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Cnidarians and human skin

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ABSTRACT: Cnidarians are aquatic animals including the jellyfish, the Portuguese man-of-war, fire coral, hydroids, sea anemones, and coral. Many of these can harm human skin and rarely some envenomations can lead to a serious or even fatal outcome. This article discusses the varied creatures in this group that can harm man and potentially lead to serious envenomation syndromes. Treatment of cnidarian injuries and stings is discussed.

KEYWORDS: bites and stings, Cnidaria, cnidarian venom, jellyfish, sea anemones.

The phylum Cnidaria is comprised of more than 9000 invertebrate species, and at least 100 are known to be dangerous to humans (1–4). The Cnidaria are further subdivided into three classes: Scyphozoa (true jellyfish), Hydrozoa (Portuguese man-of-war, fire coral, hydroids), and Anthozoa (sea anemones, true corals). The phylum Ctenophora are the comb jellyfish, which do not sting but may concern bathers. Formerly the Cnidaria and Ctenophora were collectively known as the phylum Coelenterata, but today they are each regarded as separate phyla (5).

The word cnidaria means "stinging thread" (2), and this refers to the venom tube that is part of the stinging cell, known as a nematocyst (Fig. 1), which is found in many species within this group. The nematocysts are usually located near the mouth or on the tentacles of the cnidarian (6), and function both in envenomation of and adherence to the target tissue (7). Consisting of a collagenous capsule containing an eversible, "spring-loaded" tubule capped by a harpoon-like blade at the distal end of the tubule, and a venom sac within the cell at the proximal end, the nematocyst "fires" either due to a change in ambient osmolarity or via pressure against a cellular trigger known as a cnidocil. Discharge of the cell occurs extremely rapidly, and as the operculum of the cell opens, the harpoonlike blade is forced into the target tissue (into the dermis in humans) (8) and contracture of the venom sac forces venom into the victim via the venom tube. The venom tube has numerous recurved teeth that anchor it in place, explaining the adherent properties of cnidarian tentacles to human skin. Along each tentacle, small grossly visible "dots" are known as "batteries" (Fig. 2) and each contains numerous nematocysts (9).

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Scyphozoa (true jellyfish)

True jellyfish have a dome that varies from bell- to plate-shaped which contracts, producing motility through the water. Various numbers of tentacles containing nematocysts hang from the dome. Mouthparts extend from under the dome and are used to feed on fish and other small animals. While some scyphozoa do not harm man, some are toxic and rarely may cause a fatal envenomation.

The box jellyfish, also known as "sea wasps," are in the subclass Cubomedusae, and are so named because of their cuboidal dome with one or more tentacles hanging from each of the four corners of its base (10). The most severe of all jellyfish stings comes from the box jellyfish, *Chironex fleckeri*. This jellyfish is found in the Indo-Pacific waters of Indonesia, Malaysia, the Philippines, Bougainville Island, the Solomon Islands, the Maldive Islands, and Papua-New

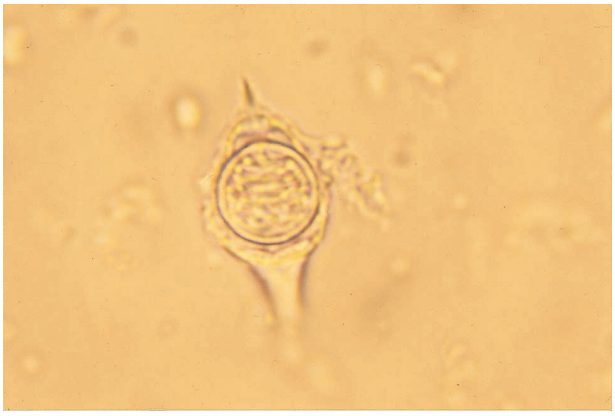

Fig. 1. A micrograph of a stinging cell (or nematocyst) from a Portuguese man-of-war (original magnification 400×).

Guinea. It is especially common in the more northern latitudes of Australian coastal waters (generally above the Tropic of Capricorn) (11–14). There have been 63 confirmed deaths caused by this jellyfish in Australia alone between 1884 and 1994 (14), although this number is likely much higher due to underreporting. *C. fleckeri* venom has hemolytic, dermatonecrotic, cardiomyotoxic, and neurotoxic components (12,15,16). Following envenomation, there is usually extreme pain, with bright red wheal formation which exhibits a characteristic "cross-hatched" or "frosted ladder" appearance. Death may occur within 4–5 minutes, usually due to cardiopulmonary arrest. To confirm a *C. fleckeri* envenomation, removing nematocysts from the skin by scalpel blade scraping or sticky tape and then examining microscopically can be useful (17). While anaphylaxis due to *C. fleckeri* has not been reported, pruritic delayed hypersensitivity (type IV, cell-mediated) reactions have been reported (12).

