BIOL3040 Marine Systems

Box Jellyfish
Cubozoa

Presentations by Students in BIOL 3040 Marine Systems

Basic Information:

Cubomedusae/Cubazoa
Common Name: Box Jellyfish

Cubazoa are the smallest class of the family Cnidaria.

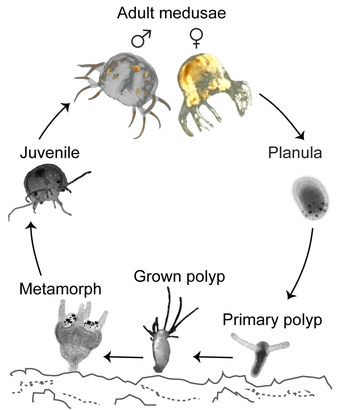
There are 50 defined species of box jellyfish.

They have many unique features, such as their swimming, advanced vision, and mating.

Box Jellyfish are unique in that their primary habitats are mangrove roots and kelp forests.

Within these dangerous habitats, box jellyfish are able to use their advanced vision to help navigate obstacles and dodge any danger

Life Cycle



Box Jellyfish have a complex life cycle. It takes around 3 months for them to reach sexual maturity. At this point, they can undergo internal fertilization.

Box Jellyfish Species in This Study:

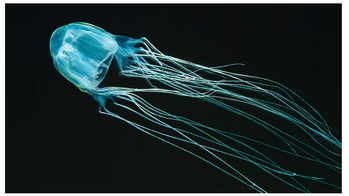
Tripedalia cystophora
(Caribbean Species)

Chiropsalmus
(Australian Species)

Box Jellyfish swimming is unique because it closely resembles that of a fish. They are considered "directional swimmers" and have the capability to turn 180 degrees very quickly.

The ability to swim and make sharp turns quickly helps them navigate their unique environments and avoid prey. It has been demonstrated in a laboratory setting and proved that they are visually guided.

Box Jellyfish are well known for many reasons, one of them being their toxicity. This varies between species, with some of them being completely harmless and others causing death within minutes



The well-known *Chironex fleckeri*, or Australian Box Jellyfish, is considered the deadliest jellyfish known to man.

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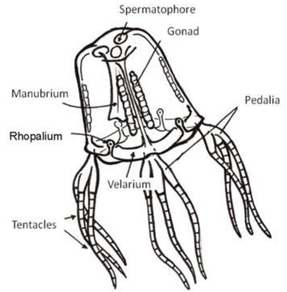
Anatomy of a Cubozoan

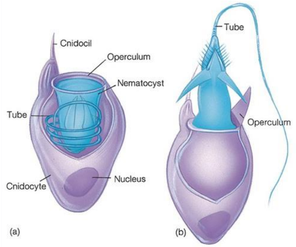


The manubrium Is a trunk like appendage of the jellyfish, with the mouth being at the end of this appendage

The verarium is a thin sheet of muscular tissue that forms the opening of the bell and helps the jellyfish steer depending on the shape.

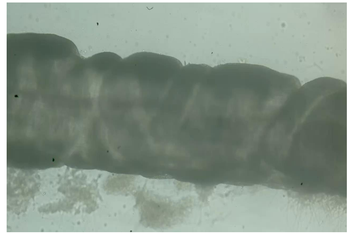
Pedalia are. The fleshy pads in which the tentacles are connected to the bell of the animal

Much like most Cnidarians, Cubozoa have specialized cells in their tentacles called nematocyst. They fire off a barb which is triggered by a hair like structure on the nematocyst, this is what causes you to feel the stinging when you get stung by a jellyfish. You feel this sensation because these barbs also inject venom into your skin an can be the quite uncomfortable experience



These specialized cells are used for hunting and even as a protection against other predators which might wish to fed on these creatures. They are commonly found in a ring formation on the tentacles and in some cases can even be found on the bell of some species of cubozoa

