

Traditional remedies used in the Western Pacific for the treatment of ciguatera poisoning

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Ciguatera is a specific type of food poisoning associated with the ingestion of tropical fish, which, although normally safe for consumption, may at times contain high amounts of ciguatoxin, as well as other chemically related toxins. Widespread in tropical regions where coral reefs are present, ciguatera fish poisoning constitutes a major hindrance for local fishing industries, local economies and foreign trade. Because no symptomatic treatment has been totally satisfactory, folk remedies remain of great interest. In this paper, a list of plants used in treating ciguatera poisoning in the Western Pacific region is presented, with emphasis on species whose exact utilization (part of plant used, preparation, dosage) has been determined.

Key words: traditional remedies; ciguatera poisoning; Western Pacific

Introduction

The ciguatera toxins are produced by the benthic dinoflagellate *Gambierdiscus toxicus* (Bagnis et al., 1980). This single-celled microalgae is ingested by herbivorous fish along with the macrophytic algae on which it grows. The toxins are then passed up the food chain until they reach sufficient concentration to provoke a type of human poisoning known as ichthyosarcotoxism. This condition is difficult to prevent, since tainted fish cannot be identified by appearance, odor or taste. All large species of fish associated with coral reefs can be toxic, particularly those at the upper end of the food chain (barracudas, groupers, sea perch, moray eels, sharks, etc).

Several 'ciguateric' toxins, some not yet identified, are involved in the etiology of ciguatera fish poisoning. The two major toxins are ciguatoxin (CTX) and maitotoxin (MTX) (Ohizumi, 1987). The chemical structure of ciguatoxin has recently been determined (Murata et al., 1989). It is one of the most potent marine toxins with a 50% lethal dose (LD₅₀) in mice of 0.45 µg/kg when injected intraperitoneally (i.p.) and cannot be destroyed by cooking or freezing. Maitotoxin, which can be biosynthesized in cultures of *Gambierdiscus toxicus* (Yasumoto et al., 1987), is particularly toxic (LD₅₀ = 0.13 µg/kg, i.p.) and is found only in the

viscera of herbivorous and bottom-feeding fish (Yokoyama et al., 1988).

Symptoms of poisoning appear 2–30 h after ingestion of toxic fish. Early signs include numbness, a prickling sensation in the lips, tongue and throat, general weakness and nausea. These symptoms soon give way to digestive (cramps, abdominal pains, vomiting and profuse diarrhea) and neurological disorders: itching (pruritus), articular pains and asthenia. In severe cases, cardiovascular and respiratory symptoms may also occur.

The severity of the symptoms varies according to the amount of toxin ingested (based on the fish size and the part of the fish consumed) and individual susceptibility.

In most cases of ciguatera fish poisoning, complete recovery may be expected, but exceptionally severe poisoning can lead to paralysis, coma and death.

Mode of action of ciguatoxin

CTX modifies cell membrane permeability to sodium ions: it opens Na⁺ channels in the nerves of intact mammals, leading to an influx of intracellular sodium and depolarization of the nerve fibre (Capra and Cameron, 1985).

Studies by Bidard et al. (1984) and Lombet et al. (1987) have further clarified CTXs mode of action: it acts at protein sites of tetrodotoxin-sensitive sodium channels. The activation of these sites leads to the opening of fast sodium channels.

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Ciguatoxin and brevetoxin (toxin implicated in neurotoxic shellfish poisoning) share the same site of action, which has been shown to be distinct from that used by other toxins acting on fast sodium channels (tetrodotoxin, saxitoxin, veratridine, batrachotoxin, aconitine, grayanotoxin, scorpion and sea anemone toxins, pyrethroids and DDT).

Membrane depolarization resulting from the influx of sodium brings about an opening of calcium channels and therefore an influx of Ca^{2+} , which in turn activates the release of sympathetic noradrenaline and parasympathetic (acetylcholine) transmitters.

Disorders observed after ingestion of CTX, therefore, result from an intermingling of adrenergic and cholinergic effects of variable intensity.

Treatment

In most cases, ciguatera fish poisoning has no lasting effect. When the condition is identified, however, patients are advised to avoid ingestion of fish or other seafood as well as alcoholic beverages, nuts and grains, since these can aggravate symptoms or slow down recovery.

