

## Chapter 13a - Darwin and Evolution

### Evolutionary Ideas before Darwin

#### *Plato (427-347 BC)*

Plato established the notion of fixed essences - unchanging ideal forms that underlie all the variable phenomena of the world.

Plato suggested there were 2 worlds:

- A real world that was ideal and eternal.
- An illusionary world of imperfection that we perceived through our senses.

Plato's philosophy ruled out evolution thinking because it would be counterproductive in a world where ideal organisms were already perfectly adapted to their environments.

#### *Aristotle (384-322 BC)*

Aristotle contended that there was gradation in the natural world and that organisms ranged from being relatively simple to extremely complex - the grand concept of the *Scala naturae* or Great Chain of Being.

This concept suggests there is a "ladder of life" and each species has an allotted rung along this ladder.

Species are fixed or permanent and therefore do not evolve.

### The Influence of Natural Theology

The eighteenth century was dominated by natural theology, a philosophy dedicated to unveiling the God's plan by studying his creation.

### Materialism

With the rise of modern science, a belief in the literal truth of the biblical story of creation began to give way

- In the 15<sup>th</sup> century, Galileo provided proof that the Earth and other planets orbited the sun; shifting from a geocentric universe to a heliocentric one
- In the 17<sup>th</sup> century, a more materialist view was being forced by Newton's explanations of physical phenomena

By the early 19<sup>th</sup> century, many of the basic concepts necessary to develop a belief in organic evolution were already present:

- The geologist Hutton conceived the age of the earth to be in the millions of years
- People accepted the reality of previously extinct fossil species
- Systematists and comparative anatomists had noted the close similarities among many different species
- Most scientists believed organisms had descended through inheritance from previously existing organisms

The notion of fixed species and a divine or “common plan” which had been proposed to account for the relationship among species by supernatural acts of creation, was by the early 1800s only a few steps away from the materialist evolutionary notion that species relationships derive from their common ancestry

Nonetheless, materialists still had to explain or face one important question:

*What natural cause or mechanism could explain why organisms change?*

### **Lamarck's Theory of Evolution**

Lamarck argued that species change over time into new species and his ideas about how this works has become known as “**transformism**”

By comparing current species with fossil species, Lamarck noticed what appeared to be several lines of descent

Evolution was driven by an innate tendency toward greater and greater complexity, which Lamarck seemed to equate with perfection

#### ***1. Use and Disuse***

The idea that those parts of the body used most to cope with the environment became larger and stronger, while those that are not used deteriorated

#### ***2. Inheritance of Acquired Characteristics***

The modifications an organisms acquires during its lifetime can be passed along to its offspring

## A Brief History of Darwin

- He was born on February 12<sup>th</sup>, 1809
- He was the son of an English physician, and the grandson of Erasmus Darwin
- He briefly studied medicine at Edinburgh
- He gave up medicine and began studying for a career in the clergy at Cambridge University; became the protege of the botanist Rev. John Henslow and the geologist Adam Sedgwick
- After receiving his B. A. degree in 1831, Henslow arranged for Charles to partake in an around the world voyage in a survey ship called the *Beagle*.
- Darwin apparently first came to the conclusion that species might have developed from common ancestors shortly after his voyages on the *Beagle*
- Shortly after his return from his voyage, Darwin married his cousin
- He was, unfortunately troubled by rather poor health throughout most of his life
- A significant moment in Darwin's life occurred on September 28, 1838 while he was reading Malthus' *Essay on the Principle of Population*
- About 20 years stood between this memorable event and Darwin's first publication on the subject.
- In 1844 Darwin did produce an essay outlining his ideas, to be published in the event of his death; and, in 1856 he finally began what was intended to be his "big book" but the book was never completed
- In June of 1858, Darwin received a letter from a young English naturalist working in the East Indies - Alfred Russell Wallace; the letter was accompanied by a manuscript in which Wallace developed a theory of natural selection that was virtually identical to Darwin's
- At the next meeting of the Linnaean Society in London, Wallace's paper along with extracts of unpublished writings by Darwin were presented
- Darwin then produced *On the Origin of Species*, which contained the theory of evolution through natural selection
- He died in 1882

## Darwin's View of Life

In *The Origin of Species*, Darwin presented two major theses:

*First*, he argued that all species, living and extinct, had descended without interruption, from one or a few original forms of life – **Descent with modification**

The *second*, and major theme of *The Origin of Species* is his theory of the causal agent (a mechanism if you will) of evolutionary change - **natural selection**

## A Synopsis of Natural Selection

A population of organisms can change over time because individuals with certain heritable traits leave more offspring than other individuals

Forms that are better adapted for survival (favorable variations) will leave more offspring and thus increase in frequency in the population

Survival in the struggle for existence is not random, but depends in part on the heredity constitution of individuals

Those individuals who possess heredity characteristics best suited for their environment are likely to leave more offspring than those that are less fit

This is a **variational theory** of change

In Darwin's theory, evolution is viewed as a branching tree, and it is largely a matter of accident what forms evolve at each stage – *what species make it and where on the tree is arbitrary*

There is nothing automatically progressive about Darwinian evolution

Darwin's theory of NS was not immediately accepted

One reason was because it lacked a satisfactory theory of heredity

Darwin supported the "**Blending Theory of Heredity**"

But how could NS operate if heredity blended

At the more popular level, two of the main objections to NS then (as now) were that it attributed evolution to *chance* (there was no purpose or means to an end) and that some *gaps* between forms in nature could not be crossed if evolution was powered by NS alone

### *Explaining complexity*

It was unfathomable to understand how the simple process of natural selection could generate complexity

However, it is important to realize that complex structures probably arose in a small series of steps over long periods of time and that each generational step is preserved during the evolutionary process and yields a change that is only slightly different from the previous step.

## Why was Darwin So Successful?

The 1920s there was a **synthesis** of Mendel's theory of inheritance (which is the basis of modern genetics) with Darwinian evolution

*The Origin of Species* provided **copious evidence** and direction for future research

Darwin's theory had a tremendous **explanatory potential**, including:

- Patterns of biological diversity
- **Patterns of geographical distributions**
- Presumed **presence and absence of design** of organisms to their surrounding environment
- NS can also explain the occurrence of "**contraptions**"
- It can explain the various **anatomical anomalies** exhibited by organisms (e.g., vestigial structures)

Darwin's Hypothesis is Testable

- Individuals within a species are variable
- Some of these variations are passed along to offspring
- In every generation, more offspring are produced than can survive
- Survival and reproduction are not random; those with favorable variations survive and go on to reproduce

## The Nature of Science

**Science is a fallible** enterprise.

Science always only gives us **tentative results**.

One great value of science is that it provides us with **methods** by which we can arrive at justified beliefs

One important way in which theories are confirmed is by making successful **predictions**.

Perhaps the most important test is the **explanatory scope** of a theory.

Doing good science does not necessarily require that we make direct observations of the natural world; hypotheses can be invalidated, or conversely it can gain credibility and stature, based on **inference** rather than observation.

**The Web Site**

<http://faculty.evansville.edu/de3/evolutionweb2/>

**Goals**

- Facilitate exploration and understanding of evolutionary theory and its broader cultural implications.
- Overcome natural resistance to learning about evolutionary theory by engaging students in interactive and inquiry-based processes.
- And because we teach at a liberal arts college in which evolution is discussed to a greater or lesser degree in a number of courses, provide support for faculty outside the natural sciences who wish to integrate evolutionary theory into the classroom.