INTRODUCTION

The South Pacific Epidemiological and Health Information Service (SPEHIS) ranked fish poisoning as the 8th most commonly reported illness in the Pacific with ciguatera being the most common type (Dalzell, 1993; Kaly et al., 1991). In 1979, Bagus et al. reported ciguatera to be an important public health problem in the tropics. Every year there are several thousand cases of ciguatera reported throughout the Indo-Pacific (Tebaro & MacArthur, 1991), Pacific and Atlantic regions (Glazier and LeGrand, 1994), yet health departments have placed much of a priority on ciguatera. This is mostly due to the fact that it is non-communicable in nature and mortality from this ailment is relatively low (Dalzell, 1993). Despite its potential for restricting the development of fisheries and lowering the consumption of fresh fish in island-communities (Bagnis et al., 1979; Yasumoto et al., 1984), fisheries departments, within the region, express relatively little concern towards Ciguatera (Dalzell, 1993). The American Samoa Government, Department of Marine and Wildlife Resources (DMWR) has begun investigating the occurrence of ciguatera in Tutuila, the most populated island of the archipelago where the reef has been highly impacted by both human and natural disturbances, in order to examine its potential threat to the fishery.

In 1987, Dalzell confirmed the occurrence of fish poisoning in American Samoa. Although the type and severity of ichthyotoxicity has never been well documented, the majority of the local population of American Samoa (in the past) has always been aware of the occurrence of ichthyotoxicity. Since ciguatera is the most common form of fish poisoning (Dalzell, 1993), the South Pacific Epidemiological and Health Information Service (SPEHIS) suspects that the majority of American Samoans, which suffer from ichthyotoxicity each year, are suffering from ciguatera. With the rapid population growth the island has recently seen, there is some concern that the public has become increasingly ignorant to such dangers. The public will occasionally seek the advice of DMWR on which areas contain toxic fish, along with which fish are safe to eat. Thus far, the department has been unable to answer such questions with certainty.

This project’s primary objective is to provide preliminary information that will give DMWR a general idea of the frequency and specificity of ciguatera throughout Tutuila, to determine whether any more extensive work on ciguatera in American Samoa is warranted. DMWR will also have an idea of the public’s general knowledge on ciguatera.

BACKGROUND

Ciguatera is the most common form of ichthyotoxicity, that is endemic to tropical and subtropical waters in the Pacific and Atlantic Oceans (Bagnis et al., 1979; Lewis, 1986; Yasumoto et al., 1984; Dalzell, 1993). Water-soluble maitsotoxin and lipid-soluble ciguatoxin are the primary toxins responsible for ciguatera (Yasumoto et al., 1979). Both types are produced by various genetic strains of Gambierdiscus toxicus, an epiphytic dinoflagellate that thrives on certain species of marine algae (Yasumoto et al., 1979). There has been some implication that the production of G. toxicus is dependent on their association with certain bacteria (Tosteson et al., 1986, 1989; Gonzalez et al., 1992. Reported by Glazier & LeGrand, 1994). Overall, ciguatera outbreaks seem to be primarily dependent upon the benthic community structure. There have been implications that anthropogenic reef disturbances actually influence ciguatera outbreaks. In the Gambier Islands, inhabitants have noticed sudden outbreaks to have been preceded by massive coral damage caused by construction (Yasumoto 1980). However, it should also be noted that ciguatera outbreaks have been associated with natural disturbances (Lewis, 1986). Regardless of the type of disturbance the probability of a ciguatera outbreak is usually higher in areas with little live
filamentous algae which harbor G. toxicus (Yasumoto et al., 1980; Kaly & Jones, 1994). In fact, algal cover and composition have actually been implicated in influencing the distribution and abundance of the toxic producing dinoflagellates. Studies conducted by Yasumoto et al. (1980, 1984) have shown a direct correlation between dinoflagellate abundances found on three genera of marine macroalgae (Laminaria sp., Aspophora sp., and Thiramnaria ornata), and ciguatera outbreaks. Yasumoto (1984) has also found these three genera to harbor more G. toxicus than any other algal species. Bottom dwelling and near-shore reef fishes that occur above 300 feet are the type which are normally ciguatoxic (Jarvinovic & Parks, 1991). Fish from all trophic levels have the potential of becoming ciguatoxic. The toxins are primarily brought into the food chain by herbivorous fishes, which eat algae that contain concentrations of G. toxicus. These toxins become readily absorbed and concentrated within the tissue and viscera of the fish. Since ciguatoxin is a bio-accumulator, carnivorous species will normally have higher concentrations of ciguatoxin than herbivores. For the same reason, larger individuals are more likely to be more ciguatoxic than smaller ones. Although mortality is quite low, people who are affected by ciguatera undergo much agony and may sometimes feel the debilitating effects months after being poisoned. Subsequent poisonings are usually more serious than previous ones since, again, ciguatoxin will have accumulated within the tissue, and their concentrations will be higher (Hokama, 1988; Katz et al., 1993).

