Evolution of Populations

Chapter 11

Terms

Population- a collection of individuals of the same species in a common area

These members can interbreed so they share a common group of genes called a gene pool

Gene pool- the combined genetic information of all the members of a particular population. It typically contains two or more alleles for each inheritable trait

Relative frequency- of an allele is the number of times that allele occurs in the gene pool compared with the number of times other alleles occur. Usually expressed as a percentage

Sources of Genetic Variation

1) Mutations
   - Mistakes in the replication of DNA
   - Result of radiation or chemicals in the environment
   - Can form new alleles
2) Recombination
   - Occurs during meiosis
   - Shuffling of alleles results in different genetic combination

- Researchers are looking into hybridization as another source of genetic variation

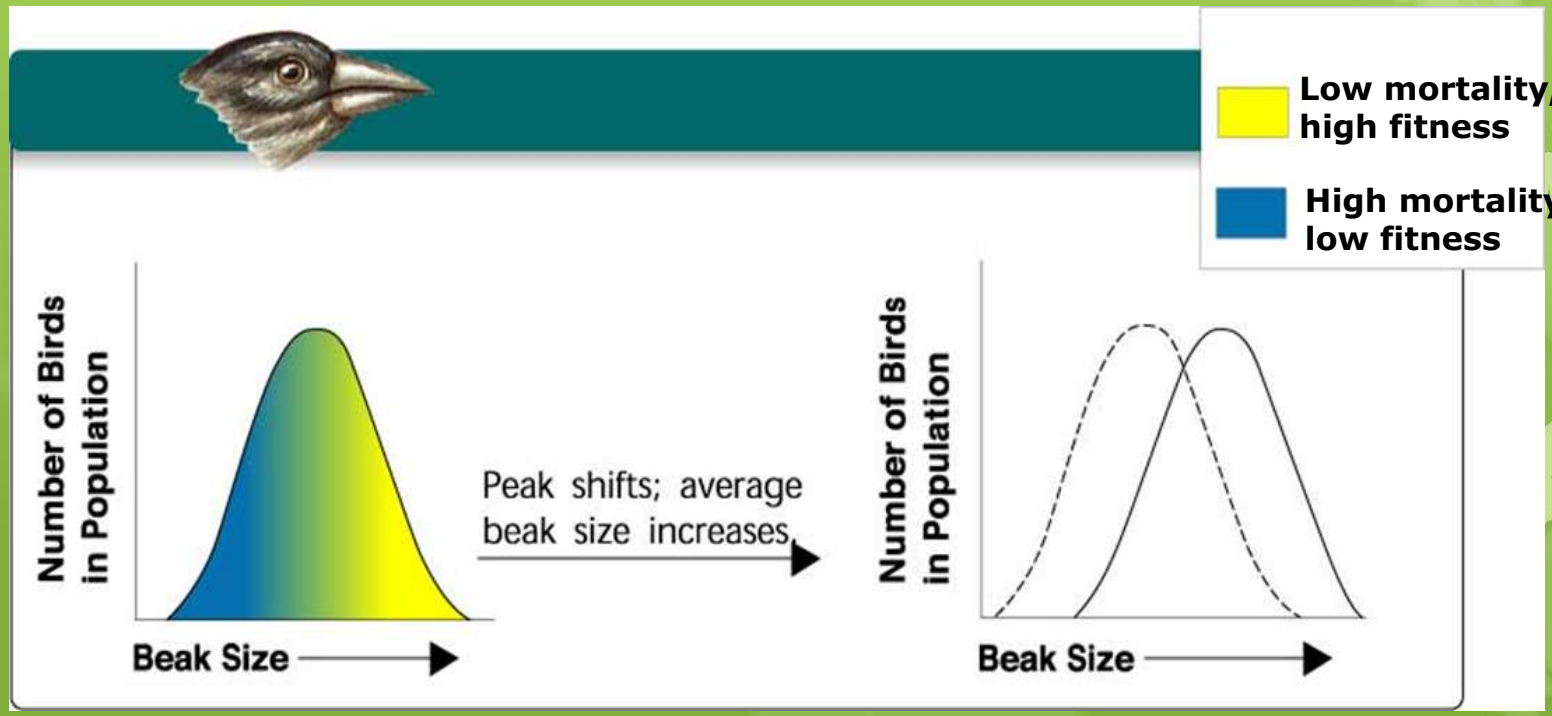
Single Gene and Polygenic Traits

- The number of phenotypes produced for a given trait depends on how many genes control the trait
  - Example: In humans, a widow's peak is controlled by a single gene with only two alleles. As a result there are only two phenotypes
  - Example: Height in humans is controlled by many genes, Skin color
  - A symmetrical bell shaped curve is typical of polygenic traits. This bell shaped curve is called a normal distribution (Fig. 11-2, page 330)

