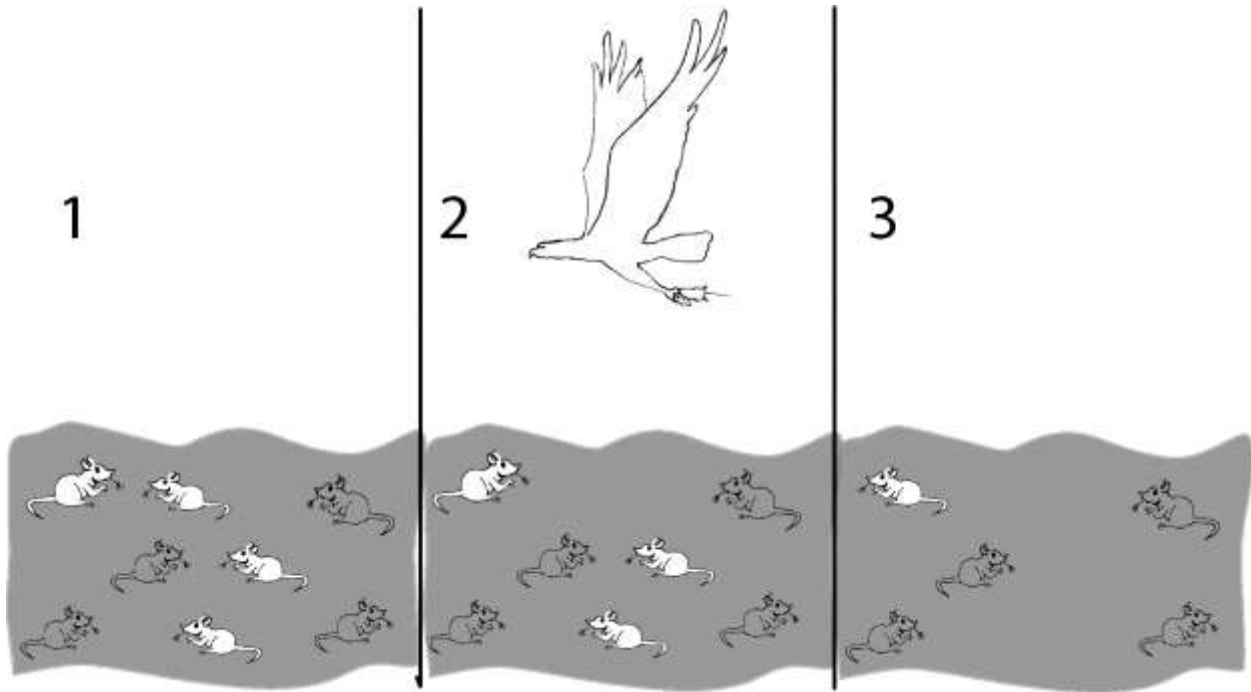


I. Mice Living in a Desert

1. What is happening in these figures? Describe how the population of mice is different in figure 3 compared to figure 1. Explain what happened to cause this difference.



An **adaptation** is any characteristic that increases **fitness**, which is defined as the ability to survive and reproduce.

2. For the mice in the figure, what characteristic was an adaptation that increased fitness?

Suppose a population had three female mice with the following characteristics.

Characteristics of each female mouse	Color of Fur		
	White	Gray	Black
Running speed	5 cm/sec.	6 cm/sec.	8 cm/sec.
# offspring produced by each female	5	19	8
Age at death	3 months	6 months	3 months

3. According to the definition of fitness given above, which of these mice would be the fittest? Explain why this mouse would be the fittest.

Evolution by natural selection

4. If a mouse's fur color is generally similar to its mother's fur color, which fur color would be the most common among the offspring? ___ black ___ gray ___ white

A characteristic which is influenced by genes and passed from parents to offspring is called a **heritable trait**. Fur color is a heritable trait for mice. In general, individuals with a heritable trait that increases fitness produce more offspring than individuals that do not have this trait. Because the trait is heritable, offspring resemble their parents, so more of the offspring will have this adaptive heritable trait. Therefore, over time, adaptive heritable traits tend to become more common in a population. This process is called **natural selection**.

5a. Suppose that one day while the mice were sleeping in their burrows, the gray sand is replaced by white sand. (Perhaps the owner of the desert has a plan to attract more tourists.) Think about what would happen to the population of mice on the white sand. After a year, which color fur do you think most of the mice would have? ___ black ___ gray ___ white

5b. Explain how the change in the color of the sand could eventually result in a change in the most common fur color in this population of mice.

6. When mice live on gray sand, which color fur is an adaptive heritable trait?

When mice live on white sand, which color fur is an adaptive heritable trait?

Notice that which trait is adaptive differs in different environments.

