LABORATORY 11. BEHAVIOR: HABITAT SELECTION

OVERVIEW

In this laboratory you will examine the habitat preferences of the brine shrimp, *Artemia*. You will use controlled experimentation to determine the thermal, pH, and light environments selected by *Artemia*. Based on your experience with this laboratory, you will design an experiment that could be used to survey other variables and other organisms.

OBJECTIVES

At the completion of this laboratory you should be able to

- describe the relationship between dependent and independent variables
- discuss the value of comparing experimental results with control results
- graph and interpret histogram data
- measure volumes, distances, and temperature using metric scales
- design and conduct an experiment to measure the effect of environmental variables on habitat selection

INTRODUCTION

Ecology is the study of the interactions of organisms and the environment. Environment refers to all things extrinsic to an organism that impinge on the organism, including both abiotic factors (temperature, wind, pH, moisture, etc.) and biotic factors (predators, parasites, competitors, etc.). Behavior is any observable action or response by an organism or species to both abiotic and biotic environmental factors.

Brine shrimp are small crustaceans that are easily cultured. They occur in salt lakes or brine ponds worldwide. The environmental conditions in these habitats are extreme and, therefore, very few brine-shrimp predators or competitors can survive. Consequently, brine shrimp often develop dense populations. Brine-shrimp habitats are formed by the evaporation of sea water in landlocked bays or lagoons, i.e., salt pans. Brine shrimp are also found inland, as in the Great Salt Lake in Utah.

The distribution of brine shrimp is discontinuous in many places of the world; that is, they do not occur in all bodies of saline water. The main reason for this is that brine shrimp cannot migrate from one saline habitat to another via the oceans because they lack defense against predation by carnivorous aquatic organisms such as larger crustaceans and fish. The principal means of dispersal of brine shrimp is the transportation of brine shrimp cysts by wind and by waterfowl or deliberate inoculation of a suitable habitat by humans.

Life History. Fertilized eggs are deposited as cysts that are dormant under dry or anaerobic conditions. On immersion in sea water, the cysts hydrate and hatch. The larvae grow and differentiate through approximately 15 molts. Adults are approximately 1 cm in length. Brine shrimp are typical filter feeders, ingesting microscopic algae and bacteria. In high-salinity waters, brine shrimp have few competitors for food.

Ecological Characteristics. Most species do not survive at temperatures below 6°C or above 35°C except in the form of cysts. Overall, the optimal temperature for them is 25°C to 30°C. The lowest salinity at which brine shrimp are found in nature varies from place to place and is determined by the upper salinity tolerance level of the local predators. Thus, their physiological adaptation to very high salinity is an ecological defense mechanism to escape from predators. In nature, brine shrimp are found in neutral to alkaline waters. Some brine shrimp demonstrate a positive phototactic response; whereas, some varieties show a negative response.

Design of the Exercise

This lab exercise examines some features of the habitat of *Artemia*. When these freely migrating organisms are placed in gradients of temperature, pH, and light, they select the most favorable habitats. Although the extremes that this organism can tolerate will not be assessed, a segment of the habitat will be defined by the distribution expressed along the gradient.

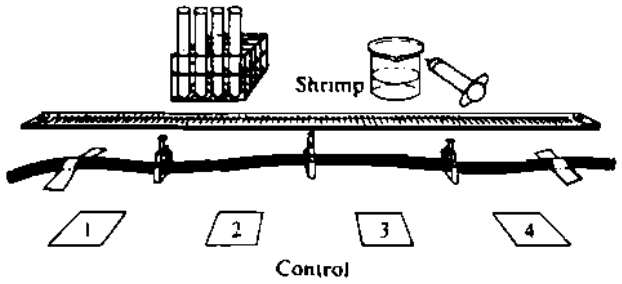
Each student in a group of four is responsible for setting up either the control or one of the three environmental gradients.

EXERCISE 11A: Control

Procedure

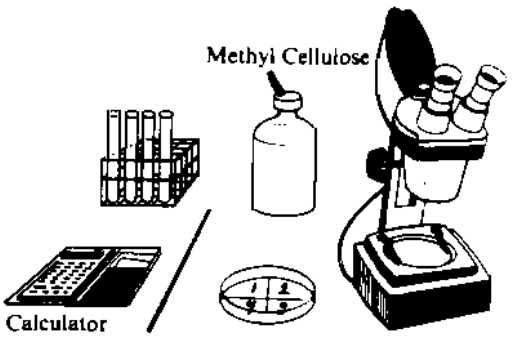
1. Using a syringe, fill a Tygon® tube with about 50 mL of brine-shrimp mixture and cork the ends. Using a meter stick to measure, place three loosened screw clamps 25 cm apart along the tube. Then slip the tube into an opaque cloth sleeve and tape the apparatus to the table. (Your teacher may choose to use aluminum foil to cover the tube.) See Figure 11.1.

Figure 11.1: Control Setup



2. After the control has run 30 minutes, tighten the middle clamp first, then the end clamps, while holding the corks so that they do not pop out. This procedure divides the tubes into four sections.
3. Pour the contents of each section (1, 2, 3, and 4) into a corresponding test tube and mark with a wax pencil.
4. Using a wax pencil, section a petri dish into quadrants to facilitate counting. Shake the first test tube to distribute the shrimp evenly. Using a 1-mL serological pipette or a 1-mL syringe, put a 1-mL sample of shrimp into a petri dish, add a few drops of methyl cellulose or "Proto-Slo®" (it will slow down the shrimp for counting and it will also break the surface tension to spread the sample evenly), and count all the live shrimp. Record the count on a data sheet. Take four more 1-mL samples of shrimp from the first test tube and count the shrimp in each of the samples. Calculate the average of the five counts and record the result on your data sheet. See Figure 11.2.