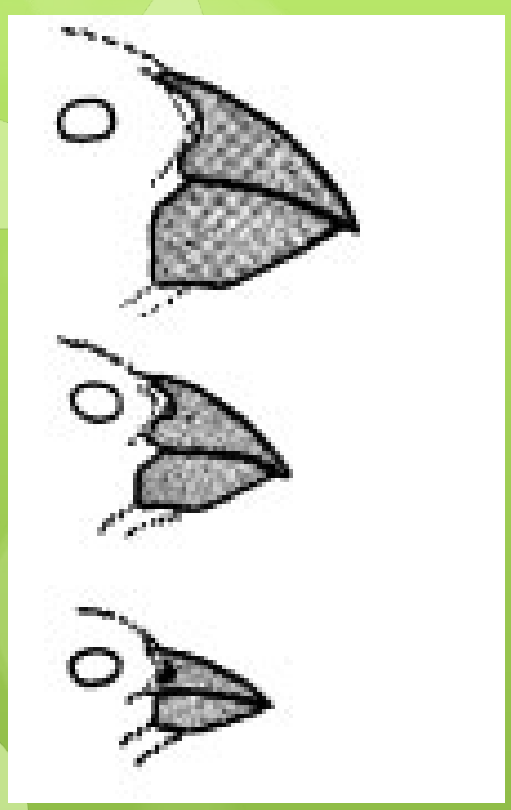
- Natural selection does not work directly on genes. Instead it affects which individuals having different phenotypes survive and reproduce and which do not. In this way, natural selection determines which alleles are passed on from one generation to the next.
- Evolution is any change in the relative frequencies of alleles in a population's gene pool
- **Evolution acts on populations not on individuals**

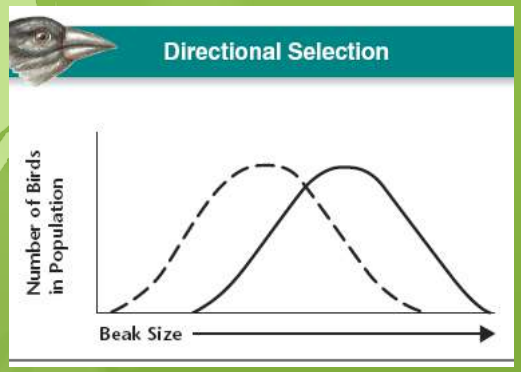
Directional Selection

- Occurs when individuals at one end of the curve have a higher fitness than the individuals in the middle or at the other end. It causes the entire curve to move.
- (Figure 11-3, page 331)



EXAMPLE OF DIRECTIONAL SELECTION





Beak size varies in a population

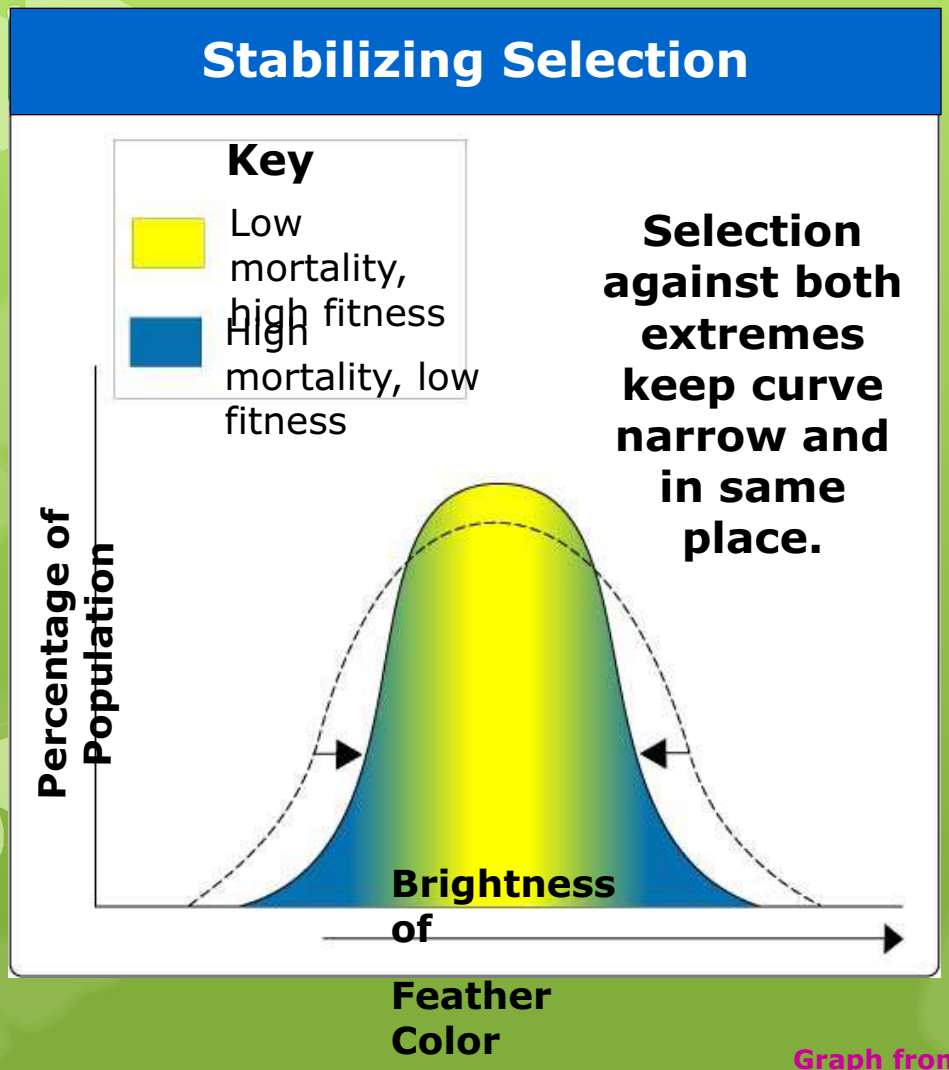
Birds with bigger beaks can feed more easily on harder, thicker shelled seeds.

