Exercise in Natural Selection

In this exercise you will explore a population of organisms living within an ecosystem, and simulate predator-prey relationships over several generations that act to modify the population. By the end of the exercise you should have a better understanding of how natural selection can act to change the genetic make-up of a population. The population that you will be exploring that contains various colors (assumed to be an inherited trait), and, as often seen in nature, the simulation will breed "like" organisms, providing offspring are similar to their parents. Adaptive selection in this simulation results from differential mortality: prey with poor camouflage are more likely to be killed by predators.

In this exercise, predators will act as agents of selection on a prey of species whose members vary in color, which we will assume is an inherited trait. Beads of various colors represent the prey, who live in an environment, or habitat, represented by pieces of colored fabric. In this simulation, predators (you) will prey upon the population and remove 75% (30 of the 40) of the original prey. The survivors will reproduce, passing along their color genes to their offspring until the population is restored to its original size.

Materials: Colored beads (prey)
Multi-colored fabric (habitat)
Zip-lock baggies
Data analysis page

Student responsibilities: You will work in groups of four to five students: the "***Mastermind***" has the primary responsibility for carefully reading the instructions, making sure that they are understood, relaying the directions to the other participants, and ensuring that each step is performed properly; the "***Architect***" is in charge of placing pieces in the habitat and distributing them evenly; and the "***Organizer***" is in charge of counting beads and recording data on the data analysis page. The "***Instigator(s)***" are the remaining player(s) and will represent the selecting agent of predation within the environment.
Before you begin: Describe your group's scenario, making sure to describe both the habitat and the diversity of color amongst your initial prey population. Then, complete the following hypothesis regarding potential adaptations against predation: *If camouflage is an effective adaptation against predation, then, through generations...*

Beginning the Exercise:
(1) Have your predators stand with their backs toward the habitat.
(2) The ***Architect*** should then spread the contents of the "initial population" bag around the habitat, making sure that the beads are roughly uniform in distribution across the habitat and not clumped together.
(3) Once beads are spread on the fabric, the ***Organizer*** will signal the predator(s) to turn around and start the process of predation. The predator should turn around, and snatch up a single bead as quickly as possible. Only one bead at a time should be preyed upon, and beads may be detected by vision only, and not by touch (i.e. don't feel around in the habitat for the prey). Once

Note: This activity was adapted from an activity by Linda Kah at the University of Tennessee Knoxville

the bead capture has taken place, the predator must turn their back on the habitat to place the bead in a plastic bag. This forces the predator to simulate a typical predatory pattern of focusing attention not on the general environment, but on very specific prey items.
Note: If there is more than one predator in the group, the predators should take turns, keeping their back turned from the habitat when the other predator is hunting. The ***Organizer*** will need to count off the total number of prey taken, to ensure the survival of 25% of the initial population (10 of 40 beads).
(4) After 75% of the beads (30 of 40) have been captured from the habitat, the ***Organizer***, with aid from the ***Architect***, should remove the remaining beads and count the number of survivors of each color. Record this data on your data sheet.
(5) In order to simulate reproduction, we are going to assume like colors mate: multiply each color by four and collect the appropriate number of new beads. This will convert the habitat back to its original population size for the next "generation". This data will later be presented in a bar graph to help you envision changes in population diversity through time.

- Repeat exercise from the beginning for Generation 2.
- Repeat exercise from the beginning for Generation 3.
- Repeat exercise from the beginning for Generation 4.

Finishing up: Once you have completed your predator-prey simulation through four generations, graph the results on your data analysis page. Describe the results of your simulation below, in a complete paragraph, noting whether your original hypothesis was supported or rejected.

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Exercise 2 – Differing Dynamics of Natural Selection

In this exercise, you are going to simulate three different modes of natural selection: directional selection, disruptive selection, and stabilizing selection. As in the previous exercise, you will be simulating population dynamics using predation as the selecting pressure. I would recommend that you retain the "***Mastermind***" and ***"Organizer"*** roles, but the remaining group members can work together, providing that each set of directions is followed precisely.

Materials: 100 beads
Data analysis sheet

Before you begin: Graph your initial population distribution on the data analysis page.

Directional selection scenario: As active predators, you have learned that "light" prey tend to be sour and generally foul tasting. Considering this factor, one by one remove 50 beads. Make sure that the group Organizer counts off the number of prey that have been captured. Once you are finished, log the remaining population on your data analysis sheet, calculate the new proportions of beads (out of 100%), and graph your new population.

Stabilizing selection scenario: Recombine beads. Imagine an environment where the prey live nestled within green and red leaves. In this scenario, the predators have learned that the more contrast between prey color and leaf color, the easier the prey is to find. Therefore, predators preferentially seek to capture the darkest and lightest colored prey. Considering this, one by one remove 20 beads. Make sure that the group Organizer counts off the number of prey that have been captured. Once you are finished, log the remaining population on your data analysis sheet, calculate the new proportions of beads (out of 100%), and graph your new population.

Disruptive selection scenario: Recombine beads. The predators in this scenario are a lazy bunch – prey is prey and it all tastes the same. The predators therefore always eat the most common beads, because they hate searching for more rare forms. They also continue to eat only one type of prey until it reaches numbers similar to that of the rarest prey. Considering these parameters, one by one remove 50 beads. Make sure that the group Organizer counts off the number of prey that have been captured. Once you are finished, log the remaining population on your data analysis sheet, calculate the new proportions of beads (out of 100%), and graph your new population.

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