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Group Co-ordinator: Richard Lewis, QDPI, Southern Fisheries Centre, P.O. Box 76, Deception Bay, Qld 4508, Australia.
Production: J-P Gaudechoux, Fisheries Information Officer, SPC, PO Box D5, Noumea, New Caledonia (Fax: (687) 26 38 18)

NOTE FROM THE CO-ORDINATOR

This issue of the Ciguatera Information Bulletin contains articles from colleagues in Japan, French Polynesia, Hawaii, mainland France, New Caledonia and Australia.

T. Yasumoto summarises the recent rapid progress his group has made into the origin and chemistry of toxins involved in ciguatera and gives his vision for future directions in ciguatera research. A.M. Legrand outlines the ambitious research programme under her direction at the Louis Malardé Research Institute. From Hawaii, further results with the SPIA assay for ciguatera in fish are summarised by Y. Hokama, while P. Amade gives an update on ciguatera in New Caledonia.

An International Workshop on Ciguatera Management was recently convened at Bribie Island, Australia. This meeting highlighted the need to develop improved screening methods and recognised the lack of understanding of the precise factors responsible for flare-ups of ciguatera. I provide a summary of the major outcomes of this meeting.

We are accepting articles for the next issue of the Bulletin. Please send any articles related to ciguatera to me at the QDPI address for inclusion in the next issue.

Richard Lewis

Inside this issue

PIMRIS is a joint project of 4 international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the South Pacific Commission (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific's Pacific Information Centre (USP-PIC), and the South Pacific Applied Geoscience Commission (SOPAC). Funding is provided by the International Centre for Ocean Development (ICOD) and the Government of France. This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ('grey literature'); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

PIMRIS

Pacific **I**slands **M**arine **R**esources **I**nformation **S**ystem

Ciguatera Research in French Polynesia

by Anne-Marie Legrand,
Institut Louis Malardé,
Tahiti, French Polynesia

The Medical Oceanography Unit at the Louis Malardé Research Institute is currently working on various aspects of ciguatera research including:

- survey, isolation and culturing of the dinoflagellate *Gambierdiscus toxicus*,
- isolation of the toxins from fish and from the dinoflagellate for chemical characterisation,
- detection of the toxins by bioassays, by fluorescence of toxin derivatives and by membrane-binding assays,
- immunochemistry of the toxins and antibody production required for immunodetection, and
- epidemiology of documented cases.

The laboratory research group is led by myself (A-ML) together with Dr Mireille Chinain and Dr Serge Pauillac . The epidemiological survey is managed by Dr Philippe Glaziou. Currently one student is completing a Ph.D. research programme on *G. toxicus*. Many of the advances reported here were the result of successful collaboration between the Tahitian group and Yasumoto's group in Japan.

1986 to 1990 — isolation of ciguatera toxins and their chemical characterisation

The multiplicity of the ciguatoxins in fish was demonstrated, including the identification of minor less polar toxins isolated from carnivorous fish. With the accumulation of pure samples of CTX isolated from moray eel livers collected in Tuamotu and the Marquesas Islands, the structure of the major toxic compound, ciguatoxin (coded CTX-1B), first isolated and named by Scheuer's group, was elucidated. Subsequently, CTX-1B was found to be the major toxin not only in moray eels but also in red snappers such as *Lutjanus bohar* and groupers such as *Plectropomus leopardus*.

We assume that it is the major compound in most of the carnivorous fish involved in ciguatera. The isolation work, conducted with a careful examination of all toxic fractions, has led to the chromatographic characterisation of several ciguatoxins that differ in polarity on reverse-phase chromatography. These toxins also differ from CTX-1B in molecular weight. The structures of some of these toxins have recently been elucidated.

Interestingly, no CTX, but only less polar ciguatoxins, was found in herbivorous fish. Isolation work was also conducted on the muscle of parrotfish collected in Gambier Islands and Tuamotu Islands. A toxin exhibiting a retention time very close to CTX-1 on reversed phase column was further characterised to be different from CTX by mass spectrum data analysis. Several less polar toxic fractions were detected as the major compounds. During the last few years, attempts to accumulate toxins from viscera were unsuccessful. This material was found to be non-toxic, the opposite of what was observed in carnivorous fish.