Suppose a food shortage causes small and medium size seeds to run low.

Birds with bigger beaks would be selected for and increase in num in population.

http://www.animalbehavior.org/ABS/Stars/ONI/Podos_-_finch_graphic.jpg

STABILIZING SELECTION

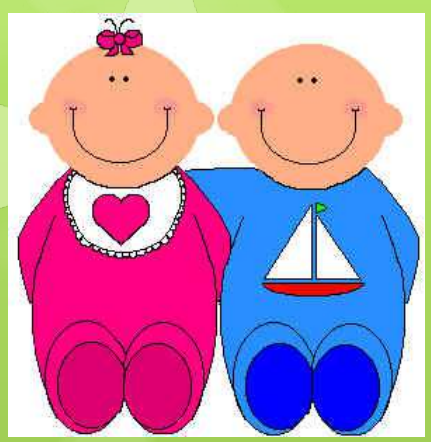


- Occurs when individuals near the center of the curve have higher fitness than individuals at either end.

(Figure 11-5, page 332)

Graph from BIOLOGY by Miller and Levine; Prentice Hall Publishing

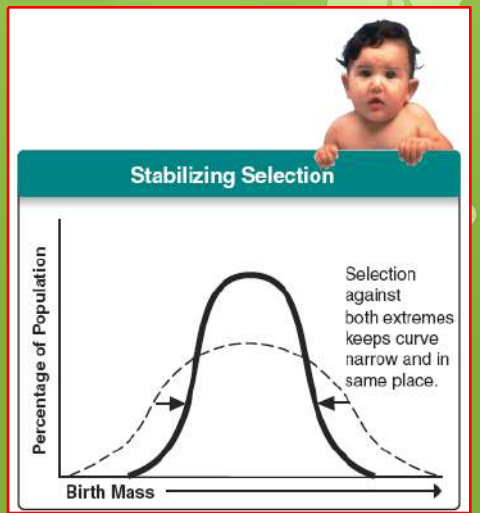
EXAMPLE OF STABILIZING SELECTION



Human babies born with low birth weight are less likely to survive.

Babies born too large have difficul being born.

