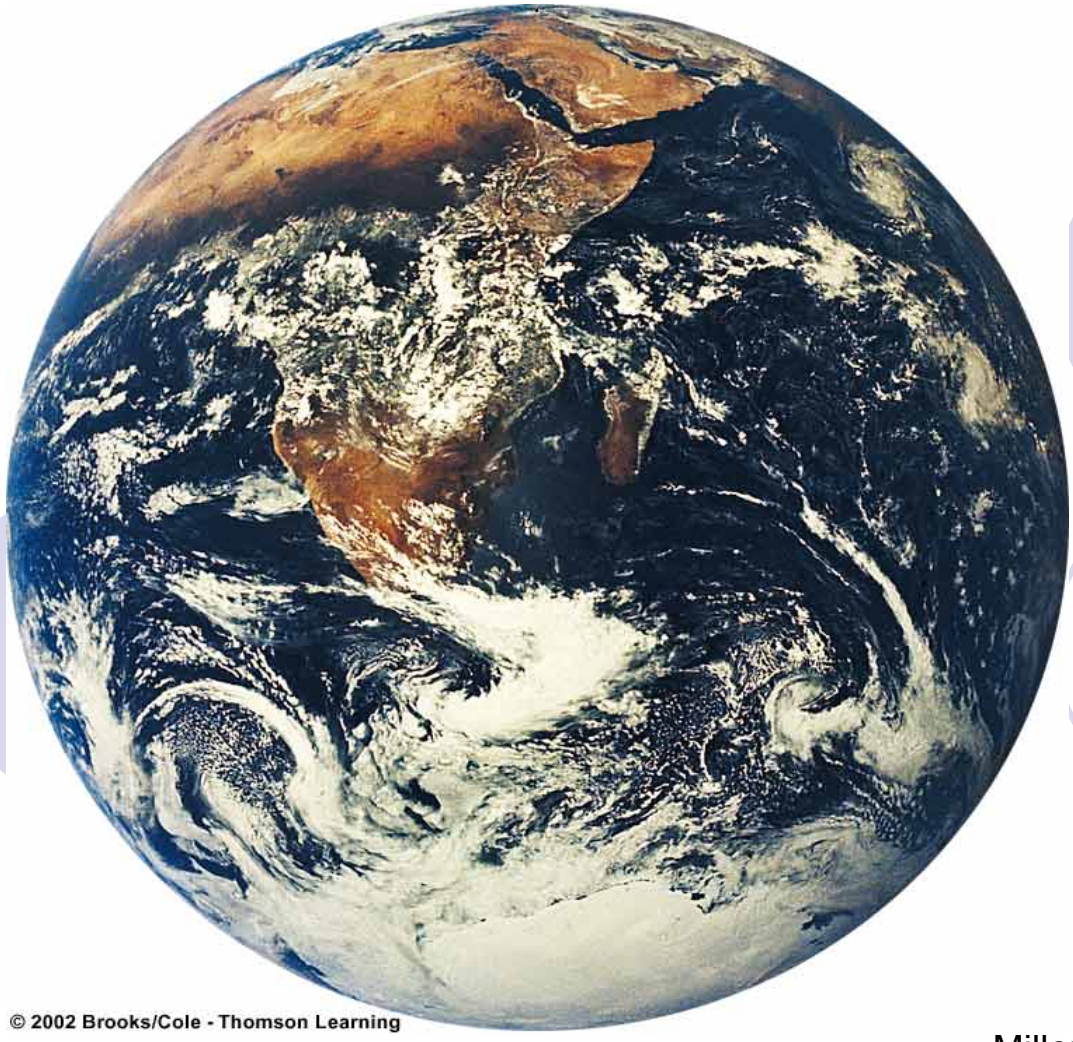
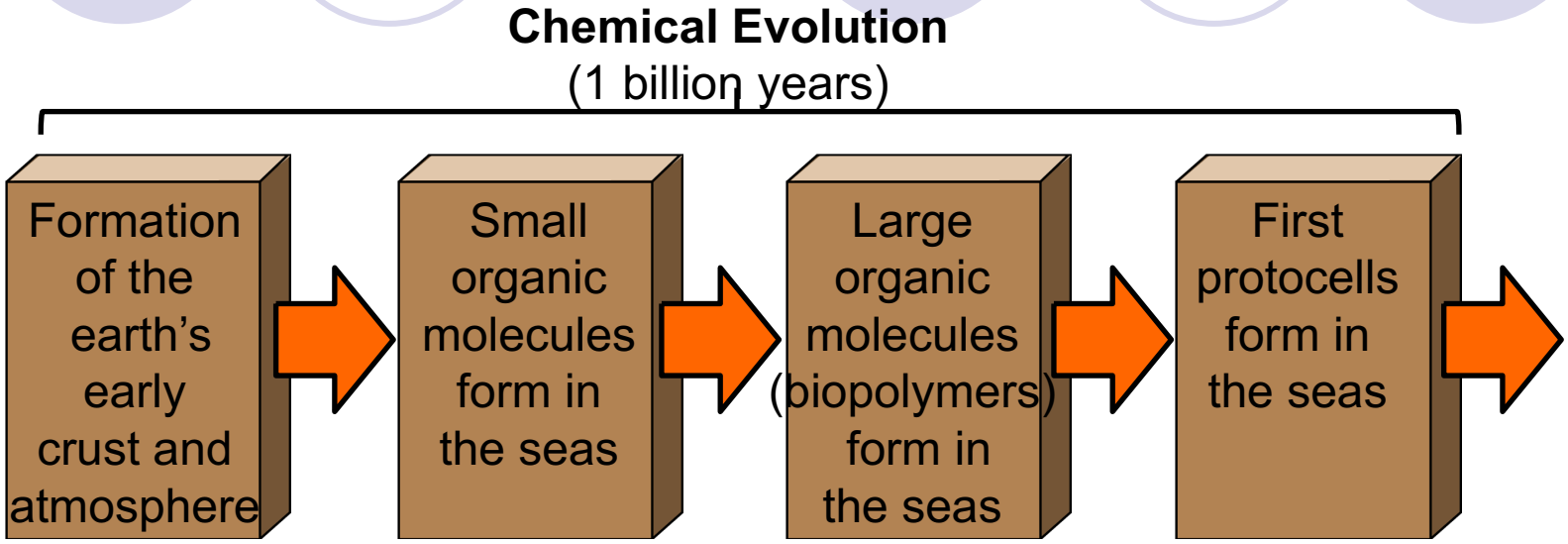
Evolution and Biodiversity

