CIGUATERA, CLUPEOTOXISM AND OTHER SEAFOOD POISONING IN FIJIAN WATERS AND THEIR IMPACT TO THE UTILIZATION OF MARINE RESOURCES

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ABSTRACT

The following forms of seafood poisoning have been confirmed: Ciguatera,Clupeotoxism,Tetrodotoxism,Scombrotocism,Ichthyo-ootoxism (from deep water),mullet poisoning,Crab poisoning, paralytic shellfish poisoning and canned fish poisoning.

Ciguatera represents 96.4 per cent of all documented cases of marine food poisoning. From a total of 925 cases reported in the period between 1975 to 1983, the annual incidence rate is seen to vary from 3-57 cases per 100,000 of population. Fish species belonging to the families LUTJANIDAE,SPHYRAENIDAE,SERRANIDAE and LETHRINIDAE constitute the mayor ciguatoxic species, with ACANTHURIDAE and SCARIDAE forming less than one per cent of all toxic fishes. Although there is common belief that toxicity is seasonal, being the highest in summer months, analysis of the recorded cases does not support this view. the occurence of the causative organism, Gambierdiscus toxicus, has been confirmed from Fiji. Although the Ciguatoxic species of fish are banned for sale, Sales figures from municipal markets shows that species implicated in Ciguatera constituted approximately 42.5 percent of all bottom dwelling lagoon and reef fishes sold in 1982. In the absence of a quick and reliable test for toxicity, ciguatera continues to pose a public health and a fishery problem.

Clupeotoxism is very sporadic in outbreak,having caused fatalities at Levuka,Bega and Namuka Islands. It has caused the highest mortality of all forms of marine food poisoning. Toxicity has been con-

firmed in three species of fishes : Atherinomorous lacunosa(family: ATHERINIDAE), Herklotsichthys qaudrimaculatus and Sardinella sirm (family:CLUPEIDAE). Initial investigations have revealed that the fat soluble fraction of mainly viscera has at least three toxins. Also, a quick acting toxin has been found in the water-soluble fraction. The outset on clupeotoxicity is very acute and death has been recorded within 1/2 hour to 11 hours after ingestion of the fish. The causative organism(s) appear to be in the plankton on which these species feed.

A new form of poisoning, arising out of the gonad and liver of Etelis ~~coruscans~~ carbunculus and Epinephelus septomfasciatus , from deep water have, been recorded. Two separate toxins from the roe of E. ~~coruscans~~ carbunculus have been confirmed. Both,human symptoms and chromatographic properties of the toxins indicate that the poisoning differs from any of the previously known ichthyo-ootoxisms such as ciguatera, dinogunellin poisoning and hypervitaminosis A.

Eleven cases of scombrotoxism have been included in health Ministry case records since 1975. The fish species involved appear to be Rastrelliger kanagurta, Rastrelliger branchysoma(family:SCOMBRIDAE), and Makaira sp.(family: ISTHIOPHERIDAE).

Five cases of shellfish poisoning have been treated at government hospital since 1975, including a single case of fatality from the consumption of Anadara antiquata in 1980.

Death of two sisters resulted from a meal of Zosimus aeneus in 1968, on the island of Serua,High levels of toxicity have been demonstrated in Z. aeneus and Atergatis floridus from Suva barrier reef.

Tetrodotoxism is very rare in occurence but three women, off Ra coast,were afflicted in 1974. Two women who ate roe of the fish died but one who ate only flesh survived.

Thirteen cases of mullet poisoning have been documented since 1975. The species involved is Crenimugil crenilabis. Kamba point, on the Southeast Viti Levu is claimed to produce mullet with poisonings.

In 1982 outbreak of canned fish poisoning in several districts of Fiji were reported. Two persons reportedly died after meals of two separate brands of canned fish.

Marine food poisoning must be regarded as a potentially important public health and fishery problem. Testing facilities for continuous surveillance and research to identify causative organisms, characterization of toxins and easy, quick and reliable method(s) of identifying toxic species must be empahasized.

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The first comprehensive review of the incidence of fish poisoning in Fiji was published by Banner and Helfrich (1964). Subsequently, Lomani (1974), Sorokin (1975), Bagnis (1976), Shiri Chand (1977), Narayan (1980), Raj (1981) and Yasumoto (1981), have given accounts of marine food poisoning in Fiji Islands. The Ministry of Health, Government of Fiji, has accumulated case reports from all hospital and medical centres since 1975, except for the year 1980, on standardized forms (see Appendix 1).

From available reports and our studies, the following forms of poisonings arising from the consumption of marine foods have been confirmed:

(i) Ciguatera
(ii) Clupeotoxism
(iii) Tetrodotoxism
(iv) Scombrotoxism
(v) Ichthyo-toxism - from deepwater fish
(vi) Mullet poisoning
(vii) Crab poisoning
(viii) Paralytic shellfish poisoning
(ix) Canned fish poisoning.

In Figure 1 the incidences of various forms of poisonings are summarized and the fatal cases, in recent years, presented in Figure 2.

CIGUATERA

Ciguatera represents 96.4 per cent of all documented cases of marine food poisoning (Figure 1). Outbreaks of ciguatera, per each month, over the period 1975-1983, are summarized in Table 1. The total number of cases reported, 925 in all, represent only persons who sought medical treatment; therefore, the actual incidence rate would be much higher than the figure. From Table 1 the annual rate reported per 100,000 population is seen to vary from 3-57. Inspite of relatively very high morbidity rate, in comparison to all other forms of marine food poisoning, only a single person is reported to have died from ciguatera after several days of hospitalization (see Narayan, 1980, for details).

Cases of ciguatera have been confirmed from throughout the Fiji Islands (Figure 3) but toxic areas are spotty in distribution and the outbreaks somewhat unpredictable. The occurrence of the causative organism, the dinoflagellate, *Gambierdiscus toxicus*, has been confirmed (Yasumoto - pers. comm. in Fiji). Fish species and the frequency with which they have been cited in ciguatera from 925 medical cases, are given in Table 2. *Lutjanus bohar*, and thus the family LUTJANIDAE, represent the largest number of poisoning cases. This is followed by the families SPHYRAENIDAE, SERRANIDAE and LETHRINIDAE. The large percentage of unknown species (11.24%) is a result of inadequate data from the patients and/or inability of medical officers to identify the fish. It is noteworthy that ACANTHURIDAE and SCARIDAE form less than 1% of all fish involved in toxicity. This is in direct contrast to reports from Tahiti where Bagnis (1967) reported 65% of poisonings owing to ACANTHURIDAE.

