Evolution of the "Theory of Evolution"

Course - History of Science
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Date - 15-4-09

Topics Covered

- The word “Evolution”.
- The Voyage of the Beagle.
- Darwin's observations while his trip on Beagle.
- Darwin's Theory of Evolution.
- Contributors to Darwin's thinking.
- Inspirations to Darwin's Theory of Evolution.
- Objections and Supports.
- Predictions made.
- Conceptual changes, Evidences and Advancement laid by the theory.
- References.

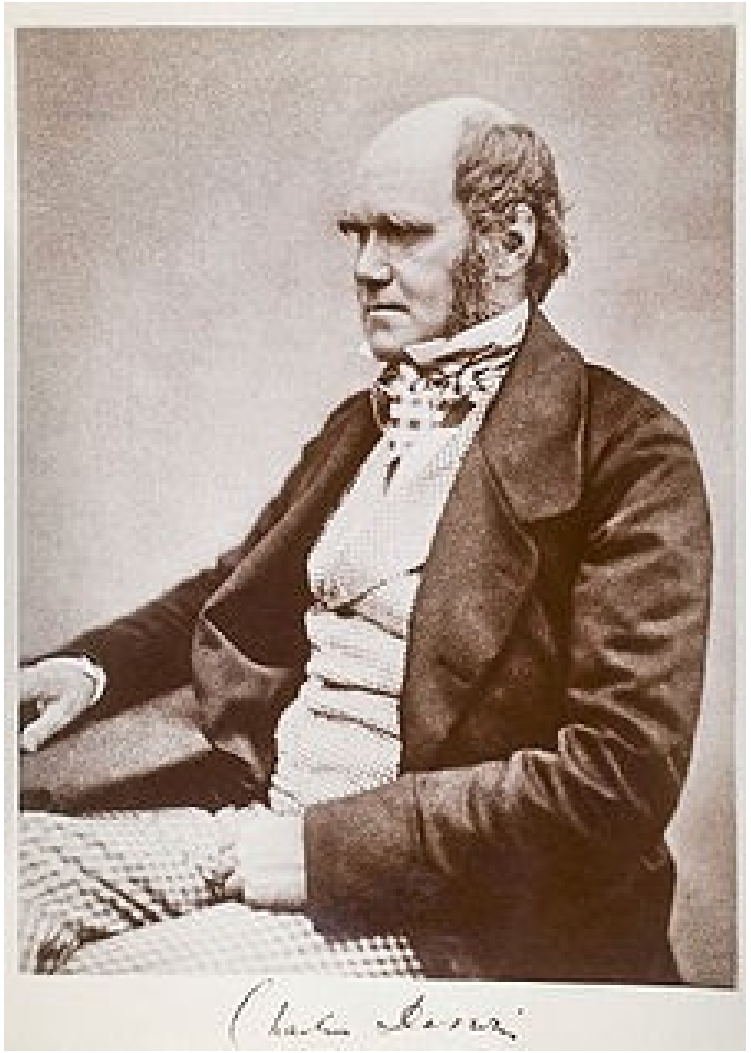
The word “Evolution”

- 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).

.....The word “Evolution”