The symptoms exhibited by ciguatera (gastrointestinal, cardiovascular, neurological and dermal disorders) are also manifested in other types of fish toxicity. For those afflicted with ciguatera, Yasumoto et al. (1984) reported that such symptoms usually manifest themselves within 2-32 hours after consumption of the toxins. Hokama (1988), on the other hand, reported these symptoms to be manifested within 10-3 hours after ingestion. Regardless of the duration, the usual symptoms include severe temperature reversal (dysesthesia); numbness and tingling of body; extremities and face (paresthesia); aching joints (arthralgia); nausea and vomiting with diarrhea; abdominal pain; muscle cramps and general malaise (Hokama, 1988).

METHODS

When this project was initiated in 1995, only one method of data collection (village interviews) was implemented. Since then, the project has been passed down to other investigators. In 1997, other methods for collecting the data were implemented to supplement the village interviews, and to also provide a more accurate assessment of ciguatera in Tutuala, American Samoa. All of the data collection methods are listed below.

1. Village interviews: Subjects from each village were arbitrarily chosen for interviews. Knowledge of many of the subjects was often learned through word of mouth. For those villages where these were no known cases, the village mayors were often the first to be questioned since they were usually aware of most of the occurrences in the village. A standardized questionnaire (Appendix I) was used in guiding the interviewers on as to what questions needed to be addressed. However, the manner in which the interview was conducted was left to the discretion of the DMWR data collectors. The questionnaire proved to be too vague due to the fact that the data collector often asked improper questions and recorded answers that were either inaccurate or irrelevant. This was later modified to prevent further confusion and misinterpretations (Appendix II). In both forms, the subject was asked to list any known cases of fish poisoning. Those who were named were also interviewed. However, those who became ill from eating the same fish were not interviewed. Almost all of the individuals that were interviewed were males above 40 years of age. This was due to cultural biases in which the data collected found that group more easily approachable.

The village interviews were conducted from June 1995 to June 1997. At this time almost all of the village on the island were interviewed. By June 1997, the number of interviewed individuals, who admitted to being poisoned, gradually decreased until none were able to be found.

2. Hospital interviews: This method (conducted from mid-April 1997 to the end of November 1997) was
used to supplement the village interviews, which were conducted during work hours, preventing a significant proportion of the population from being interviewed. In this method, Lyndon B. Johnson
Tropical Medical Center was asked for their cooperation with DMWR. DMWR provided the
emergency room physicians with a "hospital interview questionnaire" (Appendix III). Using this
questionnaire as a guideline, the physicians were asked to interview admitted chytridiomycosis
patients.

3. Market interviews: This was another method that was used to increase the sample size. In this,
individuals at the bus terminals and in the farmer's market were interviewed. The questionnaires used
were the same ones that were used in the village interviews.

4. Phone interviews: A stratified form of random sampling was used to pick phone numbers. Roughly
six phone numbers were chosen daily, for the entire month of May, using dice (to choose the three
digit phone number prefix) and a random number generator (to choose the four digit phone number
suffix). A random number generator was also used to determine the time (between 0700-1700) the
call would be placed.

Although the questionnaires had different formats, they contained the same basic questions. All of the
questionnaires asked for the individual's name, age, sex and place of residence. They also asked for the
symptoms of the illness, the type of fish consumed, how the fish was acquired, and where it was caught. In
the village questionnaires, the duration of the symptoms were noted. Individuals were also asked for their
knowledge in how they determined a fish to be toxic, and which fish were frequently toxic. With the
exception of the hospital questionnaire and the phone interviews, interviews involved asking individuals
the number of times they were poisoned. The hospital questionnaire was the most general whereas the
modified village questionnaire was the most specific. In all of the interview methods (except the phone
interviews), the questionnaires were only completed if the individual had ever been poisoned. The data
collected around the actual number of ciguatoxic fish that were consumed, and not on the actual number of
individuals that were poisoned. Therefore, if five people were poisoned from eating one fish, this was
regarded as one incident since it was only one organism that caused the illness of five individuals.
Appendix IV is a sample form that is used by the South Pacific Commission to compile histories of seafood
poisoning. Based on this format, all cases are treated as separate incidences of poisoning and does not take
into account the annual number of ciguatoxic fish consumed.

