

Phylum Mollusca

1. Snail Movement

Marine snails such as *Littorina littorea*, *L. obtusata*, and *L. saxatilis* can be collected in the rocky intertidal year round. Refer to the photographs of the three species of *Littorina* in the MITZI Image Library. *L. saxatilis* lives in the upper rocky intertidal in rock crevices and may also be found in upper tide pools. *L. obtusata* is common on the surface of or underneath brown algae (*Ascophyllum* or *Fucus*) in the brown algal zone while the periwinkle *Littorina littorea* is abundant in the mid to lower rocky intertidal as well as in upper to mid tide level tidal pools.

<<Activity>>

Waves of muscular contractions on the bottom of the foot move most marine gastropods snails. Place a marine snail (*Littorina littorea*, *L. obtusata*, *L. saxatilis*) in a glass dish filled with seawater. Allow time for the foot to attach to the bottom of the dish, and then pour out the water, invert the dish and examine under a dissecting microscope. The waves of muscle contraction should be obvious. On the basis of your observations describe in depth how the animal moves in a forward direction. Freshwater snails can be substituted for marine forms.

2. Snail Feeding-Radula Tracks

As snails move forward the radula is extended from the mouth and rocked back and forth over the substratum. The radula teeth scrape the surface directing food into the mouth. The scrape marks can be observed as snails move across a glass plate coated with India ink or a suitable substitute. Freshwater snails can be substituted for marine snails.

<<Activity>>

Fill a small plastic dishpan with several inches of seawater. Select a small piece of window glass that will fit in the dishpan and paint one surface evenly with India ink. Allow the ink to dry completely (this could take a long time) and then carefully place the plate, ink side up, in the dishpan. Introduce several snails (*Littorina sp.*) or a limpet on top of the glass plate and cover the pan with aluminum foil. After 30 minutes (it may take longer depending on the species and condition of the snails) examine the glass plate for radula scratches. Freshwater snails can be substituted for marine forms. The movement of the radula is easily visible with

3. Snail Anatomy

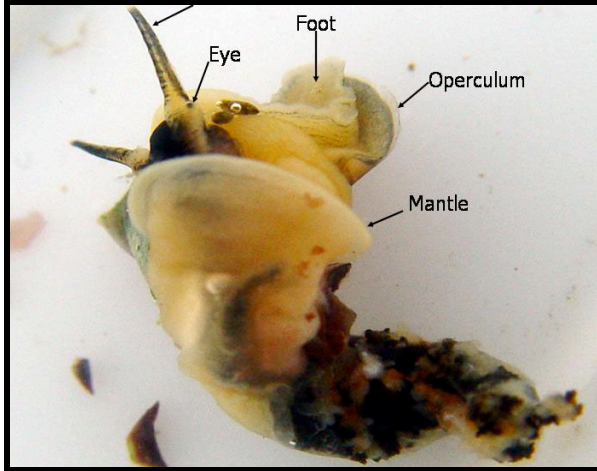
Refer to the labeled pictures of the periwinkle *Littorina littorea* in the MITZI Image Library.

<<Activity>>

Examine the structure of the shell. Note the concentric growth rings. During the colder part of the year the rings will be crowded together because the animal can't feed as often.

- Can you determine how old your snail is?

Crack open a periwinkle shell and carefully remove the animal whole and place in a small glass dish filled with seawater. Locate the head, tentacles, eyes, operculum, columnar muscle (attaches the animal to the shell) and liver. Refer to the labeled photograph of *Littorina littorea*.



Locate the sac just above the head. This is called the mantle cavity where the gills and anus are located. Examine your snail for parasites as directed below.

- a) Snail Parasites -Can you see any actively moving larval stages emerging from the liver tissue of *Littorina littorea*? If the animal is parasitized there is a good chance that you will see the parasitic larvae.

After a few minutes in the dish, the transparent larvae usually fall from the liver to the sides of the animal. The liver of the snail *Littorina littorea* is often infested with larval stages of the bird fluke (flatworm) *Cryptocotyle lingua*. The adult lives parasitically in the bird's intestine (commonly found in the Herring Gull *Larus harengus*) and the fertilized eggs leave the intestine and develop into a larval stage (miracidium) that infect snails. In the snail, the miracidium forms a larval stage called a sporocyst that internally forms several larval stages termed redia. Each redia in turn forms several cercaria. The cercaria leaves the snail and attach to fish where they form a cyst (metacercaria). Birds contract the parasite by consuming infected fish. The metacercaria leaves its cyst and develops into the adult parasite in the bird intestine. Be sure to have students wash hands thoroughly after the activity.

4. Movement of snails on a vertical surface

Refer to photographs of all three species (*Littorina littorea*, *L. obtusata*, and *L. saxatilis*) in the MITZI Image Library. All three species are available, year round, on most rocky shores. *L. saxatilis* lives in the upper rocky intertidal in rock crevices and may also be found in upper tide pools. *L. obtusata* is common on the surface of or underneath brown algae (*Ascophyllum* or *Fucus*) in the brown algal zone while the periwinkle *Littorina littorea* is abundant in the mid to lower rocky intertidal as well as in upper to mid tide level tidal pools.

