Ciguatera, also referred to as fish poisoning and ciguatera fish poisoning, is a disease resulting from consumption of fish contaminated with ciguatoxins.1 Ciguatera occurs after consumption of contaminated coral reef fish from tropical and semitropical areas. The most common types of fish that cause ciguatera include parrotfish, grouper, red snapper, and barracuda. An estimated 10,000 to 50,000 people worldwide are affected annually by ciguatera.

ABSTRACT:

Dinoflagellates (of the species Gambierdiscus toxicus), which produce precursors of ciguatoxins, are consumed by herbaceous fish. The herbaceous fish are eaten by carnivorous fish that live in tropical and semitropical areas, and ciguatoxins bioaccumulate in the carnivorous fish. Cats that eat fish contaminated with ciguatoxins exhibit signs of quadriplegia and extreme sensitivity to pain within a few hours of fish consumption. Diagnosis is based on a history of consuming coral reef fish that often contain ciguatoxins (e.g., parrotfish, grouper, red snapper, barracuda) as well as the classic clinical signs.

Ciguatera, also referred to as fish poisoning and ciguatera fish poisoning, is a disease resulting from consumption of fish contaminated with ciguatoxins.1 Ciguatera occurs after consumption of contaminated coral reef fish from tropical and semitropical areas. The most common types of fish that cause ciguatera include parrotfish, grouper, red snapper, and barracuda. An estimated 10,000 to 50,000 people worldwide are affected annually by ciguatera.1 Ciguateric fish look, smell, and taste normal, and cooking does not reduce the toxicity of the contaminated fish. Ciguatera fish poisoning occurs consistently in certain areas, whereas in other areas it is sometimes preceded by reef disturbances such as storms or nutrient enrichment. Endemic areas include Puerto Rico, the US Virgin Islands, and the South Pacific islands; epidemics have been reported in Florida and southern California. Outbreaks in humans have also been reported in New York, Rhode Island, Vermont, and Canada because of the international marketing of reef fish.2 There has been a link between the expansion of human activity and increased occurrence of ciguatera fish poisoning. The occurrence of El Niño conditions and increased numbers of cases of ciguatera have led to speculation that global warming is a contributing factor.3

The annual number of field cases of ciguatera in animals worldwide is unknown. One of the first documented cases of this toxicity in animals was reported in 1992. A 50-year-old Cook Island inhabitant was hospitalized 2 hours after consuming part of a large red snapper; the man had also fed the fish’s organs to his animals, which resulted in ciguatera in pigs, chickens, dogs, and a cat.4

ORIGINS OF TOXINS AND THEIR POTENCY

Gambiertoxins, the precursors of ciguatoxins, are produced by the dinoflagellate Gambierdiscus toxicus (Figure 1). Herbaceous fish consume dinoflagellates containing the gambiertoxins and transform these precursors into ciguatoxins. Ciguatoxins are lipid-soluble polyether compounds that bioaccumulate in the food chain.
Carnivorous fish, being higher in the food chain, consume the herbaceous fish and thus contain higher levels of ciguatoxins. The major ciguatoxin in carnivorous fish is CTX-1. Ciguatoxins are usually not toxic to the fish that harbor them; nevertheless, high levels can cause a toxicity that results in morphologic changes and even death.\(^5\)

Ciguatoxins act by binding to voltage-dependent sodium channels in the cell.\(^1\) In mice, the median lethal dose of purified toxin is less than 1 µg/kg. Research efforts to develop an animal bioassay for toxic fish flesh demonstrated that oral consumption of toxic fish by chickens, cats, mice, mongooses, painted turtles, crayfish, brine shrimp, and mosquitoes resulted in toxicosis.\(^1\)

In humans, initial symptoms of ciguatera appear 2 to 24 hours after consumption and include vomiting, diarrhea, and severe headache. A delayed neurologic sign is the reversal of temperature sensation (considered pathognomonic); cardiovascular disturbances are also observed. In rare severe cases, paralysis, coma, respiratory depression, and death may occur.\(^5\) The reversal of temperature sensation and severe headaches have lasted from months to years in some cases.\(^6\)

**CIGUATERA IN ANIMALS ON THE COOK ISLANDS**

**Identifying the Condition**

One of the authors (J. B. J.) joined the Peace Corps and worked from 1993 to 1995 as a volunteer veterinarian and teacher on the tropical island of Rarotonga (one of the Cook Islands located in the South Pacific).\(^7\) A number of puzzling cases of cats with acute onset of quadriplegia and tachycardia were presented. All cats were exquisitely sensitive to pain (they vocalized when tested for the pedal reflex) but were alert to their surroundings. Other veterinarians working in the South Pacific Islands were contacted via radio that was used for weekly scheduled communications; none of these veterinarians knew the cause of the described disease. After Dr. Jones had seen a number of these cases, an islander presented a cat exhibiting the signs of quadriplegia and extreme sensitivity to pain and reported that the cat had fish poisoning. An aquatic biologist was then consulted; she knew that ciguatera fish poisoning was endemic to the Cook Islands, that a number of people were affected each year, and that the client’s diagnosis of fish poisoning as the cause of the disease in the cat might well be correct.

