



# Living and Eating On the Web

As on land, the sun provides the energy for photosynthesis in the ocean. All photosynthesis takes place in relatively shallow water—or in the top layer of the ocean where the water is deeper. Sunlight is filtered out as it passes through water and does not reach the deep sea.

Plants are the “primary producers” in the ocean and form the first trophic level. Some are fleshy seaweeds or *limu*, some form hard skeletons similar to the structure created by coral and that help build the coral reef (“coralline algae”), some are single cells that live in the tissue of corals and provide energy to the corals (“zooxanthellae”), and some are microscopic single-celled plants that float in the ocean (“phytoplankton”).

The “primary consumers” are “herbivores” (animals that feed only on plants). Primary consumers are the animals that eat algae, either phytoplankton or seaweed. They form the second trophic level.

“Secondary consumers” are “carnivores” (animals that eat other animals). Secondary consumers are the animals that eat the animals that eat algae. They form the third trophic level.

“Tertiary consumers” are predators on carnivores. They form the fourth trophic level.

You will be constructing food chains and webs that reflect these “trophic levels,” the levels through which nutrients and energy flow, within a typical Hawaiian coral reef community.

## Creating a Marine Food Chain

- 1) Read the cards provided.
- 2) Construct a food chain using some of the cards.
  - a) On one sheet of paper, draw horizontal lines to indicate the first, second, third and fourth trophic levels. Designate one color to indicate the first trophic level (plants).
  - b) Identify organisms on the cards that are in the various trophic levels.
  - c) Tape a picture of one organism in each trophic level on the paper. Draw arrows from the plant or animal being eaten towards the animal doing the eating. These arrows represent the flow of energy between organisms. Use the designated color to draw the arrow to any animal eating a plant.

### Note

A food chain is linear. For example: seaweed is eaten by snail, snail is eaten by crab, crab is eaten by fish, fish is eaten by shark.

- 3) At this point, your teacher will ask you to present your food chain to the class.

## Creating a Marine Food Web

- 1) Dismantle your food chain and construct a marine food web using all of the cards.
- 2) On another large piece of paper draw horizontal lines to indicate four trophic levels, again designating one color to indicate the first trophic level (plants).
- 3) Place each card in a trophic level. Build the whole food web with the 20 cards before you tape down the cards. Add trophic levels if you need to do so.



## Note

A food web is not linear, there may be multiple connections among organisms in a food web.

- 4) Draw arrows from the plant or animal being eaten towards the animal doing the eating. Again, use the designated color to connect plants to any animal eating them. There may be more than one animal eating a plant or animal. Show as many connections as you can.
- 5) There are two other categories having to do with an organism's role in cycling energy through an ecosystem:
  - "Detritivores" or scavengers are animals that feed on organic materials on the seafloor. "Detritus" refers to the remains of dead organisms or cast-off material from living organisms.
  - "Decomposers" are bacteria that break down organic material further, into its inorganic components, so it can be recycled back into the system.

Using the above information, represent detritivores and decomposers on your food web (they won't necessarily fit into a trophic level). You may also wish to use the following information:

- The black sea cucumber (*loli okuhi kuhi* or *Holothuria atra*) is an example of a detritivore. It lives in shallow water on sand.



Photo: John P. Hoover, Hawai'i's Sea Creatures, Mutual Publishing

- The partridge tun snail (*pū'ōni'oni'o* or *Tonna perdix*), which is also found in shallow water and generally seen at night, feeds on sea cucumbers.

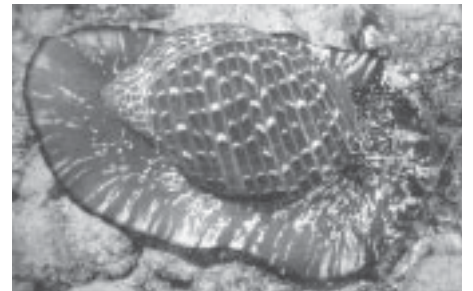


Photo: John P. Hoover, Hawai'i's Sea Creatures, Mutual Publishing

- 6) Next, add a human to the food web. Draw the arrows to the human in a different color than you have used before. Which animal has the most links to it in the food web?



# Poison Pathways

Ciguatera fish poisoning is an illness caused by eating seafood—mostly reef fishes—that have accumulated a poison called “ciguatoxin.” Each year, about ten to twenty people in Hawai‘i get ciguatera poisoning, the symptoms of which may last a week or so in mild cases. In some cases, the symptoms may persist for several months or longer.

