SPC/ICHT/WP.3
16th April 1968

SOUTH PACIFIC COMMISSION

SEMINAR ON ICHTHYOSARCOTOXISM
(Rangiroa, French Polynesia, 16th - 22nd August, 1968)

# CIGUATERA IN TAHITI: AN ENDEMIC DISEASE

## S U M M A R Y


A survey was carried out with a view to ascertaining the true extent of the incidence of poisoning by toxic fish in Tahiti, and its consequences. It covered an actual population of 33,085 persons - i.e. close on 89% of the population of the districts and the two townships of Tahiti.

The year 1966, from January to December inclusive, was chosen as the period of time in which the survey of cases of intoxication was to be made. The incidence of the illness - i.e. the total number of cases which had occurred during that period - was 2,798. The rate of incidence is 8.45%. It can be said, therefore, that this endemic disease is extensive.

This survey has also enabled a count to be made of over 40 species of toxic fish, the majority being carnivorous. This list does not include the species found in the other islands or island groups.

A survey was carried out in respect of the toxic areas and a map drawn up showing the extent of ichthytoxism in Tahiti. This map will serve as a control instrument in the event of possible changes in the toxic areas and will be placed at the disposal of anyone who may wish to consult it.

Finally, the analysis of the data collected reveals that ichthyotoxism also constitutes a fairly considerable problem in the economic field.


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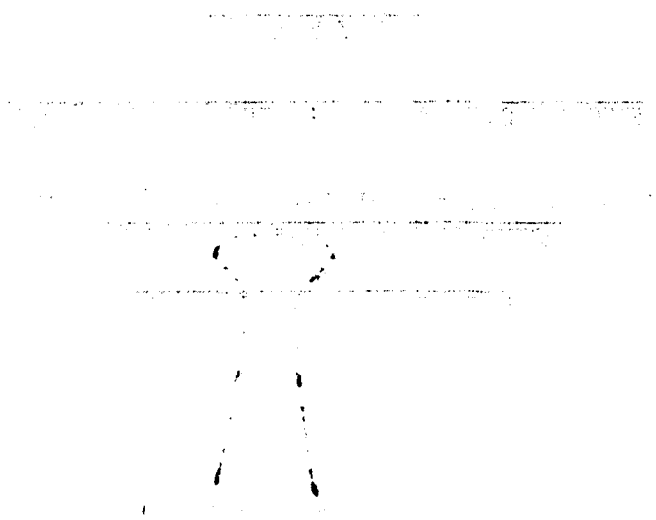

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# CIGUATERA IN TAHITI: AN ENDEMIC DISEASE

by

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Cases of poisoning following the ingestion of toxic fish have been rife in Tahiti for a very long time. The Polynesians, who are large fish consumers, are fully acquainted with the symptoms, but they continue to eat the species assumed to be toxic because their flesh has an extremely pleasant taste and the risks taken are generally mild.

Thus the "maito" (Ctenochaetus strigosus and Ctenochaetus stristus) was regarded as the "typical poisoner" when it was being fished in certain lagoon areas which appeared to be well defined.

However, the "ono" (Sphyraena baracuda), the "tonu" (Plectropomus leopardus), the "hapuu" (Epinephelus sp.), the "taivaiva" (Lutjanus monostigma) the "mara" (Cheilinus undulatus) and the "oiri" (Bendobalistes flavomarginatus) could be toxic along all the Tahitian reefs.

Consequently in recent years their sale in the Papeete market has been prohibited.

Nevertheless, the number of cases of poisoning does not seem to have decreased despite the protective measures taken.

In order to explain this phenomenon, three factors are to be taken into consideration: the population explosion recorded in Tahiti from 1964 onwards, the increased number of toxic species and the numerous suspect lagoon areas.

However that may be, the problem of ciguatera arose in Tahiti. Before investigating the mechanism of the disease, we considered it essential to assess its actual extent and its repercussions in the health, social and economic fields. This was the aim of the survey carried out during the first six months of 1967 by the Medical Oceanographic Section of the Research Institute on the instigation and under the direction of Dr. L. Malardé.