In Fiji, there is a general belief that toxicity is seasonal, from October to February or March, coinciding with the rainy season and the rising of *Balolo viridis* worm which has been wrongly implicated as a causative agent for poisoning. The analysis of all reported case histories by month (Figure 4) fails to show a clear picture on seasonality. Further studies are required to establish scientifically if indeed there is a seasonal increase in toxicity of ciguateric fish.

Several species of fish have been tested for toxicity in our laboratory by the standard mouse assay test after partial purification of the toxin through solvent-solvent partitioning. The highest toxicity scores of the flesh and viscera of the species in which toxin was detectable are given in Table 3. It is clear from the Table that viscera always showed higher toxicity scores, in comparison to the flesh. The most toxic species, *Lutjanus bohar*, was tested from several localities (see Figure 5) to determine "hot spots" but the results, presented in Table 5, failed to show excessively toxic areas. Also, there appeared to be no correlation between the size of the fish and the level of toxicity but the liver proved to be more toxic than the flesh. In 3 specimens the liver had significantly high level of toxicity when none was detectable in the flesh.

In Table 6 the frequency of clinical symptoms recorded by medical officers from 925 cases of ciguatera treated at hospitals in Fiji are given. Sorokin (1975), Shiri Chand (1977) and Narayan (1980) have published further analysis of clinical symptoms and the symptomatic treatment generally administered.

The main ciguateric fish species are banned from sale in the municipal markets. In Suva market, coloured illustrations of these fishes are displayed, but, as data in Table 4 shows, these species are still sold! The sales figures show that species implicated in ciguatera constituted approximately 42.5 per cent of all bottom dwelling lagoon and reef fishes sold in Fijian municipal markets in 1982. In the absence of a quick and reliable test for toxicity ciguatera continues to pose a public health and a fishery problem.

CLUPEOTOXISM

Outbreaks of clupeotoxism have been reported from Beqa (P.I.M., 1956), Namuka Island (Stone, pers. comm.) and Levuka (Banner and Helfrich, 1964; Lomani, 1974; Ministry of Health, case reports Government of Fiji; Govind, pers. comm.). See Figure 6 for locations. Incidence of this form of poisoning, locally called "Daniva poisoning", is very poorly documented but from Figure 2 it is evident that it has caused the largest number of fatalities (9, in recent years).

Since outbreaks of clupeotoxism are very sporadic throughout the world, the only experimental studies on this form of poisoning are the collaborate research between our laboratory and Professor Yasumoto's laboratory in Sendai, Japan.

Three species of fish (Table 7), namely, *Atherinomorous lacunosa* (family: ATHERINIDAE), *Herklotsichthys quadrimaculatus* and *Sardinella sirm* (family: CLUPEIDAE) have demonstrated the presence of clupeotoxins in the standard mouse assay tests, following injection of partially purified extracts of toxins through solvent-solvent partitioning. The toxicity scores of the viscera were always higher than that of flesh (Table 8).

Initial investigations have revealed that the fat-soluble fraction of viscera contains at least three different compounds: The first is free fatty acids group which kills mice by intraperitoneal route but gives no harm by oral administration. The second toxin has a polarity similar to that of ciguatoxin. It kills mice in a short period at high concentration. The third component is a highly polar compound(s) and acts very slowly. There is also a quick-acting toxin in the water soluble fraction of the viscera. Thus, the second fat-soluble toxin and the water-soluble toxin may account for the acuteness of clupeotoxism, but clearly, further studies are urgently needed to characterize these toxins.

As a result of high mortality rate and acuteness of occurrence, very few documented literature exists on clinical symptoms. In Table 9 the symptoms published by Banner and Helfrich (1964) and Lomani (1974) are given. Death has been reported to occur within ½ hour to 11 hours but some cases have been successfully treated (P.I.M., 1956; Dr Govind, pers. comm.).

In an attempt to find the causative agent for clupeotoxism, the plankton from Levuka wharf was concentrated by pumping large volumes of seawater through fine-mesh (30) sieves. The plankton thus concentrated was tested for toxicity by the standard mouse assay test after solvent extraction. It was found to be toxic and since clupeotoxic fishes from Levuka are planktivarous it seemed logical to conclude that plankton may contribute to clupeotoxism. Further studies are required to specify the causative organism.

TETRODOTOXISM

This form of poisoning is very rare in Fiji. The only documented occurrence has been reported by Lomani (1974). In August 1974, three women were afflicted with this poisoning, off the coast of Ra. Two of the women who ate the roe died in ½ hour while the third who ate flesh only survived. It is common knowledge in Fiji that puffer fish (Sumusumu) are toxic and generally these are avoided. Those who eat them usually remove the liver, roe and skin.

MULLET POISONING

13 cases of mullet poisoning have been recorded since 1975. The species involved is *Crenimugil crenilabis*. Kamba Point, on the South East Viti Levu is claimed to produce mullet poisoning but in all reported cases, seeking hospital treatment, localities where offending fish were caught were not identified. Since mullet poisoning produces only mild effects, this is not a serious form of poisoning.

DEEP SEA FISH
GONAD AND LIVER POISONING

In January 1982, 9 persons from Lauthala Island were poisoned after eating roe and liver of a snapper, *Etelis coruscans*, and a grouper, *Epinephelus septomfasciatus*, caught on the Vuna Seamount, at a depth of 269 metres. All nine cases were treated at Waiyevo Hospital, Taveuni Island. Three adults and one child were hospitalized for 3 days. The symptoms of poisoning developed some six hours after ingestion of the meal and included vomiting, severe headache, chest pain, general body ache, diarrhoea, thirst and overall body weakness. The roe from the patients' meal was proven to contain two lipid-soluble toxins from standard mouse assay after solvent extraction. Fresh roe of *E. coruscans* caught off Beqa Island and Dravuni Island confirmed the presence of toxins. Additionally, the liver of *E. coruscans* also had the presence of a toxin.

Both, human symptoms and chromatographic properties of the toxins, indicate that the poisoning differs from any of the previously known ichthyotoxisms such as ciguatera, dinogunellin poisoning and hypervitaminosis A.

