INSTITUTE OF APPLIED SCIENCES

THE UNIVERSITY OF THE SOUTH PACIFIC

Marine Toxins in the Island Pacific.

IAS TECHNICAL REPORT NUMBER: 2002/09

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MARINE TOXINS IN THE ISLAND PACIFIC

The earliest European explorers in the Pacific have written about the occurrence of toxic fish in the islands they visited. In the last 25 or so years scientists have begun to study and understand more about the variety of toxins that exist. This research has been hampered by the extreme toxicity and thus low concentrations of the toxins in the relevant marine organisms.

In the absence until recently of their chemical structures the different marine toxins have been traditionally classed based on the marine organism and the effect of the toxins. It was generally assumed that one toxin was responsible for each type of poisoning. More detailed investigations have shown that multiple chemical forms exist for many toxins and that a single toxic organism may contain several types of toxins. A list of some of the most common types of marine toxicities is given in Table 1.

Table 1 : Some Types of Marine Toxicity

Name	**Causative Agent(s)**
Pufferfish	Tetrodotoxin
Scombroid fish	Histamine
Paralytic Shellfish	Gonyautoxins, Saxitoxins
Diarrhetic Shellfish	Dinophysistoxin
Ciguatera	Ciguatoxins, Maitotoxins, Scaritoxins, Gambiertoxins
Clupeotoxins	

Other toxins that have been identified are brevetoxins, palytoxin and okadaic acid. A majority of these toxins originate with dinoflagellates and marine invertebrates that are eaten by the marine organisms and move their way up the food chain. This suggests that other species could cause poisoning and marine snails, crabs and turtles are also known to have caused marine toxicity.

In the above table scombroid fish poisoning is unique as it is not derived from a toxin inherent in the fish but from bacteria that transform the amino acid histidine to histamine which causes an allergic reaction. This occurs when fish are mishandled and kept for long periods without refrigeration.

Records in Fiji from 1955-1983 indicate that 96% of the cases of fish toxin affecting humans were due to ciguatera. Therefore the rest of this paper will focus on this predominant marine toxin. It should be noted, however, that in terms of severity, cigutera cases are seldom fatal compared to other kinds of marine toxicity as illustrated in Table 2 (Yasumoto, et al., 1984).

Table 2 : Fatal Cases from Consumption of Marine Foods in Fiji 1955-1983

Type	**Deaths**
Ciguatera	1
Clupeotoxism	9
Tetrodotoxism	2
Crab poisoning	2
Shellfish poisoning	1
Canned fish poisoning	2

Ciguatera in Fiji and the South Pacific

The name ciguatera comes from the Spanish name "cigua" for a marine snail in the Caribbean. In 1978 the main causative agent, <u>Gambierdiscus toxicus</u>, an epiphytic dinoflagellate growing on algae and coral rubble, was identified.

This dinoflagellate has been shown to produce water-soluble maitotoxins and fat-soluble gambiertoxins. These latter toxins are oxidised as they proceed up the food chain to the more-toxic ciguatoxins. Ciguatoxins, like many marine toxins, are large organic molecules composed of many cyclic ethers that affect sodium-ion receptors.

The resulting effects of ingesting ciguatoxins are a suite of symptoms, many common to fish toxins, such as abdominal pain, nausea, diarrhea, vomiting, general weakness, muscle and join pain and numbness and tingling of the mouth and extremities. A fairly unique sensation for ciguatera is a paradoxical sensory reversal where cold things seem hot to the touch and vice versa.

In most places there is traditional knowledge of fish species likely to be ciquatoxic. "Don't eat red fish during the hot season" is a common warning. In Fiji, for example, records from 1975-1983 show the following fish responsible for ciguatera incidence (Yasumoto, et al., 1984).

Table 3 : Percentage for Ciguateric Fish Poisoning for Main Species from Medical Reports in Fiji (1975-1983)

Species	Common Name	Incidence
Lutjanus bohar	Red sea bass	40%
Sphyraena spp	Barracuda	22%
Epinephelus spp	Flower cod, coral trout	12%
Lethrinus miniatus	Long-nosed snapper	7%
Plectorhynachus spp	Grouper	2%

Other species which accounted for less than 1% of cases are other snappers, emperors, jacks, surgeonfish, parrotfish, wrasse and moral eels (not commonly eaten in Fiji). About 11% of the reports did not identify the responsible species.