RESULTS

Of the 93 ciguatoxic fish consumed, approximately 68% occurred between 1990 and 1997
(table 1), which is a drastic increase in incidences. The number of ciguatoxic fish that were consumed,
prior to 1990 seem to be very low, and it is only after 1999 that the incidences of poisonings increase. The
number of ciguatoxic fish consumed were highest in 1994 (13 cases). The number of ciguatoxic fish
consumed, seem to level off at around 10 ciguatoxic fish consumed per year, in the years after 1994 (figure
1).

Approximately 50% of the ciguatoxic fish consumed belonged to the family Lutjanidae while
approximately 17% were muraenid eels (figure 2). Lethrinid and serranid fish were each responsible for
intoxicating approximately 5% of the interviewed individuals. Holocentridae was the only herbivorous
family that was recorded to have caused ciguatera, comprising only 1% of the reported cases (figure 2).
A more detailed description on as to which fishes caused ciguatera is all of the cases is shown in table 1. The
unknown species is an agglomeration of unidentified fish, turtles and invertebrates which had caused
ciguatera-like symptoms in the individuals that consumed the organisms. There was also a reported case in
which an individual described ciguatera symptoms from eating a fresh water eel. Tobianos & MacCarthy
(1991) suggested that such poisonings from freshwater animals, are probably caused by another species of
dinoflagellate. There were also two individuals that died from eating a turtle. Questions concerning
whether or not turtles can be ciguatoxic are yet to be answered.

In American Samoa, 80% of the individuals, that were interviewed, experienced paresthesia
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TABLE 1: Total recorded number of ciguatoxic fish consumed from 1946 to 1977, by species.
Figure 1: Total number of ciguatoxic fish consumed in Tutuila, American Samoa between 1990 and 1997 (n=63).
Figure 2: Percent composition of families that have been responsible for the reported eiguatera cases in American Samoa (n=93).
Diarrhea and arthralgia were the other two symptoms that were most frequently described by the affected individuals. Although none of the interviewed individuals knew what ciguatera specifically was, 70% of the 93 interviewees did have some knowledge of fish poisoning, and on the types of fish most commonly affected. Of the 93, 60% were aware of the serious health risks associated with eating sparrows. 52% were also aware of the high probabilities of Lutjanus bohar (especially the larger individuals) being poisonous. Roughly 11% knew of the potential dangers in consuming muraenid species. Many of the elderly that were interviewed seemed to know that diet was the reason why the fish became toxic. Most of the interviewed individuals attributed fish toxicity with the consumption of red algae known, in Samoan, as aho. A large percentage (68%) of those who were poisoned knew of some method to test for ichthyotoxicity. The most common method is a binary in which a dog or a cat is fed a piece of the suspected fish. The second most common method used to determine toxicity is to expose the meat to flies. If no flies land on the meat, it is considered ciguatoxic. Another popular method involves cooking the fish with a con. Any discoloration of the con, after being cooked, usually means that the meat is ciguatoxic. Aside from the first method, the latter two have not been proven to be effective in accurately identifying ciguatera.

**DISCUSSION**

The three symptoms (paresthesia, diarrhea and arthralgia) were given among the highest rankings by the South Pacific Commission (figure 4) in terms of the frequency of which they are manifested in individuals who are poisoned from ciguatera in the South Pacific. The profile differences in the seeking of symptoms, between that which was reported by American Samoa (figure 3) and the ranking of symptoms reported by the South Pacific Commission (figure 4), can probably be attributed to the presence of other toxins aside from those which cause ciguatera. Hókama et al. (1996) suggested that such variations in symptoms can be attributed to the presence of different toxins, which cause ciguateric symptoms. Some of these toxins may have actually formed as a result of being metabolized in different stages of the fish chain (Yasumoto & Murua, 1993). The order and intensity in which these symptoms occur also differ according to the consumption of carnivorous versus herbivorous fish, in which ciguatera from herbivorous fish tend to cause digestive and neurological symptoms while carnivorous fish cause a broader range of symptoms (Baginà & Legrand, 1987). The symptoms and their severity also seem to vary between regions (Glaziou & Legrand, 1994). Despite such differences in sympotatic frequencies, paresthesia (temperature reversal) and paresthesia are the two symptoms that distinguish ciguatera from other ichthyotoxicties (Yasumoto et al., 1984; Hókama, 1988). The relatively high frequencies in paresthesia, and arthralgia among those interviewed is probably indicative of ciguatera as being the type of ichthyotoxicity that most frequently affects Tuvalu, American Samoa.