E. coruscans is an important deep water and highly-priced fish resource hence toxicity of its viscera and gonads must be seriously considered and care taken to remove them before sales.

SCOMBROTOXISM

Eleven cases of scombrotoxism have been included in Health Ministry case records since 1975. The fish species involved (see Table 10) appear to be *Rastrelliger kunagurta, Rastrelliger brachysoma* (family: SCOMBRIDAE) and *Makaira* sp. (family: ISTIOPHERIDAE).

SHELLFISH POISONING

Five cases of shellfish poisoning have been treated at Government hospitals since 1975. The best known case, a fatal one, was that of a Police Sergeant who died in 1980 after a meal of the bivalve, *Anadara antiquata,* the most abundant marine shellfish sold in municipal markets.

CRAB POISONING

Death of two young sisters occurred on Serua Island in 1968 after they had eaten the reef crab, *Zosimus aeneus* (see Hashimoto, 1979). Recently, our laboratory has tested five species of crabs, commonly occurring on Suva Barrier Reef, for paralytic shellfish toxins (Raj et al., 1982). All the specimens of *Atergatis floridus* were found toxic with toxic scores varying from 3-717 mouse units per gram tissue. Toxicity level of *Zosimus aeneus* was significantly lower see Table 11) than that of *A. floridus*. The different level of toxicity between the two species seemed explainable by the difference in the distribution of the causative calcareous alga, *Jania* sp., in their respective habitats. Toxicity was not confirmed in specimens of *Carpilius maculatus, Carpilius convexus* and *Eriphia sebana*. *A. floridus* contained saxitoxin (55-60%), neosaxitoxin (35-40%), gonyautoxin-II (less than 5%) and a new toxin tentatively coded PBT (1%). *Z. aeneus* contained the same components, with additional trace amount of gonyautoxin-I and III, but neosaxitoxin was the major component in this species. Comparison with the results of Okinawan specimens suggests that the toxin profile is specific to species.

CANNED FISH POISONING

In 1982 outbreak of canned fish poisoning in several districts of Fiji were reported. Two persons reportedly died after meals of canned fish. Our laboratory tested the toxicity of some brands of canned fish. In two brands, significantly high levels of lipid-soluble toxins were detected, mainly in viscera, in mouse assay tests, following extraction and partial purification of toxin(s) by solvent-solvent partitioning - a method similar to one for ciguatera and clupeotoxism employed by us. The Health laboratory also found sporogenes in the same production batches. The investigations are still continuing.

SUMMARY

1. Eight forms of naturally marine food poisoning have been confirmed from Fiji. In addition, canned-fish poisoning has also occurred recently.

2. Ciguatera has the highest morbidity rate but clupeotoxism has claimed the largest number of lives.

3. Ciguatera is not only a public health problem but it also affects the utilization of the bottom-dwelling lagoon and reef fishes which comprise about 42.5% of such fish sales in municipal markets.

4. Apart from our laboratory, set up with the assistance of Toyota Foundation and Professor Yasumoto's laboratory, no reliable testing facilities for toxic marine foods exist in the South Pacific Islands.

5. It is considered very important that the testing facilities be strengthened and research on unsolved marine toxins intensified for better public health and much greater utilization of the marine resources of Fiji and other Pacific Islands.

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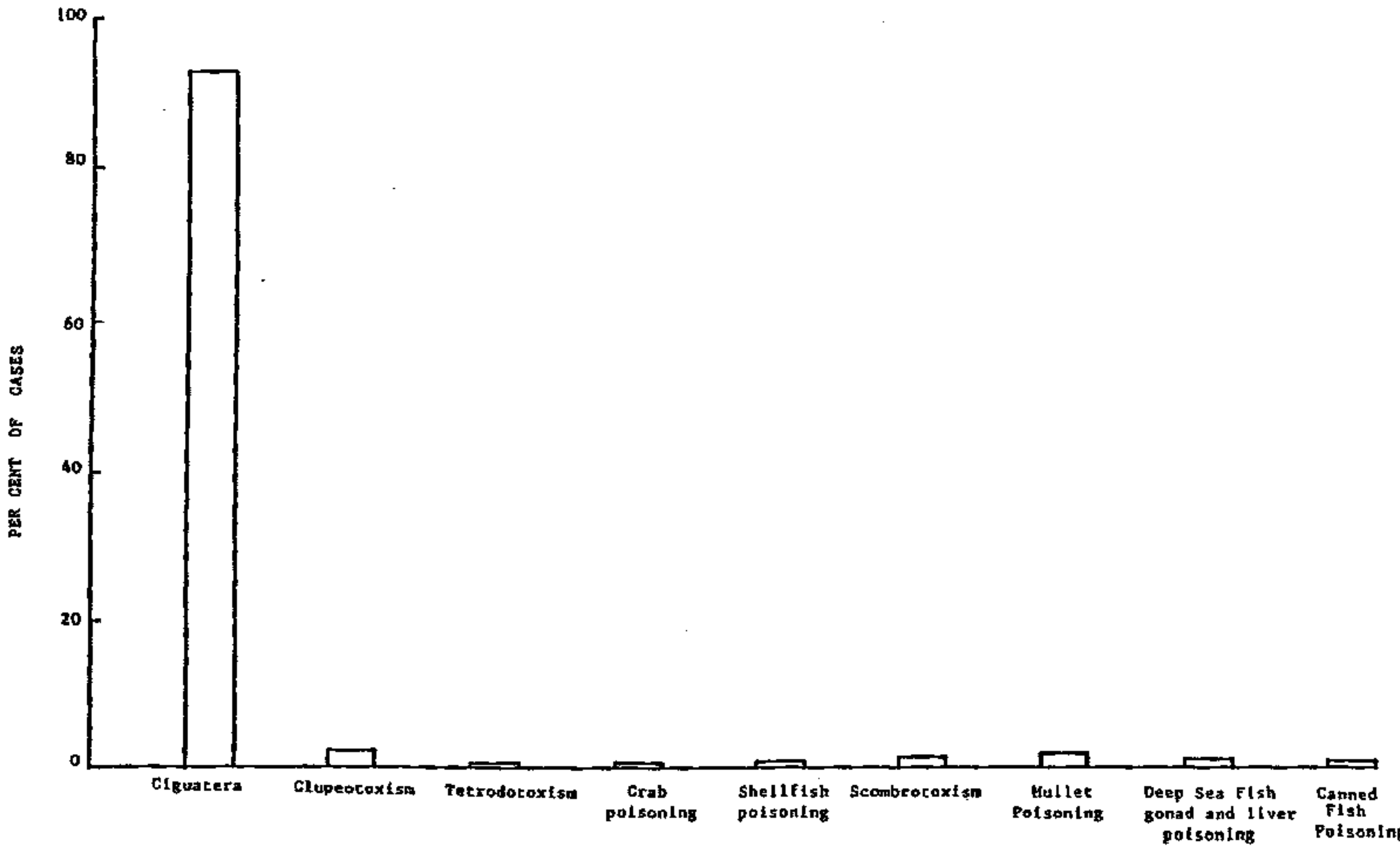