7. What is natural selection? As part of your answer, explain why an adaptive heritable trait tends to become more common in a population.

II. Natural Selection in Action – The Peppered Moth

These photos both show the two major forms of the peppered moth. Can you find the speckled form of the peppered moth on the lichen-covered tree trunk shown below? Can you find the black form of the peppered moth on the tree trunk that has been darkened by air pollution?



Peppered moths are active at night. During the day peppered moths rest on tree trunks and branches. Some of these resting moths are eaten by birds. Researchers have found that mortality is higher for the speckled form of the peppered moth in one type of environment, and mortality is higher for the block form of the peppered moth in a different type of environment.

1a. Which form of the peppered moth do you think had higher mortality in forests in unpolluted areas where tree trunks and branches are lighter? ___ black ___ speckled

Which form of the peppered moth do you think had higher mortality in forests in areas where air pollution had resulted in dark tree trunks and branches? ___ black ___ speckled

1b. Explain your reasoning.

2. The difference between the black and speckled forms of the peppered moth is a heritable trait; specifically, this difference results from different alleles of a single gene. The allele for the black form (**B**) is dominant over the allele for the speckled form (**b**). In the Punnett squares circle the genotypes of all parents and offspring that would have a speckled phenotype. Based on these Punnett squares, explain why peppered moths generally have offspring that look like their parents.

	b	b
b	bb	bb
b	bb	bb

	B	B
B	BB	BB
B	BB	BB

	B	b
B	BB	Bb
b	Bb	bb

Evolution by natural selection

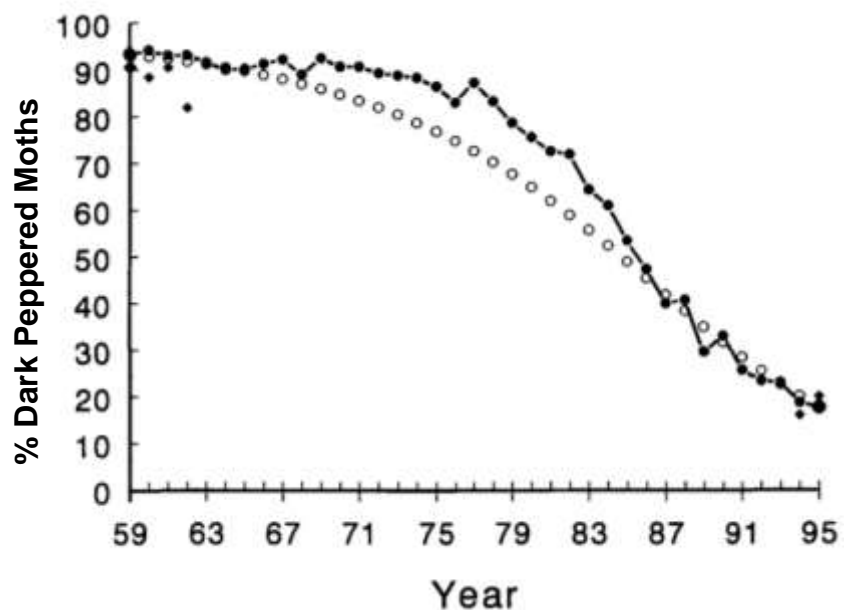
3. In the first column of this table, There are three necessary conditions for evolution by natural selection to occur. In the second column, explain the evidence that each of these necessary conditions is satisfied by the black vs. speckled forms of the peppered moth.

Natural selection can only occur if:	What is the evidence that the peppered moth example meets this necessary condition?
variation in a trait	
the variation in a trait results in differences in fitness	
the variation in a trait is heritable	

Natural selection has occurred in peppered moth populations. The black form of the peppered moth was very rare in England before 1850. After that date, industrialization resulted in air pollution which darkened tree trunks and branches. In industrialized areas with dark tree trunks and branches, the frequency of black peppered moths increased and speckled peppered moths became rare. The trend in southeastern Michigan was similar, although industrialization began later; no black peppered moths were observed before 1929; by the 1950s more than 90% of peppered moths were black.

Beginning in the late 1950s, government regulation resulted in decreased air pollution. Consequently, tree trunks and branches became lighter. As would be expected, there was a decrease in the percent of peppered moths that were black. This decrease is shown for one area in England (black dots) and one area in Michigan (diamonds for 1959-1962 and 1994-1995).

The open circles in the graph represent the trend predicted by a model of natural selection which



incorporated experimental estimates of higher mortality rates for black peppered moths in unpolluted environments.

Evolution by natural selection

4. Use the example of recent trends in black vs. speckled forms of the peppered moth to illustrate the following generalization: Natural selection acts on individuals, but only populations evolve.