Envenomations have also been reported due to a variety of other cubomedusae. Severe stings leading to death have also been reported from *Chiropsalmus quadrigatus* (Indo-Pacific) and *Chiropsalmus quadrumanus* (Galveston, TX) (12,18). Other cubomedusae capable of stinging include *Carybdea alata* (tropical worldwide), *Carybdea rastoni* ("jimble"; Atlantic and Indo-Pacific), *Chiropsoides buitendijki* (Indo-Pacific), *Chirodropus* spp. (South and West Africa), *Carybdea sivickisi* (western Pacific), *Tamoya haplonema* (western Atlantic, Caribbean), *Carybdea marsupialis* (Caribbean, West Africa, Mediterranean and Adriatic Seas), *Morbakka* (eastern Australia), and the Darwin carybdeid (western Australia) (12,18–21).

The small (1–2 cm bell) cubomedusa, *Carukia barnesi*, has a single tentacle at each corner of a cuboidal base and is the first jellyfish to be linked with the Irukandji syndrome. Named after a group of Aborigines living in northeast Queensland, Australia, where the jellyfish occurs, the syndrome usually begins in 5–50 minutes (average 30 minutes) after a sting (12). Severe lower back pain progressing to generalized myalgia, abdominal pain, nausea, vomiting, headache, hyperhidrosis, oliguria, tremors, hypertension, tachycardia, respiratory difficulty, restlessness, piloerection, priapism, severe weakness, malaise, and collapse may occur (12,22,23). Toxic heart failure and pulmonary edema also have been reported (24,25), but there have been no reported fatalities. Symptoms usually abate in 6–48 hours (22,23).

The lion's mane jellyfish (winter jellyfish or hair jellyfish), *Cyanea capillata*, is found worldwide from the Arctic to the Antarctic (18). Although more plentiful in tropical and temperate regions, they are much smaller (15–20 cm across the bell) and cause a milder sting. In Arctic and Antarctic areas, it can reach a size of 2 m in diameter with tentacles 30 m in length, and is the largest jellyfish known (20). With up to 800–1000 tentacles (26,27) arising from eight clusters beneath its flat dome, the lion's mane jellyfish has the appearance of a "mop under a dinner plate." While implicated in the death of a man in Sherlock Holmes', *The Adventure of the Lion's Mane*, by Sir Arthur Conan Doyle, no deaths due to *C. capillata* have been reported.

The sea nettle, *Chrysaora quinquecirrha* (Fig. 3), is a very common jellyfish that can deliver a potent sting (Fig. 4) in areas other than thick-

Fig. 2. Numerous "dots" seen along the tentacles of this sea anemone are called "batteries" and are made up of numerous nematocyst stinging cells.

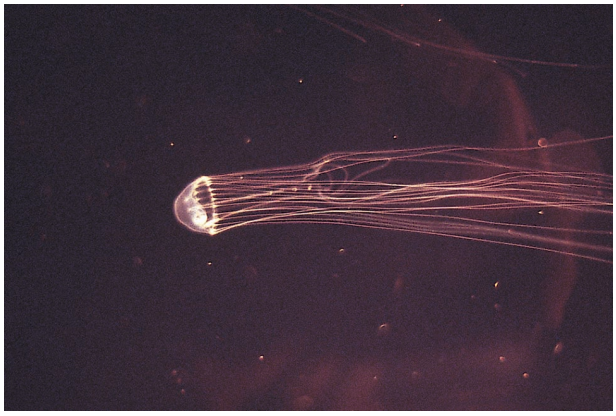

Fig. 3. The sea nettle, *Chrysaora quinquecirrha*, is a common stinging jellyfish of the Atlantic coast of the United States.

skinned areas such as the palms and soles (28). Most are 15 cm in diameter or less. The sting is felt immediately and linear wheals occur within a few minutes, and usually disappear within 1 hour.

On the west coast of North America, another sea nettle (also known as the brown jellyfish), *Chrysaora melanaster*, is a common pelagic stinging jellyfish. Although this jellyfish can deliver a potent sting, it generally occurs in largest numbers in the winter when swimmers and surfers are in wet suits, which are protective. The bell can reach 30 cm in diameter (29). Other stinging nettles include *Chrysaora hysoscella* (Mediterranean and Adriatic Seas, and Ireland) and *Chrysaora lactea* (South America) (27).