Fig. 1 : Incidence of various forms of seafood poisoning from all documented cases in Fiji

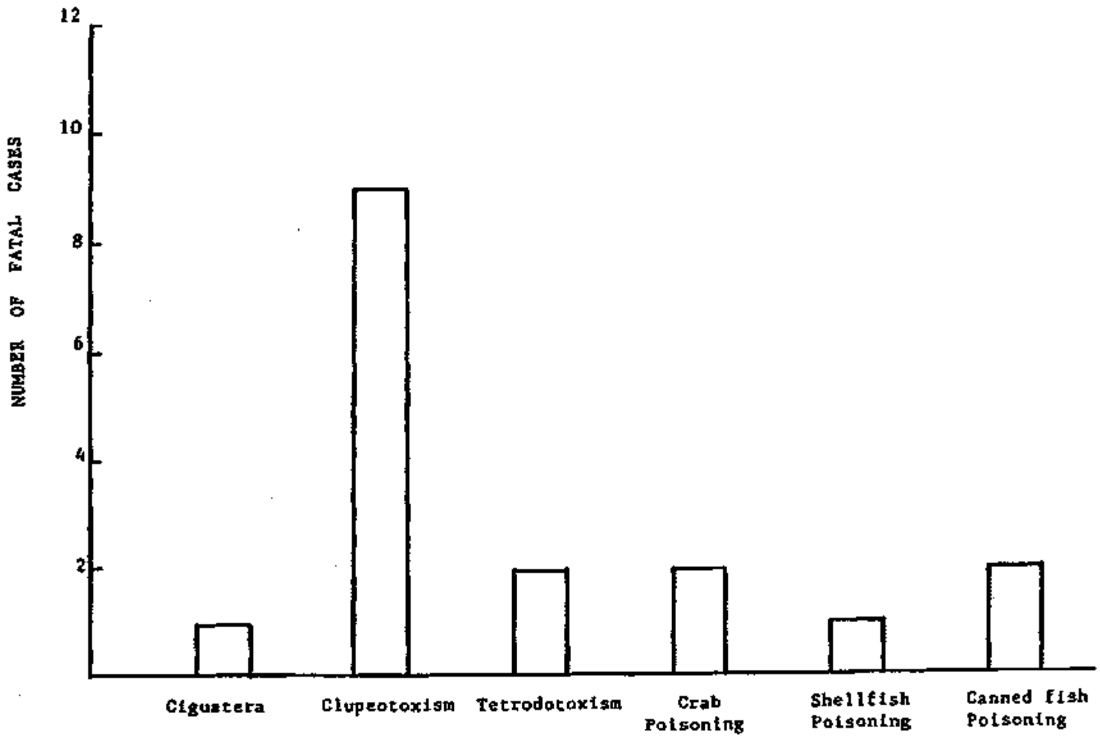

Fig. 2 : Number of fatal cases from the consumption of marine foods in Fiji, in recent years (1955-1983)