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(1) We wish to point out that large sections of this paper were extracted without any modification from a Report published in August 1967 by the Medical Research Institute of French Polynesia under the heading of:-

"Une évaluation de l'importance des intoxications par les poissons vénéneux à Tahiti et de leurs diverses conséquences".
("An Assessment of the incidence of intoxication by poisonous fish in Tahiti and its various consequences").
L. Malardé, R. Bagnis, J. Tapu, J. Bennett and F. Nanai.

The Report was edited by Dr. Malardé whose untimely death is deeply regretted. We should like to associate his name with this Paper which he would have liked to have presented himself, for he was the inspiration and the main activating force behind the survey. Our thanks are due to him for his valuable advice.

## I. AIMS OF THE PRESENT INVESTIGATION

The whole of the island of Tahiti, with the exception of the town of Papeete, was covered by the investigation, the aims of which were threefold:

1) To enumerate all the cases of intoxication which had occurred during the year 1966 in order to ascertain the incidence of the disease over this given period. The calculation of the rate of incidence would then facilitate an evaluation of the actual extent of the disease.

2) To draw up an inventory of the toxic fauna, with particular reference to the fauna responsible for the cases of intoxication enumerated in the course of the survey.

3) To draw a map showing the distribution of the so-called toxic areas around Tahiti, in order to establish a medical geography of ichthyotoxism.

## II. STAFF AND WORKING METHODS

1) Staff: All the officers involved were well acquainted with the symptoms of the disease, the reef and lagoon fauna in general and the toxic specimens in particular, together with their names in the vernacular - knowledge which was extremely useful for the purpose of identification of the various species. Lastly, they were familiar with all the suspect areas of French Polynesia.

2) Methods of Investigation:

a) Enumeration of Cases: the Medical Research Institute had available the census of the population of the island and the detailed cartography per km., together with the distribution of all the houses, each of which bears a number. The houses in each district were visited systematically, except those whose occupants were absent at the time of the visit and a few located so far away from the normal access roads that a visit would have involved a considerable waste of time. All the individuals encountered were questioned and the cases of intoxication recorded.

b) Survey of the Toxic Fauna: in French Polynesia, very few of the benthic fish have a European name. This means that the names which were collected are mainly indigenous and they have to be well known before the fish can be identified. Only professionals and experts in the subject or those who habitually practise fishing or under-water spear-fishing in French Polynesia, have the necessary knowledge. Once this first identification has been made, it is then a question of finding the precise scientific name, or at least the name of the species or family. Thanks to the various documents available at the Institute and, in particular, to the collaboration of J.E. Randall, as well as the experience of our staff members, it was possible to carry out this second identification - the most important from the scientific point of view - in a general way and without too much difficulty.

c) Survey of the Toxic Areas: Intoxicated persons were requested to indicate the origin of the toxic fish - local and personal fishing or the Papeete market. A survey of the toxic fish was

then made, but this, of course, is far from being as accurate as an ordnance survey map. Reefs are shown together with the various types of fish caught. The value of this cartography lies in the fact that it enables us to become familiar with these areas, to arrange subsequent fishing expeditions at selected times in order to catch the suspect species of fish and check their toxicity by means of animal tests or other laboratory procedure, and finally to inform the public so as to prevent further cases of intoxication.

## III. PROCESSING OF THE DATA COLLECTED

### I - Criticism

1 - 1) This is a question of a retrospective investigation based on memory. It has the disadvantages inherent in such an operation - i.e. a certain lack of accuracy or possibly errors. We did in fact ask the people to recall past events. We therefore stressed in particular the need for an accurate diagnosis in order to avoid any confusion with "Tomea", a histaminic type of intoxication. In this connection, the fish consumed in the districts - particularly the distant districts - are generally caught on the spot or in the immediate surroundings and rapidly consumed. Those bought in the market, on the other hand, may lose the whole or part of their freshness and give rise to erroneous interpretations.

However, the Tahitians were positive in distinguishing between the one or the other type of intoxication. Errors, if any, are therefore minimal and we can regard the figures obtained as fully valid, the more so as cases of intoxication of the histaminic type are in any case far less frequent and generally caused by pelagic fish.

