

## How the ciguatoxin enters into the food chain and onto the plate

Both herbivorous and carnivorous fish can become toxic, because small fish ingest the toxin and then are eaten by larger fish, which are in turn consumed by humans.

**Key facts & figures**

Ciguatoxic fish cannot be identified by **appearance, smell, or taste**. The toxin is heat stable, and remains after freezing. Its presence can only be determined by analytical methods.

**Human symptoms** after consuming ciguatoxic fish include abdominal cramps; nausea; diarrhoea; numbness in lips, tongue, fingers, toes; joint pain; muscle pain; headaches; and in severe cases cardiovascular complications.

**Over 400 species** of fish may carry these toxins, having digested harmful algal blooms that are increasingly prevalent over expanded ocean surfaces due to climate change.

Ciguatera fish poisoning cases are most common in the **Pacific and Indian Ocean islands** and the **tropical Caribbean**. Estimates of human cases range from **50 000 to 500 000**, but with low levels of awareness about ciguatoxins, this is believed to be underreported.

Source: [Food and Agriculture Organization of the United Nations -Tackling Ciguatera, a fish-borne illness.](#)

## Ciguatera (fish) Poisoning in Australia

### Frequently Asked Questions

#### Q: What is ciguatera poisoning?

**A:** Ciguatera is a foodborne intoxication caused by consumption of ciguatoxins: a group of naturally occurring, heat stable, fat-soluble, odourless and colourless toxins that can be found in several fish and shellfish species (predominantly in tropical waters). In Australia, ciguatera poisoning has only been recorded after the consumption of finfish and is hence often referred to by the outdated term ciguatera fish poisoning (now referred to as ciguatera poisoning).

#### Q: What are the symptoms?

**A:** The symptoms of ciguatera poisoning consist of range of gastrointestinal and neurological symptoms that occur within 1-24 hours of eating contaminated seafood. The severity of symptoms is dependent upon the amount of fish and which parts of the fish

are eaten, the concentration of toxin in the fish and the individual susceptibility of the consumer. The symptoms of ciguatera typically last weeks or months, but in rare cases can become chronic (>3 months to multiple years) and relapses are possible after the consumption of certain foods (e.g. alcohol, nuts, seafood or caffeine).

The symptoms of ciguatera poisoning include:

- tingling and numbness in fingers, toes, around lips, tongue, mouth and throat
- altered pain sensation, such that cold is experienced as a burning. This is often referred to as temperature reversal: burning sensations when touching cold objects (e.g. ice cubes) and cold sensations when touching hot objects.
- joint and muscle pains with muscular weakness
- nausea, vomiting, diarrhoea and/or abdominal cramps
- headache, fatigue and fainting
- extreme itchiness, often worsened by drinking alcohol
- difficulty breathing in severe cases.

#### **Q: How is ciguatera poisoning diagnosed?**

**A:** The diagnosis of ciguatera poisoning is made through a combination of the characteristic symptoms and a recent history of eating fish species that are known carriers of ciguatoxins. More severe ciguatera poisonings are often accompanied with the classical symptom of cold allodynia (burning sensation upon touching cold objects), while milder cases often present with more generic symptoms that complicate diagnosis (e.g. vomiting, diarrhoea). Since no standard test exists to detect ciguatoxins in the human body, the confirmation of ciguatera poisoning cases relies on the testing of leftover fish or meal remnants (where available).

#### **Q: What is a safe level of ciguatoxins?**

**A:** Ciguatoxins are highly potent and can cause poisoning symptoms at extremely low dosages. The limited exposure data currently available suggests that concentrations somewhere around or below one part per billion can trigger symptoms. The cumulative effect of sub-acute exposure to lower dosages of ciguatoxins remains unknown at this stage. According to the WHO/FAO (2019), there is currently not enough information available to conduct a full risk assessment on ciguatoxins in seafood and information on chronic exposure to low levels of ciguatoxin is missing. The European Food Safety Authority's panel on Contaminants in the Food Chain estimated that for the most potent Pacific ciguatoxin type 1 (P-CTX-1), levels below 0.01 µg/kg (0.01 ppb) should not have any negative effects in sensitive individuals (EFSA, 2010). Similarly, the US Food & Drug Administration (FDA) has established the identical level as a guidance level for P-CTX-1. However, these values are proposed as recommendations/guidance only and are not legally enforceable. Furthermore, no validated analytical techniques are currently available that can reliably detect ciguatoxins to this low level.

