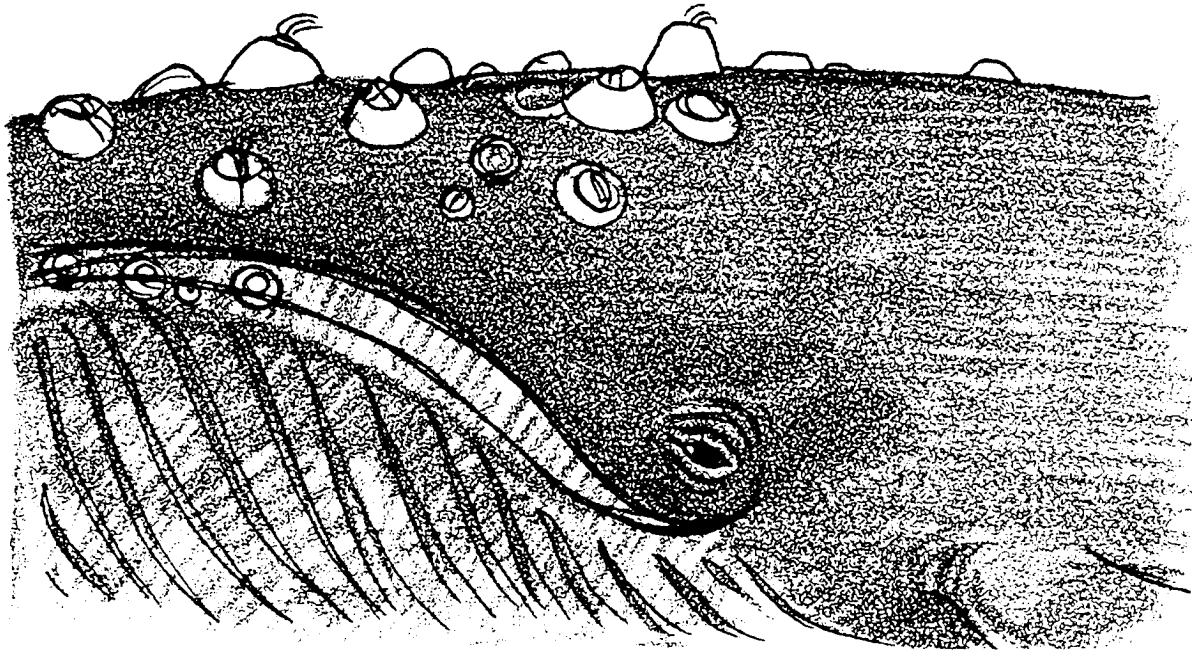
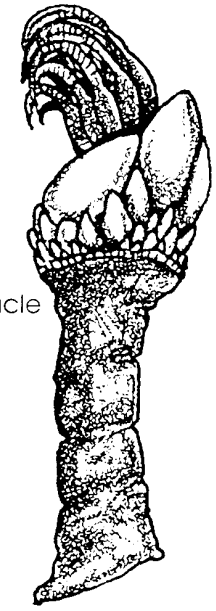
Barnacles: Still Hanging On



If you have been to a rocky or cobbly saltwater beach, you've probably seen or even stepped on a barnacle. These small, white shelled animals are abundant anywhere the salt water is cool and there are solid surfaces to which they can attach. Some species even attach to the backs of whales.

Rock barnacle
Balanus



Adult goose barnacle
Lepas

Barnacles are one of the few rocky shore animals that can live far above the low tide line. Some species live on rocks so far up the beach that they are submerged for only a short time at the highest tides. How can this tough, little animal endure so much time out of the water? How can they survive exposure to very cold temperatures on cold winter nights and very warm temperatures on hot summer days? How can they endure freshwater rainfall and then the influx of salty water at high tide? Who **is** inside that white shell?

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Part 1: Observing Barnacles and Investigating the Effect of Temperature on Cirri Movement

Materials

- live barnacles
- finger bowls
- thermometers
- watch or timer with second hand
- cool salt water (5-10° C or so) or ice in dishes to form an ice bath
- warm salt water (15-20° C or so)

Procedure:

1. Place several living adult barnacles in a finger bowl of cool salt water. Watch the barnacles for a few minutes. Find a barnacle that is opening its shell and moving. Sketch what you see below:

What do you think the barnacle is doing as it moves?

