Evolution and the Environment

- These next few slides correspond with 23.4 in your book. Specifically follow along on page 462-468.
- Use your book and it will help you!

How does natural selection actually work?

- Natural selection acts on phenotypic variations in the populations
  - Lots of variation – don't forget the sources

Variation and fitness

- New phenotype variation can increase, decrease or have no effect on levels of fitness

- The interaction of phenotype and the environment determine the organism's fitness

Illustrative Example

- Sickle Cell Anemia
  - Somebody remind me and I'll talk about this in class

The effect of natural selection on a population

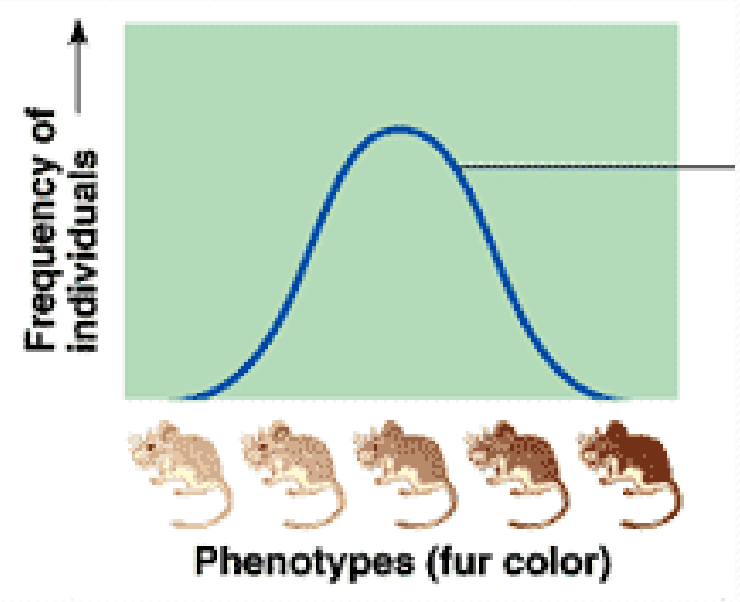
- Heritable variation is the raw material for natural selection
- Natural selection ins the only evolutionary force that adapts a population to its environment
- Natural selection is not a direct competition of individuals
  - Not "survival of the fittest"
- But we can describe and compare fitness of different organisms
  - Fitness: ability to survive and leave offspring due to adaptive advantages

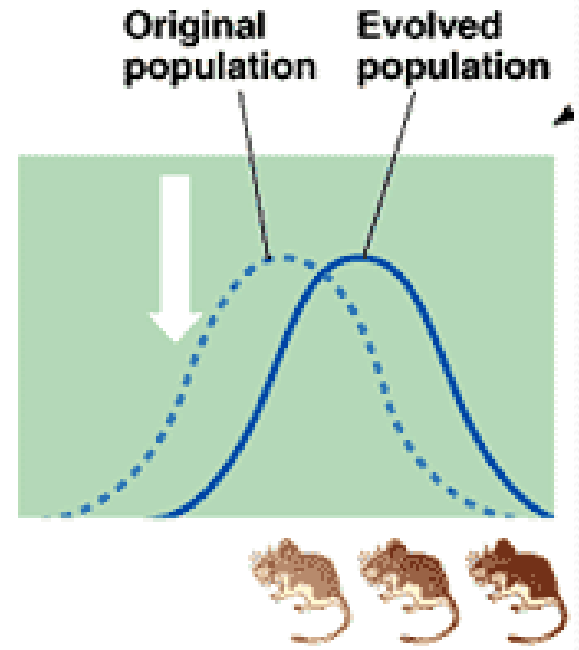
The effect of natural selection on a population

- Depending on which traits are favored, frequency can be altered in different directions
- Modes of selection
  - Directional
  - Disruptive
  - Stabilizing

Directional selection

- For new environmental conditions
- One trait is favored over another
- Frequency shifts

