Management of ciguatera fish poisoning in the South Pacific[1].

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Abstract

Catches of near-shore or coastal fish continue to be a major source of animal protein for the nations of the South Pacific region. Nominal landings of near-shore fishes amount to about 90,000 t/yr, about half of which is reef fish. Ciguatoxic fishes are found throughout much of the region but in some locations, such as the island of Niutao in Tuvalu, there is a comparatively high risk of intoxication associated with eating reef fish. Ciguatoxic fish are normally avoided, but where this is not possible due to lack of an alternative food source, they are readily consumed. The risk of poisoning is considered acceptable by the community and ciguatera is generally not regarded as a significant health problem in most island countries. This low level of concern with ciguatera is reflected in the attitude of general practitioners and other medical staff, who are reluctant to see ciguatera given priority over more serious public health problems.

Although ciguatera is of relative low priority as a medical problem in the region, fisheries development initiatives should aim to reduce the risk of ciguatera by improving supplies of non-toxic deep reef slope species and pelagic species caught in the open sea away from the reef. Elsewhere, ciguatera management is probably best focused on limiting the impact of fish poisonings on tourism and reef fish exports. Initiatives to improve the management of ciguatera such as the South Pacific Commission seafood poisoning database are discussed.

Introduction

Dalzell (1992aJpresented an overview of ciguatera in the South Pacific from the perspective of fisheries development In common with statistics on other illnesses, ciguatera cases are incompletely documented in the region. The South Pacific Epidemiological and Health Information Service (SPEHIS), maintained by the South Pacific Commission's Health Programme, records numbers of cases of fish poisonings reported by national health departments, which it is assumed represent mostly ciguatera intoxications. The annual number of reported cases of ciguatera rose from about 1000 in 1973, to between 3-4000 by the mid to late 1980s and then declined to around 2500 cases by 1992 (Figure I). Lewis (1986) suggested that reported case histories account for about only 20 % of actual incidence of ciguatera in the region as a whole The marked increase of fish poisoning case histories from 1985 onwards may be due to improvements in diagnosing ciguatera and a response to data collection efforts in the region rather than a rise in the occurrence of intoxication through eating fish.

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Landings of coastal fishes in most of the islands of the South Pacific come from coral reefs and lagoons (Table I). In many locations fish is still a principle source of animal protein and forms a major component of subsistence diets and for the smaller countries of the region, fish stocks represent one of the few viable economic resources that have potential for development. Outbreaks of ciguatera, besides posing a health risk, may have detrimental effects on fish production and marketing through adverse publicity and litigation.

The key issues that faces health and fisheries workers in the South Pacific are. :

1. How big a problem is ciguatera to community health and the economy?

2. If ciguatera is a serious problem, how and where should resources be focused in managing ciguatera?

Dalzell (1992) presented a summary of the characteristics of Pacific Island fisheries and discussed the possible effects of ciguatera on the development fisheries. A similar summary is given here as a preliminary to the main focus of this contribution which is concerned with what steps can be taken to limit the effects of ciguatera outbreaks in the region.

South Pacific reef fisheries

Statistics on the composition and distribution of landings from reef and other coastal fisheries in the South Pacific, are on the whole, poorly developed. Coastal fishing in the South Pacific is characterised by the use of small scale fishing methods catching a wide variety of species and landing fish at many locations along the coast. This, plus the limited manpower of most fisheries departments in the region, results in only poor coverage of fisheries production.

The nominal coastal fin-fish landings for the South Pacific region are given by country in Table 1 Also included in Table 1 are land area, population and mean annual incidence of ciguatera cases from SPEHIS records Nominal landings should not be confused with absolute values, rather this is the best estimate that can be made given the sources of data that are currently available The total estimated fisheries production for the region is about 90,000 t/yr (Table 1), although this figure is almost certainly biased downwards. Assuming a regional average value of $ US 2.00jkg for the value of these landings then the nominal value of coastal production in the region -were it to reach market -amounts to about $ US l74,000,000/yr

Given the quality of the data on fisheries landings and on the incidence of ciguatera, it is difficult to draw any firm conclusions from the data in Table 1. As might be expected, the volume of fish production per capita tends to be highest in the smaller, less-developed islands and atolls with limited land area and long traditions of fishing These locations also record the highest incidence of ciguatera (Figure 2) Fresh fish production (and consumption) is lowest in the large islands of Melanesia, where some of the population live in the interior (especially PNG) and people traditionally look to the land as a principal source of food.

The percentage of the total fish landings that comprise reef fish ranges from 7 to 88% with a mean of 51 % (Table I). Nominal composition by family of reef fish landings from several islands in the Pacific are given in Table 2. Of the families listed in Table 2 about half contain species in which ciguatera is known to occur at different locations in the South Pacific. Certain species SUC as the small surgeon fish *Ctenochaetus striatus,* the snapper *Lutjanus bohar* and barracuda *(Sphyraena* spp) are by tradition known to be a health risk out are still occasionally consumed despite the danger of poisoning. In some areas, these species are known not to be ciguatoxic and are safely consumed.

Fishing for reef fish in the South Pacific is accomplished mainly with hand-lines, traps, nets and spears, deployed from dinghies or canoes. Lock (1986) presented observations of the composition of the catch taken by different fishing gears deployed on the South Papuan Barrier Reef off Port Moresby (Table 3) Hand-lines select mostly for carnivorous species, which may be ciguatoxic through the ingestion of already contaminated prey species. Spearing and net fishing take a wider range of species, including reef herbivores that become ciguatoxic through the ingestion of the dinoflagellate, *Gambierdiscus taxicus* Catch rates of such small scale artisanal gears are modest at best -on average 1-4 kg/man-hour, depending on the gear (Dalzell & Wright 1986) –and there may be a disincentive for fisherman to return a portion of the catch to the sea simply because of suspected ciguatoxicity.

Food accounts for about 20 % of all imports into Pacific Island countries as opposed to less than 10 % of imports into the metropolitan countries (Dalzell 1992b). Domestic food production, and hence fisheries production, is important to diminish the reliance of the Pacific nations on imported foods. However, as island populations increase, fish harvests will also increase correspondingly, both in the subsistence and commercial sectors. There evidence to suggest that in some countries of the region, harvest levels from coastal fisheries are already very high and are fishing pressure is unlikely to diminish. The main objective for fisheries managers and administrators are developing fish production and maintaining it at optimum level

Ciguatera and fisheries development

Current improvements in shallow water reef fishing include more widespread use of outboard motors, the introduction of monofilament nets and lines and better facilities for the fishermen to dispose of their catches. In domestic markets catches are increasingly being sold at locations distant from their point of origin. In Fiji, catches made in Labasa on Viti Levu are sent to Suva where there is a greater demand for fish (Anon 1992). In the Cook Islands catches from Palmerston Atoll form a large proportion of the fresh fish supplied to the main island of Rarotonga (Anon 1988a). Reef fishes are flown from the coast of Papua New Guinea (PNG) to markets in the towns in the highlands region of the country (Dalzell unpub. data).

