Course - History of Science

Course coordinator - Dr. G. Nagarjuna

Presentation by - Amit Sharma

Date - 15-4-09

Evolution of the "Theory of Evolution"

The Word "Evolution"-

- Latin word **'*evolvere*'** means to **unroll.**
- **'*Evolutio'*** - Classical usage- ***"*Unrolling of a scroll in order to read it".**
- **'*Evolution*'- unrolling of vast records of time.** "The whole evolution of ages, from everlasting to everlasting, is represented to God at once".- Henry More (1614-87).
- **'Evolution' as 'being'-** "living things develop as the germ contained in the living organism unfolds itself in order to pass from the embryonic state". -Bonnet (1762).
- **'Evolution' as 'development'-** "the gradual evolution of the young animal or plant from the egg or seed'.- Erasmus Darwin (1791).
- **'Evolution' as 'process' or 'result of process'-** "certain organisms of the oceans existed first, until some of them by gradual evolution, were improved into those inhabiting the land".- Lyell (1831).
- **'Evolution as gradual change in population'-** "Evolution is the slow gradual change in a population of organisms over time". - Charles Darwin (1809- 1882).

Charles darwin (1809-1889 A.D.)

Charles Darwin belonged to a distinguished family in Britain. His grandfather Erasmus Darwin had written on Evolution in Lamarkian fashion. In his young age Darwin had a hobby of doing experiments and hunting. He was also fascinated with horses and other animal breeding in his friend circle.

Darwin originally intended to follow the family profession, medicine, but later changed his mind and got admitted to Cambridge University where he got through without distinction. It was during this period that he developed interest in natural history. In 1831A.D. his Botany professor J.S.Henslow recommended him for an unpaid position on the HMS Beagle, which was to sail around the world for charting the coast of South-America for the British navy.

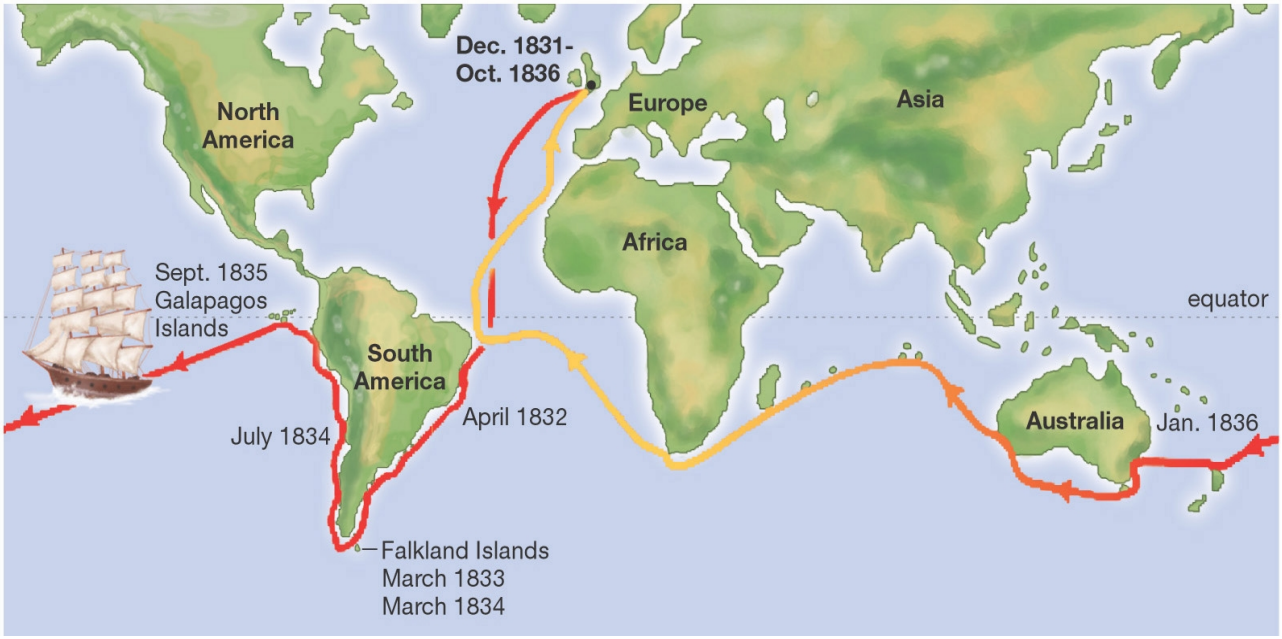
Darwin's observations during his voyage-

- Variation of species in space at the same time. (Gradual change in forms of animals Southwards in South America).
- Variation of species in time at the same place. (Fossil remains of Armadillos in

Pampas).

