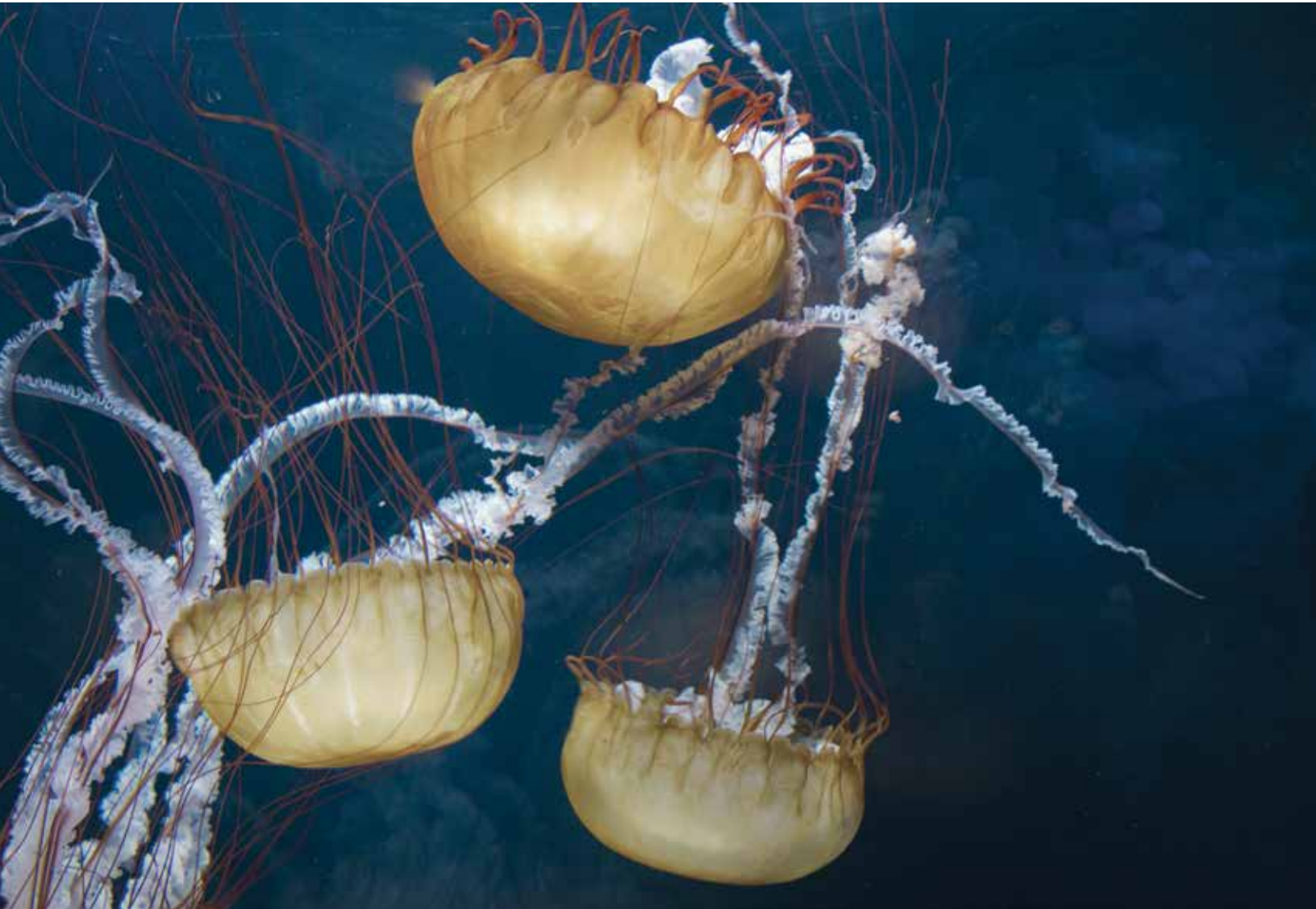




HEALTH & DIVING REFERENCE SERIES

HAZARDOUS MARINE LIFE



FOREWARD

DAN's Health & Diving Resource Series is a comprehensive collection of online and printed resources developed from years of DAN-supported research and insights gained from assisting thousands of members through dive and medical emergencies. These materials provide valuable information on topics critical to diver health and safety, as well as common issues encountered by new and experienced divers. As your dive safety association, it is our duty to provide the diving community with these vital education and reference tools. The series offers greater insight into topics such as ears and equalization, cardiovascular health, decompression sickness, hazardous marine injuries, and much more. Through information and education, we hope to enhance diver safety and incident prevention.



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1

ENVENOMATIONS

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Toxicity is in the dose.

An envenomation is the process by which a venom or toxin is injected into another being via a bite, puncture or sting. Envenomation is always due to direct contact with an animal (or parts of it like drifting jellyfish tentacles). There are two possible mechanisms of injection: active, such as jellyfish or cone snails, or passive like lionfish or sea urchins. Injuries typically occur during shore entries or exits, incidental contact or deliberate attempts to handle a specimen. Envenomations are rare but can be life threatening and may require rapid first aid response. In this chapter, we will cover some common envenomations as well as some of the more rare, but serious cases.

FIRE CORAL

Fire corals are colonial marine cnidarians that when touched can cause burning skin reactions. Fire coral-related incidents are common among divers with poor buoyancy control.

BIOLOGY AND IDENTIFICATION

Fire coral, which belong to the genus *Millepora*, are found in tropical and subtropical waters around the world. Generally fire coral adopts a yellow-green or brownish branchy formation, although its external appearance often varies due to environmental factors. Because fire coral can colonize hard structures, it can even adopt a rather stony appearance with rusty coloration.

Despite their calcareous structure, fire coral is not a true coral; these animals are more closely related to Portuguese man-of-war and other hydrozoans.

MECHANISM OF INJURY

Fire coral gets its name because of the fiery sensation experienced after coming into contact with a member of the species. The mild to moderate burning that it causes is the result of cnidocytes embedded in its calcareous skeleton; these cnidocytes contain nematocysts that will fire when touched, injecting their venom.

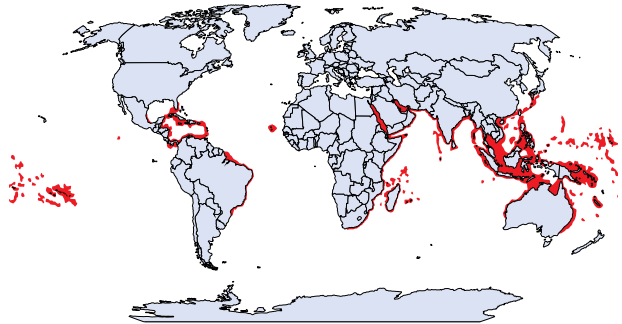
SIGNS AND SYMPTOMS

The burning sensation may last several hours and is often associated with a skin rash that appears minutes to hours after contact. This skin rash can take several days to resolve. Often, the skin reaction will subside in a day or two, but it may likely reappear several days or weeks after the initial rash disappeared.

Fire coral lacerations, in which an open wound receives internal envenomation, are the most problematic fire coral injuries. Venom from *Millepora* spp. is known to cause tissue necrosis on the edges of a wound. These injuries should be carefully observed, as necrotic tissue provides a perfect environment to culture serious soft tissue infections.

PREVENTION

- ❑ Avoid touching these calcareous formations.
- ❑ If you need to kneel on the bottom, look for clear sandy areas.
- ❑ Remember that hard surfaces such as rocks and old conchs may be colonized by fire coral even if they do not look branchy.
- ❑ Always wear full-body wetsuits to provide protection against the effects of contact.
- ❑ Master buoyancy control.
- ❑ Always look down while descending.



FIRST AID

- 1 Rinse the affected area with household vinegar.
- 2 Redness and vesicles will likely develop. Do not puncture them; just let them dry out naturally.
- 3 Keep the area clean, dry and aerated—time will do the rest.
- 4 For open wounds, seek a medical evaluation.
NOTE: Fire coral venom is known to have dermonecrotic effects. Share this information with your physician before any attempts to suture the wound, as the wound edges might become necrotic.
- 5 Antibiotics and a tetanus booster may be necessary.