Shallow reef fishes are also increasingly being targeted for export to overseas markets where they realise a higher sale price than on domestic markets. About 190 tonnes of fish, mainly reef species, were export from Kiribati to Honolulu between 1988 and 1989 (Anon. 1991a) Reef fish are regularly from Truk and Palau to Guam and the Northern Mariana Islands in response to increased demand for fresh fish in these islands and overfishing of domestic stocks (Anon. 1991 b, Dalzell. unpub. data). Reef fishes, mainly wrasse and groupers, are caught in the northern islands of PNG and kept alive for sale in Hong kong. A similar type of operation was conducted from Palau to Hong Kong before concern over leves of fishing pressure forced the closure of the fishery (Johhanes 1991). Reef fish have also been exported from Fiji and Tonga to New Zealand and Hawaii, and from the Solomon Islands to Japan (G. Preston South Pacific Commission, pers. comm.). Recently, the possibilities have been explored of air freighting reef fish from southern PNG to markets in Australia (A.D Lewis South Pacific Commission, pers. comm).

A major new developments in coastal fishing in the last 15 years has been the establishment of commercial fisheries in the Federated States of Micronesia (FSM), Fiji, Vanauatu, PNG, Tonga

Hawaii, American Samoa and Western Samoa for the snappers and groupers that live on the deep reef slope The deep reef slope is commonly defined as the depths between 80 and 400m and is usually fished with hand-lines mounted on reels or with bottom longlines. About half the catch from the deep reef slope are snappers and about 70 per cent of these belong to the subfamilies Etelinae and Apsilinae. Many of these species, which can realise high prices on overseas markets, have not been implicated in ciguatera poisonings and are therefore an added attraction for coastal fishermen (but see further below).

Since the 1950s, aquaculture of fish and invertebrates has been developed in the South Pacific as a supplement to capture fisheries production. Absence of ciguatoxicity in freshwater fishes such as tilapia in Fiji and carp in PNG is thought to be a contributing factor to the success of aquaculture in these countries.

In recent years there has also been growing interest in catching large pelagic species such as yellowfin and big-eye tunas for both domestic and overseas markets. This in turn has led to research and trials of small scale gears and crafts suitable for use by coastal fishermen. Exports of both pelagic and deep slope fish have in the main been limited to those countries that have established air-links with Japan and the United States. However, production from these fisheries for export markets has shown the economic potential of these resources and provided incomes for fishermen.

Ciguatera as a regional health issue

A range of different illnesses and afflictions are compiled in the SPEHIS database from Pacific Islands health department reports. The top fifteen of these different disease/illness categories are shown in ranking order in Figure 3. As with the fish poisoning figures the level of under reporting is unknown and some countries may report few medical statistics. Fish poisoning (which it is assumed represents mainly ciguatera) is ranked eighth in importance in the SPEHIS database.

The information is somewhat misleading as the high incidence of yaws is based on cases reported mainly from the Solomon Islands. Similarly, the incidence of malaria is confined to Papua New Guinea, the Solomon Islands and Vanuatu However, acute respiratory infections and gastro-intestinal infections are more evenly spread throughout the Pacific and are clearly the major health issue in the region. Dalzell & Gawel (1989) reported that respiratory tract infections and gastro-intestinal diseases are the main concern of the Health Department in the Federated States of Micronesia, particularly amongst the young who comprise the majority of the population.

The non-communicable nature and relatively low mortality rates from ciguatera mean that while the risk of fish poisoning is acknowledged, health departments place higher priorities on other health problems Mannitol perfusion may be. used to treat severe cases of ciguatera where this treatment has been approved. The most effort health departments are likely to devote to ciguatera, however, is publicising those species which it is dangerous to consume and sometimes restricting marketing of those species.

Despite the possible impact of ciguatera on the fisheries in the South Pacific, there appears to be little concern about this form of intoxication from fisheries departments in the region. Fisheries officers may express interest in ciguatera, particularly if these is an outbreak in their country, but in general it does not appear to be given a very high priority.

There is a wealth of fisheries related literature concerning ciguatera in the South Pacific. A search of the Commission's document archives showed that ciguatera was discussed at the first fisheries conference in 1952 (SPC 1952); was the subject of an SPC technical paper in 1963 (Banner et al 1963); and has been the topic of several workshops and conferences (SPC 1968, 1978, 1981, 1988). The Commission has also produced a handbook on ciguatera in 1973 (Bagnis 1973) and the Inshore Fisheries Research Project formed a Ciguatera Special Interest Group in 1991 which has published two bulletins in 1991 and 1992.

Besides the activities of the South Pacific Commission, there have been regular international meetings, symposia and workshops on the subject of ciguatera, held within the South Pacific and other areas of the tropics where ciguatera is a persistent problem. Despite these meetings, reports and publications, however, there has been little in the way of requests for assistance from the various member countries of the Commission to deal with the problems of ciguatera.

The SPC seafood poisoning database

In the absence of any reliable information on ciguatera from most of the South Pacific (French Polynesia, Hawaii and Australia are the exceptions), the South Pacific Commission established a regional seafood poisoning database in late 1990. The database was created using the programme Filemaker (Claris Corporation) on a Macintosh computer. The files can be readily translated, however, into other formats.

Both fisheries and health workers have been contacted to report cases of fish poisoning using the form shown in Figure 4. A version has also been produced in French for Francophone territories. The establishment of the database and the request for fisheries and health workers to report case histories has been publicised repeatedly in SPC publications and more recently in national newspapers and by radio Unfortunately, in-country training in the use of the form has been (in general) lacking Despite the repeated attempts to encourage the reporting of cases, the response from countries has been very variable.

To date over 400 case histories have been collected from eight countries in the South Pacific. The breakdown of case histories from the different countries of the region is given in Table 4. A large number of case histories has been compiled from Tuvalu and to a lesser extent from New Caledonia alia the Federated States of Micronesia. Case histories from elsewhere are limited or non-existent, even from countries known from the SPEHIS database to have a high incidence of ciguatera such as Kiribati, Tokelau and the Marshall Islands (see Table 1). This may be due to the priority accorded to ciguatera by national medical departments and the lack of training for medical and fisheries personnel in the collection of case history data.

The species responsible for intoxications are listed by country in Table 4. Not all intoxications are likely to be due to ciguatera and case histories involving skipjack tuna *(Katsuwonus pelamis),* herring *(Herklotsichthys quadrimaculatus)* and snake mackerel *(Promethichthys prometheus)* are probably the result of some other form of poisoning. Several invertebrates such as crabs, lobsters, clams and sea cucumber, have also been involved in a number of poisonings, although again, another form of toxin other than ciguatera probably was responsible for causing illness.

Given the complexities of coral reef fish taxonomy and the majority of case histories recorded by medical personnel, it is not surprising that many of the reports do not identify precisely the fish responsible for intoxications. Thus it is common, for example, for the person poisoned to give a local generic term for surgeonfishes, groupers and parrotfish Occasionally some local words for particular fish are for individual species. Good examples are the blue-line surgeon fish, *Acanthurus lineatus,* and the convict tang, *Acanthuus triostegus,* which in Tuvalu are known as 'ponelolo' and 'manini' respectively. Indeed, manini is a common name for *A. triostegus* in much of Polynesia, where it is a common food fish. However, in many of the poisonings reported from Tuvalu involving surgeonfish, the term 'pone' is used as a generic term for all acanthurids.