The majority of those interviewed had, at least, partial knowledge of ciguatera. However, because most of the interviewed individuals were males above 40 years of age, it is unclear on as to how much knowledge the female and the younger constituents of the population have concerning ichthyotoxicity. However, since sharing amongst family members (especially the elders), is an integral part of the Samoan culture, it is most likely that such knowledge concerning which fish are safe to consume would eventually be passed on to the younger generation. However, it is also unclear or as to how many Samoans, that migrate to American Samoa from off island, and other ethnicities know in regards to protecting themselves against ciguatera or fish poisoning in general. No relationship could be drawn between the number of times an individual was poisoned and the frequency of fish consumption; the reason being that many of the interviewed individuals failed to give accurate descriptions of how frequently they consumed fish. Most often, “all the time” or “not that much”, were the answers that were given whenever they were asked to recall the frequencies at which they consumed fish. Numerical estimates on such vague answers were often left to the discretion of the data collectors. Since the scope of this project primarily focused on the sexual numbers of ciguatoxic fish that were caught and, not necessarily, on the number of individuals that were poisoned, no correlation between age, and the number of times an individual has been poisoned, were drawn. The ciguatera cases served only to assess the extent of ciguatoxicity, and its severity in
Figure 3: Frequency of symptoms experienced by individuals affected by ciguatera in American Samoa (n=93).
Figure 4: SPEHIS database ranking of symptoms from the consumption of ciguatoxic organisms in the South Pacific.
Tutula, American Samoa.

Of the reported fish that caused ciguatera, Muraenidae and Lujaniae show the highest probabilities of being ciguotoxic. From 1991 to 1995, muraenids comprised approximately 1.8% of the total inshore fishery catch (table 2), yet they were responsible for 20% of the ciguatera cases (figure 2). Although lujaniae comprise 5.4% of the catch (table 2), 50% of the reported ciguatera cases were caused from eating a fish from this family (figure 2). The reputation of snappers as being toxic is probably the main reason why most of the fishermen do not target this family when fishing near Tutula. Many fishermen believe that the larger piscivores, occurring around Tutula, are toxic and, therefore, avoid snappers at the more distant seamounts where they feel contain relatively lower concentrations of ciguatoxin fish.

This explains why most of the landed snappers are usually caught around the outer seamounts, that are further away from the island than the Ta Mana Bank seamount. The available evidence seems to support this. Snappers comprised 55% of the 1995 bottomfish catch (DMWR Annual Bottomfish Report, 1995) whereas, the DMWR 1996 Annual Inshore Fishery Report showed snappers to comprise only 5.4% of the catch. Almost all of the toxic snappers that were consumed, were caught in waters immediately around Tutula. Of all the species, snappers and moray eels have among the worst reputation, in American Samoa, for being ciguatoxic, which could explain their relatively low catches around Tutula. With the exception of the family Acantthidae; Serrianeidae and Holocentridae seemed to comprise the greatest proportions of the inshore fishery catch between 1991 and 1995 with respective averages of 12.8% and 10% (table 2). Given the relatively high catches of these two families, and the low numbers of reported cases of their ciguatoxicity (especially Holocentridae), it seems probable that these fish are less likely to be ciguatoxic compared to the other families. Those that are ciguatoxic, are most likely to be the older and larger individuals.

Only 39 of the 63 separate cases, which occurred after 1990, reported where the toxic fish were caught (figure 5). A greater proportion of the fish were caught on the south side of the island as opposed to the north side. This is true even for the cases which occurred before 1990. In addition, almost all of those who were afflicted did not buy the fish from local commercial fishermen, but instead, caught the fish themselves or acquired it from friends. The majority of the population of Tutula also resides on the south side of the island. Unfortunately there are no readily available records showing fishing intensities throughout the areas of the island, much less the type and purpose of fishing, to accurately determine which areas have the highest incidences of ciguatoxin fish. Problems in determining which areas contain ciguatoxic species are further compounded by the fact that many of the fish most frequently associated with ciguatera, do not remain in specific locations (Jarman and Park, 1991). Thus, areas where a high abundance of such toxic fish are caught, do not necessarily indicate those areas to be ciguatoxic.

