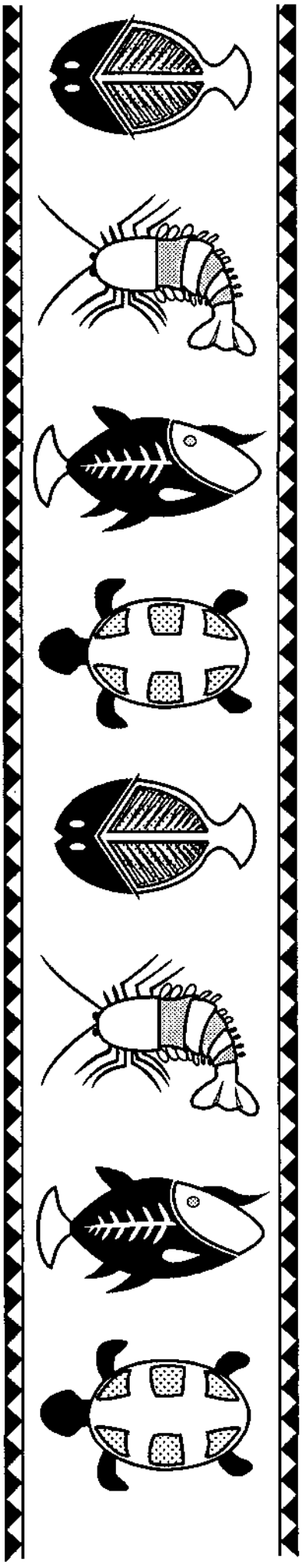

Inshore Fisheries Research Project
Meeting Report

CIGUATERA FISH POISONING AND FISHERIES DEVELOPMENT IN THE SOUTH PACIFIC

South Pacific Commission
Noumea, New Caledonia

Ciguatera fish poisoning and fisheries development in the South Pacific[1]

by

P.Dalzell
South Pacific Commission
Noumea, New Caledonia

Abstract

Ciguatera fish poisoning represents an impediment to the development of fisheries based on shallow water reef fish stocks and to the food security of islands where agriculture is limited. Although fisheries development initiatives in the past 20 years in the Pacific have focused on the development of deep slope fisheries and fisheries for large pelagics such as tuna, shallow reef fisheries continue to be a major animal protein source for Pacific Islanders and a source of commercial revenue for fishermen. Statistics on ciguatera outbreaks in the Pacific are limited to local databases in Hawaii and French Polynesia, and to the compilation by the South Pacific Commission of 'fish poisonings' reported by the medical departments of the countries of the region. A new database was established at the South Pacific Commission during 1990 to serve as a focus for detailed reporting of fish poisoning and ciguatera in the South Pacific. Some preliminary results from this database are presented and the importance of such information to the development of coastal reef fisheries is discussed.

Introduction

Poisoning through the consumption of fish containing ciguatoxins has been reported from most parts of the Pacific. The true incidence of ciguatera intoxication in the South Pacific is unknown due to the variable quality of epidemiological reporting 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, which it is assumed represent mostly ciguatera intoxications. The annual number of reported cases of ciguatera has risen from about 1000 in 1973, to over 4000 in 1990 (Fig. 1). Based on SPEHIS data for the years 1973 to 1983, Lewis (1986) suggested that reported case histories account for about only 20 % of actual incidence of ciguatera in the region. The marked increase of fish poisoning case histories from 1985 onwards may be due to improvements in reporting of health statistics in the region rather than a rise in the occurrence of intoxication through eating fish.

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

It is important, therefore, to contain the problem of ciguatera by identifying the fishes

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[1]. For presentation at the IVth International Conference on Ciguatera Fish Poisoning, 4-8 May 1992, Tahiti, French Polynesia

responsible for intoxications, locating the sources of ciguatoxic fishes and the reasons for blooms of the dinoflagellate responsible for producing the poison (*Gambierdiscus toxicus)* at particular reef areas. It is equally important to understand the characteristics of coastal or near-shore fisheries within the South Pacific, such as volumes landed, the dominant species or species groups in the catch and the areas where fishing effort is concentrated. In this paper, both the health and fisheries aspects of ciguatera fish poisoning in the South Pacific are reviewed and a new regional ciguatera data base established by the South Pacific Commission is discussed.