### Q: How do ciguatoxins end up in the fish?

**A:** Ciguatoxins and their precursors are produced by microscopic algae belonging to the benthic dinoflagellate group (*Gambierdiscus* spp. and potentially *Fukuyoa* spp.). These microalgae grow attached to substrates such as coral reefs or seagrass meadows in warm ocean waters. When feeding on these algae, small herbivorous fish can take up and accumulate these toxins, as well as pass them further up the food chain when larger predatory fish feed on the smaller herbivorous reef fish. As the toxins are taken up by the fish, the toxins undergo changes in their chemistry that can increase their toxicity by orders of magnitude. For example, the biotransformation of P-CTX-4B (Pacific ciguatoxin type 4B) to P-CTX-1B represents a ten-fold increase in toxicity.

### Q: Where does ciguatera poisoning occur in Australia?

**A:** Most ciguatera poisoning historically occurred in the warmer tropical waters of Queensland and the Northern Territory. However, since 2016, several cases have been reported in New South Wales; mostly associated with migratory Spanish Mackerel that have come down the east Australian coast from Queensland waters. While rare, there have been isolated ciguatera outbreaks reported in other states that were traced back to people travelling to ciguatera prone regions or fish being imported from tropical waters.

### Q: How frequent is ciguatera poisoning in Australia?

**A:** Since 1965, approximately 1,650 cases of ciguatera have been reported in Australia. While ciguatera is a notifiable disease in the Northern Territory and Queensland, the illness is subject to significant underreporting. It is estimated that less than 20% of cases are being reported in Australia due to affected individuals not seeking medical attention, health care providers not reporting their diagnosis or misdiagnosis of the condition due to generic symptoms. Taking this reporting rate and data from the last decade into account, this approximates to 150 cases of ciguatera per year in Australia. While ciguatera poisoning accounts for about half of all Australian seafood related illness outbreaks, the overall number of seafood related illnesses in Australia is very low when compared to other food commodities.

### Q: Are certain locations more prone to harbouring ciguateric fish?

**A:** Due to the substrate dwelling nature of the *Gambierdiscus* microalgae, ciguateric fish can often be localised in certain areas. This is particularly true for reef dwelling fish species that spend most of their life in a certain area and therefore are more likely to accumulate significant amounts of ciguatoxin. From International research conducted in French Polynesia, we know that reef areas where ciguatoxins are present tend to stay ciguatoxic for some time (multiple years), while areas where ciguatera had not previously been reported, can suddenly become ciguatoxic. It is therefore hard to predict where ciguatera will occur, but it is advisable not to consume fish from areas that are known to have produced ciguatoxic fish in the past. One such area is Platypus Bay on Fraser Island, which is listed in the Sydney Fish Market management guidelines ([available here](#)) as a prohibited supply region due to historic ciguatera cases from this area. In the Northern Territory, Bremer Island, Bonner Rocks, Miles Island, Cape Arnhem, North East Island,

Connexion Island and Gove Peninsula are also considered risk areas for certain fish species. Other risk areas may be identified through local knowledge.

**Q: Are certain fish species more likely to carry ciguatoxins?**

**A:** Over 180 different fish species have been reported as carriers of ciguatoxins worldwide, including both larger predatory fish and smaller herbivorous or omnivorous species. Testing of fish meal remnants as part of ciguatera case investigations in Australia has revealed a number of more commonly implicated fish species. However, due to the cost of testing for ciguatoxins in addition to the vast Australian coastline and often numerous common names for single fish species, the lists of confirmed ciguatera carriers below should be by no means considered complete. Taking into account how ciguatoxins accumulate in tropical reef systems, herbivorous and subsequently carnivorous fish, members of the reef dwelling parrot fish, surgeonfish, snapper, grouper, cod, barracuda, mackerel, trevally and amberjack/kingfish families could theoretically all be potential carriers of ciguatoxins.

**Q: List of fish species in which ciguatoxins have been detected in Australia:**

**A:** Blacksaddled Coral Grouper (*Plectropomus laevis*), Blotched Javelin (*Pomadasys maculatus*), Brown-marbled Grouper (*Epinephelus fuscoguttatus*), Coral Rockcod (*Cephalopholis argus*), Coral Trout (*Plectropomus* spp.), Coronation Trout (*Variola* spp.), Foursaddle Grouper (*Epinephelus* spp.), Giant Queenfish (*Scomberoides commersonianus*), Green Jobfish (*Aprion virescens*), Lyretail (*Variola albimarginata*), Moray eels (*Gymnothorax* spp.), Pickhandle Barracuda (*Sphyaena jello*), Red Bass, Red Snapper (*Lutjanus bohar*), Redthroat Emperor (*Lethrinus miniatus*), Saddle Grunt (*Pomadasys maculatus*), Sawtooth Barracuda (*Sphyaena putnamae*), School Mackerel (*Scomberomorus queenslandicus*), Spanish Mackerel (*Scomberomorus commerson*), Sweetlip Emperor (*Lethrinus miniatus*), Trumpet Emperor (*Lethrinus miniatus*), Two-spot Red Snapper (*Lutjanus* spp.), Yellow-edged Lyretail or Yellow-Edged Coronation Trout (*Variola louti*),