**Developing a Treatment Regimen for Cats**

A literature review revealed many articles describing the diagnosis and treatment of this disorder in humans,\(^8\)\(^-\)\(^11\) but only one that briefly mentioned ciguatera in cats.\(^4\) An IV infusion of mannitol had proved to be rapidly effective (sometimes within 10 minutes) in human patients when administered during the early signs of ciguatera.\(^4\) However, conditions on the Cook Islands made an IV infusion of mannitol in feline patients difficult. By means of cooperation with a local physician who supplied the mannitol, an IV bolus of mannitol was given to three affected cats, but this injection proved ineffective. Cortisone and dexamethasone have also been tried as therapy for ciguatera in humans,\(^1\) but other reports indicated that steroids are not effective.\(^6\) The administration of steroids to the cats also failed to reduce the severity of the signs of the toxicity.

During the 2 years that Dr. Jones worked on Rarotonga, he treated 40 to 50 cases of ciguatera in cats. He found that the best treatment was symptomatic and supportive care, including forced feeding of a liquid diet, and turning, cleaning, and keeping the cat warm. Remission of signs and reversal of paralysis were observed within 10 days in virtually 100% of these cats. During the period of paralysis, the cats rapidly lost weight and became quite debilitated. The recovering cats returned to their normal weights within 6 weeks.

**SIGNIFICANT DIFFERENCES IN SPECIES SENSITIVITY AND SIGNS OF TOXICOSIS**

Although the primary signs of ciguatera in the Cook Island cats included paralysis, tachycardia, and increased sensitivity to pain, experimental studies of ciguatoxin in anesthetized cats resulted in respiratory and cardiovas-
In humans, diagnosis is primarily based on a history of consumption of reef fish, the reverse cold–heat sensation perception, and development of gastrointestinal and neurologic signs. Diagnosis can be more difficult in animals. Clinical and anatomic pathologic signs are not yet well documented for any animal species. The naturally occurring disease is limited to tropical and subtropical regions, and the history of eating fish parts may be uncertain (e.g., dogs and cats may feed on discarded fish heads or entrails in garbage or on beaches but may not be observed doing so). A test for measuring ciguatoxins in fish flesh is available (Ciguac-Check, Oceanit Test Systems); it is an antibody-based assay that is approved by the Association of Official Analytical Chemists. Experimental work with a neuroblastoma cell bioassay to detect ciguatoxin in blood samples indicated that the assay has potential as a diagnostic tool.

Differentiating fish poisoning from other diseases causing paralysis in cats (e.g., organophosphate poisoning, botulism, and coral snake envenomation) should be straightforward. Cats presented had normal pupillary responses, no excess salivation, no diarrhea, and no vomiting—all of which are important when considering organophosphate poisoning. All cats affected with ciguatera did demonstrate quadriplegia, heightened pain sensation, normal alertness, and tachycardia; this set of signs is not seen with other types of neurotoxicosis.

Veterinarians practicing in tropical and subtropical coastal regions of the United States and other countries may encounter ciguatera with its unusual neurologic signs. Reef fish, especially viscera and heads, should be avoided in areas where ciguatera is reported to occur. It is hoped that informing clients about these risks and reporting field cases will improve awareness and result in a reduction of occurrences of ciguatera.

REFERENCES


**ARTICLE #3 CE TEST**

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1. **Which part of contaminated fish has the highest levels of ciguatoxin?**
   - a. scales
   - b. viscera
   - c. skin
   - d. gills

2. **Epidemics of ciguatera fish poisoning have occurred in**
   - b. Ohio.
   - c. Iowa.
   - d. Florida.

3. **Gambiertoxins, which are the precursors of ciguatoxins, are produced by**
   - a. bacteria.
   - b. herbaceous fish.
   - c. carnivorous fish.
   - d. dinoflagellates.

4. **In humans, signs of ciguatera fish poisoning include**
   - a. vomiting, diarrhea, and reversal of temperature sensation.
   - b. seizure.
   - c. drowsiness.
   - d. hepatotoxicity, nephrotoxicity, and secondary photosensitivity.

5. **In cats, signs of ciguatera fish poisoning include**
   - a. seizure.
   - b. drowsiness and confusion.
   - c. hepatotoxicity, nephrotoxicity, and secondary photosensitivity.
   - d. quadriplegia and extreme sensitivity to pain.

6. **What is an effective treatment for ciguatera fish poisoning in cats?**
   - a. IV bolus of mannitol
   - b. steroids
   - c. acetylcysteine
   - d. symptomatic and supportive care

7. **The estimated number of people throughout the world who are affected annually by ciguatera is**
   - a. 100 to 200.
   - b. 1,000 to 2,000.
   - c. 10,000 to 50,000.
   - d. 1,000,000 to 50,000,000.

8. **Cats treated for ciguatera usually recover ambulatory ability in ____ days.**
   - a. 1
   - b. 3
   - c. 5
   - d. 10

9. **The mechanism of action of ciguatoxin is**
   - a. binding to voltage-dependent sodium channels.
   - b. mobilization of intracellular calcium.
   - c. phosphatase inhibition.
   - d. Na⁺, K⁺-ATPase activation.

10. **In cats, the initial signs of ciguatera fish poisoning are observed in**
    - a. 3 days.
    - b. 2 days.
    - c. 1 day.
    - d. a few hours.