Real time reaction



Slowed down reaction time

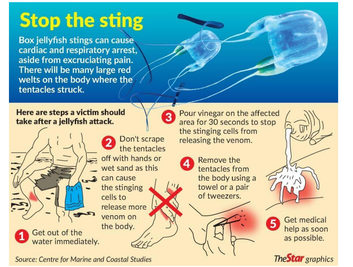
Affects of being stung

There can be varying side affects caused by the venom of the cubozoa ranging across species. The most severe stings seem to be found within the groups of *Chironex* and *Chiropsalmus*, with most cases leading to severe pain followed by even cardiac death. Other species have a sting which pain can be felt for up to hours after exposure. These stings can leave lesions and dark marks and cause effects such as coughing, nausea, vomiting, abdominal colic, diarrhea along with a variety of other sever affects

Treatment

The first step in treating these stings is to deactivate the nematocyst which can still be triggered after being detached from the jellyfish though it should be noted if left over time the stings will decrease in severity. In the case of being stung by a box jellyfish it is vital that antivenin be administered in the most severe cases. The jellyfish is not needed foridentification as the nematocyst on the skin can be sent off for testing. It is best to keep patients from moving too much to help slow the spread of venom. Nematocyst should not be rinsed off with fresh water and should be rinsed with a saline solution to prevent deactivation of nematocyst. To help with deactivation patients can use vinegar

Here are two examples of how the affected areas of box jellyfish stings can present themselves. These two are more mild cases with some being even more sever with the area swelling and even in some cases forming whelps and boils. In the worse cases the affected area can start to go necrotic. Wounds don't typically leave scarring but can. Reactions can vary from patient to patient., and can be prevented by wearing special wet suits



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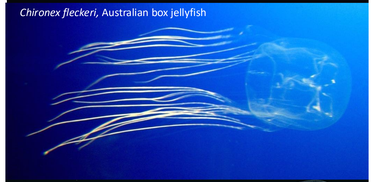
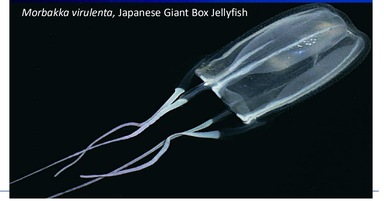
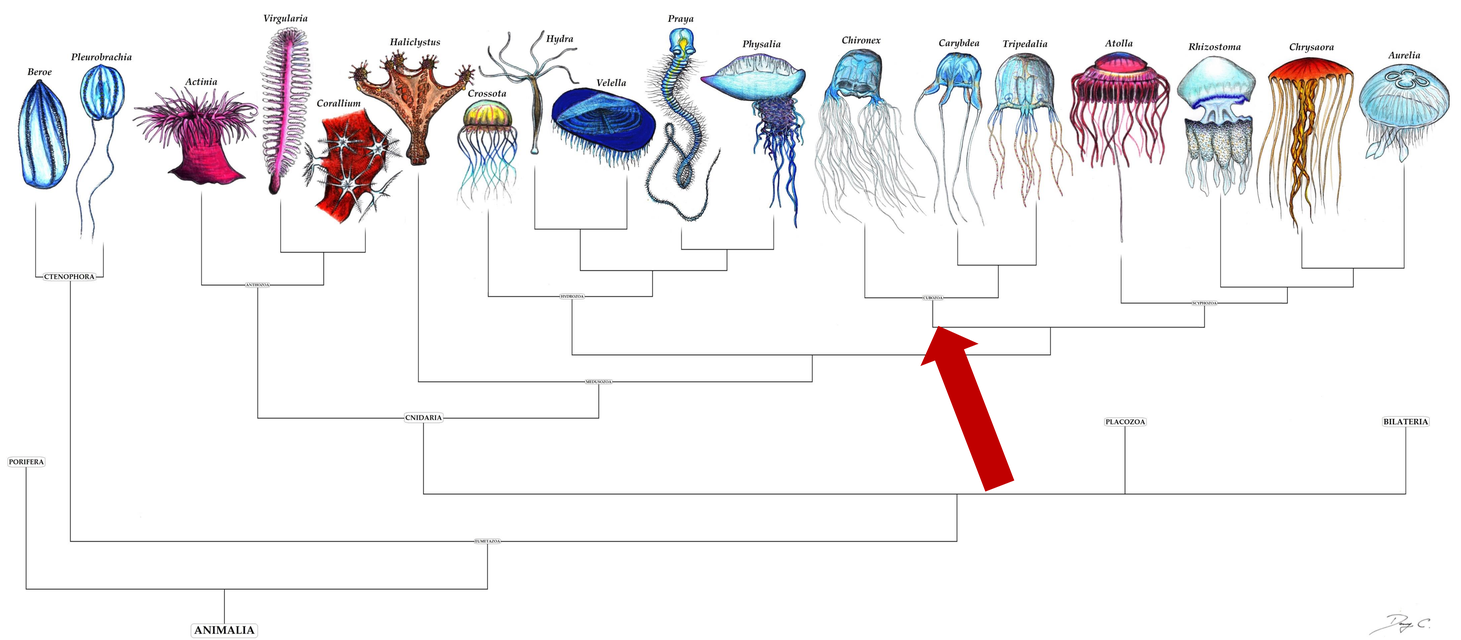
Phylogeny