The oceanic, warty or "mauve stinger" jellyfish, *Pelagia noctiluca*, is as the Latin name implies, a pelagic offshore jellyfish that bioluminesces in the dark when disturbed. Related stinging jellyfish are the little brown stinger, *Pelagia flaveola*, and the purple striped jelly, *Pelagia colorata* (Fig. 5). The appearance of these jellyfish is similar to the stinging nettle except it has fewer tentacles (eight usually) and is somewhat smaller in diameter (13 cm). It varies in color, but often has a purple coloration. Warty lesions on the external dome of *P. noctiluca* are batteries of nematocysts capable of stinging, and the tentacles also can sting. The distribution is worldwide, but it is usually found in warm and temperate ocean waters as well as in the Mediterranean, Adriatic, and North Seas (21,27,30). While the sting from this jellyfish is somewhat less than of a sea nettle, it has also been shown to produce cutaneous pigmentation (31), anaphylaxis (32), and Guillain-Barré syndrome (30).

Some of the jellyfish in the order Rhizostomeae (rhizostomes) can also sting. Especially severe stings from *Stomolophus nomurai* in the Orient have led to pulmonary edema and death (14,27). In Indo-Pacific regions, species of *Acromitus* and

Fig. 4. A painful urticarial-like reaction to an acute sting from the sea nettle, *Chrysaora quinquecirrha*.

Fig. 5. The purple striped jellyfish (*Pelagia colorata*) is an offshore, pelagic jelly that can sting.

Sandaria can also cause severe stings. Other stinging jellyfish include the stinging cauliflower (*Drymonema dalmatinum*), the upside-down jellyfish (*Cassiopea* spp.), and the marbled jellyfish (*Lychnorhiza* spp.). Other rhizostome jellyfish such as the blubber jelly (*Catostylus* spp.), mushroom jelly (*Rhopilema verrilli*), jellyball or cannonball jellyfish (*Stomolophus meleagris*), *Lobonema* spp., and *Phyllorhiza* spp. are nonstinging for much of their life cycle, although mild and rarely significant stings have been reported (3,10,27,33–35).

The Indo-Pacific medusa, *Sandaria malayensis*, can also give a potent sting (27). Moon jellyfish (*Aurelia* spp.) have a flat bell, short fringe tentacles, and a central "four-leafed clover" appearance of its reproductive structures. These jellyfish can inflict a very mild sting in thin-skinned areas. The small thimble jellyfish, *Linuche unguiculata*, can give a minimal nuisance sting and is found in the tropical oceans. The polyp form of *Nausithoë* can also sting when contacting sponges that harbor these jellyfish in their pores (27).

Hydrozoa (Portuguese man-of-war, fire coral, hydroids)

Physalia physalis, the Atlantic Portuguese man-of-war (Fig. 6), and the smaller *Physalia utriculus* have blue gas-filled pneumatophores (hence the other common name, bluebottle). In Portugal, they are called "caravellas," a name from their likeness to the fast Portuguese man-of-war fighting ships of the 16th and 17th centuries. Unlike the motile scyphozoans, the man-of-war relies on currents as well as a wind-powered "sail" atop its float to propel it. While the Pacific bluebottle has only a single tentacle, the larger Atlantic man-of-war has numerous tentacles which, in a large specimen, can be 30 m long and each have more than 750,000 stinging cells (6). Unlike many other cnidarian nematocysts, the man-of-war stinging cells can penetrate surgical gloves (35,36).

Fig. 6. The Atlantic Portuguese man-of-war (*Physalia physalis*) is a potent stinger, and rare fatalities have been reported.

The stings from man-of-war envenomation are often quite severe, with progression to vesiculation, hemorrhagic bullae, and in extensive envenomations, systemic reactions may be seen, including muscle spasms, paresthesia, nausea, vomiting, dyspnea, lymphadenopathy, chills, syncope, convulsions, and in rare instances, death (18,27,37–40). Whether death is due to the anaphylaxis (41), envenomation, or simply panic due to drowning is controversial.

Another siphonophore that is related to the man-of-war is the by-the-wind sailor, *Velella velella*. This blue floating cnidarian has a small sail atop its oval float, which is surrounded by small short tentacles. It may produce a mild papulourticarial painful or pruritic eruption in thin-skinned areas (42). Other hydrozoan jellyfish which can produce severe envenomations with vesiculation include the *Gonionemus* spp. (Japan, eastern Russia, wide distribution in northern hemisphere oceans) and *Olindias* spp. (southern hemisphere oceans) (27,43).