1 - 2) In cases where the fish was bought in the Papeete market, it was not always possible to find out its precise origin, except for the fish imported from the Tuamotu Group (island group origin). Furthermore, some people found it difficult to give the precise name of the fish or to describe it.

1 - 3) As shown in Table 4 which sets out the names of fish, in some cases it was possible to classify the fish only according to the family to which they belong.

1 - 4) The town of Papeete was left out of this investigation because of shortage of time. It will be covered later by supplementary surveys. The rate of incidence of fish toxicity may be slightly different in Papeete in view of its large number of fish consumers, the total population of the town being approximately 25,000 inhabitants.

1 - 5) Finally, the population visited represents, according to the districts, 85 to 95% of the total population of the areas included in this survey. However, a total number of 33,085 people were questioned.

### 2 - Table recapitulating the data collected

2 - 1) Tahiti is divided administratively into one town: Papeete; 2 townships: Pirae and Faaa on either side of Papeete, and 18 districts. There is a greater proportion of the total island population in the rural areas and the two townships than in the town. This administrative division offers no value from the scientific point of view, but it is of great practical interest to the people and may be of value from an economic point of view.

T1 - Table showing the overall incidence and the rate of incidence(1) of intoxication for the year 1966

| Population visited | Incidence (Total No. of cases) | Rate of incidence % |
|---|---|---|
| 33,085 | 2,798 | 8.45 |

(1) Given the total population of French Polynesia which does not exceed 100,000 inhabitants, the rate selected is the percentage. It will be easy to deduce from this the rates per 1,000, 10,000 or 100,000 inhabitants.

T2 - Table showing the distribution of cases of intoxication by age-group in 1966

| Age | 0 - 1 | 1 - 4 | 5 - 14 | 14 - 25 | 25 - 44 | 45 - 64 | 65+ | Total |
|---|---|---|---|---|---|---|---|---|
| Incidence | | 63 | 337 | 426 | 1,296 | 627 | 78 | 2,798 |

T3 - Table showing the distribution of cases of intoxication according to the districts and townships for the year 1966. (Medical Research Institute Survey)

| District or Township | Population visited | Incidence (No. of cases of intoxication) | Rate of incidence % |
|---|---|---|---|
| Arue | 2.576 | 102 | 3.95 |
| Mahina | 1.213 | 138 | 10.84 |
| Papenoo | 731 | 84 | 11.49 |
| Tiarei | 675 | 83 | 12.29 |
| Mahaena | 289 | 29 | 10.0 |
| Hitiaa | 473 | 125 | 26.42 |
| Faaone | 425 | 98 | 23.07 |
| Afaahiti | 788 | 77 | 9.77 |
| Pueu | 623 | 161 | 25.84 |
| Tautira | 779 | 75 | 9.62 |
| Teahupoo | 433 | 116 | 28.84 |
| Vairao | 772 | 183 | 23.70 |
| Toahotu | 546 | 97 | 17.76 |
| Papeari | 991 | 212 | 21.39 |
| Mataiea | 1.088 | 49 | 4.50 |
| Papara | 1.832 | 208 | 11.35 |
| Paea | 2.674 | 232 | 8.67 |
| Punaauia | 3.486 | 190 | 5.45 |
| Faaa | 7.115 | 352 | 4.94 |
| Pirae | 5.576 | 187 | 3.35 |
| GENERAL TOTAL | 33.085 | 2.798 | 8.45 |

2 - 2) General Comments: The rates of incidence are fairly variable as from one district to another, since they range from 3.35% to 28.84%. An examination of the map of Tahiti reveals that the highest rates are generally recorded in the districts very remote from the town - i.e. in the peninsula and the distal half of the main island. An explanation of these local differences will be given later when an analysis is made of the economic repercussions.

2 - 3) It is to be noted that the number of cases of intoxication is higher than the number of individuals who have been intoxicated. In fact, there are 2,187 persons affected, as against a total number of 2,798 cases of intoxication. This is due to the fact that a number of people were affected several times in the course of the year.

