EVOLUTION OF POPULATIONS

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Objectives

1. Define evolution, and list and explain the three key factors for evolution.
2. State the Hardy-Weinberg Principle and list the assumptions behind it.
3. Describe genetic drift, bottlenecks and founder effects.
4. Define selection, and contrast artificial and the three types of natural selection.

Outline

A. Evolution
    1. Population Variation
    2. Key Factors of Natural Selection
    3. Dynamics of Natural Selection
B. Hardy-Weinberg Principle
    1. Mutations
    2. Migration
    3. Nonrandom Mating
    4. Population Size
        a. Bottlenecks
        b. Founder Effect
    5. Selection
        a. Artificial Selection
        b. Natural Selection
        c. Types of Natural Selection
        d. Sexual Selection

A. Evolution

- Descent with modification (Darwin)

- Change in populations over time

- Changes in allele frequencies in populations over time

    - microevolution

- **Individuals do NOT evolve**

1. Population Variation

- Population

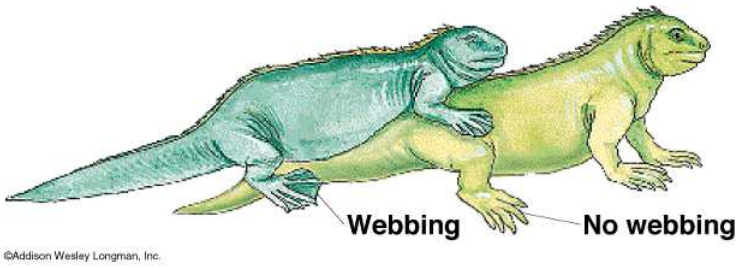
- Population genetics

- Variation within populations
  - Environment

  - Genetics

    - Heritable

      - Discrete Characteristics



      - Quantitative Characteristics

- Fixed alleles

  - Average Heterozygosity

- Variation generally considered good

  - Species can survive more conditions

2. Key Factors of Natural Selection

- Expression of trait varies
    - Not fixed
- Variation in trait is heritable
    - Genetic
- Trait effects fitness
    - Survival
    - Reproduction

3. Dynamics of Natural Selection

- Populations produce more individuals than the environment can sustain
    - Some are more successful than others
        - find food better
        - survive poor times better
        - impress the other sex better
    - Pass more of their genes to the next generation
- Repeat over billions of years

B. Hardy-Weinberg Principle

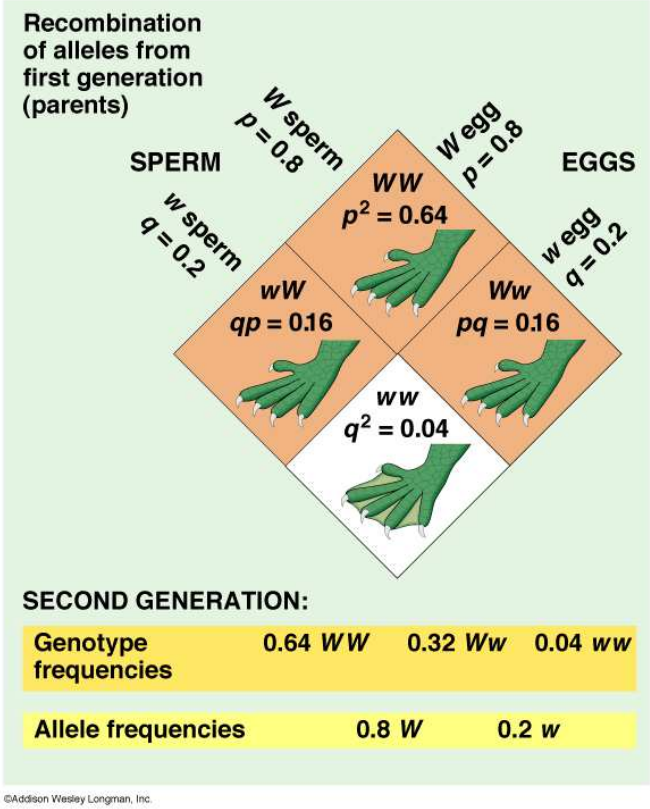
- Gene pool (alleles and genotypes) remain constant within a population

p + q = 1

- p = frequency of allele 1
- q = frequency of allele 2

p^2 + 2pq + q^2 = 1

- p^2 = frequency of homozygote 1
- 2pq = frequency of heterozygote
- q^2 = frequency of homozygote 2

