Natural Selection and Allele Frequencies

Background

In this activity, you will examine natural selection in a small population of wild rabbits. Evolution, on a genetic level, is a change in the percentage of alleles (variation of a gene) in a population over a period of time. Breeders of rabbits have long been familiar with a variety of genetic traits that affect the survivability of rabbits in the wild, as well as in breeding populations. One such trait is the trait for furless rabbits (naked bunnies). This trait was first discovered in England by W.E. Castle in 1933. The furless rabbit is rarely found in the wild because the cold English winters are a definite selective force against it.

Note: In this activity the dominant allele for normal fur is represented by a green bead, and the recessive allele for no fur is represented by a white bead. Bunnies that inherit at least one dominant allele (green bead) have fur, while bunnies that are homozygous recessive (2 white beads) have no fur.

Materials

Green beads, white beads, four containers (1 labeled 'Countryside',1 labeled 'green-green', 1 labeled 'green-white', 1 labeled 'white-white')

Procedure

1. Based on the information in the 'Background', predict and explain what will happen to the frequency of the two beads over time.
2. Place 25 green (representing the dominant allele) and 25 white beads (representing the recessive allele) in the container labeled 'Countryside'. This is our starting population (Generation 1).
    a. The starting frequencies for the alleles are…

$$\frac{25\ green\ beads}{50\ total\ beads} = 0.50 \qquad \frac{25\ white\ beads}{50\ total\ beads} = 0.50$$

3. Without looking at the beads, select two beads from the 'Countryside' container and place them into the appropriate container. This represents the bunnies mating over the course of a year. Tally the number of individuals produced in "Generation 2". Continue selecting and recording until all beads have been drawn. When finished, you should have a total of 25 rabbits.
4. The white-white bunnies are born furless. The cold weather kills them before they reach reproductive age, so they can't pass on their genes. These beads have been eliminated and will no longer be used.
5. Count the green and white beads that were placed in the other containers (they were born with fur and survived) and record the number in the chart in the columns labeled "# of Green Remaining" and "# of White Remaining".
6. Add the number of beads remaining for the second generation and record this number in the column labeled "Total # of Beads Remaining".
7. Calculate the frequencies of the two beads by…

$$\frac{\#\ green\ beads}{total\ beads\ remaining} = Frequency\ of\ Green$$

$$\frac{\#\ white\ beads}{total\ beads\ remaining} = Frequency\ of\ White$$

8. Place the beads of the surviving rabbits (which have grown, survived and reached reproductive age) back into the 'Countryside' container and mate them again to get the next generation.
9. Continue the simulation through 7 generations.
10. Graph your **frequencies of green and white** over the seven generations. Prepare a graph with the horizontal axis as the generation and the vertical axis as the frequency.

Data

Prediction:

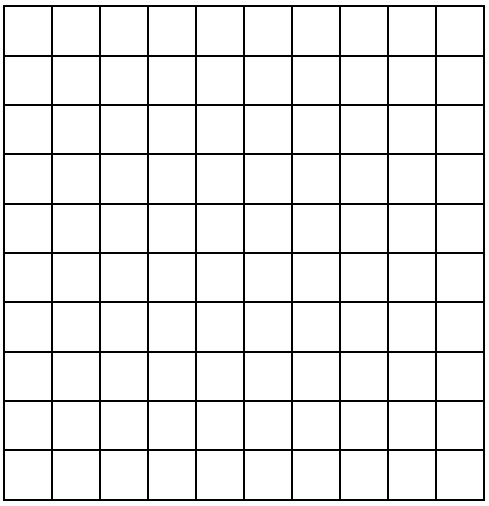
Generation 1 Allele Frequencies:
Frequency of Green – 0.50
Frequency of White – 0.50

Generation	Number of Green-Green Individuals	Number of Green-White Individuals	Number of White-White Individuals	# of Green Remaining	# of White Remaining	Total Number of Beads Remaining	Frequency of Green	Frequency of White
2								
3								
4								
5								
6								
7								

Questions

1. Was your prediction correct? Describe what occurred to the population during the simulation. Refer to your graph.

2. Based on the simulation, is it possible to eliminate all of the white beads? Why? How does this illustrate real populations?



3. In a real rabbit habitat new animals often come into the habitat (immigrate), and others leave the area (emigrate). How might emigration and immigration affect the gene frequency of green and white in this population of rabbits? How might you simulate this effect if you were to repeat this activity?

4. How are the results of this simulation an example of natural selection and evolution?

Adapted from *Breeding Bunnies* http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/act1.html, WGBH, Boston.