Reference: Chapter 2 of Futuyma

The Early Seeds of Evolutionary Thinking

- The Classical view
- Buffon 1770
- Erasmus Darwin 1770
- Lamarck 1810

The Classical view:

- Living organisms are constant and unchanging. The roots of this notion trace back to the Greeks, but even the great naturalist Aristotle pondered over bizarre life forms that he could not easily classify, e.g., sponges, which look like plants but feed like animals.

This view gets shaken up:

- Global explorations starting in the 1500s turned up extraordinary diversities of life forms, some of which appeared related to European forms, others with no resemblance.

The world distribution of organisms was puzzling:

- Marsupial mammals generally very rare, but all Australian mammals were marsupials

- Cactus plants common in North and South American deserts, absent in Australian and Asian deserts

If all species were created at the same time in the same place, how could so many be restricted to particular parts of the world?

Buffon (1750-60s)

- Noted that if there had been only a single center of creation, species spreading out from this center would have eventually been stopped by mountains or seas. He suggested that the creation of species is spread out in space.

- Buffon also noted that species might not have been created in a perfect state (e.g., pigs have lateral toes that are too high to reach the ground). He suggested that perhaps species become modified over time.

- Suggested closely-related organisms arose from a common ancestor.

Erasmus Darwin (1770s)

- Was impressed by the diversity of domesticated animals generated by selected breeding. Suggested that all organisms had a common ancestor

Jean Baptiste de Lamarck (1809)

- Suggested that life had been created long ago in a simple state, and had been gradually improving. He proposed a specific mechanism for how this change occurs: **the inheritance of acquired characteristics**

- Lamarck thus suggested that species change over time and that the environment was a factor in this change

Georges Cuvier: Contemporary and critic of Lamarck

- Life forms are so complex that no organism could function with any part altered

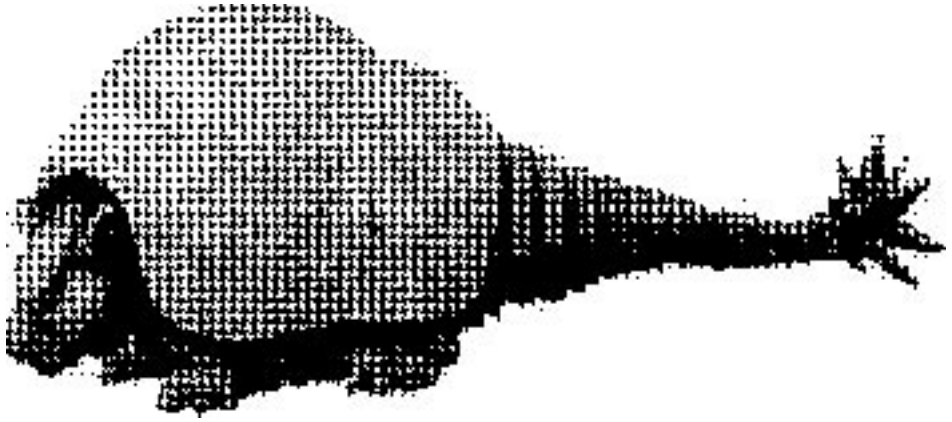
- Fossil organisms are as complex as living ones, hence modern species could not have evolved from these more ancient forms which have become extinct

- "Modern" version of these ideas is the notion of "irreducible complexity" when this same "logic" is applied to biochemical systems.

Charles Darwin (1809 - 1882)

1831-36: Served as Naturalist on *H.M.S. Beagle*. Made observations critical to forming this notion of evolution by descent with modification.

Darwin observed that organisms on isolated islands appear closest to organisms on the nearest mainland.



Armadillos and fossil Glyptodonts. : Both found in the same locations in South American.

• If these had been created separately, why would both living and extinct forms be restricted to the same area.

•Darwin thought it made more sense to assume the armadillo evolved from the glyptodon.

During his Voyage on the *Beagle*, Darwin read Charles Lyell's *Principles of Geology* (1830) . Lyell's expanded upon Hutton's notion of Uniformitarianism:

•Processes shaping the Earth today are the same as those that have shaped it in the past.

•Evidence that the earth was very old.

1838: Read Mathus (1798) *Essay on the Principle of Populations* ., came upon idea of natural selection

1858: Manuscript from Alfred Russell Wallace suggesting same idea (thought up during a two-week bout with malaria) prompts Darwin to publish.