- Variation at the same time and almost the same place with special local conditions. (Finches in Galapagos islands.)

The Voyage of the Beagle



Darwin's Theory of Evolution- The basic postulates of Darwin's theory of Evolution are as follows:-

1. **"Struggle for existence among individuals"-** Due to production of more individuals that can be supported by the environment there are always interspecific and intraspecific struggle among individuals for their existence.
2. **"Survival of the fittest"-** Due to this interspecific and intraspecific struggle only a fraction of offspring survive in each generation, the lesser fit perish, while the fittests survive.
3. **"Variations in population"-** No two individuals in a population are alike due to variations that are inheritable.
4. **"Natural Selection"-** The unequal ability of individuals to survive and reproduce leads to a gradual change in a population, with favourable characteristics accumulating over generations.
5. **"Adaptation"-** The adaptation to new environmental conditions was through the mechanism of natural selection and development of features desired by prospective sexual partners through the mechanism of sexual selection.
6. **"Evolution of new species"-** Through the above mechnisms new species are formed which are differentited from the previous forms in one or many distinguishing characters.
7. **"Evolution does not have any intrinsic direction"-** There is no predetermined direction to evolution. It depends on the type of environment and the features which

makes organisms better adapted to it.

Contributors to darwin's thinking-

- **Plato (427-347 B.C.)**- According to Plato “World attained its present form not by a single creative act, but by a slow process over long ages”.
- **Aristotle (384-322 B.C.)-** As described by Aristotle **-** “Species were fixed creations arranged by their complexity.” (**Creationism**).
- **Buffon (1707-1788 B.C.)-** Buffon made speculations about the evolution of biological species in the framework of the grand scheme of origin and physical development of Earth as **Catastrophic event**. According to him catastrophs followed naturally from cooling, contracting earth, which caused collapse of outer layers due to formation of gaps in between outer and inner layers.

  He rejected Aristotelian 'final cause' and explained that “all things that can exist do exist regardless of their usefulness to organism”.
- **Carl Linnaeus (1707-1778 A.D.)-** In 1735A.D., Linnaeus published his “System of Nature” in which he gave the 'Binomial system of nomenclature'. In this classification he included Man with apes and Sloths in the same Order in the Class “Quadrupeds”. According to him “Each species was created in its present form by God for definite purpose and is immutable” (**Creationism**). In his later works he had suggested the possibility of hybridization.
- **James Hutton (1726-1797 A.D.)-** He is also called as the father of modern Geology. He proposed the theory of **'Plutonism' (**formation of rocks due to heat and pressure inside the Earth. The upheavals powered by constant internal heat alernating with erosion) and **'Uniformitarianism'** (magnitude of geological forces never significantly different than at present). Both these theories were related to geology and geological time.
- **Jean-Baptiste Lamark (1744-1829 A.D.)-** In his theory of evolution, Lamark laid down following postulates-

1. **“Nature tends to increase the size of living individuals to a predetermined limit”**.
2. **“Tendency towards perfection”**- Organisms are continually changing and acquiring features that help them live more successfully in their environments.
3. **“Use and disuse of organs”**- The development reached by the organs is directly proportional to the extent to which they are used.
4. **“Inheritance of acquired characters”**- Everything acquired by the individual is transmitted to its offsprings.
5. **“Variations”-** Progressive development of species from simple to complex form, branching off in different directions depending on local environmental conditions.
6. **“Formation of new species”-** Over time this leads to new species.

- **Erasmus Darwin (1731-1802 A.D.)-** He examined about how living things had

acquired their manifest adaptations to their environment. He explained that the changes may arise due to- development, artificial cultivation, climate, before birth changes by crossing.

He postulated that “All animals undergo perpetual transformations; which are in part produced by their own exertions and many of these forms are transmitted to their posterity”.

