8.1: Natural Selection

Big Idea

- Types of Natural Selection
  - Directional Selection
  - Stabilizing Selection
  - Disruptive Selection
  - Sexual Selection
- Genetic Drift
- Bottlenecks Effect
- Founder Effect
- Hardy-Weinberg Principle

Directional Selection

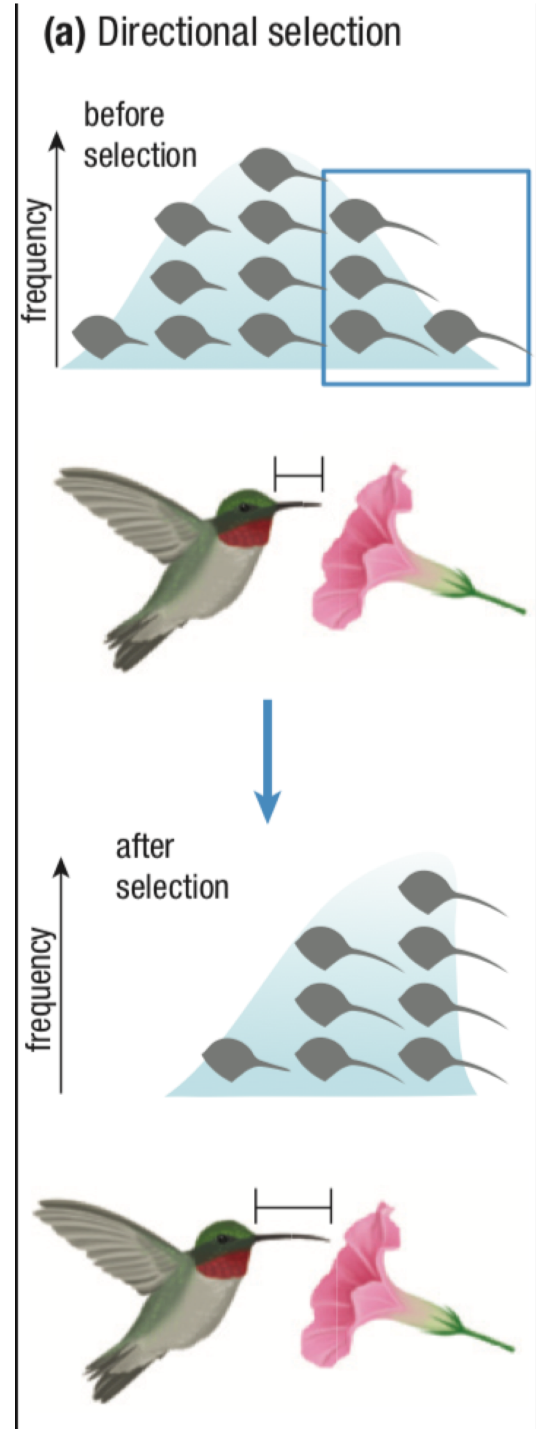
- Selective Pressure: abiotic and biotic factors – diseases, climatic conditions, food availability, predators, choice of mate.
- Directional Selection: occurs when selection favors individuals with a more extreme variation of a trait.
- Results in a shift away from the average condition.

Directional Selection

- Examples:

- Strawberries become larger and sweeter;
- Chili peppers become spicier;
- Racing horses become more muscular and running faster.

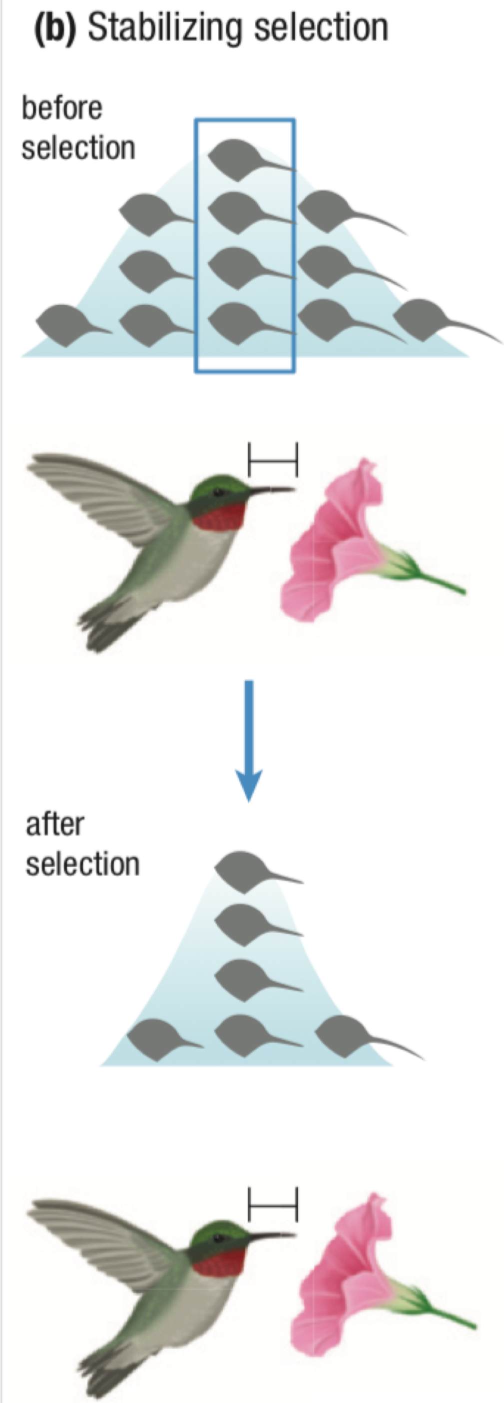
- Hummingbirds have longer bills, obtain more food and contribute more offspring



