How does a population evolve?

Outline

1. Key Concepts
2. Individuals Don’t evolve, Populations Do
3. The Hardy-Weinberg Theorem
4. The Microevolution and Natural Selection
5. Genetic drift
6. Gene flow

Key Concepts:

- Individuals of a population have the same number and kinds of genes
- In a population, a gene may exist in different forms
- Microevolution means that changes have occurred in a population’s allele frequencies
- Allele frequencies can change through mutations, gene flow, genetic drift, nonrandom mating, and natural selection
Individuals Don’t Evolve, Populations Do

- **Population** - Is a localized group of individuals that are capable of interbreeding and producing fertile offspring
- **Polymorphism** - traits come in two or more distinct forms
- **Gene Pool** - pool of genetic resources that, in theory, is shared by all members of the population

Polymorphism

A Gene Pool
The Hardy-Weinberg Theorem

- The Hardy-Weinberg Theorem: The frequencies of alleles in the gene pool will remain constant unless acted by other agents.
- This is a theoretical state in which a population is not evolving.
- Only if:
  - There is no mutation
  - The population is very large and
  - Isolated from other populations
  - There is no selection
  - Random mating

The Hardy-Weinberg theorem

- Phenotypes
  - Genotypes
  - Number of parents (total = 100)
  - Number of offspring (total = 1000)
  - Allele frequencies

- Recombination of alleles from first generation (parents)

- Second generation
  - Genotype frequencies
  - Allele frequencies

Punnett Square

<table>
<thead>
<tr>
<th>Genes</th>
<th>Phenotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>AA(p^2)</td>
</tr>
<tr>
<td>Aa</td>
<td>Aa(pq)</td>
</tr>
<tr>
<td>aA</td>
<td>Aa(pq)</td>
</tr>
<tr>
<td>aa</td>
<td>aa(q^2)</td>
</tr>
</tbody>
</table>

- p (A)  
- q (a)
**Frequencies in Gametes**

| $F_1$ genotypes: | 0.49 $AA$ | 0.42 $Aa$ | 0.09 $aa$ |
| Gametes: | $A$ | $A$ | $A$ | $a$ | $a$ | $a$ |
| Frequencies | 0.49 + 0.21 | 0.21 + 0.09 |
| Allele frequencies | 0.7$A$ | 0.3$a$ |

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**Five Causes of Microevolution**

- **Mutations**
- **Gene flow** - Emigration and immigration of individuals (Flow of alleles)
- **Genetic Drift** – Changes in the gene pool of a small population due to chance
- **Nonrandom mating**
- **Natural selection**

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**Natural Selection**

- **Steps in the process of evolution by natural selection**
  - 1. There is genetically-based variation in a population (from random mutation)
  - 2. Some individuals are more fit a certain environment (with certain genetic-based traits have greater reproductive success than others)
  - 3. Individuals with phenotypes that are better adapted to the environment pass more copies of their alleles into next generation
  - 4. As a result, there is a change in allele frequency overtime (= microevolution)
Natural Selection

- Natural selection causes changes in gene frequencies of a population
  - 1. Natural selection does not cause genetic changes in individuals
  - 2. Natural selection befalls individuals, but evolution occurs in populations
  - 3. Only natural selection generally leads to an accumulation of favorable adaptations in a population (Darwinian Changes)

- Natural selection is an outcome of differences in survival and reproduction among individuals

Genetic drift

- Genetic drift
  - Describes how allele frequencies can fluctuate unpredictably from one generation to the next
  - Tends to reduce genetic variation

The Bottleneck Effect

- In the bottleneck effect
  - A sudden change in the environment may drastically reduce the size of a population
  - The gene pool may no longer be reflective of the original population’s gene pool
Bottlenecking is an important concept in conservation biology of endangered species. Populations that have suffered bottleneck incidents have lost at least some alleles from the gene pool. This reduces individual variation and adaptability. For example, the genetic variation in the three small surviving wild populations of cheetahs is very low when compared to other mammals.

Understanding the bottleneck effect
- Can increase understanding of how human activity affects other species

Gene flow
- Causes a population to gain or lose alleles
- Results from the movement of fertile individuals or gametes
- Tends to reduce differences between populations over time