Up to now, treatment for ciguatera poisoning has consisted of methods aimed at reducing symptoms: stomach pumping and early administration of apomorphine. Subsequent treatment depends on the severity of each case and may include antispasmodics and antiemetics, for digestive disorders and vitamins B_1 , B_6 , B_{12} complex, colchicine, acetylsalicylic acid and calcium gluconate injections, for neurological symptoms.

Pruritus is treated with synthetic antihistamines. In severe cases, cardiovascular stimulants are administered to counter shock or collapse.

Alongside this approach of treatment, recent advances in knowledge of CTXs mode of action have led to treatments using various antagonists. Among the most promising are atropine-type substances, which counteract the effects associated with acetylcholine secretion. Such substances include lidocaine and tocainide (contact anesthetics with membrane stabilizing action which act as competitive antagonists with the sodium ion), phentolamine (an alpha-blocking substance) and calcium gluconate (Legrand et al., 1985; Lange et al., 1988). Clinical tests using intravenous mannitol have also been conducted with promising results (Palafox et al., 1988).

No symptomatic treatment has been totally satisfactory and many people continue to resort to healers and traditional medicines. Some of these

preparations appear to have effective therapeutic properties.

Folk remedies, therefore, remain of great interest. In many places, there are no clinics close to villages and people must treat themselves with their own time-honoured recipes. It is these type of treatments which we have attempted to document.

Methodology

The ethnobotanical data was gathered over a period of 10 years (1980–1990) by way of general ethnopharmacological surveys conducted on the various islands in the Vanuatu archipelago (G. Bourdy, A. Walter and P. Cabalion) and in New Caledonia (D. Bourret, P. Amade and D. Laurent). People from all walks of life were invited to contribute their recipes for remedies used to prevent or treat ciguatera fish poisoning. In this way, some recipes came from ordinary men and women, whereas others were volunteered by traditional doctors or by specialists. Specimens of the plant species listed below were collected with the help of these informants. Wherever possible, four specimens of each species were prepared and sent to each of the following institutions: National Museum of Natural History (Paris, France), the ORSTOM Herbarium (Nouméa, New Caledonia), the Kew Gardens Herbarium (Surrey, England) and the National Collection (Port Vila, Vanuatu). All identifications were confirmed by specialists.

Results

The results of the 10-year survey are summarized in Table 1. In this table, we have indicated the plants' species and family names and their common French names, as well as their Herbarium reference numbers, whenever these could be obtained. Plants used to treat ciguatera fish poisoning are clearly indicated and distinguished from those used to treat other types of fish poisoning. The mode of preparation and the dosage, if known, are also indicated.

Some of the information gathered here has already been published; when this is the case, the source reference is given in parentheses. If the source of data is our own observations, this is indicated by an asterisk.

In addition to methods used to treat ciguatera fish poisoning in Vanuatu and New Caledonia, those used in other Pacific countries (French Polynesia, Guam, Samoa, Tonga, Fiji) were also considered.