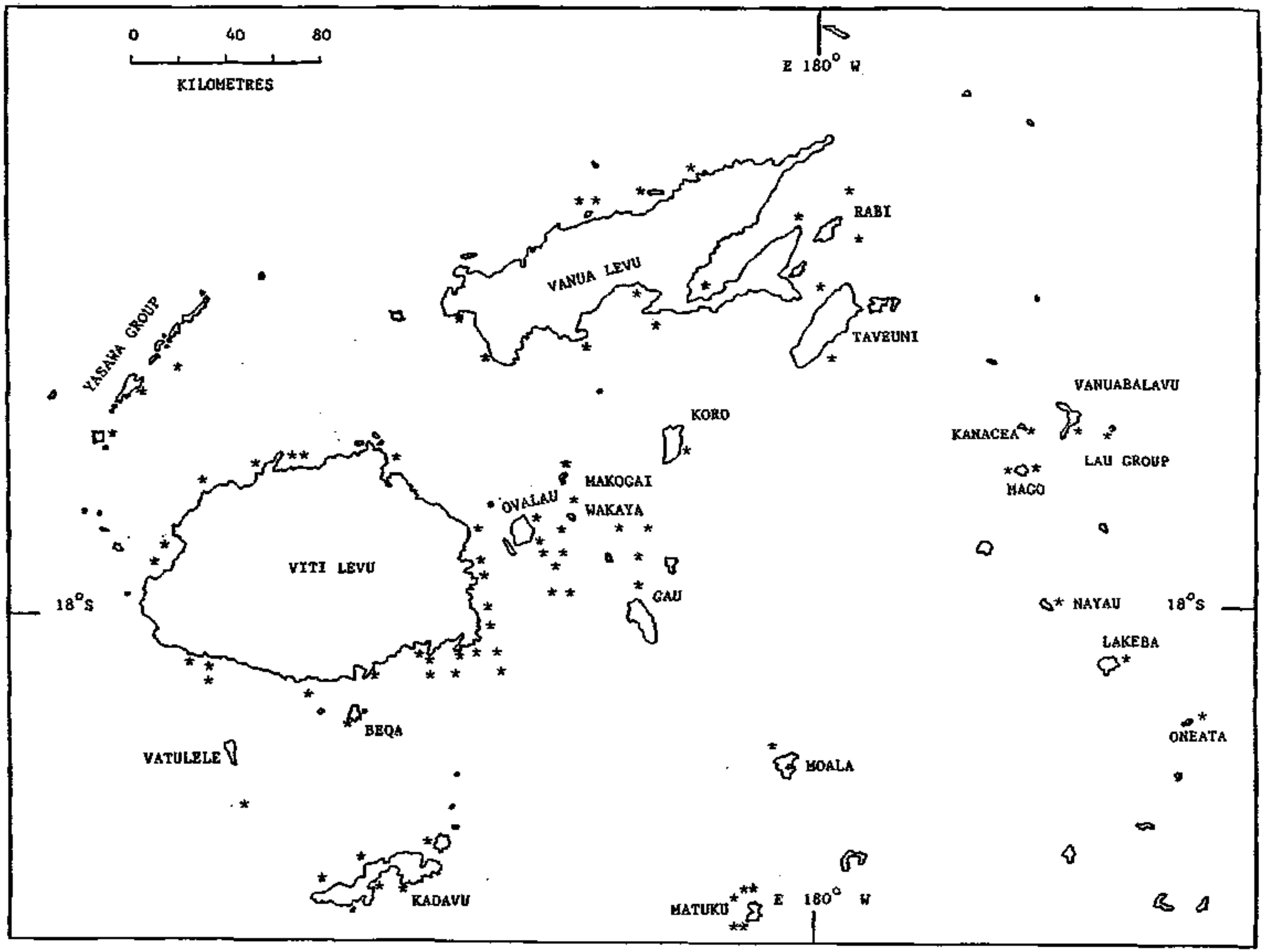

FIG. 3: LOCATIONS IN FIJI FROM WHERE REPORTS OF CIGUATERA POISONING HAVE BEEN CONFIRMED

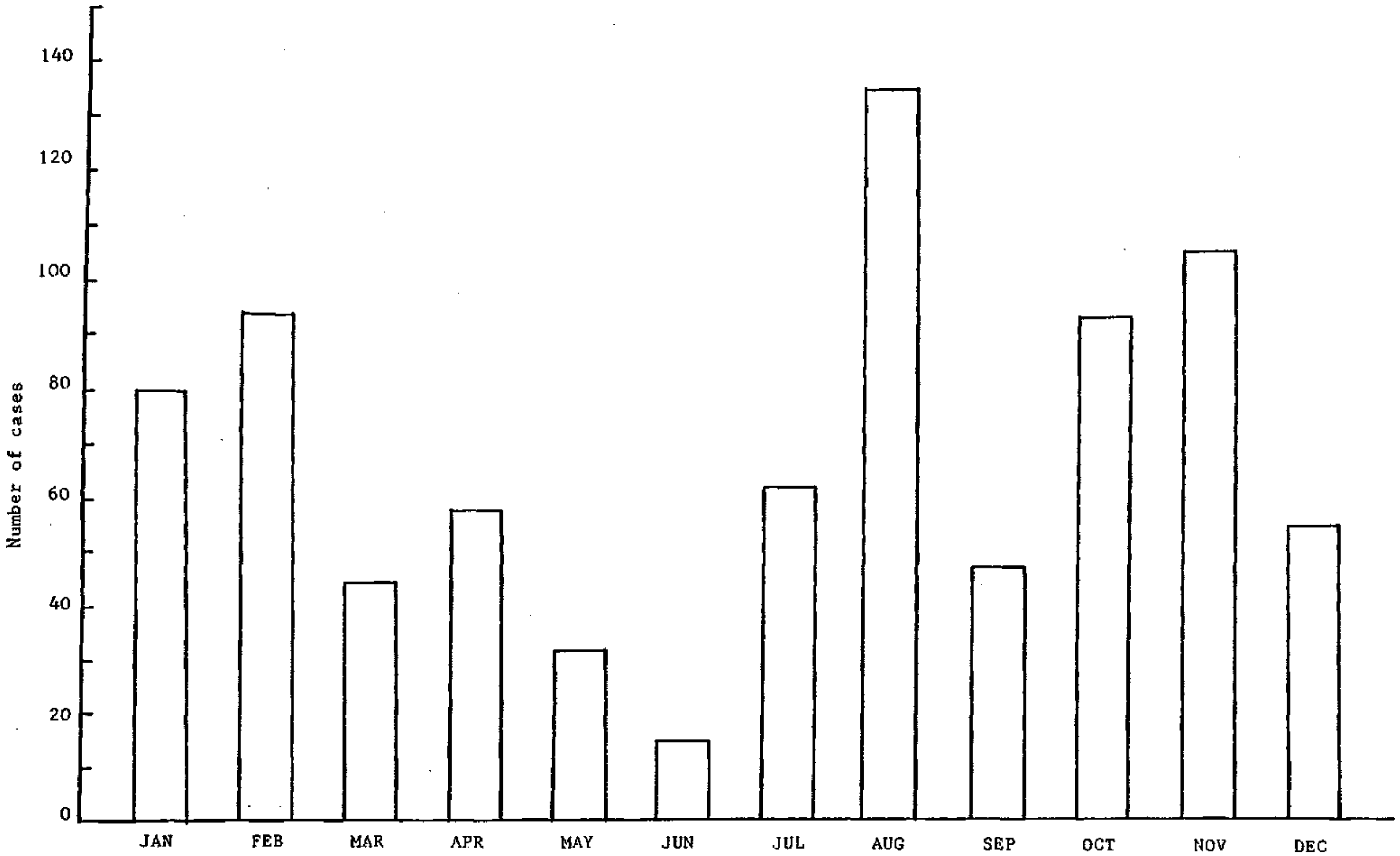

Fig. 4 : Reported cases of ciguatera, in each month, from medical records of Fiji hospitals (1975-1983)