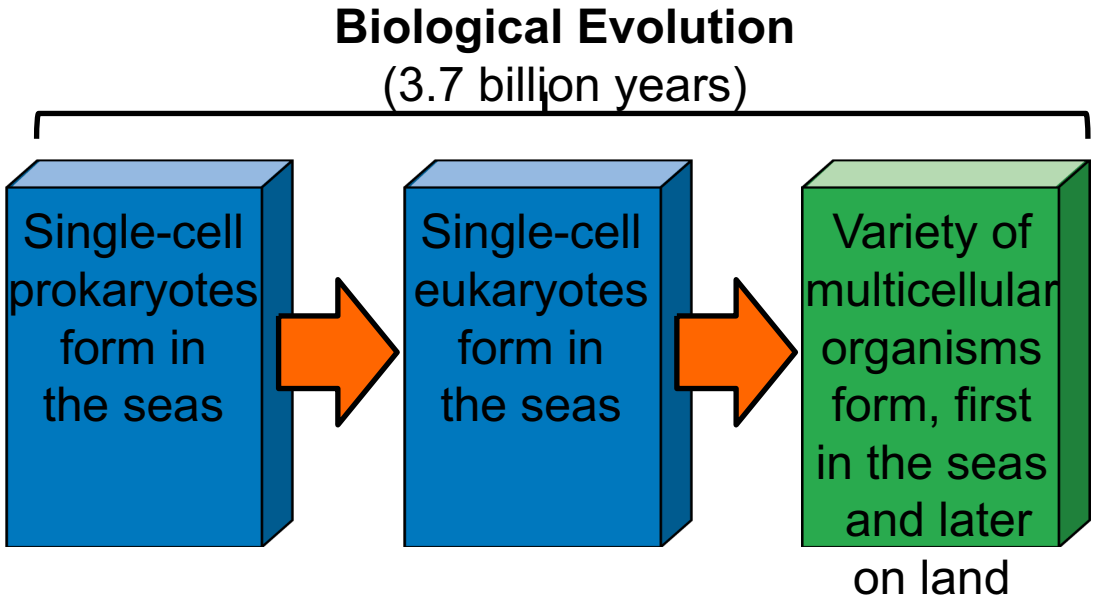


Miller Chapter 5

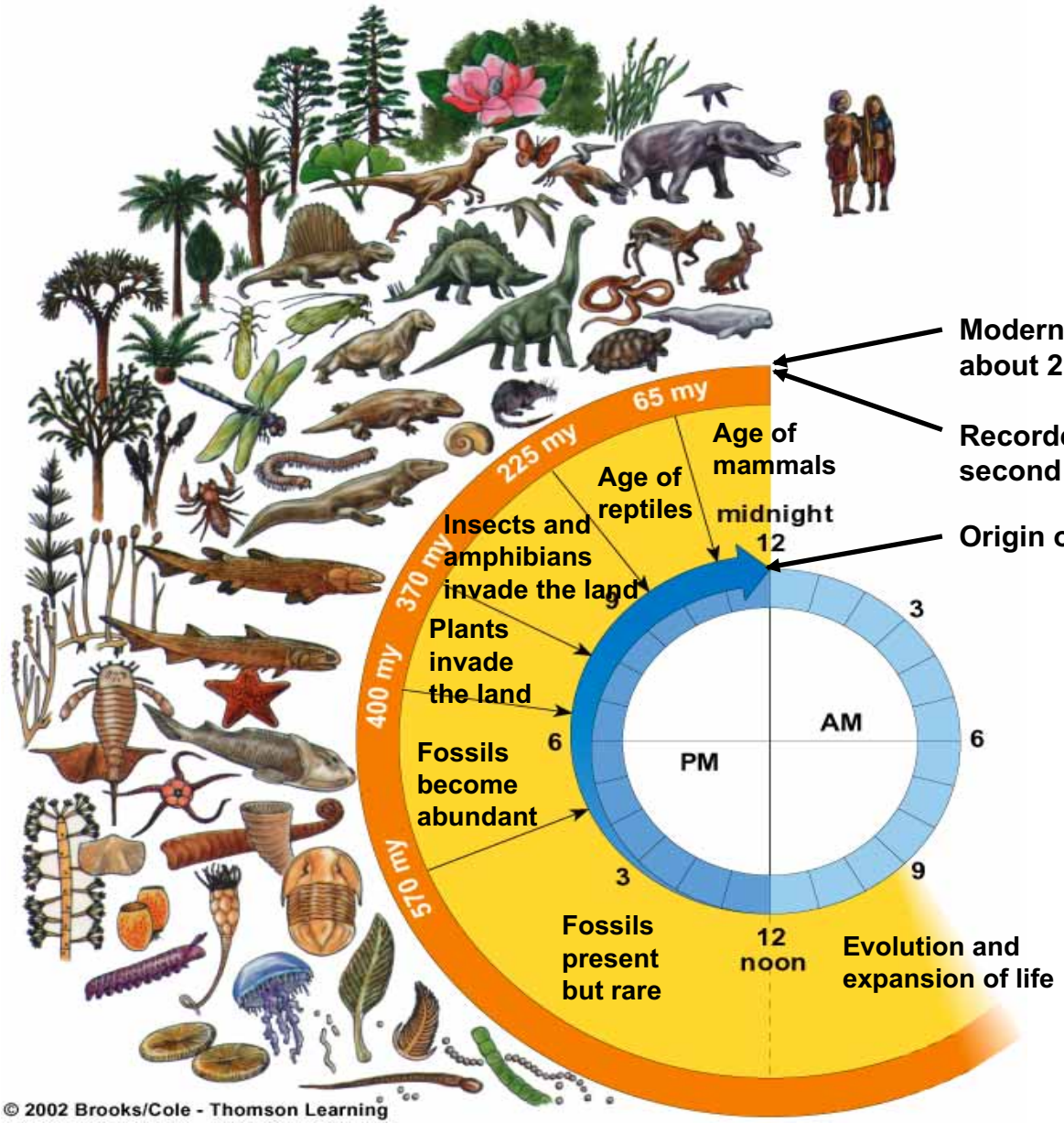
Powerpoint Adapted from:
http://yhspatriot.yorktown.arlington.k12.va.us/~mzito/APES/PPTs/Evolution.ppt

Summary of Evolution of Life





Biological Evolution



Fossil Record

- Most of what we know of the history of life on earth comes from fossils (SJ Gould)
- Give us physical evidence of organisms
  - Show us internal structure
- Uneven and incomplete record of species
  - We have fossils for 1% of species believed to have lived on earth
  - Some organisms left no fossils, others decomposed, others have yet to be found.
- Other info from ancient rocks, ice core, DNA

4 major mechanisms that drive evolution:

