



Exploration Tank

Lawrence Hall of Science

This activity outline was developed for use in a variety of informal venues. By design, it provides the content, pedagogy and strategy necessary for implementation by both the novice and experienced informal educator. It is expected that this outline will be adapted and improved upon by the user. We welcome your feedback!

Synopsis of the Activity

Learners observe and interact with marine animals in a touch tank. The educator/facilitator helps guide the learners' observations and encourages them to generate questions and find the answers to their own questions as they continue to explore.

Audience

This activity is meant for a general audience, and works best with a group of 3-5 with one facilitator.

Setting

This activity can be conducted anywhere at the informal science education institution where you can display organisms in a small touch tank.

Activity Goals

Learners will be engaged and interested in spending more quality time at a touch tank exhibit while making careful observations and asking questions about the organisms that they can answer for themselves with additional observations or mini-experiments. The learners will be able to apply this skill to other displays, exhibits and informal science education institution settings.

Concepts

- Careful observations of the structures and behaviors of marine organisms can help us to learn about how these organisms live and survive in their habitat.
- Like scientists, we too can ask questions and discover the answers to our own (or other learners') questions.
- Many tidepool organisms have "hard parts" and the ability to hang on tightly to protect themselves from predators and crashing waves.

Ocean Literacy Principles

5. The ocean supports a great diversity of life and ecosystems.
 - c. Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.
 - d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms that do not occur on land.
 - h. Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.

Materials

- Touch tank containing one or more marine animals. (A small number or variety is preferable for learner focus.)
 - Standing tabletop signs or posters with a picture of the organism and its name and maybe a few questions related to that organism.
 - Information cards (5 representative cards attached)
 - Hand washing station or facilities nearby.
 - Examples of internal hard parts from the organisms, such as fish bones or chiton plates.
- *Note: Ideally a Hard Parts artifact cart and books about each organism could be located nearby for further related investigations.
- Tables: at least one for the organisms, and another table set apart for information about each animal.

Prep Section Collect Organisms & materials

- Get to know the animal: make observations on your own to help you predict what observations and questions your learners might have. Find any relevant information about the organisms, but remember that it is ok not to know everything.
- Be prepared, but be ready to discover (or rediscover) some things along with the learners.

Procedure and Set-up

1. Collect organisms and tank. (To prevent organism fatigue, have enough organisms to rotate them in and out of the station.)
2. Display signs or posters with a picture of the organism and its name, some instructions and a few of the questions included below:
Choose an animal, then explore it by looking at it and carefully touching it.
 - How does it move around?
 - What does it look like?
 - What does it feel like when you touch it?
 - How do you think it protects itself?
 - Does it have hard parts?
 - How do you think it breathes?
 - What other questions do you have about the animal?

*Note: It is recommended to use just a few questions per sign or poster.
It is also likely that many learners will ignore these questions on the sign, so the educator should be ready to ask questions of learners verbally.
3. On a separate table, display information cards or books about each animal. The table should be separate for optimal use of space, protection from water and to keep attention focused on the actual organisms.

Guiding Questions

The visitors curiosity along with guiding questions used by the facilitating educator are the key to this activity. The intent of questions is not to barrage the learner with one after

another or to set them up to ask questions for the facilitating educator to answer, but rather to get them to think about the organism and develop an understanding of it through questions and their own observations.

This section includes examples of guiding questions to focus the learner on different aspects of the organism, as well as groups of questions that all relate to one concept. Most importantly if the learner points out something that they notice, go with their observations and enter into a conversation about their interests and expertise rather than asking a question like, “what do you notice?”

In the first part, the questions are broken up into two groups, 1) initiating questions and 2) follow-up questions. As you read through the questions you may run across some in each group that you might put into the other category. That is fine; these are meant to start you thinking about how to initiate an interaction and then continue the discussion with the learner. Facilitating the interaction with the organism can often be achieved by pairing an initiating question with one or more follow up questions.

Initiating Questions:

- Have you seen one of these before? Where did you see it?
- What is it doing?
- What does it feel like?
- How does it move around?
- What senses do you think it has?
- How does it protect itself?
- Can you see or feel any parts that may help it protect itself?
- Does it have hard parts? If so, what kinds?
- How do you think its coloring and patterns help it survive?
- How do you think it breathes?
- Do you think there might be hard parts inside its body?
- Do you think it can breathe out of the water?
- What do you notice about its body?