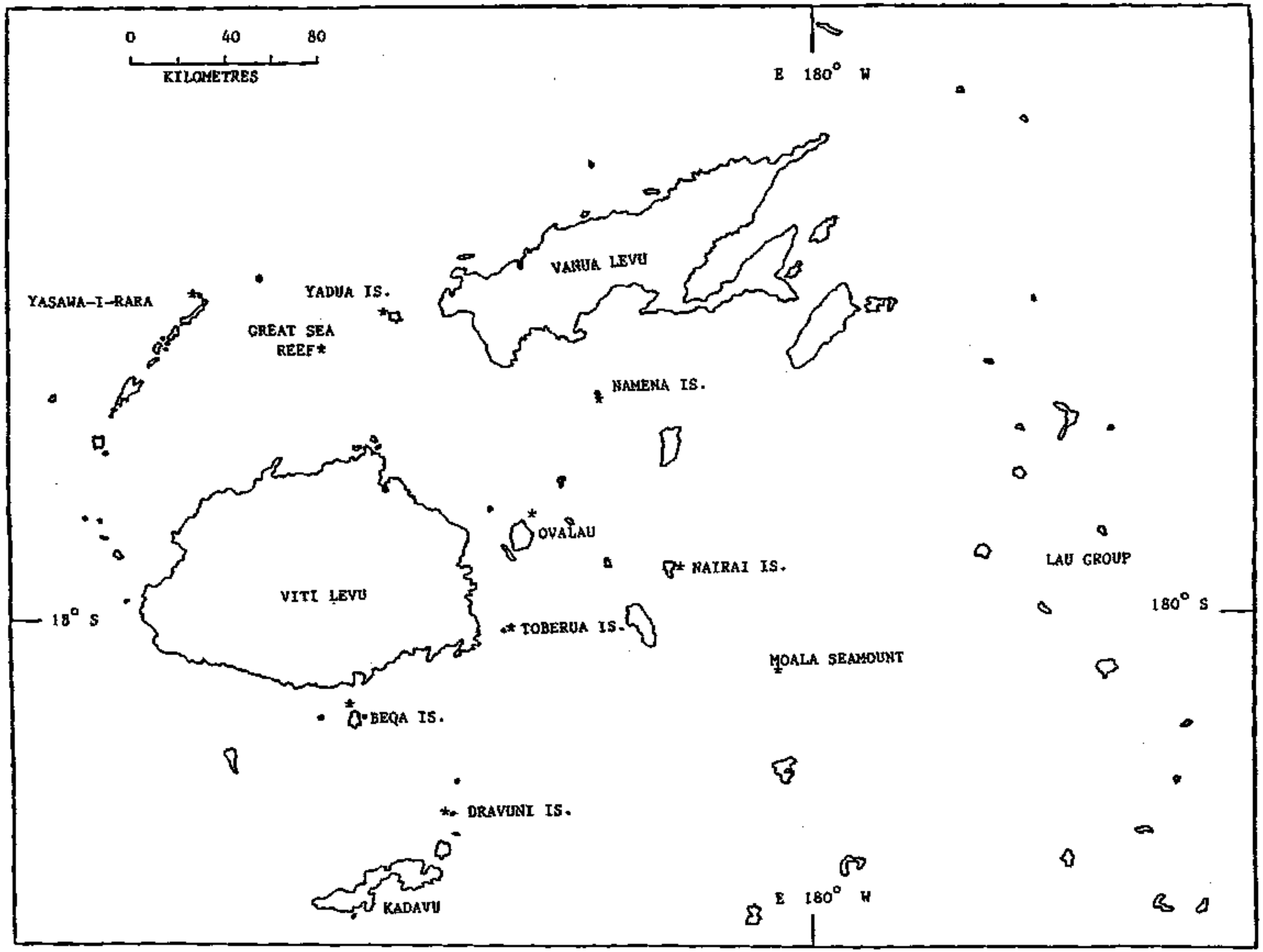

FIG. 5 : ISLAND LOCATIONS IN FIJI WHERE *Lutjanus bohar* HAS BEEN TESTED FOR CIGUATERA TOXICITY

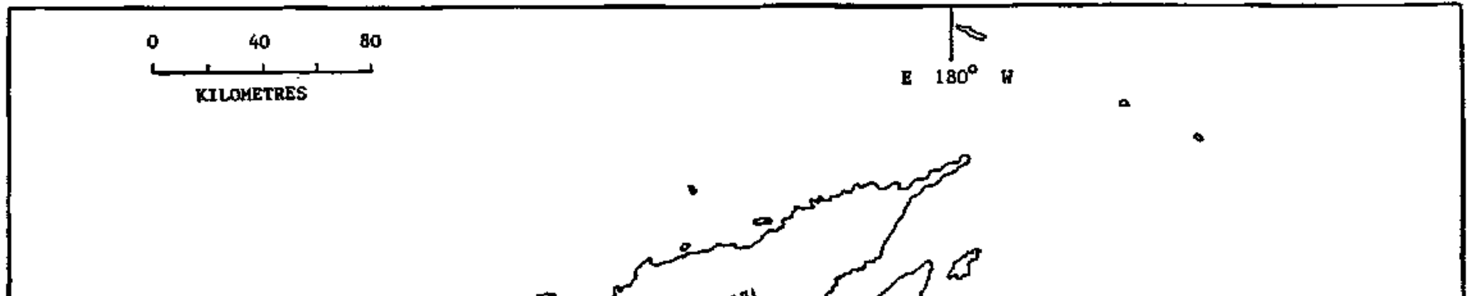
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TABLE 1: INCIDENCE OF CIGUATERA IN FIJI FROM MEDICAL RECORDS (1975–1983)

MONTH	YEAR 1975	1976	1977	1978	1979	1980	1981	1982	1983	TOTAL CASES IN EACH MONTH
JANUARY		29	7	16	9	DATA NOT AVAILABLE	10	9	6	86
FEBRUARY		22	34	14	7		12	4	3	96
MARCH		12	19	0	4		10	0	0	45
APRIL		35	17	6	0		0	0	1	59
MAY		9	15	0	5		0	2	0	31
JUNE		9	1	1	2		2	0	2	17
JULY		29	14	11	5		3	0	INCOMPLETE DATA	62
AUGUST		51	65	1	0		17	1		135
SEPTEMBER		25	18	2	2		0	0		47
OCTOBER		58	16	10	0		9	0		93
NOVEMBER	40	51	36	12	0		3	3		145
DECEMBER	54	4	28	4	5		13	1		109
TOTAL CASES PER YEAR	94	334	270	77	39	–	79	20	12	925
RATE PER 100,000 POPULATION	16	57	45	13	6	–	12	3	–	

TABLE 2: THE FREQUENCY OF CIGUATERIC FISH POISONING, BY SPECIES AND FAMILY, FROM MEDICAL RECORDS IN FIJI (1975-1983)