- Natural Selection
- Mutation
- Gene Flow
- Genetic Drift

Unifying Principles of Evolution

- **Perpetual Change: All species are in a continuous state of change**

Unifying Principles of Evolution

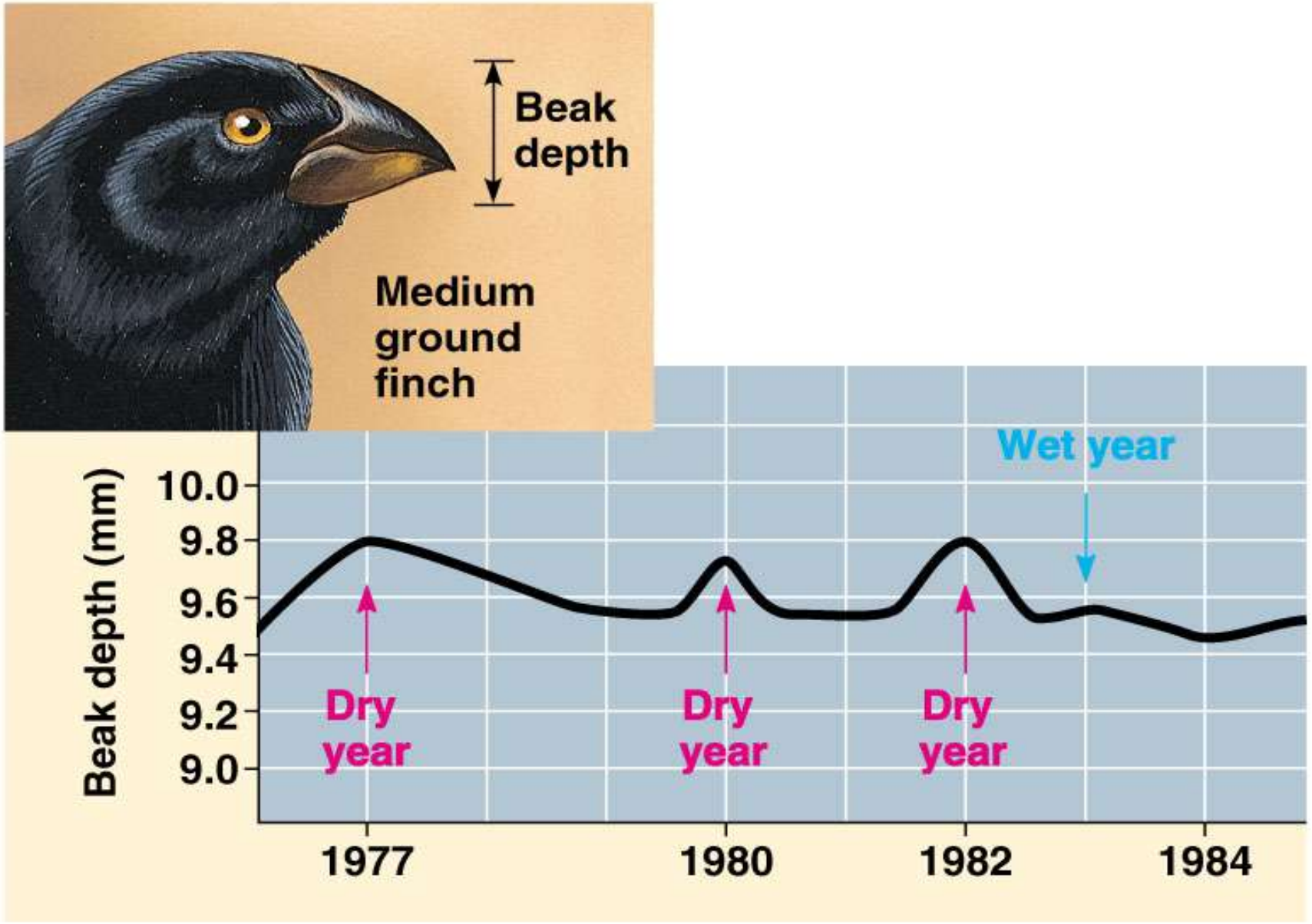
***Nature- The combined influences of physical and biological limiting factors* acting upon an organism.**