Follow up questions:

- What makes you think that?
- What’s your evidence?
- How might you test that?
- How can you tell?
- What other questions do you have about the animal?
- Do you think we can answer that question here?
- How else could we find that out?

Single Concept example:

Here is a sample of different ways to get the learner to think about what aspects of the animal’s body or behavior may help to protect it.

How does it protect itself?

How do you think it protects itself?

Do you notice any parts that might be used for protection? How might (claws, scales, exoskeleton, camouflage....) help it protect itself? How might that protect it from a predator like a seal?

Do you notice any hard parts? What do you think they are for?

How else do you think it might protect itself?

Younger learners may need more general questions to get them to focus on the animal and to start them talking about it. (What is the animal doing? What does it feel like when you touch it? Do you see (or feel) any hard parts? What do you think they are for?)

Activity Description

Invite learners to come over and touch the organisms in the tank and then engage them in a discussion of the organism. Keep in mind the following discussion map to help facilitate a discussion with the learners.

Discussion map:

- Ask a broad question
- Listen to responses and thinking
- Ask for evidence or explanations
- Ask for alternative opinions or ideas
- Ask a question leading back to the main topic

For Example:

(Learners and educator are exploring a sea star together.)

Educator: How do you think it protects itself?

Learner 1: Well, it feels kind of hard on the outside.

Educator: Yes, I feel that, too. I wonder how that might help it.

Learner 1: Maybe if a bird tries to peck at the top of it, it can't hurt the sea star.

Educator: That sounds like it makes sense. I wonder if there are any other ways it might protect itself?

Learner 2: It was really hard for me to pry it out of the container. It would probably be really hard for a predator to pick it up, too.

Learner: It is hard to pick up, isn't it? What kind of animal do you think that might help protect it from?

As new learners arrive at the touch tank, encourage those who have been there longer to share what they have tried and what they are thinking about. Encourage them to engage with each other.

When it seems like a learner may be ready to leave the touch tank, encourage them to continue their investigation by going over to the table of information cards and books or a "hard parts" artifact cart that may be nearby.

Role of educator:

- Try to adopt the role of “guide on the side” rather than “sage on the stage.” Rather than simply imparting information, be a facilitator of learning and a co-investigator, seeking evidence and explanations alongside the learners.
- Engage learners in investigating organisms themselves.
Invite learners to come over and touch the organisms in the tank and then engage them in a discussion of the organism.

Questioning:

- Try to ask more broad questions with multiple possible responses that encourage higher-level thinking, rather than focused questions with single answers.
- Care needs to be taken not to badger the learners with questions. Give room for exploration and for learners to make observations, think, wonder and discuss amongst themselves. Ask occasional questions when appropriate to focus investigations, or extend them.

Related Activities/Extensions/Modifications

A touch tank activity relates well with activities that involve animal artifacts. If a “hard parts” cart with tests, shells and skeletons were nearby, learners could go see the parts that they may only be able to feel or speculate about being part of the live animal.

Additional Resources

Life in a Tidal Pool

Describes the varied forms of shore life found in and around tidal pools and discusses their struggle for survival.

Author: Alvin and Virginia Silverstein

Publisher: Knopf

ISBN: 0316791202

The Secrets of Tidepools: The Bright World of the Rocky Shoreline (Jean-Michel Cousteau Presents) (Paperback)

by Vicki Leon

In One Tidepool: Crabs, Snails, and Salty Tails (Sharing Nature With Children Book)

by Anthony D. Fredericks, Jennifer Dirubbio (Illustrator)

The Seaside Naturalist: A Guide to Nature Study at the Seashore

Author: Deborah Coulombe

Publisher: Simon and Schuster

ISBN: 0671765034

All available from Amazon.com

<http://www.amazon.com>

Background

(The following is adapted from “Down at the Rocky Seashore,” by Robin Milton Love, MARE Teacher’s Guide to Rocky Seashore)

Intertidal organisms face many biotic challenges, such as finding food, avoiding predators, or resisting diseases. They also face the added dimension of inhabiting an environment with extreme non-living, or abiotic, conditions. In one respect the intertidal zone is totally different from all other land and water communities. It is exposed to water part of the time and dry at other times. Because the water environment is so different from the air, intertidal organisms face an almost bewildering range of conditions in the course of a day, a season or a year.

As the tide rises and falls, an organism is alternately drenched and dried. When this happens the organism’s temperature can decrease rapidly as cold water splashes its sun-warmed body or, alternately, it can heat up as it is exposed to the air. Breathing is also going to be a problem. What works in water (gills) may not be very effective in air, and what works in air (lungs) just can’t cut it in water.