The period 1975-1985 was the golden age for ciguatera research. The Director of the Institute of Marine Resources at the University of the South Pacific focused the research of the Institute on marine toxins and collaborative projects were set up by French and Japanese scientists. The South Pacific Commission kept an extensive database on ciguatera in the Pacific and researchers at the University of Hawaii were also active in the region.

Table 4 presents the data of ciguatera cases in reporting Pacific countries for the period 1973-1983 (Lewis, 1986).

Table 4 : Ciguatera Morbidity in the South Pacific Region (1973-1983) as Reported to South Pacific Epidemological and Health Information Service

Number of Cases

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
American Samoa	4	0	0	0	0	0	70	30	31	97	69
Cook Islands	0	0	0	0	0	0	0	1	2	0	0
Fiji	6	26	150	29	69	201	131	265	123	71	0
French Polynesia	607	867	625	660	502	821	677	937	1145	831	789
Guam	0	0	21	16	6	6	9	0	4	3	21
Kiribati	101	175	187	77	41	38	78	187	286	418	414
Nauru	0	0	0	0	0	0	1	5	0	0	0
New Caledonia	0	200	518	647	487	488	188	147	107	130	112
Niue	7	1	35	4	0	0	0	3	3	0	0
Papua New Guinea	0	0	16	0	0	0	0	0	0	0	0
Solomon Islands	1	7	0	7	6	6	0	4	4	0	2
Tokelau	0	0	0	8	0	0	14	0	3	17	73
Tonga	11	58	12	17	43	13	8	7	2	29	14
TIPI	240	264	208	313	326	296	191	217	163	119	120
Tuvalu	0	0	0	49	44	71	21	27	73	47	16
Vanuatu	0	0	35	28	50	53	67	0	32	12	0
Wallis and Futuna	0	0	3	7	0	0	0	0	0	0	0
Western Samoa	65	89	15	17	81	179	62	115	127	98	59
Total	1042	1687	1825	1879	1655	2172	1517	1945	2105	1870	1689

Table 5 : Per Country Totals, Means, and per 100,000 rate for two Time Periods

Number of Cases

Country	Total (1973-1983)	Mean	Rate per 100,000 1973-1983	Rate per 100,000 1979-1983
American Samoa	301	27	87	179
Cook Islands	3	0.3	1	3
Fiji	1071	97	16	18
French Polynesia	8461	769	545	585
Guam	86	8	8	7
Kiribati	2002	182	324	462
Nauru	6	0.6	7	15
New Caledonia	3024	275	200	96
Niue	53	5	130	38
Papua New Guinea	16	1	>1	>1
Solomon Islands	37	3	2	1
Tokelau	115	10	653	1338
Tonga	214	19	21	12
TIPI	2455	223	173	114
Tuvalu	348	32	439	484
Vanuatu	277	25	25	19
Wallis and Futuna	10	0.9	9	0
Western Samoa	907	82	54	59
Total	19386	1762	97.1	96.1

One must, of course, view the data with caution. Lewis (1984) based on interviews and research in a number of these countries, has estimated that perhaps 20% of all cases are reported in country. Further, it seems likely that the reporting of cases to SPC would depend of the earnestness of the country person in charge. It is difficult to believe, for example, that Fiji had no cases in 1983. Therefore, looking at trends must be handled with caution. The data do confirm, however, that there is much higher incidence in the Kiribati/Tuvalu/Tokelau region and French Polynesia compared to the rest of the Pacific. The near absence of cases from Papua New Guinea is also noteworthy.

The research in this period also sought to correlate toxic outbreaks to concentration of Gambierdiscus toxicus in the area, to discover simple ways to test if the fish was ciguatoxic or not and to try and correlate environmental factors with the outbreak of ciguatera events.

Results showed that although there was in general some relationship between concentrations of Gambierdiscus toxicus and ciguatoxin levels of fish in the area the correlations were not strong enough to be a useful predictor of ciguatera outbreaks. It has also been found that only certain of the dinoflagellates have the genetic facility to produce toxins.

Extensive research has also shown that the etiology of development of ciguatoxins in an area is a complex affair and that no one factor can be found responsible other than the general occurrence of damage to the reef. The fact that this results in coral rubble as a substrate for the algae on which the Gambierdiscus toxicus can grow makes this not-too-startling of a finding.