Unifying Principles of Evolution

***Limiting Factor- Any factor (physical or biological) which regulates**

the welfare of an organism

- **Disease, competition, predation, environmental change, etc.**



Darwinian Natural Selection

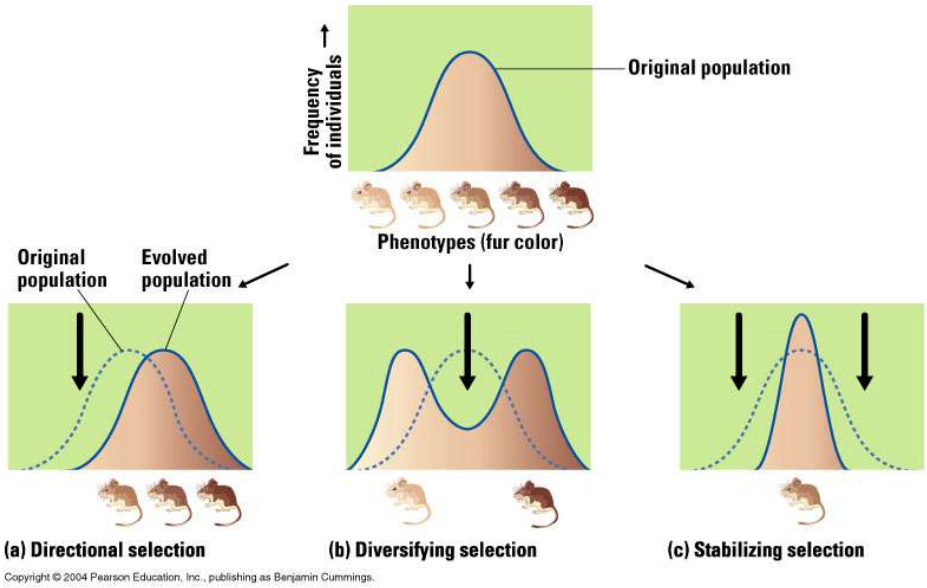
- Three conditions necessary for evolution by natural selection to occur:
  - Natural variability for a trait in a population
  - Trait must be heritable
  - Trait must lead to differential reproduction
- **A heritable trait that enables organisms to survive AND reproduce is called an adaptation**

Steps of Evolution by Natural Selection

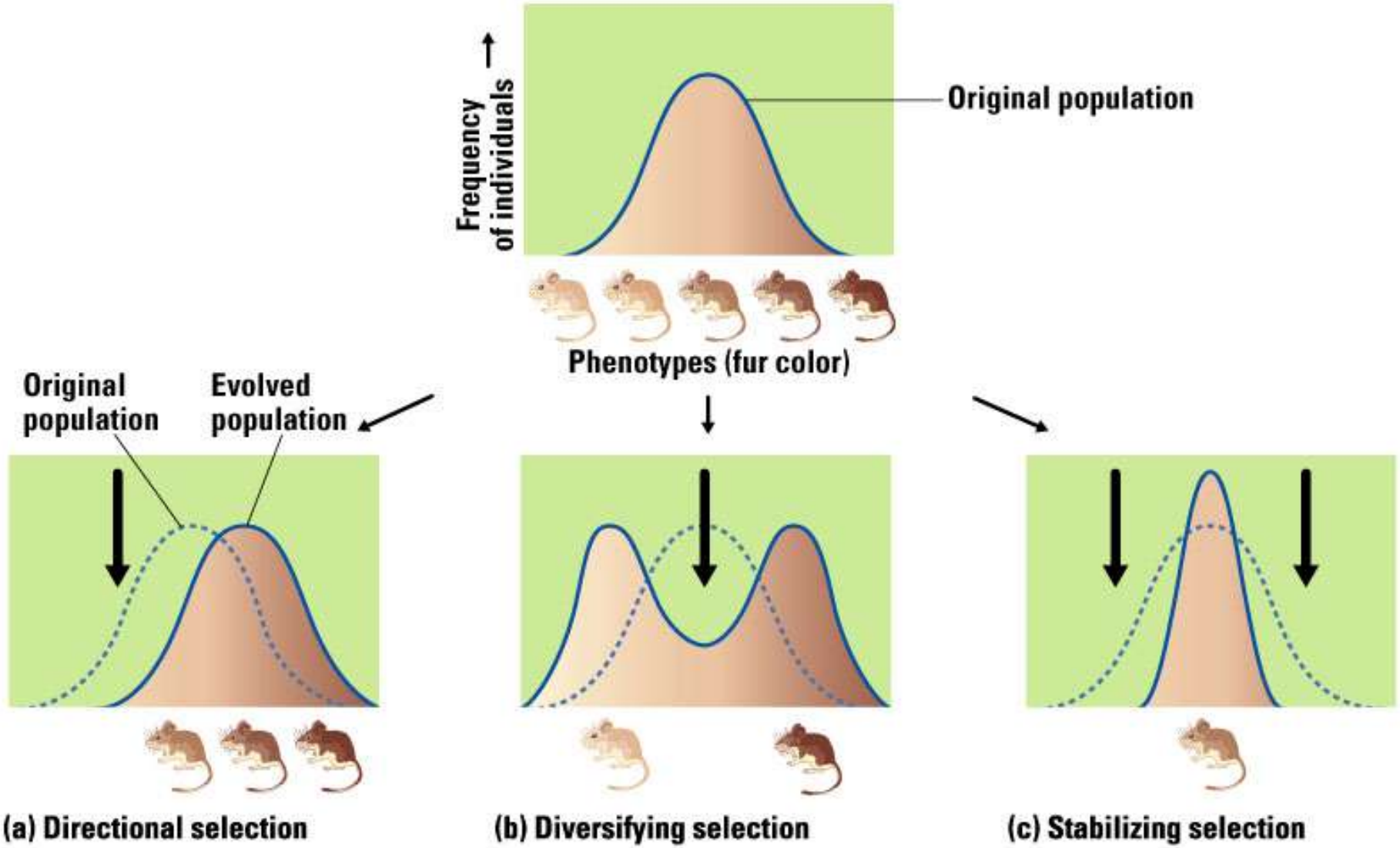
- Genetic variation is added to genotype by mutation
- Mutations lead to changes in the phenotype
- Phenotype is acted upon by nat'l selection
- Individuals more suited to environment produce more offspring (contribute more to total gene pool of population)
- Population's gene pool changes over time
- Speciation may occur if geographic and reproductive isolating mechanisms exist…
- Natural Selection in action ...
- A demonstration...

