Ciguatera Fish Poisoning–

The world's most common seafood-toxin illness in the world

Globally, there are more than 50,000 cases of ciguatera poisoning every year

By Robin Aiello

WHAT IS CIGUATERA?

Ciguatera Fish Poisoning (CFP) is an illness that people get from eating tropical reef fish that are contaminated with a toxin called 'ciguatoxin'.

What causes these fish to become contaminated? Well…it is actually a natural process that occurs as herbivorous fish (plant eating fish) graze on a certain type of marine algae (plant) that naturally contains this toxin.

There are thousands of types of marine algae, ranging in size from huge ones (e.g. kelp) to microscopic ones (e.g. diatoms). Algae plays a vitally important role in marine ecosystems, and for the most part, they are not harmful.

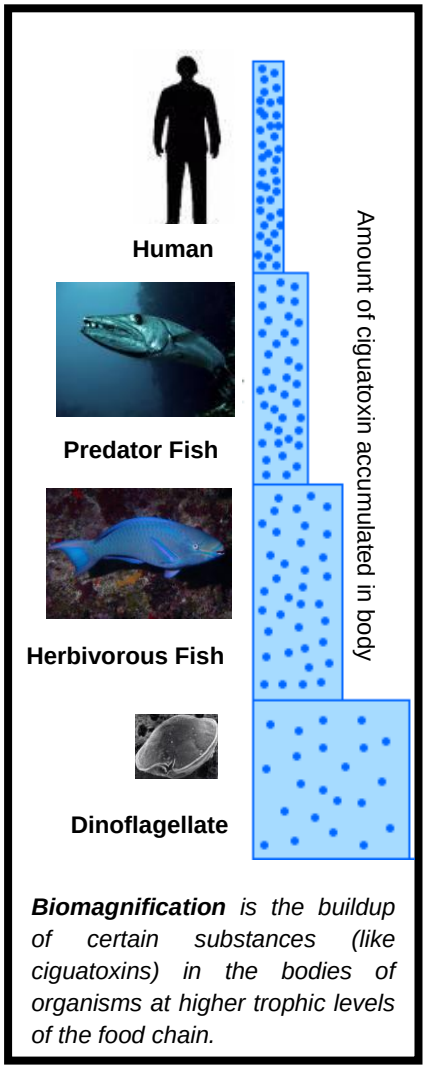
However, there are some species that ***do*** produce toxins.

The ciguatoxin, the toxin that causes ciguatera poisoning, is produced by microscopic, single-celled marine plants called dinoflagellates. Although researchers think that there may be several species of dinoflagellates that contain the toxin, the main offender is the species *Gambierdiscus toxicus*.

Gambierdiscus toxicus is found in tropical waters. The single-cell algae attaches itself to either seaweed (large leafy algae called macroalgae), coral rubble or fine sand sediment on coral reefs – much like a Bromeliad plant attaches to a large rainforest tree. They occur in vast numbers, although they are so small you cannot see them with your naked eye. They are brownish green and shaped like Smarties or M&M candies, but only diameter of a human hair (50 -100 microns).

As grazing fish feed on the seaweed, they incidentally consume the microscopic toxic algae. Unlike many other toxins that fish get rid of through their faeces, the ciguatoxin accumulates in the flesh, muscles, blood, bones, skin and roe (eggs) of the fish and does not pass through the system. In time, the toxins become more and more concentrated.

It is not much a problem for the grazing fish because the amounts remain low, but it ***does*** become a problem higher up the food chain as predatory piscivorous fish (fish-eating) feed on the contaminated herbivorous fish. Through a process called 'biomagnification', the non-excreted toxins become more concentrated in the animals in the higher trophic levels of the food chain.



Biomagnification *is the buildup of certain substances (like ciguatoxins) in the bodies of organisms at higher trophic levels of the food chain.*

It is at the highest trophic levels (in this case us - humans) that the increased concentrations become toxic.

In other words, the dinoflagellates are eaten by herbivorous reef fish, which are in turn are eaten by larger carnivorous fish, which in turn are eaten by us, humans – but with each step the toxins are more and more concentrated.