The production by *G. toxicus* of ciguatoxins as likely precursors of the fish toxins

Production of ciguatoxins in nature

Isolation work on the lipid-soluble extract of a great number of wild *G. toxicus* (around 20,000 million cells) led to the chromatographic characterisation of nine toxic compounds of different molecular weights. Two of them were identified as stereoisomers and coded CTX-4A and CTX-4B or GT-Toxins. Structural analysis of CTX-4B revealed the same 13 ether rings as CTX-1B.

Several times during the past four years, occasional mini-blooms of *G. toxicus* were observed in Tahiti. Collection of the dinoflagellates and extraction of the samples revealed a ciguatoxicity in mice close to that observed with CTX-4B.

Production of ciguatoxins in culture

The structural determination of a ciguatoxin precursor isolated from wild *G. toxicus* increased the hope of obtaining ciguatoxins and / or analogs from sources other than fish. To this end we started a mass culture programme two years ago. Unlike the previous culture work, which was concerned mostly with one strain of *G. toxicus* from the Gambier Islands whose lipid-soluble extract revealed no more than

trace amounts of toxicity, the new programme included the screening of sixteen clonal strains in mass culture. Four of these have yielded ciguatoxicity and all of them produced maitotoxin.

Detection methods for ciguatoxins in fish

Bioassays

Bioassays are still used for the individual selection of toxic fish prior to the chemical extraction (mosquito bioassay) or for the localisation of the toxic fractions during the chromatographic purification procedure (mouse bioassays). Rapid extraction procedure on 4 g of fish flesh and intrathoracic injection of three dilutions of the fish extract to batches of ten mosquitoes led to the calculation of the LD_{50} and allowed the classification of fish into four groups: non-toxic, borderline, moderately toxic and highly toxic.

Only fish from the non-toxic group can be eaten safely, while only fish from the highly toxic group are used for the isolation of ciguatoxins. Utilising dose / survival time standard curves, survival time is used to evaluate the total toxicity of toxic fractions aliquots which have been injected intraperitoneally into three mice.

Fluorometric detection of toxin derivatives by high -performance liquid chromotagraphy

The presence of a primary hydroxyl group on the side chain of CTX (coded -IB) suggested that the toxin could be derivatised into a fluorescent ester by using anthroylnitrile. Trace amounts of the toxin have been identified by fluorometric HPLC. The minimum detection level for pure CTX is around 0.3 ng.

Recently, nine less polar compounds from carnivorous fish have been screened for derivatisation and HPLC detection. Five of these toxins were identified by fluorometric HPLC and thus have been assumed to possess one primary hydroxyl group on the side chain, four other toxins could not be detected and thus have been assumed to lack this primary hydroxyl group. From these data we could evaluate that around 95 per cent of the toxicity of carnivorous fish can be detected by fluorometry.

Partially purified CTX (LD_{50} = 0.3 mg / kg) was derivatised and detected with convenient sensitivity by this method. Further experiments on pre-treatment of fish extract prior to derivatisation are still needed. However, the results currently obtained indicate that a practical HPLC detection method for ciguatoxins will be available in the near future.

Membrane-binding assay

Recently, binding studies using rat brain synaptosomes were performed. CTX-1B and CTX-4B (isolated from wild *G. toxicus)* competitively inhibited the binding of the brevetoxin [^{3}H]PbTx-3 which is well known to interact with the site 5 of the sodium channel protein. In our experimental conditions, the affinity of CTX-1B was 30 times higher than that of PbTx-3, while CTX-4B had nearly the same affinity as the brevetoxin. Experiments on minor less polar toxins isolated from ciguatoxic material are under way. Preliminary results indicate a common property of the compounds to inhibit the binding of [^{3}H]PbTx-3.

This property is currently used to evaluate the ciguatoxicity of hazardous fish. A rapid extraction procedure and a routine binding assay have been established. The method was used to screen some moray eel flesh extracts. Borderline toxic moray eel presenting low toxicity in mice could be detected. The results of this preliminary work, if applicable to various fish species, indicate that detection of hazardous fish using the high-affinity binding of ciguatoxins to voltage-dependent sodium channels is possible.

Immunodetection of ciguatoxin

The development of a sensitive and specific immunoassay for detection of ciguatoxic fish remains a great challenge. Despite the fact that a commercial kit was currently in the design and development phase, we commenced our own immunodetection project a few years ago at the Pasteur Institute in Paris. The presence of a terminal hydroxyl group in the molecule of CTX suggested that it could be selectively used for preparing a ciguatoxin-protein conjugate to be injected into animals for immunisation.