Other stinging hydrozoans include the red-spotted siphonophore (*Forskalia edwardsi*), paired-bell siphonophore (*Agalma okeni*), and the floating siphonophore (*Rhizophysa* spp.) (10).

Fire corals (order Milliporina) are hydrocorals that have hard calcareous skeletons covered with numerous gastropores (thus *"Millepora"* spp.) through which short tentacles extend. These tentacles contain batteries of nematocysts (18, 44). Fire coral ranges in color from tan-yellow to yellow-orange and the tips or fringes are much paler. Contact with the various species of fire coral throughout the world results in a mild to severe stinging sensation that is usually short lived but may rarely lead to vesiculation and necrosis. Severe pruritus and urticaria have also been reported (45).

Hydroids (order Hydroida) are delicate feathery plantlike animals. Some species contain stinging cells that can penetrate the skin of man. A swimmer feeling a "splash of grease" sensation across a bare chest while lifting himself onto a dock has likely encountered stinging hydroids just below the waterline attached to the dock. A

pruritic urticarial rash will usually follow the sting and generally fades quickly, but can last up to a week (27).

Anthozoa (sea anemones, true corals)

Sea anemones (Fig. 7) are like inverted sessile benthic jellyfish which have numerous tentacles extending from a disc-like base at the foot. Anemones are generally 1.5–10 cm in length and 1–5 cm in diameter, but in some species may exceed 1 m in diameter (46). The tentacles of anemones vary in color, shape, length, diameter, and number. They contain batteries of nematocysts, which in some species can penetrate human skin.

Sea anemone stings can range from mild to very severe. Pain is usually immediate, but may be delayed by 30–60 minutes. Erythema and wheal formation usually occur, sometimes with vesiculation and eventual necrosis and ulceration (27). Even very small anemones may be highly toxic. The turtle grass anemone (*Viatrix globulifera*) has a disc size of only about 1 cm and is found attached to blades of turtle grass. It can cause a very painful eruption (occasionally with blistering) and paresthesia which may last days (Fig. 8). Cases of mononeuritis multiplex (47), kidney failure (48), and fulminant hepatic failure (49,50) have been reported secondary to sea anemone envenomations.

Sponge diver's dermatitis is actually caused by sea anemones (*Actinia* or *Sagartia* spp.) that occur at the base of sponges (22). Following the sting, systemic complaints are common, including nausea, vomiting, fever, chills, headache, and muscle cramps (42). Larvae from anemones can cause stinging sensations while swimming and this (along with numerous other causes) is termed "seabather's eruption" or "sea lice." Larvae from *Edwardsiella lineata* has been specifically implicated (51).

Fig. 7. The ringed sea anemone (*Bartholomea annulata*) can sting where skin is thin.

Fig. 8. A small but very painful sting due to the turtle grass sea anemone (*Viatrix globulifera*).

True (or stony) corals are made up of many polyps that secrete calcium carbonate which forms the hard coral reef structure. Skin problems related to these hard corals are generally from cuts/lacerations from stepping on or handling coral or more serious injuries from being swept against a reef by wave action. In injuries where the calcium carbonate contaminates a wound, a foreign body reaction with granuloma formation is commonly seen. In coral cuts/lacerations, it is well known that these injuries are slow to heal and prone to ulceration and secondary infection. The tentacles of coral polyps contain nematocysts and, while their venom tubes are not long enough to penetrate human skin, the toxins released in coral injuries may be responsible for the slow healing process that is commonly seen. The term "coral reef granuloma" or "coral reef scar" is actually an uncommon low-grade staphylococcal pyoderma usually on the extremities and has nothing to do with coral or reefs.

Phylum Ctenophora

As mentioned above, the phylum Coelenterata included both phylum Cnidaria and the now separate phylum Ctenophora. The Ctenophora are comprised of the comb jellyfish, the venus girdle, and the sea gooseberry. None in this phylum have nematocysts and therefore cannot sting, and all are safely handled. Many are bioluminescent (52).

Treatment of cnidarian stings and injuries

First aid treatment of any cnidarian sting or injury requires both an accurate diagnosis of the disorder as well as, when possible, a correct identification of the species contacted (34). In addition, ensuring the safety of the rescuer and then getting the victim out of the water is important in assessing the severity of the problem.