The problem for humans is that this toxin is extremely powerful and is resistant to heat and cold - so cooking or freezing the fish does not get rid of the poison. In fact, the ciguatoxin is odorless, colorless and tasteless, so there is no reliable way to tell if the fish is poisonous or not by looking at it.

WHERE DO YOU FIND CIGUATERA?

Scientists do not yet fully understand what determines where you find ciguatera, and where you don't.

On a global scale, ciguatera is found throughout the world in tropical and subtropical waters, between the latitudes of 35ºN and 35ºS. It is considered endemic in Australia, the Caribbean, and the South Pacific islands. Queensland, Australia and the Great Barrier Reef, in particular, is a globally known ciguatera hot spot.

On a regional scale, the geographic distribution of toxic fish is very inconsistent - it can be very bad on some reefs, but on another reef only a few hundred metres away, there can be no problems. But that may change within a few months, and the non-affected reef can become one of the worst reefs.

IDENTIFICATION

The specific species of dinoflagellate that causes ciguatera, *Gambierdiscus toxicus*, was discovered in the Gambier Islands (French Polynesia) during an outbreak of ciguatera in 1976

It is equally unpredictable on an even smaller local reef-wide scale. In fact, it is not uncommon for fish from one side of the island to be poisonous while the same species from the other side of the island is safe to eat.

WHAT CONDITIONS MAKE CIGUATERA MORE COMMON?

Researchers are interested in determining what drives ciguatera distribution – an important consideration in fisheries management and human health issues. It still remains a mystery, but a couple elements have been brought to light:

Warm water temperatures – Several studies indicate that water temperature plays a significant role in the abundance of the *Gambierdiscus* dinoflagellate. Population blooms are more common during summer months when water temperatures are at their warmest.

This element is particular worrisome, especially with the predicted increases in water temperatures due to climate change. Will there be more incidents of ciguatera outbreaks around the world? Will ciguatera start spreading into areas that previously had waters that were too cold?

Reef damage – Research has also shown a strong correlation between ciguatera outbreaks and damaged reefs – where reefs are damaged, whether by man (e.g. dredging, excavation) or nature (e.g. cyclones, Crown of thorns, coral bleaching events), there is more ciguatera.

In fact, researchers have found a pattern - ciguatera outbreaks often occur 5 to 6 months after a reef has suffered major destruction.

Why 5 – 6 months? Well…this is the time that it takes for:

- seaweeds to settle and start growing on the bare 'new surfaces' on the reef,
- toxic dinoflagellates to settle on the seaweed fronds,
- large numbers of herbivorous (seaweed eating) fish to move into the area to graze, and
- finally, large numbers of predatory piscivorous (fish-eating) fish to come in to the area to hunt the smaller herbivorous fish.

EFFECTS IN HUMANS – WHY IS IT A PROBLEM?

In humans, ciguatera can be very debilitating. Onset of symptoms usually occurs within 15 minutes, but sometimes it can take as many as 24 hours after eating contaminated fish.

Symptoms will then increase in frequency and severity over the subsequent 4-6 hours. They can last for weeks to years – there are even some severe cases where the symptoms have lasted for as long as 20 years. Ciguatera poisoning is rarely lethal.

There are two major types of symptoms – gastrointestinal and neurological. The first to hit are the gastrointestinal symptoms (vomiting, diarrhea, nausea). Neurological symptoms follow and include headaches, muscle and joint aches, numbness or 'pins and needles' feeling in legs, arms, mouth and lips. Some people may also experience the inversion of cold and hot sensations (hot feels cold and cold feels hot).

RED TIDE VS CIGUATERA

Both Red Tides and Ciguatera are caused by the same group of algae – dinoflagellates.

However, **Red Tide** is caused by the "bloom" (population boom) of the toxic **planktonic** dinoflagellates that live their whole lives floating in the ocean waters. Shellfish, like oysters and

Unfortunately, to date, there is no cure for ciguatera poisoning.

The seriousness of the symptoms depends on the species of the fish, the amount of ciguatoxin ingested, and the individual susceptibility.