However, the very limited amount of purified toxin imposed the development of miniaturised techniques. An initial experiment was realised using monensin, a low-molecular-weight polyether. Antibodies directed against monensin have been produced in rabbits and mice. Bulk quantities of monensin were converted into hemisuccinate and covalently

linked to bovine serum albumine via the mixed anhydride method.

Both antisera were used in a micro-enzyme immunoassay on Terasaki plates and were found to react strongly with monensin-protein conjugates in an indirect test and to a lesser extent with free monensin in a competitive test. No cross-reactivity was detected against CTX but the successful development of a miniaturised immunoassay for monensin based on a monoclonal reagent provided the basis for the development of similar assays for polyether haptens.

A procedure requiring only 100 μg of hapten is under current investigation with the brevetoxin PbTx-3 and with CTX. The results of recent experiments are very promising and immunisation products are being screened.

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Structures and the origin of toxins involved in ciguartera

by Takeshi Yasumoto
Faculty of Agriculture
Tohoku University, Sendai, Japan

Structural determination of the toxins involved in ciguatera has been a difficult but excitingly challenging target for natural product chemists. Obtaining a large amount of toxic fish for extraction was difficult. The extremely low concentration of the toxins in fish made the purification procedure laborious and tedious. Tons of fish yielded only a tiny amount of pure toxins. The complexity of the toxin molecules added to the difficulty.

Nevertheless, assisted by the rapid technological advances in spectroscopy and collaboration from many friends, we were able to determine the structures of several important toxins. We are quite convinced that the structure of most ciguatera toxins will be elucidated very soon. Then what will come after structures? Many difficult tasks still await chemists: developing analytical methods, preparing antigens, and toxin synthesis. But there are several other aspects which will be interesting to biologists.

We now know the structure of ciguatoxin (CTX) isolated from moray eels and that of CTX-4B isolated from *Gambierdiscus toxicus* growing in the wild. The resemblance in the skeletal structure of the two toxins indicates that CTX-4B is the precursor of CTX and that a series of oxidative modifications to the CTX-4B molecule takes place in the fish liver. The oxidative process reminds us of the role played by hemoprotein P450 which oxidises lipophilic toxins (e.g. afla-

toxin) so that the resulting hydrophilic metabolites can be eliminated into urine. The oxidation of CTX-4B to CTX could thus be regarded as a kind of detoxification process.

What actually happens to CTX-4B is the opposite of detoxification; the toxicity of the oxidised product (CTX) is in fact enhanced ninefold.

Therefore, we can say that moray eels are more toxic than parrotfish, both because the former are at a higher trophic level and because they accumulate toxins in the most toxic forms. If someone finds the enzymes which catalyse the oxidation, such enzymes will not only help us understand the metabolic fate of toxins, but will also help chemists run reactions which they cannot run with reagents.

Recently we have determined the structure of maitotoxin (MTX), the biggest natural product ever to be elucidated. MTX is nearly three times bigger than CTX, having a molecular formula $C_{164}H_{256}O_{68}S_2Na_2$ and a molecular weight of 3422 Da.

It consists of a C142 carbon chain, 32 ether rings, 28 hydroxyls, and 21 methyls. Analogous with CTX, most of the ether rings in MTX are fused in a ladder shape. Nevertheless, the two toxins are entirely different molecular entities. MTX does not contain CTX as a part of its structure.

Therefore, it is quite clear that there will be no possibility of converting MTX to CTX by feeding MTX to fish or bacteria, as speculated earlier by some people.

Also in our recent work, one *G. toxicus* strain was confirmed as producing CTX analogues in cultures. Structures of CTX-3C and CTX-4A in the cultures were unambiguously confirmed by spectroscopic measurements. This result puts to an end the long-running argument about whether *G. toxicus* is the true source of ciguatera toxins or not. The strain (RAI1 strain) was one of six tested.

If renewed effort were made to collect and screen more strains, there would be chances of finding other strains producing CTX analogues, hopefully in even higher yields than our RAI1 strain. As future progress on ciguatera studies depends on an adequate supply of toxins, and as the current supply from fish is very limited, the prospect of obtaining toxins by algal cultures is very encouraging.

