Management of ciguatera fish poisoning in the South Pacific

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Introduction

Catches of near-shore or coastal fish are a major source of animal protein in the South Pacific region. Nominal landings amount to about 90,000 tonnes/yr, about half of which is reef fish. Ciguatoxic fishes are ubiquitous but in some areas, such as Niutao in Tuvalu, there is a higher risk of intoxication associated with eating reef fish. Commonly ciguateric fishes are normally avoided, but where alterative food sources are not available, they are readily consumed. The risk of poisoning is considered acceptable by the community and ciguatera is not regarded as a significant health problem in most island countries. This risk of ciguatera poisoning is reflected in the attitude of the medical community which is reluctant to see ciguatera given priority over other public health problems. Although ciguatera is of relative low priority as a medical problem in the region, fisheries development initiatives in high risk areas should aim to reduce the incidence of ciguatera by improving supplies of non-toxic deep reef slope and pelagic species. Elsewhere, ciguatera management is mainly required to limit the impact of fish poisonings on tourism and reef fish exports. Initiatives to improve the management of ciguatera such as the South Pacific Commission's seafood poisoning database are discussed.

Although ciguatera is of relative low priority as a medical problem in the region, fisheries development initiatives in high risk areas should aim to reduce the incidence of ciguatera by improving supplies of non-toxic deep reef slope and pelagic species.

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Dalzell (1992) presented 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) records numbers of cases of fish poisoning reported by national health departments, which it is assumed represent mostly ciguatera intoxications. The annual number of reported cases fluctuates (Dalzell,1992, Fig. 1). Lewis (1986) suggested that reported cases account for c.20% of incidence of ciguatera in the region. The increased incidence of fish poisoning from 1985 on (Dalzell, 1992, Fig. 1) may be due to improvements in diagnosing ciguatera and in data collection rather than a rise in the occurrence of ciguatera.

Landings of coastal fishes in most of the islands of the South Pacific come from coral reefs and lagoons (Dalzell,1992, Table 1). In many locations fish is still a principle source of animal protein and forms a major component of subsistence diets. In 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 being a health hazard, may have detrimental effects on fish production and marketing through adverse publicity and litigation.

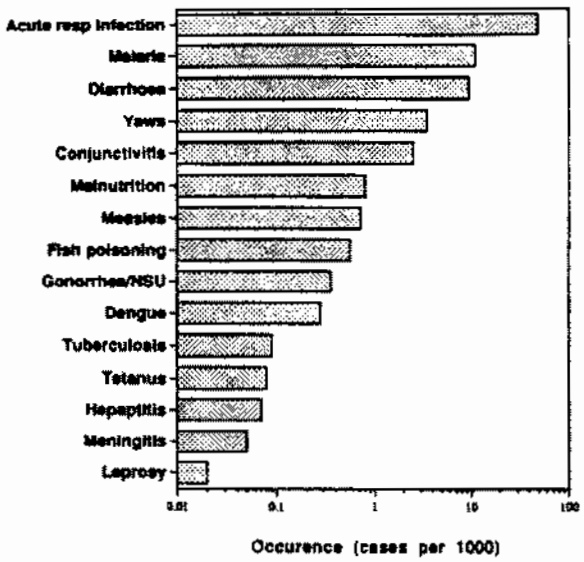
Key issues that face health and fisheries workers in the South Pacific are: 1, How big a problem is ciguatera to community health and the economy? 2, If ciguatera is a serious problem, how and where should resources be focused to manage it?

Dalzell (1992) summarized Pacific Island fisheries and discussed possible effects of ciguatera on development fisheries. A similar summary is given here as a preliminary to assessing steps that may limit ciguatera outbreaks.

South Pacific reef fisheries

Statistics on the composition and distribution of landings from reef and other coastal fisheries in the South Pacific, are

Fig 1. The 15 most commonly reported illnesses fron SPEHIS database, in ranked order of occurrence (averaged between 1988 and 1992)



poorly developed. Coastal fishing is characterised by small scale methods catching a wide variety of species and landing fish at many locations. This, plus the limited resources of most fisheries departments in the region, results in poor coverage of fisheries production.

The nominal coastal fin-fish landings for the South Pacific region (Dalzell,1992, Table 1) should not be confused with absolute values, rather this is the best estimate that can be made given data sources available. Estimated fisheries production for the region is about 90,000 tonnes/yr (Dalzell,1992, Table 1), although this is almost certainly an underestimate. Assuming a regional average value of US$2.00/kg for these landings, then the potential nominal value is c.US$174,000,000/yr.