Three types of Natural Selection

- **Directional**
  - Allele frequencies shift to favor individuals at one extreme of the normal range
    - Only one side of the distribution reproduce
    - Population looks different over time
- **Stabilizing**
  - Favors individuals with an average genetic makeup
    - Only the middle reproduce
    - Population looks more similar over time (elim. extremes)
- **Disruptive (aka Diversifying)**
  - Environmental conditions favor individuals at both ends of the genetic spectrum
    - Population split into two groups



- http://www.pbs.org/wgbh/evolution/library/05/2/l_052_04.html



MUTATIONS, MY FRIENDS!

- Changes in the structure of the DNA
- Adds genetic diversity to the population
- May or may not be adaptive
  - Depends on the environment!

Sooooo…What's Evolution?

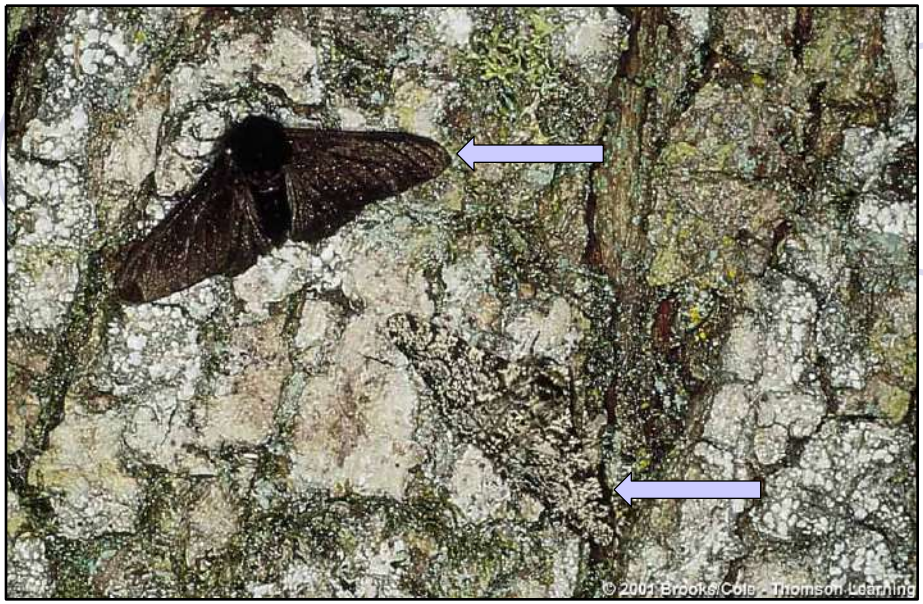
- The change in a POPULATION'S genetic makeup (gene pool) over time (successive generations)
  - Those with selective advantages (i.e., adaptations), survive and reproduce
  - All species descended from earlier ancestor species
- **Microevolution**
- Small genetic changes in a population such as the spread of a mutation or the change in the frequency of a single allele due to selection (changes to gene pool)
  - Not possible without genetic variability in a pop…
- **Macroevolution**
  - Long term, large scale evolutionary changes through which new species are formed and others are lost through extinction

Microevolution

- Changes in a population's gene pool over time.
  - Genetic variability within a population is the catalyst
- **Four Processes cause Microevolution**
  - **Mutation** (random changes in DNA—ultimate source of new alleles) [stop little]
    - Exposure to mutagens or random mistakes in copying
    - Random/unpredictable relatively rare
  - **Natural Selection** (more fit = more offspring)
  - **Gene flow** (movement of genes between pop's)
  - **Genetic drift** (change in gene pool due to random/chance events)

