Activity Description of "The Natural Selection of Forks and Beans"

This lab was modified from an activity authored by Mike Basham and is available on Access Excellence (www.accessexcellence.com)

Abstract:

In this activity, students actively participate as one of four predator species as they attempt to capture as many individuals as possible of four prey species. By maintaining the total number of both prey and predator individuals and by allowing reproduction to occur for successful species, the concept of biological carrying capacity can be simulated. The overall goals of this activity are as follows:

Students will observe how population size can vary from generation to generation in response to changing environmental conditions.

Students will determine which phenotypes (for both predator and prey) are most successful in a given type of environment.

Students will determine how populations of various predator species affect populations of various prey species and visa versa.

Students should prepare graphs comparing population size and generation for both predator and prey populations.

Introduction:

Within every ecological community there exists a variety of several species. In stable communities each of these species tends to maintain a relatively stable population size, particularly when viewed over the long term. This condition is known as equilibrium. However, during times when environmental conditions fluctuate, a new equilibrium must be established. Such is the case in this lab where some sort on environmental perturbation has recently occurred. This lab will explore (simulate) how the forces of natural selection operate to favor certain phenotypes while limiting the success of others as a new equilibrium is established. In this experiment four different prey species (food sources A, B, C, and D) and four different predator species (students equipped with different “appendages”, 1, 2, 3, and 4) will begin at equal levels and as the forces of natural selection act on each, a new equilibrium will be established. The overall goal of this simulation will be to observe the process of natural selection as new population levels are established. Predators will be allowed to "forage" / "hunt" for whichever prey type

they can find. At the end of each "season" reproduction will occur within each predator and prey population. As the forces of natural selection act on each, students will observe how each prey species is affected by each predator species and visa versa. Students will also observe how the environment affects each of the predator and prey species.

Foraging:

Each predator will be allowed to forage for 3-5 min. Each prey item must be scooped up onto the "appendage" and then placed into the cup which must be kept upright at all times. "Shoveling" the prey item into the cup is not allowed.

Generation 1: **Initial Population Counts**

Prey Types

# A= 100	% of Total Prey Population = 25%
# B= 100	% of Total Prey Population= 25%
# C= 100	% of Total Prey Population = 25%
# D= 100	% of Total Prey Population = 25%
Total # Prey= 400	Total % = 100%

Predator Types

# 1=_____	% of Total Pred. Population= ____%
# 2= _____	% of Total Pred. Population= ____%
# 3= _____	% of Total Pred. Population= ____%
# 4= _____	% of Total Pred. Population= ____%
Total # Pred. = ____	Total %= 100%

Generation 2: Starting Population Counts (use table and equations below)

Prey Types

# A= _____	% of Total Prey Population = _____%
# B= _____	% of Total Prey Population= _____%
# C= _____	% of Total Prey Population = _____%
# D= _____	% of Total Prey Population = _____%
Total # Prey= 400	Total % = 100%

Predator Types

# 1=_____	% of Total Pred. Population= _____%
# 2= _____	% of Total Pred. Population= _____%
# 3= _____	% of Total Pred. Population= _____%
# 4= _____	% of Total Pred. Population= _____%
Total # Pred. = ____	Total %= 100%

Generation 3: Starting Population Counts

Prey Types

# A= _____	% of Total Prey Population = _____%
# B= _____	% of Total Prey Population= _____%
# C= _____	% of Total Prey Population = _____%
# D= _____	% of Total Prey Population = _____%
Total # Prey= 400	Total % = 100%

Predator Types

# 1=_____	% of Total Pred. Population= _____%
# 2= _____	% of Total Pred. Population= _____%
# 3= _____	% of Total Pred. Population= _____%
# 4= _____	% of Total Pred. Population= _____%
Total # Pred. = ____	Total %= 100%

Generation 4: Starting Population Counts

Prey Types

# A= _____	% of Total Prey Population = _____%
# B= _____	% of Total Prey Population= _____%
# C= _____	% of Total Prey Population = _____%
# D= _____	% of Total Prey Population = _____%
Total # Prey= 400	Total % = 100%

Predator Types

# 1=_____	% of Total Pred. Population= _____%
# 2= _____	% of Total Pred. Population= _____%
# 3= _____	% of Total Pred. Population= _____%
# 4= _____	% of Total Pred. Population= _____%
Total # Pred. = ____	Total %= 100%

<u>To determine number of prey for next generation</u>

To illustrate the concept of "carrying capacity", the total number of prey individuals will always remain constant from generation to generation. For the 4 prey species, the total number per lab group to start each generation will always be 400. However, the number of individuals per prey species will be determined using the following formulas:

<u>1) Determine the proportion of each species that survives</u>

% of prey of each species for next generation =
# of that species that avoided predation / total # of prey that avoided predation

2) Allow all species to reproduce relative to their survival up to carrying capacity for the community

# of prey of each species for next generation =
% of each prey x 400

To determine the number of predators for the next generation

For this experiment, using lab groups of 3 or 4, we will hold the numbers of each predator species constant so each student may have the opportunity to become more adept at using their particular appendages. However, it should be understood that if the procedure were to continue for many generations, the predator populations would fluctuate as well. This can be achieved by using the following formula:

1) Determine the predation rates of each predator species

% of predator species for next generation = (total number of prey individuals that were captured by that predator species) / (total number of prey individuals captured by all predators)

2) Allow all species to reproduce relative to their predation rate up to carrying capacity for the community

# of predators of each species for next generation = % of each predator x total # of predators

Questions

1. Which prey species did you predict would be captured the most? Why?

2. Which prey species did you predict would be captured the least? Why?

3. Which prey species was actually the most difficult to capture? Which was easiest?

4. Which predator species did you predict would capture the most number of prey? Why?

5. Which predator species did you predict would capture the least number of prey? Why?

6. Which predator species was most successful? Why?

7. How do the adaptations seen here relate to real world adaptations of predators and prey? What can you conclude about how natural selection contributes to adaptation?

8. What conditions of the habitat may have affected the outcome of this experiment? How?

9. Did this help you to understand natural fluctuations in population numbers? What conditions of this experiment were held constant that might actually fluctuate in the real world?

	Prey Avoiding Capture																				
	Gen 1					Gen 2					Gen 3					Gen 4					
Pred	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total	Grand Total
1																					
2																					
3																					
4																					
Total																					
	Prey Captured																				
	Gen 1					Gen 2					Gen 3					Gen 4					
Pred	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total	Grand Total
1																					
2																					
3																					
4																					
Total																					