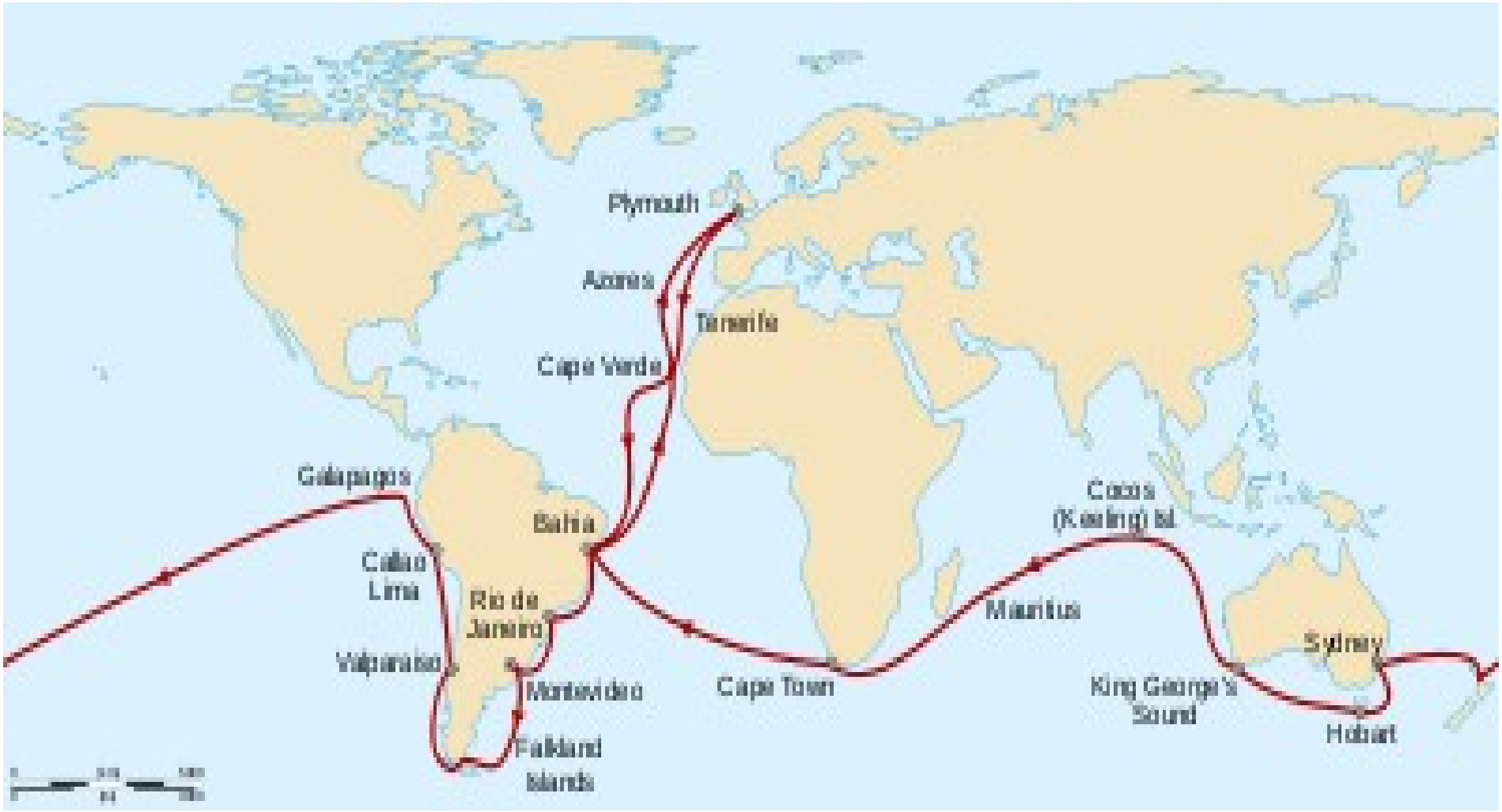
- **'Evolution' as 'being'-** “living things develop as the germ contained in the living organism unfolds itself in order to pass from the embryonic state”. -Bonnet (1762).
- **'Evolution' as 'development'-** “the gradual evolution of the young animal or plant from the egg or seed'.- Erasmus Darwin (1791).
- **'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).

Charles Darwin
1809-1882 A.D.



- "Evolution is the slow gradual change in a population of organisms over time'.
- **"The origin of species by means of natural selection of the preservation of favoured races in the struggle of life" (1859).**
- Recommended by Henslow for an unpaid position on HMS Beagle.