Stabilizing Selection

- Occurs when the average phenotype within a population is favored by the environment.

- Hummingbirds is stabilized with medium-sized bills
- Reproductive success of individuals exhibit too long or too short bills is reduced.



Stabilizing Selection

- Human birth weights
- ~3 to 4 kg has highest rate of survival and lowest rate of mortality
  - Significantly lower – developmentally premature
  - Significantly heavier – birth related complication threaten the life of both baby and mother

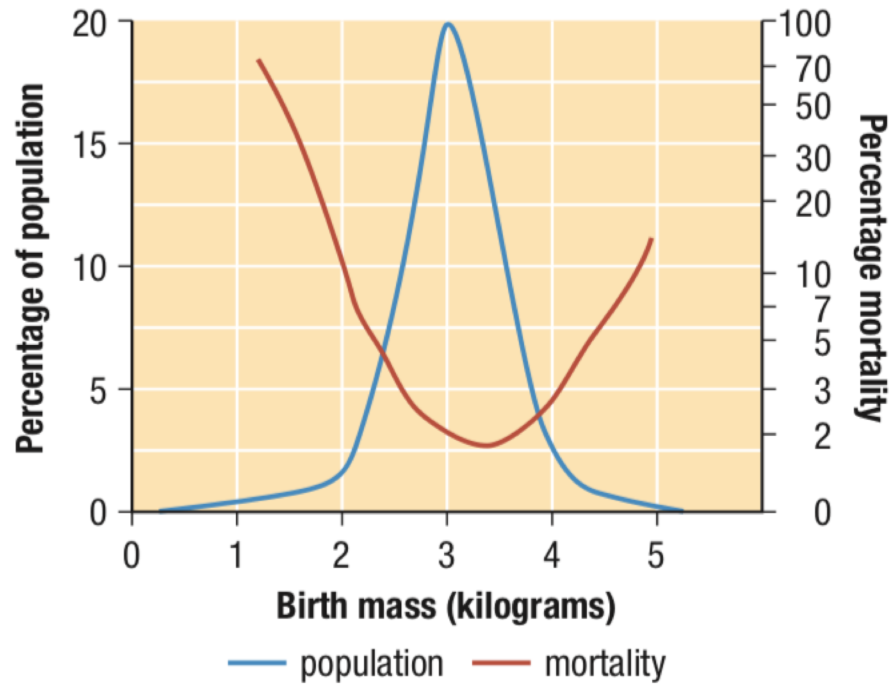
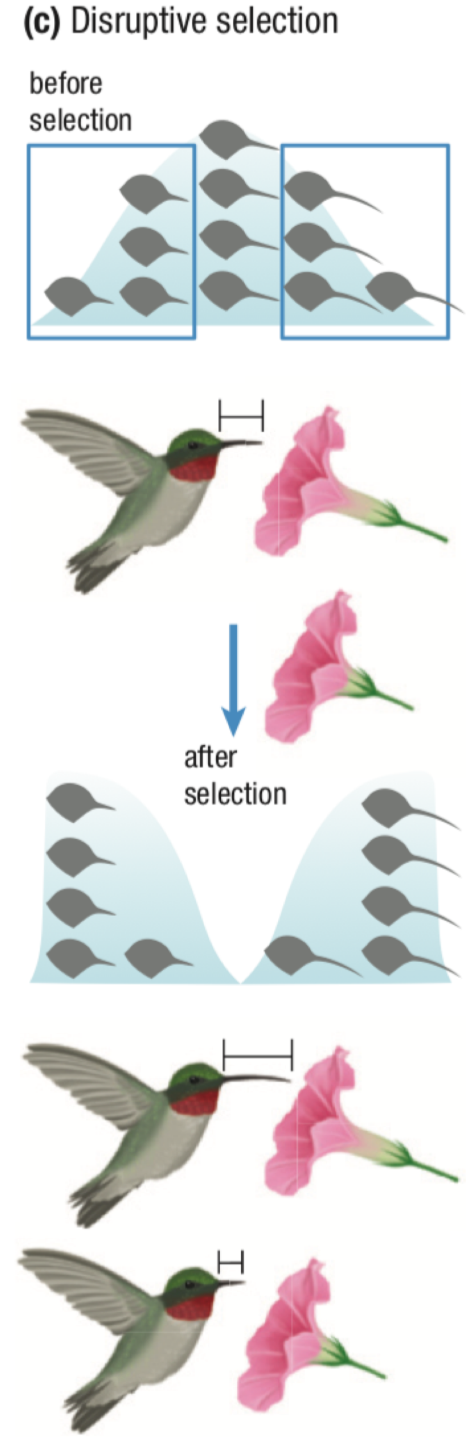
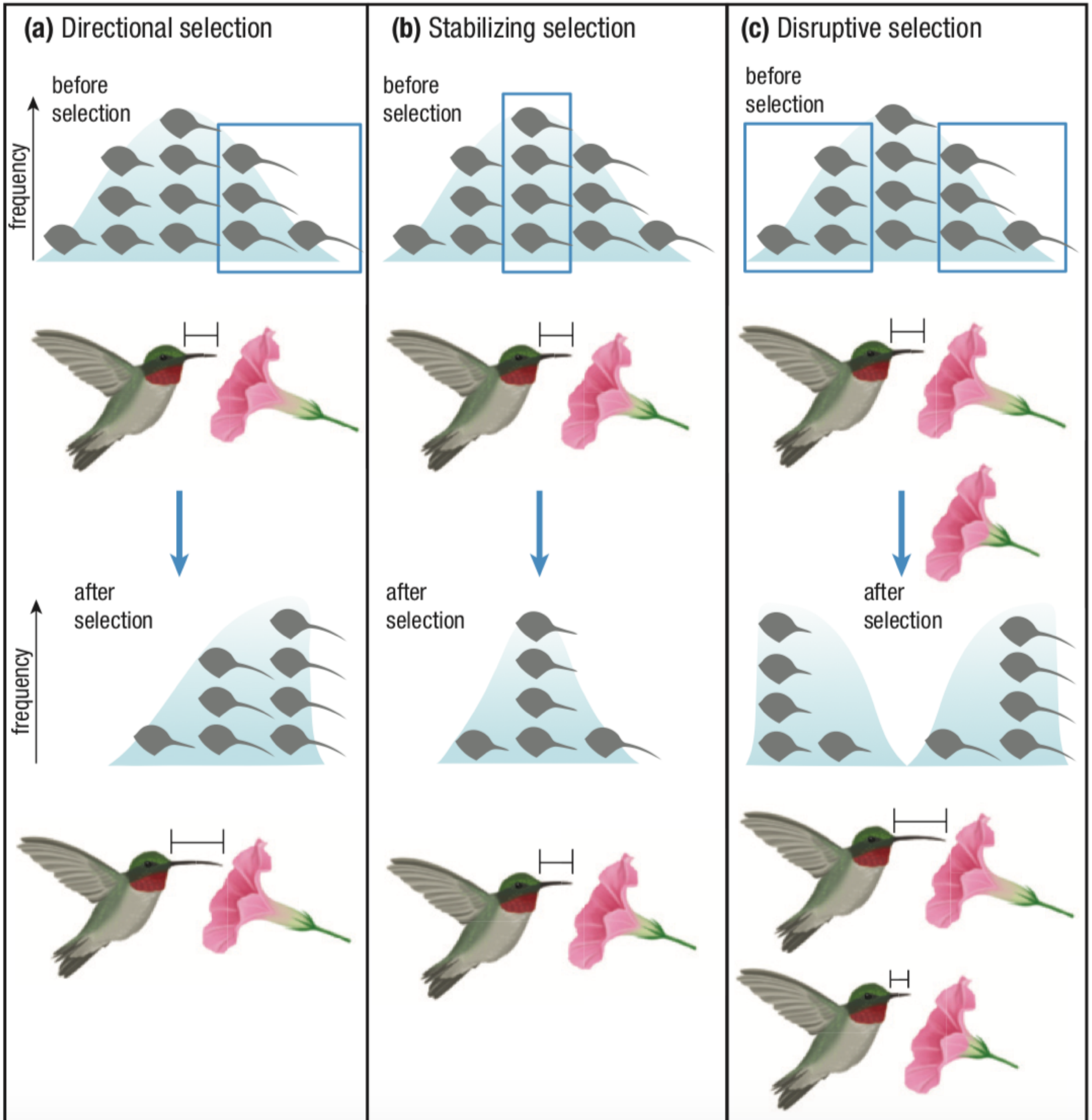