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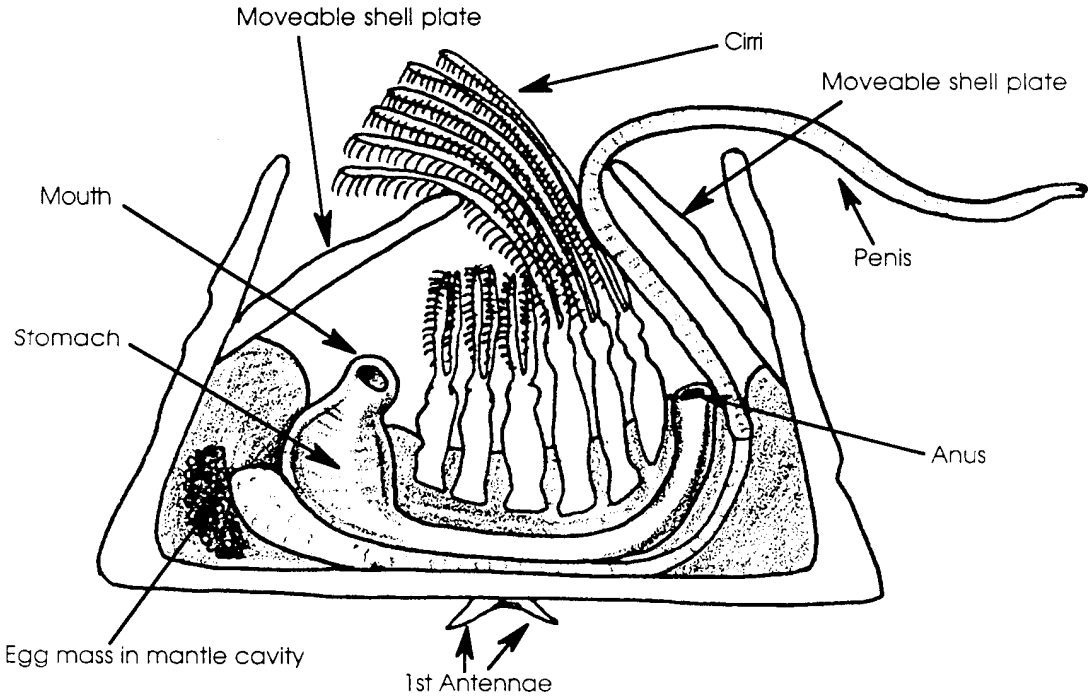
The barnacle is actually a shrimp-like creature living on its back inside a shell. The appendages you see moving are called cirri. The barnacle can absorb oxygen through its cirri. The cirri also form a net that the barnacle uses to capture plankton and bring it into the shell to the barnacle's mouth.



Acorn Barnacle
(part of shell removed to show animal in retracted position)

2. Do you think the barnacle will be more active in cold salt water or warm salt water? Explain your reasoning.

3. Test your prediction.
   a. Make sure your barnacles are in cool salt water, between 5° C and 10° C. Either replenish your dish with cool water or rest your bowl in a larger bowl of ice. Do not let the ice get into the barnacle water because it will melt and reduce the salinity of the salt water.

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b. After the barnacles have sat in the cool water for five minutes, record the temperature of the salt water on the table below.

c. Find a barnacle that is moving. Count the number of times it beats its cirri in one minute. Repeat this two more times and record your counts on the table below.

d. Replace the cool salt water with salt water which is about lO° C warmer than the cool water in the finger bowl. Let your barnacles rest in this water for five minutes. Record the temperature of the water on your data table.

e. Do the barnacles appear to be more or less active in the warm water?

f. Find a barnacle that is moving and count the number of cirri beats in one minute. Repeat two more times and record your data.

Barnacle Data Table - Part 1

Temperature of cool water	Trial	Cirri beats per minute
_____	1	_____
_____	2	_____
_____	3	_____

Temperature of warm water	Trial	Cirri beats per minute
_____	1	_____
_____	2	_____
_____	3	_____

