

Chapter 1

Science of Zoology & Evolution of Animal Diversity

Science Knowledge of the natural world

Biology Study of life

Living organisms:

- composed of cells
- complex & ordered
- respond to their environment
- can grow & reproduce
- obtain & use energy
- maintain internal balance
- allow for evolutionary adaptation

Nature of Science

1981: Arkansas: Balancing Treatment for Creation-Science & Evolution-Science Act

1982: Judge Overton US District Court, Eastern District of Arkansas:
Balancing Treatment for Creation-Science & Evolution-Science Act

- 1) Guided by natural law
- 2) Be explanatory by reference to natural law
- 3) Testable against the empirical world
- 4) Conclusions are tentative, not necessarily the final word
- 5) Falsifiable

Scientific Method

- 1) observation: of natural phenomenon, occurrence, event
- 2) question
- 3) hypothesis: initial explanation of observation
hypothesis: stronger → theory: powerful explanation → law
- 4) empirical test
- 5) conclusion: confirmation of hypothesis
- 6) conclusion: hypothesis rejected -formulate new one

Experimental Sciences: proximal causes (how)

Evolutionary Sciences: ultimate causes (why)

Differences Between Science & Religion

Science hypothesis/theory: accepted temporarily & can be “falsified” through further testing → science dynamic & in flux

Religion based on “beliefs” of tenets: thus no questioning or testing of existence of supra-natural being

Example of Conflict Between Science & Religion

- Catholic Church: geocentric: planets (also sun) revolved around earth
- Copernicus (astronomer): 1543 – heliocentric: earth not center of universe but revolved around sun
- Bruno (Dominican priest, 1548-1600): -proponent of Copernican view under Church arrest for heresy– tortured to renounce his views after death sentence: 1) jaw clamped shut with an iron gag; 2) tongue pierced with an iron spike; 3) palate driven with iron spike burned to a stake in Rome
- Galileo (1564-1642): made telescope -1610-confirm Copernican view 1632: under arrest for heresy– 1992: Church pardoned Galileo

Evolution

- 1) species change over time
(evolutionary biologists)
- 2) gene frequencies change from generation to generation (pop. geneticists)
- 3) descent with modification (Darwin)

Gene Theory: genotype \rightarrow gene products \rightarrow phenotype

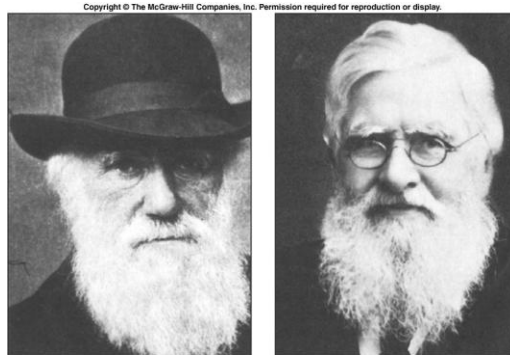


Jean Baptiste de Lamarck

1809: Inheritance of Acquired Characteristics
 genotype \leftarrow gene products \leftarrow phenotype

Transformational evolution: activity of phenotype then transfers this trait to offspring
 --e.g. blacksmith develops buff body & gives this physique to offspring

1859: Theory of Evolution by Natural Selection



^A Charles Darwin 1881

^B Alfred Russel Wallace 1895

Theory of Evolution by Means of Natural Selection*

- 1) organisms show variation which is passed on to offspring¹
- 2) organisms produce more offspring than can survive
“struggle for existence” from Thomas Malthus essay
- 3) some organisms have selective adaptations for survival*
- 4) surviving organisms reproduce & pass on these advantageous adaptations to their offspring*
- 5) new species thus can evolve

