Aquatic Antagonists: Cubozoan Jellyfish (*Chironex fleckeri* and *Carukia barnesi*)

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Some of the most venomous creatures on earth belong to the class Cubozoa, commonly known as box jellyfish (Figure 1). There are a number of species within this class, most of medical and dermatological significance. Two species are of particular relevance to the dermatologist and intensivist: *Chironex fleckeri* and *Carukia barnesi*. *Chironex fleckeri*, also called the sea wasp, is a known cause of severe envenomations with more than 100 fatalities associated with its contact in Australia and Indo-Pacific waters. *Carukia barnesi*, the cause of Irukandji syndrome,[1] also is found in Australian waters. Other jellyfish including an addition to the class Cubozoa, *Malo kingi*,[2] and the hydrozoan *Physalia physalis* (Portuguese man-of-war) also have been implicated in Irukandji-like syndromes. Rapid diagnosis of envenomation caused by these organisms is key to decreasing the risk for morbidity and mortality.

Taxonomy

Cubozoans are comprised of 2 orders: Carybdeidae and Chirodropidae.[3] For the purpose of this article, the 2 orders are distinguished based on anatomical differences found at the level of the pedalia (stalks arising from the bell or body of the jellyfish) and the number of tentacles attached to each pedalium. Most of the species in the order Carybdeidae have one tentacle arising from each pedalium. *Carukia barnesi* is one example of a carybdeid jellyfish. Chirodropid jellyfish, on the other hand, have multiple tentacles arising from each complex pedalium. *Chironex fleckeri* is an example of a chirodropid jellyfish. The cubozoans (both carybdeids and chirodropids) also possess sense organs, including eyes known as ocelli. Ocelli can detect light and dark, including shadows. In the case of *C fleckeri*, the jellyfish will swim around objects, including humans, if given enough time.[3] It is unknown how information is processed, as these organisms do not have a brain. Statocysts, structures located below the eyes, are sense organs involved with spatial orientation, allowing cubozoans to determine their position in the water.[4]

Chironex fleckeri

Symptoms of Envenomation—*Chironex fleckeri* may possess up to 60 thick ribbonlike tentacles that are 3 m or more in length with a bell equal to or larger than an adult human head.[3] Contained within the tentacles are millions of nematocysts, each capable of injecting a microdose of venom on contact with human skin. These nematocysts penetrate the skin to the level of the papillary dermis where venom is deposited into the lymphatics. The firing nematocysts also may penetrate the microvasculature of the dermis, which explains the potential rapidity of symptoms associated with envenomation. A number of factors may aid in predicting the degree of envenomation, including the size of the animal and its tentacles, body surface area affected (hair-bearing skin affords some protection), number of firing nematocysts in contact with the skin, and the physiologic state of the jellyfish at the time of contact.[3]

Cutaneous Manifestations—Unfortunately *C fleckeri* is not easily visible in its natural surroundings and individuals who are stung, though accidental, rarely see the culprit. Stings usually occur on the legs, hands, and forearms, as *C fleckeri* are most often found in shallow water. In addition to stinging nematocysts, the tentacles also contain specialized nematocysts that attach to and pull the individual into further contact with the stinging cells. Once contact with human skin occurs, there is immediate

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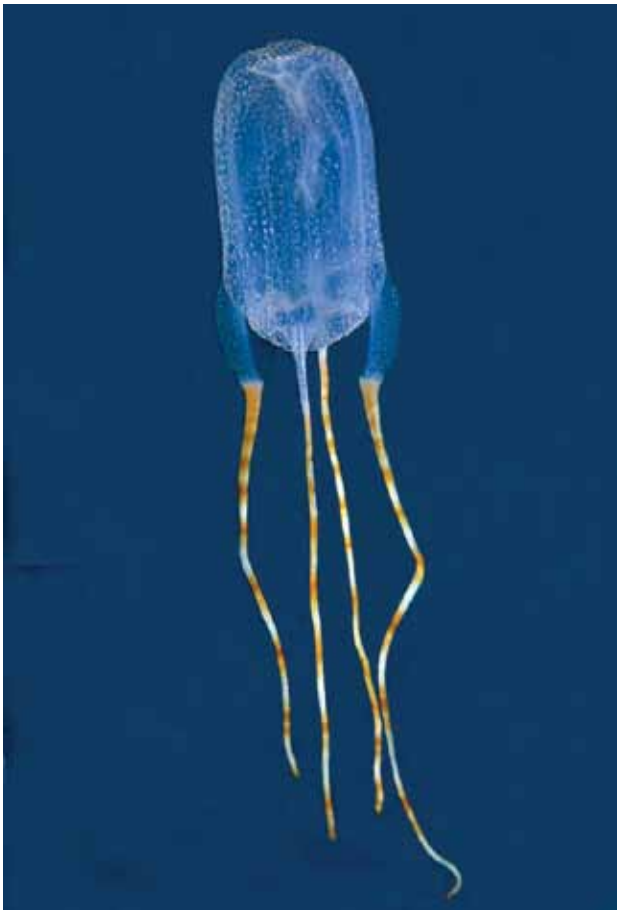

