

## Chapter 22: Descent with Modification: A Darwinian View of Life

**Evolution**-descent with modification as Darwin proposed that Earth's many species are descendants of ancestral species that were different from the present-day species, (or change in the genetic composition of a population from generation to generation), viewed as a pattern and process:

- pattern of evolutionary change revealed by data from scientific disciplines (biology, geology, chemistry and physics), facts of observed of natural world
- process of evolution-consists of mechanisms that produce the observed pattern change, (mechanisms represent natural causes of natural phenomena we observe)

Darwin developed his revolutionary proposal over time, influenced by others...

### *Scala Naturae and Classification of Species*

Greek Philosopher: Aristotle (384-322 BCE)-viewed species as fixed (unchanging), recognized "affinities" among organisms, concluded that life-forms could be arranged on scale, of increasing complexity (*scala naturae*), each form of life was assigned to its own step

Carlous Linnaeus (1707- 1778)- Swedish physician and botanist who sought to classify life's diversity, ("for the greater glory of God"), developed binomial format for naming species (such as *Homo sapiens* for humans), adopted a nested classification system-grouping similar species in increasing general categories, opposed evolution.

### *Ideas About Change over Time*

Darwin drew sources of information from the work of scientist studying **fossils**, the remains or traces of organisms from the past, many found in sedimentary rocks formed from the sand and mud that settle to the bottom of seas, lakes and swamps, new layers of sediment cover older ones and compress them into superimposed layers of rock called strata (stratum, singular)

Paleontology, was developed by French scientist Georges Cuvier (1769-1832). Examined strata, and noticed that older the stratum the more dissimilar its fossils were to current life-forms, new species appeared while others disappeared through each layer. Opposed the idea of evolution, but believed in the extinctions. Each boundary between strata suggested that catastrophe has occurred, such regions were populated with different species due to immigrations from other areas.

In 1795, James Hutton (Scottish Geologist 1726-1797) proposed that Earth's geologic features could be explained by gradual mechanisms, such as valleys being formed by rivers.

Charles Lyell (1797-1875) incorporated Hutton's thinking into his proposal that the same geologic processes are operating today as in the past at the same rate.

Both of these ideas influenced Darwin's thinking, he agreed that geological change results from the slow, continuous actions rather than from the sudden events, then Earth must be much older than accepted age, later reasoned that similarly slow and subtle processes could produce substantial biological change ( gradual change to biological evolution)

### *Lamarck's Hypothesis*

Jean Baptiste Lamarck was first to propose mechanism for how life evolved. Published *Philosophie Zoologique* (1809) describing two basic theoretical principles to explain evolution:

- Use and Disuse-the idea that parts of the body that are used are extensively become larger and stronger, while those that are not used deteriorate (giraffe stretching its neck)
- Inheritance of acquired characteristics-stated that organism could pass these modifications to its offspring (reasoned that muscular neck of the living giraffe had evolved over many generations as giraffes stretched their necks even higher)
- Proposed that organisms have innate tendency towards increasing complexity (perfection).

### *Darwin Descent with Modification*

Darwin was recommended to Captain Fitzroy for survey expedition on HMS Beagle , it was a 5 year circumnavigation of world.

#### -Darwin's Focus on Adaptation

Adaptations- inherited characteristics of organisms that enhance their survival and reproduction in specific environments. ( Finches' beaks)

Natural selection- a process in which individuals that have certain inherited traits tend to survive and reproduce at higher rates than other individuals because of those traits

Tree of life Darwin's metaphor for history of life = branching tree with multiple branching from common trunk to tips of living twigs: Symbolic of diversity of contemporary organisms. Extinct lineages help explain morphological gaps between related groups of organisms.

Artificial selection-selective breeding of domesticated animals and plants to encourage the occurrence of desirable traits

Darwin argued that Artificial selections similar process occur in nature, also saw connection between natural selection and the capacity to "over reproduce":

- Observation 1: Members of a population often vary in their inherited traits

- Observation 2: All species can produce more offspring than their environment can support, and many of these fail to survive and reproduce
- Inference 1: Individual whose inherited traits give them a higher probability of surviving and reproducing in a given environment tend to leave more offspring than other individuals
- Inference 2: The unequal ability of individuals to survive and reproduce will lead to the accumulation of favorable traits in the population over generations

Thomas Malthus, contended that much of human suffering- disease, famine, and war- resulted from the human population's potential to increase faster than food supplies and other resources. Similarly, Darwin recognized that capacity to "overreproduce" was characteristic of all species, only tiny fraction of offspring survive or develop, the rest are unable to tolerate physical conditions of the environment such as salinity or temperature

An organism's heritable traits can influence not only its own performance, but also how well its offspring cope with environmental challenges (ex. Passing trait to offspring such as escaping predators, obtaining food...etc. , advantages like these increase the number of offspring). Over time, natural selection can lead to increase in the proportion of favorable traits in a population.

#### *Summary of Natural Selection*

1. It occurs through interactions between individual organisms and their environment, *individuals do not evolve*, it is the population that evolves over time.
2. It can amplify or diminish only those heritable traits that differ among the individuals in a population. Thus, even if a trait is heritable, if all the individuals in a population are genetically identical for that trait, evolution by natural selection cannot occur.
3. Environmental factors vary from place to place and over time. A trait that is favorable in one place or time may be useless- or even detrimental- in other places or times. Natural selection is always operation, but which traits are favored depends on the context in which a species lives and mates.

#### **Origin of species**

Focused on role of natural selection in adaptation. Broken down by Ernst Mayr.

Five Observations:

- a. **All species have such great fertility** that their population size would increase exponentially if all individuals that are born would reproduce successfully.
- b. **Most populations are normally stable in size** except for seasonal fluctuations.
- c. **Individuals of a population vary extensively in their characteristics**; no two individuals are exactly alike.