19.3C: Frequency-Dependent Selection

In frequency-dependent selection, phenotypes that are either common or rare are favored through natural selection.

Learning Objectives

• Describe frequency-dependent selection

Key Points

• Negative frequency-dependent selection selects for rare phenotypes in a population and increases a population’s genetic variance.

• Positive frequency-dependent selection selects for common phenotypes in a population and decreases genetic variance.

• In the example of male side-blotched lizards, populations of each color pattern increase or decrease at various stages depending on their frequency; this ensures that both common and rare phenotypes continue to be cyclically present.

• Infectious agents such as microbes can exhibit negative frequency-dependent selection; as a host population becomes immune to a common strain of the microbe, less common strains of the microbe are automatically favored.

• Variation in color pattern mimicry by the scarlet kingsnake is dependent on the prevalence of the eastern coral snake, the model for this mimicry, in a particular geographical region. The more prevalent the coral snake is in a region, the more common and variable the scarlet kingsnake’s color pattern will be, making this an example of positive frequency-dependent selection.
Key Terms

- **frequency-dependent selection**: the term given to an evolutionary process where the fitness of a phenotype is dependent on its frequency relative to other phenotypes in a given population
- **polygynous**: having more than one female as mate

Frequency-dependent Selection

Another type of selection, called frequency-dependent selection, favors phenotypes that are either common (positive frequency-dependent selection) or rare (negative frequency-dependent selection).

Negative Frequency-dependent Selection

An interesting example of this type of selection is seen in a unique group of lizards of the Pacific Northwest. Male common side-blotched lizards come in three throat-color patterns: orange, blue, and yellow. Each of these forms has a different reproductive strategy: orange males are the strongest and can fight other males for access to their females; blue males are medium-sized and form strong pair bonds with their mates; and yellow males are the smallest and look a bit like female, allowing them to sneak copulations. Like a game of rock-paper-scissors, orange beats blue, blue beats yellow, and yellow beats orange in the competition for females. The big, strong orange males can fight off the blue males to mate with the blue’s pair-bonded females; the blue males are successful at guarding their mates against yellow sneaker males; and the yellow males can sneak copulations from the potential mates of the large, polygynous orange males.

Figure 1: Frequency-dependent selection in side-blotched lizards: A yellow-throated side-blotched lizard is smaller than either the blue-throated or orange-throated males and appears a bit like the females of the species,
allowing it to sneak copulations. Frequency-dependent selection allows for both common and rare phenotypes of the population to appear in a frequency-aided cycle.

In this scenario, orange males will be favored by natural selection when the population is dominated by blue males, blue males will thrive when the population is mostly yellow males, and yellow males will be selected for when orange males are the most populous. As a result, populations of side-blotched lizards cycle in the distribution of these phenotypes. In one generation, orange might be predominant and then yellow males will begin to rise in frequency. Once yellow males make up a majority of the population, blue males will be selected for. Finally, when blue males become common, orange males will once again be favored.

An example of negative frequency-dependent selection can also be seen in the interaction between the human immune system and various infectious microbes such as pathogenic bacteria or viruses. As a particular human population is infected by a common strain of microbe, the majority of individuals in the population become immune to it. This then selects for rarer strains of the microbe which can still infect the population because of genome mutations; these strains have greater evolutionary fitness because they are less common.

**Positive Frequency-dependent Selection**

An example of positive frequency-dependent selection is the mimicry of the warning coloration of dangerous species of animals by other species that are harmless. The scarlet kingsnake, a harmless species, mimics the coloration of the eastern coral snake, a venomous species typically found in the same geographical region. Predators learn to avoid both species of snake due to the similar coloration, and as a result the scarlet kingsnake becomes more common, and its coloration phenotype becomes more variable due to relaxed selection. This phenotype is therefore more “fit” as the population of species that possess it (both dangerous and harmless) becomes more numerous. In geographic areas where the coral snake is less common, the pattern becomes less advantageous to the kingsnake, and much less variable in its expression, presumably because predators in these regions are not “educated” to avoid the pattern.

![Figure 1: Lampropeltis elapsoides, the scarlet kingsnake](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/19%3A_T...)
Figure 1: **Micrurus fulvius, the eastern coral snake**: The eastern coral snake is poisonous.

Negative frequency-dependent selection serves to increase the population’s genetic variance by selecting for rare phenotypes, whereas positive frequency-dependent selection usually decreases genetic variance by selecting for common phenotypes.