We can even dream that some day we will be getting CTX by oxidising CTX precursors produced by the alga with liver enzymes. We would like to urge biologists to collect and test as many *G. toxicus* strains as possible for production of valuable toxins.

Evaluation of Hawaiian reef fishes with the solid-phase immunobead assay (SPIA)

by Y. Hokama,
Department of Pathology,
University of Hawaii, Honolulu

This study was published in the *Journal of Clinical Laboratory Analysis* in 1993. It presents data on the evaluation of a laboratory-made ciguatera testing system based on the solid-phase immunobead assay (SPIA) for the detection of ciguatoxin and related polyethers in Hawaiian reef fishes. The SPIA was performed on fish caught by volunteer fishermen throughout the State of Hawaii.

A total of 1,067 fish representing 61 different species was tested by the SPIA system, as reported in the *Journal of Clinical Laboratory Analysis* in 1990. Of the 1,067 fishes tested, 510 were from the island of Oahu, 402 from Hawaii (Big Island), and 75 from Maui. Other fish included 23 from Molokai, 20 from Kauai and 7 from Lanai. Twenty per cent of the total fish tested were positives, 41 per cent borderlines and 39 per cent negatives in the SPIA assay. The highest percentages of SPIA-positive fish were from the island of Hawaii (27%), followed by Oahu (19%) and Kauai (15%).

These results correlate with the incidents reported from the State Department of Health of actual ciguatera fish poisoning in the State of Hawaii.

Unfortunately fish in all categories were eaten, though warnings strongly emphasised that all borderline and positive SPIA-tested fish were *not* to be eaten. All 332 negative fish eaten (80% of 416 fish) caused no poisoning, therefore *no false negatives*.

However, of the 201 borderline SPIA value fish eaten (46% of 433 fish), 4 caused ciguatera

poisoning symptoms. These fish included 2 **papio** (*Caranx* sp.), 1 mullet (*Mugilcephalus*), and 1 **po'ou** (*Cheilinus rhodochrous*). Finally of the 17 SPIA-positive-tested fish eaten (8% of 218 fish), 5 caused ciguatera poisoning. This involved 2 **papio** (*Caranx* sp.), a **kole** (*Ctenochaetus strigosus*), an **uhu** (*Scarus*) and a **weke** (*Mulloidichythys auriflamma*).

The SPIA test used by the fishermen was successful in protecting the public when SPIA-negative fish eaten caused no illness, that is, there were *no false negatives*.

We have contended that a person who is genetically more susceptible, or has had long-term exposure to reef fish consumption in endemic regions, will be most likely to become ill from eating SPIA-borderline or positive fishes. Indeed, this appeared to be the case.

The data suggested that the probability of getting ill with SPIA-positive fish is 1 out of 3; with the borderline fish, 1 out of 50. As indicated, if the fish is negative by SPIA the possibility of ciguatera is nil. The *Caranx* spp. (**papio** or **ulua**) appeared to be the major culprits causing ciguatera. This is compatible with the Department of Health reports for ciguatera in Hawaii.

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Ciguatera fish poisoning: the situation in New Caledonia

by Philippe Amade, CR1, INSERM, La Darse, Villefranche/mer, France

Situation

The coral reef surrounding the islands of New Caledonia has a particularly rich biological diversity with numerous fish species.

However, visiting the fish market in Noumea, one is surprised that relatively few reef species of fishes are sold, compared with sales of deep-slope and pelagic fishes. Ciguatera fish poisoning is believed to be responsible for this situation.

An investigation performed in March 1992 in Noumea on a representative sample of 500 people, indicated that 124 of them (nearly 25%) had been intoxicated at least once (Laurent et al.1993). This percentage varied according to the ethnic groups: Polynesians 44 per cent, Asians 34 per cent, Europeans 24 per cent, Melanesians 23 per cent and Wallisians 18 per cent.

According to the April 1989 census, the population of the city, excluding children under 10 years old, was 79,167 . It is therefore possible to estimate that 20,000 persons were affected by this intoxication. This result suggests that the current estimates from the South Pacific Commission (based on figures reported by health authorities in New Caledonia) may be significantly below the real incidence of ciguatera intoxications in New Caledonia, mainly because a large number of cases only concern weak intoxications, not declared to doctors or hospitals, and frequently cured by traditional medicine(s).