1 July 1858: Wallace and Darwin jointly present ideas at a meeting of the Linnean Society of London.:

1859: Origin published

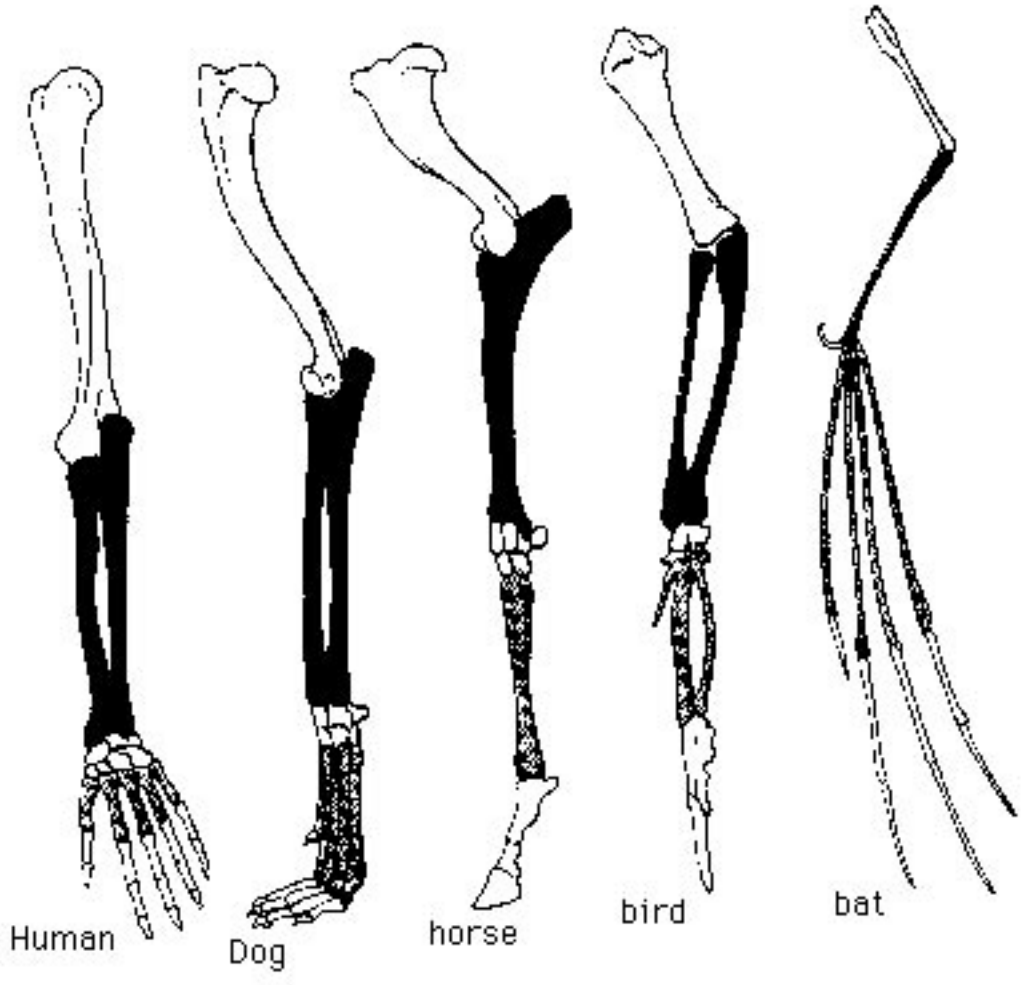
Evolution = descent with modification.

Darwin's evidence:

1) Functional Morphology: Vestigial Organs

- Humans have muscles to move their ears
- Humans have a vestigial tailbone
- Vestigial toes in the horse
- Vestigial limbs in whales and snakes