Intoxications involving surgeonfish (20.7 %) and parrotfish (12 %) together account for about one third of all case histories in the database. Other families responsible for ≥ 10 % of intoxications include the groupers (15 %) and the snappers (10 %). Besides *A. lineatus* and *A triostegu,* other species commonly implicated in poisonings are the snappers *Luljanus bohar* and *L. monostigmus,* the groupers *Plectropoma* spp. and *Cephalopholis argus,* and the soapfish, *Grammistes sexlineatus.*

Surgeonfish and parrotfish are two of the common families of fishes on coral reefs and may form major fractions of the landings in a reef fishery. At two locations in Papua New Guinea, surgeonfish and parrotfish together formed about 12 % of landings from reef fisheries in the north and south of the country (Dalzell & Wright 1986). Parrotfish and surgeonfish accounted for one third of the commercial landings of reef fish in Palau between 1976 and 1990 (Kitalong & Dalzell 1991) In the Philippines, parrotfish and surgeonfish formed 16 and 27 % of landings from two coral reef fisheries (Bellwood 1988; Alcala & Russ 1990). Sims (1988) estimated that imports of fish into Rarotonga from Palmerston Atoll were composed mainly of parrotfish (7080%) and that total annual landings of parrotfish ranged from 15 to 20 t. Smith & Dalzell (1991) found that surgeonfish and parrotfish comprised about 74 % of landings from community spear and net fishing on Woleai Atoll in Micronesia and that the Scaridae and Acanthuridae accounted for between 60 and 90 % of the fishable biomass on lagoon back reefs.

Grazing herbivores such as the parrotfish and surgeonfish are likely to be toxic if a ciguatera outbreak occurs on a reef and thus an sizeable fraction of the fishable stocks on reefs may become a health risk. The same is true of the snapper *L. bohar,* which one of the most common predatory species on coral reefs and is widely distributed throughout much of the tropical Indian and Pacific Oceans. This species may acconnt for up to half the fish caught by handlines in some locations in the Pacific (Dalzell & Preston 1992) but may be rejected due to its reputation for toxicity. Sale of *L. bohar* is prohibited in Mauritius due to its toxic reputation, although this species is a dominant feature of handline catches at the banks and islands of the western Indian Ocean (Wheeler & Ommanney 1953).

Some information is presented here on the symptoms resulting from seafood poisoning (Figure 5). Only those case histories that referred to reef fish and fish from the reef slope were used to make these summaries so that it is assumed that the symptoms refer to ciguatera intoxication When the symptoms from the entire data set are ranked by frequency the five most common maladies are joint aches, headache, temperature reversal and diarrhoea and muscle cramps.

Two subsets were created to look at the distribution of symptoms from the consumption of obligate herbivorous fish and for those arising from the consumption of carnivorous species (Figure 6). The five most common symptoms from eating herbivorous fishes were joint aches, headache, diarrhoea, temperature reversal and vomiting. Eating carnivorous fishes most commonly causes joint aches, headache, temperature reversal, muscle cramps and tingling & numbness Gastro-intestinal maladies such as vomiting and diarrhoea do occur but with less frequency.

Similar analyses can be conducted for individual species or species groups. Further summaries can be made of combinations of any of the different data in the database. Collection of case history data will continue and further efforts will be made to increase the rate of reporting, particularly from those countries where ciguatera is relatively high but case histories are not forthcoming.

Management of ciguatera

If ciguatera is not perceived as a serious health risk in most places, then this should guide the approaches taken to manage this problem. In locations such as Papua New Guinea (PNG), the incidence of ciguatera is very low although cases of ciguatera do occur intermittently A search through the PNG Medical Journal from the early 1950s to the present did not uncover a single case of ciguatera poisoning, although reports were given of turtle meat poisoning (Dewdney 1967), paralytic shell fish poisoning (Rhodes et al 1975) and scombroid fish poisoning (Barrs 1985) A summary paper by the PNG Department of Fisheries & Marine Resources (DFMR) (Anon 1988b) lists five outbreaks of ciguatera that occurred between 1971 and 1981 at Port Moresby, Finschhafen, Milne Bay and New Hanover.

The species involved in the poisonings were coral trout *(Plectropoma* sp.), red bass *(Lutjanus bohar),* parrotfish *(Scarus strongylocephalus)* and barracuda *(Sphyraena* sp.). In all cases no fatalities were recorded and most people recovered within three to five days. The only recorded instance of a commercial ban on the purchase of species on the basis of its suspected ciguatoxic effect is that of the Milne Bay Fishing Authority in regard to the red bass, *L. bohar* The general consensus from the DFMR summary is that ciguatera is only a minor problem and that the importance of fish to the economy and diet of the country is such that it would be imprudent to ban all or any species of which a few individuals may be dangerous to eat.

There are, however, places where ciguatera is a very serious problem These are in the main small atolls or coral island where per-capita fish and seafood consumption is very high (Table I). A good example for which a substantial quantity of information is available is Niutao Island in the Tuvalu archipelago. Since the establishment of the SPC database in 1990, over 200 cases of ciguatera have been reported from Niutao Island in the past two years. For a population of almost 1000 people this is an incidence rate equal to about 10 % of the population per year.

Niutao is not an atoll but a single small coral island, 226 ha in area, that encloses a small landlocked brackish lagoon and is surrounded by a fringing reef with an area of about 108 ha. Kaly et al (1991) reported 80 case histories from the Niutao ciguatera outbreak which commenced towards the end of 1988, some months prior to a programme of subtidal reef blasting to create boat passages. Some blasting was conducted on the reef at Niutao in 1981 to create a boat channel but this was not followed by a serious outbreak of ciguatera. According to Kaly et al, there were on average fewer than three cases of ciguatera per year prior to 1988 resulting from the consumption of susceptible fish such as *L. bohar*. The outbreak, which begun in 1988, shows no signs of abating. The time series of the monthly frequencies of ciguatera cases, taken from the SPC database (Figure 7), shows that intoxications occur throughout the year but with much variation between months.

Given the isolation of Niutao and its limited land area, animal protein must necessarily come from the sea. However, eating reef fish is clearly a risk on this island and persons are likely to be exposed to ciguatoxins on a regular basis through the consumption of reef fish. Since fish must necessarily continue to provide a staple source of protein for the islanders of Niutao, the most effective approach to managing the problem is to increase the supply of other non-toxic fish. This means targeting on large and small pelagic species that live in the waters beyond the reef, and on the demersal snapper and grouper stocks of the deep reef slope.

Most of the pelagic and deep slope species are normally not ciguatoxic and can be consumed without risk of intoxication. Schools of small pelagic fishes can be caught with handlines and nets by aggregating schools around lights at night. Large pelagic species (tunas, billfish, wahoo, barracuda, jacks) are caught mainly by trolling or by droplining. Fishermen traditionally have trolled and drop lined around islands at spots known from experience to be places where tunas aggregate, or looked for flocks of birds above schools of tuna feeding on smaller pelagic fishes such as the ocean anchovy *(Encrasicholina punclifer).* Deployment of fish aggregating devices (FADs) can be a great benefit to fishermen by concentrating stocks of tunas and other large and small pelagic fishes. Further, catches of pelagic species in many parts of the Pacific is seasonal and deployment of FADs may greatly extend the period when such species can be caught. Large pelagic fish stocks are also less likely to be depleted through fishing than the nearshore stocks of reef fish.

The community of fishes on the deep reef slope comprises mainly large snappers, groupers, emperors and a mix of other species including oilfish, jacks and barracuda. The deep slope dwelling snappers (sub-family Etelinae) have not been implicated in causing fish poisoning, as opposed to the shallow reef snappers (sub-family Lutjaninae). Although carnivorous, the diet of the Etelinae is mainly restricted to fish and benthos from the immediate environment (Parrish 1987) and not shallow reef dwelling herbivores. The same is probably true for grouper species such as *Epinephelus septenifasciatus, E. cometae* and *E. miliaris* that live on the deep reef slope. .