The Case of the Peppered Moths

- **Industrial revolution**
  - **Pollution darkened tree trunks**
- **Camouflage of moths increases survival from predators**
- **Directional selection caused a shift away from light-gray towards dark-gray moths**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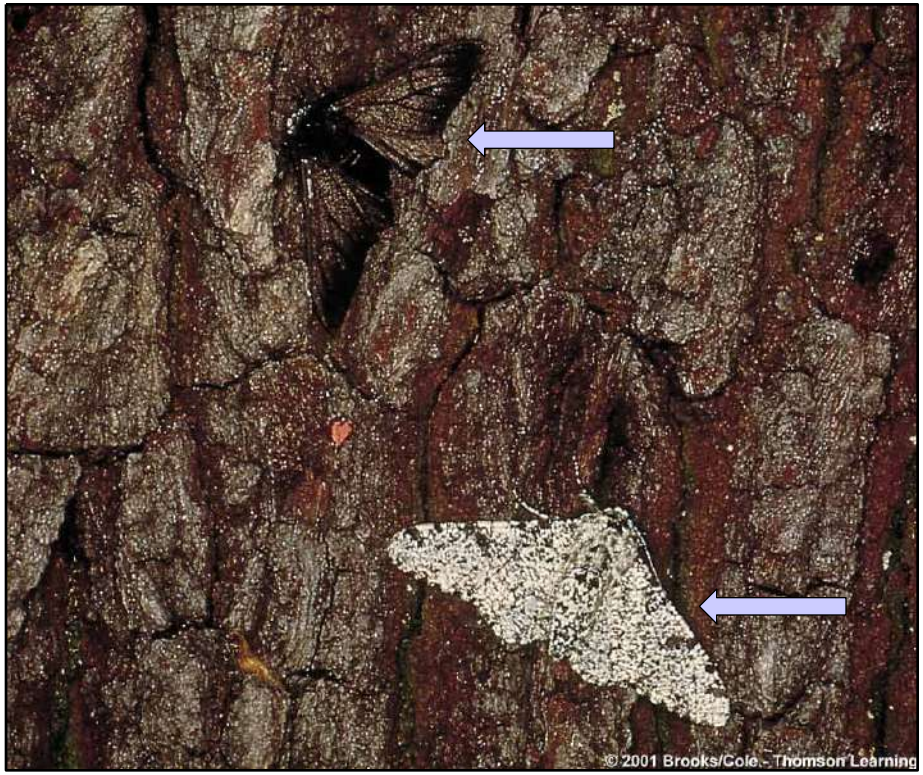
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Fig. 18.5, p. 287

Gene Flow and Genetic Drift

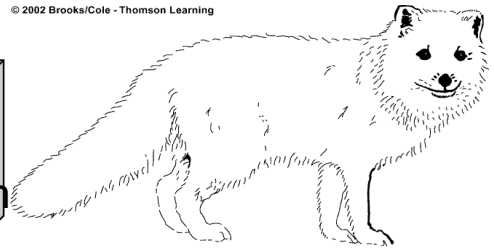
- **Gene Flow**
  - **Flow of alleles**
    - **Emigration and immigration of individuals**
- **Genetic Drift**
  - **Random change in allele frequencies over generations brought about by chance**
  - **In the absence of other forces, drift leads to loss of genetic diversity**
    - Elephant seals, cheetahs

Speciation

Early fox population

Spreads northward and southward and separates

Northern population



Arctic Fox

Adapted to cold through heavier fur, short ears, short legs, short nose. White fur matches snow for camouflage.

Different environmental conditions lead to different selective pressures and evolution into two different species.

Southern population

Gray Fox

Adapted to heat through lightweight fur and long ears, legs, and nose, which give off more heat.