The disproportionately low number of incidences, which occurred before 1990, is probably due to sampling error, since almost all of the data are based on memory. Time would most likely have clouded any recollections of past incidences. A significant amount of those who have been poisoned before 1990 may have also been missed. The results of this survey combined with the South Pacific Epidemiological and Health Information Service (SPEHIS) data base, on the incidences of ichthyotoxicity in the Pacific region, seem to indicate that incidences of fish poisoning in American Samoa are decreasing. The mean rate of poisoning from 1973 to 1983 was 0.87 per 1000 individuals (Lewis, 1986). Dalzell (1993) reported a mean rate of poisoning of 0.34 per 1000. Based on these figures, and the average amount of fish landed per capita, ciguatera in American Samoa has never really seemed to be as severe compared to New Caledonia, Vanuatu, Fiji, Kiribati and French Polynesia where ciguatera is considered to be a serious problem (Lewis, 1986; Dalzell, 1993). Dalzell further reported that, of the 23 islands in the SPEHIS data base, American Samoa had the 23rd lowest number of reported cases of fish poisonings. The results of this survey shows the average rate of poisoning for American Samoa (from 1990-1997) to be approximately 0.14 per 1000 with a 95% confidence of +/-0.06. This is actually quite low compared to the previous years reported by SPEHIS. However, the SPEHIS data base which happens to receive all of its information from The American Samoa Government, Department of Health) represents the total number of individuals who were poisoned, unlike the survey which only takes into account the number of ciguatoxic fish that were consumed. If all of the individuals who were poisoned where to be included, the mean rate of poisoning from the survey would be 0.29 per 1000 ( +/-0.17), which more closely correspond with the SPEHIS data base. However, the most recently available hospital records from 1990 to 1984 (taken from The 1995 American Samoa Department of Commerce Statistical Digest) show a mean rate of fish

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poisoning of 0.1 per 1000 +/- 0.12. When compared to the previous mean rates, this is also low. The survey itself showed a mean rate of 0.12/1000 +/- 0.11 (between 1990 and 1994), which was relatively close to that of the hospital data. However, a closer inspection of the two data sets show notable differences between the findings. The statistical Digest listed 14 and 11 incidences of fish poisoning in 1990 and 1991, respectively, for the period of five individuals who received hospital care. The Department of Health, on the other hand, reported no cases of fish poisoning, to have occurred during that year. Such wide discrepancies between the data sets raise many questions concerning their reliability. As noted by Dalzell (1993) and the SPHEIS data base (and therefore, the hospital records), the illness caused by fish is not specific to ciguatera alone but also represents other forms of ichthyotoxicity. Furthermore, many of the ciguatera cases are not reported, and that the SPHEIS data base may actually represent an average of only 20% of the actual number of incidences of ichthyotoxicity (Lewis, 1986). Bearing this in mind, it becomes quite difficult to actually determine which sources of information represents the most accurate account on the number of incidences of ciguatera. However, under reporting in 1992 and 1994 may explain why the Department of Health reported such low cases during those years.

The occurrence of Hurricane Val in 1991, and the relatively high number of intoxications (as gathered from the survey) may initially suggest an outbreak to have occurred after the hurricane's devastation of the reef. A comparison of the annual CPUEs (DMWR 1996 Inshore Fisheries Annual Report) show 1994 to have the lowest CPUE (pounds per gear hour) at 1.65, while 1991, which had only 3 separate incidences (table 1), has a CPUE of 3.57. Although the number of separate incidences that were recorded for 1995 were only slightly lower than 1994 (figure 1), its CPUE was quite large (2.24) when compared to 1994. Since only a very small percentage of the inshore fish that are caught in American Samoa are exported, it is safe to assume that the majority of the fish that are landed here are consumed by the island's residents. Despite discrepancies in the correlation between the hospital and survey data, the hospital records have shown 1991 to have a relatively high number of reported cases. This can either be interpreted as evidence supporting the initial assessment, or as evidence refuting it. Definite conclusions cannot be drawn, because it is still unclear on how to low the incubation period is before concentrations of the toxins reach high enough levels (for the organism to become ichthyotoxic). Under reporting, along with inaccuracies concerning methods in data collection, seem to explain the underlying problems related to both sources.