SCIENTIFIC NAMES	CASES	
	% of total cases per species	% of total cases per family
ACANTHURIDAE		
Naso spp	0.324	0.324
CARANGIDAE		
Caranx sexfasciatus	0.649	0.649
KYPHOSIDAE		
Kyphosus spp	0.108	0.108
LABRIDAE		
Chelinus undulatus	0.649	0.649
LETHRINIDAE		
Lethrinus miniatus	7.027	7.459
Lethrinus variegatus	0.432	
LUTJANIDAE		
Glabilutjanus nematophorus	0.405	
Lutjanus bohar	39.676	42.161
Lutjanus monostigma	1.008	
MULLIDAE		
Upeneus spp	0.324	0.324
MURAENIDAE		
Gymnothorax spp	1.838	1.838
POMADASYIDAE		
Plectorhynchus spp	0.216	0.216
SCARIDAE		
Scarus gibbus	0.324	0.324
SERRANIDAE		
Epinephelus spp	8.865	
Epinephelus fuscoguttatus	0.767	12.325
Plectropoma leopardus	2.703	
SPHYRAENIDAE		
Sphyraena spp	22.378	22.378
Unknown spp	11.243	11.243

TABLE 3: THE HIGHEST TOXICITY SCORES OF FISH SPECIES FROM FIJI TESTED FOR CIGUATERA

SCIENTIFIC NAMES	FIJIAN NAMES	ENGLISH NAMES	TOXICITY (mu/100g) FLESH	SCORE VISCERA
SPHYRAENIDAE				
Sphyraena picuda	Oqo		4.2	5.0
Sphyraena barracuda	Oqo	Barracuda	2.5	5.0
SERRANIDAE				
Epinephelus fuscoguttatus	Dela-bulewa	Flowery cod	2.5	8.0
Plectropoma leopardus		Coral trout	-	5.0
LUTJANIDAE				
Lutjanus bohar	Bati damu	Red Sea Bass	4.1	10.0
Lutjanus rivulatus	Regua	Maori chief	4.1	-
Lutjanus Monostigma	Kake or damu gumu sewa	Single-spotted snapper	4.4	-
LETHRINIDAE				
Lethrinus miniatus	Dokonivudi	Long-nosed emperor	4.1	5.0
LABRIDAE				
Cheilinus undulatus	Vari-ni-voce	Green wrasse	7.5	-

TABLE 4: CATCH COMPOSITION OF CIGUATERIC FISH EXPRESSED AS PERCENTAGE OF THE TOTAL SALES* OF ALL BOTTOM DWELLING LAGOON AND REEF FISHES SOLD IN FIJI

SCIENTIFIC NAMES	FIJIAN NAMES	WEIGHT OF FISH SOLD (METRIC TONS)	CATCH COMPOSITION BY SPECIES (% OF TOTAL)	CATCH COMPOSITION BY FAMILY (% OF TOTAL)
ACANTHURIDAE				
Naso spp	Ta	3.54	0.33	0.33
CARANGIDAE				
Caranx/Carangoides spp	Saqa	** 160.09	14.98	14.98
KYPHOSIDAE				
Kyphosus spp	Guru-ni-wai	0.27	0.025	0.025
LABRIDAE				
Chelinus undulatus	Vari-ni-voce	5.43	0.51	0.51
LETHRINIDAE				
Lethrinus miniatus	Boko-ni-vudi	6.84	0.64	2.84
Lethrinus variegatus	Kacika	23.54	2.20	
LUTJANIDAE				
Lutjanus bohar	Damu	3.14	0.29	11.81
Lutjanus monostigma	Kake	** 123.08	11.52	
POMADASYIDAE				
Plectorhynchus spp	Seva seva Bici	7.89	0.74	0.74
SCARIDAE				
Scarus spp	Ulavi	10.63	0.99	0.99
SERRANIDAE				
Epinephelus spp	Kawakawa	69.64	6.52	6.93
Plectropoma leopardus	Donu	4.41	0.41	
SPHYRAENIDAE				
Sphyraena spp	Oqo	35.34	3.31	3.31
		453.84 MT	42.475	42.475

*Data compiled from annual report of Fisheries Division, Government of Fiji, 1982

**Includes non-toxic species with common name 'kake' and 'saqa'

Table 5 : Toxicity scores of *Lutjanus bohar* caught from several locations in Fiji (ND = not detectable)

PLACE OF FISH CAPTURE	DATE CAUGHT	WEIGHT OF FISH (kg)	TOXICITY SCORE MU/100g) FLESH	LIVER
NAMENA IS	21/ 7/81	4.50	ND	-
	23/ 9/81	2.90	ND	10.0
	"	4.20	ND	-
	"	5.50	ND	8.0
	"	7.20	ND	-
OVALAU	8/11/81	2.40	4.1	-
	14/12/81	2.40	4.1	-
	8/11/81	2.70	2.5	-
	14/12/81	3.0	ND	-
	8/11/81	3.80	5.0	-
	8/11/81	4.80	5.0	12.8
GREAT SEA REEF	21/ 1/82	1.10	ND	-
	14/12/81	1.2	ND	-
	21/ 1/82	1.40	ND	-
	22/ 1/82	1.40	ND	-
	21/ 1/82	1.60	ND	-
	21/ 1/82	2.40	2.5	-
	26/ 1/82	2.50	ND	-
	21 1/82	2.60	ND	-
	21/1/82	2.80	ND	-
	22/ 1/82	2.80	ND	-
	26/ 1/82	2.80	ND	-
	21/ 1/82	2.90	ND	-
	14/12/81	3.0	2.5	-
	21/ 1/82	4.10	2.5	-
	14/12/81	4.9	2.5	-
	22/ 1/82	5.5	4.1	-
	21/ 1/82	5.60	ND	-
	21/ 1/82	6.90	ND	-
YADUA IS.	21/ 1/82	0.7	ND	-
	21/ 1/82	1.4	ND	-
	21/ 1/82	2.6	ND	-
	22/ 1/82	2.6	2.5	-
	22/ 1/82	4.1	2.5	-
	22/ 1/82	4.4	4.1	-
	22/ 1/82	4.5	4.1	-
	21/ 1/82	5.3	ND	-
	21/ 1/82	6.4	ND	-
BEQA IS.	22/ 1/82	4.0	2.5	-
MOALA SEA MOUNT	15/ 2/83	3.0	5.0	-
NAIRAI IS.	10/ 3/83		ND	-
TOBERUA	10/ 3/83		ND	-
YASAWA-I-RARA	APRIL/MAY '83	0.4	ND	6.0

Table 5 : Toxicity scores of *Lutjanus bohar* caught from several locations in Fiji (ND = not detectable)