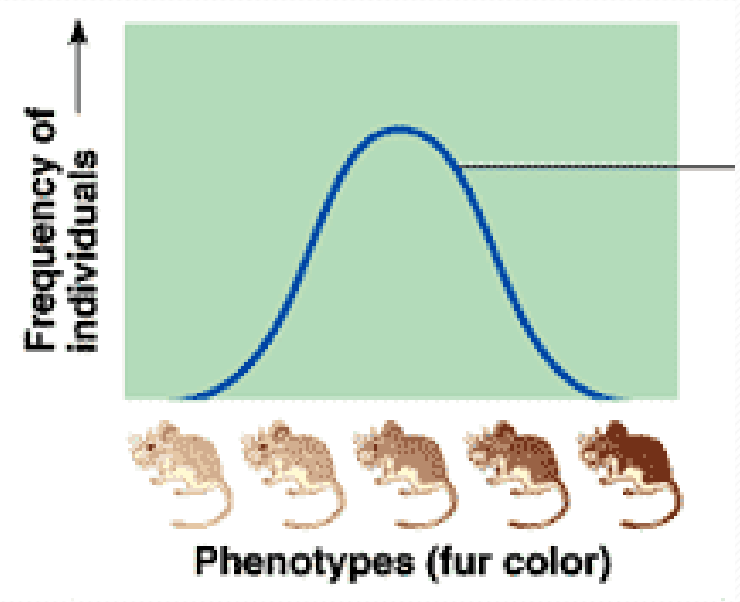


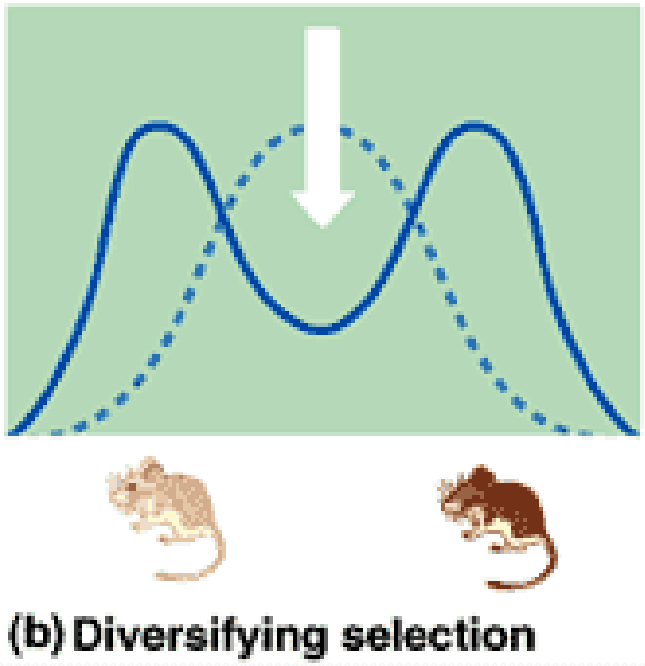


(a) Directional selection

Disruptive selection

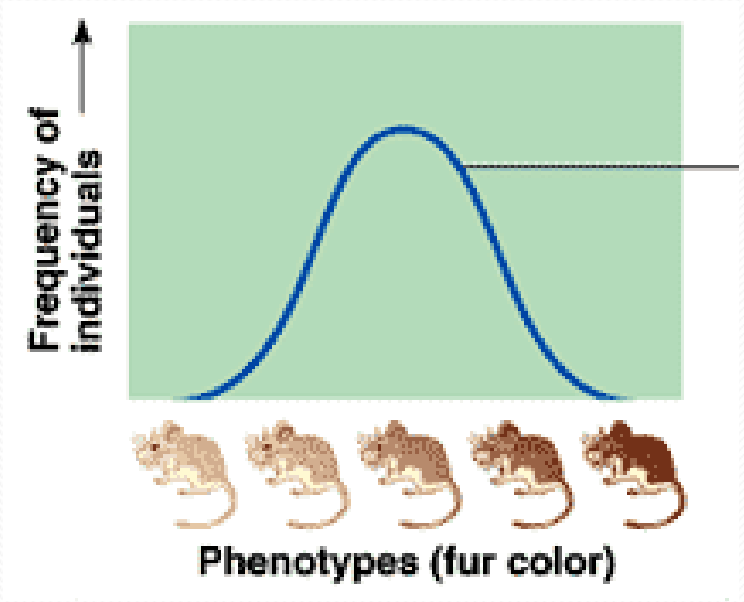
- Phenotypic extremes are favored over intermediate phenotypes

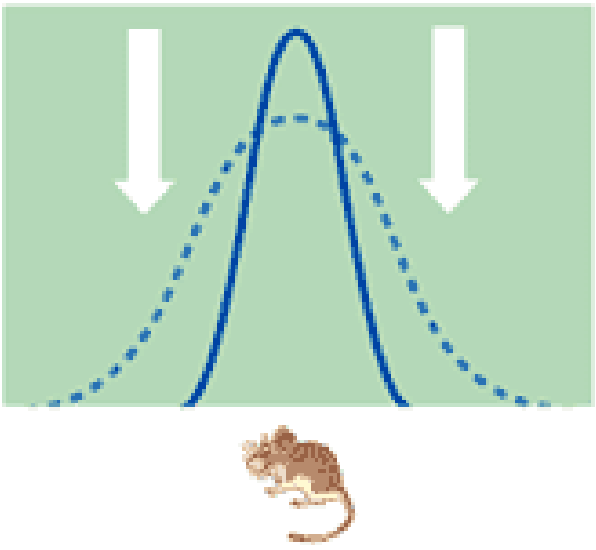




Stabilizing selection

- Intermediate phenotypes are favored over all extremes
- Reduction in variation for a trait





(c) Stabilizing selection

Another type of selection

- Sexual selection – an extension of natural selection
- Explanation for sexual dimorphism
  - Differences in secondary sexual characteristics

Sexual selection

- Intrasexual selection (male competition): Strongest gets mating privilege
  - What type of traits does this select for?

Sexual selection

- Intersexual selection (female choice):
  - Mates chosen based on appearance or behavior

- These next few slides correspond with sections 24.1 and 24.2. Feel free to look at those sections as well. In class we will talk about examples of speciation and specifics of reproductive isolation found on pages 474-475.

The diversity of life

- Why do we have so many different species of animals and plants?
- Birds
- Fish

- Adaptation through evolution is the reason we have so much diversity of life

Major processes

- Speciation: the development of a new species
- Extinction:

- Both processes have been operating since life began
- Both processes occur because life continues to evolve within a changing environment

- The rates of both processes can vary

Summary of these concepts

- Speciation and extinction have always been occurring
  - The rates of both can vary
  - Mass extinctions have occurred followed by adaptive radiation
- The species concept is based on successful reproduction
- Evolution explains the vast amount of diversity of life seen on our planet

What is a species?