2 - 4) Analysis by age-group: Young children (1 to 4 years of age) and those of school-age (5 to 14 years of age) are the least affected, for they represent less than 15% of the persons who have been intoxicated. This phenomenon may be explained by the fact that parents hesitate to give their young children fish which is known to be toxic at times. Furthermore, school-age children often take their midday meal at school. Finally, infants under one year of age have not been included in this survey, for it is fairly unusual for fish to be given to them, especially if it is suspect.

This analysis by age-group also shows that at least 80% of the people affected are adolescents and so-called active adults between the ages of 15 and 64. This may be important from the social and economic aspect.

## 3 - Inventory of the toxic fauna

This survey has enabled us to draw up a fairly impressive list of "toxic" species. Over 40 of them are, in fact, included in this list which is not, however, restrictive since it does not take into account the fish which caused cases of intoxication before and after 1966, or fish of other island groups.

They have been arranged in groups according to their feeding habits. This distinction assumes a certain importance, if it is conceded that the food chain is the means whereby toxic substances enter the fish, whether it be carnivorous or omnivorous or whether it grazes on algae and madrepores.

Tables recapitulating the names of fish which have caused cases of intoxication in the course of the year 1966 on the island of Tahiti (Medical Research Institute survey).

T4 - Carnivorous Fish

| Scientific name | Tahitian Name | English Name |
|---|---|---|
| Carangidae Family | | |
| Caranx malampygus (Cuvier and Valenciennes) | Pa'aihere | Trevally |
| Caranx sp. | Uruati | Trevally |
| Chorinemus tol. (Cuvier and Valenciennes) | Rai | |
| Holocentridae Family | | |
| Myripristis murdjan (Forskal) | I'ihi | Red mullet |

T4 - Carnivorous Fish (contd.)

| Scientific name | Tahitian Name | English Name |
|---|---|---|
| Lethrinidae Family | | |
| Lethrinus miniatus (Schneider) | A'aravi (1) | Sweetlip |
| Lethrinus miniatus (Schneider) | D'eo uturoa | Sweetlip |
| Aprion virescens (Valenciennes) | Utu | |
| Lutjanidae Family | | |
| Lutjanus bohar (Forskal) | Haamea | |
| Lutjanus rivulatus (Cuvier and Valenciennes) | Haputu | |
| Lutjanus kasmira (Forskal) | Taape | |
| Lutjanus fulviflamma (Forskal) | Taivaiva | |
| Lutjanus flavipes (Valenciennes) | To'au | |
| Lutjanus gibbus (Forskal) | Tuhara | |
| Murenidae Family | | |
| Gymnothorax flavimarginatus (Ruppell) | Puhi iari | Moray eel |
| Pentapodidae Family | | |
| Monotaxis grandoculis (Forskal) | Mu | Dolphin |
| Priacanthidae Family | | |
| Priacanthus macracanthus (Cuvier and Valenciennes) | Maere | |
| Serranidae Family | | |
| Epinephelus microdon (Bleeker) | Atara | |
| Epinephelus tauvina (Forskal) | Faroa | |
| Epinephelus fuscoguttatus (Forskal) | Hapuu | Sea bass |
| Variola louti (Forskal) | Ho'a | |
| Cephalopholis coatesi (Whitley) | Rari | |
| Cephalopholis argus (Bloch and Schneider) | Roi | |
| Epinephelus merra (Bloch) | Tarao | |
| Plectropomus leopardus (Lacépède) | Tonu | Grouper |
| Sphyraenidae Family | | |
| Sphyraena barracuda (Walbaum) | Ono | Barracuda |
| Sphyraena picuda (Bloch and Schneider) | Tatia | Barracouti |
| Sphyraena forsteri (Cuvier and Valenciennes) | Tiatao | |
| Tylosuridae Family | | |
| Tylosurus leiurus (Bleeker) | Aavere | Garfish |
| Omnivorous Fish, feeding on molluscs, crustaceans and coral | | |
| Balistidae Family | | |
| Pseudobalistes flavomarginatus (Ruppell) | O'iri mahe'o | Trigger-fish |
| Balistoïdes viridescens (Bloc and Schneider) | O'iri pa'o | Trigger-fish |
| Labridae Family | | |
| Cheilinus undulatus (Ruppell) | Mara | Wrasse |
| Cheilinus Trilobatus (Lacépède) | Paepae mara | Wrasse |