Stocks of deep slope species are more limited then pelagic fishes, particularly around small islands and atolls where the steep submarine gradient of the island shelf limits the deep slope habitat. However, subsistence catches of deep slope species could play their part in displacing reef fish from the diet where ciguatera is a severe problem. The South Pacific Commission has been instrumental in successfully introducing the simple technology required to catch deep slope fishes in a number of countries of the region.

It should be stressed here however, that catches of deep reef slope species may contain some species that range between the shallow reef and the deeper waters away from the reef. In Hawaii the amberjack *(Seriola dumerili)* has been implicated in a number of ciguatera outbreaks, despite being caught predominantly from the deep reef slope. Outbreaks of ciguatera led to the demise of the fishery for this species which amounted to about 30 tonnes annually (Humphreys 1986) Similarly, catches of deep slope fishes in throughout much of the South Pacific include the snapper *Lutjanus bohar* Unlike the eteline snappers, this species is found throughout the water column and is an opportunistic predator (Wright et a 11986) with a diet that includes reef fish. *L. bohar* comprised 8 % by weight of the catches of deep slope species in the South Pacific reported in SPC fishing surveys (Dalzell & Preston (1992). For the atolls and coral islands only, catches of *L. bohar* amounted to about 15 % of the total landings. Thus, although deep slope species can be an important supplement to the diet, potentially toxic fish may still be caught.

Similar strategies can be adapted for other countries where small islands are severely affected by ciguatera. In larger coral atolls where there is a substantial lagoon and reef area, sites that are known to produce ciguatoxic fish can be avoided in favour of safe fishing grounds. Development of pelagic and deep slope fisheries should be pursued, however, so that the resource base in widened resource base is widened and reef fish is not the sole source offish protein. However, people may persist in fishing in known risk sites and eating fishes which are recognised as being potentially dangerous It will be difficult to control consumption of fish in most countries and there is an accepted risk in eating reef fishes even in those islands where they may be ciguatoxic. Management under these circumstances should be restricted to publicising those species which are known to be implicated in causing ciguatera.

A number of countries and territories of the South Pacific are heavily dependant on aid to maintain their economies. The typical island state is small and it has few natural resources. Trade between other islands is also limited because what one island can offer, the products of subsistence farming and fishing, can be found on most other islands. Islands that produce cocoa, palm oil and copra are competing against much larger producers elsewhere in the tropics. Revenues are accrued from permitting foreign fishing vessels to catch tuna within the 200 n.mi exclusive economic zones (EEZ) of some of the Pacific Islands.

Some manufacturing enterprises do exist but are small and generally serve limited domestic markets. Further, imports of raw material tend to be costly because relatively small quantities have to be shipped over long distances. Probably the greatest economic potential for many of the South Pacific Islands, particularly those with limited natural resources, is tourism (Anon 1991 c). In some countries such as Fiji, Vanuatu, and parts of Micronesia, tourism is a major source of revenue and employment. Other countries in the region are trying to develop a better tourist industry infrastructure and increase earnings from this sector of the economy.

Ciguatera can be a threat to the hotel and restaurant business and to the tourist trade in general. The results of intoxication may include loss of business for the individual establishment and potentially for a particular location if the problem is severe enough. Further, there is the added risk of litigation brought by persons who have been poisoned. Hotels and restaurants in countries where tourism is important should be clearly informed about which fishes are in the high risk category. This is particularly important in institutions that have chefs and kitchen staff from overseas and who may not be familiar with potentially toxic fish, and where perhaps, fishermen may tend to sell suspect fish rather that might be rejected by local consumers.

Most nations in the South Pacific have devoted considerable resources to expanding commercial fishing industries As described earlier, increasing volumes of reef, pelagic and deep slope fishes are being sent to markets in Japan, Hawaii, New Zealand and Australia from Pacific Islands to take advantage of high market prices. Outbreaks of ciguatera poisoning can have adverse effects on all coastal fisheries since, in the mind of retailers and consumers, even fish which are perfectly safe may be feared. As with tourism, litigation may be brought against fishermen and exporters with adverse consequences for an expanding fishing industry.

If countries manage to establish exports of reef fish to overseas markets, then high risk species such as *Lutjanus bohar,* moray eels, barracuda and some surgeonfish (eq. *Acanthurus lineatus, Acanthurus triostegus, Ctenochaetus striatus)* might be proscribed from export. Unlike subsistence production, the scale of fish exports is likely to be such that control and management can be effectively implemented. Fishes that are sent for export should be scrutinised and checked as to the location of the catch, particularly if reef areas with ciguatoxic fish are known to exist. Commercially manufactured and affordable tests for ciguatera have been developed (Park 1992) and, when freely available, might be considered for routine testing of export fishes.

In summary, prevention of ciguatera in the general population of the South Pacific is likely to be very difficult to achieve given the limited resources available. In islands where ciguatera occurs people are usually aware of the locations where fish are toxic. Exposure to ciguatera does not act as a complete deterrent to eating fish or even fish that are known to be ciguatoxic and this appears to be an accepted risk amongst many Pacific Islanders. The management of ciguatera is therefore probably best directed at those industries that generate earnings for the countries of the region — tourism and export fisheries — and which need protecting from the adverse effects of intoxications. A combination of education, inspections, regulations and testing should be devised to prevent ciguatoxic fish being sold abroad or used in the tourist industry.

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Table 1. Summary of land area, population and fisheries statistics, and incidence of ciguatera for South Pacific states and territories

Country/Territory	Land area (km^2)[a]	Population (N)[b]	Nominal fish landings(t)	Ladings/capita (kg)	Percent of reef Fish in landings	Incidence f ciguatera (cases/1000)[t]
America Samoa	201	33,000	300[c]	9.1	680[c]	0.34
Cook Islands	240	17,200	1,100[c]	64.0		4.20
Fiji	18,274	715,375	21,500[e]	30.1	638[e]	1.70
French Polynesia	4,000	197,000	1,719[d]	8.7		5.10
Guam	541	106,000	547[d]	5.2	71[m]	0.76
Kiribati	710	68,207	12,300[g]	180.3	406[n]	11.40
Marshall Islands	701	36,090	200[d]	5.5		4.40
Nauru	21	8,900	190[u]	21.3	600[x]	0.07
New Caledonia	18,734	164,173	3,863[d]	23.5	848[o]	0.96
Niue	259	2,200	60[h]	27.3	500[h]	0.40
Northern Mariana Islands	478	20,350	322[d]	15.8	483[m]	1.40
Palau	488	16,000	1,050[i]	65.6	884[i]	
Pitcairn Island	4.5	53	8[v]	15.0		
Papua New Guinea	462,840	3,592,900	25,554[d]	7.1	333[p]	0.02
Solomon Islands	28,370	307,597	800[j]	26.0	657[q]	0.02
Tokelau	12.2	1,690	137[k]	81.1		12.00
Tonga	780	94,535	2,700[d]	28.6		0.06
Tuvalu	24	8,230	927[d]	81.1	635[r]	9.55
Vanutau	12,190	142,630	3,249[l]	22.8	170[l]	4.60
Willlis & Futuna	153	14,000	1,000[d]	71.4		0.50
Western Samoa	2,831	156,349	3,500[d]	22.4	324[s]	0.17
TOTAL	552,551.7	5,775,639	89,632			
MEAN				43.9	51.9	288

a & b. Douglas & Douglas (1989)
c. Wass (1980)
d. FAO(1991)
c. Anun(1992)
f. Dalzell (unpub. data)
g. Mees Yeeting & Taniera (1988)
h. Dalzell et al (1990)
i. Kitalong & Dalzell (1991)
j. Anon (1987)
k. Based on computations from fish consumption data for atolls in Kiribati (Walter & Banabiti 1977) and Tuvalu (Chambers 1984)
l. David & Cillauren (1988)
m. Hamm et al (1991)
n. Anon (1991b)
o. Anon (1988c)
p. Dalzell & Wright(1986)
q. Crossland & Grandperrin (1979)
r. Chambers (1984)
s. Preston et al (in press)
t .Average of year 1986-1990 from SPEHIS database, except for Solomon Islands and Nauru, from Lewis 1986.
u. Auou (1988d)
v. Dalzell (unpub data from monthly fish reports in Pitcairn Miscellany)
x. Dalzell (unpub data from sampling fish landings July—December 1992)