- Species: a group of individuals capable of interbreeding and exchanging genetic information to produce viable, fertile offspring

How does speciation occur?

- Two populations diverge and become reproductively isolated
- What is reproductive isolation?
  - Something prevents the individuals from mating and producing offspring
- As long as isolation is maintained for a time, speciation will remain distinct

The process of speciation

- Two main types

- Allopatric speciation
- Sympatric speciation

- That's all! We'll get to examples on Monday.

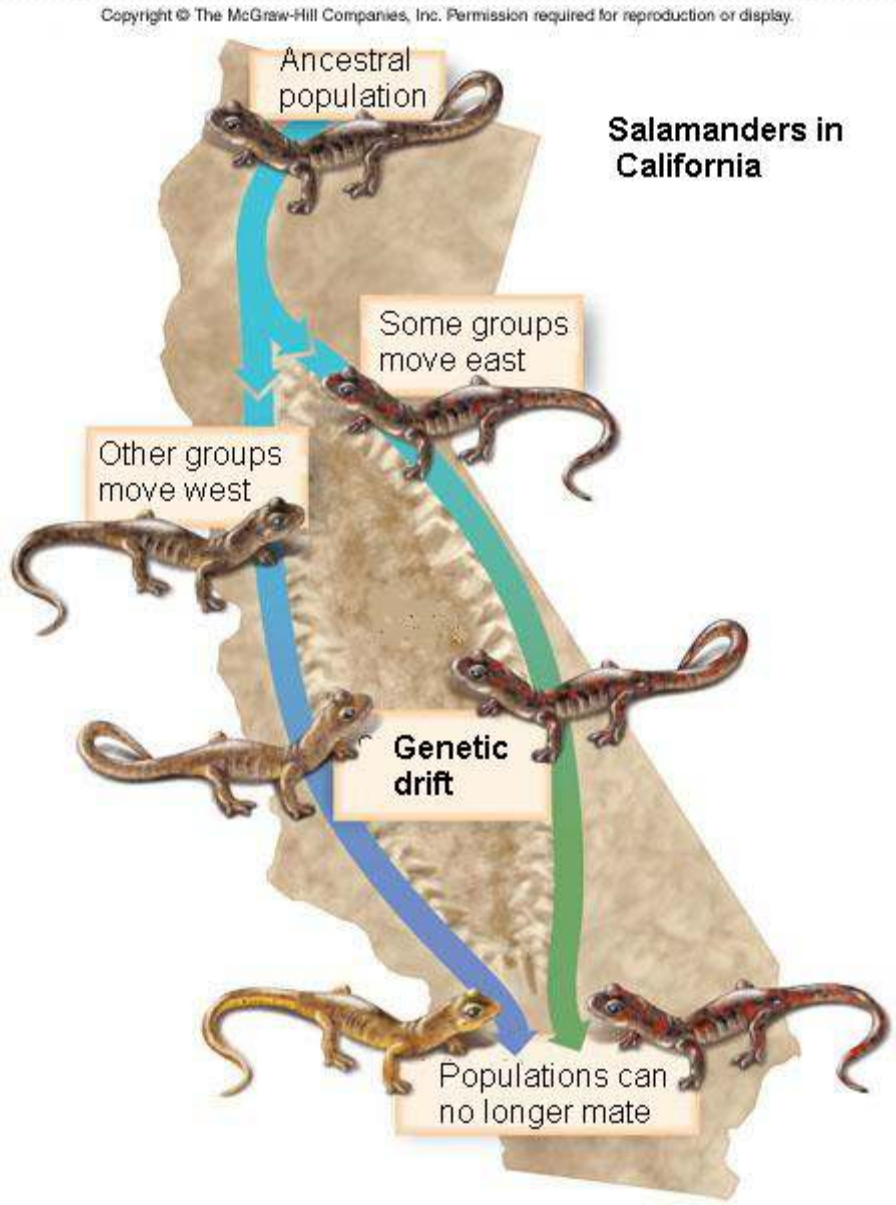
Allopatric speciation

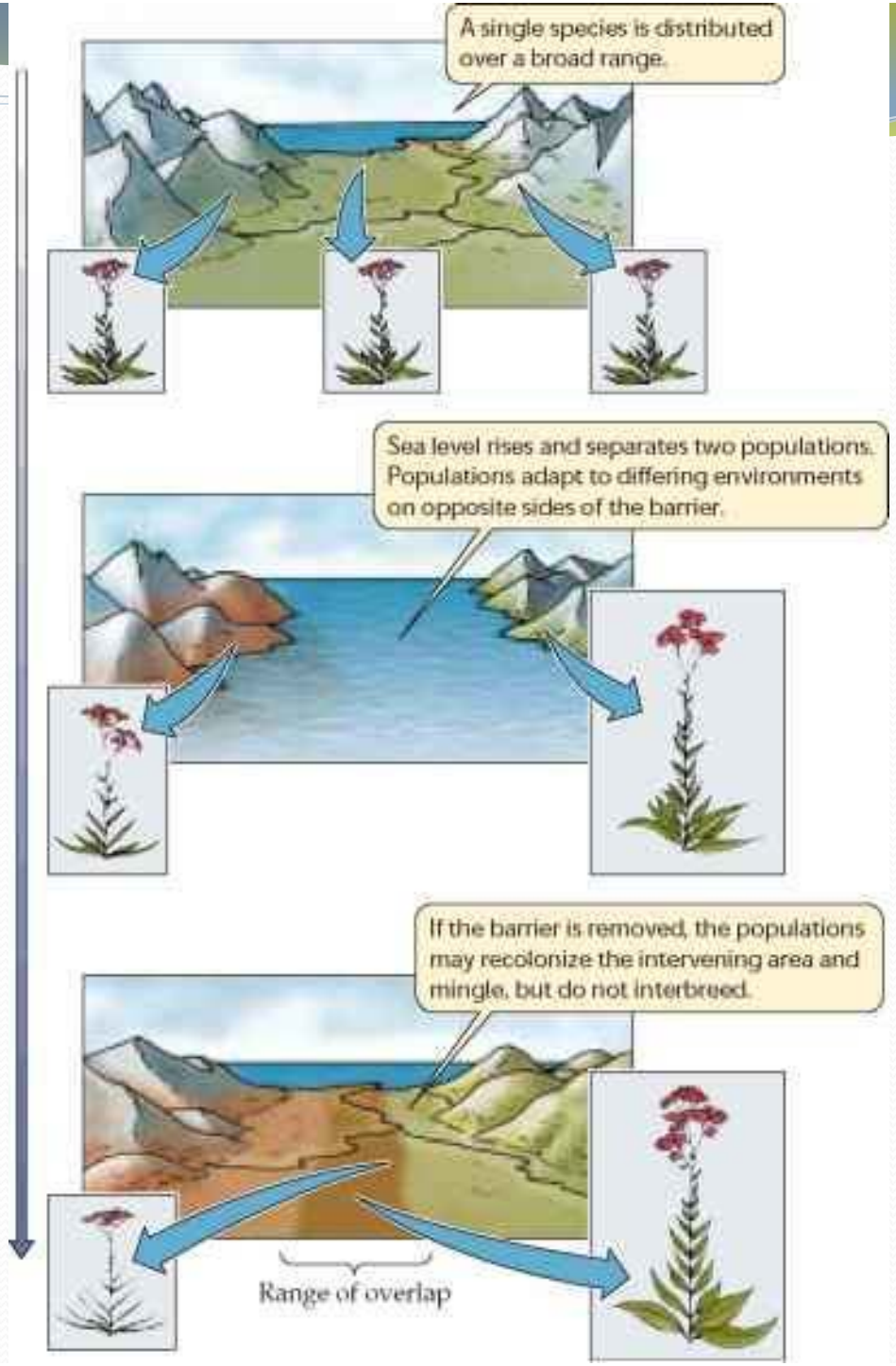
- Allo- other
- Patra – homeland

- Occurs when a population is geographically isolated by a natural feature or movement to remote area

Allopatric speciation

- Once isolated, gene pools diverge