Rain and other freshwater are stressors, too. A body responds differently when in salt water (water tends to leave it), than in freshwater (water tends to go into it). How can an organism cope with these very different environments?

Then there is wave shock, the remarkable powerful force of crashing water. How does a typical organism not get swept away or crushed? Waves also send water splashing up into the high intertidal. But, unlike tides, they do this unpredictably. Organisms high up in the intertidal can’t depend on large waves every day and must be able to withstand prolonged periods of drying.

The BIG Factors:

Tides: Obviously, tides are a major (perhaps the major) controlling force in many intertidal habitats, because they dictate how long organisms are under water. Tides are rhythmic, predictable, periodic changes in the height of a body of water. The tides are caused by a combination of the gravitational pulls of the sun and moon and the centrifugal force caused by the rotation of the Earth/moon system. Throughout the year, tides vary in their heights, and the highest highs and lowest lows occur together during the new and full moons, when the moon and sun are directly aligned with the Earth. These extreme tides are called *spring tides*, which comes from the Old English word *springen*, meaning to jump or move quickly. Spring tides occur every two weeks and alternate with less extreme, or *neap*, tides.

Tidal patterns (how often highs and lows occur within 24 hours) and ranges (the difference between high tide and low tide water levels) differ in different parts of the world. Some areas, such as much of the east and west coasts of the United States, usually have two high and low tides per 24 hours. These are *semi-diurnal tides*. On the other hand, Gulf Coast states tend to have one high and one low tide (*diurnal tides*) during the same period. Tidal ranges vary dramatically depending on the shape of the water basin the tides flow through. The narrow Bay of Fundy, in New Brunswick, Canada, has tides of about 50 feet. This does not mean that the water goes inshore 50 feet. It means that it rises in height that amount. So if the land is pretty flat, the sea might flow inshore for miles before reaching the necessary elevation. Tidal ranges for much of the west and east

coasts of the United States are around 6-8 feet. The Gulf Coast tides are narrower, perhaps a foot or two.

Waves: Waves also play a major role in deciding what organisms live where. Not only can waves knock organisms off their perches, they (along with tides) dictate how high up into the rocky intertidal water will splash. Far more territory gets wet during a 6-foot tide with 10-foot storm waves, than with a 6-foot tide and one-foot placid waves. Though they help determine sea life along all shores, waves are particularly important along much of the Pacific Coast, where wave size varies a great deal. The size of waves depends on several factors. The most important is the size of the area a wave travels through without being hindered by islands or undersea ridges. The more wide open an area, the larger the waves that can be generated. If you stand on the shore anywhere from Cape Flattery, northwest Washington to Pt. Conception in central California, there is absolutely nothing between you and the Aleutian Islands. That is a long way and it allows some fearsome waves to form. Of course, wind velocity is also important, which helps explain why waves tend to be higher during storms. On much of the Gulf Coast, waves tend to be small, and they are a factor only during hurricanes and other storms. Because waves have such a profound effect on sea life, any protection from their power alters the makeup of the animals and plants living in the habitat. For instance, along the Pacific Coast, wave-swept rocks are home to the powerfully-built sea star *Pisaster* (or ochre star), which can hang on even when slammed by direct hits from huge waves. In the same vicinity, but in protected tide pools, lives the more delicate bat star, *Patiria*, which can barely hold its own in very mild surges.

The shape of the coastline has a large influence on wave action. The rocky shores of open coasts, where waves come to shore unimpeded, tend to have somewhat fewer plants and animals than habitats in protected coasts, where the force of the waves is deflected somewhat. More commonly, coastlines tend to be at least partially protected, by offshore kelp beds, reefs, or by irregularities (such as indentations) in the coastline. Somewhat protected rocky shores are usually chock full of goodies, because compared to the open wave-swept habitats, they are an easier environment in which to live. Rock position and location are also important factors. Because waves and tides have such a large influence on the environment, not all places in the rocky intertidal are identical. Generally, the higher up the intertidal you are, the more extremes (in wetness, waves, wind, etc.) you will face. Moreover, vast differences in these conditions may occur even on a single rock. For instance, the top of the rock is drier and more subject to wave action than a crevice. The southwest-facing part of the rock (which faces the sun most of the day) is drier than the north-facing side (which tends to be in shadow). The crevice is probably drier and more wave-swept than the under parts of the rock. And the deep pool next to the rock is continually wet and probably quite protected from many waves. Commonly, different organisms will be found in these different areas, even if they are inches apart.