Figure 11.2: Counting Setup



5. Count the live shrimp in five 1-mL samples from the test tubes of the other three sections of the Tygon® tube.

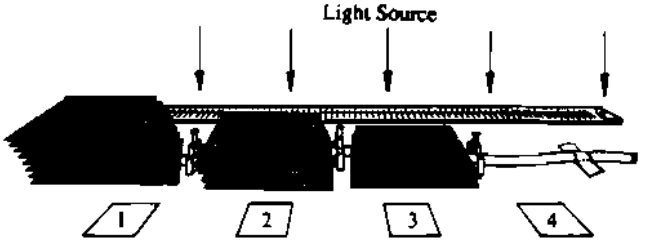
   Note: An alternate method for counting is to pipette a 1-mL sample, hold the sample up to the light, and use the naked eye to count the shrimp in the sample.

EXERCISE 11B: Light Gradient

Procedure

1. With a syringe, fill a Tygon® tube with about 50 mL of brine-shrimp mixture and cork the ends. Using a meter stick to measure, place three loosened clamps 25 cm apart along the tube. Then tape the Tygon® tube below a light source (floodlight, fluorescent light, window, etc.). If a floodlight is used, make sure that the temperature does not get too hot.
2. Cover section 1 with eight layers of screen, section 2 with four layers of screen, and section 3 with two layers of screen; leave section 4 uncovered. See Figure 11.3.

Figura 11.3: Light Setup



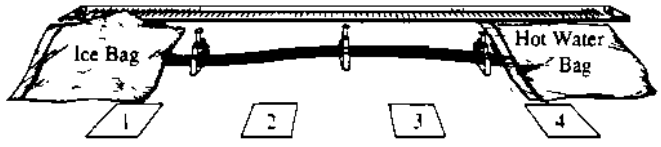
3. After this experiment has run 30 minutes, tighten the middle clamp first, then the end clamps, while holding the corks so they do not pop out. This procedure divides the tubes into four sections.
4. Pour the contents of each section into a test tube marked with a wax pencil (sections 1, 2, 3, and 4).
5. Again, as described in the control, make five counts of the live brine shrimp in each section of the Tygon® tube and record the average on your data sheet.

EXERCISE 11C: Temperature Gradient

Procedure

1. With a syringe, fill a Tygon® tube with about 50 mL of brine-shrimp mixture and cork the ends. Then slip the Tygon® tube into an opaque cloth sleeve. Using a meter stick to measure, place three loosened clamps 25 cm apart along the apparatus. Place one end of the Tygon® tube beneath a hot water bag filled with 60°C water, and the other end beneath a bag of ice. Then tape the tube to the table. See Figure 11.4.

Figure 11.4: Temperature Setup



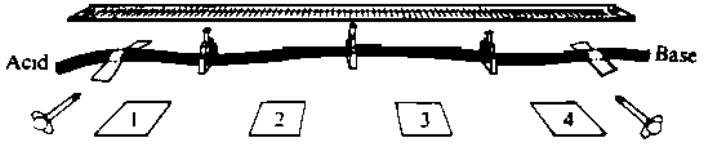
2. Every 10 minutes replace the hot water bag with another hot water bag. After this experiment has run 30 minutes, tighten the middle clamp first, then the end clamps, while holding the corks so they do not pop out. This procedure divides the tubes into four sections.
3. Mark four test tubes with a wax pencil (sections 1, 2, 3, and 4), pour the contents of each section of the Tygon® tube into the test tubes, and **immediately** determine and record the temperature of the contents of each test tube.
4. Again, as described in the control, make five counts of the live brine shrimp in each section of the Tygon® tube and record the average on your data sheet.

EXERCISE 11D: pH Gradient

Procedure

1. With a syringe, fill a Tygon® tube with about 50 mL of brine-shrimp mixture and cork the ends. Using a meter stick to measure, place three loosened clamps 25 cm apart along the tube and lay the tube on the table.
2. Lift an end, remove the cork, and using a pipet, remove 1 mL of the liquid. Try not to remove any shrimp. Refill the end slowly with 1 mL of KOH, and recork. On the opposite end of the Tygon® tube, carefully remove 1 mL of the liquid. Again, try not to remove any shrimp. Refill the end slowly with 1 mL of HCl, and recork. Then slip the Tygon® tube carefully into the opaque cloth sleeve, and tape to the table. See Figure 11.5.

Figure 11.5: pH Setup



3. After this experiment has run 30 minutes, tighten the middle clamp first, then the end clamps, while holding the corks so they do not pop out. This procedure divides the tubes into four sections.
4. Mark four test tubes with a wax pencil (sections 1, 2, 3, and 4) and then pour the contents of each section of the Tygon® tube into the test tubes. If a precipitate forms in one of the tubes, ignore it. Using pH paper, determine and record the pH of the contents of each test tube.
5. Again, make five counts of the brine shrimp in each section of the Tygon® tube and record the average on your data sheet.

Reporting of Data

In the space below, organize your data in a table that shows the results of each sample and the averages of the samples for each section of the control and the three gradients (light, temperature, and pH).

In the space below, for the control and for each gradient, construct histograms of the average shrimp concentration (number/mL) in each section. Label the actual temperature, pH, and light conditions beneath the appropriate section number.