WHICH FISH CARRY IT

The risk of ciguatoxicity varies greatly, depending upon

1) the amount of toxic dinoflagellates in the diet,
2) the rate of food consumption,
3) the ability to absorb, metabolize, or excrete the toxins; and
4)) the individual growth rate of that fish.

As a rule, within species, the larger individuals have a higher chance of being poisonous because the older fish have had more time to consume and accumulate toxins in their tissues.

Fish larger than 2 kg contain enough toxins to trigger ciguatera poisoning in a person.

More than 400 species of fish, belonging to 60 different families, have been with toxic levels of ciguatoxins.

The worst offenders include:

- Barracudas
- Groupers
- Moray eels
- Wrasse
- Snappers
- Trevallies
- Surgeonfish
- Triggerfish
- Parrotfish
- Hogfish

HISTORIC IMPACTS OF CIGUATERA ON PEOPLE

References to what could be ciguatera poisoning events are found throughout historic literature. One of the earliest references is in Homer's Odyssey (800 BC). During the times of Alexander the Great (323-356 BC), soldiers were prohibited from consuming fish to avoid illness during the conquests. More definite reports come from Pedro Martyr D'Anghera in 1555, who was a Spanish Crown rapporteur on board the ships of the great discoverers Columbus and Cortez. In his writings he attributed some illnesses to intoxication by poisonous fish - but he thought the poisons came from the fruits of a tree (*Hippomane*

mancinella) that fell into the sea and leached their toxins. Even Captain Cook (during his voyage off New Caledonia in the *HMS Endeavour*, mid 1700s) and James Morrison (while on the *HMS Bounty*, late 1700's) reported cases of ciguatera poisoning, some ending in the death of crew.

In communities that rely on a fish diet for survival, ciguatera fish poisoning can be a real problem. In fact, some historians believe that ciguatera outbreaks in the Polynesian islands might have triggered the migratory voyages of the Polynesians to New Zealand and Easter Island between 1000 and 1400. Basically, if their staple diet become poisonous and inedible, then they must move on to find an alternative.

A similar event, with similar outcomes, happened recently in the 1990's in the Cook Islands. A severe ciguatera fish poisoning outbreak caused the local people to shift from eating mainly fish to relying on processed foods that had to be shipped in from overseas. This triggered a mass emigration of islanders to New Zealand and Australia because they could not afford the expensive store-bought food on the island.

This MTSRF Project

Researchers from James Cook University, with the support of MTSRF funding, are conducting a study looking into ciguatera incident distributions (nationally and globally), the potential seasonality of outbreaks, and the identification of high-risk ciguatera fish groups. Through this study they will get a better understanding of the situation on the Great Barrier Reef.

This ciguatera project lies within Theme 2 of the MTSRF research themes:

Theme 2 - Risks & Threats to the Ecosystems

Program 6 – Understanding Threats and Impacts of Invasive Pests on Ecosystems

Project 2.6.1 – Understanding Threats and Impacts of Invasive Pests on the GBR

- Analysis of recorded ciguatera poisoning incidents, distribution and seasonality, Kirsten Heimann, Leanne Sparrow, and David Blair
- Assessment of the Threat of Toxic Microalgal Species to the Great Barrier Reef World Heritage Area, Samantha Garrard, Kirsten Heimann and David Blair

For more info see: http://www.rrrc.org.au/mtsrf/theme_2/program_6.html

Relevant MTSRF Research

The Marine and Tropical Sciences Research Facility (MTSRF) is part of an Australian Government initiative to "develop collaborative, public benefit research between Australia's best tropical environmental researchers to support the conservation and sustainable use of North Queensland's environmental assets - the Wet Tropics rainforests, the Great Barrier Reef and the connecting coastal regions".

The Reef and Rainforest Research Centre (RRRC) is contracted to administer the MTSRF Research Programme in North Queensland.

There are 5 main themes of study:

Theme 1	Status of ecosystems
Theme 2	Risks and Threats to the Ecosystems
Theme 3	Halting & Reversing decline in water quality
Theme 4	Sustainable use and management of natural resources
Theme 5	Enhancing Delivery