PORTUGUESE MAN-OF-WAR



Portuguese man-of-wars are free-floating cnidarians characterized by blue gas-filled bladders and long tentacles that drift on the surface of the ocean. Contact with a man-of-war's tentacles can cause intense pain and other systemic symptoms.

BIOLOGY AND IDENTIFICATION

There are two species for the genus: *Physalia physalis* in the Atlantic and *Physalia utriculus* in the Indo-Pacific. The Atlantic man-of-war may reach slightly larger dimensions, with the gas bladder rarely exceeding one foot (30 centimeters) and tentacles averaging 33 feet (10 meters) and possibly extending up to 165 feet (50 meters).

Though many people mistake the Portuguese man-of-war for species of jellyfish, this genus belongs to the order Siphonophora, a class of hydrozoans. What we see as a single specimen is actually a colony composed of up to four different types of polyps. Despite its resemblance, these animals are more closely related to fire coral than to jellyfish.

The Portuguese man-of-war is easily recognizable; if you see blue tentacles, you can bet they belong to *Physalia*.

RISK TO HUMANS

The man-of-war's polyps contain cnidocytes delivering a potent proteic neurotoxin capable of paralyzing small fish. For humans, most stings cause red welts accompanied by swelling and moderate to severe pain. These local symptoms last for two to three days.

Systemic symptoms are less frequent, but potentially severe. They may include generalized malaise, vomiting, fever, elevated heart rate at rest (tachycardia), shortness of breath and muscular cramps in the abdomen and back. Severe allergic reactions to the man-of-war's venom may interfere with cardiac and respiratory function, so divers should always seek a timely professional medical evaluation.

EPIDEMIOLOGY

Approximately 10,000 cnidaria envenomations occur each summer off the coasts of Australia, the vast majority of which involve *Physalia*. In fact, man-of-wars cause the most cnidarian envenomations prompting emergency evaluation globally. The risk may not be so great for divers, however, as most *Physalia* stings occur on beaches or on the surface of the water rather than while submerged. Certain regions are known to have seasonal outbreaks, but incidence is highly variable between regions.

PREVENTION

- Always look up and around while surfacing. Pay special attention during the last 15-20 feet of your ascent, since this is the area where you may find cnidarians and their submerged tentacles.
- Wear full body wetsuits regardless of water temperature. Mechanical protection is the best way to prevent stings and rashes.
- In areas where these animals are known to be endemic, a hooded vest may be the best way to protect your neck.

FIRST AID

- 1 Avoid rubbing the area. Cnidarian tentacles are like nematocyst-coated spaghetti, so rubbing the area or allowing the tentacles to roll over the skin will exponentially increase the affected surface area and, therefore, the envenomation process.

NOTE: Initial pain may be intense. Though life-threatening complications are rare, monitor circulation, airway and breathing, and be prepared to perform CPR if necessary.

- 2 Remove the tentacles. You must take great care to remove the man-of-war's tentacles in order to avoid further envenomation. Those distinctive blue tentacles are quite resistant to traction, so you can remove them fairly easily with some tweezers or gloves.

NOTE: If you do not have access to tweezers or gloves, the skin on your fingers is likely thick enough to protect you. Keep in mind, however, that after removal your fingers may contain hundreds or even thousands of unfired nematocysts, so pretend you have been handling hot chili peppers that cause blisters anywhere you touch and treat your fingers as recommended from the next step on.

- 3 Flush the area with seawater. Once the tentacles and any remnants have been removed, use a high volume syringe and flush the area with a powerful stream of seawater to remove any remaining unfired nematocysts. Never use freshwater since this will cause unfired nematocysts to fire.

- 4 Apply heat. Immerse the affected area in hot water (upper limit of 113°F/45°C) for 30 to 90 minutes. If you are assisting a sting victim, try the water on yourself first to assess tolerable heat levels. Do not rely on the victim's assessment, as intense pain may impair his ability to evaluate tolerable heat levels. If you cannot measure water temperature, a good rule of thumb is to use the hottest water you can tolerate without scalding. Note that different body areas have different tolerance to heat, so test the water on the same area where the diver was injured. Repeat if necessary. If hot water is not available, apply a cold pack or ice in a dry plastic bag.

NOTE: Application of heat has two purposes: 1) it may mask the perception of pain; and 2) it may assist in thermolysis. Since we know the venom is a protein that has been superficially inoculated, application of heat may help by denaturing the toxin.

- 5 Always seek an emergency medical evaluation.
- 6 Continue monitoring the patient until a higher level of care has been reached.



VINEGAR APPLICATION

Use of vinegar is controversial with *Physalia* spp. Though the use of vinegar has traditionally been recommended, several studies both in-vivo and in-vitro show massive nematocyst discharge upon pouring household vinegar over certain species of cnidarians, including *Physalia*. Still, the most current American Heart Association guidelines (AHA 2010) recommend application of vinegar for all jellyfish, including *Physalia* spp. If anything changes, DAN will let you know.

If you do choose to apply vinegar, you can optimize application and significantly economize by using spray bottles. Generously spray the area with vinegar for no less than 30 seconds to neutralize any invisible remnants. Pick off any remaining tentacles.



The lionfish is a genus of venomous fish commonly found in tropical reefs. Native to the Indo-Pacific, the fish is one of the most infamous invasive species in the western Atlantic. This voracious predator is not a threat to divers, but its introduction into exotic ecosystems can decimate juvenile specimens. In an attempt to control the spread of lionfish populations, recreational divers in the Americas have started aggressive campaigns to hunt them; in the process, many divers are stung with the lionfish's sharp spines, which can cause very painful and sometimes complicated wounds.

IDENTIFICATION AND DISTRIBUTION

Lionfish, turkeyfish and zebrafish are common names for fish species of the genus *Pterois*, a subset of fish of the venomous *Scorpaeniform* family. Though lionfish are native to the Indo-Pacific, members of the order *Scorpaenidae* can be found in oceans all over the globe, even in arctic waters. Lionfish specimens are typically red with white and black stripes and have showy, spiky fins. Species include *Pterois volitans*, *P. miles*, *P. radiata*, and *P. antenata* among a few others.

WESTERN ATLANTIC INVASION

Since the early 1990s, invasive lionfish have wreaked havoc on local juvenile reef fish populations in the western Atlantic. Out of the nine species of *Pterois*, only *P. volitans* and *P. miles* are found in Western Atlantic waters, but they range from as far north as Rhode Island down to Venezuela and The Guianas.

RISK TO HUMANS

Knowing no predators, these fish are generally docile, allowing divers to approach closely enough and making themselves easy targets for spearfishing. Unfortunately, the desperate attempts to eradicate these fish from the Americas have caused a significant rise in the incidence of lionfish puncture wounds.

EPIDEMIOLOGY

The prevalence and incidence of lionfish envenomations is unknown. Treating physicians may not choose to consult a poison control center, and in the United States are under no obligation to report these injuries to state or federal agencies. Scientific literature accounts for 108 cases of lionfish envenomations reported between 1976 and 2001, and almost all of these reports are actually from marine aquarists. It is impossible to know how often victims go untreated and how often treatment goes unreported, but the frequency of case reports seems to indicate that lionfish envenomations are not uncommon.

Lionfish culling tournaments are becoming more and more popular all over the Caribbean. Recent studies conducted by DAN staff from Cozumel, Mexico accounted for a total of 26 cases of lionfish envenomation over four years of tournaments. Incidence of injury during these events was between 7-10% of participants.

MECHANISM OF INJURY

Most lionfish-related incidents occur as a result of careless handling, usually during spearfishing or while preparing them for consumption. Lionfish have needlelike spines located along the dorsal, pelvic and anal fins, and punctures can be extremely painful and lead to rapid development of localized edema and subcutaneous bleeding. Pain can last for several hours, edema typically resolves in two to three days, and tissue discoloration can last up to four or five days. Due to edema and the venom's inherent toxicity, puncture wounds on fingers can lead to ischemia (restriction of blood supply to the tissues) and necrosis.

PREVENTION

Lionfish are by no means aggressive. To prevent injuries, maintain a prudent distance. If you are committed to engage in spearfishing or culling activities, avoid improvisations and do not try to handle these animals until you learn from more experienced divers.