Of the methods, the village interview was the most frequently used, which provided most of the information gathered in this survey. The hospital interview method was the only other method, which provided any information. It served to supplement the village interviews and only provided data for the later half of 1997. The accuracy of the hospital interviews are somewhat questionable because many of the cases were misdiagnosed as ciguatera. Such errors were easy to identify due to the fact that the symptoms, most frequently associated with ciguatera, were not present in any of the misdiagnosed cases. The medical practitioners also failed to fill out hospital interview forms for some of the ichthyotoxicity cases, and often did not include pertinent data, which resulted in submitting incomplete forms. Unfortunately, DMWR was not granted any access to the emergency room log books which supposedly show all of the admitted ichthyotoxic patients.

The unwillingness of subjects to cooperate was the major reason as to why the phone and market interview methods were unsuccessful. To test the sincerity of those who participated in the phone interviews, individuals, already identified as being poisoned, were also called. Of the ten that were called only two admitted to being poisoned. Overall, none of those who participated in the phone and market interviews admitted to ever being poisoned. In the market survey, none of those who were approached cooperated with being interviewed. In all of the cases for all of the methods (except the hospital interviews), the initial response was usually denial of ever being. It normally took some coaxing to convince the individuals into giving accurate recollections; their past experiences with ciguatera, much less disclose their knowledge of other cases.

Typically, the general population of American Samoa and the health department, do not consider ciguatera to be severe enough to warrant the undertaking of any immediate actions. In many of the cases
the symptoms usually do not seem severe enough to request medical attention, and the majority of those intoxicated will usually seek traditional folk remedies for treatment. Because of this, many cases go unreported. In conclusion ciguatera is probably more prevalent in American Samoa than what is generally believed.

RECOMMENDATIONS

Under reporting seems to be the major under lying problem in obtaining accurate values for the actual incidences of ciguatera. The flaws in reporting ichthyotoxicities by the hospital, and the flaws in the collection methods of this survey showed that the present information is not sufficient to accurately determine the actual severity of ciguatera in American Samoa. However, the number of actual ciguotoxic fish consumed are probably higher than what is currently reported, since many individuals prefer to seek alternative traditional remedies. The public should be educated on what ciguatera is, and how it can be acquired.

Avoiding the consumption any of the larger individuals of bottom and reef dwelling carnivorous fish, that are caught around Tutuala and the Taema Bank will greatly reduce the chances of acquiring ciguatera. The chances of becoming intoxicated with ciguatera from fish caught around the outer banks are very slim, and are therefore, considered relatively safer for consumption. However, it should be pointed out that, these areas cannot be considered absolutely free of ciguatera, and that outbreaks can still occur in these areas. Presently, there are no cheap, simple and definitive ways for determining whether or not a fish is ciguatoxic. Short of laboratory tests, the best tests for ciguatoxicity, that are currently being implemented by the locals, are bioassays (i.e., feeding a sample to a dog or cat) are the best home tests for detecting ciguatoxicity. However, such tests require time for observations, and the potential for false results are high if improperly done. The degree of accuracy of the other home tests (i.e., the fly and coin tests) have not been fully determined. Therefore, the potential risk of these tests doing more harm than good are relatively high. The safest way of preventing from becoming ciguateric would be to simply avoid eating any of the larger individuals of certain carnivorous species (especially those belonging to the families: Lutjanidae, Muraenidae, Sphyraenidae and Carangidae) regardless of where they were caught.

However, ciguatera in American Samoa, presently, does not seem severe enough to warrant such extreme measures. There are, however, certain safety precautions that should be practiced when consuming the larger individuals fish belonging to the afore-mentioned families which are caught around Tutuala. The toxins associated with ciguatera are more highly concentrated in the viscera, and eating such parts of the fish should be avoided. Juranovic & Park (1991) mentioned that the head is another part of the fish where the toxins tend to reach relatively higher concentrations than the flesh. Juranovic & Park (1991) also recommended that the flesh should be soaked in several baths of salt water over a thirty minute period. This will reduce the concentrations of the water-soluble maotoxins, and, thus, reduce toxicity levels.

However, it will not affect the levels of ciguatoxin since it is lipid-soluble.

Aside from limiting the type of catch around Tutuala (to minor extent), the fishery, as a whole, does not seem to be significantly affected by ciguatera when compared to the more heavily affected areas in the Pacific. Neither does it seem to be much of a serious health issue. However, a more accurate assessment of ciguatera should be undertaken so that a better understanding of its severity and locality, in American Samoa, is obtained. Advertisements encouraging the public to report their experiences with ciguatera can actually be beneficial in increasing our present knowledge of ciguatera. Monitoring stations, similar to those implemented in the Cook Islands and French Polynesia, can provide some forecast on future outbreaks of ciguatera by monitoring levels of Gt. toxicus concentrations in certain species of macroalgal.