**Q: List of fish species that has been associated with ciguatera poisoning in Australia (as per clinical diagnosis):**

**A:** Black Kingfish (Cobia) (*Rachycentron canadum*), Coral Cod (*Cephalopholis* spp.), Giant Trevally (*Caranx ignobilis*), Grey Mackerel (*Scomberomorus semifasciatus*), King Snapper (*Pristipomoides* spp.), Mangrove Jack (*Lutjanus argentimaculatus*), Maori Wrasse (*Cheilinus* & *Oxycheilinus* spp.), Narrow-barred Spanish Mackerel (*Scomberomorus commerson*), Passionfruit Trout (*Plectropomus areolatus*), Queensland Groper (*Epinephelus lanceolatus*), Red Emperor (*Lutjanus sebae*), Striped Perch (*Terapontidae* – undifferentiated), Yellowtail Kingfish (*Seriola lalandi*).

**Q: Are certain sizes of fish more likely to carry ciguatoxins?**

**A:** The relationship between fish length, age, weight and ciguatoxin concentration remains unconfirmed for the fish species in Australian waters. It was originally thought that larger predatory fish might present a higher risk of ciguatera by potentially having been exposed to ciguatera sources for a longer period during their life, but there is insufficient data to confirm this frequently circulated hypothesis. Overseas studies indicate that for most fish species, there is no direct relationship between fish size and

ciguatoxin concentration. For those few species where a direct relationship has been detected, it appears that these relationships are location specific (i.e. at one location the relationship holds true, but not at another). Efforts are currently underway to better understand the ciguatoxin content in Australian Spanish Mackerel of differing sizes.

**Q: Are certain parts of the fish more likely to carry higher concentrations of ciguatoxins?**

**A:** The head, roe, liver or other viscera (guts) of the fish generally contain higher amounts of ciguatoxin and are best avoided when consuming warm water reef fish. Preliminary data suggests that toxin concentrations in the liver in particular tend to be several times higher than in the flesh of Spanish Mackerel.

**Q: How many types of ciguatoxin are there?**

**A:** There are 3 different groups of ciguatoxins that have been categorised based on their geographical location: Indian, Caribbean and Pacific ciguatoxins. Each of these groups has a base chemical structure, with minor variations in this structure accounting for distinct differences in their toxicity. To date, 47 CTXs have been identified, although less than half are structurally characterised due to insufficient amounts of purified toxin standard being available for analysis. In Australia so far, only Pacific ciguatoxins have been detected in fish flesh, more specifically P-CTX-1 (most potent), P-CTX-2 and P-CTX-3. The P denotes the toxins origin (Pacific), CTX stands for ciguatoxin and the number denotes the analogue (chemical variant).

**Q: Do we expect ciguatera poisonings to increase with climate change?**

**A:** The *Gambierdiscus* microalgae that produce the ciguatoxins and their precursors thrive on disturbed coral reefs. Coral reef bleaching and extreme weather events, such as cyclones causing physical disturbance of Australia's tropical reefs, are forecast to increase in duration and frequency. It appears likely that this will lead to increased *Gambierdiscus* growth and more ciguatoxic fish.

**Q: Can ciguatoxins be destroyed by cooking or freezing?**

**A:** Ciguatoxins are thermally stable and cannot be destroyed by cooking or freezing. The stability of these toxic compounds is part of the reason why they can be accumulated at different levels in the food chain.

**Q: How is it treated?**

**A:** There currently is no treatment for ciguatera poisoning that has been proven effective in all cases. Treatment of ciguatera poisoning focuses on alleviating the symptoms of ciguatera sufferers. After contracting ciguatera, certain foods can trigger relapses or amplify existing symptoms. It is generally advised to avoid seafood, nuts, alcohol and caffeine. Your health care provider will be able to assist you with managing your symptoms. An active ciguatera sufferers support group exists on Facebook to share ciguatera experiences ([click here](#)).