- Confirmed by determining if members are capable of interbreeding




A single species is distributed over a broad range.
Sea level rises and separates two populations. Populations adapt to differing environments on opposite sides of the barrier.
If the barrier is removed, the populations may recolonize the intervening area and mingle, but do not interbreed.
Range of overlap

Sympatric speciation

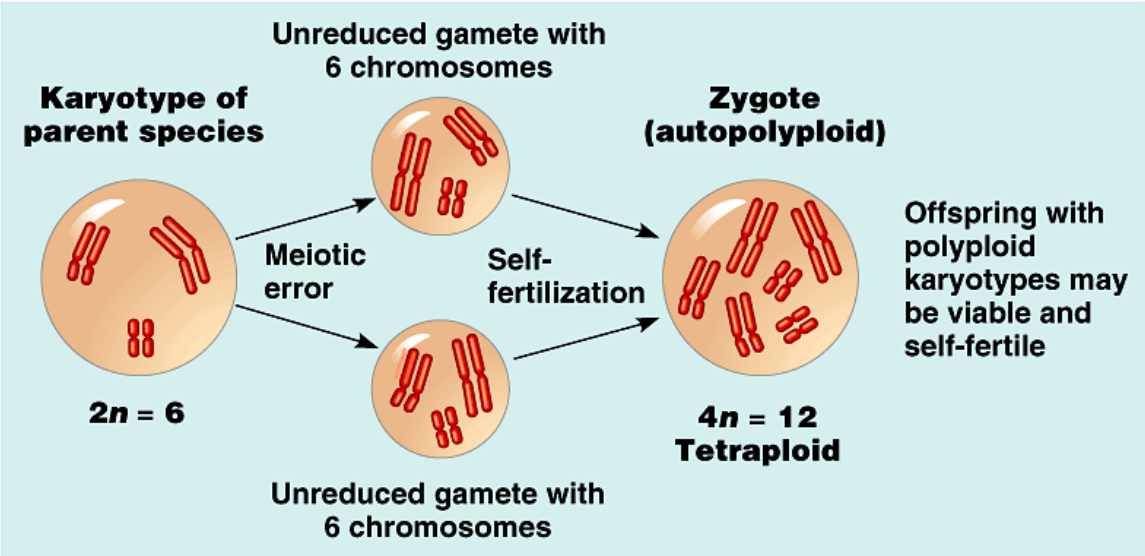
- Sym – together
- Patric-

- Reproductive barriers evolve between species that share the same area

  - How?
    - Chromosomal changes
    - Habitat differentiation

Sympatric speciation

- Polyploidy
  - Multiple sets of chromosomes
  - Results from error in meiosis
  - More common in plants
    - Can only fertilize with others with same number of chromosomes
    - Some initially are sterile but reproduce asexually

