The idea of writing this article for the Bulletin originated after a bout of fish poisoning: I had eaten a "loche saumonee" (Plectropomus maculatus) caught while spearfishing, and it had been cleaned and cooked the very same day.

The aim of this article, however, is not so much to recount my own misfortunes as to encourage readers to inform the Commission of similar cases which no doubt frequently occur in various South Pacific territories.

I have often attended to patients complaining of skin, digestive or nervous troubles which they attributed, often with rather too much readiness, to having eaten a fish of dubious quality the previous day. The remnants had been thrown away, thus making identification impossible.

Several obstacles are encountered in making an epidemiological survey. The same species is not poisonous throughout the year; very often the period when the coral is "in flower" is considered dangerous. The influence of the moon is also suggested—not without foundation, since it has been proven scientifically as regards the toxicity of medicinal herbs, for instance.

Moreover, a particular rock of coral, bed of algae, or sandy hollow in the same lagoon may be reputed to be contaminated to a higher degree than the rest. In New Caledonia fish poisoning is common at Canala (on the east coast) but seldom happens at La Foa (on the west).

It takes an experienced fisherman to state with assurance: "Don't eat such-and-such a fish caught at a particular place on such-and-such a day." And even the cleverest are sometimes caught.

The islanders say they can tell whether a fish is poisonous or not by its colour, the appearance of its gills or the bitter taste of the liver. Some of them use the well-known silver coin method as country folk still do in Europe when cooking mushrooms. We could hardly expect them to take extracts by the alcohol method for intraperitoneal injection to mice, but they might, however, make use of "gustators" such as, for example, their cats and dogs.

The islanders also claim: "If there are living worms inside the stomach of the fish it is safe," and "Do not eat an animal if your hands itch or feel inflamed when you clean its flesh."

I have witnessed an empirical test used in New Caledonia which consists of placing the liver of the fish on an ant-hill. If the ants run away, the fish should not be eaten.

It is a current opinion among fishermen that big fish or deepsea fish are more poisonous than smaller ones or those caught in lagoons. In parts of the Marshalls, they say, the only poisonous fish are those found in the passes. The tail end is often considered less toxic than the head or middle of the body; the poisonous substances circulate in the blood (their presence was proved as early as the last century in eels, conger-eels and moray eels) and when the fish is caught, bleeding occurs most freely at the head end. In Hawaii, the brain of the surmullet (its flesh was considered...
a delicacy by the Romans) is said to cause mental disturbance and delirium.

Once the fish is dead, the toxins contained in the viscera spread rapidly through the adjacent flesh. The flesh itself then becomes pathogenic.

Warm-blooded animals are particularly liable to be affected by absorbing this flesh, whereas fish, crabs and sea snakes feed on it with impunity. Farmyard poultry, fed on the left-overs, die by the dozen.

Biologists use rats and mice for laboratory experiment. Loss of hair is a frequent symptom in cats and dogs and has also been observed in humans. Indeed, fish poisoning can cause disturbances of varying gravity. I remember one Sunday in New Caledonia (Saturday is the regular fishing day) a whole native family being brought into hospital in a state of deep coma.

I diagnosed the cause of my own particular case on the very first day, when I got up and washed my hands. It was certainly the cold tap I had turned on, and yet I started at the excruciating burning pain experienced. This sensation was to last for several weeks. Similarly, drinking a cold beverage caused an unbearable impression of agonising burning.

Gastro-intestinal troubles were of minor importance, and ended after 48 hours, leaving me to cope with a far more unpleasant symptom: a general itching that continued constantly for a very long time, and that, being a doctor, I might have followed some more drastic treatment. In fact, I did what everybody else does in the South Pacific: I drank, with no firm conviction, quarts of an infusion of "itch herb" (Messerschmidtia argentea, Linné).

Those of my readers who live in the Pacific will have learnt nothing new from my story. Such cases, indeed, are common in all the territories.

The first and most famous European to suffer from fish poisoning through eating swell-fish in New Caledonia was Captain Cook himself, during his second voyage of exploration in 1774. The excellent description he gave of his symptoms is worth reading. In particular, he was amazed at his inability to distinguish between the weight of a feather and that of a decanter of water.