- **Thomas Malthus (1766- 1834 A.D.)**- He postulated in his “Essay on Population” that the population tends to grow geometrically (2,4,8,16....), while the food supply cannot grow more than arithmetically at best (1,2,3,4...). So, there is an inevitable competition for food among the members of the human race, and population is limited by famine, disease or war.
- **Joseph Fourier (1768-1830 A.D.)-** He derived equation for the time required to cool down to the present temperature. The numerical value he obtained was - 130-300 million years. He also discovered that the changes in the rate of temp. are only fractions of degrees per century.
- **Georges Cuvier (1769-1832 A.D.)-** He worked in Anatomy and Palaeontology comparing living animals and fossils. He was the proponent of **'Catastrophism'** in Geology, and established that extinction was a fact.
- **Charles Lyell (1797-1875 A.D.)-** According to Lyell's “**Uniformitarian theory**”- “laws of nature always remain the same”. And the “Magnitude of geological forces have never been significantly different than at present age”. He excluded the cooling Earth theories.
- **Alfred Russel Wallace (1823-1913 A.D.)-** After reading Malthus's essay, Wallace reached to the conclusions of struggle of existence and natural selection which were similar to that of Darwin's. Darwin and Wallace published extracts of their work together in 1858.
- **Thomas Henry Huxley (1825-1895 A.D.)**- Huxley English Geologist and Biologist defended Darwin's theory of natural Selection.

Some Objections and Supports to darwin's Theory

Objections-

- **William Thomson Kelvin (1824-1907 A.D.) -** Based on Nebular Theory Kelvin calculated that the Earth must have been liquid as recently as 100 million years ago, while Darwin had carelessly mentioned 300 million years as a time scale available for evolution.
- **Fleeming Jenkin (1867)**, British engineer pointed out that a single chance variation, even if favourable to survival had infinitesimal chance of being adopted by population.

Supports-

- **Henry Becquerel (1852-1908)-** Around 1900 A.D. when Radioactivity was discovered, it was estimated through radioactive dating that the Earth had been solid for some 3 Billion years (10 times longer than Darwin's original figure).
- **Gregor John Mendel (1822-1884 A.D.)-** The problem of inheritance was solved by Mendel's theory of heredity- “Variation once introduced in a gene pool is never lost but remains available, even if in a recessive form, to cooperate with other similar variations”.
- **Othneil C. Marsh-** found a series of fossil horses that very neatly displayed a gradual change in bone structure (going from four toed foot to single toe of present horse).

  In 1872-73 he found the fossil of Archaeopteryx 'the missing link” between Aves and reptiles. These gave a direct proof to Darwin's theory of evolution.
- The fossil remains of Neanderthal-man (1856) Cromagnon-man (1868), and Pithecanthropus had implication that the human race evolved from other species. This also led to the view that humans had existed much longer than the Biblical 6000 years.
- **Earnst Haeckel (1834-1919 A.D.)-** Haeckel (1868) postulated 'Biogenetic law' as “Ontology recapitulates phylogeny”, which states that “Individual organism, in its development as a foetus and later to maturity, goes through same sequence of forms that species itself has followed in its previous evolution from lower forms of life”. This gave embryological evidences of evolution.

Some predictions made by the theory

- Huxley predicted a fossil horse with four complete toes in front and a rudiment of another and with a rudimentary fifth toe on the hind foot. Within 2 weeks Marsh had discovered such fossil.
- Darwinians predicted that the skull and jaw of Piltdown man did not belong to the same individual. Later the Piltdown man was found to be a fraud.
- Darwin predicted that our earliest ancestors would be found in Africa. Australopithecus africanus and Zizanthropus were found there later on.

Conceptual changes made by the theory

- Conceptual change from Creationism to Evolution.
- Common descent to many diverse organic forms.
- Species are inconstant.
- Change in forms of species (adaptation) through natural selection.
- Transmission of favourable characters through sexual selection.
- From “Essentialism” (all individuals of a species are essentially alike as approximations to an ideal type)- to “Population thinking” (species is a collection of

different unique individuals).

Evidences for the theory

- Fossils.
- Radioactive dating of rocks.
- Record of variations in species in response to the difference in environment at same time (finches, tortoises and iguanas in Galapagos islands).
- Comparative Embryology.
- Homologous characters.
- Genetics.

Theory as an advancement

- Clearly discarding Creationism.
- Evidences of development of humans from lower forms similar to other species.
- Establishing the concept of evolution of life on Earth from time in hundreds of million years.
- View of species as inconstant.
- Links in between Classes and Orders of organisms.
- Shift from “Soft inheritance” **(**inheritance of characters through inherent tendency to progress or use-disuse) – to “Hard inheritance” (denial of inheritance of acquired characters).

References

Stephen G. Brush, The History of Modern Science.

Charles Singer, A History of Scientific Ideas.

Johnathan Howard, Darwin , a very short introduction.

Wikipedia Encyclopedia.