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 artisanal gears 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, has led to poor records of coastal fisheries production in many parts of the region. Estimated nominal landings for most of the countries within the South Pacific are given in Table 1, based on a variety of sources. In most cases landed volume of catch is probably an underestimate as figures for subsistence fisheries production were either computed empirically or absent altogether. Included in Table 1 are land area, population, fishery landings and mean annual incidence of ciguatera cases from SPEHIS records.

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, and which, not surprisingly, are the locations where ciguatera incidence is generally the highest (Fig. 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 supplier of food. Similarly, the larger islands of the South Pacific, especially Melanesia, have a variety of different aquatic habitats and reef fish production forms only part of the total fisheries landings.

The percentage of the total fish landings that comprise reef fish ranges from 7 to 88% with a mean of 51% (Table 1). 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 that are known to be ciguatoxic at different locations in the South Pacific. Although the reef fish resources are varied, so also is the number of different species that are potentially toxic. Certain species such as the small surgeon fish *Ctenochaetus striatus,* the snapper *Lutjanus bohar* and barracudas (*Sphyraena* spp) are traditionally known to be a health risk but are still consumed despite the danger of poisoning. In some areas, these species are not known to be ciguatoxic and are consumed in apparent safety.

Fishing for reef fish in the South Pacific is accomplished mainly with small scale gears such as hand-lines, traps, nets and spears, deployed from dinghies or canoes. Lock (1986) presented observations of the catch composition of 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 *G.toxicus.* 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 little incentive for fisherman to return a portion of the catch to the sea simply because the fish might be ciguatoxic.

In areas where ciguatera persists, however, certain species are avoided because of the health risk and local people have developed traditional explanations and remedies for ciguatera intoxication. In New Caledonia certain snappers (Lutjanidae) and species of coral trout (*Plectropoma)* spp are not eaten by Kanak villagers living in the north of the main island (Teulières 1988). Similarly, in parts of Fiji outbreaks of ciguatera are traditionally associated with the mass spawning of the marine palolo worm (*Eunice viridis)* (T. Adams, South Pacific Commission, pers. comm.).

Fisheries Development

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 1988). 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 fish, were exported from Kiribati to Honolulu between 1988 and 1989 (Anon. 1989). Reef fish are regularly exported 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. 1990, Dalzell. unpub. data). Reef fishes are caught in the northern islands of PNG and kept alive for sale in Taiwan (A.H. Richards Dept. of Fisheries & Marine Resources, PNG pers. comm.). A similar type of operation was conducted from Palau to Hong Kong before concern over levels 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 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.).

One of the major new developments in coastal fishing in the last 15 years has been the establishment of fisheries based on the snappers and groupers that live on the deeper slopes of reef areas. 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 sub-families Etelinae and Apsilinae. These species, which can realise high prices on overseas markets, have not been implicated in ciguatera poisonings and are therefore an attractive target for coastal fishermen. 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.

Deep slope fisheries were established with the support of the South Pacific Commission in the Federated States of Micronesia (FSM), Fiji, Vanauatu, PNG, Tonga and American Samoa and Western Samoa. In recent years there has 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 domestic markets has shown the economic potential of these resources and provided incomes for fishermen. 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. This in turn have a negative influence on the planned expansion of fisheries production.

Limiting the effects of ciguatera

Complete eradication of the problems associated with ciguatera is unlikely unless consumption of reef fish is stopped throughout the region. Given that this is both unlikely and undesirable, what are the options for limiting the effects of this form of fish poisoning? Clearly some form of control on catching and consumption of fish that are ciguatoxic is needed in parallel with research efforts on the detection of ciguatoxic fish and treatment of the intoxication.

Present reporting of ciguatera outbreaks in the region is poorly developed at the primary health level. However, it is only through the identification of cases that information on the origin and identity of poisonous fish can be recorded. The SPEHIS system established by the SPC Health Programme is only of limited value in the respect since only gross national statistics on fish poisoning are available. This also highlights the problems of demarcation between Fisheries and Health Departments with respect to responsibility of action on ciguatera. Who should be responsible for the task of conducting question and answer surveys after an outbreak of ciguatera? Clearly fisheries officers cannot be expected to diagnose ciguatera when it occurs, but they can record details of poisonings and the symptoms when intoxication occurs through the consumption of seafood.

The SPC Health and Fisheries Programmes have established a database to improve the reporting of ciguatera in the region. Both fisheries and health workers have been contacted to report cases of fish poisoning using the form shown in Fig 3. A version has also been produced in French for Francophone territories. This database was established in 1990 and to date about 200 records have been accumulated, most of which come from Tuvalu and New Caledonia (Table 4). The emphasis with this form is on describing the causative agents of poisoning. This information will be used to examine the distribution of different ciguatoxic species and the variation of symptoms associated with them. Publicity on the database has so far been restricted to the newsletters of the SPC Health and Fisheries Programmes, and to the information bulletin of the Ciguatera Special Interest Group established through the SPC Fisheries Information Project.