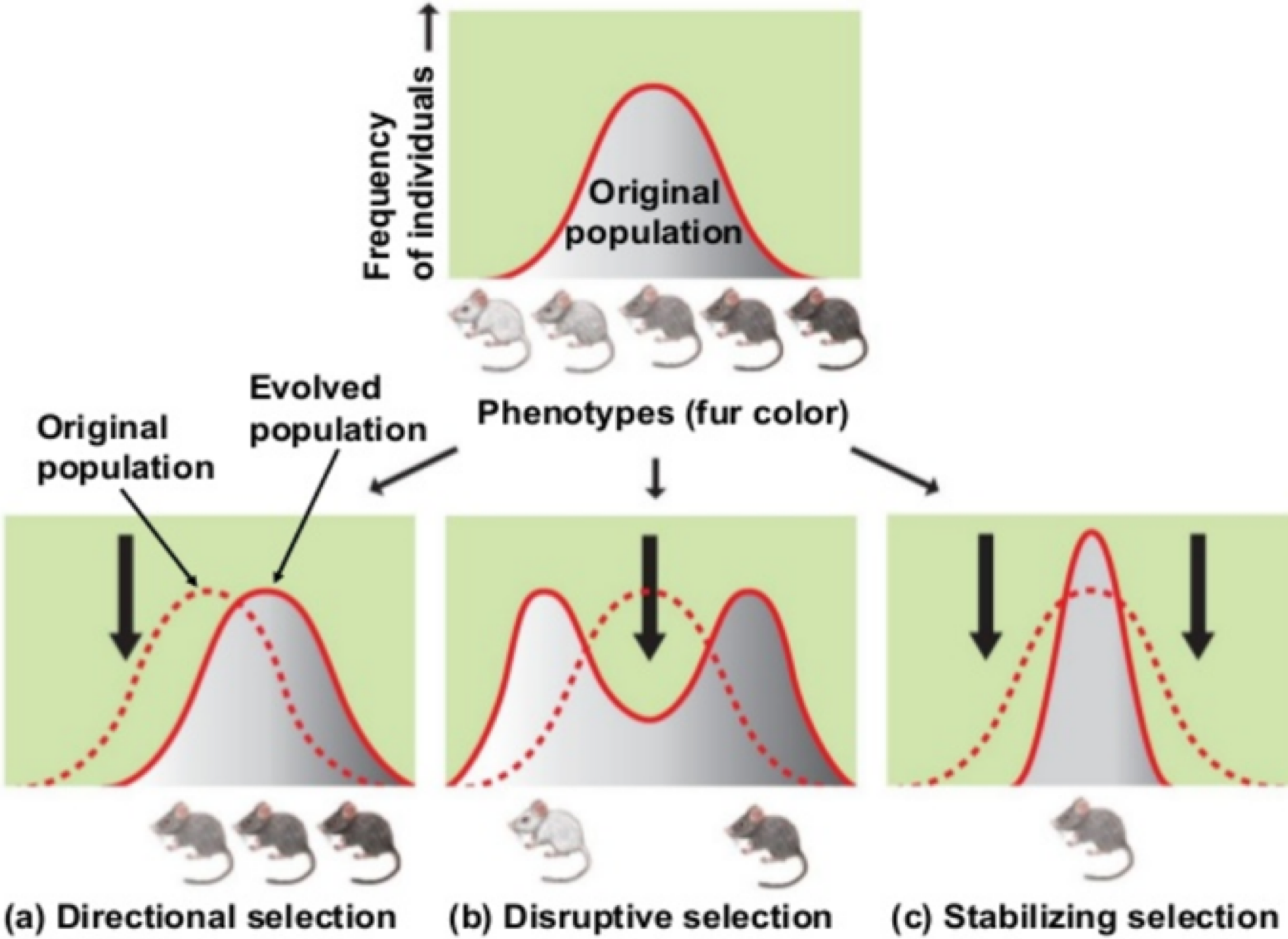
Figure 4 Human babies with average birth weights have a higher rate of survival than very large or very small babies.

Disruptive Selection

- Favors individuals with variations at opposite extremes of a trait over intermediate variations.
- Environmental conditions favor more than one phenotypes




(a) Directional selection
before
selection
frequency
after
selection
frequency
(b) Stabilizing selection
before
selection
after
selection
(c) Disruptive selection
before
selection
after
selection



Frequency of individuals
Original population
Phenotypes (fur color)
Original population
Evolved population
(a) Directional selection
(b) Disruptive selection
(c) Stabilizing selection

Sexual Selection

- is the favoring of any trait that specifically enhances the mating success
- different appearances and behaviors
- Female mate choice & male-versus-male competition
- Bright coloration and large horn – attract predators

Figure 5 (a) Male cardinals use brightly coloured plumage and song to attract females. (b) Male bighorn sheep compete head to head, using their horns for head-on clashes. Female bighorn sheep have much smaller horns.