Given the quality of the data on fisheries landings and on the incidence of ciguatera, it is difficult to draw any firm conclusions (Dalzell, 1992, Table 1). 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. 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 7-88% with a mean of 51% (Dalzell, 1992, table 1). About half the families of reef fish landed in the Pacific contain species known to have been ciguateric (Dalzell,1992, table 2). Certain species such as the small surgeon fish *Ctenochaetus striatus*, the snapper *Lutjanus bohar* and barracudas (*Sphyraena* spp.) are known health hazards but are still occasionally consumed. 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. 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 ingestion of the *dinoflagellate, Gambierdiscus toxicus*. Catch rates of such small scale artisanal gears are modest at best - on average 1-4kg/man-hour, depending on the gear (Dalzell & Wright, 1986) and there may be a disincentive for fishermen to return a portion of the catch to the sea simply because of suspected ciguatoxicity.

Food accounts for c.20% of imports into Pacific Island countries as opposed to <10% of imports into the metropolitan countries (SPC, 1992). 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, both in subsistence and commercial sectors. In some countries of the region, harvest levels from coastal fisheries are already very high and fishing pressure is unlikely to diminish. The main objectives for fisheries managers and administrators are developing fish production and maintaining it at a sustainable level.

Ciguatera as a regional health issue

A range of different illnesses and afflictions are recorded in the SPEHIS database (Fig. 1). 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. The information is 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 gastrointestinal infections are more evenly spread throughout the Pacific and are the major health issue in the region. Dalzell & Gawell (1989) reported that respiratory tract infections and gastrointestinal 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. The most effort health departments are likely to devote to ciguatera is publicising those species which are 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 he little concern about this form of intoxication from fisheries departments in the region. Fisheries officers may express interest in ciguatera, particularly if there is an outbreak in their country, but in general it does not appear to be given a very high priority.

Ciguatera was discussed at the first SPC fisheries conference (SPC, 1952); was the subject of an SPC technical paper (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 (Bagnis,1973) and the Inshore Fisheries Research Project formed a Ciguatera Special Interest Group in 1991 which has published two bulletins.

Regular international meetings, symposia and workshops have addressed the subject of ciguatera. Despite these meetings, reports and publications there has been little in the way of requests for assistance from the various member countries of the Commission to deal with ciguatera.

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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.

Both fisheries and health workers have been contacted to report (Dalzell,1992, Fig.3) cases of fish poisoning. The database has been publicised repeatedly in SPC publications and in national newspapers and by radio. Despite repeated attempts to encourage the reporting of cases, the response has been variable.

Over 400 case histories have been collected from eight countries in the South Pacific (Table 1). 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 (Dalzell, 1992: 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.

Not all intoxications (Table 1) 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 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, *Acanthurus 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%) togetheraccount for c.1/3 of 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. *triostegus*, other species commonly implicated in poisonings are the snappers *Lutjanus 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 often form major fractions of the landings in a reef fishery. At two locations in Papua New Guinea, they formed c. 12% of landings from reef fisheries in the north and south of the country (Dalzell & Wright, 1986). Parrotfish and surgeonfish accounted for 1/3 of commercial landings of reef fish in Palau during 1976-1990 (Kitalong & Dalzell, 1994). 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 (70-80%) and that annual landings of parrotfish ranged from 15-20t. Smith & Dalzell (1993) found that surgeonfish and parrotfish comprised about 74% of landings from

Table 1. Species implicated in fish poisoning, by country

Species	Tuvalu	New Caledonia	Federated States of Micronesia	Marshal Is.	Fiji	Niue	Kiribati	Nauru
FINFISH								
Abudefduf spp.	1							
Acanthuridae	41							
Acanthurus leucopareius	1							
Acanthurus lineatus	16		1					
Acanthurus triostegus	22							
Balistidae	3							
Carangoides ferdau	4							
Caranx ignobilis	2						1	
Carcharinus longimanus	7							
Cephalopholis argus	9							
Chaetodontidae	1	1						
Cheilinus undulatus			4					
Ctenochaetus striatus			2					
Decatpterus macarelius			1					
Epinephelus cyanopodus		1						
Epinephelus fuscogattatus	3							
Epinephelus melanostigma	1							
Epinephelus microdon	1	1						
Epinephelus spp.				2				
Grammistes sexlineatus	16							
Gymnothorax javanicus	5				1			
Herkiosichthys quadrimacalatus					1			
Holocentridae	12							
Katsuwonus pelamis	1		1					
Kyphosidae	2							
Lathrinidae		4		1				
Lethrinus elongatus	3							
Lutjanidae	4	2						
Lutjanus argentimaculatus		1	1					
Lutjanus bohar	12		7	1				1
Lutjanus gibbus	1							
Lutjanus monostigmus	12							
Lutjanus sebae		2						
Monocanthidae	12							
Monotaxis grandoculus	4		1					
Mugilidae		1						
Mullidae	1							
Naso brevirostris	1							
Naso unicornis		1						
Plectropoma spp.		10						
Promethichthys prometheus			1					
Sargocentrum spiniferum	2							
Scaridae	45	5	1					
Serranidae	25	9						
Shark			1					
Siganidae	1							
Soleidae		1						
Sphyraena jello		2						
Sphyraenidae	5		9			2		
Symphorus nematophorus		1						
Unknown fish	21	4	12					