FIRST AID

If you are stung, remain calm. Notify the dive leader and your buddy. The priority is to safely end your dive, returning to the surface following a normal ascent rate. Do not skip any decompression obligation.

On the surface, first aid providers should:

- 1 Rinse the wound with clean freshwater.
- 2 Remove any obvious foreign material.
- 3 Control bleeding if needed. It is ok to allow small punctures to bleed for a minute immediately after being stung (this may decrease venom load).
- 4 Apply heat. Immerse the affected area in hot water (upper limit of 113°F/45°C) for 30 to 90 minutes. If you are assisting a sting victim, try the water on yourself first to assess tolerable heat levels. Do not rely on the victim's assessment, as intense pain may impair his ability to evaluate tolerable heat levels. If you cannot measure water temperature, a good rule of thumb is to use the hottest water you can tolerate without scalding. Note that different body areas have different tolerance to heat, so test the water on the same area where the diver was injured. Repeat if necessary.

NOTE: Thermolysis can also be a secondary benefit worth pursuing, but it tends to be less effective in cases where the venom has been injected deep into the tissues.
- 5 Apply bandaging as needed.
- 6 Seek a professional medical evaluation.

BLUE-RINGED OCTOPUS



Blue-ringed octopus are a small species of venomous octopi that live in tropical tide pools from south Japan to the coastal reefs of Australia and the western Indo-Pacific. These small octopi are the only cephalopods known to be dangerous to humans

IDENTIFICATION

The blue-ringed octopus hardly ever exceeds eight inches (20 centimeters) in size. Their most distinctive feature is the blue iridescent rings that cover their yellow-colored body; however, it is important to emphasize that this feature is only displayed when the animal is disturbed, hunting or mating. When calm or at rest, the animal may display an overall yellowish, grey or beige coloration without any visible blue rings. The blue-ringed octopus is more active at night, spending most of the day hidden in its nest in shallow areas or tide pools.

EPIDEMIOLOGY

Blue-ringed octopus envenomations are very rare. These animals are only endemic to southern Japan, Australia and the western Indo-Pacific. Cases outside of this region are generally due to deliberate handling of aquarium specimens. There are only a handful of reported fatal cases. Full recovery is expected with timely professional medical intervention.

MECHANISM OF INJURY

As with all cephalopods, octopi have a strong beak similar to those of parrots and parakeets. All octopi have some sort of venom to paralyze their victims, but the blue-ringed octopus bite may contain an extremely powerful neurotoxin called tetrodotoxin (TTX), which can be up to 10,000 times more potent than cyanide and can paralyze a victim in minutes. Theoretically, a little over one-half milligram of this venom—the amount that can be placed on the head of a pin—is enough to kill an adult human.

Certain bacteria present in the blue-ringed octopus' salivary glands synthesize the toxin. TTX is not unique to the blue-ringed octopus; certain newts, dart frogs, cone snails and pufferfish can also be a source of TTX intoxication, though from different mechanisms.

SIGNS AND SYMPTOMS

A blue-ringed octopus bite is usually painless or no more painful than a bee sting; however, even painless bites should be taken seriously. Neurological symptoms dominate every stage of envenomation, and manifest as paresthesia (tingling and numbness) progressing to paralysis that could potentially culminate in death.

If envenomation has occurred, signs and symptoms usually start within minutes and may include paresthesia of the lips and tongue. This is usually followed by excessive salivation, trouble with pronunciation (dysarthria), difficulty swallowing (dysphagia), sweating, dizziness and headache. Serious cases may progress to muscular weakness, incoordination, tremors and paralysis. Paralysis may eventually affect respiratory muscles, which can lead to severe hypoxia with cyanosis (blue or purple tissue discoloration due to insufficient oxygen in the blood).

PREVENTION

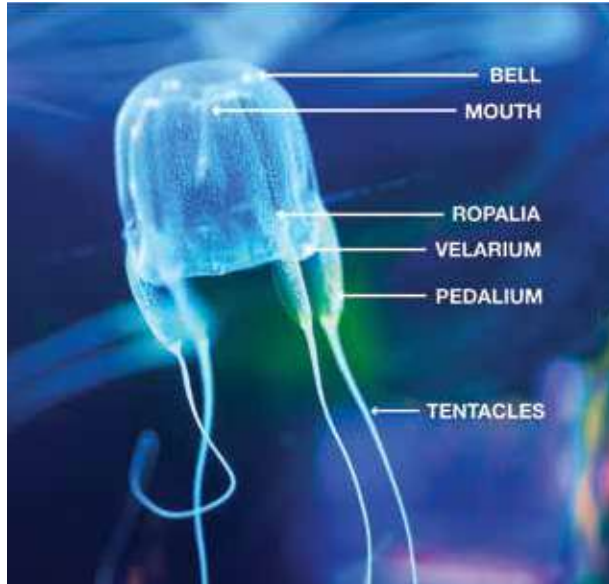
- I These animals are not aggressive, and divers should not fear blue-ringed octopi.
- I If encountered, avoid handling these animals.
- I Due to their small size and lack of skeleton, a blue-ringed octopus den might be a small space only accessible through a tiny crevice, so avoid picking up bottles, cans or mollusk shells in areas they inhabit.

FIRST AID

Care is supportive. There is no antivenom available. If someone is bitten:

- 1 Clean the wound with freshwater and provide care for a small puncture wound.
- 2 Apply the pressure immobilization technique.
NOTE: TTX is a heat-stable toxin, so the application of heat will not denature the toxin.
- 3 Watch for signs and symptoms of progressive paralysis.
 - I Be prepared to provide mechanical ventilations with a bag valve mask device or a manually triggered ventilator.
 - I Do not wait for signs and symptoms of paralysis. Always seek an evaluation at the nearest emergency department.
NOTE: The bite site might be painless and still be lethally toxic.
- 4 Wound excision is never recommended.

BOX JELLYFISH (CUBOZOANS)



Box jellyfish (cubozoans) are cube-shaped medusa notorious for possessing one of the most potent venoms known to mankind. Certain species can kill an adult human in as little as three minutes, scarcely enough time for any rescue response.

BIOLOGY AND IDENTIFICATION

Medusas are the migrant form of cnidarians. In the case of box jellyfish, their bell-like body is cube shaped, with tentacles extending from each corner. Box jellyfish are complex animals with a propulsion mechanism and a relatively sophisticated nervous system for a jellyfish. They have up to 24 eyes, some of them with corneas and retinas, enabling them to not only detect light but also to see and circumnavigate objects to avoid collision.

While some jellyfish live off of symbiotic algae, box jellyfish prey on small fish, which are immediately paralyzed upon contact with their tentacles. Then the tentacles are retracted, carrying the prey into the bell for digestion. Some species hunt daily, and at night some species can be observed resting on the ocean floor.

EPIDEMIOLOGY AND DISTRIBUTION

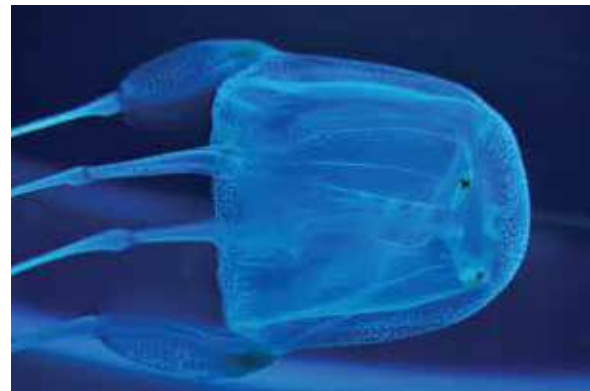
From 1884 to 1996, there were more than 60 reported fatalities from box jellyfish stings in Australia. There are species of box jellyfish in almost all tropical and subtropical seas, but life-threatening species seem to be restricted to the Indo-Pacific.

NOTORIOUS SPECIES

SEA WASP

Found in the coastal waters of Australia and Southeast Asia, sea wasp is the common name for the most dangerous cnidarian: *Chironex fleckerii*. The largest cubozoan, sea wasps have a bell approximately eight inches (20 centimeters) in diameter and tentacles ranging from a few centimeters to up to 10 feet (three meters). Contact with these animals triggers the most powerful and lethal envenomation process known to science. Sea wasp envenomation causes immediate excruciating pain followed by cardiac failure. Death may occur in as little as three minutes.

