Kristy King
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Evolution through Natural Selection

The following activity was designed for the Ecology and Evolution units in a high school Biology class consisting of 25 students. This activity helps students visualize the difficulties predators face when trying to find prey in their habitat. The students also observe changes in population sizes and natural selection.

In this activity, the students become predators with a variety of different mouthparts, and their prey will be a species of bean that comes in four different colors. This is a fun activity for the students even though some of them may become “extinct”.

Background:

The results of natural selection are everywhere. The warning (i.e. aposematic) coloration of a stinging bee, a woodpecker's bill (shaped to extract insects from rotting wood), and the camouflaging (i.e. cryptic) color of a lizard against tree bark have resulted from natural selection.

These changes are the result of non-lethal genetic mutations. The ancestors of organisms alive today had mutations that might have made them slightly better "prepared" for survival in a changing environment than other members of their species (i.e. their conspecifics). Whoever had the most babies won the evolutionary contest!

Supplies:

600 dry beans: 150 black, 150 white, 150 pinto, 150 red
5 tongs, 5 forks, 5 knives, 5 spoons and 5 chopsticks
Gallon-sized Zip-lock bag
25 cups
A lawn

Bean Camouflage vs. Predator Mouthparts:

Many predators rely on visual cues to detect prey. Tasty prey items that are less conspicuous than equally tasty members of their population may have a selective advantage over their more visible conspecifics.

You will scatter a population of 600 *Beanus gooberensis* (i.e. prey), consisting of equal numbers of four color morphs of *B. gooberensis*: 150 black, 150 white, 150 pinto, and 150 red. Which color of bean is best at hiding from predators?

Predators will have one of five different kinds of specialized feeding structures: 5 tongs, 5 forks, 5 knives, 5 spoons and 5 chopsticks. Which type of predator is best able to find and handle bean prey?

Before beginning:

For the prey species:
What is your null hypothesis?

What is your alternative hypothesis?

For the predator species:
What is your null hypothesis?

What is your alternative hypothesis?

Directions:

1. Count out 150 individuals of each of the four available bean color morphs.
2. Place all beans together in the Zip-lock bag and shake well to mix them thoroughly.
3. Predators: There should be equal numbers of predators equipped with each of the five types of feeding apparatuses.
4. The teacher will scatter beans in a pre-determined area on the lawn. On the timer's mark, the predators begin foraging. WARNING! Scatter the beans in a big enough area to allow room for the students to move around and search.
5. Predators will have 90 seconds to capture as many beans as possible and place them in their mouths (cups).
6. At the end of the 90 seconds, predators will band together and count how many of each color bean they have captured.
7. When all predators are ready, they will report the results, and everyone will write the results in Table 1.

Rules:

1. Predators must pick up prey with their feeding apparatus only. No helping with fingers or other objects, including the cups!
2. Predators may not remove prey from a fellow predator's cup, but they may feel free to dash in and 'fight' for any prey being pursued by another predator.

Questions:

1. Which color prey seem to be the best adapted to this lawn environment and its predators? Which is the least adapted? Explain.

2. Which predators seem to be best adapted to exploit this bean-rich environment? Which is the least adapted? Explain.

3. Can you think of any factors besides bean color which could have affected the bean survival? Do you think that only one phenotypic character is primarily responsible for survival in a complex environment? Why or why not?

4. Can you think of any factors besides type of feeding apparatus which might contribute to an individual predator's success (i.e., were any of the predators more aggressive than others? Did any have better or poorer eyesight than the others?)

5. Did any predator or prey type become extinct? Why or why not? If none went extinct, would you predict that any might go extinct over more generations? Which ones, and why?
6. Did the experimental results support or refute your null hypothesis? Can you make a new hypothesis in light of your results? What further tests might you perform on these populations?

Table 1:

Predator	black	white	pinto	red	TOTAL
spoon					
tongs					
fork					
chopsticks					
knife					
Starting # beans	150	150	150	150	600
bean kills					
bean survivors					

References:

"Evolution by Means of Natural Selection." *Research in Ecology - Lecture Notes*. University of Miami, 14 July 2014. Web. 16 Jan. 2015. <http://www.bio.miami.edu/ecosummer/lectures/>.