Data from the South Pacific Commission seafood poisoning database.
Fish that could not be identified to species are grouped under family headings.

Table 1. (cont.) Species implicated in fish poisoning, by country

Species	Tuvalu	New Caledonia	Federated States of Micronesia	Marshal Is.	Fiji	Niue	Kiribati	Nauru
CRUSTACEA								
Carpilius maculatus	1							
Panulirus spp	4							
Scylla serata			1					
MOLLUSCS								
Chama pacifica	2							
ECHINODERMS								
Holothuroidea			8					
TOTALS	**304**	**46**	**51**	**4**	**2**	**2**	**1**	**1**

Data from the South Pacific Commission seafood poisoning database.
Fish that could not be identified to species are grouped under family headings.

community spear and net fishing on Woleai Atoll in Micronesia and that the Scaridae and Acanthuridae accounted for 60-90% 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 a sizeable fraction of the fishable stocks on reefs may become a health hazard. The same is true of the snapper *Lutjanus bohar*, which is 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 account for up to half the fish caught by handlines in some areas (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).

The five most common maladies from ciguatera are joint aches, headache, temperature reversal, diarrhoea and muscle cramps (Fig.2). The five most common symptoms from eating herbivorous fishes were joint aches, headache, diarrhoea, temperature reversal and vomiting (Fig.2). Eating carnivorous fishes most commonly caused joint aches, headache, temperature reversal, muscle cramps and tingling & numbness (Fig.2). Gastro-intestinal maladies such as vomiting and diarrhoea occur but with less frequency.

Collection of case history data will continue and further efforts will be trade to increase the rate of reporting, particularly from those countries where ciguatera is relatively common but case histories are not forthcoming.

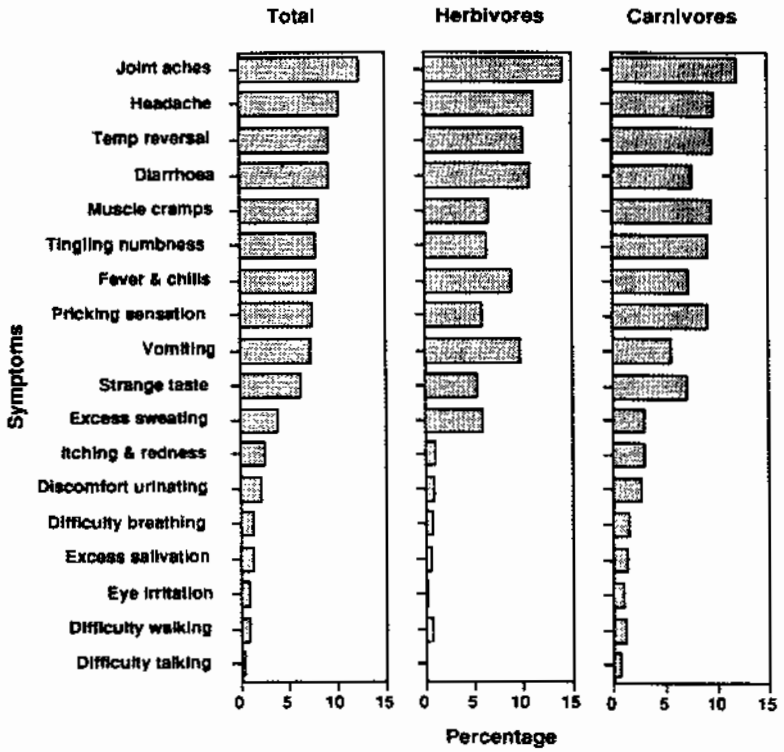
Management of ciguatera

If ciguatera is not perceived as a major health hazard 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 do occur intermittently. The PNG Medical Journal (1950s - 1993) 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). According to the Department of Fisheries and Marine Resources (DFMR) 5 outbreaks of ciguatera occurred between 1971 and 1981 at Port Moresby, Finschhafen, Milne Bay and New Hanover (Anonymous 1988b).