(1) Young "Lethrinus miniatus"

T5 - Grazing fish (Medical Research Institute - Tahiti)

| Scientific name | Tahitian Name | English Name |
|---|---|---|
| Acanthuridae Family | | |
| Acanthurus achilles (Shaw) | Hami | Surgeon-fish |
| Ctenochaetus strigosus (Bennett) | Maito | " |
| Ctenochaetus striatus (Quoy and Gaimard) | Maito | " |
| Acanthurus lineatus (Linnaeus) | Maro'a | " |
| Acanthurus xanthopterus (Cuvier and Valenciennes) | Parai | " |
| Callyodontidae Family (1) (2) | | |
| Callyodon fosteri (Cuvier and Valenciennes) | Paati | Parrot fish |
| Callyodon sordidus (Forskal) | Pahoro | " |
| Callyodon sp, | Rotea | " |
| Callyodon sp. | Uhu mamaria | " |
| Callyodon microrhinos (Bleeker) | Uhu nana'o | " |
| Callyodon sp. | Uhu raepuu | " |
| Callyodon sp. | Uhu ? | " |
| Kyphosidae Family | | |
| Kyphosus cinerascens (Forskal) | Nanue | Pilot-fish |
| Mugilidae Family | | |
| Crenimugil crenilabis (Forskal) | Tahu | Mullet |

We were not able to identify all the toxic species, but we hope to complete this essential task in due course. At any rate, no difficulties were encountered in classifying the fish according to their families. The Tahitian terminology is rich in the case of some families and poor in the case of others, which does not facilitate the task. The European names are not very numerous, perhaps because the fish in question are mainly species which live in warm, tropical seas. On the whole, therefore, it will above all be a question of family names.

It may usefully be recalled here that the species concerned are mainly benthic. These fish live in lagoons, in the vicinity of reefs and in the rocky or coral areas of the sea-bed. Some are settled in a particular locality, others are migratory to some extent, covering short distances along the reefs or inside the lagoons.

It was considered useful to determine the percentage of cases of intoxication attributed to each species or family. A first Table sets out the classification per family (T6, page 8).

This Table shows that 65% of the cases were caused by the ingestion of surgeon-fish (Acanthuridae), in particular the following species: Ctenochaetus strigosus, Bennett and Ctenochaetus striatus, Quoy and Gaimard more commonly known as "maito" in French Polynesia. The indigenous people continue to eat them in abundant quantities despite the risks incurred, and this mainly for two reasons - i.e. because of the delicacy of their flesh and the normally mild nature of the resultant illness.

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(2) or Scaridae Family. It is difficult to identify the species belonging to this family both on account of the poor quality blocks from which the various treatises are printed, the confusion created by the authors themselves, and lastly the numerous Tahitian names which are given according to the size and sex of the fish.

The rôle of certain species is minimal, especially when the percentage is lower than one. In the latter instance, it may be said that the incidence of toxicity in the case of these species is low. Finally, in other cases the incidence is low since these types of fish, which have for a long time been known to be strongly and frequently toxic, are only rarely or accidentally consumed by the uninitiated.

The following Table (T7), which is of particular interest to the people of Tahiti, shows how the incidence of intoxication is distributed according to the species. Only the vernacular names have been given. The corresponding scientific names may be found in Tables No. 4 and 5 (pages 5 and 7).