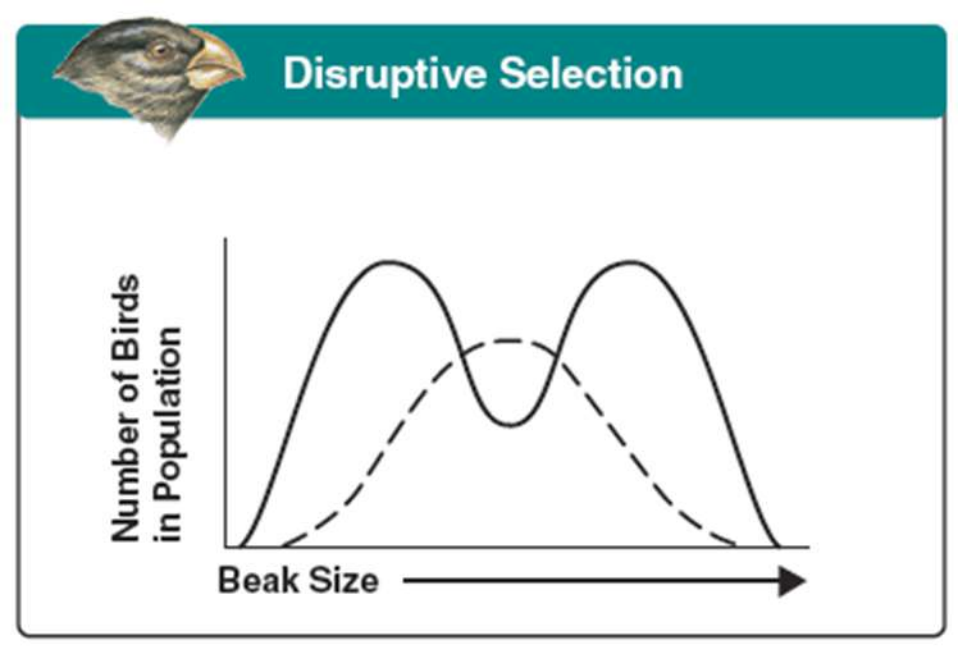
Average size babies are selected f



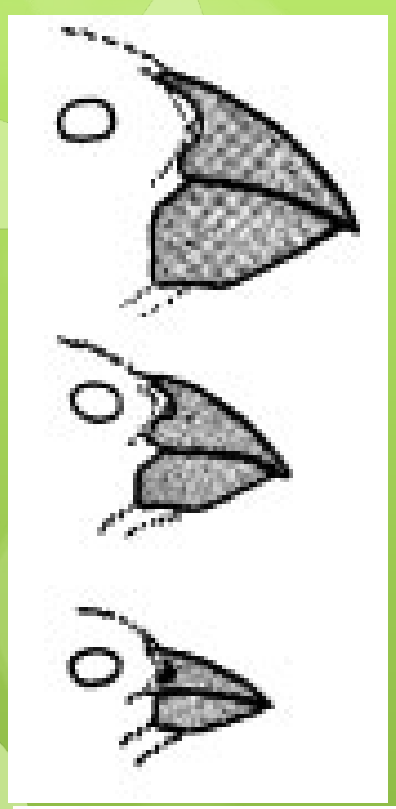
http://www.animalbehavior.org/ABS/Stars/ONI/Podos_-_finch_graphic.jpg

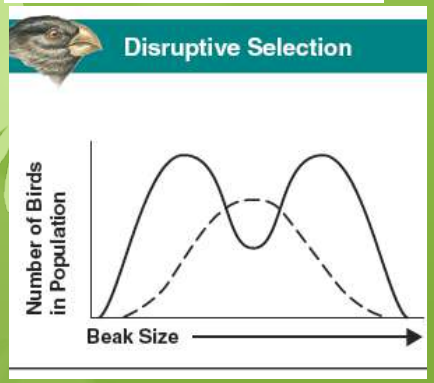
Disruptive Selection

- Occurs when individuals at the upper and lower ends of the curve have higher fitness than the individuals near the middle. (Figure 11-6, page 333)



EXAMPLE OF DISRUPTIVE SELECTION





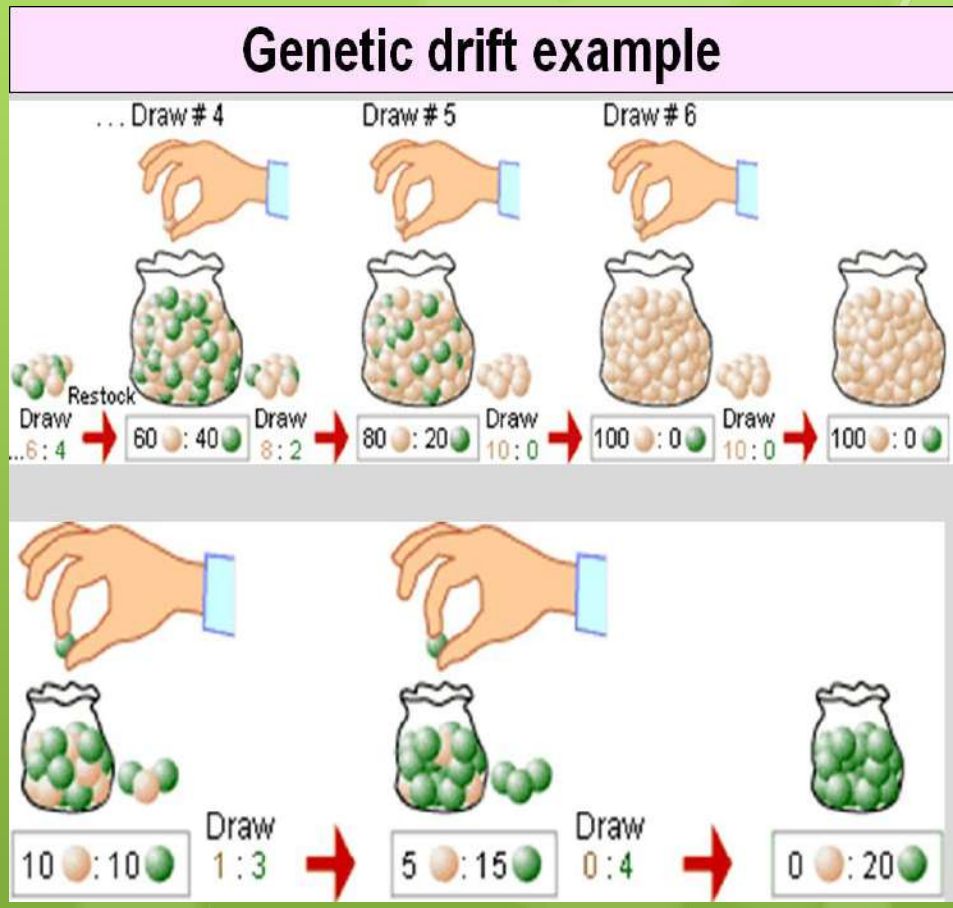
Suppose bird population lives in a where climate change causes med size seeds become scarce while la and small seeds are still plentiful.