Genetic Drift

- Other than natural selection, genetic makeup or species variation can also change <u>by chance</u>

- Genetic Drift: changes to allele frequency as a result of chance, more pronounced in small population

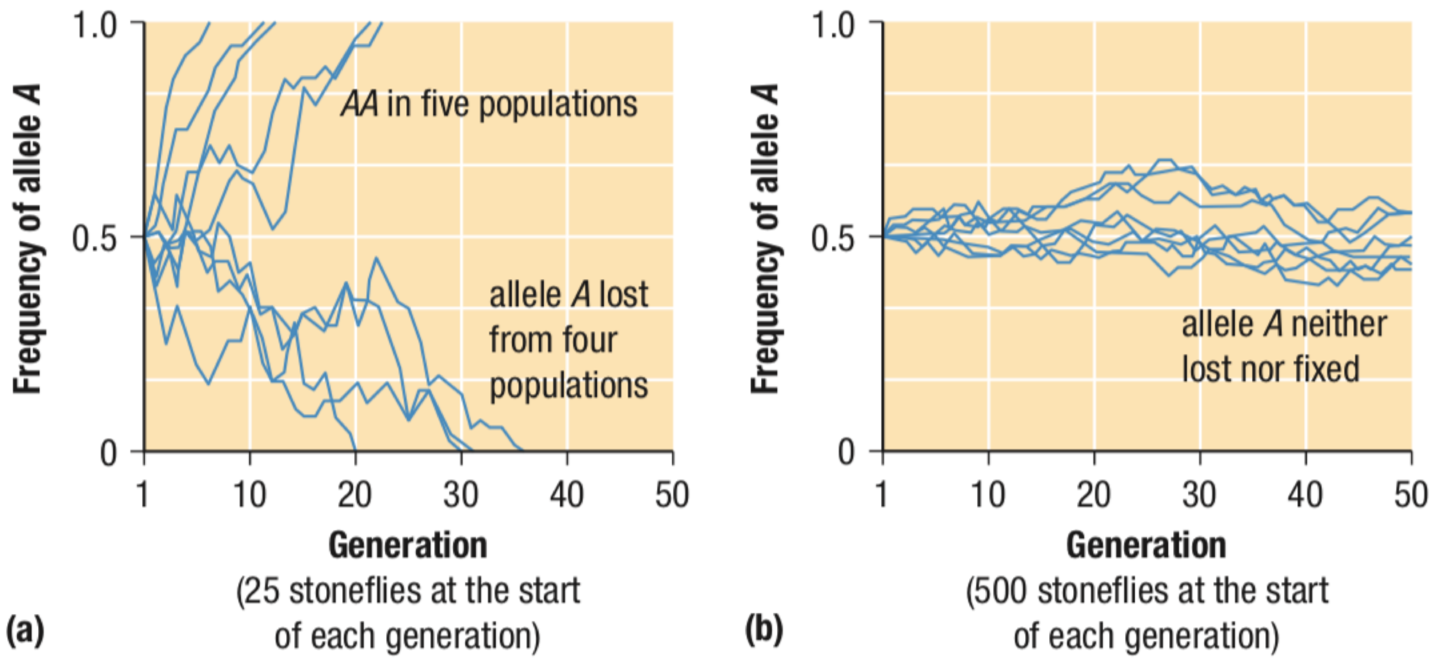


Figure 12 (a) In small populations, genetic drift can result in dramatic changes in allele frequency. (b) In larger populations, genetic drift is not usually significant.

Genetic Bottlenecks

- Result in a loss in genetic diversity following an extreme reduction in the size of population.
- 1,000 down to 5 individuals
- Unlikely to contain all of the alleles
- Reducing gene pool and eliminating rarer alleles
- After recovery, next generation has less genetic variation and vulnerable to disease.
- Extinction

