Sea Urchins

by: Rachael Landrie

Belonging to the Phylum Echinodermata and the class Echinoidea, there are about 700 different species of sea urchins. They only live in oceans, found in the intertidal to the deep ocean among bed floors, within rocks, coral reefs, or anywhere kelp/algae is plentiful. They range in size from 3 to 10 centimeters. Common colors include black, purple, red, and brown.

Image 1-1
Aboral side of a sea urchin.
The aboral area of the sea urchin is the top side. The anus, gonopores, and genital plate are located here in an area called the periproct. A sea urchin is sometimes referred to as the “hedgehog of the sea” because it resembles a hedgehog.

Image 1-2
Oral side of a sea urchin
The oral area of the sea urchin is the bottom. Located here are the mouth, teeth, gills and modified tube feet in an area called the peristome. Sea urchins are indicator species because they are sensitive to changes in their environment. Biologist monitor them to see if anything is wrong within the ocean environment.

Anatomy

Image 2-1 Sea Urchin Test Fossil Oral

Sea urchins are unsegmented and have a fivefold symmetry, called pentamerism. Although, from fertilization to metamorphis the young sea urchin is bisymmetrical. The endoskeleton of the sea urchin, called the test, is globular and is composed of fused plates of calcium carbonate. The plates of the test have perforations through which five rows of tube feet are extended. The tube feet, in conjunction with the spines, allow the sea urchin to move and trap food. Surrounding the tube feet are 5 rows of rounded tubercles, to which the spines are attached by ball-joints. Each area on the test consists of 2 rows of plates, so that the test has 20 rows total. Among the tube feet and spines are tiny pedicellarines, which are small stinging structures that are used for defense and for obtaining food.

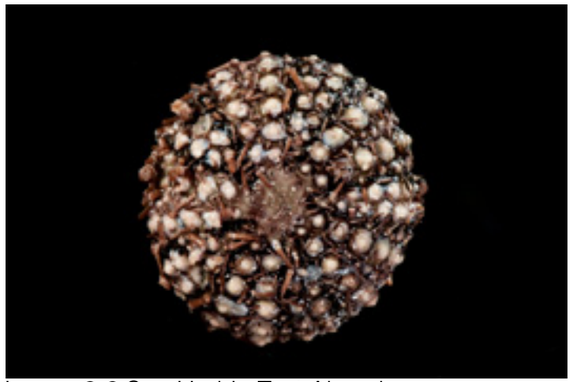


Image 2-2 Sea Urchin Test Aboral

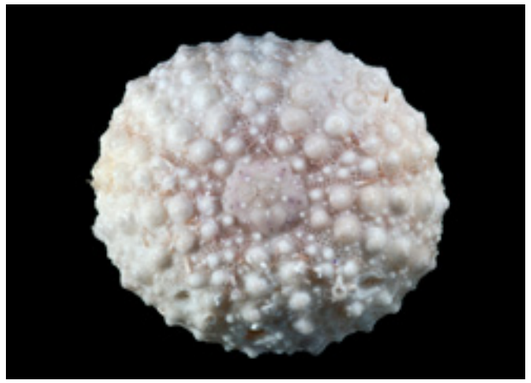


Image 2-3 Sea Urchin Test Fossil Aboral

Image 2-5 Sea Urchin Spine

Image 2-4 Sea Urchin Tube Feet

The lower half of the sea urchin's body is referred to as the oral side because it contains the mouth, teeth, and gills. The mouth, called Aristotle's Lantern[1], is claw-like and has 5 teeth that point inwards. The teeth are very sharp and can claw through rock. The most interesting fact about the sea urchins teeth is that they are a structure in nature that self sharpen. The tooth is a "biomineral mosaic composed of calcite crystals with two forms- plates and fibers- arranged crosswise and cemented together with super hard calcite nanocement."[2]The lantern surrounds the mouth and extends into the body of the sea urchin. The top opens into the esophagus, which runs back down the outside of the lantern into the intestine. The upper half is referred to as the aboral side because it contains the anus, genital plate, and gonopore. Waste is brought up from the intestines and expelled through the anus.

