Selection on Populations

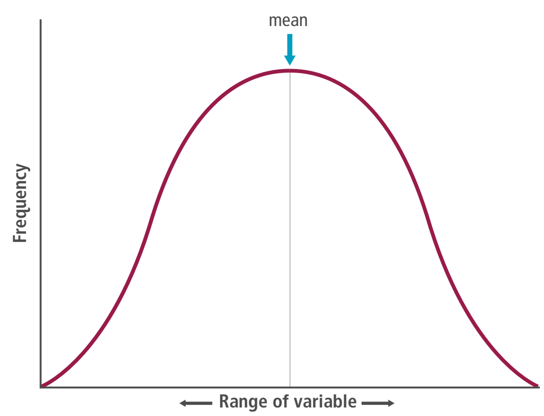
Though king penguins look similar, members of the population differ in some of their physical traits. Some penguins may be larger and some smaller. Some individuals may have long beaks, and some may have short beaks. The majority of penguins have characteristics somewhere between these two extremes.

Normal Distribution

If penguin beak lengths and their frequencies are graphed, the result is a bell-shaped curve, shown in Figure 8. The shape of the curve shows that the beak length of the majority of the individuals is close to the mean length. Mean (also called average) beak length is determined by adding the beak lengths of all the individuals and then dividing the sum by the number of individuals. The graph also shows that there are not many individuals with extreme traits (very short or very long beaks).

Normal Distribution

FIGURE 8: Most individuals in this population have traits that fall between two extreme phenotypes.



Analyze Why do few individuals have very extreme phenotypes, such as very long or very short beaks, and more individuals show a trait somewhere in between?

A normal distribution shows an arrangement of data in which most of the values fall in the middle of the data set, represented by the mean. The curve that results is bell-shaped and symmetrical. The frequency is highest near the mean value and decreases toward each extreme end of the range. This means that for a population showing normal distribution, the alleles for the mean phenotype are more advantageous than the alleles associated with either extreme phenotype.

Changing Populations

King penguins live and breed on islands around Antarctica. Like other penguin species that live in cold areas, king penguins have features that allow them to live in this type of environment. They have layers of feathers as well as thick layers of fat to help keep them warm. Suppose the climate in this area warms up and continues to warm up. How might this continuing change in temperature affect the population?

Collaborate Suppose as a result of increasing temperatures, the trait for having a thick layer of fat was selected against and the thinner layer of fat was selected for. With a partner, discuss how the normal distribution graph will be affected.

FIGURE 9: King Penguins

In populations, natural selection favors phenotypes that allow individuals in the population to adapt to their environment and selects against phenotypes that make individuals less able to adapt to their environment. This "favoring" and "selecting against" result in observable changes in the allele frequencies in a population. Microevolution is the observable change in the allele frequencies of a population over time. Microevolution occurs on a small scale—within a single population.

Stabilizing Selection

In humans, very low or very high birth weight can cause complications that affect a baby's health. Many infants with very low or very high birth weights do not survive to adulthood. Over many generations, these two phenotypes were selected against. More average birth weights, which had fewer weight-related complications, were selected for. Today, the frequency of individuals with an average birth weight is higher than those with extremely low or extremely high birth weights.

Stabilizing Selection

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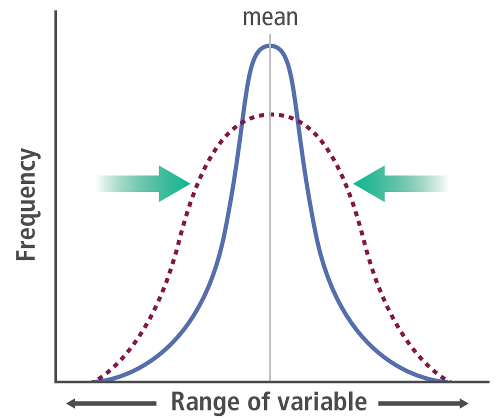
FIGURE 10: In stabilizing selection, intermediate phenotypes are selected over phenotypes at both extremes.



This type of selection is called stabilizing selection. This is the type of natural selection in which intermediate phenotypes are selected over phenotypes at both extremes. In the example of birth weight in humans, individuals with average birth weights were more successful than those with very low or very high birth weights.

In stabilizing selection, extreme phenotypes are selected against. Over time, the survival rate of the individuals with these phenotypes decreases, so the frequency of these traits in the population also decreases. Phenotypes near the mean are selected for, so individuals that express these traits survive and reproduce more effectively than individuals without these traits. This results in an increase in the frequency of these phenotypes in the population.