A widespread phenomenon

Ciguatera poisoning is widespread in the outer islands of New Caledonia. According to local reputation rather then scientific analysis, the north of the mainland has non-toxic fishes as compared with the south. A similar comparison can be made between the island of Ouvea and the other Loyalty Islands. Some places are reputed always to harbour toxic fishes.

To eat fish safely in a specific location, people must refer to local knowledge on species and / or trust the supply from fishermen or from restaurant owners. Many people have adopted the habit of always choosing the same fish, not changing even when there is no intoxication. New Caledonia has no laws or regulations concerning ciguatera poisoning.

Ciguatera is a fisheries and a health problem in New Caledonia. As it has been known to exist since before the 1600s, people 'live with' this intoxication as a common problem associated with fish consumption. The number of severe cases is not sufficiently high to provoke a political response and the precise impact of these intoxications on social life still remains unknown.

Fish incriminated

The incriminated fish species in 90 per cent of cases are carnivorous species:

Serranidae	43% (groupers, coral trout)
Lethrinidae	13% (emperors)
Scombridae	13% (Spanish mackerel)
Lutjanidae	11% (red snapper, hussard)
Carangidae	3% (trevallies)
Haemulidae	3% (sweetlips)
Scaridae	6% (parrotfish).

Traditional medicines and tests

The use of traditional cures is appreciable. It reaches 56 per cent among Melanesians, 44 per cent for Polynesians and 36, 29 and 29 per cent for Asians, Wallisians and Europeans respectively.

The medicine preferred for 40 per cent by people is *Argusia argentea* .

In an attempt to avoid ciguatera, some local people use tests including (i) the repellent effect of toxic fishes on ants, (ii) the toxicity test on cats, (iii) black colouring of a silver stick, and (iv) an electrical sensation on tasting the liver. Only the cat test and probably the liver-tasting test are likely to provide a margin of safety.

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Overview of the International Workshop on Ciguatera Management

by Richard J. Lewis,
Queensland Department of Primary Industries
Deception Bay, Australia

An International Workshop on Ciguatera Management was held at QDPI's Joondoburri Conference Centre on Bribie Island in April 1993. This meeting provided the first opportunity to discuss issues related to ciguatera at an international forum in Australia.

The Workshop covered a broad range of topics through presentations from invited speakers and included two workshop sessions that addressed the clinical management of ciguatera and the detection of ciguateric fish, as well as a poster session.

The proceedings of the workshop will be published as a special issue of *Memoirs of the Queensland Museum.* We anticipate approximately 30 papers will be published in early 1994 following peer review. The workshop reinforced the need for further research on (i) the detection of ciguateric fish and (ii) the environmental factors contributing to outbreaks of ciguatera. At this meeting it was determined that the next ciguatera meeting would be in mid-1994 in Hawaii.

Fifty-six registrants from Japan, mainland USA, Hawaii, France, French Polynesia, New Caledonia, Germany and each of the eastern seaboard states of Australia attended. The invited speakers included 16 international leaders in the field. The Organising Committee for the workshop comprised: Richard J. Lewis (Chairman), Michael J. Holmes, Michelle Sellin, Barry Pollock, Mike Dredge and Noel Gillespie.

The Scientific Committee comprised: Richard J. Lewis (Australia, Chairman), Michael J. Holmes (Australia), John H. Pearn (Australia), Milani Y. Chaloupka (Australia), Anne-Marie Legrand (French Polynesia) and Takeshi Yasumoto (Japan). Four main areas of ciguatera management were covered by the workshop.

Detection of ciguateric fish

At the meeting a cost-effective screen for ciguateric fish was widely recognised as perhaps the single most effective management tool able to directly reduce the adverse effects of ciguatera on public health, fisheries, trade and tourism (R. Lewis). Several different approaches to the detection of toxic fish were presented.

Two approaches measured the interaction between ciguatoxin and the sodium channel through (i) the inhibition of brevetoxin binding to sodium channels in a rat brain synaptosome preparation (A-M. Legrand), and (ii) the cytotoxic effects of ciguatoxin on sodium channel-containing cell lines preexposed to ouabain and veratridine (R. Manger). Both assays were more sensitive than the mouse bioassay and may replace *in vivo* assays in laboratories possessing the specialised equipment required. These approaches require further development before they can be used as cost-effective screens.