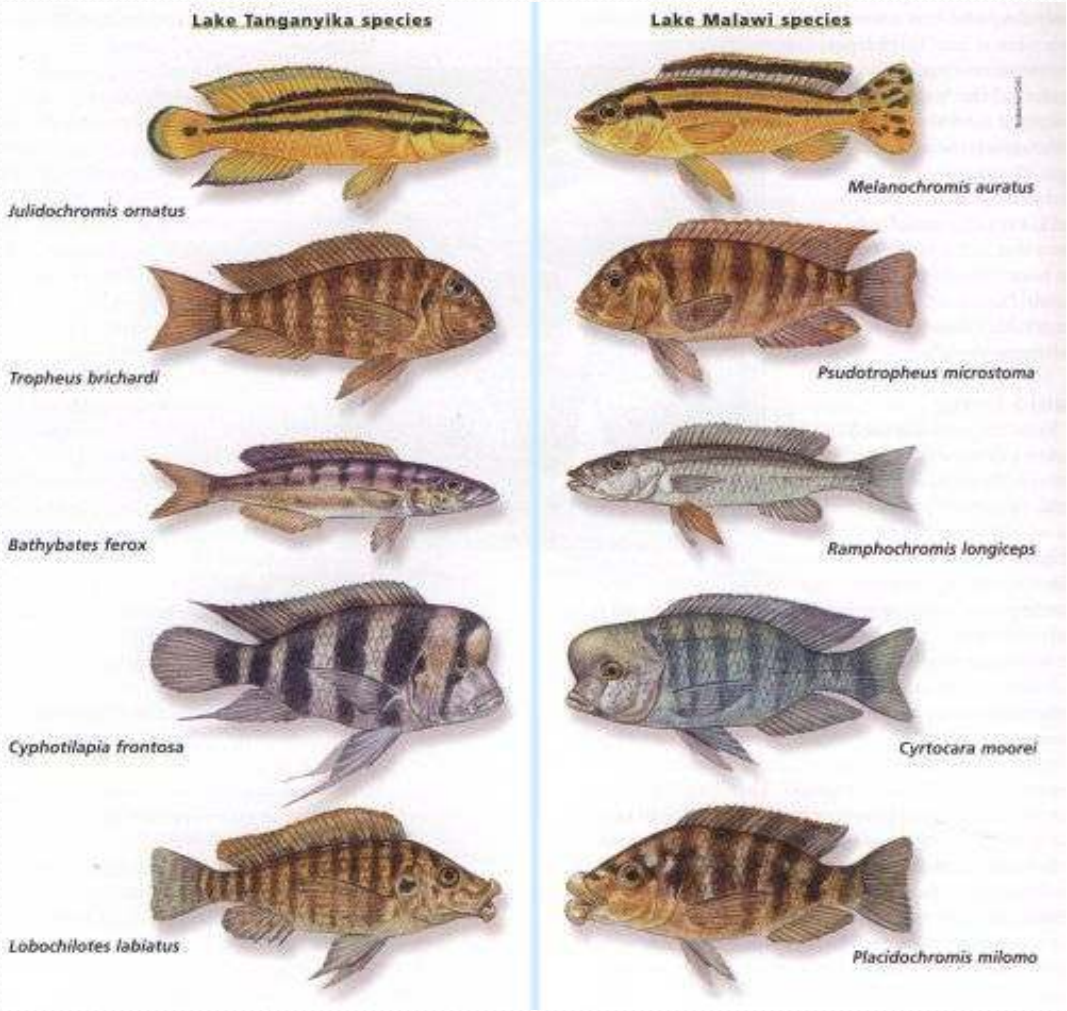


Sympatric speciation

- Habitat differentiation
  - Variation allows an individual to use a resource unavailable to others
    - Food or area
      - Apple Maggot Fly
        - Hawthorns and Apples

Sympatric speciation

- Sexual selection – mates selected on appearance
  - Variation drives separation



Speciation rates can vary

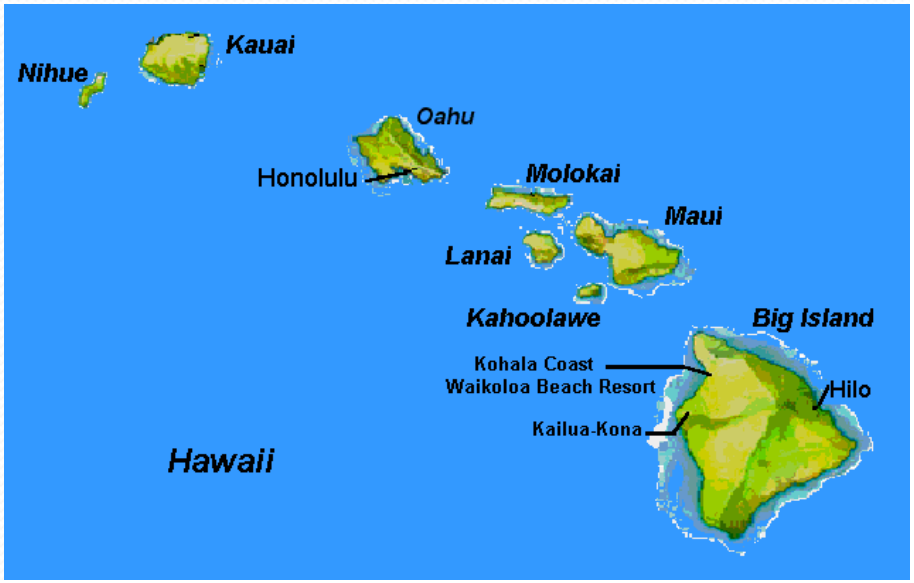
- There is no standard rate, but the rate can be accelerated
- Adaptive radiation: new areas become available for colonization
  - Environmental changes extinct others
  - New land: island or complete destruction of existing habitat