Directional Selection

Another type of selection can be seen in the case of the peppered moth. Recall that before the Industrial Revolution, there were more sightings of light-colored (*typica*) moths and few sightings of dark-colored (*carbonaria*) moths. As factories were built during the Industrial Revolution, pollution increased. At this time, scientists observed that the number of *typica* moths decreased, while the number of the *carbonaria* moths increased and became more abundant in the population than the *typica* variety.

Model In your Evidence Notebook, draw a normal distribution graph for peppered moth coloration before the Industrial Revolution. Then, show how the frequencies of the phenotypes changed during the Industrial Revolution.

The type of selection observed in peppered moths is called directional selection. This is the type of natural selection in which one extreme phenotype is selected over the other extreme phenotype, shifting the mean toward one of the extremes. In the case of the peppered moths, the dark phenotype was selected over the light phenotype during the Industrial Revolution.

Directional Selection

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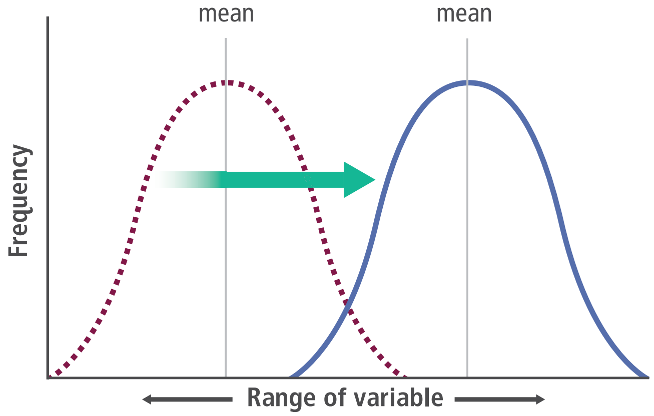
FIGURE 11: After directional selection occurs, an extreme phenotype becomes the more abundant phenotype.



In directional selection, one extreme phenotype becomes more advantageous in the environment. Over time, individuals with this trait are more successful than individuals without the trait. Directional selection shifts the phenotypic frequencies, favoring individuals with genotypes that code for the extreme phenotype. The mean value of the trait shifts in the direction of the more advantageous phenotype.

Disruptive Selection

Lazuli buntings are birds found in the western part of the United States. The male birds have feathers with colors that range from brown to bright blue. The dominant adult males have the brightest blue feathers. They are the most successful in winning mates and have the best territories. For young buntings, the brightest blue and the dullest brown males are more likely to win mates than males with bluish-brown feathers.

Analyze In your Evidence Notebook, compare and contrast stabilizing, directional, and disruptive selection.

Research suggests that dominant adult males are aggressive toward young buntings they see as threats, including bright blue and bluish-brown males. The dullest brown birds can therefore win a mate because the adult males leave them alone. Meanwhile, the bright blue birds attract mates simply because of their color.

The type of selection observed in male lazuli bunting birds is called disruptive selection. This is the type of natural selection in which both extreme phenotypes (brown and bright blue feathers) are favored, while individuals with the intermediate phenotype (in between brown and blue) are selected against.

In disruptive selection, both extreme phenotypes are favored, while intermediate forms are selected against. The middle of the distribution graph is disrupted: individuals with genotypes that code for intermediate phenotypes are less successful that those with genotypes that code for extreme phenotypes. By favoring both extreme phenotypes, disruptive selection can lead to the formation of new species.

Disruptive Selection

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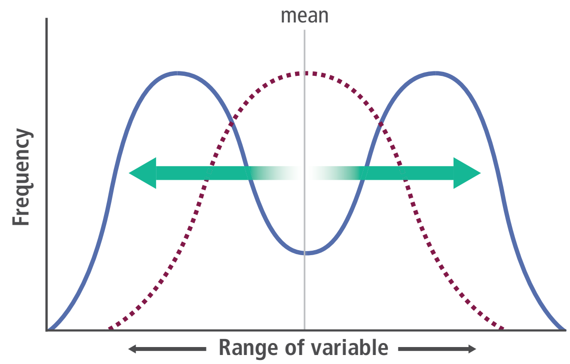
FIGURE 12: In disruptive selection, the extreme phenotypes are selected over the intermediate phenotypes.



Explain Using evidence from this lesson, explain why populations, and not individuals, evolve.