4. Return the barnacles to the cool saltwater aquarium.

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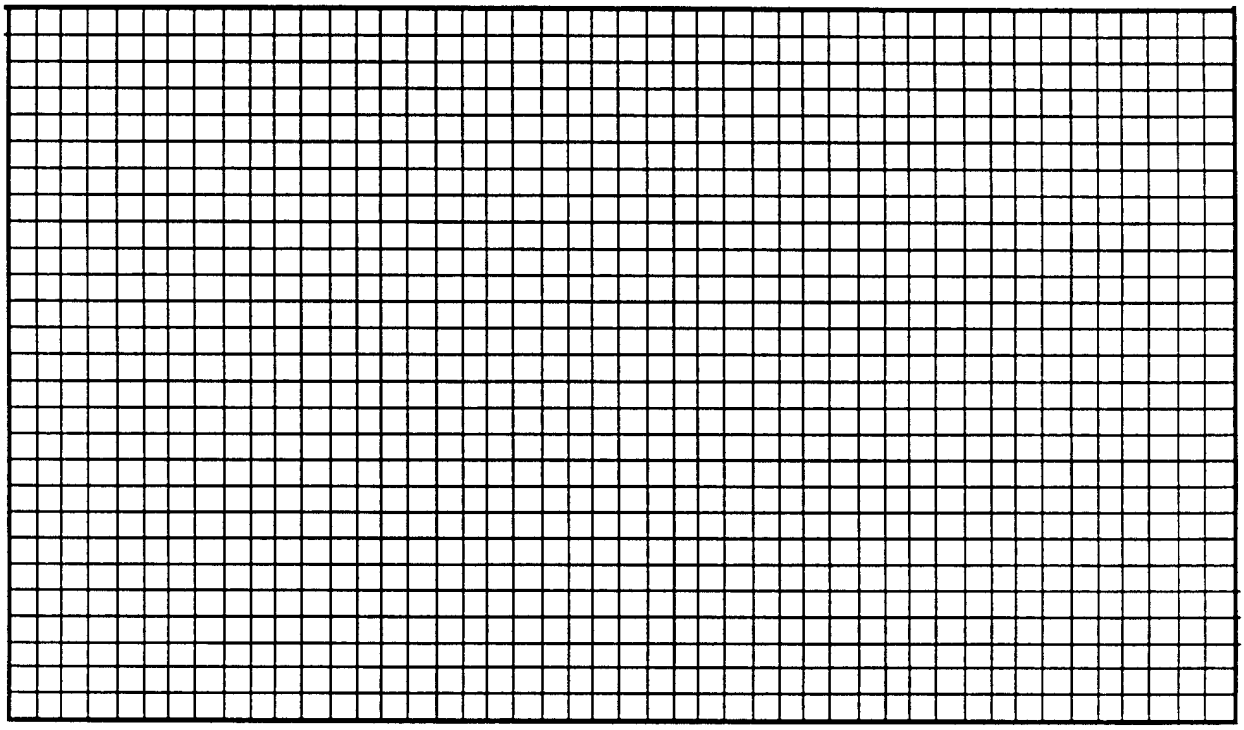
Analysis and Interpretation - Part 1

1. Use the following grid to graph your results. Plot number of beats per minute



on the vertical axis and temperature on the horizontal axis.

2. At which temperature did the cirri beat most rapidly?

3. Observe your graph and the graphs of other students in the class. What is the apparent relationship between water temperature and the action of the cirri?

4. Barnacles are complex animals. There may be many explanations for their behavior. Why do you think they are more active in one temperature than in another?

When the tide goes out, barnacles hold some seawater in their shell, close the plates on top and remain fairly inactive until the tide comes back in. When the water returns, however, they open and move, expelling wastes, acquiring oxygen and sweeping the water for food. The next part of "Barnacles" gives you a chance to feed barnacles and see how they respond.

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Part 2: Investigating Barnacle Feeding

Materials

- live barnacles
- finger bowls
- salt water
- dissecting microscopes
- live brine shrimp (*Artemia sp.*), fine fish food, or plankton sample to feed adult barnacles
- glass stirring rod or eye dropper
- vegetable dye (food coloring)

Procedure:

1. Place several living adult barnacles in a finger bowl of salt water.

2. Center the finger bowl on the stage of a dissecting microscope and do not disturb until the barnacles become active.

3. How many moveable plates do you see covering the opening?

4. Draw a close up view of the cirri, showing any small structures you see that might help them trap food.

Cirri movement actually occurs in two steps. First, there is a slow initial step in which the moveable shell plates open and the cirri protrude and unroll. Then there is a rapid second step when the cirri are projected forward as water is sieved through the filtering hairs on the limbs and withdrawn into the body.

5. Find a barnacle that is moving and count the number of cirri beats per minute in this bowl of sea water. Repeat two more times. Record your data in the table below.