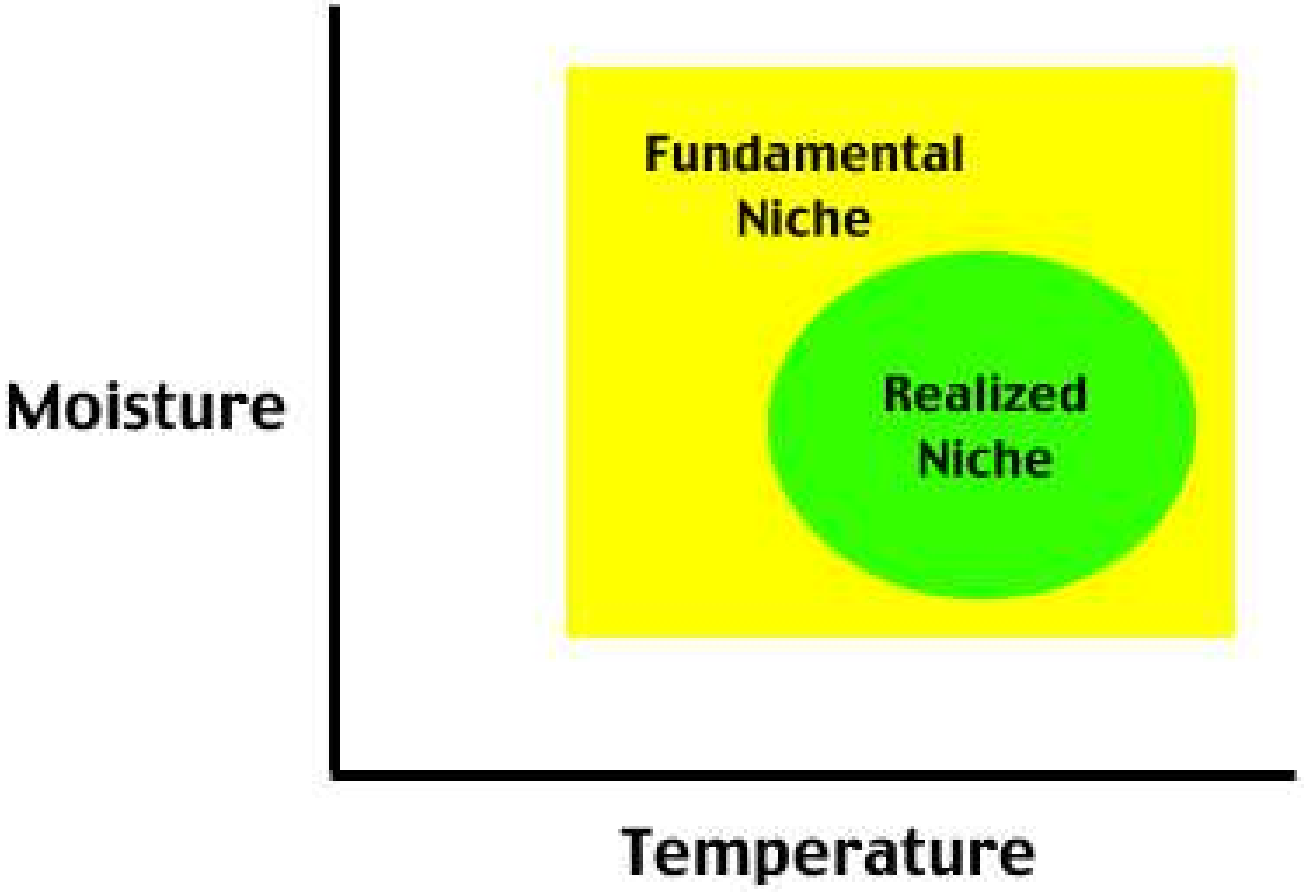
Speciation

- Two species arise from one
  - Requires Reproductive isolation
    - Geographic: Physically separated
    - Temporal: Mate at different times
    - Behavioral: Bird calls / mating rituals
    - Anatomical: body parts must match
    - Genetic Inviability: Mules

Niches

- A species functional role in an ecosystem
- **Fundamental Niche**
  - Full potential range of physical chemical and biological conditions and resources it could theoretically use if there was no direct competition from other species
- **Realized Niche**
  - Part of its niche actually occupied

Competition Shrinks Niches



Extinction

- Local, ecological and true extinction
- The ultimate fate of all species just as death is for all individual organisms
- 99.9% of all the species that have ever existed are now extinct
  - To a very close approximation, all species are extinct
- Extinctions open up new opportunities for speciation and adaptive radiation..BUT you can have too much of a good thing!

Factors Affecting Extinction Rates

- **Natural Extinctions**
  - Climate change
  - Cataclysmic event (volcano, earthquake)

- **Human Activities**
  - Habitat Loss/Fragmentation
  - Introduction of exotic/invasive species
  - Pollution
  - Commercial harvesting
  - Accidental killing (tuna nets)
  - Harassing
  - Pet Trade
  - Urbanization
  - Damming/Flooding
  - Agricultural conversion

Extinction in the Context of Evolution

- If
  - the environment changes rapidly and
  - The species living in these environments do not already possess genes which enable survival in the face of such change and
  - Random mutations do not accumulate quickly enough then,
- *All members of the unlucky species may die*