TABLE 1

PLANTS USED FOR THE TREATMENT OF CIGUATERA FISH POISONING

Species (Family) French name used in New Caledonia English common name Herbarium number	Use ^a	Plant part used	Preparation, dosage (References) (* = Data derived from field observations and interviews	Frequency and Origin ^b	Other uses ^c (References) (* = Data derived from field observations and interviews
<i>Achyranthes aspera</i> L. (AMARANTHACEAE) "Queue de rat" GB507	Ciguatera	Whole plant	Decoction (Rageau, 1973)	(1) N.C.	Relief of dysenteric symptoms; diuretic (Rageau, 1973)
	Ciguatera	Root	Macerate in a bottle of water Drink one bottle a day until recovery is complete (*)	(3) N.C. Van.	Antispasmodic (Rageau, 1973); relief of dysenteric symptoms (*)
<i>Aglaia elaeagnoides</i> (Jussieu) Benth (MELIACEAE) "Bois rose" PC1462	Ciguatera	-	Used in mixture with the following : <i>Maesa ambrymensis</i> , <i>Erythrina variegata</i> , <i>Metrosideros collina</i> var. <i>villosa</i> , <i>Pandanus</i> sp., <i>Terminalia catappa</i> , <i>Dysoxylum</i> <i>bijugum</i> , <i>Dysoxylum gaudichaudianum</i> (Cabalion 1984e)	(1) Van.	-
<i>Aglaia saltatorum</i> A.C. Smith (MELIACEAE)	Ciguatera	Stem	The stem is scraped and squeezed into water in the preparation of a remedy for fish poisoning (Weiner, 1985)	(1) Fiji	Bark infusion is taken as an emetic (Whistler, 1991)
<i>Argusia argentea</i> (L.f.) Heine (BORAGINACEAE) "Faux tabac" PC2282	Ciguatera	Leaf	One large leaf in an infusion or decoction. Use internally and externally (baths) (Bourret, 1981)(*)	(3) N.C. Van. Pol.	Muscle pain relief; antirheumatic (Rageau, 1983); antipruritic (Geremie, 1988; Rageau, 1973); depurative (Pétard, 1986)
	Fish poisoning	Leaf	Leaf infusion is taken as an antidote for poisoning caused by eating tainted fish (Whistler, 1991)	Tonga	Antipruritic (Bourret, 1981)
	Ciguatera	Stembark	Boil a piece of the stembark the size of the palm of the hand in a litre of water for 10 minutes (Bourret, 1981; Cabalion, 1984b; Pétard, 1986)(*)	-	-
Ciguatera	Root		(Rageau, 1983)	(1) N.C.	-

TABLE 1 (continued)

<i>Artocarpus altii</i> (Parkinson) Fosberg (MORACEAE) "Arbre à pain" "Breadfruit"	Ciguatera	Leaf bud and latex	Chew and swallow from one to five fresh leaf buds ; then drink one small glassful of fresh latex. Repeat one to three times per day, until recovery is complete (Bourret, 1981) This potion is made from the fresh leafbuds together with coconut oil (Lobel, 1979) Fluid pressed from the shoots (Weiner, 1985)	(3) Fiji Kir. N.C.	An infusion of the leaf ashes, rubbed on skin rashes (Whistler, 1985)
	Ciguatera	Bark	(Rageau, 1973)	(2) N.C.	Rashes (Whistler, 1985) For facial rashes (Whistler, 1991)
<i>Barringtonia asiatica</i> (L.) Kurz (LECYTHIDACEAE)	Ciguatera	Stembark	Infusion (Haddock, 1973)	(2) Guam	-
	Fish poisoning ^(a)	Stembark	The bark of the tree is boiled into a strong tea that is taken internally (McMakin and Moore, 1977)	-	-
<i>Canavalia rosea</i> (Sw.) DC. (PAPILIONACEAE)	Ciguatera	Root	(Rageau, 1973)	(1) N.C.	-
<i>Capsicum frutescens</i> L. (SOLANACEAE) "Piment", "chili pepper"	Ciguatera	Fruit	Swallow a handful of small raw chilies at once (Bourret, 1981)	(1) N.C.	-
<i>Carica papaya</i> L. (CARICACEAE) "Papayer", "papaw"	Ciguatera	Leaf	Boil three chopped leaves in half a litre of water. Drink this decoction three times a day (Rageau, 1973; Bourret, 1981)	(3) N.C. Van.	Antiemetic (Bourdeau, 1985); cardiac action, depurative (Bourret, 1981; Rageau, 1973)
	Ciguatera	Flower	Boil approximately ten male flowers in one litre of water. Drink one litre per day until the recovery is complete (Cabalion, 1984b)(*)	(3) N.C. Van.	-
	Ciguatera	Fruit	Boil unripe fruits; eat the cooked fruit or drink the cooking water (Pétard, 1986)	(1) Pol.	-
<i>Cerbera manghas</i> L. (APOCYNACEAE) "Faux manguier"	Fish poisoning	-	(Weiner, 1985)	(1) Fiji	Antirheumatic (Weiner, 1985)
<i>Chenopodium ambrosioides</i> L. (CHENOPODIACEAE) "Herbe à puce" "Mexican tea, wormseed"	Ciguatera	Leaf	Decoct 3 to 5 leaves in one litre of water (Bourret, 1981; Rageau, 1973)	(3) N.C.	Antispasmodic (Rageau, 1973); diaphoretic (Rageau, 1973); antirheumatic (Rageau, 1973; Bourret, 1981)
<i>Citrullus lanatus</i> (Thunb.) Matsum. et Tanaka (CUCURBITACEAE) "Pastèque", "watermelon"	Ciguatera	Peel	Cut the melon peel into small pieces. Boil in seawater (Pétard, 1986)	(2) Pol.	Purgative (Pétard, 1986)