A general summary of some of the data contained in this database is given in Table 4. Much greater resolution of various aspects of the database can be extracted and summarised. For example, although the toxic fishes are reported here at the family taxon, in many instances the species are given. In Tuvalu, commonly toxic fishes include the snappers *Lutjanus monostigma* and *L. bohar* and the surgeonfish, *Acanthurus triostegus,* whilst in New Caledonia coral trout *(Plectropoma* spp) and Spanish mackerel are frequently responsible for intoxications. Most of the case histories come from Tuvalu, New Caledonia and the Federated States of Micronesia (FSM). Information from the FSM was collected by the author during field work there in 1989 and 1990. Reporting of case histories from Tuvalu and New Caledonia is by health workers who

have responded to appeals for case histories in a newsletter distributed by the SPC Health Programme.

Further effort needs to be directed towards publicising this initiative and to formalizing the responsibilities for reporting case histories to the SPC. As case history reporting improves then it should become possible to consolidate data on sites where ciguatera is known to occur and identify the species that are known to be principle health risks at given locations. This information can then be used to warn people of the risks of catching and eating fish from ciguatera 'hot spots' and to study the evolution of ciguatera epidemics. Further, fishes caught from or adjacent to ciguatoxic areas can be tested regularly to determine the incidence of fishes that contain the poison.

From the fisheries perspective, greater emphasis needs to be placed on the gathering of fisheries statistics on coastal fish landings. Statistics are frequently available on gross landings of reef fish, but there is usually little information on areas fished, fishing effort, composition of catch and the seasonal variation of these factors. Should fish from a given reef become ciguatoxic there is no way of assessing how important such a reef may be in terms of net contribution to fisheries production. Thus there is no way of judging the social and economic impact of a total, selective or temporal ban on fishing from such locations.

Discussion

The foregoing has assumed that ciguatera is a serious health issue in the Pacific. Nellis & Barnard (1986) have reviewed the social and legal implications of ciguatera, based mainly on experiences in the US Virgin Islands. They report that a fatalistic attitude is held by native seafood consumers in areas with ciguatera. Care and attention is given to species size and origin of a fish, but an occasional ciguatera intoxication is accepted as inevitable. Dalzell & Gawell (1989) reported similar attitudes from the FSM and it is likely that this is typical of the region as a whole. However, if Lewis (1986) is correct and reported case histories account for only 20% of the true incidence of ciguatera in the South Pacific then annually about 20,000 persons are afflicted with this intoxication.

Despite this, health departments in the region tend not to regard ciguatera as a serious issue and concentrate their limited resources on other priorities. For example, in the FSM, upper respiratory tract infections and gastro-intestinal disease are major health problems, particularly amongst the young who now comprise half the population (Dalzell & Gawell 1989). This attitude is understandable given that ciguatera is rarely fatal (and in most cases causes little more than extreme discomfort), and that there is no available preventative or remedial medical treatment, other than intravenous perfusion of manitol solution, which is only warranted in a few very extreme cases. For these reasons, it appears that greater emphasis on education of the public, sponsored jointly by Fisheries and Health Departments is the most appropriate response to the problem.

Ciguatera represents a significant threat to the food security of smaller islands and atolls in the Pacific if reef areas cannot be fished and certain fishes must be rejected. Further, fish are one of the few resources that have any economic potential for development for the small islands and atolls. Ciguatera outbreaks are potentially a serious impediment to development of these resources, particularly if fish are destined for wide market distribution nationally or exported overseas. Some advances in the sector have been made with the development of a 'poke stick' test for ciguatoxins in fish flesh (Hokama et al 1987, Park 1992) which should shortly be

produced commercially for rapid testing of fishes. Species known to be ciguatoxic might be included in a general screening of catches, particularly those destined for export.

For ciguatera to be placed in its true perspective in the region, there needs to be a more accurate reporting of the true incidence of poisonings and of the social and economic costs of poisoning outbreaks. Such information will only be available if the case histories are faithfully reported following outbreaks and case history information is properly followed up. The SPC ciguatera database is a contribution towards these improvements

Acknowledgements

I thank my colleagues, Kevin Bailey and Tim Adams their comments on the manuscript and for correcting some errors in the tables.