In terms of simple tests to determine the presence of ciguatoxin the traditional method of feeding viscera of the fish to a nearby cat still seems the most reliable low-cost method. Immunoassays and mouse assays have been developed but are expensive and/or time consuming and only useful in research or to test high-priced species of fish.

This apparent lack of practical results that were more useful to common people than their own traditional knowledge led to a lessening of interest in ciguatera research.

In 1990 the SPC revised its database to gather more data about ciguatera incidents that was thought to provide information that would be more useful in giving people advice on which areas and fish species might be especially affected. It appears that these added reporting requirements resulted in even a lower percentage of cases reported. An exception was the island of Niutao in Tuvalu, which reported more than half the total cases more than 200 over a two year period for a population of 1,000. This is especially startling as prior to 1988 the average was fewer than three cases a year (Dalzell, 1994).

The policy of SPC has, in recent years, become more of responding to major outbreaks than basic results. This reflects the concerns of the Pacific countries which has not placed this as a high priority. As a health issue it rarely causes deaths and does not therefore attract attention. As a fisheries issues it affects mainly the subsistence fishery and thus also does not attract the attention of export-oriented Fisheries Departments (Snowdon, pers. comm.).

I believe these views are very short-sighted for a number of reasons.

1. Although usually not lethal, severe cases can be very debilitating. The patient may be bed-ridden for a few weeks and feel effects for months. As a fat-soluble substance the toxin appears to build up in the body and recurrence of poisoning can occur when fish that would not normally cause symptoms are consumed. Many victims have to remove fish from there diets. Alcohol consumption can also trigger relapses in some people.

2. The in-shore fishery provides in many islands the principle source of animal protein and a major component of subsistence diets. Dalzell (1992) reports that on average reef fish comprise 51% of total fish landings in Pacific Island countries. About half of the fish families are known to be potentially ciguatoxic. Thus, as resources decline, people are likely to be eating more ciguatoxic fish with greater health consequences. In Table 6 data on fish poisonings in Fiji from 1995-2000 are given (Government of Fiji, pers. comm.).

Table 6 : Fish Poisoning Cases for the Years 1995-2000 in Fiji

Year	Cases
1995	826
1996	807
1997	859
1998	1,754
1999	2,827
2000	1,932

It is assumed these cases not only include those due to ingestion of fish toxins but also due to bacterial spoilage of fish. Note the SPC data in Table 4 gives an average incidence from 1973-1983 in Fiji of 97 cases a year. Looking at this difference, and the increase in cases in the period 1998-2000 compared to 1995-1997, something seems to be happening.

3. Increased outbreaks of ciguatera, besides being a health hazard, can also have detrimental effects on fish production and marketing through adverse publicity and litigation.

4. New economic possibilities such as tourism and the live-fish trade to Hong Kong can be endangered by ciguatera. The tourism image of a country can certainly be damaged by a tourist returning home spending the entire holiday in ciguateric agony. Foreign chefs and staff not from the area near the hotel make it likely that the chance of ciguatera might be greater for a tourist than a local resident. The issue of compensation for a tourist fed a ciguatoxic fish at a hotel is also interesting to ponder.

   Kiribati has joined other Pacific countries offering large fish such as groupers to be taken live for sale in Hong Kong. They only did this once, though, as several of the fish sent were cigatoxic and fish from Kiribati have been black-listed.

5. The data from Fiji in Table 6 brings to mind the thought of how global climate change might effect the incidence of ciguatera. The waters around Fiji have been warming especially since 1998 resulting in major coral bleaching events. As corals die due to this they become a good substrate for algae and thus Gambierdiscus toxicus. Most models agree that in the next 50 years the average strength of Pacific cyclones is likely to increase by 20%. Table 7 presents estimated increases in incidence of ciguatera poisoning in Kiribati presented in a recent World Bank study (World Bank, 2000).

Table 7 : Estimated Increase in Incidence of Ciguatera Poisoning in Kiribati as a Result of Climate Change, 2025-2100

	1990	2025	2050	2100
Ciguatera poisoning (per 1,000)	35-70	105-240	160-430	245-1010

These chilling data highlight the urgency for a revitalisation of researching ciguatera in the Pacific. It is hoped this Workshop will be a productive starting point.

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