<i>Clerodendrum inerme</i> (L.) Gaertner (VERBENACEAE)	Fish poisoning	Seed	Decoct freshly pounded seeds (Weiner, 1971)	(1)	-
<i>Cocos nucifera</i> L. (ARECACEAE) "Cocotier", "coconut tree"	Fish poisoning	Fruit	Coconut milk, produced by grating and squeezing the flesh, is used to treat fish poisoning (Weiner, 1985) Mix coconut cream (obtained by scraping two coconuts) with cocoa and sugar to a consistency of molasses. Drink one cup (McCuddin, 1974)	(3) Fiji Samoa	Emetic (McCuddin, 1974), Coconut oil is a purgative (Pétard, 1986)
	Ciguatera	Fluff (mesocarp)	Drink during three days the juice from the fluff (mesocarp) of the coconut ("ovisi" or "nia" stage). This drink is claimed to induce vomiting, which increase the elimination of the poison (Pétard, 1986)	(1) Pol.	-
<i>Coix lacryma-jobi</i> L. (POACEAE) "Lames de Job"	Ciguatera	Root	Infusion (Rageau 1973)	(1) N.C.	-
<i>Crinum</i> spp. (AMARYLLIDACEAE) "Lys sauvage"	Ciguatera	Bulb	(Rageau, 1973)	(2) N.C.	Purgative, diuretic, emetic, diaphoretic (Rageau, 1973)
<i>Davallia epiphylla</i> J.R. et G. Forster (DAVALLIACEAE)	Ciguatera	Rhizome	Use a 30 cm piece of rhizome, cleaned of soil : chew and swallow the juice, spit the fibrous part out. Repeat the treatment the following day if symptoms persist (Vienne, 1981 ; Cabalion, 1984b)(*) Boil the rhizome pulp in 1 litre of water for 3 minutes; drink the decoction within 24 hours ; repeat the following day, if necessary (Vienne, 1981 ; Cabalion, 1984b)(*)	(3) N.C. Van.	Analgesic (Vienne, 1981)
<i>Davallia solida</i> (J.R. et G. Forster) Swartz (DAVALLIACEAE) PC1012	Ciguatera	Rhizome	Same recipes as for <i>D. epiphylla</i> (same references)	(3) N.C.	Analgesic (Vienne, 1981); purgative (Whistler, 1985)
<i>Duboisia myoporoides</i> R. Br. (APOCYNACEAE) "Bois bouchon"	Ciguatera	Leaf	Infuse young leaves (Barrau, 1950 ; Dufva et al., 1973)	(2) N.C.	-
<i>Dysoxylum bijugum</i> (Labill.) Seemann PC1963b and <i>Dysoxylum gaudichaudianum</i> (Juss.) Miq. PC2268 (MELIACEAE)	Ciguatera	-	See <i>Aglaia elaeagnoidea</i>	(1) Van.	-
	Ciguatera	Stembark	Use the stembark of these two <i>Dysoxylum</i> spp. together with the stembark of <i>Pandanus</i> sp. and the twigs of <i>Terminalia catappa</i> (*)	(1) Van.	-

TABLE 1 (continued)

