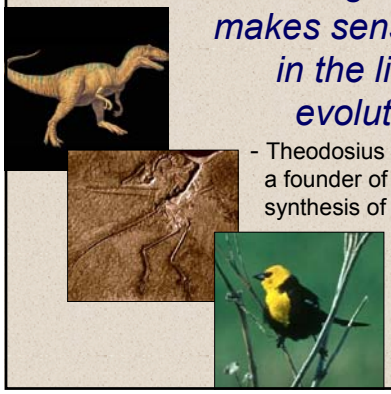
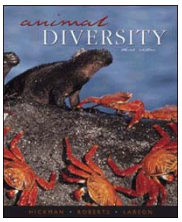


"Nothing in biology makes sense except in the light of evolution."

- Theodosius Dobzhansky, a founder of the modern synthesis of evolutionary theory

Biol 201: Organismic Biology



Zoology Section

Instructor: Ryan Rehmeier
(532-0123)
ryman@ksu.edu

Lecture text: Union/Varney's
Lab manual: Claflin Books & Copies
Website: www.ksu.edu/organismic
K-State Online: www.online.ksu.edu

Syllabus and Expectations – Zoology Section

- 3 lecture exams and 2 lab practicals
- 5-hour course means considerable effort required
- Lecture slides available as PDFs on both websites
- Class attendance policy
- Want to do well in class?
  - Lecture: read book, come to class, participate, download & review slides
  - Lab: read manual, come to class, check out all displays, actually find structures & learn functions

Care of Lab Specimens

- Displays: preserved specimens, freeze-dried animals, taxidermy mounts, skins and skulls
- Display materials must be treated with care
  - Do not shake or stir contents of jars
  - Do not draw on specimens with pen or pencil
  - Handle all dried materials with care
- Problems with compliance?
  - ✓First occasion will result in a warning
  - ✓Second occasion will result in cutting off your writing hand
  - ✓Third occasion: no lab for you

Lecture 1

The importance of biological diversity

Zoology and the scientific method

The evolution of animal diversity

What is biodiversity, and why is it important?

- Biodiversity: richness, evenness, and abundance of plant and animal species in an area
- 30-100 million species, only 5% described so far
- We're observing an accelerated rate of extinction
  - birds and mammals: 100-1000x greater rate of extinction than expected from past events
- Earth facing a "biodiversity crisis;"
  - sixth major extinction event in 600 MY history of animal life; now caused by humans

Why is loss of biodiversity a concern?

1. Species provide the ecosystem goods and services upon which human society depends
   - Water purification, flood damage control, forest carbon storage, pollination, wildlife recreation
2. Organisms contain the genetic information for all life processes on the planet
   - Example: Gastric brooding frogs of Australia
     - Discovered 1972
     - Extinct 1981
     - Ulcers in humans? We'll never know...

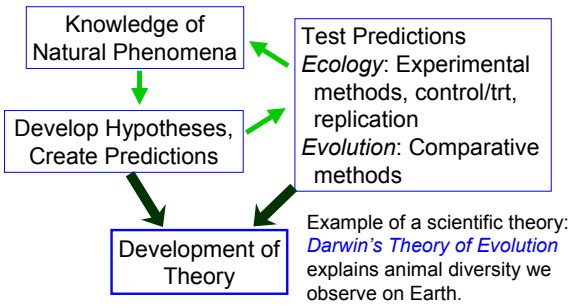
3. Species have intrinsic value

What is Zoology?

- Scientific discipline directed at the study of animal diversity
  - *Ecology* of how animals live, function, reproduce and interact
  - *Evolutionary relationships* among animal groups and the origins of animal diversity

Zoology and the Scientific Method

The hypothetico-deductive method



Example of a scientific theory: *Darwin's Theory of Evolution* explains animal diversity we observe on Earth.