Genetic Bottlenecks

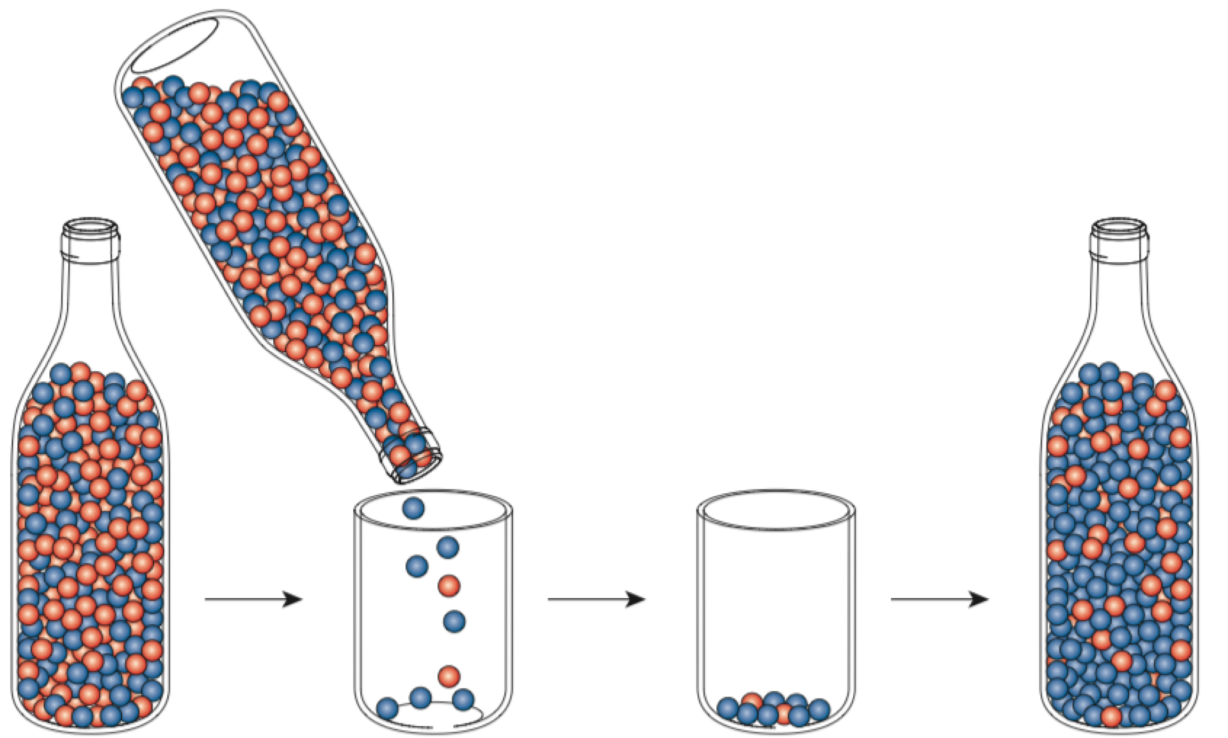


Figure 13 A dramatic reduction in the size of a population can result in a bottleneck. Here, the original population had equal numbers of blue and orange alleles. Following the bottleneck, the blue allele is much more prevalent.

Founder Effect

- Occurs when a small number of individuals establish a new population
- For example:
  - a finch travels from mainland to Galapagos islands, by chance, a gene that was common in the large population might be uncommon in founding population, vice versa.
  - Causes genetic drift, and increases speciation

Hardy-Weinberg Principle

- Even though natural selection, bottleneck events, and founder effect results in change (either increase of decrease) of gene pool, Godfrey Hardy and Wilhelm Weinberg used mathematical equation to explain and prove the allele frequencies within a population are expected to remain constant.

- Read Textbook pg334 – Consequences of Human Influence

8.2: Speciation

Big Idea

- Microevolution
- Speciation
- Reproductive isolation mechanism
- Allopatric speciation
- Sympatric speciation

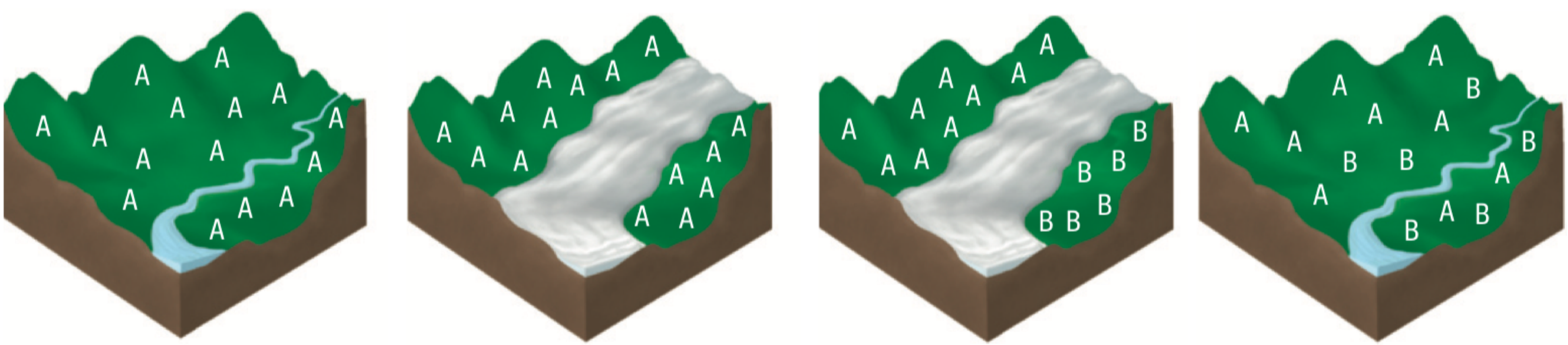
Mechanisms of reproductive isolation

- Microevolution: focus on changes of allele frequency/phenotypic traits WITHIN a species
- Speciation – formation of new species; reproductive isolating; can't exchange genetic information
- Prezygotic Mechanisms: different in breeding season, behavioral traits, habitat preferences, incompatibility of gametes
- Postzygotic Mechanisms: fertilized egg can't grow into a viable and reproducing adult.

Read pg337 for more info

Allopatric Speciation

- A new species formed due to geographical separation, results in no way of exchange genetic information anymore.



At first, a population is distrubuted over a large geographical area.

A geographical change, such as the advance of a glacier, separates the original population, creating a barrier to gene flow.