Birds with bigger or smaller beaks would have greater fitness and the population may split into TWO GROUPS. One that eats small seeds and one that eats large seed

http://www.animalbehavior.org/ABS/Stars/ONI/Podos_-_finch_graphic.jpg

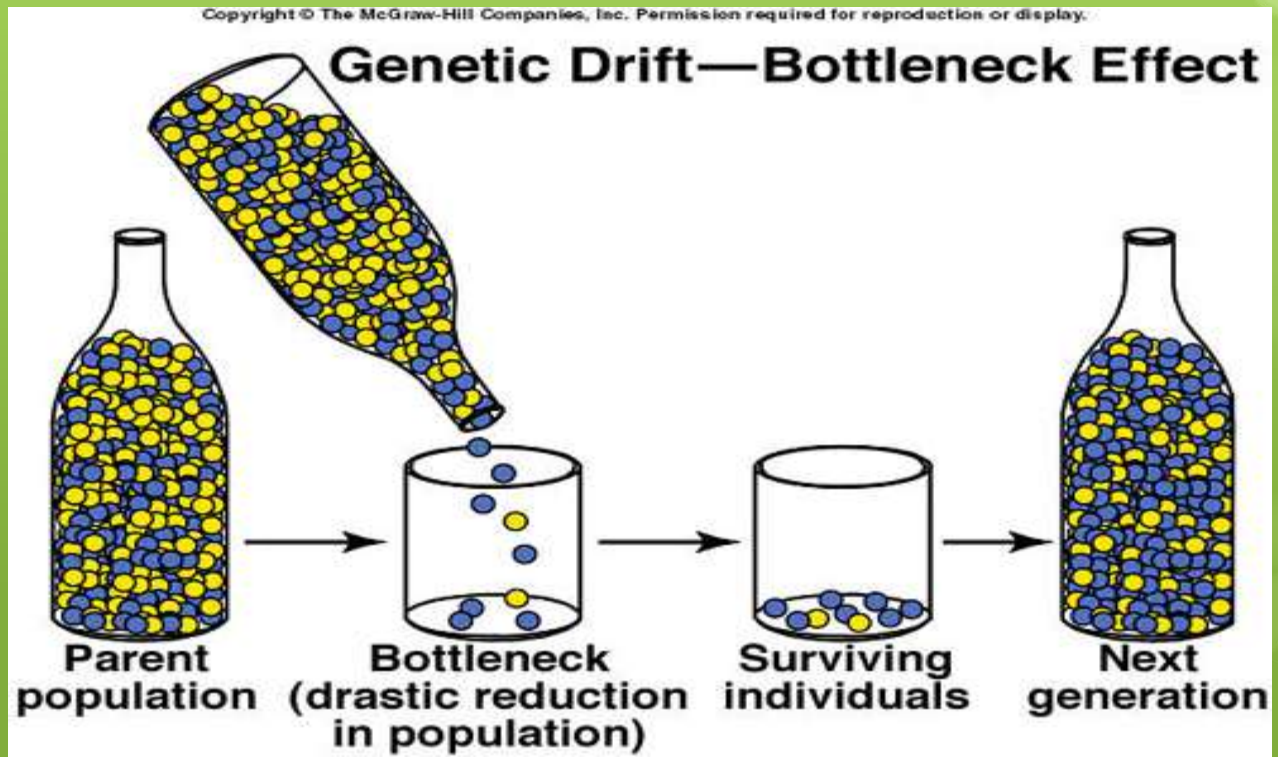
Genetic Drift

- In small populations, an allele can become more or less common simple by chance. This kind of random change in allele frequency is called genetic drift.
- Causes a loss in genetic diversity within a population.