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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)	Landings/capita (kg)	Percent of reef fish in landings	Incedence of ciguatera (cases/1000)[t]
American Samoa	201	33,000	300[c]	9.1	68[C]	0.34
Cook Islands	240	17,200	l,100[d]	64.0		4.2
Fiji	18,274	715,375	21,500[e]	30.1	63.8[e]	1.7
French Polynesia	4,000	197,000	l,719[d]	8.7		5.1
Federated States of Micronesia	700	73,160	l,406[f]	19.2	55.78	0.04
Guam	541	106,000	547[d]	5.2	7.1[m]	0.76
Kiribati	710	68,207	12,300[g]	180.3	40.6[n]	11.4
Marshall Islands	701	36,090	200[d]	5.5		4.4
Nauru	21	8,900	190[u]	21.3		0.07
New Caledonia	18,734	164,173	3,863[d]	23.5	84.8°	0.96
Niue	259	2,200	60[h]	27.3	50.0[h]	0.4
Northern Mariana Islands	478	20,350	322[d]	15.8	48.3[m]	1.4
Palau	488	16,000	1,050[i]	65.6	88.4[i]	
Pitcairn Island	4.5	53				
Papua New Guinea	462,840	3,592,900	25,554[d]	7.1	33.3[p]	0.2
Solomon Islands	28,370	307,597	8,000[j]	26.0	65.7[q]	0.02
Tokelau	122	1,690	137[k]	81.1		12.0
Tonga	780	94,535	2,700[d]	28.6		0.06
Tuvalu	24	8,230	927[d]	81.i	63.5[r]	9.55
Vanuatu	12,190	142,630	3,249[l]	22.8	17[l]	4.6
Wallis & Futuna	153	14,000	l,000[d]	71.4		0.5
Western Samoa	2,831	156,349	3,500[d]	22.4	32.4[s]	0.17

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

Table 2. Composition of reef fish landings from different locations in the South Pacific

Family	Fiji[a]	PNG[b] (North)	PNG[b] (South)	Solomon Islands[c]	Kiribati[d]	Palau[e]	Woleai Atoll (Yap, FSM)[f]	Tikehau Atoll (French Polynesia)[g]
Lethrinidae	16.7	10	29	62	7.8	14	4	6
Chanidae		2						
Balistidae		2					4	2
Albulidae		1			16.5			2
Hemiramphidae			1					
Serranidae	13.7	9	3	6.6	3.1	9	3	4
Scombridae	20.9	3	10	15.3	24.3			
Carangidae	8.6	14	8	102	32	4		18
Mullidae	1.6		5	5.1	2.9	1		10
Lutjanidae	9.7	13	5	19.2	11.1	12	1	6
Acanthuridae	2.0	5	7	6.4		14	39	16
Scaridae	7.0	8	5	1L5		18	35	10
Belonidae	0.3		5	3.9				
Polynemidae	0.8							
Elopidae	0.1							
Muglidae	8.4	21	4		3.3	1		6
Siganidae	1.0	1	6	3.9		10	5	2
Sphyraenidae	5.0				32			2
Trichuridae	0.7							
Leiognathidae	1J							
Gerridae	0.3		2		5.3	0		
Haemuiidae	12	3	4	5.4		0		
Theraponidae	0.5							
Others		8	6	6.3	19.3	17	9	16
Total	100	100	100	100	100	100	100	100

a, Anon (1991a)
b, Dalzell & Wright (1986)
c, Crossland & Grandperrin (1979)
d, Anon (1991b)
e, Kitalong & DalzeU (1991)
f, Smith & Dalzell (1991)
g, Morise (1985)

Table 3. Catch composition by different artisanal fishing methods on reef fish stocks on the South Papuan Barrier Reef

Family	Fishing method				
	Spear	Hand-line	Gill net	Drive-in net	Surround net
Carcharinidae			1	2	
Mylobatidae				1	
Chanidae			2	1	
Hemiramphidae					3
Belonidae			0		1
Serranidae	21	10	3		1
Carangidae	5	7	11	13	4
Lutjanidae	3	12	13		6
Gerridae			0	3	
Haemulidae	14		10	5	1
Lethrinidae	1	65	42	31	37
Sparidae					0
Mullidae				3	12
Mugilidae				11	
Platacidae	4				
Kyphosidae	8		2		1
Sphyraenidae	2			1	
Labridae	2				2
Scaridae	3		1	7	10
Acanthuridae	17		2	2	17
Siganidae			0	8	5
Scombridae	17		11	5	
Balistidae		3	0	1	
Others	3	3	2	6	0
Total	100	100	100	100	100