What does it feel like to have ciguatera fish poisoning? Your mouth, hands, and feet may go numb and tingly. Your joints and muscles might hurt, cramp up, or become weak. You could have chills, itching, headaches, sweating, dizziness, vomiting, or diarrhea. None of that is very pleasant—and your symptoms may range from mild to severe, beginning two to five hours after eating contaminated fish. There’s another symptom that doesn’t usually kick in until two to five days after eating a toxic fish. It’s known as “temperature sensation reversal.” Cold objects feel hot, and hot objects feel cold.

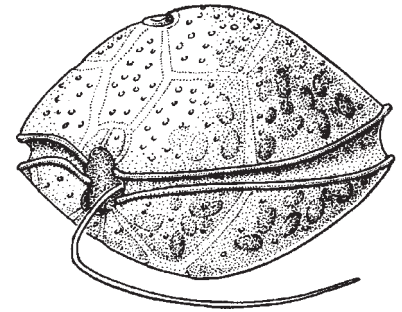
If ciguatera poisoning sounds like something you want to avoid, use these precautions:

- Do not eat the head, guts, or roe (eggs) of any reef fish. The ciguatoxin is concentrated up to 100 times in these parts of the fish, compared to other parts.
- Thoroughly clean reef fish as soon as possible after they are caught. This is to prevent the toxin that has accumulated in the organs from further contaminating the flesh.
- Remember that ciguatoxin is not destroyed by cooking, drying, salting, or freezing fish.
- Avoid eating fish caught at sites known to have a ciguatoxic algae problem.

## Toxic Algae?

What is ciguatoxic algae? Ciguatoxin is produced by microscopic marine organisms called

“dinoflagellates.” Dinoflagellates of a particular species, *Gambierdiscus toxicus*, bloom among and on the algae on which herbivorous fish such as *kole* (gold-ring surgeonfish) and *palani* (eyestripe surgeonfish) feed. As they forage through the algae, these fish ingest the dinoflagellates and the ciguatoxin they produce. The algae itself is not toxic, but it may as well be.



*Gambierdiscus toxicus* magnified approximately 400 times  
Image: The Epidemiology Branch, State of Hawai‘i

## Accumulating up the Food Chain

The ciguatoxin accumulates in the flesh and organs of herbivorous fish. When these fish are eaten by carnivorous fish, the toxin travels up the food chain, accumulating in the bodies of the carnivores as well. Through this process of “bioaccumulation,” carnivores may end up with greater concentrations of ciguatoxin than herbivores because they may repeatedly eat animals with the toxin concentrated in their tissues.

Humans can be carnivores, too. When people eat toxic fish—either herbivorous or carnivorous fish—they are exposed to ciguatoxin. Depending on the individual’s sensitivity and prior exposure to ciguatoxin, a person may become mildly to severely ill.

You can reduce your chances of a run-in with ciguatoxin by knowing how ciguatoxin fits in to Hawaiian marine food chains. Use the information on the next two pages to answer the questions that follow.



## Fish Species to Watch Out For

Most incidents of ciguatera poisoning in Hawai‘i have been caused by four types of fish: *ulua* (jack), *kāhala* (amberjack), *kole* (gold-ring surgeonfish), and *pō‘ou* (ringtail wrasse). But other fish species have been implicated in incidents of ciguatera poisoning, too. Here is a list of these species, along with a brief description of what they eat. You will use this information to help you answer the questions that accompany this reading.

### The Big Four

#### *Ulua* or Jack (*pāpio* = juvenile)

*Caranx sexfasciatus* (Bigeye jack), *Carangoides orthogrammus* (Yellowspotted jack), among others

Length: Maximum one meter (three feet), depending on the species

Feeding: These swift, strong-swimming predators, which frequent open water near dropoffs or over reefs, feed primarily on other fishes, and forage on the bottom for crustaceans and other invertebrates.

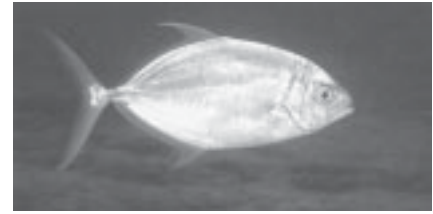


Photo: John P. Hoover

#### *Kāhala* or Amberjack

*Seriola dumerili*

Length: Up to two meters (six feet)

Feeding: These large predators occasionally come inshore to feed off schooling fishes in shallow water.