Table 2. Composition of reef fish landings from different locations in the South Pacific. Asterisks denote those families with species known to become ciguatoxic

Family	Fiji[a]	PNG[b] (North)	PNG[b] (South)	Solomon Islands[e]	Kiribati[d]	Palau[e]	Woleai atoll (Yap, FSM)[f]	Tikehau Atoll (French Polynesia)[g]
Lethrinidae*	16.7	10.0	29.0	6.2	7.8	14.0	4.0	6.0
Chanidae		2.0						
Balistidae*		2.0					4.0	2.0
Albulidae		1.0			16.5			2.0
Hemiramphidae			1.0					
Serranidae*	13.7	9.0	3.0	6.6	3.1	9.0	3.0	4.0
Scombridae*	20.9	3.0	10.0	15.3	24.3			
Carangidae*	8.6	14.0	8.0	10.2	3.2	4.0		18.0
Mullidae*	1.6		5.0	5.1	2.9	1.0		10.0
Lutjanidae*	9.7	13.0	5.0	19.2	11.1	12.0	1.0	6.0
Acanthuridae*	2.0	5.0	7.0	6.4		14.0	39.0	16.0
Scaridae*	7.0	8.0	5.0	11.5		18.0	35.0	10.0
Belonidae	0.3		5.0	3.9				
Polynemidae	0.8							
Elopidae	0.1							
Mugilidae	8.4	21.0	4.0		3.3	1.0		6.0
Siganidae*	1.0	1.0	6.0			10.0	5.0	2.0
Sphyraenidae*	5.0			3.9	3.2			2.0
Trichuridae	0.7							
Leiognathidae	1.5							
Gerridae	0.3		2.0		5.3	0.0		
Haemulidae*	1.2	3.0	4.0	5.4		0.0		
Theraponidae	0.5							
Others		8.0	6.0	6.3	19.3	17.0	9.0	16.0
Total	100	100	100	100	100	100	100	100

a. Anon (1992)
b. Dalzell & Wright (1986)
c .Crossland & Grandperrin (1979)
d. Anon(1991)
e. Kitalong & Dalzell (1991)
f. Smith & Dalzell (1991)
g. Morize (1985)

Table 3. Catch composition by different artisanal fishing methods on reef fish stocks on the South Papuan Barrier Reef. Asterisks denote those families with species known to become ciguatoxic

Family	Fishing method				
	Spear	Handline	Gillnet	Drive-in net	Surround net
Carcharinidae			1	2	
Mylobatidae				1	
Chanidae			2	1	
Hemiramphidae					3
Belonidae					1
Serranidae*	21	10	3		1
Carangidae*	5	7	11	13	4
Lutjanidae*	3	12	13		6
Gerridae				3	
Haemulidae*	14		10	5	1
Lethrinidae*	1	65	42	31	37
Sparidae					
Mullidae*				3	12
Mugilidae				11	
Platacidae	4				
Kyphosidae	8		2		1
Sphyraenidae*	2			1	
Labridae*	2				2
Scaridae*	3		1	7	10
Acanthuridae*	]7		2	2	17
Siganidae*				8	5
Scombridae*	17		11	5	
Balistidae*		3		1	
Others	3	3	2	6	
Total	100	100	100	100	100

Table 4. Summary *of* species implicated in fish poisoning by country in the South Pacific Commission seafoods poisoning database. Fishes that could not be identified *to* the species level are grouped as miscellaneous under the family taxon

Species	Fiji	Federated States of Micronesia	Kiribati	Marshall Is	Nauru	New Caledonia	Niue	Tuvalu
DAMSEL FISH								
Abudefduf spp								1
SURGEONFISH								
Misc. Acanthuridae								41
Acanthurus leucopareius								1
A. lineatus	1							16
A. triostegus								22
Ctenochaetus striatus	2							
Naso brevirostris								
N. unicornis						1		
TRIGGERFISH								
Misc. Balistidae								1
JACKS & SCADS								
Carangoides ferdau								4
Caranx ignobilis		1						2
Decapterus macarellus	1							
SHARKS								
Carcharinus longimarus								7
Shark sp	1							
BUTTERFLYFISH								
Misc. Chaetodontidae						1		1
WRASSE								
Chelinus undulatus		4						
SOAPFISH								
Grammistes sexlineatus								16
MORAY EELS								
Gymnothorax javanicus	1							5
HERRINGS								
Herklosichthys quadrimaculatus	1							
SOLDIERFISH & SOUIRRELFISH								
Misc. Holocentridae								12
Sargocentrum spiniferum								2
TUNA								
Katsuwonus pelamis	1							1
DRUMMERS								
Misc. Kyphosidae								2
EMPERORS								
Misc. Lethrinidae			1			4		
Lethrinus elongatus								3
Monotaxis grandoculus	1							4

Species	Fiji	Federated States of Micronesia	Kiribati	Marshall Is	Nauru	New Caledonia	Niue	Tuvalu
SNAPPERS								
Misc. Lutjanidae						2		4
Lutjanus argentimaculatus		1				1		
L. bohar		7		1	1			12
L. gibbus								1
L. monostigmus								12
L. sebae						2		
Symphonus nematophorus						1		
FILEFISH & LEATHERJACKETS								
Misc. Monocanthidae								12
MULLET								
Misc. Mugilidae						1		
GOATFISH								
Misc. Mullidae								1
SNAKE-MACKEREL								
Promethichthys prometheus	1							
PARROTFISH								
Misc. Scaridae	1					5		45
GROUPERS								
Misc. Serranidae						9		25
Cephalopholis argus								9
Epinephelus sp				2				
Epinephelus cyanopodus						1		
E. fuscoguttatus								3
E. melanostigma								1
E. microdon								1
Plectropoma spp.						10		
RABBITFISH								
Misc. Soleidae								1
SOLES						1		
Misc. Soleidae								
BARRACUDA								
Misc. Sphyraenidae		9					2	5
Sphyraena jello						2		
Unknown fish		12				4		21
Crabs								
Carpilius maculatus								1
Scylla serrata		1						
CLAMS								
Chama pacifica								2
SEA CUCUMBERS								
Misc. Holothuridae		8						
SPINY LOBSTER								
Panulirus spp.								4
Total number of case histories	2	54	1	4	1	53	2	305