<i>Elatostachys falcata</i> (A. Gray) Radlk. (SAPINDACEAE)	Fish poisoning	Leaf	Juice pressed from the leaves is used as an antidote to ingestion of poisonous fish (Weiner, 1985)	(1) Fiji	-
<i>Elephantopus mollis</i> H.B.K. (ASTERACEAE)	Ciguatera	-	Decoction (Vienne, 1981)	(1) N.C.	-
<i>Entada phaseoloides</i> (L.) Merrill (MIMOSACEAE) "Water vine"	Fish poisoning	Stem	Crush the stem with a small amount of water (Weiner, 1985)	(1) Fiji	Antirheumatic, muscle pain relief (Weiner, 1985)
<i>Erythrina fusca</i> Lour. (PAPILIONACEAE)	Ciguatera	Stembark	Macerate (Rageau, 1973)	(2) N.C.	Purgative (Rageau, 1973)
<i>Erythrina variegata</i> L. (PAPILIONACEAE) "Peuplier canaque", "coral tree"	Ciguatera	Stembark	Macerate (Rageau, 1973) Use with the bark of <i>Pterocarpus indicus</i> . Grind the barks, add water and drink the juice (Cabalion, 1984e)	(3) N.C. Van.	Purgative (Rageau, 1973)
			See <i>Aglaia elaeagnoides</i>	-	-
<i>Euphorbia hirta</i> L. (EUPHORBIACEAE) "Herbe à dysenterie" "Hairy spurge"	Ciguatera	-	Decoction. Do not exceed 1 g of dried plant per day (Rageau, 1973; Rageau, 1983)	(2) N.C. Pol.	Antispasmodic, relief of dysenteric symptoms (Rageau, 1973)
<i>Ficus habrophylla</i> G. Bennett ex Seemann and <i>Ficus aspera</i> Forster f.	Ciguatera	Leaf	Cook the fish with the leaves; their sap is said to detoxify the fish poison (Bouret, 1981)	(1) N.C.	-
<i>Ficus</i> sp. (MORACEAE)	Ciguatera	Leaf	Warm the leaves over a fire then press to extract the juice; drink this juice (Cabalion, 1984e)	(1) Van.	-
<i>Hernandia nymphaeifolia</i> (Presl) Kubitzki (HERNANDIACEAE)	Fish poisoning	Root	Chew the roots (Pétiard, 1986)	(1) Pol.	-
<i>Inocarpus fagifer</i> (Parkinson) Fosberg (PAPILIONACEAE) "Chataignier de Tahiti", "Tahitian chestnut tree"	Fish poisoning	Leaf	Press the juice of the leaves (Weiner, 1985)	(1) Fiji	-
<i>Ipomoea pes-caprae</i> (L.) R. Brown (CONVOLVULACEAE) "Liseron de mer" "Beach morning glory vine"	Ciguatera	Leaf	Drink the juice extracted from the nearly wilted leaves (Cabalion, 1984e)	(1) Van.	-

<i>Maba buxifolia</i> Pers. (Doubtfull name) (EBENACEAE)	Ciguatera	Leaf, Stembark	Prepare a decoction from the leaves and bark (Rageau, 1973)	(1) N.C.	-
<i>Macropiper latifolium</i> (L.f.) Miquel (PIPERACEAE) "Faux kava" AW126	Ciguatera	Fruit	Eat 4 to 5 uncooked fruits. Repeat if symptoms persist (*)	(1) Van.	-
<i>Maesa ambrymensis</i> Guillaumin (MYRSINACEAE)	Ciguatera	-	See <i>Aglaia elaeagnoidea</i>	-	-
<i>Maesa insularis</i> Gillespie (MYRSINACEAE)	Fish poisoning	Stembark	The bark is scraped, mixed with milk from the red-skinned coconut and drunk (Weiner, 1985)	(1) Fiji	-
<i>Metrosideros collina</i> (J.R. et G. Forster) A. Gray var. <i>villosa</i> (L.f.) A. Gray (MYRTACEAE)	Ciguatera	-	See <i>Aglaia elaeagnoidea</i>	-	-
<i>Microsorium punctatum</i> (L.) Copeland (POLYPODIACEAE)	Ciguatera	-	(Rageau, 1973)	(1) N.C.	-
<i>Morinda citrifolia</i> L. (RUBIACEAE) "Fromager" "Indian mulberry"	Ciguatera	Fruit	Crush together 3 unripe and 3 ripe fruits, then extract the juice. Mix with coconut milk and drink (Pétard, 1986)	(2) Pol.	Antidiarrheal (Bagnis, 1973)
<i>Pandanus tectorius</i> Parkinson (PANDANACEAE) "Pandanus" "Screw pine" AW104	Ciguatera	Aerial root	Scrape the inside of an aerial root and press out a teaspoonfull of juice. Drink a teaspoonfull of juice three times a day, until recovery is complete (*)	(3) Van.	Muscle pain relief, cardiac action (Weiner, 1985)
	Ciguatera	Leaf	Drink the juice pressed from young leaves (*)	(3) Van.	Emetic (*)
	Ciguatera	-	See <i>Aglaia elaeagnoidea</i>	-	-
<i>Pandanus</i> sp. (PANDANACEAE) PC2262	Ciguatera	Bark	See <i>Dysoxylum bijugum</i> and <i>D. gaudichaudianum</i>	-	-
	Fish poisoning	Aerial root	Fluid is pressed from the above ground prop root (Weiner, 1985)	Fiji	-
<i>Phaleria glabra</i> (Turrill) Domke (THYMELAEACEAE)	Fish poisoning	Leaf	Juice is pressed from the leaves (Weiner, 1985)	(1) Fiji	-