Darwin's Theory of Evolution

- Evolutionary theory comprised of five major theories with different origins and fates

1. **Perpetual Change**
2. **Common Descent**
3. **Multiplication of Species**

Strongly supported, universal application throughout living world

4. **Gradualism**
5. **Natural Selection**

Important, but pervasiveness still controversial

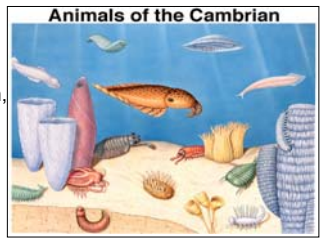
- Arguments about gradualism and natural selection **do not** challenge theories of perpetual change, common descent and multiplication of species

Theory of Evolution, Part 1: Perpetual Change

- Living world constantly changing in form and diversity
- Basic theory on which others are based

Evidence

1. 600-700 MY animal fossil record
   - exoskeletons, teeth, shells, bones preserved
   - sediment, amber, ice serve as substrates

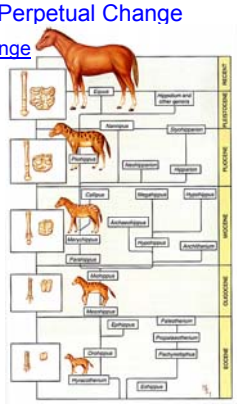


Fossils of Burgess Shale provide glimpse into the fauna of the Cambrian period (540 MYA)

Theory of Evolution, Part 1: Perpetual Change

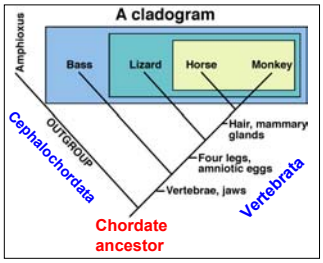
Further Evidence for Perpetual Change

2. Geologic principles
   - Law of stratigraphy, radiometric dating
3. Evolutionary trends (directional changes in features and diversity)
   - Species arise and go extinct repeatedly (last 1-10 my)
   - Trends in horses since Eocene epoch (57 mya); size, molar elaboration, toes



Theory of Evolution, Part 2: Common Descent

- All forms of life descended from one common ancestor; this is basis for construction of phylogenies
- Phylogeny: evolutionary history of a taxon's origin and diversification, usually depicted in the form of a branching tree

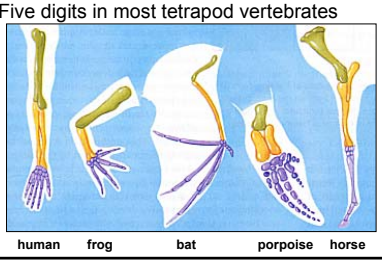


Theory of Evolution, Part 2: Common Descent

Evidence for Common Descent

Homology: similarities in structures because of evolutionary derivation from a shared ancestor

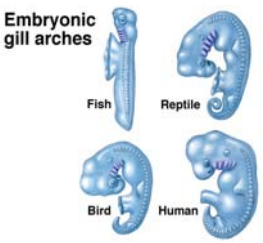
1. Shared morphological traits
   - Five digits in most tetrapod vertebrates



Theory of Evolution, Part 2: Common Descent

Further Evidence for Common Descent

2. Shared genetic material and biochemical molecules:
   - DNA, ATP/Kreb's Cycle, hemoglobin, melanin
3. Shared larval traits
   - Deuterostome larvae of starfish (Echinodermata) and humans (Chordata)
   - Gill arches among vertebrates



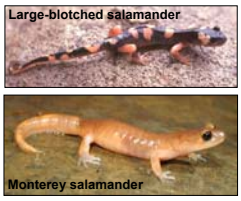
Theory of Evolution, Part 3: Multiplication of Species

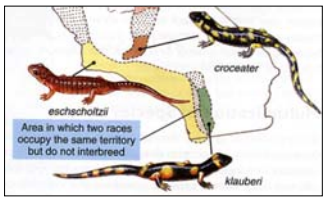
- New species produced by splitting and transforming older ones is process called speciation
- Reproductive barrier prevents interbreeding between different species (assuming use of biological species concept)
  - Evolution of reproductive barrier often requires physical separation of populations by some a geographical barrier for long period of time – called allopatric speciation

Theory of Evolution, Part 3: Multiplication of Species

Evidence for multiplication of species

- Example of allopatric speciation: *Ensatina eschscholtzii* salamanders, a "ring species"
  - Gradual accumulation of reproductive differences among contiguous populations around ring, two southernmost populations overlap but do not interbreed