Figure 1. Recently discovered banded box jellyfish, Bonaire, Netherlands Antilles. Photograph courtesy of Ned DeLoach, Jacksonville, Florida.

excruciating stinging and burning pain, many times causing the individual to attempt to leap away from the organism. The individual also may try to remove the tentacles manually, increasing envenomation. However, in moderate to severe envenomations and in small children, the individual quickly may become incoherent and prostrate. This dramatic chain of events is due to the dermonecrotic, neurotoxic, and myotoxic properties of the venom. The venom also is cardiotoxic, causing an overload of intracellular calcium in cardiac myocytes.[5] Following contact, there is a rapid inflammatory response in the skin with whiplike erythematous lesions that can approach 10 mm in diameter. Erythema is quickly followed by surrounding edema and ischemic color changes progressing to a dusky red and violaceous hue. A characteristic sign of chirodropid stings, especially C *fleckeri*, is the development of white ischemic centers within the erythematous flares. This crosshatched or frosted ladder appearance is due to the architectural orientation of the stinging nematocysts and is reminiscent of the frost seen in deep chemical peels and their associated tissue necrosis. As previously mentioned, tentacles should be safely removed and examined for identification of the organism, as the nematocysts of various cubozoa[6] in addition to other jellyfish species have been categorized. Vesiculation, crusting, secondary infection, sloughing, and scarring are all potential cutaneous sequelae associated with C *fleckeri* stings. Unfortunately, with severe envenomations and their fatal outcomes, the inflammatory response usually does not progress to these later stages.

Other clinical findings in moderate to severe envenomations have included cardiac and respiratory complications. Animal studies with doses of higher concentrations of venom have elicited respiratory depression, cardiac contractile dysfunction, rhythm disturbances, conduction defects, hypotension and hypertension, and decreased coronary blood flow.

Treatment—As with all envenomations, avoidance of the offending agent is paramount. In Australia, safety nets are now in place at major public beaches to prevent jellyfish (including C *barnesi*) from entering such areas. Wet suits and stinger suits made of Lycra offer protection from the stinging nematocysts; although rare, stings of the face and neck have been reported. Once contact is made, it is imperative to remove the individual from the water and attempt to restrain excessive muscle movements, as muscle contraction speeds venom dissemination. As with any emergency, the patient needs to be assessed for a patent airway, respirations, and a pulse. Acetic acid in concentrations of 2% to 10% (household vinegar) should be doused over the tentacles for at least 30 seconds to inactivate any unfired nematocysts. The acetic acid, however, does not alleviate the pain of the sting. If available and in cases of extensive envenomation, severe unrelenting pain, or possible scarring, C *fleckeri* antivenom should be administered. The current recommended dose by the intravenous route is 1 ampule (20,000 U) for non–life-threatening stings to 3 ampules (60,000 U) for incapacitating or life-threatening injuries. Pain management also is imperative, as the writhing patient may rapidly decompensate. Depending on the conscious state of the patient, intravenous narcotic analgesics, anesthesia gas with 50% oxygen and 50% nitrous oxide, and cold packs may be used. Compression bandages remain a recommendation and topic of debate; although the bandages slow lymphatic drainage from the site of envenomation, they do not prevent microhematogenous circulation of the venom. Myotoxicity including cardiotoxicity may present as an arrhythmia, poor or undetectable blood pressure, and concomitant pulmonary edema.

Various pharmacologic agents including epinephrine, angiotensin-converting enzyme inhibitors, and calcium channel blockers have been used with some success, but further studies need to be performed prior to making specific recommendations.

Carukia barnesi

Symptoms of Envenomation—Unlike the large jellyfish C *fleckeri*, the Irukandji jellyfish now known as C *barnesi* is a small jellyfish with a bell approximately 2 cm in diameter (Figure 2).[7] It is a carybdeid species; therefore, it has one tentacle attached to each of the 4 pedalia. Similar to C *fleckeri*, this small jellyfish is difficult to see prior to envenomation. Stings due to C *fleckeri* usually occur in shallow water. In contrast, C *barnesi* envenomations usually occur in deeper water and present with stings on the torso. Stings have occurred at Australian beaches, most likely due to transport of the organism by storms or ocean currents. Anatomically, stinging nematocysts occur both on the bell and tentacles of this organism. A single tentacle usually is 3 to 5 cm in length in the contracted state but may reach up to 35 cm when extended.[3] One of the most important concepts to emphasize with C *barnesi* envenomation is the paucity of initial symptoms upon contact with the organism, which is in sharp contrast to the experience with C *fleckeri*.