**Recorded Fatal Cases**

In Netherlands New Guinea, a few years ago, four fatal cases have been recorded: the patients died in Fakfak, two hours after eating "Ikan Bibit", whose heart and liver only are considered poisonous. In Sorong it is common for men to die from decaying fish, of the botulism or "Sanguine tjekalang" (tunas) cause the same fatal aftermath of dizziness, vomiting, diarrhoea and coma, for which there is no known antidote.

In Polynesia, the same species are also considered poisonous but at every new visit to an island new names can be collected; indeed, the list is so long I wonder whether it would not have been easier to write an article on fish reputed to be non-poisonous.

At the beginning of the century, in American Samoa, MyNeo, Taiva Uluiti, Filoa, Ataata, Algo, file fish and sas (swell-fish) were declared harmful. Since then, Mu, Sasaaw, Vaola, Maue and Ugauv have been added. Moreover, any fish which eats the Ana alga is said to become poisonous. From October to November, during the season when palolo (the milk of Eunice viridis, an annelid) is abundant, cases of fish poisoning also appear to be numerous, although palolo itself is eaten in quantity without ill effect.

During the war, 400 Japanese died in Micronesia from eating poisonous fish. In the Marianas, an American ship was held up because half of its crew were sick from eating barracuda. In Saipan the problem is of such magnitude as to render the organization of any fishing industry impossible. The islanders eat a few species of fish which they are perfectly familiar. In 1949, 57 Philippinos fell ill after a meal of moray eels; two of them died.

In the Marshall Islands in 1953, the flesh of a black moray caused five deaths. In 1950, 35 cases of fish poisoning were recorded at Kwajalein, also six in Majuro and three in Ponape.

In 1944, poisonous fish from Midway and Christmas Islands caused panic on the Hawaiian market, resulting in an estimated loss of thousands of dollars.

On Johnston Island (usually uninhabited) 75% of species are dangerous. Twenty cases of fish poisoning were recorded in 1950 among personnel of the U.S. army base. On Sydney Island (Phoenix), fish poisoning is held responsible for the high infant mortality rate.

In Fiji, at the meeting-point of Micronesia, Polynesia and Melanesia, we again find the species mentioned above. Listing them rationally is difficult for a non-ichthyologist, as everybody, even Europeans with a scientific training, uses their native names. An Indian pointing to a trigger-fish called it by a name (Ndamu) which represents a Lutianidae for Europeans. A reference book listing synonyms used in the South Pacific territories would, in my opinion, be useful. In Fiji "Ika Ndamu" has been responsible for several deaths. Ulavi (parrot-fish) takes its toll here as elsewhere; and the palolo season has the same fatal reputation.

In the high islands, where cattle and game are found, the proportion of fish-eaters is smaller than in the low islands, and cases of fish poisoning are relatively less numerous. However, fish poisoning is an important medical and social problem in those territories where fish is one of the main components of daily diet (providing almost the entire protein content).

A typical illustration is Fanning...
Island. Up to 1946 the population (224) of this atoll had eaten all species of fish. However, between February, 1946, and April, 1947, 95 cases of fish poisoning occurred. Before that date the inhabitants were only wary of the swell-fish (Tetraodon), and that only to a certain extent since, after removing the toxic viscera (especially the genitals) they would use it to make soup.

At the time when the epidemic of fish poisoning broke out more than ten species were claimed to be responsible. There was a doctor on the atoll who advised the population to eat only fish that had been properly cleaned and gutted. In spite of this, other cases occurred from eating scorpion-fish, trevally, parrot-fish, sea-bream, mullet, etc.

In his search for new factors likely to have rendered previously innocuous species poisonous, the doctor suggested metal as a possible cause. Indeed, enormous quantities of American war equipment had been thrown into the sea close inshore in 1945. It was believed that two years later it had deteriorated to an extent that the surrounding plankton and algae on which the suspected species fed, became permeated with toxic substances. The literature supporting this theory mentions metals containing copper, or nitro-cellulose in ammunition, as being the most dangerous element.

The poisoning of fish by manchineel berries, jellyfish or coral eaten by the fish has been suggested.

However, all these hypotheses have been rejected one by one. The various species of poisonous fish have different dwelling places and feeding habits. Ecology and toxicity do not seem to be inter-related. The same holds true for the possibility of bacterial origin, because of the difference between its symptoms and those of fish poisoning, nerve and sensory disturbances being more predominant than digestive disorders.