For the rare case of anaphylaxis, cardiopulmonary support, oxygen, bronchodilators, systemic corticosteroids, and epinephrine are utilized if available and the victim is then moved to a medical facility (53). For severe and potentially life-threatening stings from the box jellyfish (*C. fleckeri*) or the Portuguese man-of-war (*P. physalis*), cardiopulmonary resuscitation may also be needed. The nematocysts on the tentacles of these jellyfish can be fixed by pouring vinegar (or 2–10% acetic acid) for at least 30 seconds to prevent further nematocyst discharge and envenomation (14,54–56). If vinegar is unavailable, Coca Cola or wine may have at least some effect on nematocyst inhibition in box jellyfish (57). However, recent work (58) studying *P. physalis* (multitentacled) in Pacific waters showed that vinegar may actually cause discharge of nematocysts with this particular man-of-war, so treatment here remains controversial (27).

For stings from the sea nettle (*C. quinquecirrha*), application of a baking soda slurry has been shown to be effective in preventing nematocyst discharge (59). Other first aid measures for jellyfish stings have been advocated, including urinating on tentacles, use of papain-containing meat tenderizer, aluminum sulfate, alcohol, sodium hypochlorite bleach, ammonia, or gasoline/kerosene, and rubbing sand on the involved area. None of these have proven to be helpful, and some may be harmful (27,28,54–60). Freshwater should never be used to flush or wash the involved area, as a change in osmotic pressure can cause a massive discharge of nematocysts, causing a more serious envenomation and, in the case of the more serious stingers, shock and death. Ambient seawater can be used if needed.

Jellyfish tentacles can be removed from involved areas using a credit card, knife blade, towel, or palmar skin if nothing else is available. In serious stings, pressure immobilization bandages should be applied proximally to distally to obstruct lymphatic spread of the venom, although use of this remains controversial (61–64).

At the medical center, *C. fleckeri* antivenom (Commonwealth Serum Laboratories, Melbourne) should be administered if the sting was due to a box jellyfish. While there does not appear to be cross-protection against the venom of *C. quadrigatus*, current recommendations include the use of *C. fleckeri* antivenom in envenomations from the *C. quadrigatus* species (14). This is a sheep-derived antivenom and systemic reactions are rare (12). Verapamil has been shown to delay death in an animal model (65). No other antivenoms are currently available for any other cnidarian species.

Observation for the development of Irukandji syndrome is also important when in endemic areas, usually following the sting of a small carybdeid jellyfish. Pain relief can be obtained with morphine or pethidine, and phentolamine is used to reverse the catecholamine effects (66).

Most mild jellyfish stings require only observation and symptomatic care, and most reactions will subside quickly. Cold or ice packs have been shown to assist in pain control, even in more substantial stings due to *Physalia* (67).

Stings due to fire coral, hydroids, or sea anemones are also treated by flushing with ambient seawater, followed by an application of vinegar. Pain control can be obtained with ice packs, analgesics, or menthol-containing lotions.

Coral cut injuries (Fig. 9) should be scrubbed gently using a soft bristle brush and freshwater containing a nonirritating antiseptic (27). If there is concern about coral in the wound, radiographic examination may be helpful. Involvement of deep structures may require surgical consultation. Delaying exploration and cleansing of coral lacerations can lead to prolongation of healing and

Fig. 9. A coral cut injury caused by stepping on sharp coral.

Fig. 10. A delayed reaction to the sting of a sea nettle (*Chrysaora quinquecirrha*). The patient presented with a papular eruption reactivating at the sting site 10 days after the initial sting and complained of severe pruritus.

increased risk of secondary infection. As with all cnidarian stings and injuries, there should be strict attention to tetanus immunization protocols.

Delayed reactions to cnidarian stings are not uncommon and usually occur 2–14 days (average approximately 1 week) following a sting injury (Fig. 10). Unlike the acute painful sting, these reactions (which arise as a papular or papulonodular eruption at the site of the original sting) itch severely and take weeks to subside, suggesting a cell-mediated type IV hypersensitivity phenomenon (68–72). If a stung patient is reexposed and stung again by another similar cnidarian within several months, the previous sting sites may "reactivate" and be severely pruritic. Unlike the acute stinging injury from a cnidarian, pruritic delayed eruptions should be treated with topical or systemic corticosteroids as well as the usual antipruritics.

Conclusion

The phylum Cnidaria has many marine creatures that can harm man—some of them fatally. Common sense and avoidance are the mainstays of prevention. Wet suits and swim-skins as well as goggles are protective against most of these stingers. Protective skin barrier creams have been developed recently, but their use must currently be viewed as anecdotal, and one product notes that it has not been tested against box jellyfish or man-of-war stings.

When an envenomated victim presents to the physician, a knowledge of the various cnidarian species, as well as the expectations of the characteristic envenomation syndrome can enable the physician to provide proper medical care or just simply reassurance.

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