Recent studies have identified a component of the venom that drills a hole in red blood cells, causing a massive release of potassium, possibly responsible for the lethal cardiovascular depression. The same study may have also identified a way to inhibit this effect, which in the coming years could prove to be clinically promising.



FOUR-HANDED BOX JELLYFISH

The four-handed box jellyfish (*Chiropsalmus quadrumanus*) habitat spans from South Carolina to the Caribbean, the Gulf of Mexico and as far south as Brazil. The four-handed box jellyfish can inflict extremely painful stings and is the slightly smaller American cousin to the Australian sea wasp. There is one documented case of a four-year-old boy who was stung in the Gulf of Mexico and died within 40 minutes.

BONAIRE BANDED BOX JELLYFISH

Bonaire banded box jellyfish (*Tamoya ohboya*) is a relatively unknown, highly venomous species found in the Dutch Caribbean. Since 1989, there have been roughly 50 confirmed sightings primarily in Bonaire with the remainder on the shores of Mexico, St. Lucia, Honduras, St. Vincent and the Grenadines. There have only been three reported cases of envenomation, which lead to intense pain and skin damage; only one case required hospitalization.

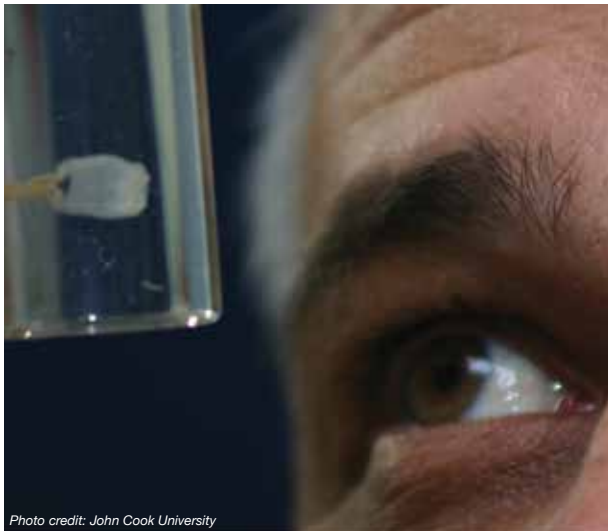


Photo credit: John Cook University

IRUKANDJI SYNDROME

Tiny box jellyfish found near Australia, *Carukia barnesi* and *Malo kingi*, are responsible for the infamous and extremely painful symptomatic complex known as Irukandji syndrome. These small cubozoans' bells are only a few millimeters with tentacles up three feet (one meter). Fortunately, fatalities from these smaller species are rare, but stings are extremely painful and can cause systemic symptoms including cardiovascular instability that should prompt immediate medical attention. Survivors have reported a feeling of impending doom, claiming they were certain that they could not survive such intense, generalized pain; however, it is important to emphasize that a single sting should not be fatal.

Though stings from lesser-known species of cubozoans are not necessarily lethal, they can still be very painful. An immediate medical evaluation is always recommended.

PREVENTION

- | Properly research the areas you intend to dive.
- | Avoid known box jellyfish habitats if you are not sure the dive site or swimming area is safe. If stung, cardiovascular stability can rapidly deteriorate with very little time for any effective field intervention.
- | In Northern Queensland, Australia, net enclosures are placed in the water where box jellyfish are known to be during summer months (November to May), but these cannot guarantee safety.
- | Minimize unprotected areas. Always wear full wetsuits, hoods, boots and gloves. Something as simple as nylon pantyhose worn over the skin will prevent jellyfish stings.
- | Carry sufficient household vinegar with you to all dive sites.



FIRST AID

If stung by any jellyfish, follow these procedures in this order:

- 1 Activate local emergency medical services.
- 2 Monitor victim's airway, breathing and circulation. Be prepared to perform CPR at any moment (particularly if you suspect box jellyfish).
- 3 Avoid rubbing the area. Box jellyfish tentacles can be cylindrical or flattened, but they are coated with cnidocytes, so rubbing the area or allowing the tentacles to roll over the skin will exponentially increase the affected surface area and the envenomation process.
- 4 Apply household vinegar to the area. Generously pour or spray the area with vinegar for no less than 30 seconds to neutralize any invisible remnants. You can pour the vinegar over the area or use a spray bottle, which optimizes application. Let the vinegar stand for a few minutes before doing anything else.

NOTE: This will not do anything to the pain or the venom already injected, but it is intended to stabilize any remaining unfired nematocysts on the diver's skin before you try to remove them.

- 5 Wash the area with seawater (or saline). Use a syringe with a steady stream of water to help remove any tentacle remains. Do not rub.

NOTE: Do not use freshwater; this could cause massive nematocyst discharge.

- 6 Apply heat. Immerse the affected area in hot water (upper limit of 113°F/45°C) for 30 to 90 minutes. If you are assisting a sting victim, try the water on yourself first to assess tolerable heat levels. Do not rely on the victim's assessment, as intense pain may impair his ability to evaluate tolerable heat levels. If you cannot measure water temperature, a good rule of thumb is to use the hottest water you can tolerate without scalding. Note that different body areas have different tolerance to heat, so test the water on the same area where the diver was injured. Repeat if necessary. If hot water is not available, apply a cold pack or ice in a dry plastic bag.

NOTE: Application of heat has two purposes: 1) it may mask the perception of pain; and 2) it may assist in thermolysis. Since we know the venom is a protein that has been superficially inoculated, application of heat may help by denaturing the toxin.

- 7 Always seek an emergency medical evaluation.

CONE SNAILS



Cone snails are marine gastropods characterized by a conical shell and beautiful color patterns. Cone snails possess a harpoon-like tooth capable of injecting a potent neurotoxin that can be dangerous to humans.

IDENTIFICATION AND DISTRIBUTION

There are about 600 different species of cone snails, all of which are poisonous. Cone snails live in shallow reefs partially buried under sandy sediments, rocks or corals in tropical and subtropical waters. Some species have adapted to colder waters.



MECHANISM OF INJURY

Injuries typically occur when the animal is handled. Cone snails administer stings by extending a long flexible tube called a proboscis and then firing a venomous, harpoon-like tooth (radula).

SIGNS AND SYMPTOMS

A cone snail sting can cause mild to moderate pain, and the area may develop other signs of acute inflammatory reaction like redness and swelling. Conustoxins affect the nervous system and are capable of causing paralysis possibly leading to respiratory failure and death.

EPIDEMIOLOGY

The prevalence and incidence of cone snails envenomations is unknown, but it is probably a very rare occurrence in divers and the general population. Shell collectors (professional or amateur) may be at higher risk.

PREVENTION

If you see a beautiful marine snail that looks like a cone, it is probably a cone snail. It is difficult to tell whether a cone snail inhabits a given shell as they are able to hide inside them. Since all cone snails are venomous, err on the side of safety and do not touch it.

FIRST AID

Unfortunately, there is no specific treatment for cone snail envenomations. First aid focuses on controlling pain, but may not influence outcomes. Envenomation will not necessarily be fatal, but depending on the species, the amount of venom injected, and the victim's size and susceptibility, complete paralysis may occur and this may lead to death. Cone snail venom is a mixture of many different substances including tetrodotoxin (TTX).

- 1 Clean the wound with freshwater and provide care for a small puncture wound.
- 2 Apply the pressure immobilization technique.

NOTE: Application of heat might help with pain management, but since TTX is a heat-stable toxin, the application of heat will not denature the toxin.

- 3 Watch for signs and symptoms of progressive paralysis.

- Be prepared to provide mechanical ventilations with a bag valve mask device or a manually triggered ventilator.
- Do not wait for signs and symptoms of paralysis. Always seek an evaluation at the nearest emergency department.

NOTE: The bite site might be painless and still be lethally toxic.

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TRAUMATIC INJURIES AND COMPLICATIONS

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Wash thoroughly, use soap and keep it clean and dry.