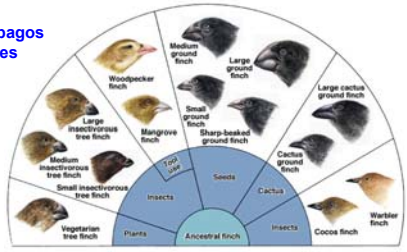


Theory of Evolution, Part 3: Multiplication of Species

Evidence for multiplication of species

- Another example of allopatric speciation: splitting of existing species into new, ecologically diverse ones on isolated oceanic islands (adaptive radiation)

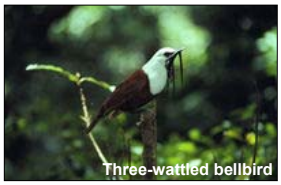
Galápagos finches

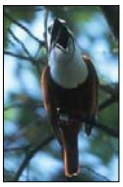


Theory of Evolution, Part 3: Multiplication of Species

Evidence for multiplication of species

- Speciation does not necessarily require geographical separation of populations
  - Sympatric speciation: reproductive isolation by sexual selection or female mate choice



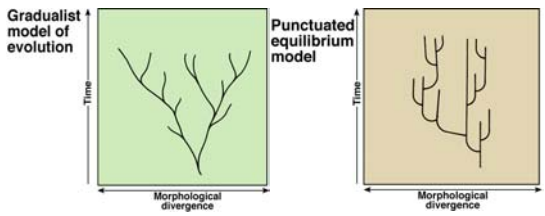


Theory of Evolution, Part 4: Gradualism

- Large anatomical differences observed between species are result of gradual accumulation of small, incremental changes over very long time
  - Countered idea that sudden genetic change required to cause large differences between species
  - Problem: Where are all transitional fossils?
  - Bottom line: Gradual evolution documented, but may not explain origins of all differences among species

Theory of Evolution, Part 4: Gradualism

- Alternatively, Punctuated Equilibrium model predicts rapid, episodic speciation
  - Some genetic variants with large effect are sufficiently beneficial to be selected for over time

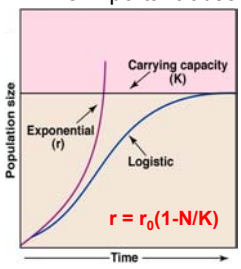


Theory of Evolution, Part 5: Natural Selection

- Process by which certain adaptations are favored over time, leading to evolutionary change
- Acts on whole animal with its combination of traits, not just the isolated beneficial trait
- Controversial
  1. Can not generate new structures, only modify old ones; So, what use is a partial wing?
     - Answer: exaptation
  2. Other non-selective forces: genetic drift, gene flow, neutral mutations, etc?
     - Answer: natural selection one of many processes

Theory of Evolution, Part 5: Natural Selection

Five important observations made by Darwin:

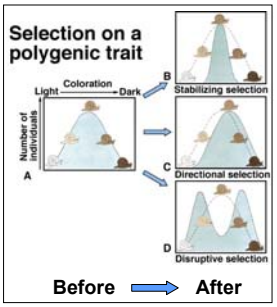


1. Organisms have great potential for reproduction (exponential growth)
2. However, natural populations do not grow unchecked (logistic growth)
3. Natural resources are limited (K = carrying capacity)
4. All organisms show variation in characteristics
5. Variation is heritable and can be passed to offspring

Theory of Evolution, Part 5: Natural Selection

Three major inferences from Darwin's observations:

1. Competition among individuals ("struggle for existence")
2. Differential survival and reproduction = fitness
3. Over *many generations,* differential success leads to new adaptations and new species



Revisions to Darwinian Evolutionary Theory

Neo-Darwinism

- Mechanisms of inheritance unknown when Darwin first proposed ideas; maybe use/disuse affected traits passed along to offspring?
- Why didn't Darwin just incorporate Mendelian inheritance (1868) into his theory of natural selection?
- August Weismann's experiments reject use/disuse hypothesis

Modern Darwinism (aka "Modern Synthesis")

- Synthesis of population genetics, paleontology, biogeography, embryology, systematics and animal behavior

Next time

Taxonomy and systematics of the animal kingdom

Readings: Chapter 1 (today's material) & Chapter 4