Image 3-1 Lantern Aboral View

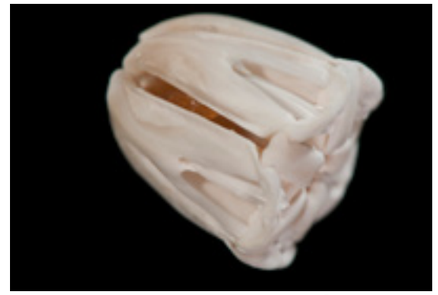


Image 3-2 Lantern Side View

Sea urchins have no brain and therefor have a simple nervous system. The center is a large nerve ring encircling the mouth used to power the tube feet. They have a water vascular system which aids in movement of the tube feet and releasing of sperm/eggs from the gonopores. Sea urchins are, however, sensitive to light and touch. The spines will converge toward touch points and shadows. They are nocturnal because of their sensitivity to light. Like their relative the star fish, sea urchins have a regenerative ability. If their spines become damaged or lost they can rebuild them, but only if the damage to their test isn't too severe.

Image 3-3 Lantern Oral View

Image 3-4
Peristome Region of the Sea Urchin. The area surrounding the mouth is the peristome membrane

[1] Aristotle, greek philosopher, coined the term for the mouth of the sea urchin which many researchers use today. Said by Aristotle, "In reality the mouth-aparatus of the urchin is continuous from one end to the other, but to outward appearance it is not so, but looks like a horn lantern with the panes of horn left out." During Aristotle's life, horn lanterns had five sides. This made for a good comparison when writing about the sea urchin.

[2] Pupa Gilbert, UW-Madison professor of physics

Diet
Sea urchins feed mainly on kelp and algae, although they may eat mussels, barnacles, sea cucumbers and other invertebrates.

Predators
Known predators are sea otters, wolf eels, some birds, star fish, bacteria, and humans. Humans harvest sea urchins for their roe. It is called Uni and served as sushi in the US as well as Japan.

Reproduction
There are male and female sea urchins although it is difficult to distinguish between the two. One way is their location on the ocean bottom. Males choose elevated locations so that their sperm can be broadcast by sea currents. Females choose low-lying locations so that the eggs can have better protection from predators. Fertilization is external. Eggs and sperm are released through the gonopores on the aboral side of the urchin and come together to fertilize forming a larva called a pluteus. The pluteus becomes part of the plankton and do not leave the plankton until they are about 2-5 years old.

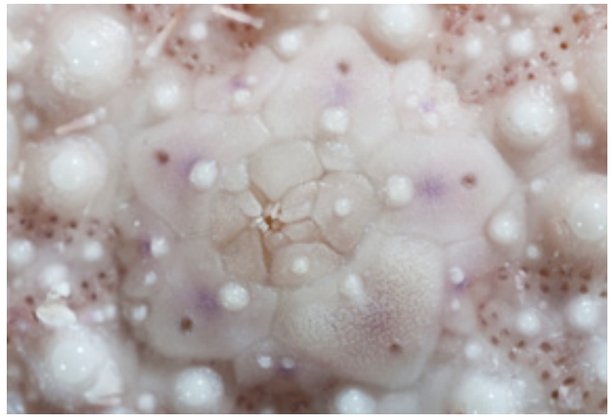


Image 4-1 Periproct area. In this image the anus is visible as well as the 5 gonopores where sperm/eggs are released.

Image 4-2 Sea Urchin Roe

Image 4-4 Sea Urchin Roe called Uni, a Japanese delicacy

Image 4-3 Sea Urchin Roe

Sea Urchins in the News

Sea Urchins Turning Into Cannibals
http://news.discovery.com/animals/sea-urchins-cannibalism-110419.html

Sea Urchin Genome Yields New Understanding of “Chemical Defense.”
http://www.whoi.edu/page.do?pid=9779&tid=282&cid=17868&ct=162

Be Green 2: Sea Urchins Battle Invasive Species
http://www.khon2.com/content/begreen2/story/Be-Green-2-Sea-urchins-battle-invasive-species/-PIJNSBzBEuZedCJKPOE_Q.cspx