Bites account for the majority of marine life associated trauma. Fortunately, serious encounters are extremely rare. Traumatic injuries are usually the result of an animal's defensive reaction to a perceived threat or misidentification of a diver's body part as a food source. Most puncture wounds do not contain venom and are, therefore, a traumatic injury. Bleeding is the most common acute complication to trauma, while infections are the most common secondary complication. In this chapter, we will cover the more common traumatic injuries, how to prevent them and how to properly manage them.

SKIN ABRASION

An abrasion is a superficial scrape that occurs when the skin is rubbed or bumped against a rough object.

EPIDEMIOLOGY

Skin abrasions, minor skin cuts and scrapes are very common among recreational divers. Accidental contact with rocks, corals, wrecks and other hard surfaces in or around dive sites can cause injury. Divers with poor buoyancy control frequently report abrasions. In addition, divers who dive close to the bottom or through narrow passageways without the protection of full-length wetsuits often report minor abrasions on their lower extremities.

*Though not very common, it is possible that some superficial wounds occurring in watery environments could become infected with *Mycobacterium marinum* (responsible for the disease known as aquarium granuloma), especially when the scratch does not seem to properly heal after weeks of what seemed proper and sound care.*

RISKS TO DIVERS

Skin abrasions expose your underlying tissues to microorganisms, significantly increasing the risk of infections. Bleeding can also be of concern, particularly when the injury occurs on highly perfused areas like your face, head, hands and fingers.

PREVENTION

To avoid skin abrasions, you must master buoyancy control and use mechanical protection like gloves and full-body wetsuits. Though thermal insulation may not be necessary in tropical dive destinations, protection from potential skin abrasions as well as from stinging microscopic life is always a good idea. It is important to note that in an attempt to protect underwater fauna, gloves might not be permitted at some dive destinations. Ask the local dive operator about its protocols before wearing gloves; it may help to explain your reasons for wanting to wear them.

FIRST AID

In case of minor skin abrasions, follow these basic first aid guidelines:

- 1 Wash the area thoroughly with clean freshwater (sterile if available).
- 2 Apply antiseptic solution (iodine-based antiseptic solutions may be contraindicated in patients with hyperthyroidism).
- 3 Control bleeding by applying direct pressure with a sterile bandage.
 - If bleeding has been controlled:
 - Let the area dry out.
 - Apply triple antibiotic ointment.
 - Cover the area with a sterile bandage.
 - Have the wound evaluated by a medical professional within 24 hours to assess risk of infections.
 - If bleeding persists:
 - Cover the wound with clean dressings and keep them in place.
 - Continue to apply pressure.
 - Seek an immediate medical evaluation.

TREATMENT

For abrasions or amputations with significant bleeding, contact local emergency medical services immediately, apply bleeding control techniques and monitor the patient's vital signs. Be prepared to manage shock.

STINGRAYS



Stingrays are shy, peaceful fish. They do not represent a threat to divers unless startled, stepped on or deliberately corralled and threatened. Most injuries occur in shallow waters when divers or swimmers are walking in areas where stingrays reside.

BIOLOGY AND IDENTIFICATION

Rays are closely related to sharks: class Chondrichthyes, *chondr-* meaning cartilaginous and *-ichthyes* meaning fish. It's important to note that not all rays have stingers. Stingrays are a specific group of rays classified in the suborder Myliobatoidei, which consists of eight families: deep water stingrays, sixgill stingrays, stingarees, round rays, butterfly rays, river stingrays, eagle rays and whiptail stingrays.

The approximate stingray wingspan varies across species from one foot to more than six feet (two meters). Some freshwater species can weigh up to 1,300 pounds (600 kilograms).

DISTRIBUTION

There are species of stingrays in nearly all oceans. Some families consist of only freshwater species, which are typically found in tropical, subtropical and temperate river environments.

MECHANISM OF INJURY

Stingrays are not aggressive by any means, and injuries are rarely fatal. The stingray's defense mechanism consists of a serrated barb at the end of its tail with venom glands located at the base of the barb. The venom is a variable mixture of substances, none of which are specific to the animal; therefore, the creation of antivenom is not possible. Stingrays will strike when threatened or stepped on. The barb can easily tear wetsuits and penetrate skin, and may cause deep, painful lacerations.



EPIDEMIOLOGY

It is estimated that stingrays are responsible for approximately 1,500 accidents each year in the United States. Prevalence on other countries might be higher, particularly injuries associated with freshwater species, but epidemiological data is either elusive or inexistent.

SIGNS AND SYMPTOMS

Stingrays can inflict mild to severe puncture wounds or lacerations. The initial symptom is pain, which can be significant and intensify over several hours. Both puncture wounds and lacerations can damage major blood vessels causing severe, potentially life-threatening bleeding. The barb usually breaks off and may require professional surgical care.

It is common for stingray wounds to become infected despite proper care. Notable possible infections include cellulitis, myositis, fasciitis and tetanus.

PREVENTION

- I Avoid stepping in murky or low-visibility shallow waters where stingrays naturally inhabit.
- I Stingrays often burrow in the sand, making them difficult to see even in tropical waters.
- I If you are shore diving and you suspect there may be stingrays, carefully shuffle your feet while entering or exiting the water. This technique is known as the “stingray shuffle.” Stingrays are very sensitive animals, and the vibrations caused by this shuffling may scare them away.

FIRST AID

- 1 Clean the wound thoroughly.
- 2 Control bleeding if necessary.
- 3 Do not delay professional medical evaluation. The risk for tetanus and other serious infections must be professionally minimized.

SEA URCHINS

Sea urchins are typically small, rounded spiny creatures found on shallow rocky marine coastlines. The primary hazard associated with sea urchins is contact with their spines.

BIOLOGY AND IDENTIFICATION

Sea urchins are echinoderms, a phylum of marine animals shared with starfish, sand dollars and sea cucumbers. Echinoderms are recognizable, because their pentaradial symmetry (they have five rays of symmetry), which is easily observed on a starfish. This symmetry corresponds with a water vascular system used for locomotion, transportation of nutrients and waste, and respiration. Sea urchins have tubular feet called pedicellariae, which enable movement. In one genus of sea urchin—the Flower Sea Urchin—some of the pedicellariae have evolved into toxic claws. In this species, the spines are short and harmless, but these toxic claws can inflict an envenomation.

Sea urchins feed on organic matter in the seabed. Their mouth is located on the base of their shell and their anus is on the top. The color of sea urchins varies depending on the species—shades of black, red, brown, green, yellow and pink are common.



DISTRIBUTION

There are species of sea urchins in all oceans from tropical to arctic waters. Most human-sea urchin incidents occur in tropical and subtropical waters.

MECHANISM OF INJURY

Sea urchins are covered in spines, which can easily penetrate divers' boots and wetsuits, puncture the skin and break off. These spines are made of calcium carbonate, the same substance that comprises eggshells. Sea urchin spines are usually hollow and can be fragile, particularly when it comes to extracting broken spines from the skin.

Injuries usually happen when people step on them on while walking across shallow rocky bottoms or tide pools. Divers and snorkelers are often injured while swimming on the surface in shallow waters as well as when entering or exiting the water from shore dives.

EPIDEMIOLOGY

Although little epidemiological data is available, sea urchin puncture wounds are common among divers, particularly when in shallow waters, near rocky shores or in close proximity to wrecks and other hard surfaces. The DAN Medical Information team receives at least one call a week regarding sea urchin injuries, typically from divers and snorkelers swimming in very shallow waters near rocky shores.

SIGNS AND SYMPTOMS

Injuries are typically in the form of puncture wounds, often multiple and localized. Skin scrapes and lacerations are also possible. Puncture wounds are generally painful and associated with redness and swelling. Pain ranges from mild to severe depending on several factors, including the species, the body area of the wound, joint or muscular layers compromised, number of punctures, depth of puncture, and the individual's threshold for pain. Multiple puncture wounds may cause limb weakness or paralysis, particularly with the long-spined species of the genus *Diadema*. On very rare occasions, immediate life-threatening complications may occur.