1) Functional Morphology: Homologous structures



3) Fossils

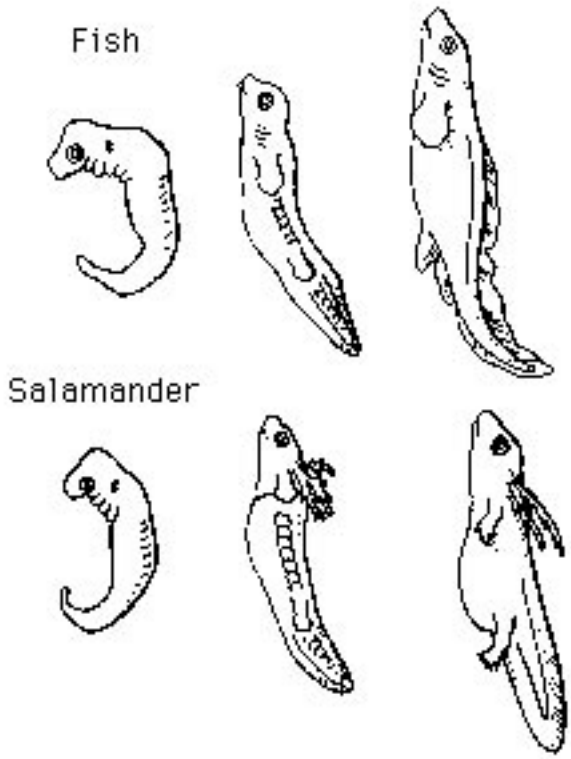
- Fossils show a succession from very simple morphological forms early in the fossil record to much more complex forms that appear much later in the fossil record.

- Fossils show multiple examples of transitional forms.

- Direct evidence for descent with modification

4) Comparative embryology

Early embryos of very different organisms closely resemble each other



5) Animal breeding

Domesticated animals greatly changed by artificial selection.

THE REACTION:

1870's: Overwhelming acceptance of descent with modification.

Shared common ancestry nicely accounts for observations in paleontology, comparative morphology, embryology

Widespread rejection of Darwin's mechanism

The Flaw in Darwin's idea: His mechanism of inheritance

Darwin assumed **Blending inheritance**

Fleeming Jenkin (1867) pointed out that blending inheritance results in genetic variation being halved each generation.

Var[(A+B)/2] = Var(A)/4 + Var(B)/2 = half initial variance

Thus, Darwin's mechanism of inheritance does not allow genetic variability to be maintained.

The mechanism of inheritance is key, as Darwin presented a ***variational theory*** (existing variation exploited), while Lamarck presented a ***transformational theory*** (the process itself generates new variation)

Mendel (1865) held the key: Particulate inheritance

Although Darwin had a copy of Mendel's paper in his library, he either did not read it or did not get Mendel's idea.

Indeed, while Darwin had immediate acceptance, Mendel was ignored until "rediscovered in 1900.

The Stormy courtship: The Biometricians versus the Mendelians (1900 - 1918)

REF: A nice (short) book on this debate is Provine, 1971. ***The Origins of Theoretical Population Genetics***

The Biometricians

- Motivated by Darwin's belief that selection acts on small changes in continuous characters, they developed the framework for the modern theory of statistics (regression, correlation)

- Francis Galton (Darwin's cousin) and Karl Pearson were the key figures.

- More concerned with the mechanisms of selection than the mechanisms of heritability.

The Mendelians

- Lead by Bateson

- Felt that the particulate nature of the gene rules out natural selection (as they thought different alleles had very large

effects). They felt mutation generating alleles of large effect was the driving force of evolution.

The reconciliation: Population Genetics:

Fuses the genetics of Mendel, the idea of natural selection, and the machinery developed by the biometricians**.**

Hardy-Weinberg (1908) theorem

R. A. Fisher (1918)

Key paper (rejected by the Proceedings of the Royal Society of London) showed how particulate genes could generate a continuous distribution and also the observed resemblance between relatives. Paper inverts term variance, machinery of ANOVA.

1930's - 1940's The Modern Synthesis

Fisher 1930: *Genetical theory of Natural Selection*

J.B.S. Haldane 1932: *The Causes of Evolution*

Sewall Wright (1920's- 1930s) Hugely influential papers on inbreeding, resemblance between relatives, selection

T. Dobzhansky (1937) *Genetics and the Origin of Species*

E. Mayr (1942) *Systematics and the Origin of Species*

L. Stebbins (1950) V*ariation and Evolution in Plants*

G. G. Simpson (1944) *Tempo and Mode of Evolution*
(1955) *Major Features of Evolution*

OTHER THEORIES OF EVOLUTIONARY MECHANISMS

Tend to be recycled every 20-30 years

Orthogensis: Species evolve towards particular goals even in the absence of selection.

Basically, an inertial theory of evolutionary change (Irish Elk example)

Modern re-incarnation: G. Dover's "Molecular Drive"

Neo-Lamarckism: Inheritance of acquired characteristics

Epigenetics: non-Mendelian inheritance of acquired characteristics (phage lambda example)

Mutationism: Mutations drive evolution

Hopeful monsters of Goldschimidt (1940's). Minor resurrection in 1980's (Chicago macroevolution meeting)

Directed-mutation ideas of Cairns and others (present version)