Research Scientist's Theory

According to Dr. Bruce W. Halstead, Professor of Medical Zoology at the Evangelical School of Tropical Medicine of Loma Linda, California, fish poisoning definitely originates in the diet of the fish, and research should be directed towards the analysis of stomach content. Dr. Halstead, who has been carrying out research for several years past in the Phoenix, Marshall, Caroline, and Marianas Island Groups, is of the opinion that by tracing back the stages of digestion of each species of fish, it is possible to arrive at the cause of toxicity; obviously a primum movens of vegetable origin.

Fish poisoning is perhaps caused by Gonvaulax catenella, the only plankton element that has been proved fatal for man. It has already been recognized as the cause of toxicity in mussels. It is particularly abundant along the coasts of the Pacific islands, forming long rusty-coloured trails on the sea. Fish, crabs and shell-fish are permeated with its poison, a more dangerous one than that of botulism.

For those readers who might wish to send samples to Dr. Halstead, here is the procedure to follow:

1. For Analysis: put 0.3 ounces (minimum weight) of the flesh of the toxic animal in a bottle, and cover with the following solution:
   - Concentrated hydrochloric acid
   - 95° alcohol
   - 99 parts

2. For Identification: place a fish exactly similar to the suspect in a container. This time use a 5% formalin solution for preservation.

In the course of laboratory experiment, Dr. Halstead has listed the poisonous and non-poisonous fish of those islands which he has visited. The chemical nature of the toxin is still unknown; it is neither protein, protamine nor alkaloid.

Japanese literature also covers the same subject (Tetraodons are responsible for the death of a hundred persons every year in Japan). Particular mention should be made of Dr. Yoshiro Hiyama's work on the South Seas. He suggests a possible connection with the nematocysts of the polyps—a theory based on the predominance of poisonous species in the tropical belt and notably in the coral atoll groups.

Common Conclusions

An analysis of literature on the problem would occupy too much space here; reference can be made to more than a thousand books or papers. However, I quote below the few conclusions common to all authors (which as will be seen often coincide with popular beliefs):

- The maximum concentration of toxins is in the liver and intestines of the fish, but this is known to vary considerably according to locality and season.
- Fish of the same species may or may not be dangerous, according to their habitat.
- The swell-fish and barracuda are particularly poisonous during the spawning season.
- Drying does not affect the toxins. Some of them will survive a 20-minute boiling, and in certain cases are even rendered more deadly.

Research in this field has been neglected for too long. At a time when the world demand for fish is increasing and new fishing-grounds are being sought, the problem of poisonous fish attains an importance hitherto unsuspected by the natives of the South Seas. Experiments are in progress in California with a view to reducing the toxicity of certain species of Tetraodons by preservation. From the economic view, the bogy of fish poisoning will need to disappear before the fishing industry can be fully developed in the Pacific.

As regards medical protection, several Governments have published advisory handbooks intended mainly for the military forces stationed in these islands where tropical foods, especially the most dangerous ones, present an irresistible attraction.

The problem is no less important for those doctors concerned with native health. The islanders, indeed, on account of their diet, are frequently affected.

What advice can they be given in the present state of knowledge?

The species mentioned most often amongst the 300 reputed poisonous are the swell-fish (1 oz. of its flesh can kill a man within 20 minutes), box-fish, horned box-fish, moon-fish, porcupine fish, trigger-fish and barracuda whose characteristic shapes—often grotesque or terrifying—and gaudy colours are easily recognized, even by an inexperienced fisherman.

When it comes to avoiding poisonous fish belonging to the numerous edible species such as the Serranidae, trevally, king-mackerel, tuna, moray eel, sardine, lujiniidae, parrot-fish, etc., it is better to err on the side of caution rather than be guided by uncertain, and often faulty, knowledge.

In New Caledonia, the fisherman who nets a school of sardine is patient enough to sort out and throw away the blue-backed and pink-capped ones (Clupea venenosus).

Generally speaking, it is unwise to eat either the liver or the roe. In most cases poisonous fish is covered with rough
Among the commonest of poisonous fish found in Pacific waters are the box fish (left) and file, or trigger, fish (right).

spines or discs set side by side, rather than with thin overlapping scales; a beak similar to that of a tortoise is often found in place of the usual jaws and teeth.