Bottleneck Effect

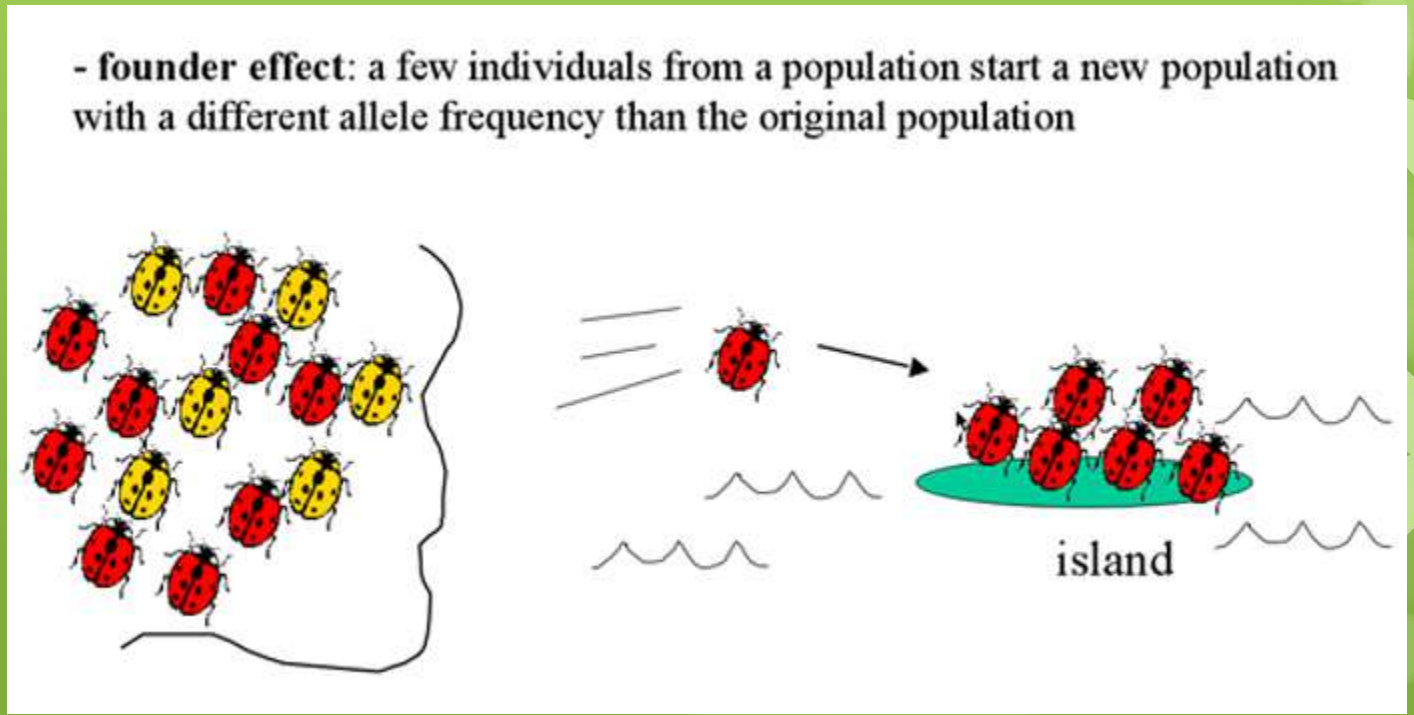
- A genetic drift event that occurs after an event that greatly reduces the size of a population.
- Leaves only a few survivors in a population.



Founder Effect

- A situation in which allele frequencies change as a result of migration of a small subgroup of a population is known as the founder effect

(Figure 11-8, page 337)



Sexual Selection

- Occurs when certain traits increases their mating success.
  - Intrasexual selection involves competition among males, whoever wins, wins the female
  - Intersexual selection occurs when males display certain traits that attract the female

Evolution vs Genetic Equilibrium

- The Hardy-Weinberg principle states that allele frequencies in a population will remain constant unless one or more factors cause those frequencies to change. The situation in which allele frequencies remain constant is called genetic equilibrium. If the allele frequencies do not change the population will not evolve.

Genetic equilibrium

- Five conditions are required to maintain genetic equilibrium from generation to generation
  - There must be random mating
  - The population must be very large
  - There can be no movement into or out of the population
  - No mutations
  - No natural selection

5 factors for evolution

- Genetic drift: allele frequencies change due to chance
- Gene flow: movement of alleles from one population to another
- Mutation: new alleles form
- Sexual selection: traits improve mating success
- Natural selection: certain traits are advantageous

The Process of Speciation

- Speciation- the formation of a new species
- As new species evolve, populations become reproductively isolated from each other. When members of two populations cannot interbreed and produce fertile offspring, **reproductive isolation** has occurred.

Reproductive isolation

- Can occur in a variety of ways including
  - Behavioral isolation – occurs when two populations are capable of interbreeding but have differences in courtship rituals or other types of behavior.
  - Geographic isolation – occurs when two populations are separated by geographic barriers such as rivers
  - Temporal isolation – occurs when two or more populations can interbreed but they only reproduce at different times

Patterns of Evolution

- Macroevolution refers to the large scale evolutionary changes that take place over long periods of time
- Six important patterns of macroevolution are
  - Mass extinctions
  - Adaptive radiation
  - Convergent evolution
  - Coevolution
  - Punctuated Equilibrium
  - Changes in developmental genes