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6. Place a small amount of food on the end of a glass stirring rod or in an eye dropper and offer it to the barnacle. Describe how the barnacle responds to the addition of food. In what ways are their movements different in water with food?

7. After the food has been in the dish for a few minutes, count the cirri beats per minute three times and record your findings on the table below.

Barnacles Data Table - Part 2

	Trial	Cirri beats per minute
Seawater without food	1	_____
	2	_____
	3	_____
Seawater with food	1	_____
	2	_____
	3	_____

8. In general, did the barnacles move more or less often in the water with food?

9. Why do you think the pace of the barnacle cirri movements changes in water with food?

If it is difficult to see the movement of food into the barnacle, use dye to try tracing the currents the cirri create.

10. Use the eye dropper to gently place a drop of vegetable dye near the portion of the barnacle containing the attached ends of the cirri. In the space below, show direction of the water current created by the cirri.

11. How effective are the cirri in moving water past the barnacle?

12. Return the barnacles to the saltwater aquarium.

Analysis and Interpretation - Part 2

1. In nature, what factors might cause the barnacle to close its moveable shell plates?

2. Did all of the barnacles observed behave in the same way when food was added? If not, explain how the barnacles' behavior differed.

3. How might the water currents caused by the moving cirri help the barnacle to obtain food?

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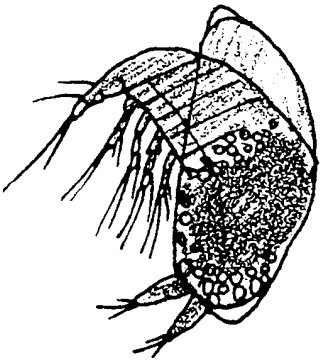
Part 3: Barnacle Life Cycle and Reproduction

Barnacles have to survive periods of exposure during low tide. You have examined ways they capture food and oxygen when the tide does come in. To survive as a species, barnacles also must reproduce. Barnacles reproduce sexually. But how do they do this when they live in small shells attached to rocks or pilings?

Barnacles are hermaphroditic, each individual containing both female and male reproductive organs. Each barnacle has a penis to pass sperm to neighboring barnacles to fertilize their eggs. The fertilized eggs are retained within the barnacle and hatch within about ten days. The young develop in the mantle cavity until they reach the free-swimming nauplius stage. At this stage, the nauplius larva escapes and becomes a free living member of the zooplankton.

Nauplius of barnacle



Cyprid larva of barnacle

The six-legged nauplius molts each three to five days as the animal grows and develops. The mouth and head parts are reduced and the larva develops a bivalve shell resembling a minute clam. The larva now enters the cyprid stage. The cyprid does not feed at this stage of its life cycle. The cyprid larva has six pairs of legs and large antennae. It develops cement glands in the antennae. It crawls about the substrate, testing for an appropriate spot to settle.

The cyprid larva settles to the bottom and attaches itself to a suitable substrate (surface) where it metamorphoses (changes) into an adult. The six pairs of limbs point upward and the mantle secretes calcareous (made of calcium carbonate, like seashells) plates. For the rest of the barnacle's one to seven year life, the plates grow taller and broader at the base to make room for the animal growing inside.

The following activity gives you a chance to observe larval barnacles.

Materials:

- live barnacles
- finger bowls or petri dishes
- fine mesh nylon cloth or plankton net
- dissecting and compound microscopes

Procedure:

1. Obtain living barnacles.

2. Strain the water in which the barnacles were collected or the water in which they were maintained through a fine mesh nylon cloth.

3. Rinse the cloth into salt water in a petri dish or finger bowl.

4. Observe the water under high power of the dissecting microscope and take samples for observation under the compound microscope.

5. In the space below, sketch the larvae you observe:

   a. How many pairs of appendages (legs) do the barnacle larvae you observe have:

   b. What stage(s), nauplius or cyprid, of development have you observed and sketched above?

   c. Label your sketches with the appropriate life cycle stage name(s).

6. Return the water sample to the saltwater aquarium.

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Analysis and Interpretation:

1. Adult barnacles are permanently attached to the substrate. How, then, does the population of barnacles get distributed?

2. Adult barnacles often are found closely crowded on pilings and other submerged objects. What advantage might adult barnacles derive from being crowded together?

3. Some barnacles are found living in the intertidal zone where they are exposed to drying and wetting twice every 24 hours. What adaptation helps prevent barnacles from drying out?