Substrate: The type of substrate found in the intertidal also effects what lives there. For instance, granite is pretty tough stuff, it takes a lot of waves and a lot of water to begin to crack, chip or flake it away. On the other hand, sandstone or shale is (relatively speaking) pretty delicate; crevices, holes and cracks develop quickly. These openings provide habitat for many animals which cannot live on open rock. Therefore these softer substrates may have a greater variety of organisms than ones found on harder

surfaces. On the Gulf Coast, there are few natural rock outcroppings. Take heart, however, for there are an abundance of rock jetties and dock pilings to choose from. These structures often provide homes for a myriad of organisms.

A few ways organisms survive in the rocky intertidal: Let us assume that rocky intertidal organisms face two major problems: drying out (and that includes changes in temperature as well) and being dislodged and killed by wave action. How do organisms cope with these problems?

Drying out: Location in the intertidal is the main way animals find their drying out comfort zone. If they like it drier, they live higher up; if they like it wetter, further down. Even within a zone, there are differences in wetness and organisms take advantage of this. Crevices, cracks, and holes are shady and often contain pockets of water; here you will find those animals which prefer a bit more moisture. In fact, these slightly wetter areas allow organisms that would usually be found in the lower and wetter intertidal to live higher up. Intertidal organisms, particularly those high up the intertidal, often have shells which can be tightly closed or skins that are particularly thick. Both of these can trap water and help provide protection from evaporation. Some anemones cover themselves with bits of shells and rocks to provide shade.

Wave action: First, as with protecting against drying out, almost all the animals that live in heavy surf have hard shells or tough skins. Many of these organisms have evolved clever ways to hang on in surge conditions. Sea stars have tube feet, mussels have special tough threads with glue on the ends and barnacles have a cement so effective, even in a wet environment, that dentists are thinking about using it to keep fillings in place. Other organisms find places where waves are disrupted or blocked. Periwinkles, limpets and other snails tend to congregate in partially protected crevices. Sea urchins, hermit crabs, and sea slugs, to name a few, all tend to live in protected pools. At the extreme are boring clams with shells resembling files. They bore into rocks and live their lives sealed off from the environment, except for a small hole, through which water and food travel.

As you go down the intertidal, from the high and dry to the low and wet, you will encounter different species. These aquatic organisms arrange themselves by the amount of time they can tolerate being out of the water. In the highest intertidal, the splash zone, animals may be out of the water for days between high tides (and/or large waves) high enough to cover them. By the same token, in the lowest of the intertidal, animals may be uncovered for only a day or two a year. Every species has a unique set of environmental requirements. This is the basis for zonation, the occurrence of organisms or groups of organisms with the same requirements, in specific areas. In the case of the rocky intertidal, some zones are so well-defined that they can be seen all around the world.

Vocabulary

The vocabulary will be determined by the specific organisms you use. Please create this section for your facilitators specific to your organisms. Likely words include:

adaptation- any alteration in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment.

arthropod- a group of organisms such as crabs and insects with jointed legs and covered with a protective exoskeleton

carnivore- an animal that only eats other animals

crustacean- a group of aquatic organisms with exoskeletons belonging to the arthropod group such as crabs and crayfish.

echinoderm- a group of spiny skinned organisms such as sea stars and sand dollars

exoskeleton- the outer protective layer on organisms such as crabs and insects

gills- a structure used by many aquatic organisms to breathe underwater

holdfasts- a structure that anchors seaweeds to rocks and other hard surfaces

mollusk- a group of organisms with soft bodies; most have shells like clams and snails, but a few mollusks like octopus and squid do not have shells.

omnivore- an animal that eats both animals and plants

predator- an organism that exists by killing and eating other organisms

prey- an animal hunted or seized for food

scavenger- an animal that eats dead plants, dead animals or droppings

tube feet- a structure on organisms like sea stars and sand dollars used for locomotion, for hanging onto hard surfaces like rocks, or for obtaining food.

Following are some sample information cards for five representative organisms.

Gumboot Chiton

Chitons have eight overlapping plates instead of just one shell like snails, limpets or abalones. This gives them more flexibility to mold their fleshy bodies to the rocks and hang on tightly. Their eight plates make them so different from other mollusks that they are put in a special group all by themselves.

Chitons move very slowly on their one very muscular foot. They use their foot for clinging to rocks and also for creeping slowly. They can roll into a ball if they are disturbed. This helps protect their soft body.