<<Activity>>

All three species can be kept in a covered container with a small amount of seawater in the refrigerator for one week. Place several snails in a tall glass container (a 1000ml graduated cylinder is ideal) with a small amount of seawater on the bottom. As snails climb upward trace their path with a wax pencil or marking pen and the time it takes them to get there. Next, cover the glass containers completely with aluminum foil and repeat. Discuss the following questions:

- Which species climbs the highest in the least amount of time?
- Is this related to where the snails live?
- Does absence of light affect snail movement?

5. Shell Adaptation in the Dogwhelk

Nucella lapillus, an exercise using statistical analysis. *Littorina littorea*, the periwinkle can be substituted for the dogwhelk. The dogwhelk *Nucella lapillus* is a carnivorous snail (Phylum Mollusca, Class Gastropoda) living in northern temperate waters both in the United States and Europe. It feeds almost exclusively on barnacles and blue mussels by chemically and mechanically drilling a hole through the shell and then consuming the flesh beneath.

- Extension question: Are snails larger in sites protected from wave action than at locations exposed to wave action?

<<Activity>>

Nucella lapillus were collected, at low tide (12:15 PM), from three sites at Rye Harbor State Park, Rye, New Hampshire on 11/20/2000 by Robert Zottoli.

Site 1 (S1) is a boulder field on the northern side of the entrance to Rye Harbor. It is directly exposed to incoming waves. The boulders were generally between 0.25 and 1 meter in length and rested either on other boulders or on a layer of peat formed from a sunken forest. Snails were found either on or underneath exposed rock surfaces.

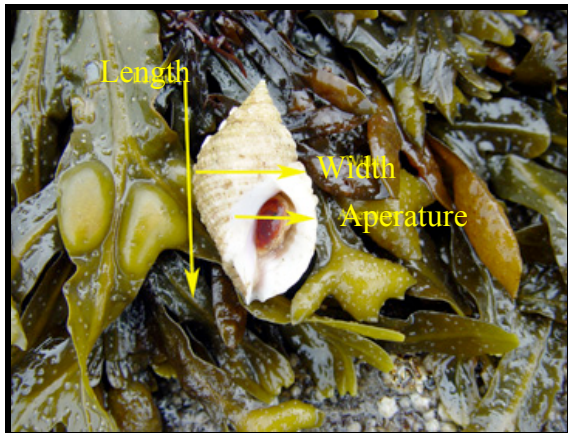
Site 2 (S2) is on the ocean side of the jetty protecting Rye Harbor. It is also exposed to incoming waves. The large granite slabs that make up the jetty, are placed haphazardly, and presumably offer more protection from incoming waves.

Site 3 (S3) is a boulder field, on the northern side, within the harbor, adjacent to the inner side of the jetty. The boulders are about the same size as those in Site 1. Approximately 30 of the largest specimens encountered within each site were collected at about the time of low tide.

- Do you think this is a valid way of collecting specimens? Explain.

The shells of the snails from S1 were marked with red fingernail polish while those from S2 and S3 were marked respectively with pink and black fingernail polish. Snails were then boiled for 3 minutes and removed from their shells with a toothpick or nail.

Shell height, shell width, and shell aperture were all measured for each site to the nearest 0.1 mm with sliding Vernier calipers. See the data below. Calculate the height/aperture ratio for each specimen and enter the data in the appropriate column on the blackboard. Calculate mean values for each measurement. Enter the data into a statistical program and compare mean values between each of the three populations using the t-test.



Discussion:

- Is there a significant difference between the mean values of shell height; shell width; or aperture width between S1 and S2?
- Between S1 and S3? Between S2 and S3?
- Does the data support your original hypothesis?
- What can you conclude from these results?
- Can you think of a way to improve this exercise?

Measurements (mm) of Length, Width, and Aperture width of *Nucella lapillus* from three sites at Rye Harbor, New Hampshire. Descriptions of sites 1-3 are discussed above.

Key to data chart L = length, W= Width, AP= Aperture.
 Site 1 is exposed; Site 2 is intermediate; Site 3 is protected.

Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
L	L	L	W	W	W	AP	AP	AP
27	26.4	30.5	26	16.6	15.8	24.3	16.3	19.4
30	25	32.5	10.6	15	17.4	20	15.3	22.5
27	26	31.9	16.5	11.2	18.9	13.5	11.1	22.3
23.5	25.3	32.4	14	15.6	17.3	16	15.1	19.1
27	25.6	28.2	15	15	15.5	12.3	15.1	19
31	21	28.3	17.4	10.6	15.3	13	14	18.4
25.5	24.6	28.7	14	14	15.9	15.8	15.4	18.9
24	22.4	30	14	12.5	16.8	14.8	14.6	20.3
27.5	24.5	29.5	15.6	13.3	16.9	19.7	15	20.2
28	26.5	33.5	15	14.5	18.4	20	20	20.9
28.5	27	30.7	15.2	15.2	18	18	15.6	16.7
26.3	25.6	29.7	16	14.4	18.2	15.5	15.7	17.4
31.3	25.5	27	18	14.5	17	20.4	16.7	17.6
28.5	21.1	31.2	14.6	11.2	18.3	20	14.7	19.3
27	26.6	29.8	15	14.4	15.8	18	16.4	15.3
24	27.8	28.2	14.6	14.7	16.3	16	16.1	16.6
23.5	27.5	28.4	15.7	14.1	16.8	14.6	17.1	17.6
25.6	26.7	31.5	15.5	14.7	17.8	17	18.3	19
23.8	24.4	31.3	14	12.4	19.3	15.8	17.1	19.7
23.4	24.7	34	15	13.8	19.4	16	16.3	20.8
30.3	26.5	33.5	20.4	15.4	18.3	20.9	14.3	22.7
30.1	25.5	33.1	14	13.3	18.8	15.2	14.6	20.4
20.4	12.1	36.5	14	12.5	21.9	15.2	14.7	23.1
29	12.3	32.5	17.3	14.1	19.2	19.4	14.4	20.1
30	12.1	32.2	15.5	14.4	19.2	15.8	12.8	22.1
25	22.6	29.1	18.7	11.4	17.2	18.8	12.2	21
28.8	22.9	27.2	17.3	12.7	16.1	18.4	15.1	17.3
24.4	21.3	31.4	14.1	12.1	18.3	15.2	12.4	19.9
23.2	25.1	32.3	14.3	14.4	19.5	16.7	24.5	21.1
26.5	22.2	30.2	15.5	13.1	18.2	16.4	14.2	20.4

6. Blue Mussel (*Mytilus edulis*) Anatomy

Refer to the labeled photograph of the blue mussel in the MITZI Image Library. Blue mussels can be collected on intertidal rock surfaces or on the sides of marina or commercial fishing floats. They are also available commercially in many Maine supermarkets or seafood stores.

<<Activity>>

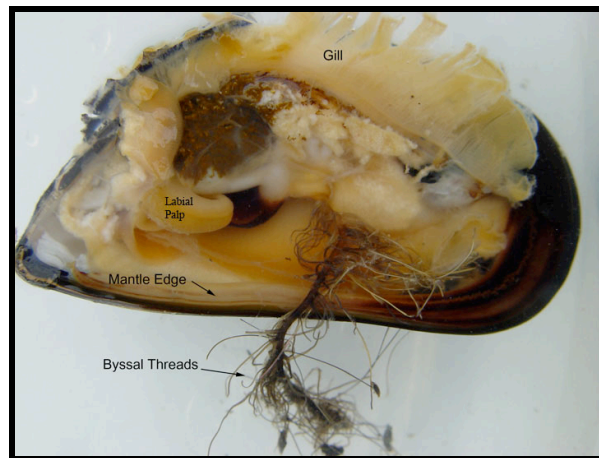
Examine the external surface of the shell. Note the concentric external growth rings. In places where the rings are crowded together, slower growth took place.

- How old do you think your specimen is?
- What is the advantage of a heavy exoskeleton?
- Does it hinder the animal in any way?

The oldest part of the shell is the broad dorsal umbo. The elastic hinge ligament attaches the two shells dorsally.

- What function does the hinge ligament perform?

Right vs. Left Valve - Place the valve in your hand with the dorsal surface facing toward you and the umbo pointing up. If the umbo points toward the right, it is the left valve, and if the umbo is toward the left, it is the right valve. Remove the right valve by first cracking it with a hammer and then carefully remove the shell pieces. You must cut the adductor muscles that hold the shells together. Place the animal in a dish of seawater. The mantle tissue, responsible for secreting the shell along its free edge, covers the surface immediately under the shell. Remove the mantle tissue. It may already have been torn loose. Examine the foot. The byssal threads that attach the animal to the substratum should be visible at the base of the foot.



Find the pair of gills exposed when the mantle tissue is removed. Water is drawn by ciliary action through the inhalant ventral siphon, passes upward through the gill and out through the exhalent siphon. Place some Congo red-stained yeast (red food coloring will also work) or a small amount of mud from the animals' habitat on the surface of the gill and describe its movement. Food is eventually passed from the gill to the labial palps. There is a food groove between the palps that leads into the mouth.

<<Activity con't>>

With a scalpel or dissecting knife, remove a filament (dorsal to ventral) from the gill and examine under the microscope. Describe what you see and make a sketch of the gill tissue paying special attention to the placement of cilia. Note the heart just below the hinge ligament the holds the shells together. The ventricle surrounds the white intestine and has two auricles leading from it.

- Is it still beating? Record the number of beats per minute.

The main purpose of the heart is to move blood through the gills.

- Why is this essential?

Mussels have an open circulatory system.

- What does that mean?

The dark reddish kidney can be seen below the heart.

The visceral mass lies under the gill. It contains the dark green digestive gland (located near the labial palps), the gonad and the intestine. Using a diagram as a guide, carefully slice away the epidermis until you can see the digestive gland, gonad, and portions of the intestine. It's unlikely that you will find the entire digestive tract.