### **Q: How can I tell if a fish is ciguatoxic?**

**A:** Fish that have been contaminated with ciguatoxins cannot be distinguished from non-toxic fish by taste, smell or visual inspection. Due to their very low concentrations, yet high potency, the detection and quantification of ciguatoxins can only be achieved through complex laboratory analysis. A plethora of crude tests are advocated by certain individuals but have not been proven to be able to reliably detect ciguatoxins. These tests range from tingling fingers during filleting, to ants and flies refusing to sit on affected fish, to colour changes of silver spoons/coins or coconut when cooked with fish. The rigor mortis test (stiff = non-toxic, floppy = toxic fish) and bleeding test (when cut freshly after death, excessive bleeding = toxic fish) have been investigated by scientists in French Polynesia. Five experienced Islanders who had been fishing most of their life were asked to conduct these tests on up to 107 fish, which gave a success rate of only 30-70%.

### **Q: Is there a rapid test kit to detect ciguatoxins?**

**A:** A commercial CiguaCheck® test kit (produced by Oceanit Test Systems Inc.) was available from 1998, but has since been taken off the market, as there was mounting concern regarding its accuracy. There currently is no rapid test kit for ciguatoxins; the ciguatoxin concentrations that can cause ciguatera poisoning are so low and the toxins bound to the fish tissues so tightly that only sophisticated analytical techniques can detect and quantify these low toxin concentrations.

### **Q: What is currently being done in Australia to manage ciguatera?**

**A:** Current Australian seafood industry risk management protocols involve restrictions on sale based on maximum size limits, high-risk species and capture location. See the [Sydney Fish Market Schedule](#) for details.

### **Q: How can you manage the risk of ciguatera poisoning?**

**A:** Fish contaminated with ciguatoxins cannot be readily distinguished from non-ciguateric fish and no reliable rapid test method exists. However, you can reduce your risk of contracting ciguatera through the following:

- Do not catch or eat fish from areas known to harbour ciguatera (these can be identified from the [Sydney Fish Market guidelines](#) or by consulting local knowledge).
- Avoid eating the head, roe, liver or other viscera, as these tissues have been shown to harbour higher concentrations of ciguatoxins than the flesh. Consuming these tissues may otherwise increase exposure.
- If you consume warm water ocean fish, eat small portions no bigger than 200 grams. Should ciguatera-like symptoms develop when eating a warm water ocean fish, do not eat further portions of that fish and seek medical advice immediately. It is worthwhile to keep a piece of fish in the freezer in case symptoms develop to confirm the diagnosis via laboratory analysis of the left-over fish (~20 grams).
- Remember also that spoilage can cause you to suffer general food poisoning (not ciguatera) from any fish that has not been cleaned and stored properly.

## Q: What do I do if I suspect that I am suffering from ciguatera poisoning?

A: If you suspect that you are suffering from ciguatera poisoning, please seek your nearest health care provider. Request attending doctors to inform public health authorities if ciguatera poisoning is diagnosed to facilitate recording of cases.

### Further reading

In case you require further information on ciguatera poisoning that is not contained within this FAQ, please find additional resources listed below. Should you have further questions on ciguatera poisoning that are not covered by these, please get in touch through the [Contact Us](#) section of the SafeFish website.

The NT, QLD and NSW state health departments maintain websites providing state specific contact information for ciguatera poisoning sufferers and like the SafeFish website have fact sheets available for download.

*SafeFish fact sheet*

<https://www.safefish.com.au/reports/food-safety-fact-sheets/ciguatera-fact-sheet>

*Queensland Health fact sheet*

<http://disease-control.health.qld.gov.au/Condition/731/ciguatera-poisoning>

*New South Wales Department of Primary Industries fact sheet*

<https://www.foodauthority.nsw.gov.au/consumer/food-poisoning/fish-ciguatera-poisoning>

*Northern Territory fact sheet*

<https://digitallibrary.health.nt.gov.au/prod/ispui/bitstream/10137/1212/1/Ciguatera%20Aug%202015.pdf>

This French Polynesian website provides some great additional background on ciguatera:

<https://www.ciguatera.pf/index.php/en/>

This Facebook group is a platform for ciguatera sufferers to exchange their experiences:

<https://www.facebook.com/Ciguatera-Support-Group-178962905543570/>

### References

1. [Food & Drug Administration \(FDA\), 2021. Appendix 5 - Safety levels in regulations and guidance.](#)
2. [World Health Organisation, 2020. Report of the expert meeting on ciguatera poisoning: Rome, 19-23 November 2018. Food & Agriculture Organisation.](#)
3. [European Food Safety Authority, 2010. Panel on Contaminants in the Food Chain Scientific Opinion on marine biotoxins in shellfish—Emerging toxins: Ciguatoxin group. EFSA Journal 8\(6\), 1627.](#)