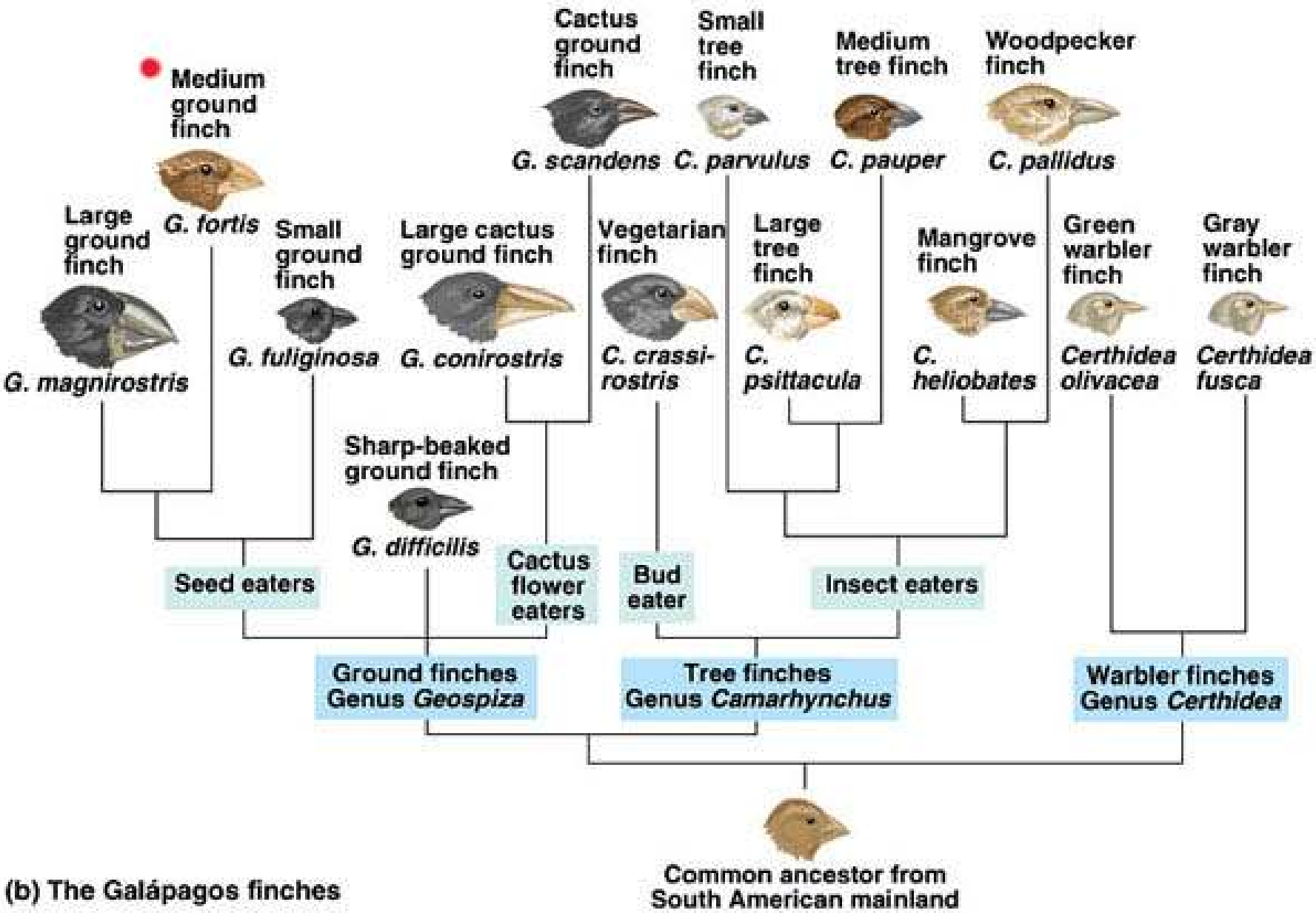
Adaptive variation

- Rate of speciation increases
- Organisms encounter new habitats and quickly change by natural selection
- Adaptations to use unclaimed resources
  - EX: Dinosaur extinction

    Hawaii

    (Like garden weeds)