The three orders of cubozoan are *Chirodropidae, Carybdeidae, and Tripedalia.* Carybdeids have each tentacle attached to their own pedalium . Chirodropids have four pedalia with multiple tentacles on each. Tripedalians have two to three tentacles on a pedalium.

Initially, cubozoans were considered a subgroup of *Scyphozoa*, or the true jellyfish. But distinctions in the polyp formation between cubozoans and the scyphozoa class lead to cubozoans being in their own class.







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The eyes of a cubozoan are in the rhophalia. Rhophalia are sense organs attached to the main body by stalks and are weighed down by a statolith. The statolith function is not known, but it is theorized to keep the eyes oriented correctly despite their body orientation. Each rhopalium has 6 eyes: Two lens eyes (upper and lower), an identical pair of slit eyes, and a pair of pit eyes. Each side of the bell of the cubozoa has a rhophalia, leading to 4 rhophalia being present. Each rhophalia has 6 eyes. In total, a box jellyfish has 24 eyes.

Lens (Complex) Eyes

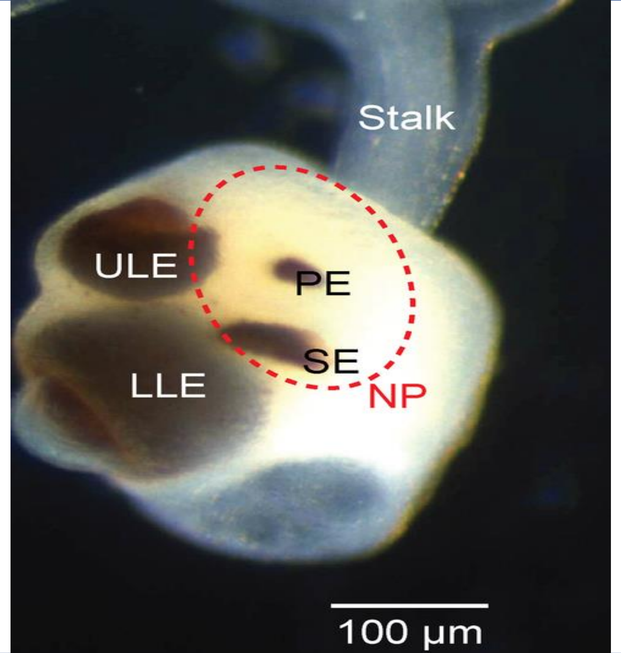
The lens morphology is similar to the camera-type eyes found in cephalopods and vertebrates. They are composed of a hemispherical retina, a cornea, and a graded refractive index optical fiber.

