

## Big Picture

Microevolution is the evolution of one population or one species over a short period of time. We can study microevolution by observing the traits of various organisms within a species and how those traits' purposes fit into the species' ecological niche. We combine our knowledge of Mendelian inheritance and Darwin's theory of evolution to predict how a species will change over time.

## Key Terms

**Microevolution:** Evolution over a short period of time within a small population or just one species.

**Population Genetics:** Combines Darwin's evolutionary theory and the principles of Mendelian inheritance.

**Gene Pool:** All genes in a population.

**Allele Frequency:** How often an allele shows up in a population.

**Genetic Diversity:** How many different alleles there are in a gene pool.

**Hardy-Weinberg Theorem:** Founding principle of population genetics that proves allele and genotype frequencies do not change in a population that meets the conditions of no mutation, no migration, large population size, random mating, and no natural selection.

**Gene Flow:** A change in allele frequencies in a population due to movement in and out of a population.

**Genetic Drift:** A change in allele frequencies in a small population.

**Disruptive Selection:** Type of natural selection for a polygenic trait in which phenotypes in the middle of the phenotypic distribution are selected against, resulting in two overlapping phenotypes, one at each end of the distribution.

**Stabilizing Selection:** Type of natural selection for a polygenic trait in which phenotypes at both extremes of the phenotypic distribution are selected against, resulting in a narrowing of the range of phenotypic variation.

**Directional Selection:** Type of natural selection for a polygenic trait in which one of two extreme phenotypes is selected for, resulting in a shift of the phenotypic distribution toward that extreme.

**Sexual Dimorphism:** Differences between the phenotypes of males and females of the same species.

## Population Genetics

**Population genetics** is a part of **microevolution** that looks at evolution within a population.

- A population is made up of organisms of the same species living in the same area
- Population assumed to be relatively closed group so that mating takes place primarily within the population
- The **gene pool** is made up of all the different alleles for each gene that exist in the population
- The **allele frequency** is how often an allele occurs in a gene pool relative to the other alleles for that gene
  - This is NOT the same as the genotype frequency, because if an organism is homozygous, then it would contribute not one, but two alleles to the allele frequency
- A greater number of different alleles in the gene pool implies that there is a higher likelihood of a greater diversity of phenotypes
  - If there is some sort of huge environmental change, the species with more **genetic diversity** is more likely to survive because its high diversity of phenotypes makes it more likely that there are a few organisms whose traits are better fit to the new environment, thus allowing the species to continue and survive.

## Hardy-Weinberg Theorem

If all conditions of the **Hardy-Weinberg theorem** are met, the allele and genotype frequencies will never change in a population. Because this is not realistic, as it is very unlikely for all five conditions to be met in any particular population, we can use this theorem as the foundation of our understanding the changes in allele frequency in a population. If there is a change in allele frequency, we know that at least one of the conditions of the Hardy-Weinberg theorem was not met. The five conditions of the Hardy-Weinberg theorem are:

1. No mutations
2. No migration
3. Random mating  
(individuals do not choose mates based on genotypes)
4. No natural selection
5. Extremely large population

The Hardy-Weinberg equation is:  $p^2 + 2pq + q^2 = 1$

The variables **p** and **q** represent the frequencies of two different alleles for a genotype, and this equation determines approximately what percentage each allele should occupy, if all the conditions of this theorem are met. **p<sup>2</sup>** and **q<sup>2</sup>** represent homozygous genotypes, while **pq** represents the heterozygous genotypes.

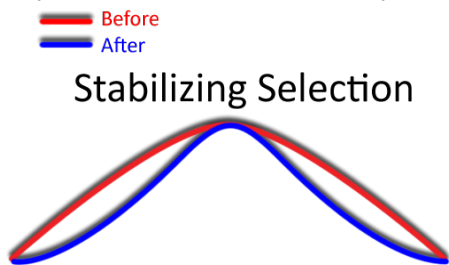
# MICROEVOLUTION CONT.

## Forces of Evolution

- Mutation: Creates new genetic variation needed for other forces of evolution to act.
- Migration results in **gene flow**: When organisms from another population move into a certain population, these organisms bring about alleles that exist in the other population but perhaps not the population they are entering, thus changing the allele frequencies.
- Small population is susceptible to **genetic drift**: This is a natural process as the allele frequencies will not stay the same when passed from one generation to another, just by probability.
- Natural selection: Individuals with greater fitness pass on more genes to the next generation than the other individuals of a population.

## Natural Selection

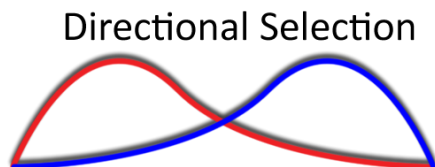
Ways that natural selection affects phenotypes:



### Stabilizing selection

The phenotype distribution is shifted towards the middle, and both extremes eventually die off.

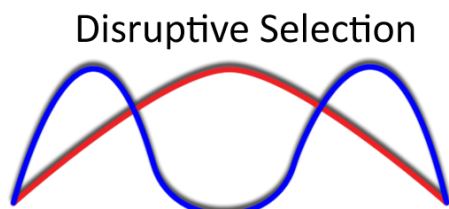
- Example: In a particular environment, there are gray rocks and butterflies of many different phenotypes, including black, white, and gray. Because the butterflies that best camouflage to the environment will likely survive, the gray butterflies, or the intermediate phenotype, will survive. Thus, the phenotype distribution moves away from both extremes and toward the intermediate phenotype.



### Directional selection

The phenotype of the species in the environment will shift towards one extreme over time.

- Example: In a particular environment, there are black rocks, but there are butterflies that are either white or black. The two extremes are black or white, but because the environment favors one extreme, the black butterflies, the butterflies that can camouflage better will not get eaten. Therefore, the phenotype distribution of the butterflies will move towards the black butterflies, and the number of white will decrease.



### Disruptive selection

The phenotypes of this species is distributed between the two extremes, and the number of organisms with the intermediate phenotypes decreases.

- Example: In a particular environment, there are black and white rocks, but the butterflies range in phenotypes from black and white, with an intermediate phenotypes of differing shades of gray. Because the butterflies that camouflage the best with the rocks will survive, the two extreme phenotypes, the black and white butterflies, will survive, but the intermediate phenotypes of gray butterflies will not.

Image Credit: Azcolvin429, CC-BY-SA 3.0

- Another example of disruptive selection is **sexual dimorphism**. As females of a species are allowed to pick males to mate with, males often evolve to have certain traits or behaviors to attract female mates. Over long periods of time, females that are attracted to showy traits or behaviors cause males to develop extremely elaborate physical traits or behaviors.

Figure: This is an example of sexual dimorphism in pheasants. Notice that the male have different colored feathers, and the female's feathers are simple.

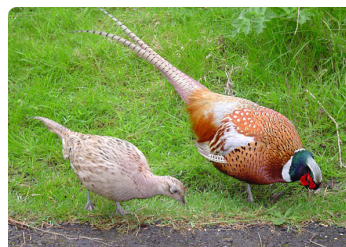


Image Credit: ChrisO, GNU-FDL 1.2

## Notes

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