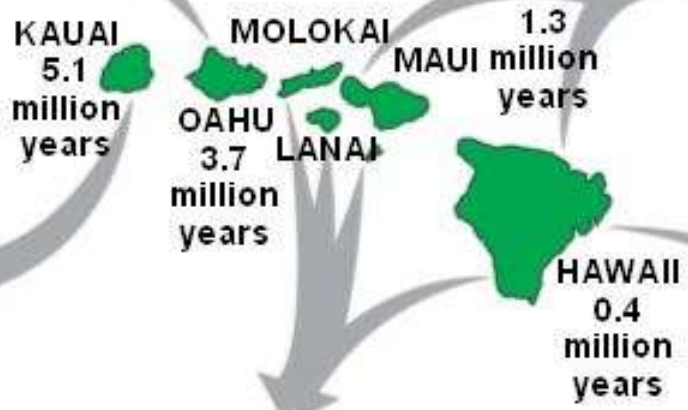


(b) The Galápagos finches

Dubautia laxa

Close North American relative, the tarweed *Carlquistia muirii*

Argyroxiphium sandwicense



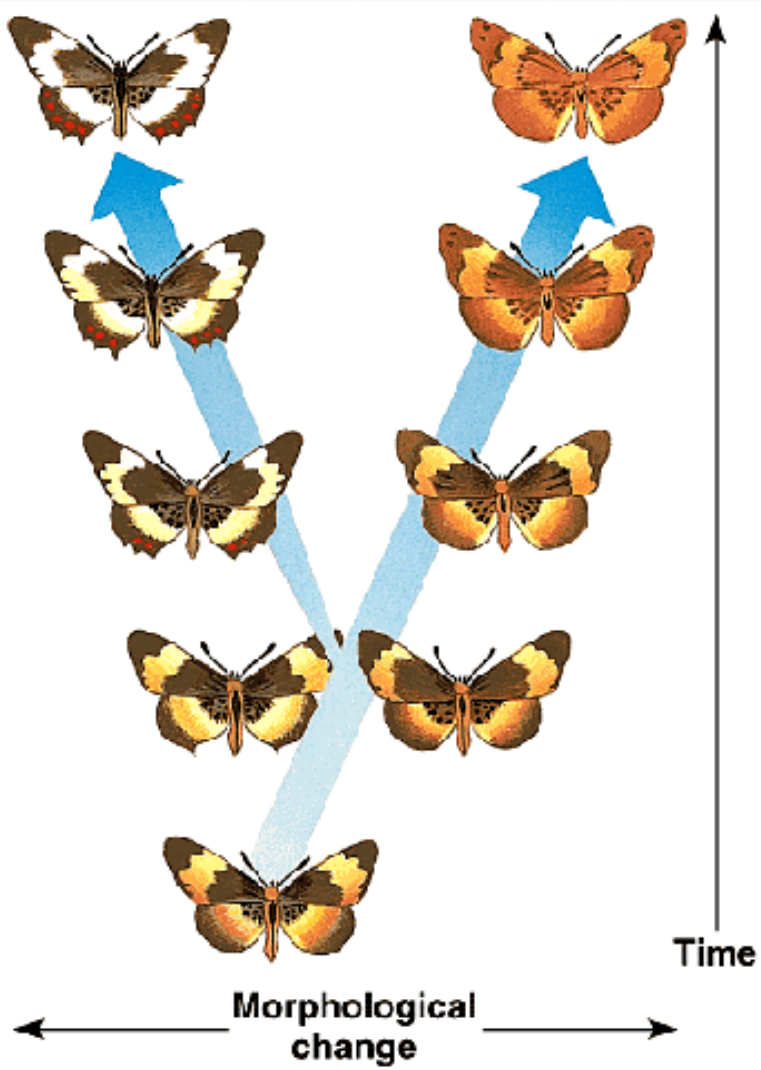
Dubautia waialealae

Dubautia scabra

Dubautia linearis

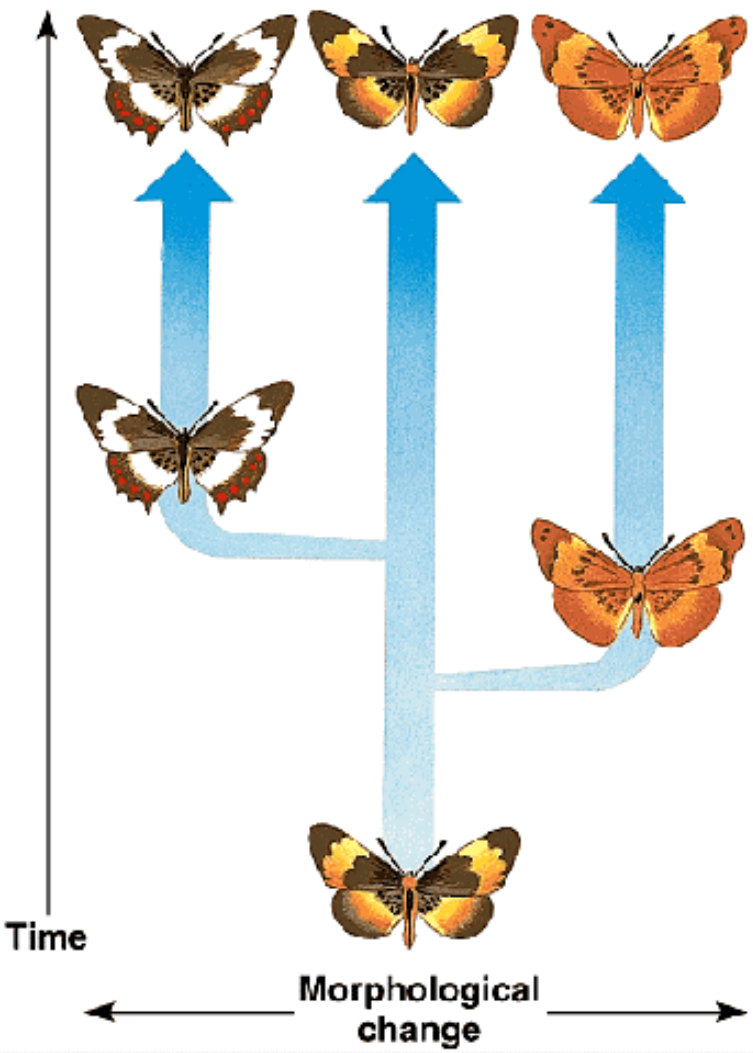
The speed of speciation

- Gradualism- divergence based on small changes over a long period of time



The speed of speciation

- Punctuated equilibrium- species quickly diverge, then remain static



Extinction

- Extinction is a natural and normal part of life
- Extinction rates can vary
- Ecological (environmental) stress increases the rate of extinction

How do we get reproductive isolation?

- Pre-zygotic or post-zygotic separations may exist
- Prezygotic barriers: before a zygote can be formed
- Postzygotic barriers: after the zygote is formed

Prezygotic barriers

- No mating attempted
- Geographic isolation: two species are physically separated and do not encounter one another (allopatric)
- Habitat isolation: two species do not (or rarely) encounter one another
- Temporal isolation: species breed at different times of day, seasons or years