T6 - Table showing the distribution of the number of cases of intoxication according to the families in question
(Year 1966 - Medical Research Institute)

| Family | No. of cases of intoxication | % |
|---|---|---|
| Acanthuridae | 1,819 | 65.01 |
| Serranidae | 256 | 9.14 |
| Callyodontidae | 137 | 4.86 |
| Lethrinidae | 137 | 4.89 |
| Lutjanidae | 116 | 4.14 |
| Carangidae | 103 | 3.68 |
| Mugilidae | 70 | 2.50 |
| Labridae | 51 | 1.85 |
| Balistidae | 25 | 0.86 |
| Murenidae | 18 | 0.64 |
| Sphyraenidae | 18 | 0.64 |
| Pentapodidae | 16 | 0.57 |
| Tylosuridae | 9 | 0.32 |
| Kyphosidae | 4 | 0.14 |
| Holocentridae | 3 | 0.13 |
| Priacanthidae | 1 | 0.03 |
| Various unidentified | 15 | 0.57 |
| TOTAL | 2,798 | |

T7 - Incidence of intoxication according to the species

| Percentage Incidence | Indigenous Names |
|---|---|
| 61.24% | Maito |
| 4.79% | O'eo - Aaravi |
| 3 to 4% | Maroa, Pa'aihere |
| 2 to 3% | Tehu, Uhu, Faroa, Roi |
| 1 to 2% | Tonu, Haputu, Taivaiva, Hoa, Hapuu, Mara, Rotea |
| Less than 1% | Parai, Haamea, To'au, Taape, I'ihi, Tuhara, Mu, Utu, Rari, Paapae mara, Uruati, Rai, Ono, Tatia, Tiatao, Manue, Oiri, Puhi miti, Maere, Aavere, Atara, Hami, Tarao, Uhu nanao, Uhu raepuu, Uhu mamaria, Uhu moreo, Paati, Pahoro. |

Remark: Only the poisonous species caught in Tahiti are included in this list.

## 4 - Survey of the so-called toxic areas

The expression "toxic area" is certainly not the most appropriate, although it has now become common parlance, since it means in fact the areas where toxic species have been caught. A first series of maps on the kilometre scale has been drawn up. The "danger points" have been indicated by the fishermen and the consumers themselves. The degree of accuracy is not absolute, but this is not vitally important, since fish obviously do not remain stationary. They are not necessarily caught in the spot where they have ingested the toxic substance or substances.

This detailed series of maps cannot be attached to this Report, since it includes approximately one hundred Roneoed sheets. The results have therefore been transferred onto a map of Tahiti, the scale of which is large enough to give an adequate approximation. An examination of the attached map clearly shows that the whole island of Tahiti is, so-to-speak,"affected" by this phenomenon of ichthyotoxism. From the epidemiological point of view we should consider the map as a whole.

A second fact has been established and should be recorded here: most often the suspect areas are the fairways and their immediate surroundings. These fairways, which vary in width, are normally opposite or close to a river mouth.

Furthermore, the "toxic areas" also seem to be more common inside the lagoons than on the outside slope of reefs. This, however, depends on the habits of the various species involved.

Two islets which are very close - one at Mahaena and the other at Hitiaa - are particularly affected. It will be useful to examine them with a view to discovering a possible explanation through a study of their topography or their environment.

However that may be, poisonous fish are to be found all round the island and the surgeon fish ("maito") is decidedly the most widespread amongst them.

It should not be inferred, however, that edible benthic fish are no longer to be found. Fortunately the toxic species are not toxic everywhere. This observation was made a very long time ago and still remains valid. Furthermore, within a batch of fishes of the same species, only some are dangerous.

## IV. SOCIO-ECONOMIC EFFECTS OF ICHTHYOTOXISM

### I - Social Aspects

An attempt was made to estimate the number of working days lost. This is a very approximate estimate and should be regarded only as an indication. The main criterion used in the assessment is the length of absence - i.e. the period of time spent in bed or at home without performing any major activity. Furthermore, the estimate was left entirely to the people concerned. In this way it has been established that the period during which the person affected is unable to work normally varies from two to seven days, and that in extreme cases it may extend to 2 to 4 weeks. The latter applies to serious cases generally treated at home with traditional medication. The period of absence from work depends on the severity of the illness which in turn varies according to the species concerned.