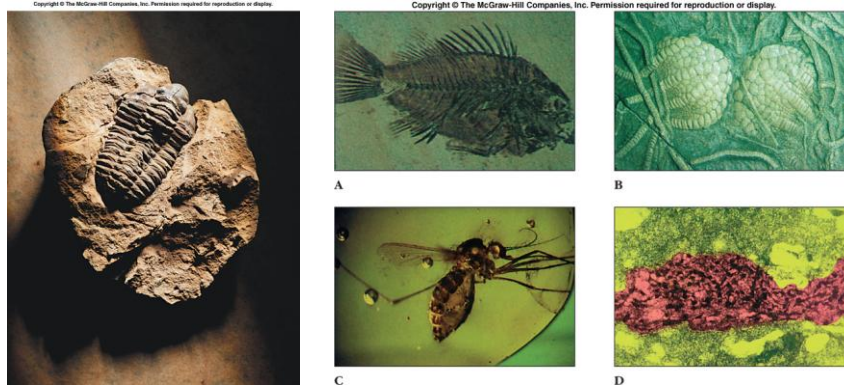
* natural selection: differential survival & reproduction

¹ weakest part of theory since variation could not be explained

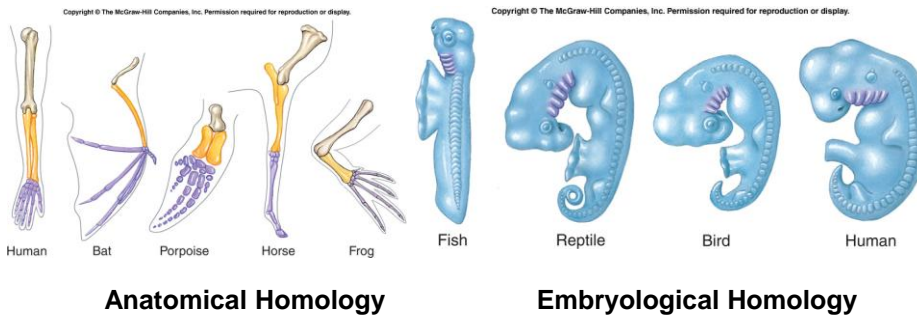
Evidences for Evolution

- 1) Fossils
- 2) Homology
 - anatomical
 - embryological
 - biochemical

Fossils: remains of the past



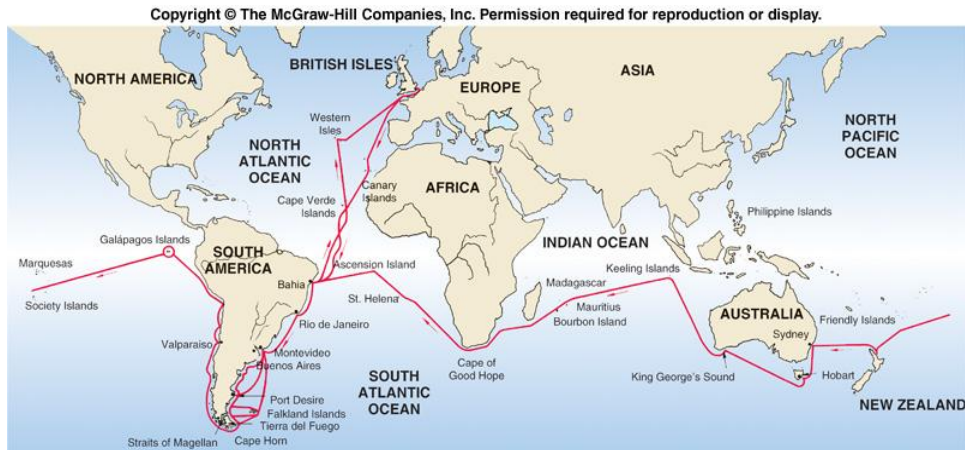
Homology: similarities



Biochemical Homology: genetic mechanisms (DNA, RNA, codons) & metabolic pathways (enzymes, proteins)-- present in primitive, single-celled, common ancestor: inherited by successive organisms, eventually leading up to higher organisms

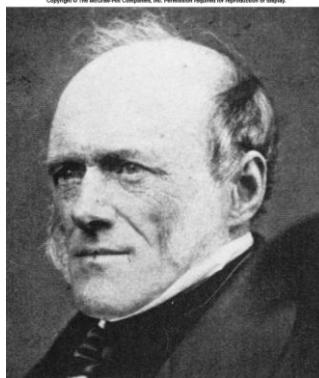
Voyage of the Beagle: 1831-1836

Darwin: 22 year old hired as companion for Captain Robert Fitzroy
Became naturalist after original one left position in South America