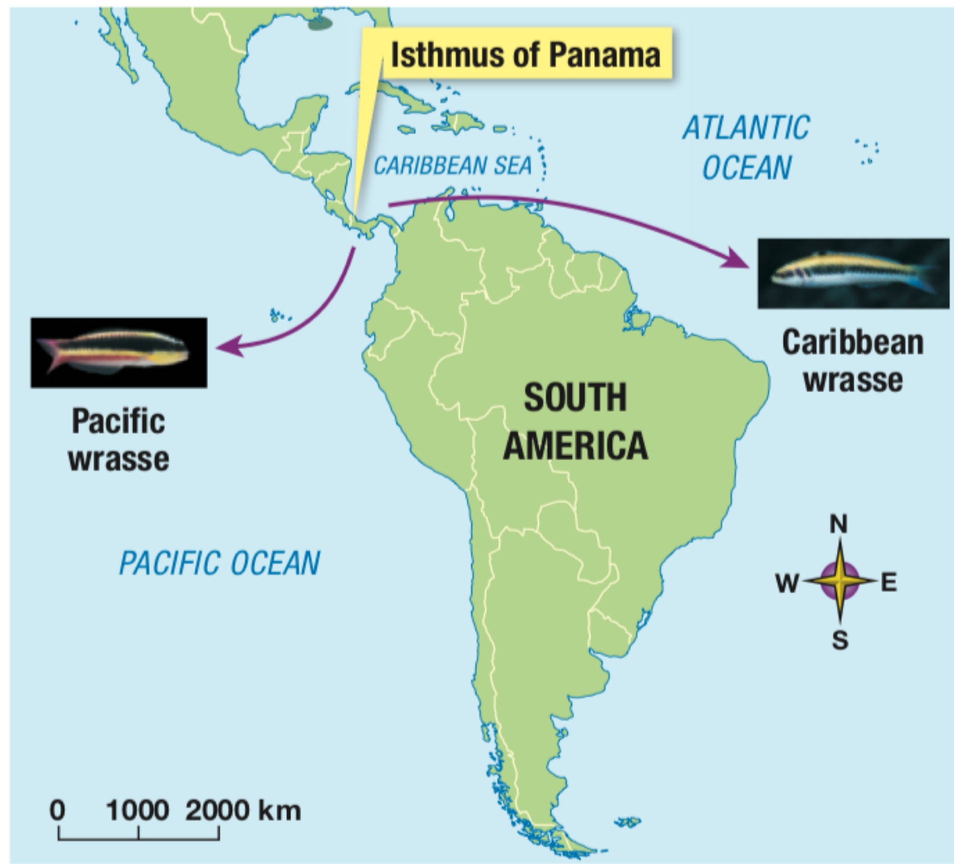
In the absence of gene flow, the separated populations evolve independently and diverge into different species.

When the glacier later melts, allowing individuals of the two species to come into secondary contact, they do not interbreed.

Figure 5 Geographic separation leads to allopatric speciation.

Allopatric Speciation

Figure 6 The Galapagos cormorants lost their ability to fly.



Sympatric Speciation

- The evolution of populations WITHIN the same geographic area into separated species

- Example: Original population of hawthorn fly was originally lay eggs in hawthorn tree, but due to massive planting of apple tree due to human disruption, flies began laying eggs on apples.

Figure 9 Disruptive selection is resulting in the sympatric evolution of a new species of fly. The original species now consists of two distinct populations. The original form, seen here, mates and lays eggs on native hawthorn fruit. The recently evolved form lays eggs on the fruit of introduced apple trees.

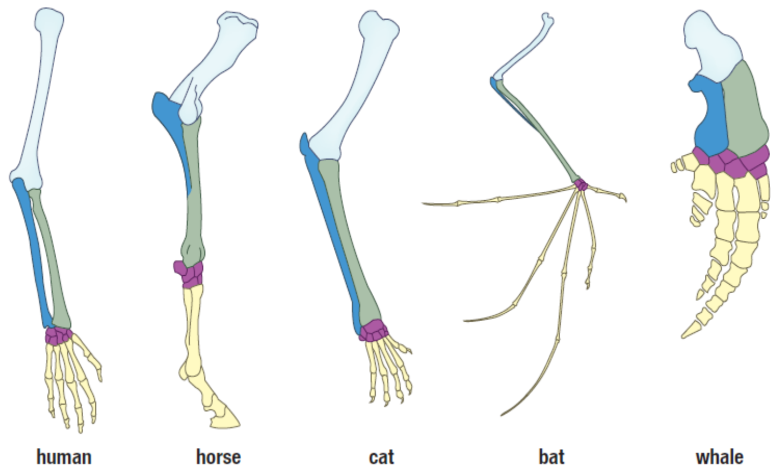
8.3: Patterns of Evolution

Big Idea

- Divergent Evolution
- Adaptive Radiation
- Convergent Evolution
- Coevolution

Divergent Evolution

- **Divergent Evolution** is the evolution from a single common ancestor to a big variety of species under 2 different selective pressures.
- Producers, consumers, decomposers, and scavengers
- Results in less competition between the new species to fill specialized ecological niches



