

Chapt. 22 – Descent with Modification: A Darwinian View of Life

Why are there so many species?

The **Theory of Evolution by Natural Selection**, especially as conceived of and elaborated by **Charles Darwin**, is our best explanation

Hypothesis – Tentative explanation of observations; educated guess

Theory – General explanation of important natural phenomena, developed through extensive & reproducible observations & experiments

Western Historical Context for the Theory of Evolution by Natural Selection

[See timeline in Fig. 22.2]

Aristotle (384-322 B.C.) – Greek philosopher

Species are permanent, perfect, immutable ← dominant world view for > 2000 years

A.D. – Natural Theology (Creationism)

Species are permanent, perfect, immutable

Carolus Linnaeus (1707-1778) – Swedish physician & botanist whose passion was taxonomy

Developed a hierarchical classification scheme & **binomial nomenclature**

[See Fig. 25.8]

Take, for example, the timber wolf: *Canis* = genus, *lupus* = specific epithet that refers to one species (the timber wolf) in the genus *Canis*

The **binomial** is always italicized or underlined, the genus name is always capitalized, and the specific epithet is always lower case

Kingdom Phylum Class Order Family Genus Species

“**King Philip Came Over For Gumbo Sunday**”

Georges Cuvier (1769-1832) – French anatomist who largely developed **paleontology**, the study of fossils

Deeper strata contain older taxa

Preferred hypothesis for profound geologic change = **catastrophism**

James Hutton (1726-1797)

Scottish geologist who offered an alternative to catastrophism

Preferred hypothesis for profound geologic change = **gradualism**

Charles Lyell (1797-1875)

Scottish geologist who incorporated Hutton's gradualism into the theory of **uniformitarianism**

Uniformitarianism – geological processes & rates today are those that also operated in antiquity; suggested that the Earth is > 6000 yr old

Jean Baptiste Lamarck (1744-1829)

Invertebrate Curator of the Natural History Museum in Paris

One of the 18th & 19th centuries' biologists who hypothesized that traits of species are not immutable, *i.e.*, they can evolve

Hypothesized **mechanism of evolution**: Use & disuse alters traits; inheritance of acquired characters results in adaptations to environmental conditions

Thomas Malthus (1766-1834)

English demographer

Hypothesis: Plants and animals are capable of producing far more offspring than resources can support; the "struggle for existence" (*e.g.*, famine, war) is an inescapable consequence

Within this context, **Charles Darwin (1809-1882)** served as Ship's Naturalist on the HMS Beagle's circumnavigation of the globe (1831-1836)

Charles Darwin (1809-1882)

Galapagos Islands, Ecuador were influential in Darwin's thinking

Darwin was a good observer of both wild and domesticated organisms (*e.g.*, birds)

English gentleman who conceived of **natural selection** as the **principal mechanism of adaptive evolution**

Alfred Russel Wallace (1823-1913)

English biologist who also (independently) conceived of **natural selection** as the **principal mechanism of adaptive evolution**

Lyell presented the independently derived hypothesis to the Linnaean Society of London on July 1, 1858

The Origin of Species (Darwin, 1859), final paragraph:

"It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us..."

There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed laws of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.”

Darwinian Theory of Evolution

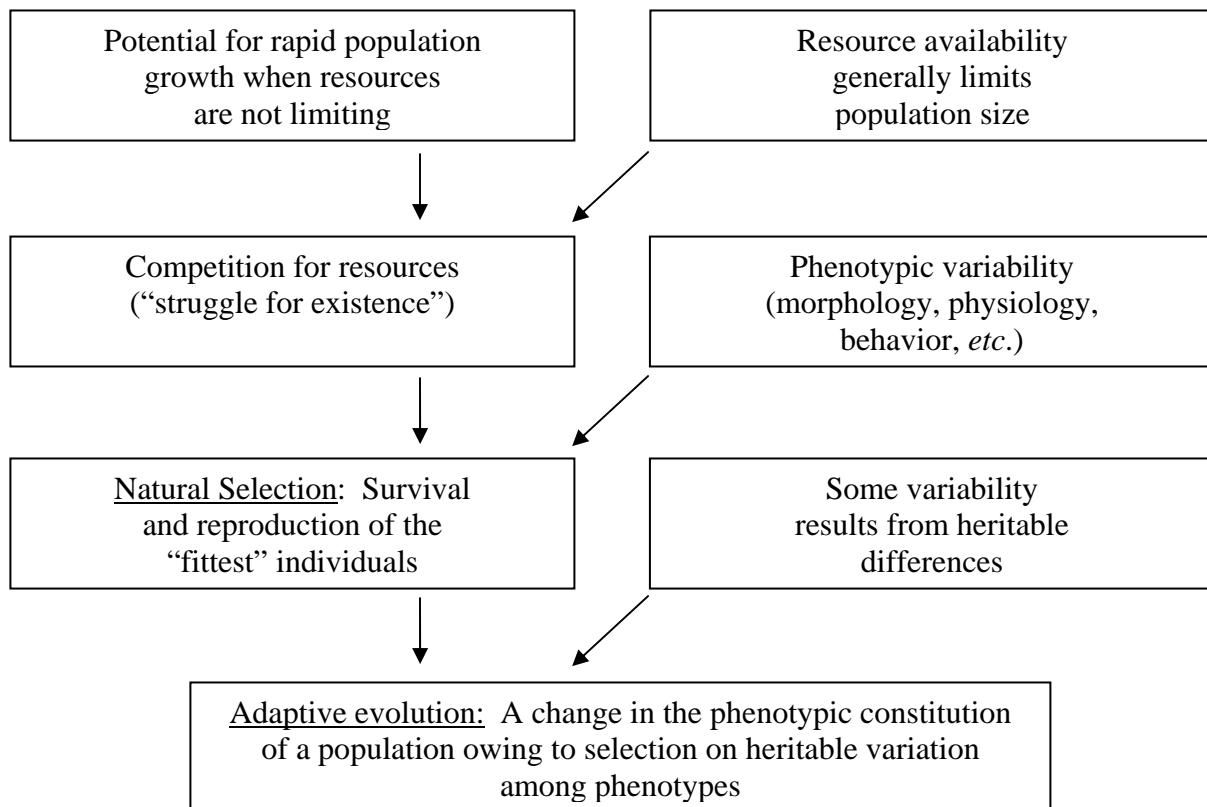
Descent with modification

Descent implies common ancestry

Modification to better suit the environment = adaptation

Natural selection is the process that drives adaptation [See Fig. 22.7]

Organisms have enormous potential for population increase, but the potential is rarely reached...



Evidence for the Theory of Evolution by Natural Selection

Darwin used **artificial selection** to illustrate the modifying potential of selection

Rapid changes in populations under strong selection, *e.g.*, pesticide resistance

Homologous & analogous traits

Homologous traits (a.k.a. characters, attributes) = traits in different species that arose from the same ancestral trait (may or may not have similar function)
[See Fig. 22.14]

Analogous traits = traits in different species that have similar function, but arose from different ancestral traits

To distinguish homologous vs. analogous traits, the relatedness of the organisms doesn't matter as much as the evolutionary history of the traits themselves

Vestigial organs = remnants of organs that had important functions in ancestors

Biochemical homologies

Common use of DNA, RNA, amino acids, ribosomes, genetic code, ATP, electron carriers, electron transport system, *etc.*