Table 4. Summary of information from the SPC fish poisoning database

Country	Number of case histories	Fishes most commonly reported causing intoxication
Tuvalu	186	Acanthuridae, Lutjanidae, Serranidae, Monocanthidae, Holocentridae, Cirrhitidae
New Caledonia	31	Serranidae, Scaridae, Scombridae (Sp. mackerel)
Federated States of Micronesia	36	Sphyraenidae, Lutjanidae, Serranidae, Acanthuridae
Niue	2	Sphyraenidae
Kiribati	1	Carangidae
Fiji	1	Muraenidae

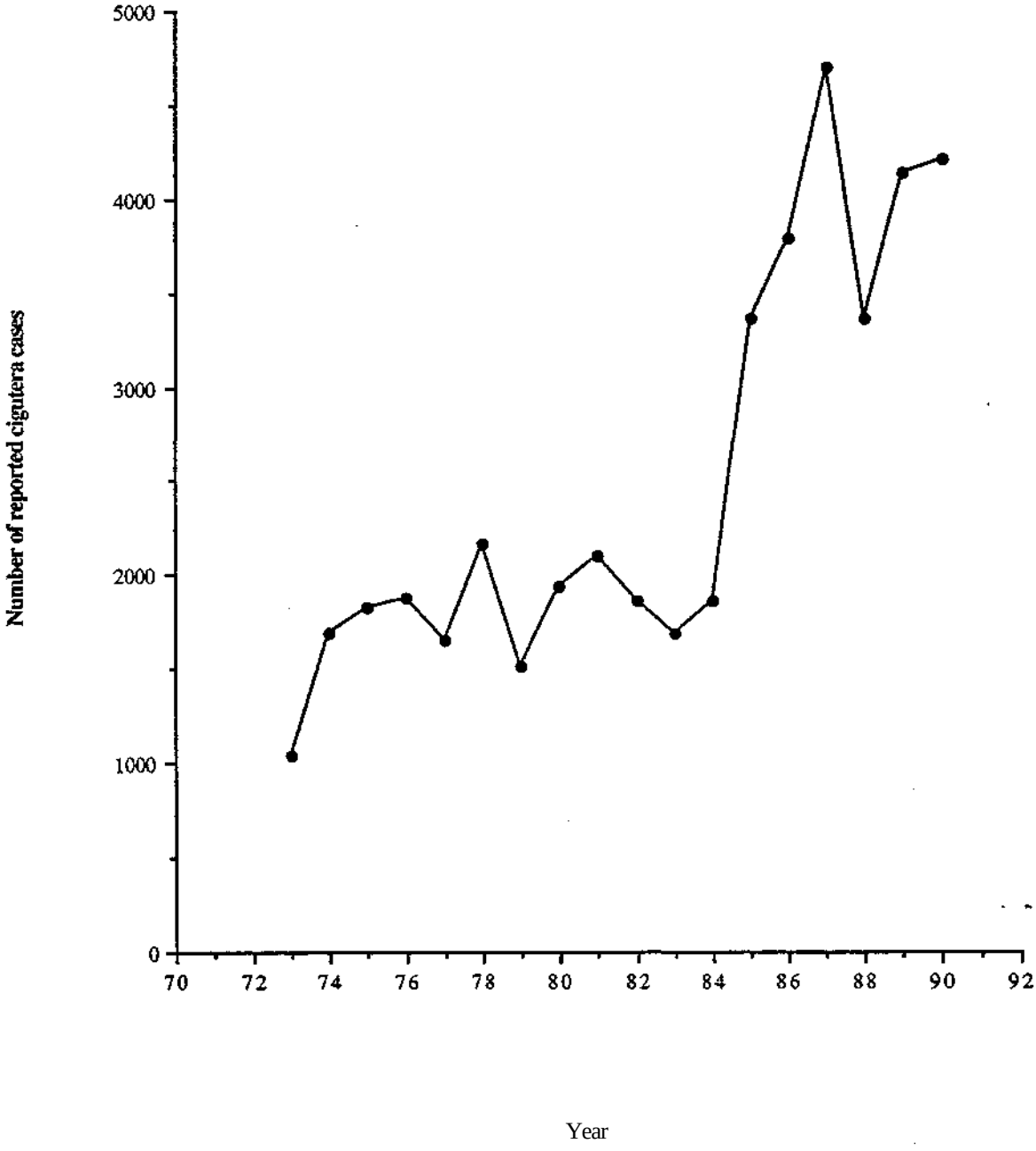

Figure 1. Annual number of ciguatera case histories reported to the SPEHIS database between 1973 and 1991

