

Barnacles: Still Hanging On

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Key Concepts

1. Many species of barnacles live in intertidal area and are particularly well adapted to endure the stresses of long exposure at low tide.
2. Barnacles extend their cirri and move them through the water to absorb oxygen and collect food.
3. Cirri movements vary with environmental changes.
4. Barnacles are hermaphroditic, reproduce sexually and go through planktonic larval stages before attaching to hard surfaces.



Background

Barnacles are one of the most common rocky shore intertidal marine animals. There are species of barnacles living in all intertidal zones, some are subtidal and some even live on whales. Some barnacles are parasitic and look so different from their free-living barnacle relatives that they were only found to be barnacles because of the presence of a typical barnacle cypris larva stage. But perhaps the most amazing barnacles are those that live in the upper intertidal zones, submerged only for a short time during each tidal cycle. Their endurance is remarkable.

Their adaptations for intertidal life also make them excellent laboratory animals. With just a little care, they can survive some handling in the laboratory and some manipulation of environmental conditions.

Barnacles also make an excellent animal for experimentation because their behavior of moving their cirri through the water is easy to count and changes when environmental conditions change. At the same time, different barnacles can have different behaviors and one barnacle's behavior can change unpredictably. This makes them varied enough to stay interesting. Students will be fascinated watching the movements of the complex animal hidden inside the tiny, ubiquitous barnacle shells.

Materials

Part 1

For each student or pair of students:

- 1 clump of live barnacles
- 1 fingerbowl
- 1 thermometer
- watch or timer or clock with a second hand
- cool saltwater (5-10° C) or ice in large dishes to form an ice bath
- warm saltwater (15° - 20° C)
- “Barnacles” student pages

NOTE: the cool and warm water should have a temperature difference of 10° C or more.

Part 2

For each student of pair of students:

- one clump of live barnacles
- fingerbowls
- saltwater
- dissecting microscope
- live plankton or brine shrimp or fine fish food
- eye dropper (or a stirring rod if using fish food)
- food coloring
- “Barnacles” student pages

Part 3

For each student or pair of students:

- one clump of living barnacles
- fingerbowl
- fine mesh nylon cloth or plankton net
- dissecting or compound microscope
- “Barnacles” student pages

Teaching Hints

“Barnacles: Still Hanging On” requires living barnacles, either collected from a local beach or purchased from a scientific supply company. Please check the laws governing collection of barnacles and other invertebrates before collecting. Many states require permits, most often available from the State Department of Fisheries. It is probably easiest to collect small rocks with their attached barnacles. Collected in this way, they can also be returned alive. Barnacles may be maintained in a saltwater aquarium with relative ease. You can even keep them in a refrigerator if you aerate them periodically with an air pump or by blowing into their water with a straw.

The lab is divided into three sections, which may be performed on successive days, if desired. In the third investigation, a plankton net or fine mesh nylon cloth may be used to collect the larval stages of barnacles. A local plankton shore tow, especially one done during spring, summer or fall, may contain ample larvae.

Circulate through the class as the investigations are being performed. Upon completion of the investigations, plan to provide time for a discussion of the results and techniques, as well as to provide answers to the questions.

Key Words

adaptation - hereditary characteristic of an organism in a population that improves its chances for survival

calcareous - of, containing, or like calcium carbonate

cirri - slender appendages serving as feet

Crustacea - group of arthropod animals (class) possessing a hard shell and including lobsters, crabs, and barnacles

cyprid stage - developmental stage of barnacles characterized by six legs, large antennae, and cement glands

hermaphroditic - characterized by the presence of the reproductive organs of both sexes

nauplius stage - developmental stage of barnacles beginning at about 10 days after fertilization during which the larvae are free swimming; precursor to cyprid stage

substrate - the base on which a sessile (nonmotile) organism lives or grows

taxonomists - scientists who describe, identify, name, and classify organisms

zooplankton - animal plankton

Extensions

1. If time permits, the investigations of the effect of environmental influences on barnacles may be expanded. To observe the role of the cirri in securing oxygen, you may substitute boiled sea water which has less dissolved oxygen in the water. (It is generally observed that the barnacles will increase their beats per minute when placed in water with less oxygen unless that water has no oxygen. Then they will stop moving.)
2. Substitute distilled water and salt solutions of different concentrations for the warm water to show the effect of changes in salinity on metabolism. (It is usually observed that lowering the salinity increases the rate of beating). "Barnacle Beats" in Unit VI: People and the Sea - Estuaries describes in detail how to test the effects of salinity changes on barnacles. The possibilities for experimentation are many.

Answer Key

Part 1

1. Answers will vary. Accept students' hypotheses about what the barnacles are doing as they move.
2. Answers will vary. Accept student predictions about how barnacle movements will vary with water temperature.
3. d. The answer will depend on experimental results. In general, barnacles are more active in warm water. They will slow and stop in water above 25° or 30°C.

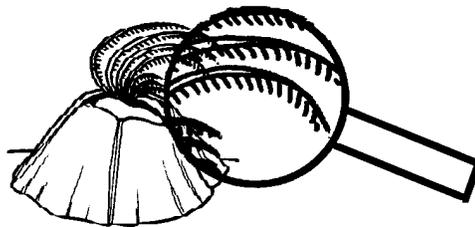
Analysis and Interpretation

- 2., 3. Experimental results will vary.
4. Accept student ideas. You may want to share with students that cold water tends to hold more oxygen than warm water. Barnacles may move more in warm water because they are working harder to get oxygen. In addition, barnacles warm as the temperature of their environment warms, increasing their metabolism and speeding up their activity.

Part 2

3. The opening of an acorn barnacle is covered by two pairs, or four, shell plates.

4.



6. Student descriptions of changes in barnacle movements will vary. The barnacles may speed up or slow down. They may extend more or less completely. They may wave their cirri from side to side instead of opening and closing.
8. Answer depends on experimental results. In general, barnacles either continue to extend and retract their cirri but at a faster rate when food is present in order to catch more food, or they hold their cirri open for a long time allowing food to accumulate. This latter behavior will result in lower cirri counts.
9. Student responses will vary. See explanations for cirri movements in answer #8 above.
11. Answers will depend on what students observe. Cirri usually create a definite water current.

Analysis and Interpretation

1. A receding tide or the threat of a predator would cause a barnacle to close its shell plates.
2. Answers will vary depending on the behaviors students observed.
3. Barnacles feed by setting up a current with their cirri that brings plankton to them. The cirri then trap the plankton and pull it into the barnacle shell to the barnacle's mouth.

Part 3

Analysis and Interpretation

1. The distribution of barnacles is accomplished during the larval stages. The free-floating larvae effectively spread the barnacle population.
2. There are several possible advantages to the crowding seen in adult barnacles. The crowding may serve to trap water and reduce the effects of drying for intertidal species. Crowding facilitates reproduction. Dense aggregations also increase the likelihood of cross-fertilization. It is also possible that the combined beating of numerous cirri may serve to create more substantial currents and move more food and oxygen past the barnacles. Your students will probably have other hypotheses.
3. The most obvious adaptation that helps prevent drying is the moveable shell plates, which may be tightly closed. In addition, the impervious shell also resists drying. The barnacle also traps a small amount of water inside when it closes, thereby reducing the effect of any drying by providing additional moisture. Many of the structures and behaviors observed in studying the barnacle relate to protection from desiccation.