Even when a fish offering every guarantee of safety is caught it is better to kill it immediately, remove the head and gills, and bleed, gut and wash it thoroughly. But it is no use salting or soaking the flesh of a doubtful fish in lemon for the purpose of destroying the poisonous substances. The fact must not be forgotten that putrid germs are not involved, and that therefore the freshness of the fish will only provide a minor hindrance to its pathogenic power.

In order to neutralize the toxic substances the natives of New Caledonia wrap the fish before cooking it in the broad leaves of a purple-blossomed liana growing by the shore. They also place a few young leaves inside it.

Cooking in itself does not destroy the toxins. In cases of absolute necessity (after a shipwreck, for instance) it would be preferable to eat the fish raw and unprepared without delay.

Another piece of advice is that if you wish to make use of your personal knowledge of fish to distinguish a poisonous species, do not trust the local terminology used by the inhabitants, since the same names may be applied to different fish in localities only a few miles apart.

What should you do if one day, in spite of these precautions, you fall ill through not daring to refuse the fish a friend brought you or because your host was not an experienced fish-eater? If a doctor can be consulted almost immediately he will treat the various symptoms by prescribing emetics, gastric lavages, purgatives, diuretics, physiological salt solution, cardiotonics, vitamin B complex, strychnine or atropin; morphia to kill the pain, calcium for the cramp.

Native Remedies

In remote villages, the inhabitants combat fish poisoning by the same methods as the doctor, making use of available medicines. Salt water will act as an emetic and purgative. As diuretics they use infusions of sour-sop, dittany, maize “beard”, roots of sursparilla or couch-grass. Rum is a handy stimulant (but is not recommended by doctors). It is sometimes taken with the addition of coconut milk, or roasted gombo beans are soaked in it. However, no personal opinion can be given on these recipes nor on the efficacy of melted pork-fat or broiled shark-flesh as antidotes.

In my own case the accepted European treatment, including the use of several new antihistamines, did not prove entirely satisfactory. I would have liked to have tested the curative powers of homeopathic drugs because of a certain clinical similarity with aconite poisoning, but none is available in Nouméa.

I insisted on trying the most popular remedy in all the Pacific islands: Messerschmidia argentea, Linné. I cannot say it hastened recovery appreciably. The decorative tree is commonly found growing on the shore. A handful of the velvety leaves is allowed to stand in boiling water, which is then boiled down to one-third of its original volume until a brownish, bitter liquid is obtained. Drunk ice-cold and sweetened with sugar, it is not unpleasant.

Some Micronesians prefer to chew the bark of the tree. In the Marianas, the dried leaves and bark are roasted before macerating. In the Marshalls, patients eat a mixture of raw leaves and crushed coral.

Experiments with Messerschmidia argentea on animals have not produced conclusive results.

Crushing the leaves of Piphecolobium dulce, a tree with thorny branches, produces a purgative liquid sometimes used to alleviate the effect of the poison.

In New Caledonia an infusion is used, made from some seven or eight roots of a wild lily growing along the river banks. If the dose is exceeded the patient suffers from extreme excitability.

Thus, empiric methods alone have not provided a decisive remedy for the symptoms of fish poisoning. Analysis of Messerschmidia argentea would probably make it possible to extract a useful palliative. On the other hand, it is interesting to note that after being poisoned by fish, several patients have recovered from rheumatic pains or oxyuriasis. During my attack the hay fever from which I had suffered almost daily for the past twenty years quite disappeared, but unfortunately this comforting recovery did not outlast the illness.

You may guess with what impatience I am waiting for the beneficial toxin to be chemically isolated. Others wait, too, with even far greater impatience than mine. Fish provides them with their daily requirements of proteins, and they know that sooner or later they are bound to suffer from poisoning; perhaps even die from it.

Surveys In Progress

Surveys are progressing in the region. They require the joint efforts of scientists in various fields (clinicians, ichthyologists, planktonologists, ecologists, pharmacologists, etc.), costly equipment and long-term research from which no positive results can be expected for many years to come. At the present time research workers are pursuing the following aims: the collection of information on the exact identity of poisonous fish and their usual distribution; the determination of the nature of the types of fish concerned; and the discovery of a method for rapid detection with possibilities of use on the fishing grounds.

Hitherto, the long-neglected problem of ichtyotoxism has mainly been presented in picturesque reports from our predecessors, the naval medical officers; now it has entered the field of scientific research.