Adaptations to the deep sea: Teacher's guide

Exercise 1: Deep-sea invertebrate profiles

In groups, have students watch the informative videos (links below). Each group should pick two invertebrates and fill out the worksheet. If available, encourage them to use other resources (see the Teacher Resource List at http://www.mun.ca/osc/oscedu/tlinks.php).

Suggested resources for this exercise:

http://www.montereyinstitute.org/noaa/

Lesson 3: Deep-sea corals
Lesson 6: Deep-sea benthos
Lesson 15: Seamounts as habitats for invertebrates

http://www.youtube.com/user/MBARIvideo

Hide and seek in the deep	(http://youtu.be/lXRaaHxshWg)
Challenges of the deep	(http://youtu.be/IeXUuhLGBCQ)
Do the locomotion in the deep	(http://youtu.be/gtj_JSlKXgY)
Coral-devouring sea stars	(http://youtu.be/OxuGalZUeYY)
Feast in the deep	(http://youtu.be/rdI3eFrTGs8)

http://www.asnailsodyssey.com/

Detailed invertebrate information (make sure to look through all of the drop-down menus). Site mostly talks about intertidal organisms but is still relevant.

If they can't find the answer, have them make an educated guess of how the animal might live. Encourage them to compare some of the strange animals to well-known ones. For example, I don't know how sea spiders move, but I'm guessing they use their long legs to walk around like crabs.

Example answers

Name of deep-sea invertebrate: Crab

1. **Is this animal sessile or motile? If it moves, how does it move?**
   Motile. Crabs have jointed legs that they use to walk around on the bottom.

2. **Describe its habitat (benthic, pelagic, mud, rock).**
   Benthic (sea floor), mud or rock

3. **How does it use camouflage? If it doesn't, how does it avoid or scare away predators?**
   Some are red in color. Some (like decorator crabs) cover themselves with debris or other animals. Hermit crabs live in snail shells that they can retreat into to hide. Crabs also have hard skeletons and sharp claws that might scare away predators. Some crabs can make their legs fall off ("autonomy") to distract the predator while the crab gets away.

4. **What kind of food does it eat? How does it catch food?**
   Crabs can attack prey, dig in the sediment, or scavenge on dead animals. Crabs sometimes eat the flesh of dead whales on the ocean floor ("whale falls").

Name of deep-sea invertebrate: Octopus

1. **Is this animal sessile or motile? If it moves, how does it move?**
   Motile. Octopuses can move by jetting water or pulsing their arms. Dumbo octopuses have fins on the sides of their bodies that they can also use for movement.

2. **Describe its habitat (benthic, pelagic, mud, rock).**
   Some are benthic (sea floor), while others are pelagic (live in the water column)

3. **How does it use camouflage? If it doesn't, how does it avoid predators?**
   Some are red, some are transparent. Octopuses that live on the sea floor can change their color to perfectly match the sediment. Some octopuses make burrows for shelter.

4. **What kind of food does it eat? How does it catch food?**
   Octopuses are active predators that use their tentacles to grab prey. The tentacles have suckers that can be very strong. They eat crustaceans, fish, and other invertebrates.

Name of deep-sea invertebrate: Corals

1. **Is this animal sessile or motile? If it moves, how does it move?**
   Sessile. Most corals are attached to the sea floor, but they have tiny polyps that can extend tentacles to grab food.

2. **Describe its habitat (benthic, pelagic, mud, rock).**
   Benthic (sea floor), usually rock but sometimes mud

3. **How does it use camouflage? If it doesn't, how does it avoid predators?**
   Many are red or pink in color. Some corals use chemicals or stinging cells called nematocysts to deter predators. Some have small, sharp calcareous skeletal structures called sclerites within their tissues to deter predators.

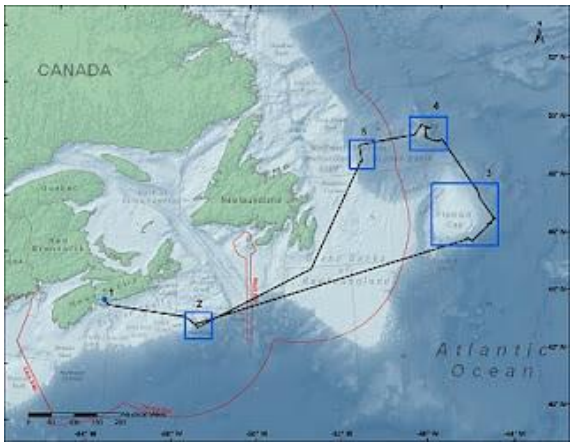
4. **What kind of food does it eat? How does it catch food?**
   Deep-sea corals are suspension feeders that catch plankton or marine snow. Tropical reef corals have symbiotic algae that photosynthesize and provide energy to the corals.

Exercise 2: Deep-sea adaptations of invertebrates from Canada

Assign groups of students to either watch deep-sea video from Newfoundland or British Columbia.

Both videos were taken from the Canadian remotely operated vehicle (ROV) ROPOS. Neither video is narrated or labeled, so students may not know what all of the animals are. Don't worry too much about getting the names right, but encourage the students to look for adaptations for feeding, living, hiding from predators, or anything else they find interesting.

Newfoundland:



Flemish Cap and Orphan Knoll northeast of Newfoundland. Map from the researchers' blog: http://hudson0292010.blogspot.ca/2010/06/cruise-track.html.