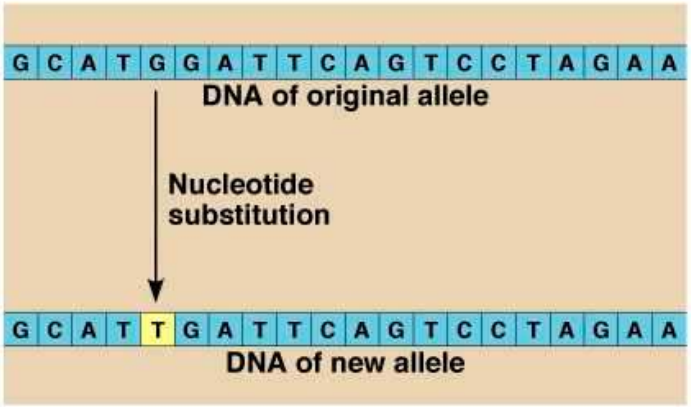


- Requirements
  - No mutations
  - No migration among populations
    - i.e., no gene flow
  - Random mating
  - Population size infinitely large
  - No selection

- All assumptions violated sometimes
    - Violations cause microevolution

1. Mutation

- Generates new alleles
- Ultimate source of new alleles



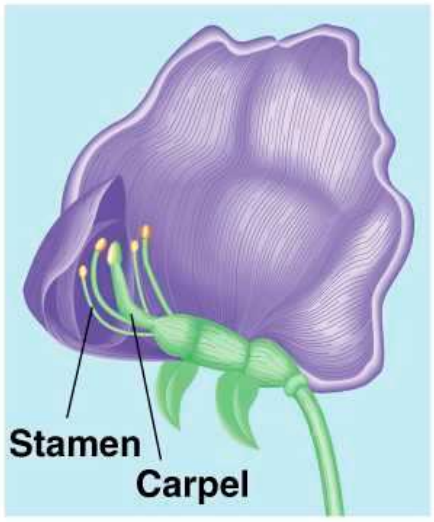
2. Migration

- Gene flow
    - Changes allele frequency
    - Can introduce new alleles

3. Nonrandom Mating

- Inbreeding

- Self fertilization



4. Population Size

- Genetic Drift

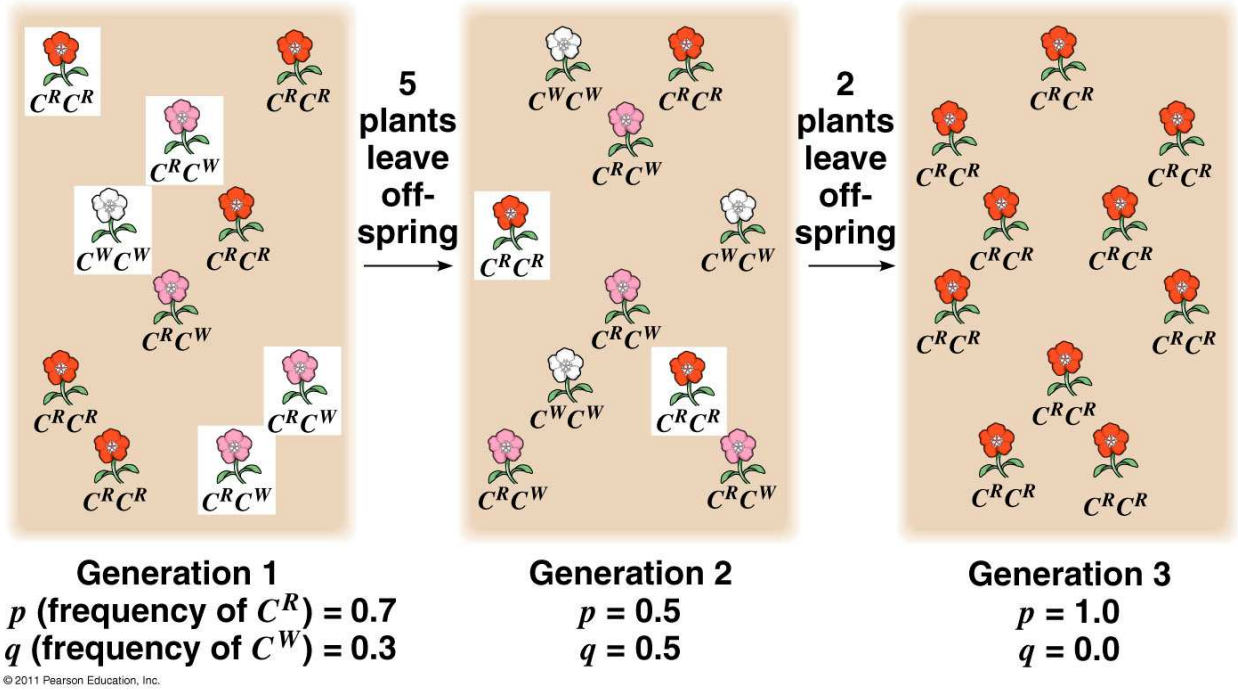
    - Frequencies change due to chance

    - Have little effect on large population

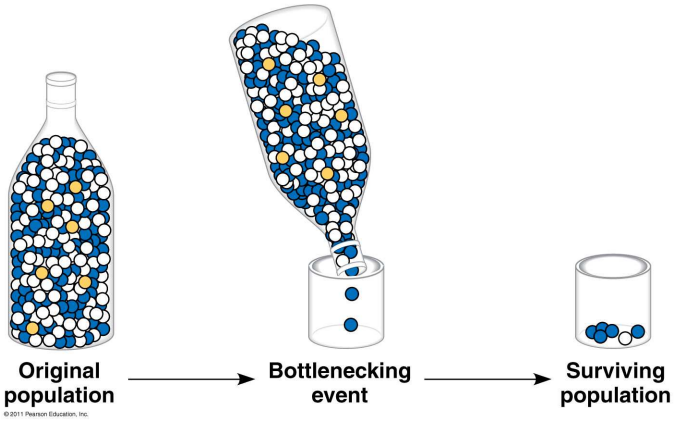
    - Effects greatest in small populations

        - Alleles lost or fix more often

        - Causes loss of genetic variation



a. Bottlenecks



- Population size drastically shrinks
    - Becomes large later in time
- Death of individuals is random
    - e.g., volcanic eruption, habitat loss
- Genetic drift affects population during small population size
    - Variation returns slowly
- Major concern for endangered species

Location	Population size	Number of alleles per locus	Percentage of eggs hatched
Illinois 1930–1960s 1993	 1,000–25,000 <50	 5.2 3.7	 93 <50
Kansas, 1998 (no bottleneck)	750,000	5.8	99
Nebraska, 1998 (no bottleneck)	75,000–200,000	5.8	96

(b)

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b. Founder Effect

- Few individuals begin new population
  - e.g., migrate to new island

- Compared to parent population:
  - All alleles not present
  - Alleles not in same proportion

- Genetic drift affects small population

5. Selection

- Some traits better than others
    - Survive better
    - Produce more offspring

- Acts on **PHENOTYPES**
- Requires variation in trait
    - Passed on if heritable