REFERENCES CITED


Bagnis, R., T. Kuberski, and S. Laugier 1979. Clinical observations on 3,009 cases of ciguatera (fish


Appendix I: Original village interview form created by prior investigators.

INTERVIEW QUESTIONNAIRE

DATE: ___________ VILLAGE: ___________ INTERVIEWER: ___________

SEX: Male _______ Female _______ OTHER _______ AGE: ________

FOOD POISONING FROM EATING LOCAL SEA FOOD IN AMERICAN SAMOA

1. How often do you eat sea food?

2. Have you ever had food poisoning from eating fish or other sea animal?

3. If so, how many times?

4. And how long ago?

5. Do you know what animal(s) made you sick?

6. Where did you get the animal(s) from?

7. How do you know it was that particular animal?

8. Were any other people poisoned by the same animal? If so, how many people were affected?

9. How did you know it was food poisoning?

   a. Based on symptoms

   b. Doctor confirmed diagnosis

   c. Other

10. What were your symptoms?
Appendix II: Modified village interview form.

INTERVIEW QUESTIONNAIRE

Date: ________

Interviewer: ________

Name of Interviewed Person: ________

Village of Residence: ________

Sex: ________

Age: ________

1. How many times a week do you eat seabird? (Check one)
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] 7
   - [ ] Other: ________

2. Have you ever had seabird poisoning? (Check one)
   - [ ] Yes
   - [ ] No
   - [ ] IF NO then do you know of anyone else who was poisoned? (Check one)
     - [ ] Yes
     - [ ] No
     - [ ] Name: ________
     - [ ] Village: ________

3. How many times? (Check one)
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] Other: ________

4. Do you know of any other cases of seabird poisoning? (Check one)
   - [ ] Yes
   - [ ] No
   - [ ] Name: ________
   - [ ] Village of residence: ________

5. Are there any other edible marine animals that sometimes give seabird poisoning? (Check one)
   - [ ] Yes
   - [ ] No
   - [ ] If yes, list: ________
   - [ ] What are their names? ________
   - [ ] English name: ________
   - [ ] Reason: ________

   How did you find out to avoid these animals? (Check all that apply)
   - [ ] Passed down from friends and family
   - [ ] From books and television
   - [ ] Other: ________

6. Is there any way you can tell if a particular seabird is poisonous or not? (Check one)
   - [ ] Yes
   - [ ] No
   - [ ] Explain: ________

MENTS: ________
11. Are there any reef animals that you don't eat? If so, which ones and why don't you eat them (they are poisonous or you are not allowed to eat them)?

12. How did you know to avoid animals because they were poisonous?
   Traditional knowledge

13. Recent knowledge (you or someone you know got sick when they ate one)

14. Explain what your symptoms were:
   A. Diarrhoea
   B. Headache
   C. Stomach pain
   D. Numb/pain all over
   E. Numb/pain in extremities
   F. Affected taste
   G. Aching joints
   H. Temperature sensation reversed (hot feels cold and vise versa)
   I. Painful urination

Comment:
INCIDENT NUMBER:______ OF ______

1. How long ago?
   [ ] 1 yr  [ ] 2 yr  [ ] 3 yr  [ ] 4 yr  [ ] 5 yr  [ ] Other _______

2. Were you hospitalized?
   [ ] Yes  [ ] No

3. What animal made you sick?
   Surname: ____________________________
   Given Name: _________________________

4. When did you start feeling sick after eating the animal?
   [ ] 1 hr  [ ] 6-12 hr  [ ] within a 24 hr period  [ ] After 24 hours

5. How did you get this animal?
   [ ] Friend (Name: ______________________)
   [ ] Fisherman (Name: ______________________)
   [ ] Caught it myself

6. Do you know where this animal was caught?
   [ ] Yes
       Location: ____________________________
   [ ] No

7. Was it fish?
   [ ] Yes
   [ ] No

8. Did anyone else get sick from eating the same animal?
   [ ] Yes
       What are their names and where do they live? ____________________________
   [ ] No

What were your symptoms?