PREVENTION

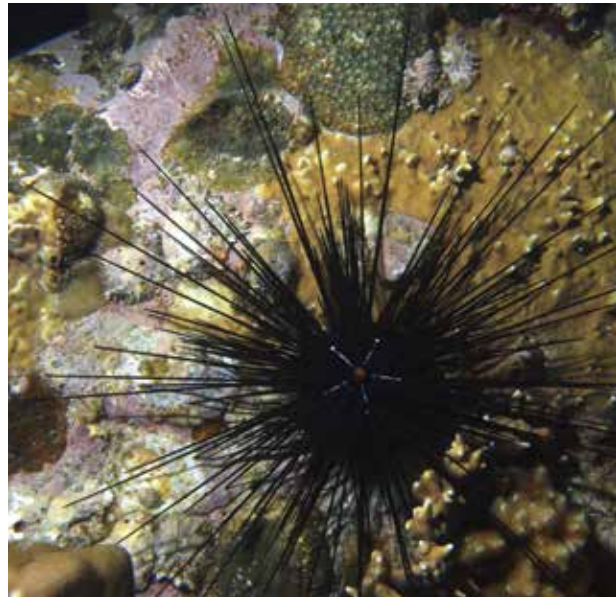
- 1 Be observant while entering or exiting the water from shore dives, particularly when the bottom is rocky.
- 2 If swimming, snorkeling or diving in shallow waters, near rocky shores or in close proximity to wrecks and other hard surfaces, maintain a prudent distance and buoyancy control.
- 3 Avoid handling these animals.

FIRST AID

There is no universally accepted treatment for sea urchin puncture wounds. Both first aid and definitive care is symptomatic.

- 1 Apply heat. Immerse the affected area in hot water (upper limit of 113°F/45°C) for 30 to 90 minutes. If you are assisting a sting victim, try the water on yourself first to assess tolerable heat levels. Do not rely on the victim's assessment, as pain may impair his ability to evaluate tolerable heat levels. If you cannot measure water temperature, a good rule of thumb is to use the hottest water you can tolerate without scalding. Note that different body areas have different tolerance to heat, so test the water on the same area where the diver was injured. Repeat if necessary.

NOTE: Very few species of sea urchins contain venom. If present, hot water immersion may also help denature any superficial toxins.



- 2 Remove any superficial spines. Tweezers can be used for this purpose; however, sea urchin spines are hollow and can be very fragile when grabbed from the sides. Your bare fingers are a softer alternative to hard tweezers.

NOTE: Do not attempt to remove spines embedded deeper in the skin; let those be handled by medical professionals. Deeply embedded spines may break down into smaller pieces, complicating the removal process.

- 3 Wash the area thoroughly, but avoid forceful rubbing and scrubbing if you suspect there may still be spines embedded in the skin.
- 4 Apply antiseptic solutions or over-the-counter antibiotic ointments if available.
- 5 Do not close the wound with tape or glue; this might increase the risk of infection.

NOTE: Deep puncture wounds are the perfect environment to culture an infection, particularly tetanus.

- 6 Regardless of any first aid provided, always seek a professional medical evaluation.

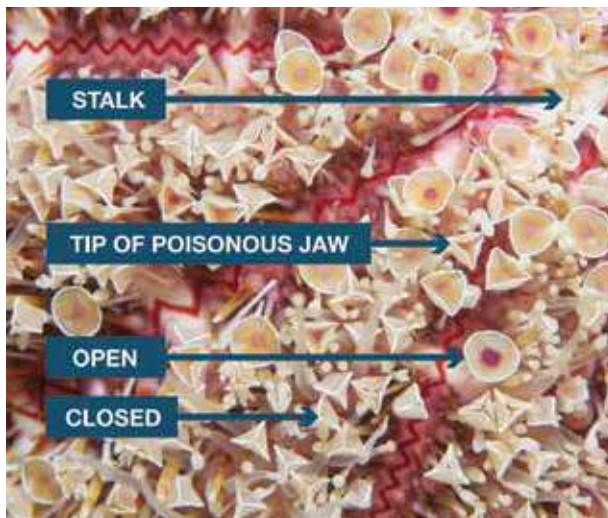
TREATMENT

Contrary to popular belief, very few species of sea urchins are actually toxic. Pain and swelling is often the result of the body's reaction to myriad different antigens present on the surface of the spines.

Spines are usually covered with strong pigments, so individual puncture wounds are often clearly visible and may cause suspicion that each puncture contains a fragment of a spine. Though this is possible, it may not necessarily be the case. It is easier to assess each individual puncture once the acute inflammatory process has started to recess.

The decision of whether or not surgical removal of retained spines is necessary is usually based on joint or muscular layer involvement, and whether there is pain with movement or signs of infection. Spines will usually encapsulate in a short time, but they may not always dissolve. A reactive granuloma is a common reaction to remaining small foreign bodies. Radiological localization, fluoroscopy or an ultrasound might be useful to avoid a blind surgical extraction that may cause further spine fracture.

The use of anti-inflammatories and physical therapy is often key for managing these injuries, particularly when they involve small joints as a prolonged inflammatory process may result in fibrosis, which may limit range of motion. If signs of infection are present, the doctor may prescribe antibiotics and a tetanus booster.



FLOWER SEA URCHIN

The Flower Sea Urchin (*Toxopneustes* spp.) is the most toxic of all sea urchins. Its short spines are harmless, but its pedicellariae, which look like small flowers, are tiny claws (*Toxopneustes*, meaning toxic foot). These claws contain a toxin that can cause severe pain similar to that of a jellyfish sting, faint giddiness, difficulty breathing, slurred speech, generalized weakness, and numbness of the lips, tongue and eyelids.

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SEAFOOD POISONING

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Know what you are eating.

”

Seafood poisonings are illnesses caused by ingestion of a natural toxin present in seafood. This toxicity can be inherent to the species as is the case in fugu and other tetraodontiforms, or toxicity can result from external contamination such as shellfish poisonings or ciguatera. Many gastrointestinal issues commonly attributed to seafood poisonings are often actually result of gastrointestinal infections caused by ingestion of harmful bacteria, parasites or viruses, and for that reason they are not included in this text.

In this chapter, we will discuss ichthyosarcotoxism, a form of food poisoning resulting from ingestion of fish flesh containing natural toxins. Ichthyosarcotoxism originates from the Greek words *ichthyo* (fish), *sarx* (flesh) and *toxism* (intoxication or poisoning). The three main ichthyosarcotoxisms are ciguatera, scombroid fish poisoning and tetrodotoxism. We will also cover shellfish-related intoxications. Since shellfish are bivalve mollusks not fish, these cases cannot be called an ichthyosarcotoxism.

CIGUATERA



Ciguatera poisoning occurs when contaminated reef fish are consumed. Specific reef fish bioaccumulate toxins produced by microorganisms in their diet. Though ciguatera intoxication should not be fatal, there is no treatment, so it is prudent to become familiar with potentially toxic species to avoid this poisoning.

SOURCE OF INTOXICATION

Ciguatera is caused by ingesting fish contaminated with certain toxins collectively known as ciguatoxins, which are produced by photosynthetic unicellular dinoflagellates (*Gambierdiscus toxicus*) that are part of phytoplankton. Dinoflagellates are epiphytes, which means they live on macro algae and dead coral surfaces. Small reef fish feed on these corals and macro algae accidentally ingesting these dinoflagellates. As

these smaller fish are eaten by larger predators, the toxin is transmitted up the food chain and accumulates in the tissues of top predators through a process known as bioaccumulation. Human poisoning can potentially occur when any of the fish involved in this chain are consumed, but poisoning is much more likely when eating the larger predators.

Species known to be a source of intoxication include barracudas, snappers, moray eels, parrotfish, groupers, triggerfish and amberjacks, but other species have been known to cause occasional outbreaks. Ciguatera toxins rarely contaminate pelagic fish such as tuna, marlins, dolphinfish or other ray-finned fish. Ciguatoxin can be found around the world in the tropical reef belt between 35 degrees north latitude and 35 degrees south latitude.

EPIDEMIOLOGY

Ciguatera is probably the most common type of marine food poisoning. It is endemic in Australia, the Caribbean and the South Pacific islands. Ciguatera cases should be naturally limited to these areas, but due to commercial imports, cases of ciguatera have been reported in areas like St. Louis, Missouri and New York City.