Depth: about 1000-3000 m.

Video: http://www.youtube.com/user/ROPOSROV, find the video called "Hudson2010_720P_AVC_4mbps.mp4" (or go straight to http://youtu.be/pbGAMe0DfR0)

British Columbia:

Juan de Fuca Canyon near the BC/Washington border (A) and Dixon Entrance in northern BC (B).

Depth: about 50-400 m

Video: http://www.youtube.com/user/FisheriesCanada, find the video called "2008 ROPOS Expedition" (or go straight to http://youtu.be/d5Ya_2NauPs)

Identification guides for both videos are on the next two pages. There are many possible answers that may not be written here. Encourage students to come up with their own ideas of how the animals in these videos live.

Newfoundland video guide (http://youtu.be/pbGAMe0DfR0)

Time	Animal	Adaptations
1:24	Sea cucumber ("sea pig")	Color: clear body, Feeding: tentacles sorting through sediment
1:43	Coral being sampled by ROV	Feeding: tall to capture plankton
2:15	Sea cucumber	Color: purple/clear, Feeding: tentacles sorting though sediment
2:28	Stalked sponge	Feeding: raised into water to collect plankton
2:45	Sea pen (coral)	Color: red
2:55	Shrimp	Color: red Locomotion: swimming using legs
3:19	Octopus- movement, red	Color: red Locomotion: swimming using fins
3:31	Sea spider on coral	Color: sea spider is red Feeding: sea spider is eating something small from coral Movement: walks using legs
3:51	Coral	Feeding: the coral colony is made of many small polyps that capture plankton
4:43	Octopus	Color: purple/red Feeding: suckers on tentacles, large eyes for seeing prey
5:08	Sea anemone	Color: purple/red Feeding: long tentacles to catch plankton
5:45	“Dumbo” octopus	Color: white Movement: swimming using fins
7:18	Octopus	Color: purple/red Movement: moves along sea floor with arms
8:03	“Dumbo” octopus	Color: White/transparent/red
8:34	Coral being sampled by ROV	Color: red Feeding: can see small polyps all over colony
8:53	Corals and sponges	Feeding: these are all filter or suspension feeders. They have many branches and pores to filter the water.
9:23	Sponge	Feeding: pores for filtering water
9:28	Corals (many types)	Habitat: rocky areas are important habitat for corals Color: many are red or pink Feeding: many animals reach tall into the water to catch food
10:17	Corals	Color: red Feeding: corals in left corner (*Anthomastus* sp.) have very long polyps to catch food
10:40	Yellow crinoids (feather stars) and sponges	Feeding: crinoids reach tall into the water, and are all facing the same direction to capture food from the currents

British Columbia video guide (http://youtu.be/d5Ya_2NauPs)

Time	Animal	Adaptations
0:26	Large sponge	Feeding: filter feeding Movement: sponges are sessile and grow big
0:30	Many sponges with sea stars and shrimp	Feeding: sponges filter feed Camouflage: shrimp blend in to bottom
0:35	Coral next to sponge with crinoids at base	Feeding: suspension feeding (coral, crinoids) Color: coral is red
0:42	ROPOS sampling arm	
0:55	Large sponge being sampled	Feeding: sponge filter feed
1:00	Rockfish	Color: red Movement: swims with fins
1:07	Large corals with sea stars eating them	Feeding: corals grow tall to collect more food from the water column Sea stars crawl onto the coral to eat them
1:15	Large corals with a crab	Color: corals and crab are red Camouflage: crab matches coral color
1:22	Crinoids (echinoderms, related to sea stars)	Color: red Feeding: use long arms to catch food
1:28	Sea star on coral, fish hiding underneath	Color: all of the animals are red Feeding: sea star is feeding on the coral Habitat/camouflage: fish hiding under coral
1:36	Corals	Feeding: Corals are tall to collect food out of the water Color: red
1:42	Skate, rockfish, brittle stars, sea anemones	Color: most of the animals are red Movement: fish swims away with fins, but skate doesn't
1:54	Corals, sea stars, sponges	Feeding: corals and sponges filter feed, sea stars eating things in mud?
2:04	Flatfish	Movement: swimming
2:13	Fish hiding in coral	Color: both red Camouflage/ habitat: is the coral a shelter?
2:25	Coral, sponges, crinoids, sea stars all on big rock	Habitat: Increased number of species on rock compared to surrounding area
2:23	Tiny octopus on red coral	Habitat: octopus maybe using coral as shelter
2:51	Rocks being collected	-
3:25	Crinoid on sponge, fish hiding inside	Feeding: filter or suspension feeding (sponge and crinoids)- Habitat: fish using sponge as shelter
3:35	Small red octopus	Color: red
3:49	FIsh on rock beside anemone	Camouflage: fish is splotchy like the rock
4:02	Huge red coral	Color: red Feeding: filter feeding,
4:26	Fish	Color: red
4:38	Bryozoans (colonial animal)	Feeding: colonial animal- many small zooids that catch food
4:53	Bryozoan with well-hidden shrimp	Camouflage: shrimp matches color of bryozoan
5:09	Coral, brittle stars, sea urchin, sea stars, crinoids, fish	Color: all are red Feeding: sea stars feeding in mud, crinoids/corals suspension feeding