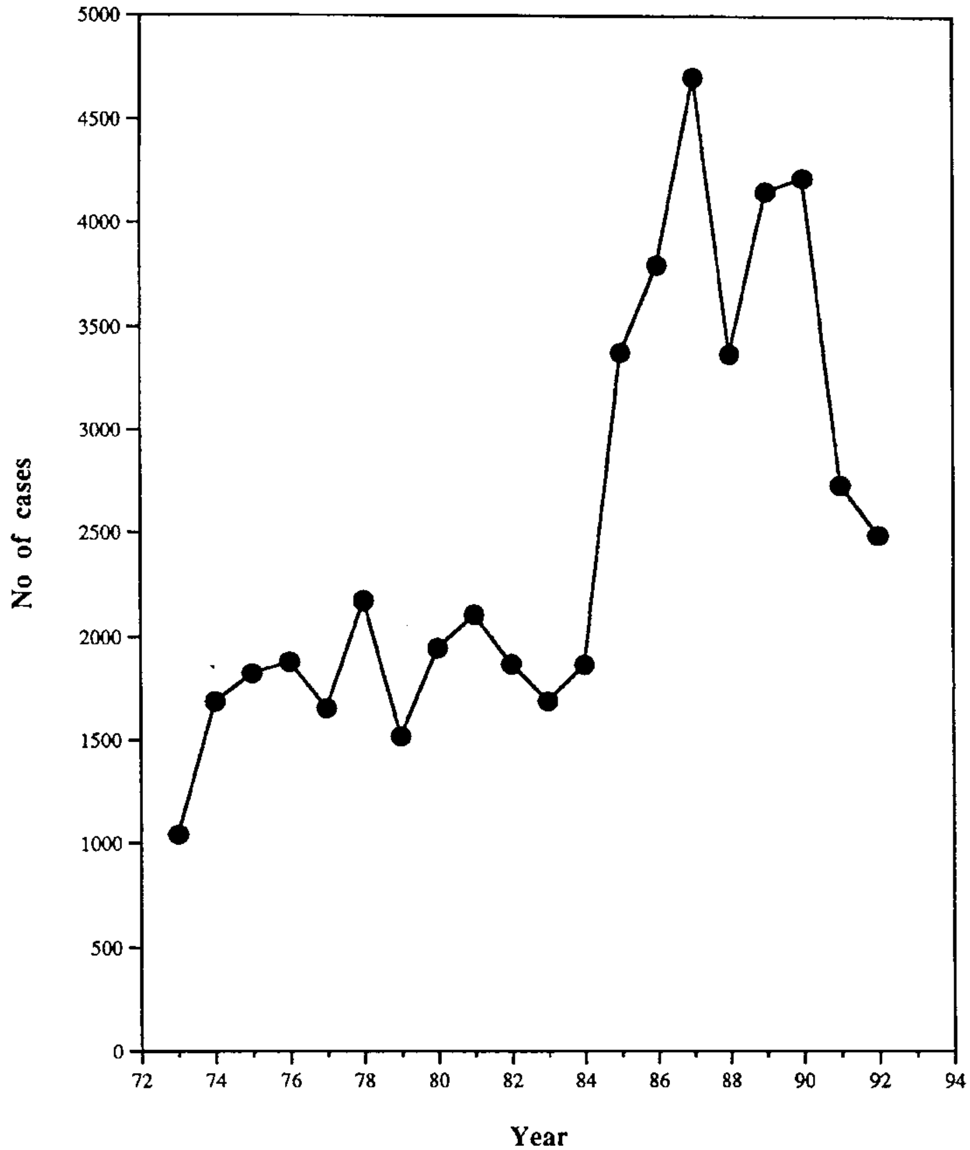

Figure 1. Annual number of case histories reported to the SPEHIS database between 1973 and 1992

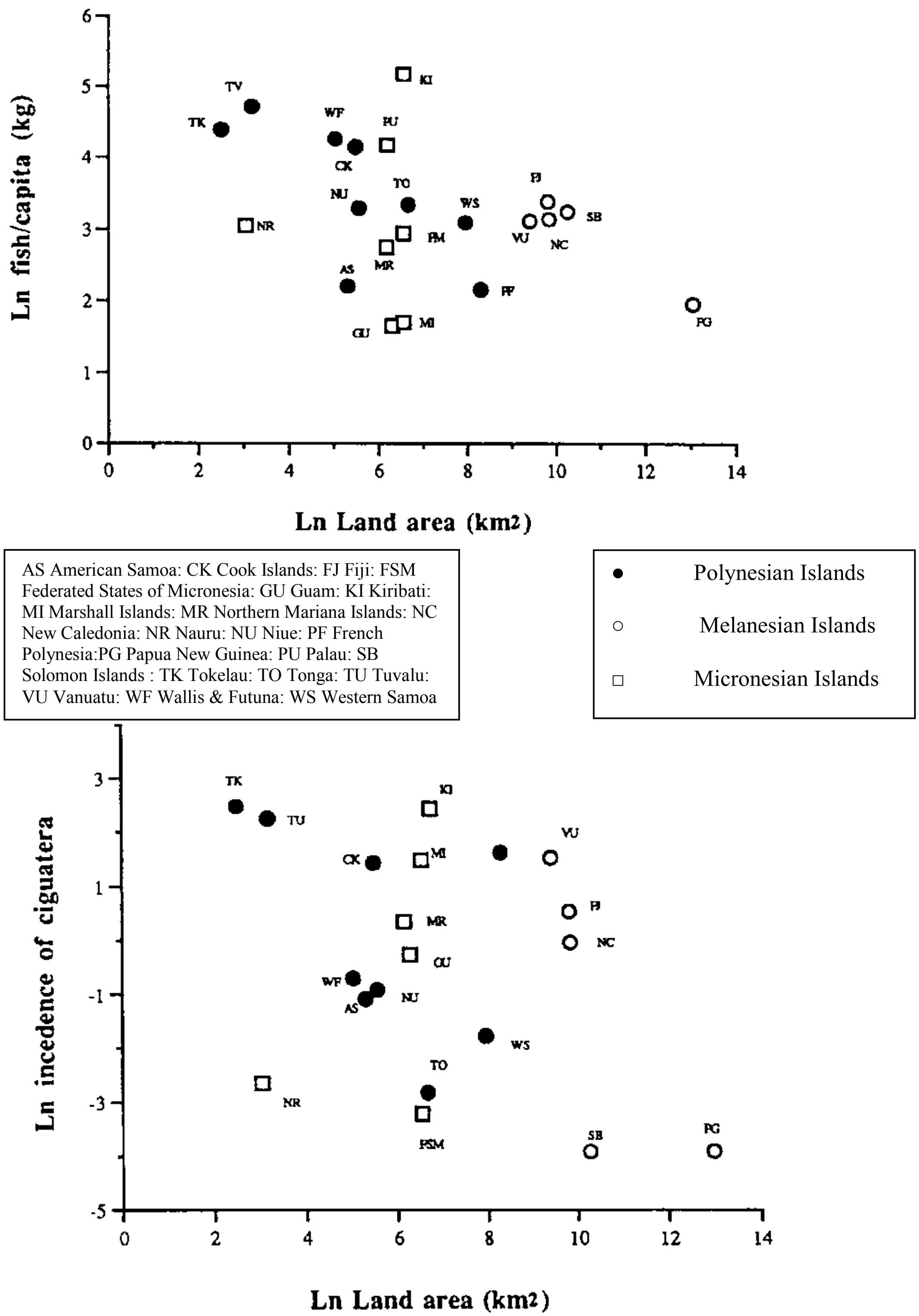

Figure 2. Double logarithmic plots of (top) annual production offish expressed as landings per capita and (bottom) mean annual incedence of ciguatera, versus land area for South Pacific countries and territories