Approximately 50,000 reported cases of ciguatera poisoning occur annually worldwide. Epidemiological data regarding ciguatera poisoning is challenging to collect; because of the wide array of symptoms, ciguatera is often misdiagnosed or undiagnosed. People in endemic areas often disregard medical evaluation, while imported cases probably go undiagnosed or unreported, because physicians outside of endemic regions may be unfamiliar with symptoms of a tropical toxin. Recent studies have suggested that the incidence of this illness is continuing to increase, though this might be due to increased reporting rather than an increased occurrence of the disease.

SIGNS AND SYMPTOMS

Toxicity depends on exposure and dose (how much is ingested). Symptom onset usually occurs two to six hours after ingestion. Symptoms can last for weeks to years, and in some cases may lead to long-term disability.

Signs and symptoms can be highly variable, but typically include neurological or gastrointestinal manifestations; about 80 percent of patients showing varying degrees of impairment in both systems. The most common manifestations include:

- I **Gastrointestinal** symptoms such as abdominal pain and gastroenteritis, nausea, vomiting or diarrhea. These initial symptoms typically resolve without intervention within a few hours.
- I **Neurological** symptoms including paresthesia (tingling and numbness), ataxia (uncoordinated muscle movements) and vertigo. Severe cases may include cold allodynia (temperature reversal), a burning sensation upon contact with cold objects. Neurological symptoms may persist and are occasionally misdiagnosed as multiple sclerosis. In patients with a recent history of diving, muscular weakness and pain, these neurological symptoms can also be confounder for decompression illness.
- I **Skin itching** that can persist for weeks and worsen as a result of activities that increase skin temperature like exercise and alcohol consumption.

PREVENTION

- I Avoid consuming fish species commonly associated with ciguatera include barracuda, grouper, snapper, parrotfish, moray eels, triggerfish and amberjacks. Ciguatoxin is odorless, tasteless and heat-resistant—it will not taste different, and cooking will not prevent intoxication.
- I While the whole fish will contain toxins, the highest concentrations are typically found in the liver, intestines and gonads.

TREATMENT

There is no definitive treatment for ciguatera poisoning. Both first aid and hospital care is aimed at symptom control. If vomiting is profuse, it is important to correct possible dehydration. If you suspect ciguatera, you should seek a medical evaluation. There are many folk remedies, but the efficacy of these has not been studied. The best course of action is prevention through education and avoidance of seafood in endemic or suspected areas.

The term ciguatera is actually inaccurate. “Ciguatera” was coined by Don Antonio Parra in Cuba in 1787 to describe an indigestion following ingestion of a type of marine snail called “cigua” (Turbo pica). The term “cigua” was somehow transferred to an intoxication caused by the ingestion of coral reef fish.

SCOMBROID FISH POISONING



Scombroid fish poisoning is a foodborne illness that results from eating spoiled fish containing high amounts of histamine.

SOURCE OF INTOXICATION

There are many different species of fish that can be involved in scombroid poisoning, including mackerel, tuna, bonito, albacore, sardines, anchovies, mahi-mahi, amberjacks, marlin and herrings.

If scombroids are poorly refrigerated after being caught, the fish will begin to decompose, and bacteria from the fish's gastrointestinal tract will invade its flesh. Many fish contain a significant amount of an amino acid called histidine in their flesh. When decomposition begins, the bacteria from the gastrointestinal tract breaks histidine down into histamine (a small nitrogen compound involved in regulation of immune reactions and inflammatory responses). While ingestion of histidine is harmless, ingestion of large quantities of histamine can mimic an allergic reaction.

EPIDEMIOLOGY

In the United States and Europe, scombroid fish poisoning accounts for up to 40 percent of seafood-borne illness outbreaks. Between 1998 and 2002, there were 167 reported outbreaks in the United States affecting 703 persons with no fatalities. Scombroid fish poisoning can happen anywhere in the world where susceptible fish are harvested. This poisoning is more common when consuming fish caught recreationally or from small-scale operations; it rarely occurs in highly regulated fish harvests.

SIGNS AND SYMPTOMS

Ingestion of large quantities of histamine can mimic an allergic reaction. Symptom onset may range from minutes after consumption to up to two hours and typically resolves within 24 hours.

Symptoms may include:

- | Skin flushing
- | Oral burning
- | Nausea
- | Abdominal cramps
- | Diarrhea
- | Palpitations
- | Sweating

Signs may consist of:

- | Redness (diffuse erythema)
- | Elevated heart rate at rest (tachycardia)
- | Hypo- or hypertension
- | Wheezing (likely in individuals with a history of asthma, chronic obstructive pulmonary disease or reactive airway disease)

Due to its resemblance to an allergic reaction combined with poor knowledge of intoxication, scombroid fish poisoning is commonly misdiagnosed as a seafood allergy. Anyone showing signs and symptoms compatible with allergic reactions should seek an immediate medical evaluation as allergic and allergic-like reactions can be life threatening.

PREVENTION

- | Scombroid fish poisoning is entirely preventable by immediately storing fresh fish in coolers or ice containers away from direct sunlight. The Centers for Disease Control and Prevention (CDC) recommends temperatures below 40°F (4.4°C) at all points during the fish supply chain.
- | Affected fish may have a peppery taste, but normal taste does not guarantee safety.
- | Histamine is heat stable, so cooking does not prevent scombroid fish poisoning.

TREATMENT

As opposed to genuine allergic reactions, where the source of histamine is internal, treatment for scombroid fish poisoning does not require the use of corticosteroids or adrenaline (epinephrine). Instead, scombroid fish poisoning responds very well to oral antihistamines, typically showing positive results within 10 to 15 minutes.

Never assume oral antihistamines are enough to control a presumed scombroid fish poisoning on your own. Always seek for professional medical evaluation and let a medical doctor decide over treatment and best course of action.

RED TIDE & SHELLFISH POISONINGS



Red tide is a colloquial term for a specific phenomenon known as harmful algal bloom. Occasionally, large concentrations of aquatic microorganisms naturally bloom in coastal areas. The rapid accumulation of algal blossom can be significant enough to cause a green, red or brown discoloration of estuarine and freshwater environments.

Scientists discourage the term red tide, because these phenomena are unrelated to tidal water movements and may not necessarily be red in color or present any discoloration at all. Instead, when these algal blooms are associated with potentially harmful toxins, a more precise and favored terminology is harmful algal bloom (HAB).

NEGATIVE IMPACT ON ECOSYSTEMS

Among the involved microorganisms certain species of phytoplankton may be present, which can produce harmful natural toxins that can become concentrated in tissues of filter feeders like shellfish and other mollusks

and crustaceans. The whole food chain may be affected, and millions of fish may die as a result.

DANGER TO HUMANS

These toxins can affect commercial fisheries and represent a public health threat. People who consume contaminated shellfish may suffer a variety of shellfish poisonings, some of which are potentially lethal. Hazards related to HAB may not be limited to shellfish consumption, so avoid harvesting any type seafood on areas where HAB is known to have endemic outbreaks.

SHELLFISH POISONINGS

Shellfish are bivalve (two-part shells) mollusks that capture nutrients by filtering water. During this process, these filter feeders can accumulate toxins and other contaminants. When humans consume these bivalves, they may be poisoned. These toxins are water-soluble and heat- and acid-stable—they are unaltered by ordinary cooking methods. Shellfish poisonings are a group of four different syndromes caused by eating bivalve mollusks contaminated with toxins produced by microscopic algae.



SYNDROMES

There are four different types of shellfish poisonings that are primarily associated with mollusks such as mussels, clams, oysters and scallops.

PARALYTIC SHELLFISH POISONING (PSP)

These mollusks can accumulate a toxin called saxitoxin, which is produced by phytoplankton (dinoflagellates, diatoms and cyanobacteria). Some shellfish remain toxic for several weeks, while others can store the toxin for up to two years.

PSP blooms are associated with harmful algal blooms, which can occur in almost all oceans. PSP can be fatal, particularly in children. Symptoms can appear a few minutes after ingestion and include nausea, vomiting, diarrhea, abdominal cramps, numbness or burning around the mouth, gums, tongue and progressing to

the neck, arms, legs and toes. Other symptoms may include dry mouth, shortness of breath, slurred speech and loss of consciousness. Signs of toxicity and mortality are also seen in wild animals.

AMNESIC SHELLFISH POISONING (ASP)

This rare syndrome is caused by consuming shellfish contaminated with a toxin called domoic acid produced by certain marine diatoms.