After the Gold Rush
http://www.downeast.com/Down-East-Magazine/December-2008/After-the-Gold-Rush

Sea Urchin Body Is One Big Eye
http://news.nationalgeographic.com/news/2011/05/110502-sea-urchins-eyes-science-animals/

Specimen Prep
To get the images of the sea urchin’s test I used an enzyme-based bleach to dissolve the organic material surrounding the test. I removed all of the spines from the sea urchin. I then filled a beaker with water and a couple teaspoons of the detergent Biz. I placed the sea urchin in Biz mixture for about 2 days, rotating the test as needed. Once all of the organic material dissolved I rinsed the test with plenty of water and let it air dry.

Challenges
The sea urchin was wet and when lit had speculars. I tried putting the specimen in water but I didn’t like the look. Some of the fine detail was lost. So I chose to shoot the specimen out of water, but I allowed it to sit out for a while to dry so it wasn’t as wet. It still had some speculars but not as many. I recommend diffusing the light with either ping pong balls or some kind of diffusing material.

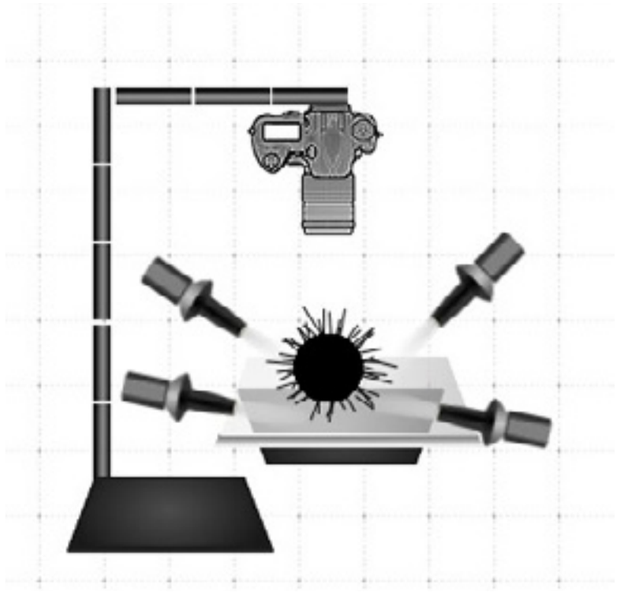
I ordered the specimens live and they were shipped over night from CA. I chose live specimens because they still had color, as opposed to fixed specimens. When shipped over night they became very stressed and died within a day. I recommend having an established tropical tank set-up and ready to go for when you are working with these live specimens as they are very sensitive to their environment. As living in an area where there is no ocean my only choice was to order them from a scientific company. It is unfortunate that they died because I had hoped to photograph them living, as well as their insides. Because they had died they lost color, their spines fell over or off, and their insides had turned to mush.

Photo Equipment

- Nikon D300s
- Nikon 105 mm lens
- Various mm thimble lenses
- Bellows
- Fiber optic lights
- Computer
- Tether cable

Photo Set-up

The camera was tethered to a computer. The software used to capture the images was Camera Control Pro. This helped to reduce camera vibration by not having to push the shutter button on the camera. The specimen was placed on a piece of glass on top of 2 wooden blocks and black velvet was placed underneath to add a black background to the image. The fiber optic lights were then placed around the specimen for optimum lighting. Please see the photo set-up image below.



Photographing

All images were photographed in RAW format and converted to high resolution JPEG's for image stacking and screen display. When using a higher magnification image stacking was used because obtaining the most detail and depth of field was important. Images were taken at different depth of focuses within the specimen and put into stacking software to combine all the images into one. The software used was Zerene stacking software (http://www.zerenesystems.com/cms/stacker).Other software used for slight editing were Photoshop CS5 and Lightroom.

About the Author/Photographer

Rachael Landrie is a 4th year Biomedical Photography student at Rochester Institute of Technology in Rochester, NY. Her concentration focuses on macrophotography and photomicrography.

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Resources

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