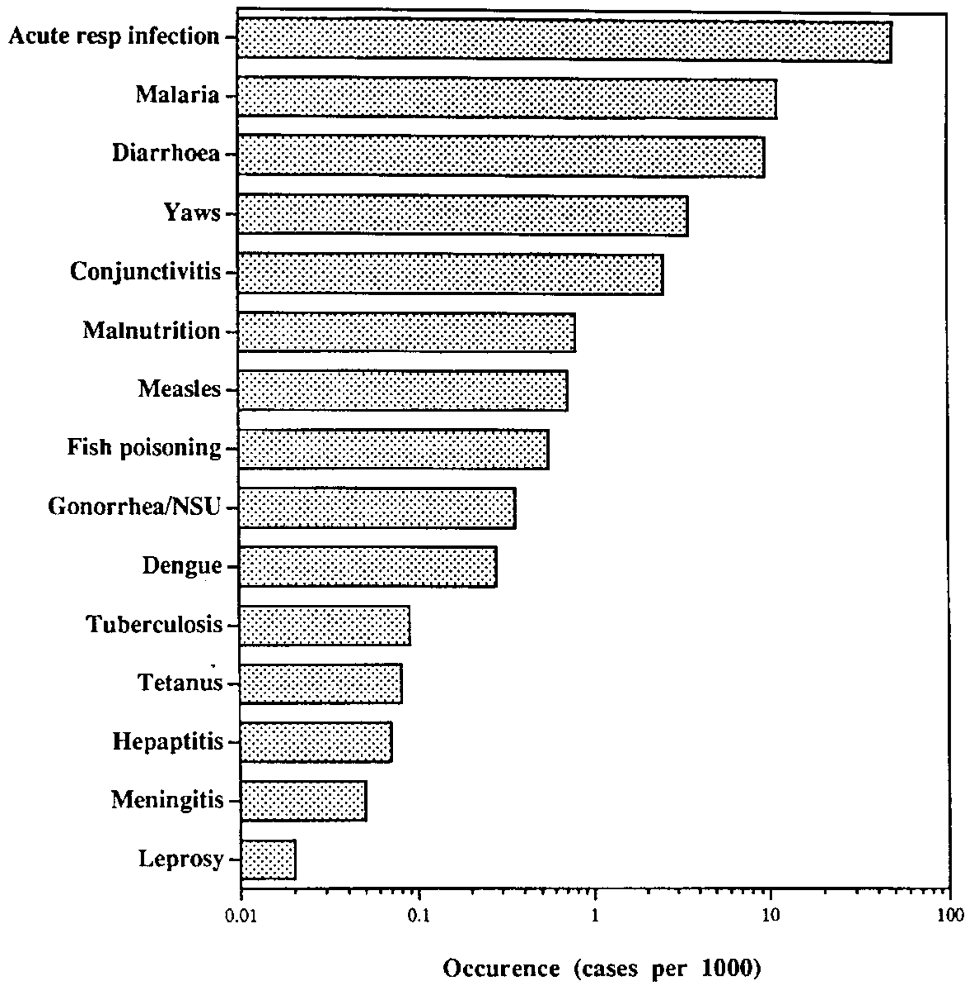

Figure 3. The 15 most commonly reported illnesses from the SPEHIS data base in ranked order of occurence (averaged between 1988 and 1992)

South Pacific Commission
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: *South Pacific Commission, P. O. Box D5, Nouméa CEDEX, New Caledonia*

THANK YOU

Figure 4. Specimen of the report form used to compile case histories for the SPC seafood poisoning datatbase

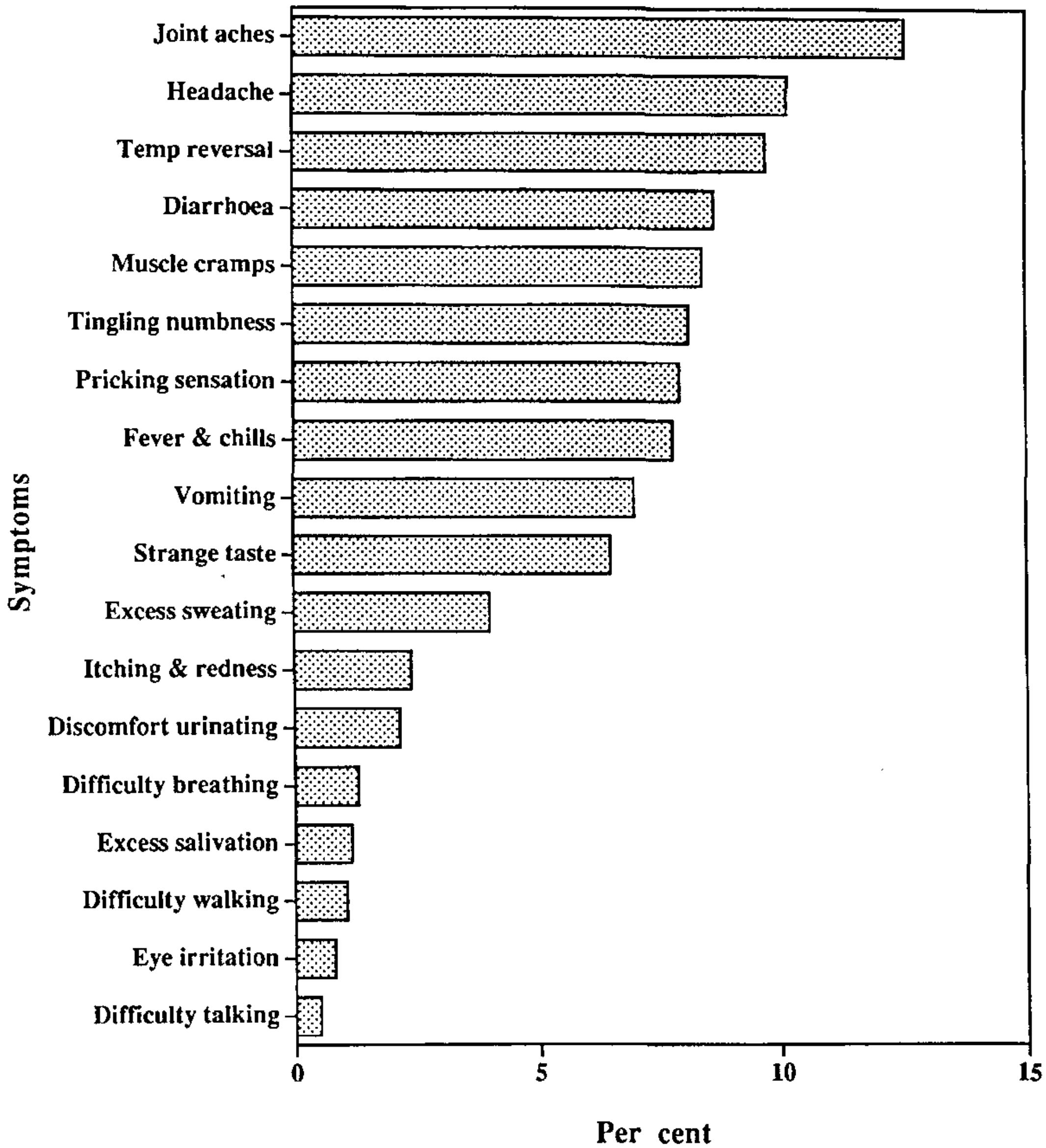

Figure 5. Ranking of symptoms from the consumption of ciguatoxic fishes from the South Pacific reported to the SPC seafoods poisoning data base