TABLE 1 (continued)

<i>Phymatosorus nigrescens</i> (Blume) Copeland (POLYPODIACEAE)	Fish poisoning	Stem	Filtrate of stem. Drink and pour in ears and nose (Weiner, 1985)	(1) Fiji	Antispasmodic (Weiner, 1985)
<i>Phymatosorus scolopendria</i> (Burman f.) Pichi-Sermolli (POLYPODIACEAE)	Ciguatera	Leaf	Wash the fish in macerated fronds which have been previously heated over a flame (Rageau, 1973)	(1) N.C.	Skin inflammation (to infants) (Weiner, 1971 ; Bloomfield, 1986; Whistler, 1991)
	Ciguatera (b)	Rhizome	Wash the toxic fish with the foamy juice of the rhizomes (Bourret, 1981) Eat the rhizome in cases of ciguatera ("la gratte ") caused by coconut crab (Rageau, 1973)	(1) N.C. (1) N.C.	Against skin inflammation (to infants, same references) Purgative (Bourret, 1981; Whistler, 1985), antipruritic (Rageau, 1973)
<i>Pithecellobium dulce</i> (Roxburgh) Benthham (MIMOSACEAE) "Pois doux", "Madras thorn"	Fish poisoning	Leaf	Crushing the leaves produces a liquid claimed to be purgative (Loison, 1955)	(1) N.C.	-
<i>Plectranthus parviflorus</i> Willd. (LABIATAE) AL1	Ciguatera	Stem	Boil 4 to 5 leaves in 3/4 litre of water. Reduce to half a litre. Drink one litre within 24 hours (*)	(1) N.C.	-
<i>Polyscias guilfoylei</i> (Bull.) L.H. Bailey (ARALIACEAE) AL2	Ciguatera	Stembark	(*)	(1) N.C.	-
<i>Polyscias scutellaria</i> (Burman f.) Fosberg (ARALIACEAE) AL3	Ciguatera	Bark	Macerate the bark (Rageau, 1973)(*)	(1) N.C.	-
	Ciguatera	Leaf	Prepare a decoction using 4 to 5 leaves in 3/4 litre of water ; reduce to half-a-litre. Drink this decoction within 24 hours (*)	(2) N.C.	-
<i>Pterocarpus indicus</i> Willdenow (PAPILIONACEAE) "Narra tree, New guinea rosewood" GB879, PC1308	Ciguatera	Leaf	Prepare a decoction using a handful of leaves. Drink the water. Repeat the following day if symptoms persist (*) See <i>Erythrina variegata</i>	(2) Van.	-
<i>Santalum austro-caledonicum</i> Vieillard (SANTALACEAE) "Bois de santal", "sandalwood"	Ciguatera	Stembark	Use the aromatic essence of this plant (Rageau, 1973)	(1) N.C.	Relief of dysenteric symptoms (Rageau, 1973)