Antibody-based screens or related assays still hold most promise for the cost-effective detection of ciguateric fish. This approach is the basis of a potential commercial test to detect ciguateric fish being developed by Hawaii-Chemtect. D. Park presented a summary of the performance of the solid-phase immunobead assay (Ciguatect™) which was claimed to be able to detect ciguateric fish.

D. Park reported that the test may be unsuitable for detecting toxins in slightly acidic fish flesh (pH ≈ 6.5), a factor that could considerably limit the usefulness of the test. Y. Hokama commented that the test may not work because the solid-phase used in the Ciguatect™ test may not be as efficient at extracting ciguatoxins from fish as the 'correction fluid' used for the solid-phase in the format of the stick test (the same antibody was apparently used for both tests).

This explanation does not account for the high number of positive results obtained by the Ciguatect™ test. Predictive indices from 5% to 75% (compared with carefully conducted mouse bioassay results) were obtained when this test was used in an independent study of ciguateric fish from the Caribbean by R. Dickey (Food and Drug Administration, USA). Lack of available pure ciguatoxin and inability to independently validate the levels of ciguatoxins present in test fish samples hamper attempts to validate any potential screen, including the Ciguatect™ test.

Pharmacology and treatment of ciguatera

Major advances are being made in knowledge of how ciguatoxins cause poisoning (P. Hamblin, J. Brock, J. Molgo, M. Capra, F. Vogalis, C. Purcell, E. Benoit, K. Terao), but the precise mechanism of action of mannitol to relieve the symptoms of ciguatera is still a matter of debate.

A double-blind clinical study of the mannitol treatment is being conducted, but the results of this study are being acquired slowly and were not available at the time of the meeting (N. Palafox). Clinical experiences with mannitol therapy continue to be positive and mannitol should remain the treatment of choice for ciguatera in Australia, especially for the acute phase of the disease (N. Palafox, D. G. Blythe) especially as mannitol has proven a safe therapy. Full acceptance by medical practitioners of the therapy will come about slowly until the treatment is confirmed by clinical studies, preferably with the support of an animal model for ciguatera that responds to mannitol.

Clinical aspects and epidemiology of ciguatera

While most of the clinical features of ciguatera are well documented, the long-term effects of ciguatera and how frequently these occur are poorly understood. Follow-up research on victims is required to establish the true extent of long-term effects, especially the allergy-like reactions that can last after a single exposure to toxic fish (T. Ruff). The significant problems of misdiagnosis and non-reporting were discussed by J. Pearn.

Analysis of the ciguatera database maintained by QDPI using the most recently developed statistical modelling approaches revealed major shifts over time in the nature of the poisoning in Queensland and in the species of fish involved (M. Chaloupka). The high incidence of ciguatera in the Pacific Islands region and a detailed report of how these countries address the problem was discussed by P. Dalzell.

The legal situation with regard to ciguatera in Queensland was also discussed (J. Payne). Duty-of-care issues and the Queensland Workplace Health and Safety Act could be pursued for a successful court action against suppliers of toxic fish. The 'ban on red bass and chinaman fish, but not on other species known to be

intermittently toxic in Queensland (especially coral trout and Spanish mackerel), may weaken industry's argument that it is satisfying duty-of-care issues with regard to ciguatera.

Origin of the toxins involved in ciguatera

Gambierdiscus toxicus is now widely accepted as the organism that produces the toxins (ciguatoxins and gambiertoxins) involved in ciguatera (T. Yasumoto, M. Holmes). Indeed this organism may be the only source of toxins involved in ciguatera. Structure for GTX-4A (52 epi-GTX-4B), the major gambiertoxin produced by a Rangiroa Atoll strain of *G. toxicus* grown in culture, was presented at the meeting (T. Yasumoto). This toxin is likely to be the precursor of ciguatoxin-2 (CTX-2).

From this work we now have a much clearer understanding of how the ciguatera toxins arise. GTX-4A and further oxidised forms could undergo acid-catalysed spiroisomerisation to the other ciguatoxins found in fish (ie GTX-4B, CTX-I and -3). The structure of maitotoxin was also presented at this meeting by T. Yasumoto. Maitotoxin consists of numerous transfused polyether rings, as do the ciguatoxins, but otherwise is not closely related to the ciguatoxins.

At the present time little is known of the environmental factors that cause the upsurges of ciguatera (M. Holmes, J-P. Vernoux, U. Kaly, S. Hahn, J. Babinchak, R. Bagnis, G. Hallegraeff, Y. Hokama, P. Scheuer). Further research in this area is expected to result in significant advances, perhaps leading to an understanding of how human activities influence the distribution of ciguateric fish.