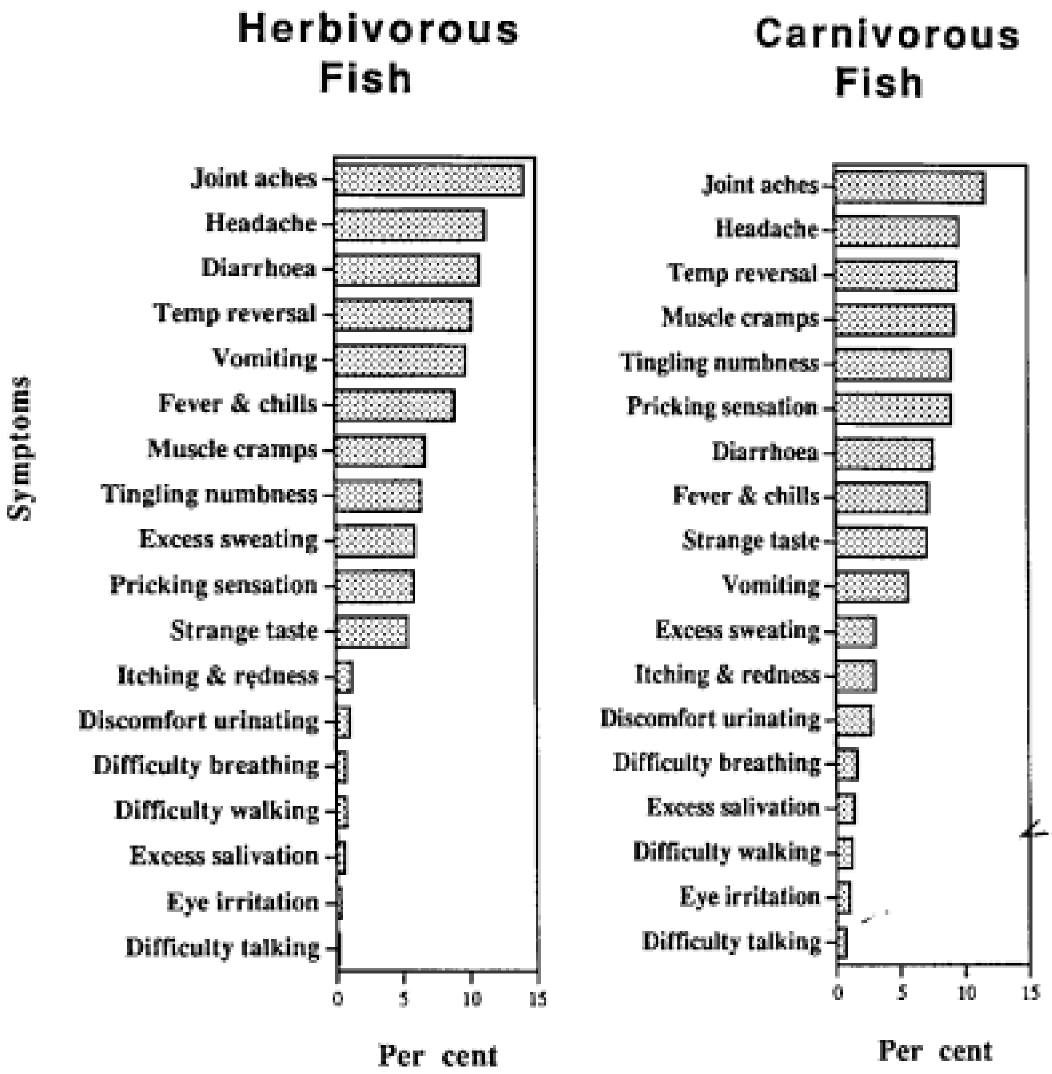

Figure 6. Ranking of symptoms from the consumption of ciguatoxic herbivorous and carnivorous fishes from the South Pacific reported to the SPC seafoods poisoning data base

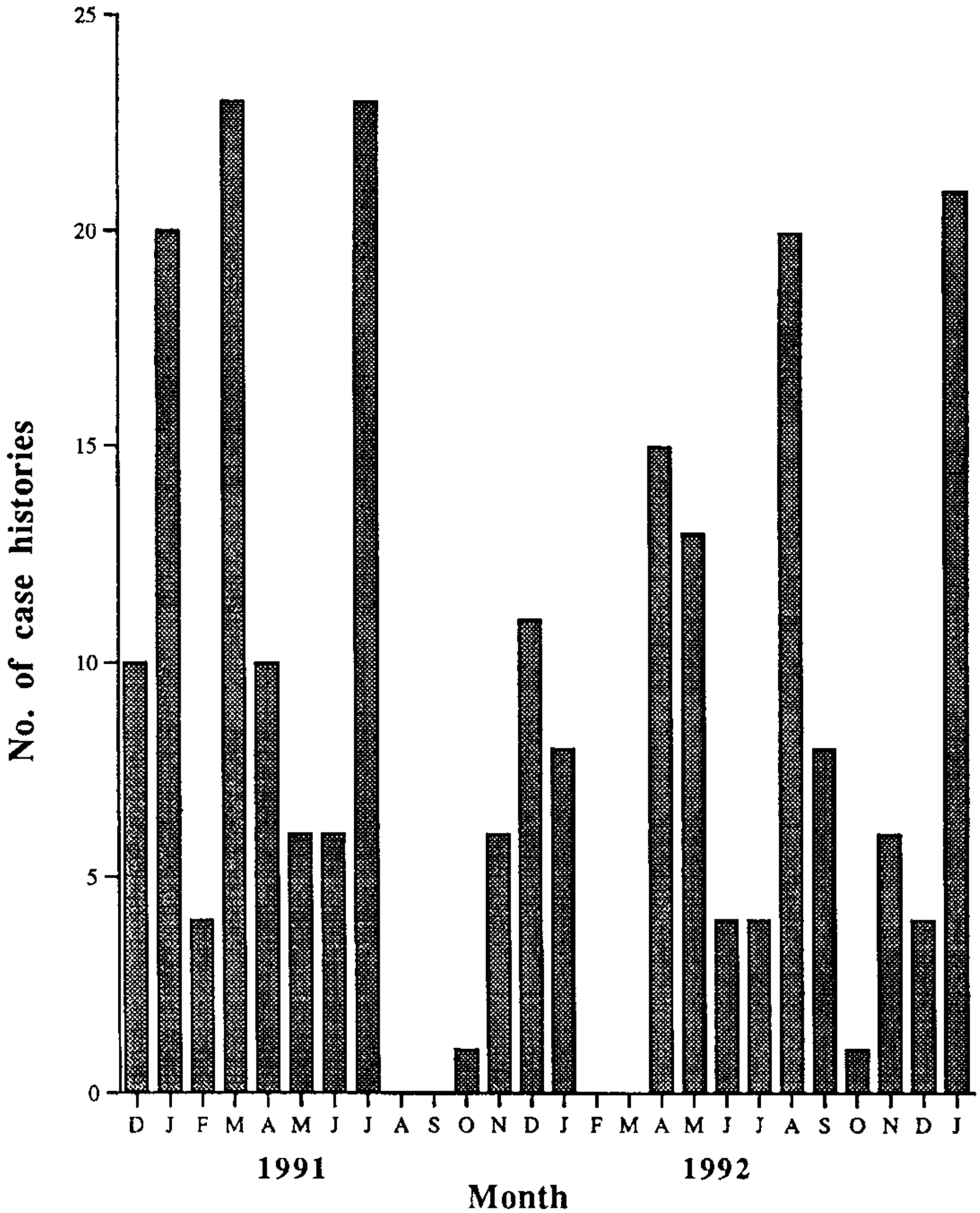

Figure 7. Time series of monthly number of case histories of ciguatera fish poisoning at Niutao, Tuvalu