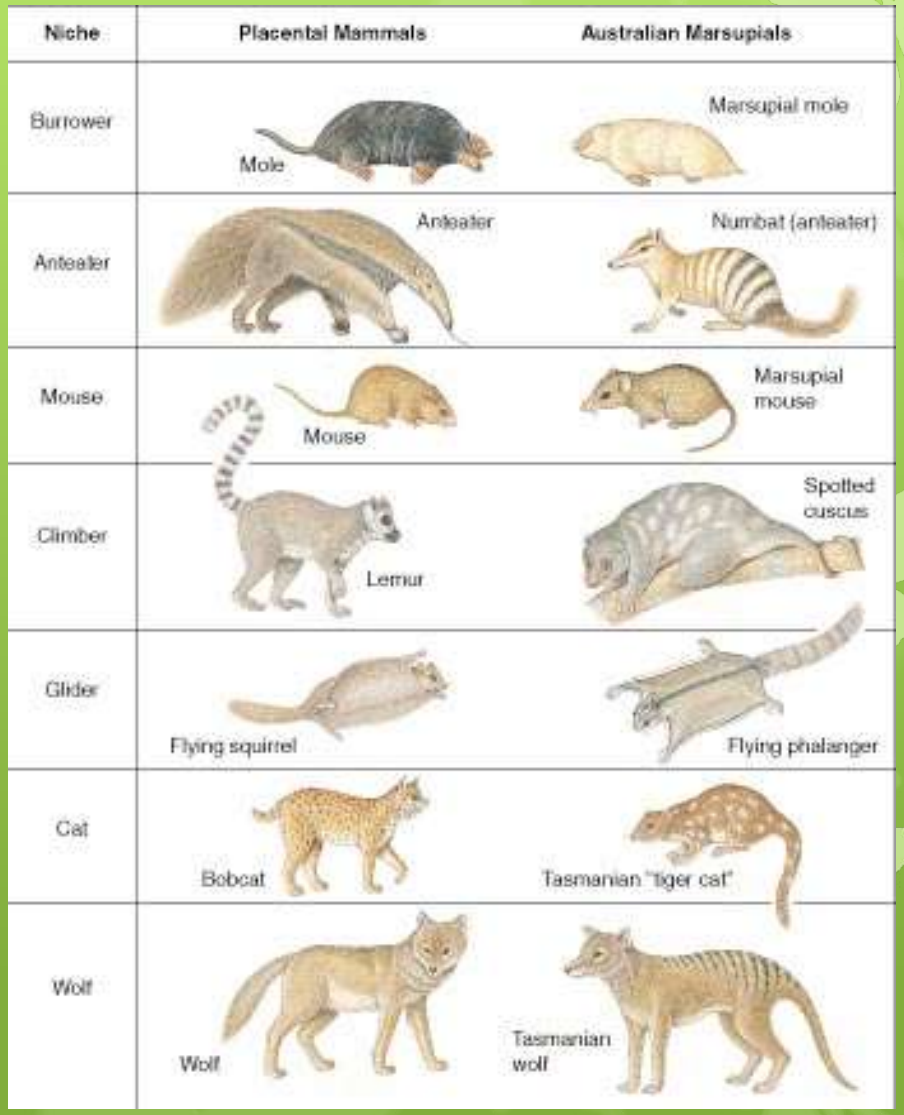
Convergent Evolution

- The process by which unrelated organisms come to resemble one another
- Note: structures which look and function similarly but are made up of parts that do not share a common evolutionary history are called **analogous structures**

These organisms face similar environmental demands

Divergent Evolution

- When closely related species evolve in different directions.
- May have different appearances that result from adapting to different environments.



Coevolution

- The process by which two species evolve in response to changes in each other over time. An evolutionary change in one organism may also be followed by a corresponding change in another organism

The Acacia plant and ants

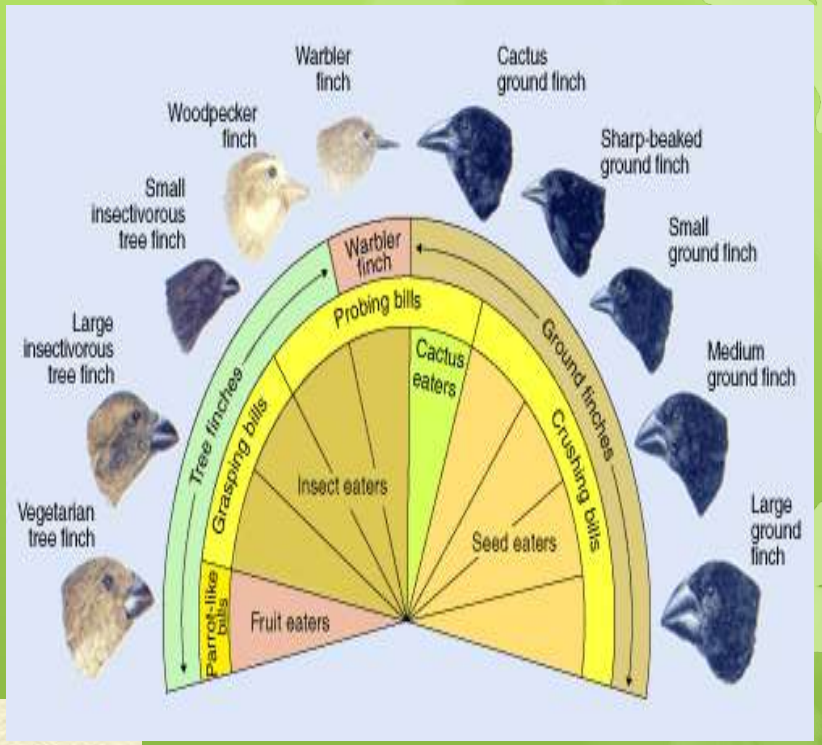
Bumblebees and the flowers they pollinate have **co-evolved** so that both have become dependent on each other for survival.