We thus reached a total count of 6,580 days of inactivity which represents the number of working days lost. This is not a negligible figure. Unfortunately, we have not been able to distinguish, in this total number of patients, between wage-earners and others, the latter being definitely more numerous in the distant rural areas. However, it may be assumed with good reason that the rural population has suffered greater damage, even though it is composed mainly of individuals who are not wage-earners, since any stoppage of work always represents a total loss. Furthermore, many of them are socially regarded as indigent during the course of their hospital treatment. The costs - whatever may be their extent - are then directly and fully borne by the Territory's Health Service. As for the wage-earners, they continue to receive their wages if they consult a Medical Officer who issues them with a Medical Certificate confirming their inability to work.

### 2 - Economic Aspects

The repercussions in the economic field mainly concern the fish market in general. Supplies, whether or not they be provided through sales centres, should cover the needs of the population. Consequently, there is a risk that this balance established between supply and demand will be destroyed either through the progressive extension of prohibition measures which already affect certain benthic species, or through the attitude of excessive mistrust adopted by the consumers themselves towards perfectly edible fish.

Table 3, page 4, has already shown that the strongest incidence of the illness was noted in distant rural areas. On the other hand, the map of Tahiti shows an approximately equal distribution of the toxic areas all round the island. There is, therefore, another explanation for the differences in the rate of incidence.

The inhabitants of the distant districts live primarily on locally caught fish. This has always been the case, since this is their main source of animal protein. It is hardly imaginable that they should come every day to the Papeete market. They therefore eat mainly benthic fish, and are thus exposed to a greater risk of intoxication.

In support of these considerations, an analysis was made of the origin of the fish which gave rise to these cases of intoxication during the year 1966. It shows very clearly that, the closer one is to the town, the more these cases are due to the ingestion of fish from the Papeete market. There is, therefore, a cause and effect relationship between the origin of the fish and the intoxication. This appears logical, for those who live in the Papeete region depend on the market for their fish supply.

Table T8 summarizes the data which led to these conclusions or interpretations. Column (1) repeats the figures already shown in Table T3: incidence and rate per district. Column (2) indicates for each district:

a) the number of cases of intoxication per fish bought in the market, this number being included in the overall incidence shown in Column (1);

b) the percentage of these cases of intoxication in relation to the overall incidence.

Finally, Column (3) adds a further very useful detail: out of the total number of cases of intoxication caused by fish bought in the market, it shows the proportion of cases caused by fish imported from the Tuamotu Group, this proportion being indicated in terms of absolute value and as a percentage in relation to Column (2).

Comments

Column (2) of Table T8 shows in fact that, in distant districts, there are few or no cases of intoxication caused by fish bought in the market. This is additional evidence that these people live mainly on local produce. Inversely, it may be noted that in the other districts and townships, the Papeete market is responsible for a large proportion of cases of intoxication.

Column (3) is instructive in many respects. It shows that the fish imported from the Tuamotu Group are sometimes toxic, and this has never been questioned by anyone. Authority to export these fish, however, is given simply on presentation of a Certificate issued by the District Officer of the atoll concerned, confirming that they come from fishing areas which are free from toxicity. The facts prove the arbitrary nature of such "Certificates" in relation to a phenomenon of which all the data are variable in time and space, and bring to light certain economic aspects of the problems raised by provisioning the Papeete market with fish.

To sum up, within the framework of this survey it was noted that 21.01% of the cases of intoxication which arose in Tahiti during the year 1966 were caused by fish bought in the Papeete market, and that the fish from the Tuamotu Group was responsible for 39.11% of the cases caused by this fish bought in the market.

The situation should not be dramatized, however, and the market should not be regarded as a danger to the public. Municipal statistics show that during the year 1966, 902 tons of pelagic fish (tuna, skipjack, skad mackerel) were sold in the Papeete square, none of which are ever toxic, as well as 995 tons of benthic fish. As we now know, the latter come from various sources: Tahiti, the Tuamotu islands and other island groups. The risk of intoxication to which the urban and suburban population is exposed is therefore half that of the other sectors of the population, since the tonnage sold is roughly identical for each species. To put the matter more clearly, the inhabitants of the town and townships have only one chance out of two of being intoxicated, this being naturally a theoretical estimate. It certainly explains the low rates of incidence noted in these areas of the island.