<i>Scaevola montana</i> Labillardière (GOODENIACEAE)	Ciguatera	Leaf	Use the young leaves (Rageau, 1973)	(1) N.C.	-
<i>Scaevola neoebudica</i> Guillaumin (GOODENIACEAE) PC2594	Ciguatera	Leaf	Crush a handful of leaves until you obtain a small glassful of juice. Drink one glass per day ; repeat if necessary (*)	(2) Van.	-
<i>Scaevola sericea</i> Vahl (GOODENIACEAE)	Ciguatera	Fruit	Crush the fruit ; mix with coconut milk. Drink this preparation (Pétard, 1986)	(1) -	-
<i>Schinus terebenthifolius</i> Raddi (ANACARDIACEAE) "Faux poivrier", "Christmas berry" AL4	Ciguatera	Leaf	Prepare an infusion from a bunch of leaves in one litre of water (*)	(1) N.C.	Antirheumatic (Rageau, 1973)
<i>Senna occidentalis</i> (L.) Link (CAESALPINIACEAE) "Casse puante"	Ciguatera	Leaf	Eat the uncooked leaves (Bourret, 1981)	(1) N.C.	Diaphoretic (Bourret, 1981) Depurative (*)
<i>Sophora tomentosa</i> L. (PAPILIONACEAE)	Ciguatera		Eat 3 to 7 seeds (Pétard, 1986)	(1) Pol.	Antidiarrheal, relief of dysenteric symptoms, antiemetic (Pétard, 1986)
<i>Spondias cytherea</i> Somnerat (ANACARDIACEAE) "Pomme cythere", "Polynesian plum" AW21, PC572, CS355	Ciguatera	Leaf	Maceration (Vienne, 1981) Express the juice from the leaves to obtain a small glassful of juice. Drink one-half glass per day until recovery is complete (*) Prepare a decoction from the leaves. Drink one-half glass per day until recovery is complete (*)	(3) Van.	Emetic (Vienne, 1981)
	Ciguatera	Stembark	Grind the inside of the bark and express the juice from it. Drink from 3 to 4 small glassfuls of juice per day until recovery is complete (Weiner, 1985)	(3) Fiji	-
<i>Stachytarpheta urticaefolia</i> (Salisb.) Sims (VERBENACEAE) "Herbe bleue" AL9	Ciguatera	Root	Maceration (Bourret, 1981)	(1) N.C.	Diaphoretic (Bourret, 1981)
<i>Syzygium malaccense</i> (L.) Merrill et Perry (MYRTACEAE) CS376 "pomme canaque", "malay apple"	Ciguatera	Stembark	Decoction (Rageau, 1973) Prepare a small glassful of the concentrated juice from the inner bark; drink three small glassfuls per day ; repeat if necessary (*)	(3) N.C. Van.	Depurative, laxative (Bourret, 1981), antirheumatic (*)

TABLE 1 (continued)

<i>Terminalia catappa</i> L. (COMBRETACEAE) "Badamier", "tropical almond tree"	Ciguatera	-	See <i>Aglaia elaeagnoidea</i>	-	Cardiac action (Bourret, 1981), emetic in infants (Whistler, 1991)
	Ciguatera	Stembark	See <i>Dysoxylum bijugum</i> and <i>D. gaudichaudianum</i> Cut out a sheet of stembark 5 by 10 cm in size; boil in one litre of water until a light red decoction is obtained; drink one glassful 2 to 3 times a day (Bourret, 1981)	(2) N.C. Van.	
<i>Thespesia populnea</i> (L.) Solander ex Correa (MALVACEAE) "Bois de rose", "milo tree"	Ciguatera	Fruit, Bark	Juice of the unripe fruit and decoction of the bark orally (Rageau, 1973)	(2) N.C.	Relief of dysenteric symptoms (Rageau, 1973)
	Ciguatera	-	Decoction (Bourdeau 1985)	-	-
<i>Vitex rotundifolia</i> L.f Moldenke (VERBENACEAE) PC3092 "Gatillier"	Ciguatera	Leaf	Maceration and decoction; use internally and externally (baths) (Rageau, 1973; Bourret, 1981; Vienne, 1981; Cabalion, 1984e)(*)	(3) N.C. Van.	Antiallergic (Rageau, 1973); diaphoretic (Burkill, 1935)
	Ciguatera	Root	Decoction; use internally (same references)	(1) N.C.	
<i>Wikstroemia indica</i> (L.) C.A. Meyer (THYMELAEACEAE) GB1218	Ciguatera	Stembark	Rub the entire body with the inside part of the bark. Repeat these body rubs several times a day (*)	(1) Van.	Purgative, emetic; species reputed to be highly toxic (Rageau, 1983 ; Pétard, 1986)
	Ciguatera	Leaf, bark	(Rageau, 1983; Pétard, 1986)	(3) Pol.	
<i>Ximenia americana</i> L. (OLACACEAE) "prune de mer" AL8	Ciguatera	Bark	(Legrand et al., personal communication)	(1) N.C.	-
<i>Zingiber zerumbet</i> (L.) Roscoe ex J. E. Smith (ZINGIBERACEAE) "Gingembre", "shampoo ginger"	Fish poisoning	Rhizome	Fluid pressed from the rhizome (Weiner, 1985)	(1) Fiji	-

^aUse column: We made a distinction between ciguatera and other fish poisoning. (a) In some references, the term 'fish poisoning' appears; in such a case, it is not possible to state whether or not the poisoning is due to the ciguateric toxin; for this reason, we have retained the term 'fish poisoning'. (b) In other cases, ciguatera poisoning may be caused by non ciguateric toxins, despite the author's use of the term 'la gratte', or ciguatera.