- Behavioral isolation: courtship rituals and behaviors are unique and must be followed

Prezygotic barriers

- Mating attempted
- Mechanical isolation: morphological differences prevent mating
- Gametic isolation: sperm may not be able to fertilize eggs of another species

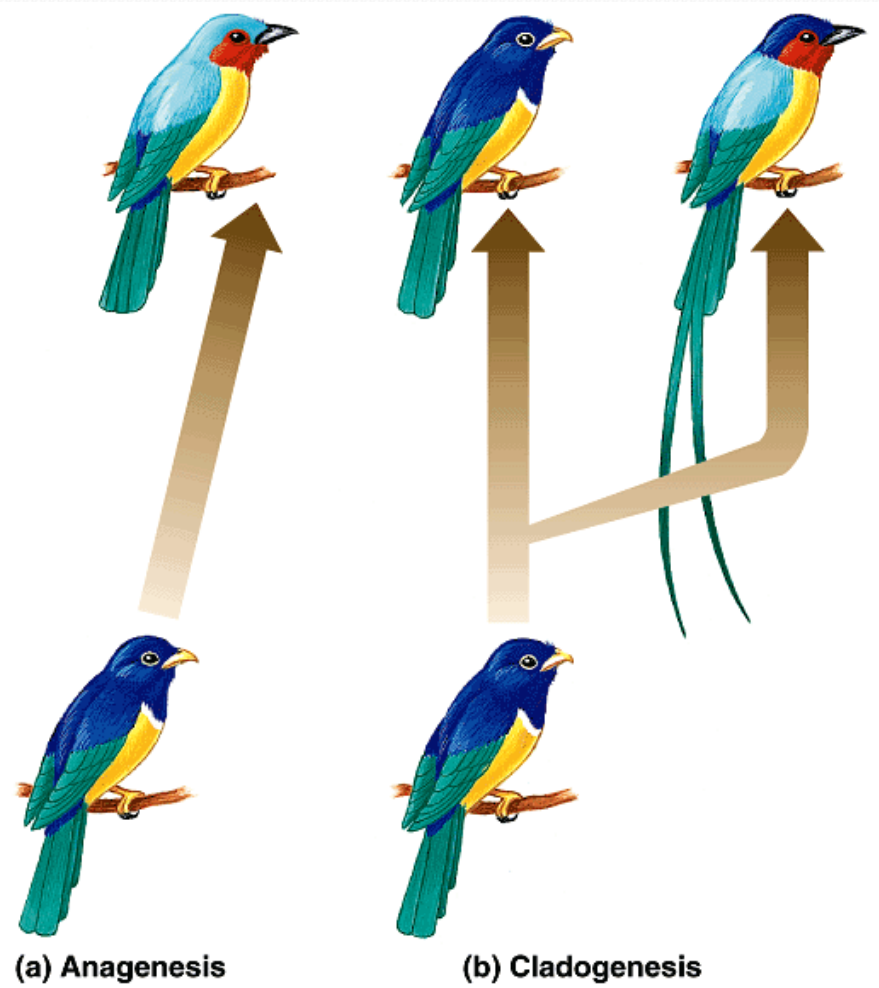
Postzygotic barriers

- Fertilization has occurred
- Reduced hybrid viability: If hybrids are produced, they are weak or do not develop properly due to gene incompatibility
- Reduced hybrid fertility: Hybrids are sterile (infertile)

Postzygotic barriers

- Hybrid breakdown: 1st generation hybrids are fine but later generations are sterile or feeble

Living things are always changing



Its everywhere!

- Based on scientific evidence, evolution can (and has) occur in ALL species

It never ends!

- Based on scientific evidence, evolution is still occurring and will continue

- Evolution has no particular end goal
  - Stay successful and alive in the changing environment

Homework

- Look up the following terms using the internet

- Divergent evolution
- Convergent evolution
- Parallel evolution
- Coevolution