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 in 3-5 days. The only instance of a commercial ban on the purchase of species on the basis of suspected ciguatera 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 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 serious problem. These are usually small atolls or coral islands where per-capita fish and seafood consumption is very high (Dalzell, 1992: Table 1). A good example 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. For a population of almost 1000 people this is an incidence equal to about 10% of the population per year. Niutao is a coral island of 226ha, that encloses a small landlocked brackish lagoon is surrounded by a fringing reef of c. 108ha Kaly et al. (1991) reported 80 case histories from 1988 Niutao ciguatera outbreak, some months prior to a programme of subtidal reef blastings

Fig 2. Ranking of ciguatera symptoms from the consumption of all fishes, and separately the herbivores and carnivores in the South Pacific reported to the SPC seafoods poisoning database (N = 380)



create boat passages. Some blasting was conducted on the reef at Niutao in 1981 to create a boat channel but this was not followed 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 . Monthly occurrence of ciguatera cases (Fig.3), shows that intoxications occur throughout the year but with much variation between months.

Given the isolation and size of Niutao animal protein necessarily comes from the sea. However, reef fish are a risk on this island and persons are likely to be exposed to ciguatoxins on a regular basis through the consumption of reef fish. The most effective approach to managing the problem is to increase the supply of non-toxic fish. This means targeting pelagic species that live beyond the reef, and demersal snapper and grouper of the deep reef slope. Most pelagic and deep slope species are rarely ciguatoxic.

Deep reef slope fishes include mainly large snappers, groupers, emperors and a mix of other species including oilfish, jacks and barracuda. The deep slope dwelling snappers (Etelinae) have not been implicated in fish poisoning, as opposed to the shallow reef snappers (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 groupers on the deep reef slope.

Stocks of deep slope species are more limited then pelagic fishes, particularly around small islands where the steep submarine gradient off the 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.

Deep reef slope species may range between the shallow reef and 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 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 al., 1986) with a diet that includes reef fish. L. *bohar* comprised 8% by weight of the catches of deep slope species in the South Pacific (Dalzell & Preston,1992). For the atolls and coral islands only, catches

of L *bohar* amounted to about 15% of total landings. Thus, although deep slope species can be an important supplement to the diet, potentially toxic fish may still be involved.

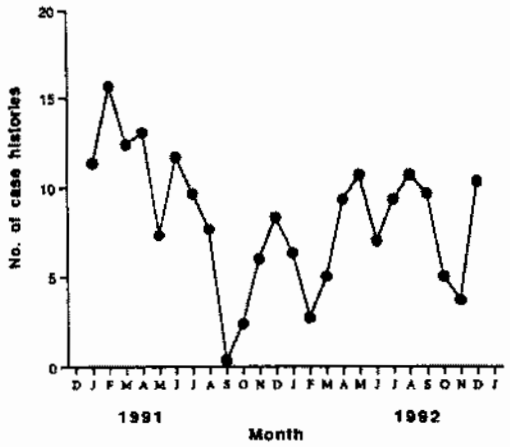
Similar strategies can be adapted for other countries where small islands are severely affected by ciguatera. In larger coral atolls where there is a substantial lagoon and reef area, sites that are known to produce ciguatoxic fish can be avoided in favour of safe fishing grounds. Development of pelagic and deep slope fisheries should be pursued, however, so that the resource base is widened and reef fish is not the sole source of fish protein. However, people may persist in fishing in known ciguateric 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 dependent 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). 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 fishermen may tend to sell suspect fish that might be rejected by local consumers.

Fig 3. Number of case histories of ciguatera fish poisoning recorded in Niutao. Data smoothed by a running average of 3.



Most nations in the South Pacific have 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, then high risk species such as *Lutjanus bohar*, moray eels, barracuda and some surgeonfish (eg. *Acanthurus lineatus, Acanthurus triostegus, Clenochaetus striatus)* might be prohibited 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 he scrutinised and checked as to the location of the catch, particularly if reef around ciguatoxic fish are known to exist. Affordable tests for ciguatera (Park, 1992) should be routine for export fishes.

Acknowledgements

I thank Dr Tim Adams and Mr Peter Cusack (SPC Fisheries Programme), and Dr SteveTerell-Perica (SPC Health Programme) for reviewing this paper and for their helpful comments and suggestions which greatly improved the final draft.

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