^bFrequency and Origin column: We noted in this column a rough estimation of the frequency of use of the remedies listed and their geographical origin. (1) Recipe mentioned only once during the interviews or in the literature; (2) recipe mentioned twice or more; (3) recipe in general use. Kir., Kiribati; N.C., New Caledonia; Pol., Polynesia; Van., Vanuatu.

^cOther Uses column: We noted in this column other properties of the plants when they were also used to treat some symptomatic effects of ciguatera (antiemetic, antispasmodic, relief of dysenteric symptoms, antidiarrheal, against skin inflammation, antiallergic, analgesic, muscle pain relief, antirheumatic, against rashes/antipruritic, cardiac action) or were likely to increase the elimination of the toxin (depurative, diaphoretic, emetic, purgative, diuretic, laxative properties).

Plant uses other than for treating ciguatera poisoning were also noted when related to the symptomatic effects of ciguatera fish poisoning.

Discussion and Conclusions

The names of 64 different species reputed to be effective in treating ciguatera poisoning have been presented. These folk remedies are of two types: preventive and curative. For example, the leaves of *Ficus* spp. (Moraceae) may be used to wrap the fish, or are cooked along with it; alternatively, the fish may be rinsed in an infusion prepared by using a plant, such as *Phymatosorus scolopendria* (Polypodiaceae). This is claimed to destroy the toxin during cooking.

'Preventive' methods are questionable, since the ciguatera toxin is known to be heat-resistant and water-insoluble.

Among other remedies administered as cures, some are used much more often than others. The following plants are used in remedies that are popular throughout Polynesia and/or Melanesia: *Argusia argentea*, *Artocarpus altilis*, *Carica papaya*, *Syzygium malaccense* and *Vitex rotundifolia*.

These remedies consist mostly of single plants and in some cases there is no special preparation involved; the plant is simply eaten in its natural state. When preparation is necessary, three methods are commonly employed: extraction of the juice using a mortar and pestle, infusion and decoction. Dosage is rarely precise. In many cases, a 1-l bottle of the remedy is prepared, which must be drunk during the course of the day; the quantity is replenished until symptoms disappear.

Remedies are taken internally, except those involving *Argusia argentea* and *Vitex rotundifolia*, which may also be used as a bath to relieve itching and *Wikstroemia indica* which is used externally.

Information on other medicinal uses of the species used to treat ciguatera poisoning is also listed in the table. Eight species are thus also known for their anti-diarrheal, anti-dysenteric or antispasmodic intestinal effects. These are: *Achyranthes aspera*, *Chenopodium ambrosioides*, *Euphorbia hirta*, *Morinda citrifolia*, *Phymatosorus nigrescens*, *Sophora tomentosa*, *Spondias cytherea* and *Thespesia populnea*.

Five species are alleged to have a soothing effect on rheumatism and other pains, including muscle pains and pains of the joints. These are: *Argusia argentea*, *Chenopodium ambrosioides*, *Entada phaseoloides*, *Pandanus tectorius*, *Schinus terebent-*

thifolius (this one used as a liniment) and *Syzygium malaccense*.

Other uses of the plants listed include cardiac activity (four species), antiallergic and local analgesic activity (six species), depurative, general detoxifying or diaphoretic activity (nine species).

Considering each species individually, the comparison of its ethnobotanical uses suggests that some species may act on the symptoms caused by the ciguatera toxin and thus have antidiarrheal, antispasmodic, antipruritic or cardiac tonic effects.

On the other hand, pharmacological tests are necessary in order to determine whether or not these plants indeed have direct 'detoxifying' action on the ciguatoxin itself. That is our program's goal, which is to evaluate these remedies' therapeutic potential by studying their effects in mice intoxicated with liver extracts of a carnivorous fish (moray eels) containing ciguatoxin.

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