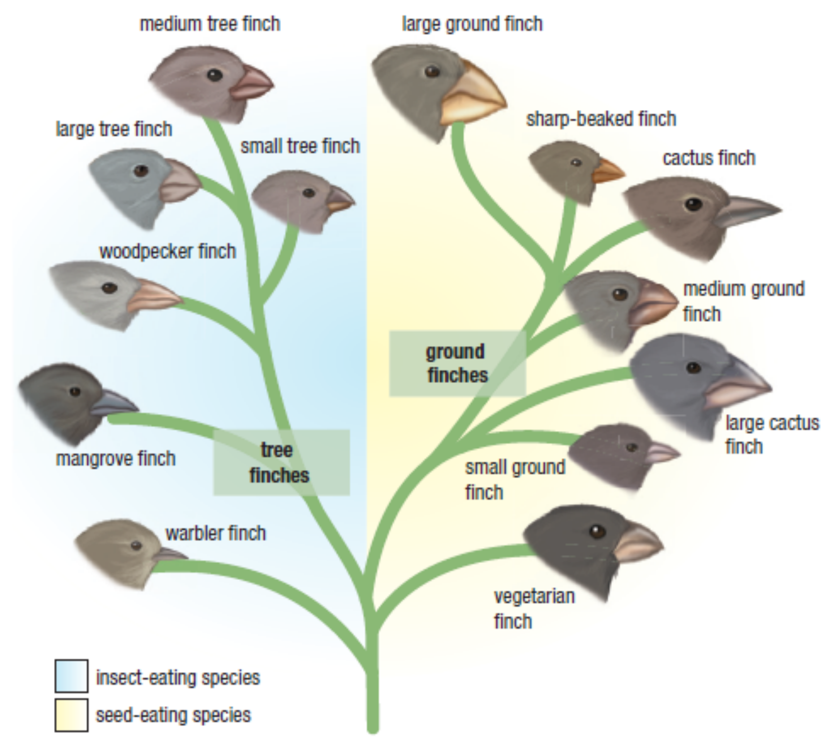
E.g. Humans, horses, cats, bats, and whales evolved from the same common ancestor

Adaptive Radiation

- **Adaptive radiation** is a type of divergent evolution in which a single species is relatively rapidly evolved into many new distinct, but closely related species.

Occurs when species are in an **isolated region** where few species are competing for resources.

Example: in the Galapagos Islands, finch species with various beak shapes and sizes evolved from a single species



Convergent Evolution

- **Convergent Evolution**: the evolution of similar traits in distantly related species
  - Occurs when species are placed under similar selective pressure (e.g. must adapt to the same kind of environment)
  - Note: while some traits will converge, each species retains their own distinct features

Convergent Evolution

- **Cacti** (from South America) and **Euphorbia** (from South Africa) evolved similar features in response to extremely dry conditions

- Cacti spines evolved from leave
- Euphorbia spines evolved from the outward growth of stem tissues.

- Thick green stems (photosynthesis, water storage)
- Sharp protective spines (ward off predators)

Convergent Evolution

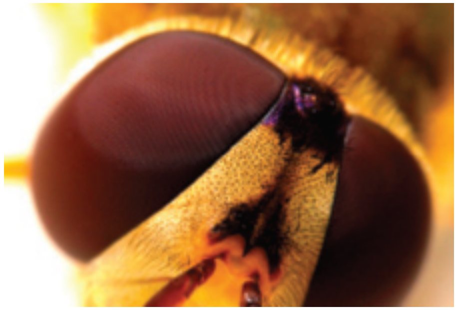
- Sharks and dolphins both evolved similar streamlined bodies due to their high-speed carnivorous behavior in deep sea.

- **Sharks** evolved from primitive fish
- Tail moves side-to -side, with flukes pointing upward

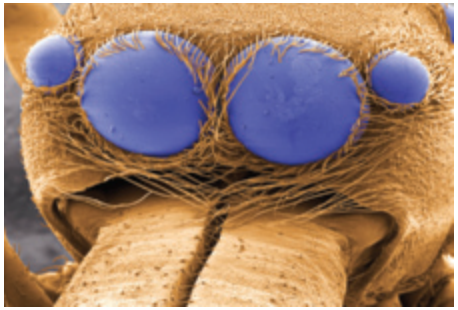
- **Dolphins** evolved from land mammals, descendants of dorudon.
- Tail moves up-and-down, with flukes pointing sideways

Convergent Evolution

- Various species evolved **light-detecting organs** due to the selective advantage of detecting and responding to light
  - Protists have simple eyes spots
  - Other species have evolved complex and varied eyes



Fly



Spider

Cat

Coevolution

- **Coevolution**: one species evolves in response to the evolution of another species
  - Some plants have evolved hard protective shells to protect their seeds
  - Some seed-eating mammals have evolved powerful jaws and teeth for chewing through hard shells.
- Coevolving species may become increasingly dependent on the other.

Coevolution

- Madagascar long-spurred orchid is completely dependent on hawk moths to pollinate their flowers
  - Orchids have evolved extremely long spurs, which contain nectar.
  - Moths depend on nectar for food, and the more time they spend obtaining it, the more likely they will pick up pollen
  - Moths evolved tongues long enough to reach the nectar at the bottom of the longest spurs (30cm)