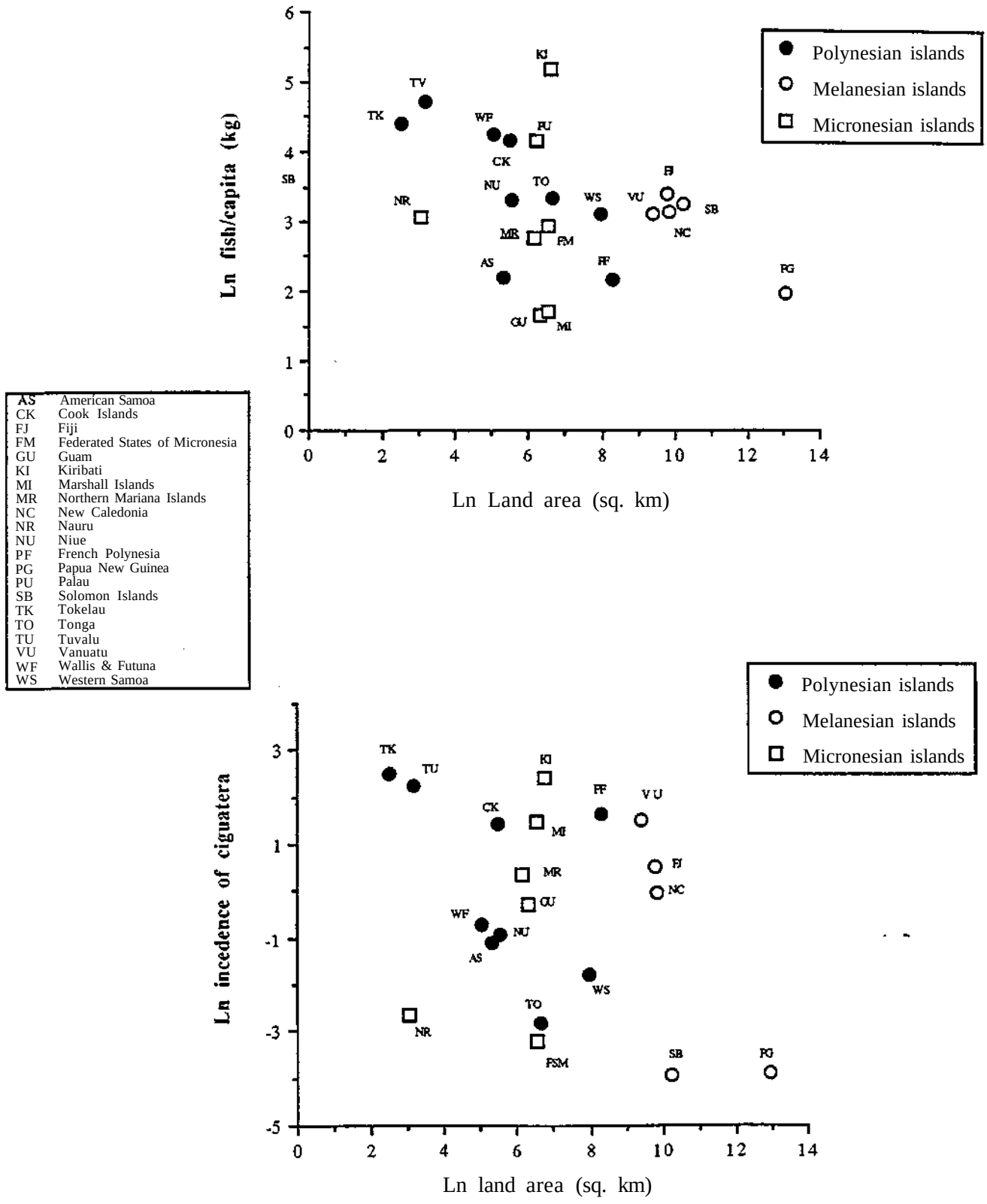

Figure 2. Double logarithmic plots of (top) annual production of fish expressed as landings per capita, and (bottom) mean annual incidence of ciguatera, versus land area for South Pacific countries and territories.

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 3. Specimen of the report form used to compile case histories for the SPC seafood poisoning database