Uniformitarianism

- 1) laws of physics & chemistry remain same throughout earth's history
- 2) past geological events occurred by natural processes similar to those observed today



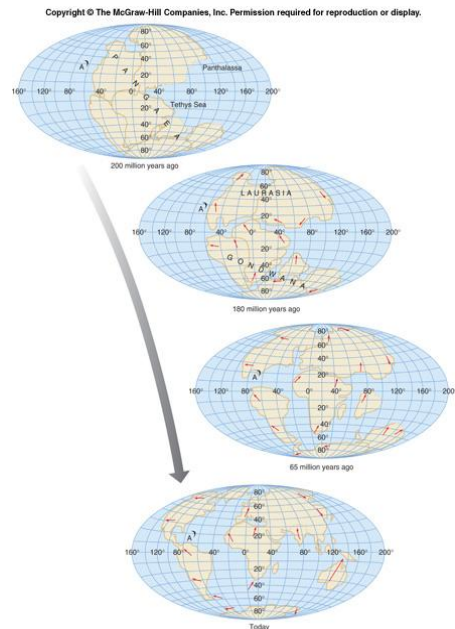
Charles Lyell: Principles of Geology

Organisms Evolve Because of Changing Environment

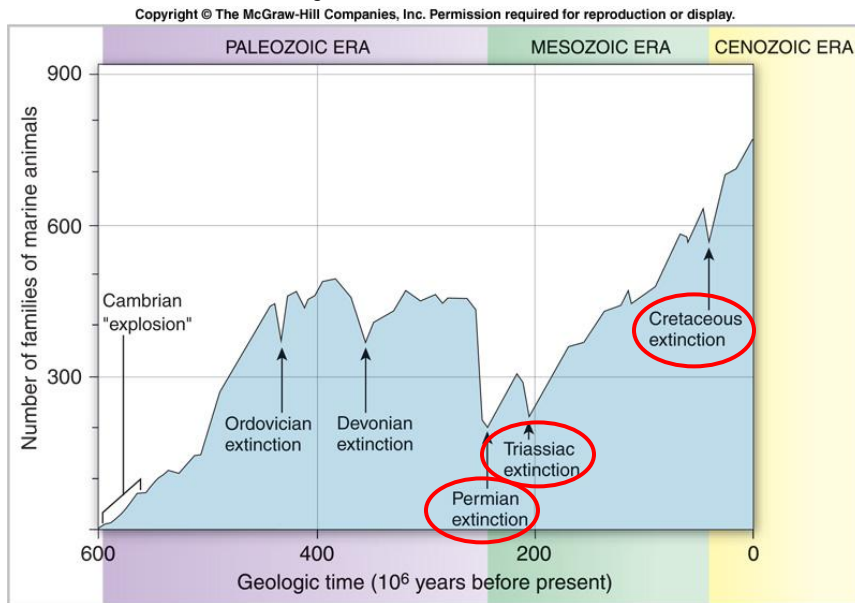
- I. Plate Tectonics: earth composed of 6 massive plates
~60 miles thick
 - North American Plate
 - South American Plate
 - Eurasian Plate
 - African Plate
 - Antarctican Plate
 - Pacific Plate
- A. Subduction zone-plates colliding →
volcanoes, mountains, islands, deep sea trenches
- B. Transform faults -plates sliding past each other →
earthquakes
- C. Oceanic ridges -plates pulling apart →
deep sea vents → pogonophoran (bearded worms)

Organisms Evolve Because of Changing Environment

II. Continental Drift—continents splitting up



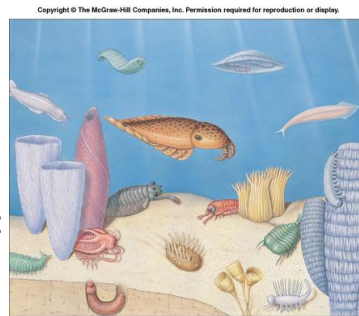
5 Major Extinctions



Geologic History and Benchmarks of Evolution of Life

- 4.8 bya*: formation of Earth
- 3.6 bya*: prokaryotes (no nucleus)
- 1.6 bya*: eukaryotes (true nucleus)
- 0.6 bya (600 mya**): ↑ multicellular

