Group Member Names (yours) ______________________________ Biology II --- November 2011

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Oystercatchers and Mussels --- A Natural Selection Simulation

INTRODUCTION

The process of natural selection occurs because organisms vary in their heritable characteristics, and because some variants survive and reproduce better than others. As a result, the genetic structure of a population changes through time, which is a factor in evolution. Although evolution may be defined in terms of genetic change, natural selection occurs by the interaction of the environment and whole organisms, and not directly on their genome. The genome is affected by mutations. In this exercise, we want to reinforce the concept with a demonstration of how natural selection works. It is far too time-consuming to observe natural selection at work in natural populations, so we will use artificial populations consisting of paper dots.

The Black Oystercatcher (*Haematopus bachmani*) is a medium-sized relative of the sandpipers. It lives along the rocky coasts of western North America. Along these coasts, it enjoys a wide-ranging diet of invertebrates, but its favorite food is the mussel. It pries open mussels by stabbing their abductor muscles with their beak so the mussel can't close anymore. Then, *bon appétit*!

In Oregon, Black Oystercatchers commonly feed on mussels. Thus, the population of mussels is kept in check by the oystercatchers feeding on them. However, there is another way mussel populations are kept in check…driftwood. Driftwood is often large and heavy, and when the powerful waves knock the driftwood against the rocks where the mussels live, many mussels can get scraped off and fall into the sea. Once they are separated from the rocks, it is unlikely they will survive and reproduce.

In this activity, you will be simulating natural selection in a population of mussels. The mussels will be represented by the colored dots of paper, someone's fingers will represent the beak of a Black Oystercatcher, and the masking tape on the pencil will represent driftwood.

MATERIALS

- "Habitat mat" (patterned material)
- "Nest" (bowl)
- "Mussels" (Dots of colored paper (10 colors)
- "Driftwood log" (pencil with masking tape)

PROCEDURE

1. Spread out the fabric or paper habitat given to you on the table top.
2. Count out 10 dots of the 10 colors for a total of 100 as your initial population.

   At this point, the procedure is split between 2 categories… (1) the OYSTERCATCHERs and (2) the LOGs. Follow the directions first for the Oystercatchers, then when you're finished collecting data follow the directions for the Logs. DO NOT do the exercise for the Oystercatchers while you are doing the exercise for the Logs. THEY MUST BE DONE SEPARATELY!!!

3. Appoint one person as the mussel (dot) distributor. That person should spread the dots out **randomly** over the entire fabric, making sure the dots do not stick together. *****The other members of the group should have their backs turned during this part of the procedure.**

4. **OYSTERCATCHERS**: The oystercatcher (predator) should turn around and pick off the mussels (prey) one by one until **only 25% remain. COUNT CAREFULLY**. Predators are to take the first dot they see and follow each dot to the nest with their eyes so as not to see more dots, and keep track of the number of dots they "eat." Proceed to step 5.
   LOGS: The log should carefully be rolled, tapped, or otherwise contact the mussels so they get stuck to the masking tape. Check how many mussels you've "killed" often until **only 25% remain. COUNT CAREFULLY.** Proceed to step 5.
5. Carefully shake off the fabric to remove survivors (remaining 25 dots).
6. Group the survivors according to color. Count and record these numbers in the appropriate data table.
7. Assume each survivor produces three offspring. Using the reserve dots, place three dots of the same color with each of the survivors (i.e., for each color dot, take the number of survivors multiplied by 4).
8. Mix these chips together and re-distribute them as in step 3. There should be a total of 100 dots to start each generation.
9. Repeat the entire process five more times, making a total of six generations of mussels being preyed upon/killed.
10. When all data have been collected, construct a BAR GARPH of the **LAST GENERATION** showing the number of mussels on the y-axis and colors of mussels on the x-axis. This must be done for BOTH the Oystercatcher data and the Log data. To compare with other groups, list the colors on the x-axis in alphabetical order.
11. When you're finished with your graphs, we will tape them to the front white-erase board so we can compare them to other groups' graphs.

*******I will collect **ONE** packet per group. The packet will contain the completed data tables and the completed graphs. **EACH PERSON** should turn in the answers to the Discussion Questions.***

Discussion Questions

1. Which, if any, colors of paper dots survived better than others in the fifth and sixth generation?

2. What might be the reason that predators did not select these colors as much as they did other colors?

3. What effect did capturing a particular colored dot have on the numbers of that color in the following generation?

4. Why do all of the Oystercatcher graphs (from the same habitat) look similar and the log graphs look so different?

5. What might happen if color was not heritable (i.e. offspring did not resemble parents)?

6. How would population size and mortality rate affect the outcome for the
   - Oystercatchers?

   - The Logs?

7. What might happen of the population size of the Mussels is
   - Larger?

   - Smaller?

8. The scenario with the Oystercatchers represents **Natural Selection**. What is the *selective pressure?*

9. The scenario with the Logs represents a process called **Genetic Drift**. Why do you suppose it's called this?

10. What if both selection and drift are operating in a population?

11. How can you predict ahead of time which colors will survive on a new color pattern?

12. What if mussels varied in size rather than color (or if larger mussels left larger numbers of offspring)?

13. In addition to natural selection, how might genetic drift, immigration (movement into a population), emigration (movement out of a population), and mutation played a role in adaptation?

14. Consider problems conservation biologists face in the design and management of nature preserves. How will the process of genetic drift, migration and natural selection be influenced by management choices, and how, in turn, will these processes affect organisms in the preserve?

15. Do organisms in nature preserves evolve? Do they do so adaptively?