Cutaneous Manifestations—While contact with C *fleckeri* results in immediate agony, contact with C *barnesi* may be felt as a quick sharp burning, mild tingling, or it may go unnoticed. The cutaneous manifestations also may be evanescent with urticarial linear patches that quickly fade away. If contact with nematocysts on the bell of the organism occurs, erythematous papules may be of longer duration and may aid in diagnosis. The delayed response to the sting is of major importance and is named *Irukandji syndrome*.

Irukandji Syndrome—The syndrome was named after the aboriginal tribe that lived in an area of Australia with a high concentration of reported stings.[3] In 1963, Jack Barnes, MD, captured and identified the C *barnesi* jellyfish and identified it as a cause of the syndrome. Through self-inflicted envenomation, he experienced firsthand the full effects of the venom. Three patterns of symptoms have been reported: pain, catecholaminelike effects, and cardiopulmonary decompensation (Table).[3] It is especially important to distinguish these symptoms of Irukandji syndrome, as the condition may mimic decompression sickness. The delay in symptoms from the time of the sting to the onset of the syndrome may range from 5 to 50 minutes; therefore, it is important for the individual to immediately leave the water after initial envenomation. Bathers and divers must be discouraged from reentering the water if there is a possibility of a sting by C *barnesi*. In addition, numerous other jellyfish species and the hydrozoa *P physalis* have been implicated in causing Irukandji-like syndromes. Once identified, first aid for the sting is similar to C *fleckeri* stings: douse the affected area with vinegar water, avoid excessive muscle movements, and issue pain relief. The patient should be immediately transported to the hospital for further medical management of the systemic effects of the venom. For instance, hypertension due to excessive catecholamine effects may be treated with phentolamine hydrochloride, an adrenergic (α-receptor) blocking agent. Associated

Figure 2. *Carukia barnesi.* Each pedalium gives rise to only one tentacle. Photograph © Lisa-ann Gershwin, PhD, Australian Marine Stinger Advisory Services, Townsville.

Systemic Manifestations of Irukandji Syndrome

Pain

Lower back/sacral boring type

Limb, abdominal, chest wall: may mimic myocardial infarction or acute abdomen

May come in waves

Incapacitating frontal or global headache

Catecholaminelike Effects

Sweating: localized or extensive

Piloerection

Anxiety, feeling of impending doom

Restlessness

Headache

Nausea, vomiting

Hyperventilation

Tremor

Pallor/cyanosis

Oliguria

Tachycardia

Hypertension

Cerebral edema

Cardiopulmonary Insult

Acute pulmonary edema

Cardiac dilation

Arrhythmias

Data from Burnett et al.[3]

tremor, anxiety, and sweating also may respond to this treatment. Other treatment modalities of possible benefit include nifedipine, calcium channel blockers, and chlorpromazine. Pulmonary edema, if evident, is treated in the acute care setting.

Conclusion

Although C *fleckeri* and C *barnesi* are isolated to areas of Australia and Indo-Pacific regions, chirodropid and carybdeid stings with similar envenomations may occur elsewhere, as many of the world's oceans are populated by similar creatures. It is important to attempt to identify the organism involved and initiate immediate care of the patient prior to transport to the hospital. In the case of C *fleckeri* and C *barnesi* stings, this approach may be lifesaving. It also is important to identify the Irukandji and Irukandji-like syndromes, especially noting the delayed effect of the C *barnesi* venom.

REFERENCES

1. Angelini G, Bonamonte D. Dermatitis caused by coelenterates. In: Angelini G, Bonamonte D. *Aquatic Dermatology*. Milano, Italia: Springer Verlag Italia; 2002:13-58.
2. Gershwin L-A. *Malo kingi*: a new species of Irukandji jellyfish (Cnidaria: Cubozoa: Carybdeida), possibly lethal to humans, from Queensland, Australia. *Zootaxa*. 2007;1659:55-68.
3. Burnett J, Currie B, Fenner P, et al. Cubozoans (box jellyfish). In: Williamson JA, Fenner PJ, Burnett JW, et al, eds. *Venomous and Poisonous Marine Animals: A Medical and Biological Handbook*. Sydney, Australia: University of New South Wales Press; 1996:236-283.
4. Cubozoa: more on morphology. University of California Museum of Paleontology Web site. http://www.ucmp.berkeley.edu/cnidaria/cubozoamm.html. Accessed June 9, 2008.
5. Izbister GK. Marine envenomation and poisoning. In: Dart RC, ed. *Medical Toxicology*. Philadelphia, PA: Lippincott, Williams and Wilkins; 2004:1621-1644.
6. Yanagihara AA, Kuroiwa JM, Oliver LM, et al. Ultrastructure of a novel eurytele nematocyst of Carybdea alata Reynaud (Cubozoa, Cnidaria). *Cell Tissue Res*. 2002;308:307-318.
7. Dangers on the reef: Irukandji (*Carukia barnesi*). Great Barrier Reef Web site. http://www.barrierreefaustralia.com/the-great-barrier-reef/irukandji.htm. Accessed June 10, 2008.