Cambrian Explosion (580-540 mya): rapid burst of multicellular animals

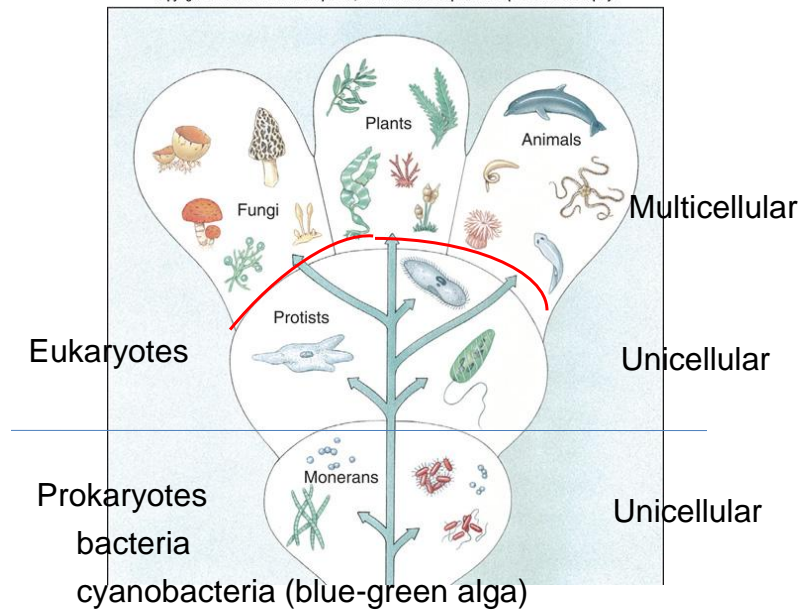


*bya (billion years ago)

**mya (million years ago)

Whittaker's 5 Kingdoms

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Hardy-Weinburg Equilibrium

Gene frequencies do **not** change from generation to generation provided that the following 5 assumptions are met:

- 1) large population size
- 2) no migration
- 3) random mating
- 4) no mutation
- 5) no natural selection

Genetic drift → gene migration

Violation of #1 & #2, e.g. small population size migrating to new habitat:

- 1) **Founder effect:** small group of individuals with a genes migrating out of large original population to establish a new population at different habitat
- 2) **Bottlenecking:** small surviving group of individuals (e.g. hunting) from large original population to whether return to gene pool of original population after hunting is banned—important in conservation biology

Industrial Melanism

1840s: industrial revolution- mass production of good powered by factories burning coal

before 1840s: peppered moths flourished against lichen tree trunks
Bird predators difficult to spot moths (A)

1849: mutation caused appearance of black moths flourished against now soot covered trunks; bird predators difficult to spot black moths but easier detection of peppered moths (B)

>1970: environmental air pollution controls allow peppered moths flourished against lichen tree trunks & bird predators detect black moths (C)

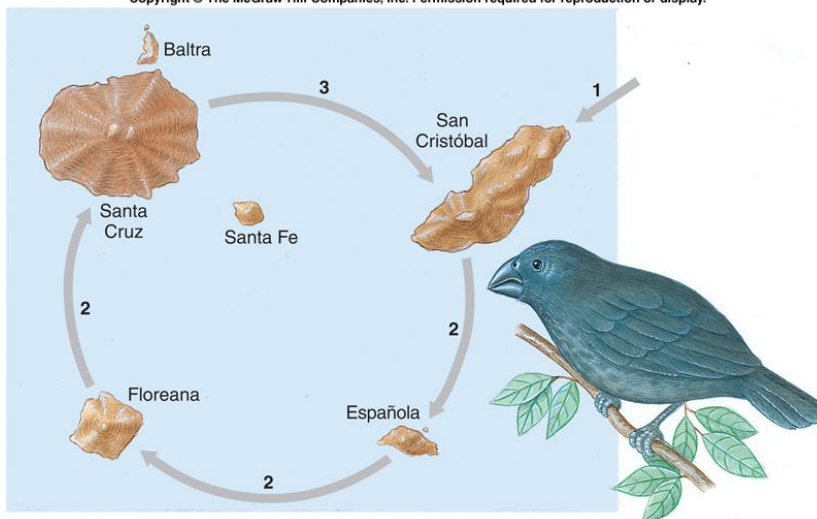
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gene frequency change of peppered moths & black moths through time