Also discussed at the meeting was the potential for a range of other toxic algae to be introduced into Australia with resultant outbreaks of diarrhoeic, paralytic, neurotoxic and amnesic shellfish poisoning (G. Hallegraeff). Such outbreaks may arise through ballast water introduction and/or environmental degradation. These biotoxins have the potential to severely damage a number of fisheries in the Pacific as well as Australia.

Fish poisoning cases (1991–1992)

Source: South Pacific Epidemiological and Health Information Services (SPEHIS) SPC, Noumea

The South Pacific Epidemiological and Health Information Service records between 3,500 and 5,000 cases of fish poisoning each year (see tables on the following pages). Not all of these are due to ciguatera intoxication.

The effect that fish poisoning has on island societies is largely unknown due to the poor reporting of case histories. To improve the current under reporting, it is necessary to encourage both health and fisheries workers in the region to record cases histories on a standard ciguatera reporting form (attached with this bulletin), and to send them to SPC where they can be entered in a database.

This form can be used as a template for making multiple copies, or, where copying facilities are unavailable, the Resource Assessment Section (contact Paul Dalzell) will be happy to supply copies.

We also would be glad to hear from persons who have criticisms or suggestions for improving the form.

Finally, we would encourage fisheries workers in the region to work in co-operation with their colleagues in their health departments to record all incidents of ciguatera that they hear about. Only with your help can we gauge the true extent of this problem and plan to coordinate future work accordingly.

Countries Currently in South Pacific Commission	jan 91	fév 91	mars 91	avr 91	mai 91	juin 91	juil 91	aoû 91	sep 91	oct 91	nov 91	déc 91	Cum. Total 1/91 - 12/91 Cases	Rates*
American Samoa	0	0	0	0	0	10	0	0	1	3	0	0	14	0.4
Cook Islands	4	3	3	7	16	16	17	8	4	18	10	7	113	6.6
Fiji	73	41	163	91	92	153	116	120	130	71	87	70	1,207	1.7
French Polynesia	60	70	48	36	53	84	47	48	52	47	90	83	718	4.1
Fed. States of Micronesia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Guam	0	0	0	0	1	0	5	0	1	0	10	0	17	0.1
Kiribati	241	0	70	85	0	0	0	0	0	0	0	0	396	5.8
Marshall Islands	7	15	9	11	11	10	11	11	11	10	9	0	115	3.0
Nauru	0	0	0	0	0	0	0						0	0.0
New Caledonia	27	28	17	26	28	13	0	0	0	0	0	0	139	0.8
Niue	0	0	0	0	0	0	0	0	0	4	0	0	4	1.6
Northern Mariana Islands	1	0	1	3	0	0	2	2	0	0	0	0	9	0.4
Palau	0	0	0	0	0	0	0		0					
Pitcairn Island	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Papua New Guinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Solomon Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Tokelau Islands	0	0	0	0	0	0	7	4	12	4	0	47	74	46.3
Tonga	0	0	0	3	0	0	0	0	0	0	0	0	3	0.0
Tuvalu	30	8	33	13	12	25	68	11	4	6	17	30	257	30.2
Vanuatu	51	9	48	52	0	0	0	0	0	0	0	44	204	1.4
Wallis and Futuna	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Western Samoa	8	17	12	12	19	22	6	13	20	21	2	5	157	1.0