ULE: Upper Lens

The upper lens is used to see landmarks above the surface of the water for better navigation. The rhophalia are always oriented to where the upper lens eyes are looking upward despite the positioning of the rest of the body. The upper lens also has a vertically centered visual field. The angle of this field allows them to have a visual field between 95-100 degrees, allowing them to see the terrestrial world above them.

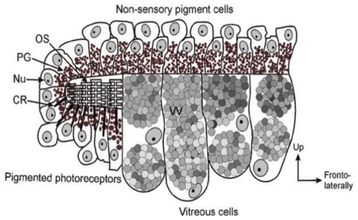
LLE: Lower Lens

The lower lens eye also has a mobile pupil, allowing it to change its viewing area despite the orientation of the rhophalia. The lower lens has thousands of photoreceptors, while the upper lens only has a few hundred. The lower lens' photoreceptors are needed to see dark objects underwater.



SE: Slit Eyes

The slit eyes have four cell types, pigmented and unpigmented photoreceptors, vitreous cells, and non-sensory pigment. These cells form a lens in the eye. It is theorized the slit eye is used to form images.



PE: Pit Eyes

The primitive pit eyes are theorized to be used to measure light intensity. They only have pigmented photoreceptor cells. The diameter of the pit eye is half the size of the retina, thus preventing the eye from having any spatial resolution. This limitation indicates the pit eye is used only as a light meter. But the structure of the pit eye makes it difficult to visualize under transmission electron microscopes (TEM), so their purpose is not fully understood. Like the upper lens eye, they are always pointed upward by the orientation of the rhophalium.

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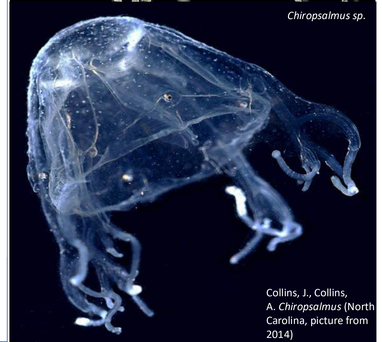
Box jellyfish exhibit slow photoreceptor response and colorblindness

Studies conducted on *T. cystophora* and *Chiropsalmus sp.* indicated that box jellyfish eyes have low resolution and slow reaction time. They are also believed to only have one type of photoreceptor.



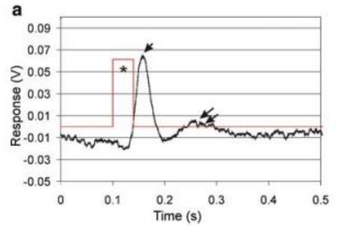
Extracellular electrophysiological recordings were used to determine the speed of the eyes' reaction time in both upper and lower lens.

1. Rhopalium cut in half and placed in a Petri dish with sea water.
2. Suction electrode applied to upper and lower lens of eyes where photoreceptors were most superficial.
3. Suction applied until pigment observed in suction electrode.
4. Black cloth placed over rhopalium for 15 mins for dark adaptation.
5. 50 W bulb focused into light guide and set to flash to stimulate lens eye.

To assess photoreceptors, two mixed light beams were used to stimulate the eyes, as well as flashes of varying colors of light.

Experiments placed the minimum peak time for *T. cystophora's* photoreceptors to respond to stimulus at around 47 ms, and *Chiropsalmus sp*. at 55 ms.

Researchers believe that their eyes' slow response time could serve the purpose of not overwhelming the box jellyfish's delicate central nervous system: by not fully processing fast-moving objects, the jellyfish won't become overstimulated. Likewise, the box jellyfish's photoreceptors were shown to peak in the blue-green region, another way it is believed the jellyfish decrease stress on their nervous system.



The above graph demonstrates the response time of *T. cystophora's* eyes to a flash. The asterisk represents the stimulus. The single arrow on the black line represents the receptor potential (when it initially fires), and the two arrows represent a much smaller response that peaks hundreds of ms after the initial response; the jellyfish's response is thought to be biphasic to assist in stabilizing their vision while not overloading their nervous system.

References

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