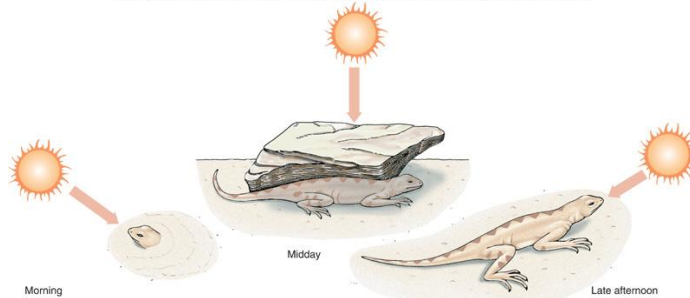
Example of Founder Effect

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Lizard genes: →physiological & behavioral adaptations for survival

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ectothermic (poikilothermic): gain heat from external sources
 invertebrates, fish, amphibians, reptiles--inexpensive –need not to feed constantly; no structures needed to conserve heat--restricted to warm-hot habitats since enzymes operate at suboptimal temperatures

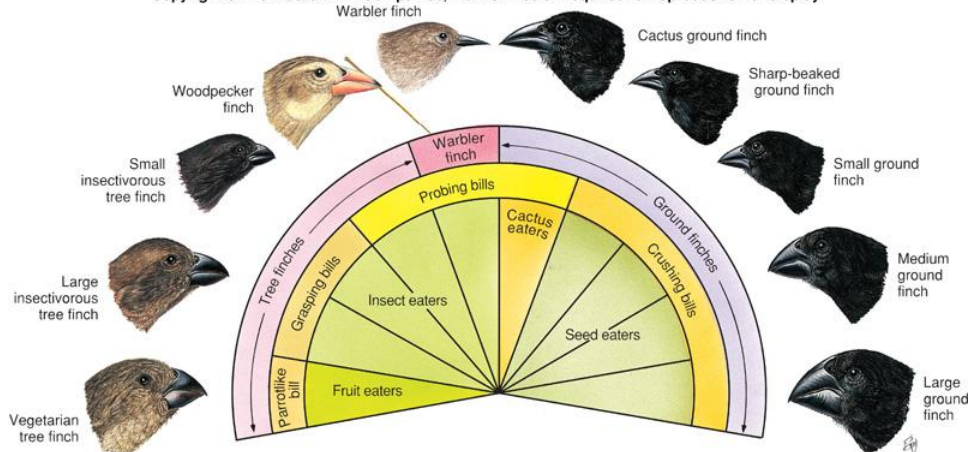
endothermic (homeothermic): generating internal heat

birds & mammals -- expensive –need to feed constantly; production of structures (hair, fur, feathers, blubber to conserve heat -- allow to live in Many habitats from hot to cold environments

Adaptive Radiation

few individuals colonizing & exploiting a new habitat
 & rapidly undergoing successful speciation

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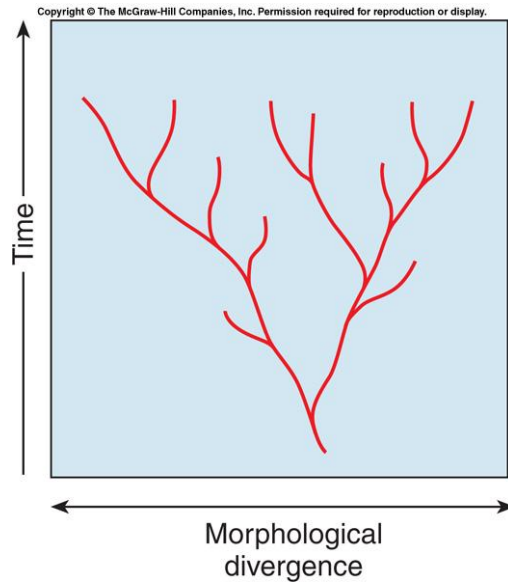


A

niche/resource partition: lessening competition by increasing resources can actually enhance speciation

Gradualism

Darwin's view: adaptation-slow gradual changes within species



Punctuated Equilibrium

1972 Eldredge & Gould: macroevolution of new species