PLACE OF FISH CAPTURE	DATE CAUGHT	WEIGHT OF FISH (kg)	TOXICITY SCORE MU/100g) FLESH	LIVER
NAMENA IS	21/ 7/81	4.50	ND	-
	23/ 9/81	2.90	ND	10.0
	"	4.20	ND	-
	"	5.50	ND	8.0
	"	7.20	ND	-
OVALAU	8/11/81	2.40	4.1	-
	14/12/81	2.40	4.1	-
	8/11/81	2.70	2.5	-
	14/12/81	3.0	ND	-
	8/11/81	3.80	5.0	-
	8/11/81	4.80	5.0	12.8
GREAT SEA REEF	21/ 1/82	1.10	ND	-
	14/12/81	1.2	ND	-
	21/ 1/82	1.40	ND	-
	22/ 1/82	1.40	ND	-
	21/ 1/82	1.60	ND	-
	21/ 1/82	2.40	2.5	-
	26/ 1/82	2.50	ND	-
	21 1/82	2.60	ND	-
	21/1/82	2.80	ND	-
	22/ 1/82	2.80	ND	-
	26/ 1/82	2.80	ND	-
	21/ 1/82	2.90	ND	-
	14/12/81	3.0	2.5	-
	21/ 1/82	4.10	2.5	-
	14/12/81	4.9	2.5	-
	22/ 1/82	5.5	4.1	-
	21/ 1/82	5.60	ND	-
	21/ 1/82	6.90	ND	-
YADUA IS.	21/ 1/82	0.7	ND	-
	21/ 1/82	1.4	ND	-
	21/ 1/82	2.6	ND	-
	22/ 1/82	2.6	2.5	-
	22/ 1/82	4.1	2.5	-
	22/ 1/82	4.4	4.1	-
	22/ 1/82	4.5	4.1	-
	21/ 1/82	5.3	ND	-
	21/ 1/82	6.4	ND	-
BEQA IS.	22/ 1/82	4.0	2.5	-
MOALA SEA MOUNT	15/ 2/83	3.0	5.0	-
NAIRAI IS.	10/ 3/83		ND	-
TOBERUA	10/ 3/83		ND	-
YASAWA-I-RARA	APRIL/MAY '83	0.4	ND	6.0

TABLE 6: FREQUENCY OF CLINICAL FEATURES RECORDED FROM 925 CASES OF CIGUATERA TREATED AT HOSPITALS IN FIJI (1975-1983)

CLINICAL FEATURES	NO. OF CASES	FREQUENCY %
Vomiting	276	29.8
Diarrhoea	476	51.2
Abdominal pain	545	58.9
Tingling, numbness: lips, nose, tongue	478	51.7
Pin-pricking heads, feet	516	55.8
Burning when contact with cold water	512	55.3
Joint and muscle pains	641	69.3
Sweating	314	34.0
Body chilliness	388	42.0
Giddiness, vertigo	348	37.6
Itching	325	35.1
Weakness of the legs	501	54.2
Difficulty to urinate	93	10.0
Difficulty to breathe	79	8.5
Paralysis	11	1.2
Eruption or rash	22	2.4
Other symptoms or signs	43	4.6
Previous history of fish poisoning	104	11.2

TABLE 7: FISH SPECIES IN FIJI IN WHICH CLUPEOTOXINS HAVE BEEN PROVEN EXPERIMENTALLY

SCIENTIFIC NAMES	FIJIAN NAMES	COMMON NAMES
ATHERINIDAE		
Atherinomorous lacunosa (old name: *Pranesus pinguis*)	Sara	Silversides
CLUPEIDAE		
Herklotsichthys quadrimaculatus (old name: *H. punctatus*)	Daniva	Gold spotted herring
Sardinella sirm	-	Sardine

TABLE 8 : THE HIGHEST TOXICITY SCORES OF FISH SPECIES FROM FIJI TESTED FOR CLUPEOTOXISM

SCIENTIFIC NAMES	FIJIAN NAMES	COMMON NAMES	TOXICITY SCORE (mu/100g) FLESH	VISCERA
ATHERINIDAE				
Atherinomorous lacunosa	Sara	Silverside	3.3	6.7
(old name: *Pranesus pinguis*)				
CLUPEIDAE				
Herklotsichthys quadrimaculatus	Daniva	Sardine	5	10
(old name: *H. punctatus*)				
Sardinella sirm	–	Sardine	4	5.6

TABLE 8: THE HIGHEST TOXICITY SCORES OF FISH SPECIES FROM FIJI TESTED FOR CLUPEOTOXISM

SCIENTIFIC NAMES	FIJIAN NAMES	COMMON NAMES	TOXICITY SCORE (mu/100g) FLESH	VISCERA
ATHERINIDAE				
Atherinomorous lacunosa	Sara	Silverside	3.3	6.7
(old name: *Pranesus pinguis)*				
CLUPEIDAE				
Herklotsichthys quadrimaculatus	Daniva	Sardine	5	10
(old name:*H. punctatus)*				
Sardinella sirm	-	Sardine	4	5.6

TABLE 9: SYMPTOMS OF CLUPEOTOXISM PUBLISHED FROM CASES IN FIJI

Banner, A.H. & Helfrich, P., 1964	Lomani, S., 1974
Severe vomiting	nausea
Diarrhoea	vertigo
Fever with profuse sweating	itching
Restlessness	abdominal pain
Pulse first rapid then gradually slowing	tenesmus
Low blood pressure (90/60)	tachycardia
Rapid respiration	cold sweat
Skin itchy	dyspnoea
Eyes dilated	cyanosis
Reflexes of biceps, knee & ankle absent	mydriasis
	Coma and convulsion

Note: Death has resulted within ½ hour to 11 hours after consumption of fish

TABLE 10: FISH SPECIES RECORDED IN SCOMBROTOXIC CASES TREATED AT HOSPITALS IN FIJI

SCIENTIFIC NAMES	FIJIAN NAMES	COMMON NAMES
SCOMBRIDAE		Mackerel & Tunas
Rastrelliger kunagurta	Salala	Indian mackerel
Rastrelliger brachysoma	Salala	wide bodied mackerel
Scomberomorous commerson	Walu	Spanish mackerel
ISTIOPHERIDAE		
Makaira sp.	Sakurorowaqa	Swordfish/Marlins