Symptoms can appear 24 hours after ingestion of contaminated mollusks and may include nausea, vomiting, diarrhea, abdominal cramps and hemorrhagic gastritis. Neurological signs are severe and can take up to three days to develop. Neurological signs include dizziness, disorientation, visual disturbances, short-term memory loss, motor weakness, seizures, increased respiratory secretions and life-threatening dysrhythmias (irregular heartbeat). Death is rare. Resulting conditions due to permanent damage to the central nervous system may include short-term memory loss and peripheral neuropathy (weakness, numbness or pain as a result of nerve damage).

DIARRHEAL SHELLFISH POISONING (DSP)

Certain dinoflagellates produce a toxin known as okadaic acid that can cause a diarrheic syndrome. This toxin can damage the intestinal mucous membrane making it very permeable to water, which causes significant diarrhea as well as nausea, vomiting and abdominal cramps.

Symptoms can strike within a few minutes to an hour of ingesting contaminated shellfish and can last for about one day. No life-threatening symptoms have ever been recorded, but serious dehydration may occur.



NEUROTOXIC SHELLFISH POISONING (NSP)

NSP is caused by a toxin called brevetoxin, naturally produced by a dinoflagellate known as *Karenia brevis*. Brevetoxin can cause a variety of neurological symptoms very similar to ciguatera. NSP is generally not life threatening, but hospitalization is recommended until all other possible causes have been ruled out. In the United States and the Gulf of Mexico, a blossom of *Karenia brevis* usually causes the phenomena known as HAB.

PREVENTION

HABs occur throughout the world, killing millions of marine animals and affecting fisheries. Before harvesting your own seafood from coastal areas, research where HABs may occur and avoid consuming self-caught shellfish and fish from areas known to have HABs. Commercial fisheries tend to be safer than small scale artisanal harvesters.

The National Oceanic and Atmospheric Administration (NOAA) has a NOAA HAB (Red Tide) Watch page on Facebook. This system provides an operational forecast for harmful algal blooms. For those not on Facebook, NOAA's Tides & Currents portal also provides an Operational Forecast System for HABs.

The Florida Fish and Wildlife Conservation Commission offers an online resource with a current map of Red Tide counts in the state of Florida.

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APPENDIX

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Safety is a consequence of education.

Divers Alert Network encourages divers from all levels of certification to get first aid training so they are prepared to respond to diving injuries, including marine life injuries. The following chapter details some of the first aid techniques and treatments mentioned throughout the book including thermolysis, antivenoms and the pressure immobilization technique. However, it is important to emphasize that reading and understanding these materials is not a substitute for first aid training.

If you have not been formally trained, DAN highly recommends you find a qualified instructor. To find a First Aid for Hazardous Marine Life Injuries Instructor, visit DAN.org/Training/Directory.

THERMOLYSIS

Thermolysis describes the use of heat to break down substances (thermo meaning temperature, and lysis meaning breakdown or destruction). This is often accomplished by immersing the affected area in hot water.

Proteins are essential organic compounds that perform a vast array of functions within living organisms. Most life forms live in temperatures below 122°F (50°C). Above this temperature, their proteins will suffer an irreversible unfolding of their three-dimensional biomolecular structure. This process has damaging consequences to their function and is called protein denaturation.

Application of heat may denature venoms that are comprised of proteins, thus eliminating their effect or reducing their potency.

TECHNIQUE

The standard recommendations for toxin denaturation as a first aid measure call for immersing the affected area in hot freshwater with an upper limit of 113°F (45°C) for 30 to 90 minutes. This may work reasonably well when the toxin inoculation is skin deep, like a jellyfish sting, but will be less effective when toxins have been inoculated by means of deeper puncture wounds, as is the case of lionfish spines. Though quick reasoning could call for increasing the temperature, applying higher temperatures at skin level in an attempt to reach the desired temperature at a deeper level poses an unacceptable risk of burning the skin. In addition, vasodilatation caused by exposure to elevated temperatures may expedite the onset of absorption and of systemic effects.

Each case is unique and requires some estimation of the depth to which the venom was injected; for superficial inoculations, application of heat might be useful to manage pain and denature toxins, whereas for deeper inoculations, heat is for pain management only.

RISK CONSIDERATIONS

If you attempt to use thermolysis as a first aid measure, minimize the risk of local tissue damage to the injured diver by testing the water on yourself first on the same area that the diver is injured. Use the hottest temperatures you can tolerate and avoid scalding. Do not rely on the victim's assessment, as intense pain may impair his ability to evaluate temperature tolerability.

ANTIVENOM (ANTIVENIN, ANTIVENENE)



Antivenom is a biological product used in the treatment of venomous bites or stings (not to be confused with antidote). Though it is rare, recreational scuba divers might incur a venomous sting from certain marine life, such as stonefish or box jellyfish, necessitating the use of antivenom. Venomous bites, such as those from sea snakes, are even more uncommon.

WHAT IS ANTIVENOM?

Antivenoms are blood-derived biological products developed by injecting an animal—typically a horse, goat or sheep—with sublethal doses of venom. The animal will gradually develop antibodies against the venom, which can then be extracted from its blood as a serum to be administered to humans. Like most blood-derived products, antivenoms require an unbroken cold chain (proper refrigeration from production through storage until administration).

RISKS CONSIDERATIONS

Though generally not a concern for first responders, administering antivenoms is not free of risk. Intravenous administration of animal serums can cause anaphylactic shock in susceptible individuals.

WHAT ABOUT ANTIVENOM AUTOINJECTORS?

Occasionally, DAN is asked about autoinjectors for antivenoms. Conceptually, these antivenom autoinjectors would work similarly to the way epinephrine autoinjectors (like EpiPen®) work for intramuscular administration. Though it is certainly a compelling idea, antivenoms are much more complex blood-derived products than epinephrine. As such, they have a much shorter shelf life and require an unbroken cold chain. In addition, antivenoms are administered intravenously, a skill which is beyond first aid responders. These limiting factors make this idea relatively impractical for field operation.

PRESSURE IMMOBILIZATION TECHNIQUE

The pressure immobilization technique is a first aid skill intended to contain venom within the bitten area and prevent it from moving into central circulation, where the venom could affect vital organs. The technique consists of pressure to prevent lymphatic drainage and immobilization to prevent venous return (blood flow back to the heart) caused by the pumping action of skeletal muscle.



TECHNIQUE

Use an elastic bandage and splinting to administer proper pressure and immobilization. An inelastic cloth is not ideal as it is difficult to achieve optimal pressure.

- 1 Begin bandaging a few inches above the bite site (between the bite and the heart).
- 2 Wind the bandage around the limb with overlapping turns moving up the limb and then back down past the bite site.
- 3 The wrap should be tight enough to administer pressure, but you should still have normal feeling, color and a palpable pulse.
- 4 Use a splint or suitable substitute to immobilize the limb.
- 5 If possible, hold upper extremities with a sling.

DAN HEALTH & DIVING RESOURCES

HEALTH & DIVING REFERENCE BOOKLETS

Generated from more than 30 years of research and medical data analysis, each reference booklet provides extensive insight into a single topic critical to diver health and safety.

For more information about DAN's Health & Diving initiative, visit [DAN.org/Health](https://www.dan.org/Health).



THE EARS & DIVING:

Ear injuries are the leading cause of injury among scuba divers. Many of these injuries can be easily prevented. The Ears & Diving reference booklet examines the complex anatomy of the ear, proper equalization techniques, symptoms of injury, medical conditions and the importance of good aural hygiene in the preventative care and management of this vital organ.



THE HEART & DIVING:

Cardiovascular health is an essential component of scuba diving safety. However, heart health may deteriorate gradually as divers age and can put divers at risk. This booklet covers the basic concepts of normal heart functions in physical activities, physical fitness requirements of diving, how heart diseases may affect dive fitness and how divers can maintain their fitness capacity.



DECOMPRESSION SICKNESS:

Decompression sickness (DCS) is an unwanted outcome of diving. Measures to mitigate the risk of DCS have to be a part of every dive. This booklet provides updated concepts of causes and mechanisms, typical manifestations, standard management and prevention of DCS.



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