Dueling Alleles: A Simulation of Genetic Drift and Selection

Overview

We can track the fortunes of a population by noting how the number of individuals rises and falls. However, if we are more interested in the evolution of the population, it would be more productive to keep track of its genes, and how their numbers rise and fall. We track the abundance of an allele by a measure called the allelic frequency.

Say we are studying the B/b locus, and this locus has two alleles, B and b. The frequency of B is defined as the fraction of all the alleles at the B/b locus in a population that are B. For example, if the whole population has the Bb genotype, half the alleles at the B/b locus are B, and the frequency of B is 0.5. If 90% of the population is bb and 10% is Bb, then we compute the frequency of B by reasoning that none of the bb alleles is B and only half of the Bb alleles are B, so the frequency of B, written as [B], is given by

$$[B] = (0)(0.9) + (0.5)(0.1) = 0.05.$$

An allelic frequency can never get higher than 1.0 (at which point the allele is said to be "fixed") and cannot get lower than 0 (at which point the allele is said to be "extinct").

Evolution is a change in allelic frequencies. This change might be adaptive, as when natural selection gradually eliminates a harmful allele, or it might be neutral or even harmful, as when random fluctuations eliminate an allele, reducing the ability of the population to adapt to future changes in the environment.

Dueling Alleles will allow you to simulate both kinds of evolution. Exercise A will allow you to observe genetic drift, which often causes random loss of alleles. Exercise B allows you to experiment with the effect of selection on allelic frequencies.

The Role of Genetic Drift and Selection

The Hardy-Weinberg principle states that five conditions must be met for allelic frequencies to remain constant: (1) no mutation, (2) random mating, (3) large population, (4) no migration, (5) no selection. Under these conditions, evolution will not occur.

Why won't evolution occur under these conditions? _____
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These conditions are so restrictive that they are almost never met in nature, even for short periods. The consequence of this is that allelic frequencies are constantly changing. In this exercise you will use a microcomputer simulation called Dueling Alleles to explore other ways in which population size and selection cause changes in gene frequencies.

Exercise A GENETIC DRIFT

Genetic drift is the change in allelic frequencies that results from the random outcome of matings. An analogy would be a coin toss. If 100 people each tossed coins at the same time, we would be very surprised if exactly 50% of the coins turned up "heads" and 50% "tails" on toss after toss. The same chance deviations from predicted frequencies occur for combinations of alleles. For example, even if the frequency of both B and b is 50% in a population, and BB, Bb, and bb zygotes are all