 2 | ibid | 19 | 0 | 0 |
| 3 | ibid | 18 | 0 | 0 |
| 4 | ibid | 22 | 0 | 0 |
| 5 | ibid | 25 | 0 | 0 |
| 6 | ibid | 24 | 0 | 17 |
| 7 | ibid | 17 | 10 | 0 |
| 8 | ibid | 33 | 19 | 36 |
| 9 | ibid | 27 | 6 | 58 |
| 10 | ibid | 15 | 0 | 0 |

Table 4. Growth of *Gambierdiscus toxicus* and *Ostreopsis renticularis* at Ulong Island

| Sampling Sites | Species of Benthic Algae | Weight of Algae (g) | No. of *G. toxicus* | No. of *O. lenticularis* |
|---|---|---|---|---|
| 1 | *Turbinaria* sp. | 24 | 12 | 2 |
| 2 | ibid | 18 | 18 | 42 |
| 3 | ibid | 16 | 35 | 32 |
| 4 | ibid | 16 | 13 | 9 |
| 5 | ibid | 16 | 26 | 34 |
| 6 | ibid | 29 | 0 | 0 |
| 7 | ibid | 16 | 26 | 3 |
| 8 | ibid | 16 | 70 | 409 |
| 9 | ibid | 16 | 41 | 21 |
| 10 | ibid | 17 | 59 | 12 |
| 11 | ibid | 17 | 66 | 0 |
| 12 | ibid | 19 | 28 | 147 |
| 13 | ibid | 23 | 67 | 75 |
| 14 | ibid | 22 | 43 | 77 |
| 15 | ibid | 31 | 95 | 6 |
| 16 | ibid | 14 | 3 | 92 |
| 17 | ibid | 32 | 0 | 41 |
| 18 | ibid | 17 | 62 | 68 |
| 19 | ibid | 12 | 12 | 9 |
| 20 | ibid | 25 | 28 | 40 |
| 21 | ibid | 19 | 44 | 40 |

As shown in Table 4, many more toxic dinoflagellates were observed on the samples at Ulong Island. Only two samples showed no *G. toxicus* among 20 tested. The biggest population density of *G. toxicus* (70 cells per 100 g of benthic algae) and *O. lenticularis* (409 cells per 100 g algae) was recognized on No. 5 sampling site situated at the third line from the shore. This biggest population density obtained in this survey, however, is far less than those reported previously in Micronesia (INOUE, 1988) and in the Southern islands of Japan (KOIKE et al., 1991). Rather big differences were noticed in the number of inhabited dinoflagellates from sample to sample even in such a small area and on the same species of macroalgae, *Turbinaria* sp. Having taken into consideration the results obtained by the survey in Ngaruangul Atoll, the possibility of ciguatera occurrences, especially in this Atoll, was mentioned in the previous report (INOUE et al., 1987). This Atoll is located at northern end of the territory of the Republic of Palau where no people live and fishermen seldom go fishing. Fortunately no fish poisonings have been reported officially in the last 10 years in the Republic of Palau. However, the authors confirmed the growth of *G. toxicus* at all the areas investigated in the surveys either in 1987 or in 1995 at various population densities, that might lead to ciguatera occurrences at any time. A more detailed investigation, both in time and space, would be beneficial.

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