The gumboot chiton is a very special chiton. It is the largest chiton in the world and can grow to be 1 foot long. It is reddish-brown and its shell plates are completely hidden. It feeds on algae. It doesn't have very many enemies. Native Americans ate gumboot chitons.

Gumboot chitons can breathe a little when they are out of water. They breathe much better in the water though. They have gills located in grooves on both sides of their foot.

For Young Visitors:

The chiton shell has eight parts.

Chitons scrape algae off rocks with a scratchy tongue.

Chitons move very slowly and can roll up into a ball for protection.

Chitons have one large foot like a snail.

Chitons move around at high tide, but stick tight at low tide.

Rock Crab

Rock crabs have a hard exoskeleton that protect them from predators. They have eight walking legs and two pincers. They use the pincers to get food and to protect themselves from predators. Rock crabs, like other crabs have gills to breathe underwater.

The rock crab is a scavenger and a predator. It captures hermit crabs by walking over them or sitting on them. They hold the hermit crabs there in a cage formed by the rock crab's body and legs. Then the rock crab grabs the hermit crab with both its pincers sticking into the opening of the hermit crabs shell and breaks bits of the shell away. Finally, when the hermit crab can't hide in the shell anymore, the rock crab grabs and eats it.

For Young Visitors:

Rock crabs have 8 walking legs and 2 pinchers.

They have gills and can breathe underwater.

Rock crabs are predators and eat other crabs.

Rock crabs are also scavengers and will eat dead animals.

Rock crabs have a hard skeleton on the outside of their body.

Sea otters and people eat rock crabs.

Sea Star

Most sea stars have five arms and hundreds of feet that look like suction cups. These suction cup-like feet are called tube feet. Sea stars use their tube feet for holding on tight, moving around and capturing food.

The mouth of the sea star is in the middle of the underside of the star. To eat, sea stars push their stomach out through their mouth and digest their food outside of their bodies. Then they pull their stomach back into their body. At high tide, sea stars travel up to the mussel beds to feed.

A sea star can grow back a new arm if a predator bites it off. Sea otters and gulls are predators of sea stars.

For Young Visitors:

Most sea stars have five arms, but some have many more. Sea stars have hundreds of tiny tube feet that help them move and stick tightly to a rock.

The skin of sea stars is rough.

Sea stars come in many different colors including orange, purple, brown or red.

Sea stars eat mussels and other animals with shells.

Sea stars stick their stomach out of their mouth to eat.

Hermit Crab

Hermit crabs are different from shore and rock crabs. Shore and rock crabs are covered by a hard exoskeleton that protects them. Hermit crabs are only partly protected by a hard exoskeleton. Their walking legs, claws and head have protective armor, but their stomach and abdomen are soft and vulnerable so they need to find a shell to wear for protection.

A hermit crab wears the empty shell of a dead snail for protection. It will fight with other hermit crabs to steal a larger shell once it has outgrown its old shell. It curls its soft abdomen around the inside of the shell and holds it in place with short little hind legs. If a hermit crab is threatened it will retreat into the shell. Then it puts its pincers across the opening of the shell to protect itself.

For Young Visitors:

Hermit crabs live inside empty snail shells.

They fight with other hermit crabs to get larger shells.

Hermit crabs move into larger shells as they grow.

Hermit crabs are scavengers and eat dead things.

Hermit crabs have antennae to help learn about their habitat.

Flat Fish

Flat fish start out their life looking like a regular fish with one eye on each side of their head. They swim like a regular fish swims too. When they are still very tiny though, one of their eyes migrates to the other side of their head. They end up with two eyes on one side! Now they lay on their side, staying as still as possible on the bottom of the ocean. What are they doing there? They are watching carefully for prey to come near. When it does, they dart off the bottom and grab it. Then they return to the bottom, lay quietly on their side with both eyes looking up and wait for more food to come by.

Since flat fish are waiting for their prey to come near, it is important that they are camouflaged so that they can remain hidden. Many flat fish can change their color and pattern of spots to match the background. They become almost invisible. Some flat fish bury themselves just under the sand with only their eyes showing. It is very difficult for their prey to see them. This also helps the flat fish to hide from predators that might want to eat them.

For Young Visitors:

Flat fish are predators that eat shrimp, crabs, worms and smaller fish.

Flat fish are camouflaged and can change color and pattern.

Flat fish have two eyes on one side of their head.

Flat fish lie flat on the ocean bottom.