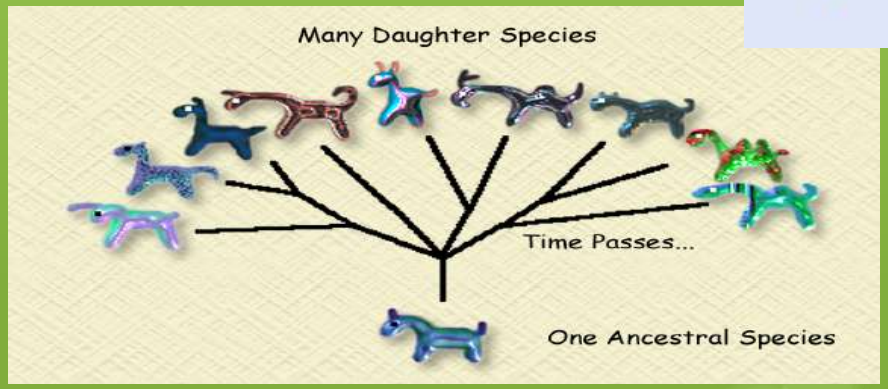
Mass Extinctions

- Mass extinctions killed species, wiped out ecological systems, caused the collapse of food webs
- One hypothesis suggests that a huge asteroid caused the Cretaceous Period
- Many paleontologists think that mass extinctions were caused by multiple problems
- Records confirm 5 mass extinctions

Adaptive Radiation

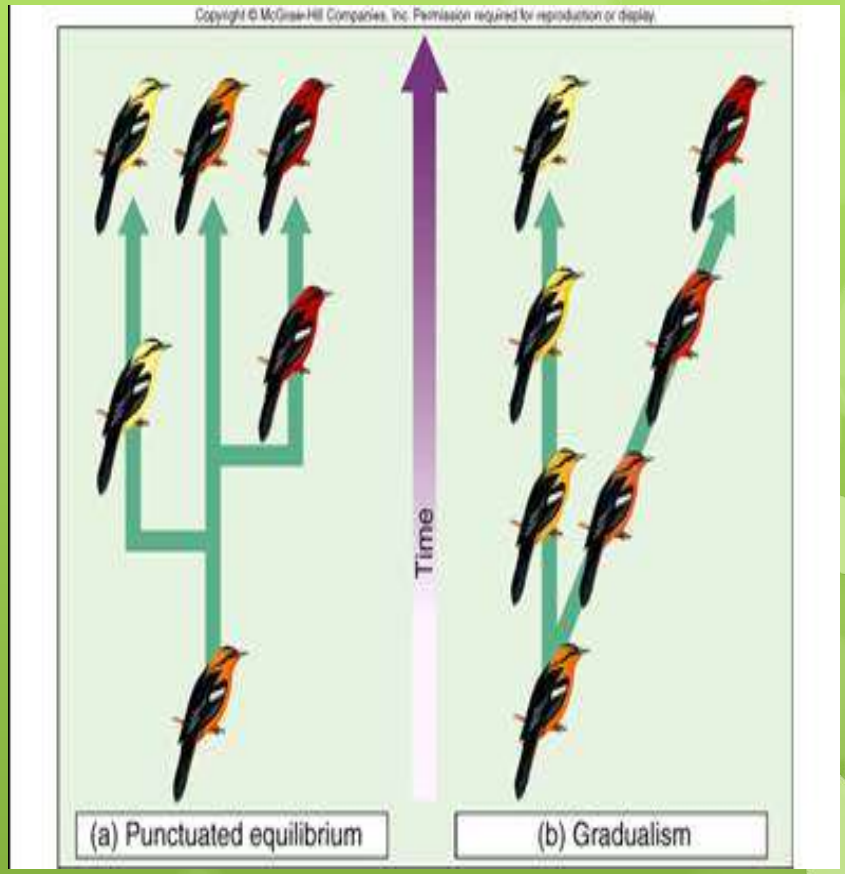
- The process in which a single species or small group of species has evolved into several different forms that live in different ways.
- E.g. Darwin's finches





Punctuated Equilibrium

- A pattern of long, stable periods interrupted by brief periods of more rapid change.



Darwin felt that biological change needed to be slow and steady, an idea known as gradualism

Speciation in Darwin's Finches

- Speciation in the Galapagos finches occurred by founding of a new population, geographic isolation, changes in the new population’s gene pool, reproductive isolation and ecological competition