a. Artificial Selection

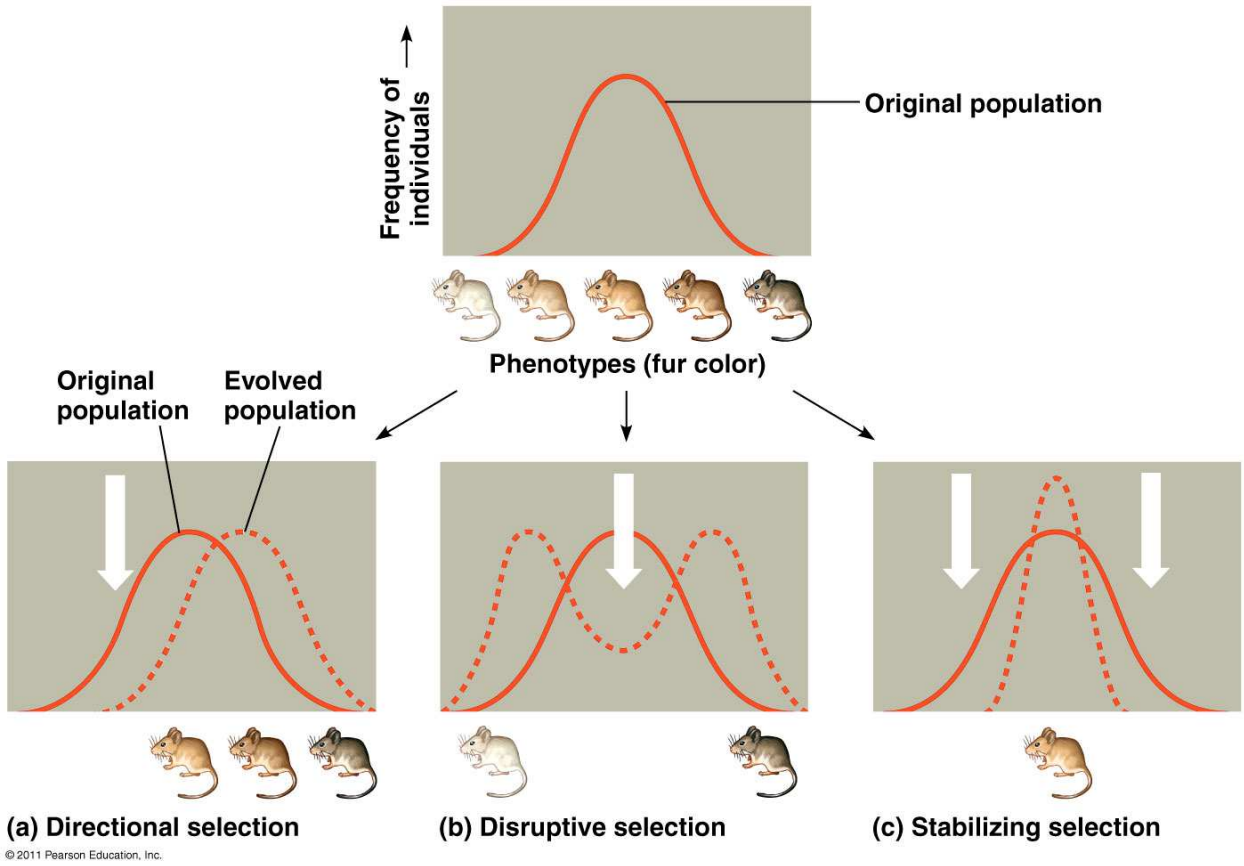
- Human breeds and culls offspring
    - i.e., Human determines survival and reproductive success of individuals
        - Breeder pairs organisms
        - Chooses offspring from mating
        - Mate those that best display trait
    - e.g., cows for most milk production
    - e.g., wheat with highest yields

b. Natural Selection

- Nature determines survival and reproductive success of individuals
    - Individuals choose mate
    - Number of surviving offspring based upon parental traits
        - e.g., fertility
        - e.g., ability to provide food
- Environment selects for better adapted
    - Most fit = most offspring
    - More alleles in next generation
- Developed by Darwin and Wallace

c. Types of Natural Selection

- Demonstrate with a continuous trait



- Stabilizing Selection
    - Width based on severity of selection
- Directional Selection
    - Allele frequency shifts toward extreme
    - Similar to artificial selection

- Disruptive/Diversifying Selection
    - Bimodal distribution of phenotypes
        - dimorphic
        - polymorphic

d. Sexual Selection

- Intrasexual competition
- Mate choice
- “Good Genes” hypothesis
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