* Number of active cases per 1,000 population

Total **3,427**

SPEHIS – Monthly summaries – Fish poisoning – 1992

Countries Currently in South Pacific Commission	jan 92	fév 92	mars 92	avr 92	mai 92	juin 92	juil 92	aoû 92	sep 92	oct 92	nov 92	déc 92	Cum. Total 1/92-12/92 Cases	Rates*
American Samoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Cook Islands	19	15	5	8	6	5	4	27	26	15	13	5	148	8.7
Fiji	141	144	106	66	11	84	92	32	115	179	165	24	1,159	1.6
French Polynesia	91	63	80	66	39	74	48	66	97	42	49	58	773	4.4
Fed. States of Micronesia	0	0	0	0	0	0	0	0	6	0	0	0	6	0.1
Guam	0	0	1	0	0	1	0	0	0	0	0	0	2	0.0
Kiribati	126	89	86	93	219	112	65	51	59	79	61	132	1,172	17.3
Marshall Islands	8	13	5	16	7	13	29	15	44	37	15	14	216	5.7
Nauru													0	0.0
New Caledonia	36	19	15	45	18	13	2	0	0	0	0	0	148	0.9
Niue	0	0	0	0	0	0	1	0	0	0	0	0	1	0.4
Northern Mariana Islands	3	2	0	0	0	1	0	0	0	0	0	0	29	1.4
Palau													0	0.0
Pitcairn Island	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Papua New Guinea													0	0.0
Solomon Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Tokelau Islands	0	0	0	0	0	0	0	0	0	3	6	4	13	8.1
Tonga	0	0	0	3	0	0	0	0	6	1	0	0	7	0.1
Tuvalu	14	17	14	15	19	6	8	31	12	17	9	6	168	19.8
Vanuatu	73	136	81	73	88	77	76	72	60	76	92	105	1,009	7.0
Wallis and Futuna													0	0.0
Western Samoa	17	16	12	18	0	8	2	2	12	14	11	10	122	0.8

* Number of active cases per 1,000 population

Total **4,973**

Secretariat of the Pacific Community
SEAFOOD POISONING REPORT FORM

Please fill in the answers to the questions completely. Tick the boxes where appropriate.

Details of person filling in report form:

Name _____ Job/ Position _____

Contact address _____

Date: _____ Signature _____

Poisoned person's details:

Name _____ Sex (M/F) _____ Age (yrs) _____

Address _____

Details of the seafood that caused the poisoning: *(tick all the boxes that apply)*

Type of food	**Where caught**	**How preserved**	**What eaten**	**How eaten**
Fish _____ ❑	River _____ ❑	Fresh, no ice _ ❑	Head _____ ❑	Unprepared (raw) ❑
Crab _____ ❑	Mangrove ___ ❑	Fresh, iced __ ❑	Flesh _____ ❑	Marinated _____ ❑
Lobster _____ ❑	Beach _____ ❑	Frozen _____ ❑	Skin _____ ❑	Cooked _____ ❑
Other crustacean ❑	Reef patch ___ ❑	Salted _____ ❑	Liver _____ ❑	
Gastropod* ____ ❑	Lagoon _____ ❑	Dried _____ ❑	Roe _____ ❑	
Bivalve* _____ ❑	Outer reef ___ ❑	Smoked _____ ❑	Other organs	**How many others**
Other mollusc __ ❑	Open sea ____ ❑	Pickled _____ ❑	(specify)	ate this meal? _____
Other (specify)	Other (specify)	Other (specify)	_____ ❑	felt sick? _____
_____ ❑	_____ ❑	_____ ❑	_____ ❑	were admitted _____
Unknown _____ ❑	Unknown ____ ❑	Unknown ____ ❑	Unknown __ ❑	to hospital? _____

What is the local name of the seafood? _____
What is the English name of the seafood? _____
Name of vendor or restaurant (if bought) _____
Name of place it was caught (if known) _____
When was the food eaten? Date _____ Time _____
When did you first feel sick? Date _____ Time _____

* *Gastropods are one-shelled seafoods like snails, trochus, conches, etc.*
Bivalves are two-shelled seafoods like clams, mussels, cockles, oysters, etc.

Symptoms: *(tick all the boxes that apply)*

Burning or pain when touching cold water ____ ❑	Pin pricking sensation on touching water _____ ❑	
Tingling or numbness sensations _____ ❑	Strange taste in mouth _____ ❑	
Difficulty or pain in urinating _____ ❑	Skin itching or redness _____ ❑	
Difficulty in breathing _____ ❑	Excessive salivation _____ ❑	Fever or chills _____ ❑
Difficulty in walking _____ ❑	Excessive sweating _____ ❑	Headache _____ ❑
Difficulty in talking _____ ❑	Diarrhoea _____ ❑	Joint aches _____ ❑
Eye irritation _____ ❑	Vomiting _____ ❑	Muscle cramps _____ ❑

Medical data:

Pulse _____ Blood pressure _____/ _____ Pupils _____

In case of death:

Date of death _____ Autopsy findings _____

Other information _____

Please return this form to: **Secretariat of the Pacific Community, BP D5, Nouméa Cedex, 98848 New Caledonia**

THANK YOU