T8 - Table showing the number of cases of intoxication caused by fish bought in the Papeete market, some of which are imported from the Tuamotu islands - Year 1966

| District | (1) Overall Incidence Tahiti | Rate of Incidence % | (2) Incidence per fish bought in the market | % in relation to overall incidence | (3) Incidence per fish imported from Tuamotu Islands | % in relation to market incidence |
|---|---|---|---|---|---|---|
| Arue | 102 | 3.95 | 74 | 72.54 | 15 | 20.25 |
| Mahina | 138 | 10.84 | 65 | 47.10 | 41 | 63.07 |
| Papenoo | 84 | 11.49 | 66 | 78.57 | 22 | 33.33 |
| Tiarei | 83 | 12.29 | 25 | 30.12 | 18 | 72.00 |
| Mahaena | 29 | 10.0 | 0 | 0 | 0 | 0 |
| Hitiaa | 125 | 26.42 | 0 | 0 | 0 | 0 |
| Faaone | 98 | 23.07 | 0 | 0 | 0 | 0 |
| Afaahiti | 77 | 9.77 | 6 | 7.79 | 6 | 100.00 |
| Pueu | 161 | 25.84 | 0 | 0 | 0 | 0 |
| Tautira | 75 | 9.62 | 5 | 6.66 | 0 | 0 |
| Teahupoo | 116 | 18.84 | 1 | 0.86 | 0 | 0 |
| Vairao | 183 | 23.70 | 1 | 0.54 | 0 | 0 |
| Toahotu | 97 | 17.76 | 1 | 1.03 | 0 | 0 |
| Papeari | 212 | 21.39 | 21 | 9.90 | 15 | 76.19 |
| Mataiea | 49 | 4.50 | 5 | 10.20 | 0 | 0 |
| Papara | 208 | 11.35 | 20 | 9.61 | 16 | 80.00 |
| Paea | 232 | 8.67 | 31 | 13.36 | 15 | 48.38 |
| Punaauia | 190 | 5.45 | 53 | 27.89 | 24 | 45.28 |
| Faaa | 352 | 4.94 | 103 | 29.26 | 44 | 42.71 |
| Pirae | 187 | 3.35 | 111 | 59.35 | 24 | 21.62 |
| TOTAL | 2,798 | 8.45 | 588 | 21.01 | 230 | 39.11 |

## V. CONCLUSION

Thanks to this survey, which was genuinely exhaustive by reason of the large number of people covered, certain unknown aspects of poisoning by toxic fish in Tahiti, indeed in French Polynesia, were made known.

From the medical angle the disease may be called endemic. This endemic disease affects a little over 8% of the population - a relatively high rate. Furthermore, it affects more severely people in modest or poor social circumstances who draw the bulk of their animal protein supply from the lagoon.

The social repercussions are extensive, for 80% of the people affected are active adults and adolescents of working age. The consequences are legion: physical suffering, loss of wages, expenditure in drugs, various costs to be borne by employers, etc. ....

Finally, ichthytoxism presents a problem in the economic sphere. It may one day endanger the fish supply of a population which, by tradition, lives on the produce of the sea. It is astonishing to see the number of species of poisonous fish, although the list is not complete. Whilst many of them are only sporadically toxic, the fact nevertheless remains that they represent a permanent danger. For a long time it has been agreed that the supply of fish to the market and the various food centres of Papeete, as well as the numerous public or private bodies in Tahiti presents a problem. This is so acute that importations from other islands and island groups have been steadily increasing. The catastrophe which would arise if a mass consignment of toxic fish were one day to find its way into the market can easily be imagined.

It is therefore essential that this threefold problem be given all the necessary attention and that the means be deployed whereby the origin of the toxicity of these fish might be discovered. It will be a long and difficult task which will require considerable effort by all concerned, but a policy of inactivity or simply of laissez-faire must be avoided at all costs.

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Work carried out at the
LOUIS MALARDE RESEARCH
INSTITUTE

5th April 1968.

Original text: French