Photo: John P. Hoover

#### *Kole* or Gold-ring surgeonfish

*Ctenochaetus strigosus*

Length: Up to 17 centimeters (seven inches)

Feeding: Algae feeders



Photo: John P. Hoover

#### *Pō‘ou* or Ringtail wrasse

*Cheilinus unifasciatus*

Length: Up to 45 centimeters (18 inches)

Feeding: Predators of fishes, they typically hover several feet off the bottom, head angled down, ready to strike.



Photo: John P. Hoover



## Other Species to Watch

### ‘Ama‘ama or Striped mullet

*Mugil cephalus*

Length: Up to 50 centimeters (20 inches)

Feeding: They feed primarily off the bottom, taking in sand or mud and filtering out the organic material through their gills.

### Palani or Eyestripe surgeonfish

*Acanthurus dussumieri*

Length: Up to 45 centimeters (18 inches)

Feeding: These are algae feeders.

### Kākū or Great barracuda

*Sphyrna barracuda*

Length: Up to two meters (six feet)

Feeding: These lean, fast, and powerful predators hunt in schools or alone and are often found in shallow water close to shore.

### Uku or Gray snapper

*Aprion virescens*

Length: Up to one meter (three feet)

Feeding: These are long, powerful-looking, greenish to bluish gray predators.

### Roi or Peacock grouper

*Cephalopholis argus*

Length: Up to about 40 centimeters (16 inches)

Feeding: These are large-mouthed, bottom-dwelling predators introduced from Moorea, French Polynesia in 1956. They rely on ambush or careful stalking to get within striking distance of their prey. When the prey is sufficiently close, the grouper opens its large expandable mouth and takes in water, along with its meal.

### Weke or Goatfish

*Mulloidichthys spp.*

Length: Up to 60 centimeters (24 inches), depending on species

Feeding: They probe the sand with their whisker-like barbels, searching for worms, molluscs, and other invertebrates.

### Pūhi or Moray eel

*Gymnothorax flavimarginatus* (Yellowmargin moray) and others

Length: Up to 2.5 meters (eight feet), depending on species

Feeding: These predators feed on fish and crustaceans.

### Ta‘ape or Bluestripe snapper

*Lutjanus kasmira*

Length: Up to 37 centimeters (15 inches), but usually smaller

Feeding: These predators range from shallow water to deeper waters. Introduced from the Marquesas in 1958, they are low priced and compete with more favored food fish.

### Wahanui or Forktail snapper

*Aphareus furca*

Length: Up to .3 meters (one foot)

Feeding: These predators typically scout the reef from a position well off the bottom, often near dropoffs.

### ‘Ū‘ū or Soldierfish

*Myripristis spp.*

Length: Up to 27 centimeters (11 inches), depending on the species

Feeding: These medium-sized nocturnal fishes are usually red, with big scales and large dark eyes. They favor plankton in the water away from the bottom.

## Sources

Epidemiology Branch, *Fish Poisoning in Hawai‘i*, State of Hawai‘i, Department of Health, Honolulu, 1997.

Hawai‘i Department of Health, “Ciguatera Fish Poisoning” at <[www.hawaii.gov/doh/resource/comm\\_dis/cddcigua.htm](http://www.hawaii.gov/doh/resource/comm_dis/cddcigua.htm)>.

Cigua-Check Fish Poison Test Kit website at <[www.cigua.com](http://www.cigua.com)>.

Shirai, J. L., L. K. Shirai, and Y. Hokama, *Seafood Poisoning: Ciguatera*, Yosh Hokama Family Trust, Gardena, California, 1991.





- 3) ‘*Ū*‘*ū* or soldierfish do not fit into the two categories of fish that become ciguatoxic: herbivores that graze on “toxic” algae, and carnivores that feed on toxic herbivores. ‘*Ū*‘*ū* feed on plankton in midwater—away from the algae growth. Come up with one possible explanation for the fact that ‘*ū*‘*ū* have been implicated in at least one case of ciguatera poisoning in Hawai‘i and describe it below in as much detail as you can. (You do not need to do additional research to formulate your explanation, but make sure you clearly explain your idea and your reasoning.)