   [ ] Excitation (weakeness, tired)
   [ ] Visual problems
   [ ] Numbness, pins all over
   [ ] Numbness pain in the extremities only
   [ ] NA
   [ ] Numbness
   [ ] Abdominal pain
   [ ] Cold sweats
   [ ] Extreme sensitivity to cold water
   [ ] Extreme sensitivity to hot water
   [ ] Headache
   [ ] Muscle ache
   [ ] Dizziness
   [ ] Blotching and loss of skin on hands and feet
   [ ] Numbness of mouth
   [ ] Paraesthesia
   [ ] Weakness in extremities
   [ ] Loss of stress
   [ ] Dizziness
   [ ] Paresthesia
   [ ] Other __________________________________

   Temperature when unwell:_____________________
   Temperature when reversed (hot feels cold and cold feels hot)_____________________

How long did they last?
   ___________________
Appendix III: Hospital interview form that were handed to the emergency room physicians, at the Lyndon B. Johnson Tropical Medical Center, for reporting patients treated for seafood poisoning.

GOVERNMENT OF AMERICAN SAMOA
DEPARTMENT OF MARINE AND WILDLIFE RESOURCES
CIGUATERA POISONING SURVEY
Hospital Information Form

DATE: ______________________

PATIENT NAME (first & last): ___________________________ Age: ____ Sex: ____

VILLAGE OF RESIDENCY: __________________________________________

* FREQUENCY OF FISH CONSUMPTION IN DIET: __________________________

1. SYMPTOMS AND THEIR SEVERITY:
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

2. DIAGNOSIS: _______________________________________________________

3. NAME OF ANIMAL EATEN: _________________________________________

4. HOW WAS IT ACQUIRED:
   ☐ Caught it myself  ☐ Store (Name: ____________________________)
   ☐ Friend (Name: ____________________________)
   ☐ Other: __________________________________

5. WHERE WAS IT CAUGHT (Village): _________________________________

6. NAMES OF OTHERS AFFLICTED (First & Last): ______________________
_________________________________________________________________
_________________________________________________________________
Appendix IV: Sample of the report form used by The South Pacific Commission for reporting seafood poisoning throughout the South Pacific.

South Pacific Commission  
SEAGFOOD 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:  

Details of person’s details:
Name:  
Sex (M/F):  
Age (yr):  
Address:  

Details of the seafood that caused the poisoning: (tick all the boxes that apply)

<table>
<thead>
<tr>
<th>Type of food</th>
<th>Where caught</th>
<th>How preserved</th>
<th>What eaten</th>
<th>How eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>River</td>
<td>Fresh</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Crab</td>
<td>Mangrove</td>
<td>Fresh, raw</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Lobster</td>
<td>Beach</td>
<td>Frozen</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Other mollusc</td>
<td>Reef</td>
<td>Sailed</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Gastropod</td>
<td>Lagoon</td>
<td>Dried</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Bivalve*</td>
<td>Other reef</td>
<td>Smoked</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Other mollusc</td>
<td>Open sea</td>
<td>Pickled</td>
<td>Raw</td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Other (specify)</td>
<td></td>
<td></td>
<td></td>
<td>Unprepared (raw)</td>
</tr>
<tr>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unprepared (raw)</td>
</tr>
</tbody>
</table>

What is the local name of the seafood?

What is the English name of the seafood?

Name of vendor or restaurant (if known)

Name of person it was caught (if known)

When was the food eaten?

When did you first feel sick?

* Gastropods are one-shelled seafoods like snails, trochus, conch, etc.

Bivalves are two-shelled seafoods like clams, mussels, cockles, oysters, etc.

Symptoms: (check all the boxes that apply)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning or pain when touching cold water</td>
<td></td>
</tr>
<tr>
<td>Tingling or numbness sensations</td>
<td></td>
</tr>
<tr>
<td>Difficulty or pain in urinating</td>
<td></td>
</tr>
<tr>
<td>Difficulty in breathing</td>
<td></td>
</tr>
<tr>
<td>Difficulty in walking</td>
<td></td>
</tr>
<tr>
<td>Difficulty in talking</td>
<td></td>
</tr>
<tr>
<td>Eye irritation</td>
<td></td>
</tr>
<tr>
<td>Excessive salivation</td>
<td></td>
</tr>
<tr>
<td>Excessive sweating</td>
<td></td>
</tr>
<tr>
<td>Fever or chills</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td></td>
</tr>
<tr>
<td>Joint aches</td>
<td></td>
</tr>
<tr>
<td>Muscle cramps</td>
<td></td>
</tr>
<tr>
<td>Pin pricking sensation on touching water</td>
<td></td>
</tr>
</tbody>
</table>

Medical data:

Pulse:  
Blood pressure:  
Pupils:  

In case of deaths:

Date of death:  
Autopsy findings:  

Other information:  

Please return this form to:  
South Pacific Commission, P. O. Box 157, Nouméa CEDEY,  
New Caledonia  

THANK YOU