The voyage of the Beagle



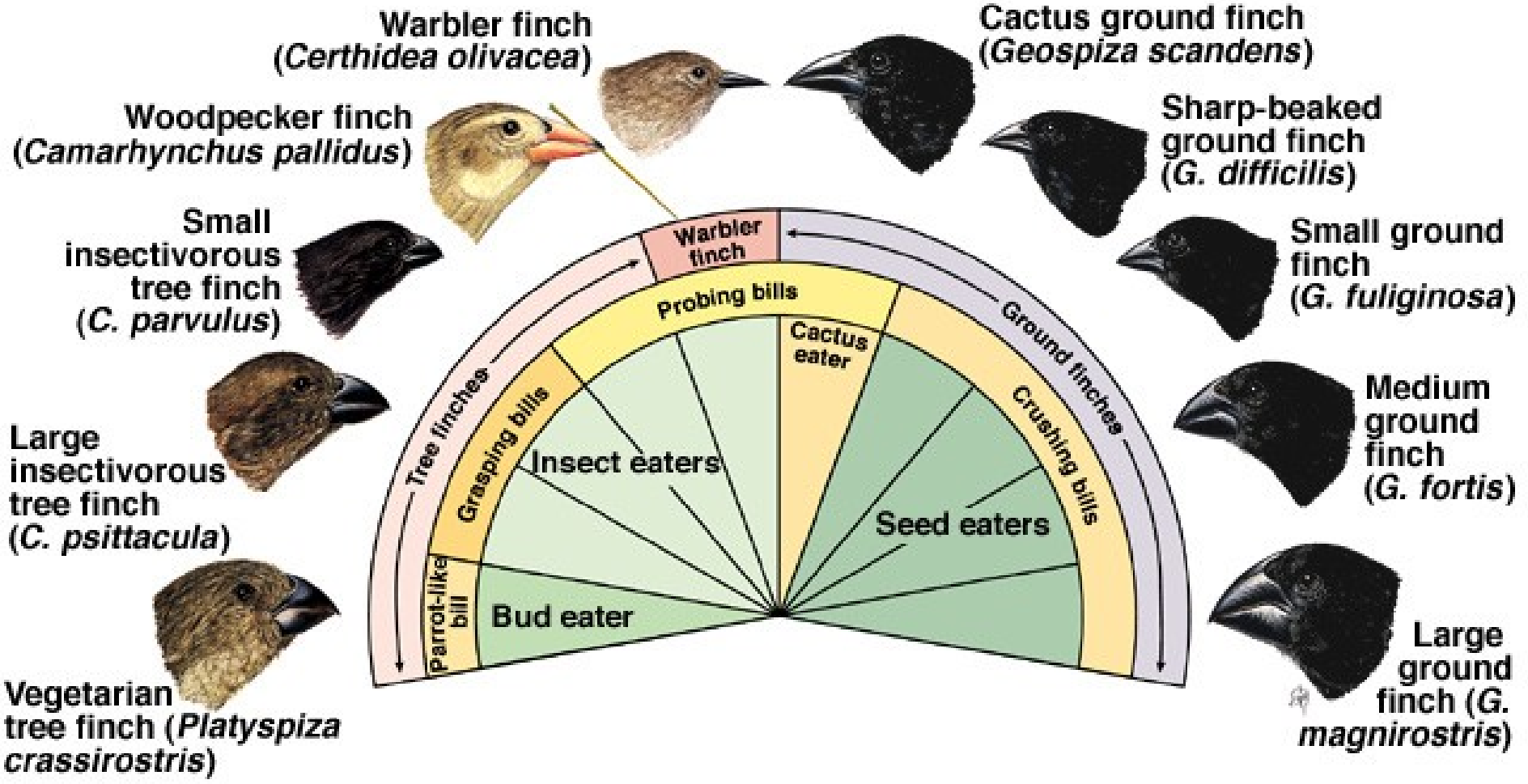
Darwin Left England in 1831

Darwin returned 5 years later in 1836

Darwin's observations while his trip on Beagle

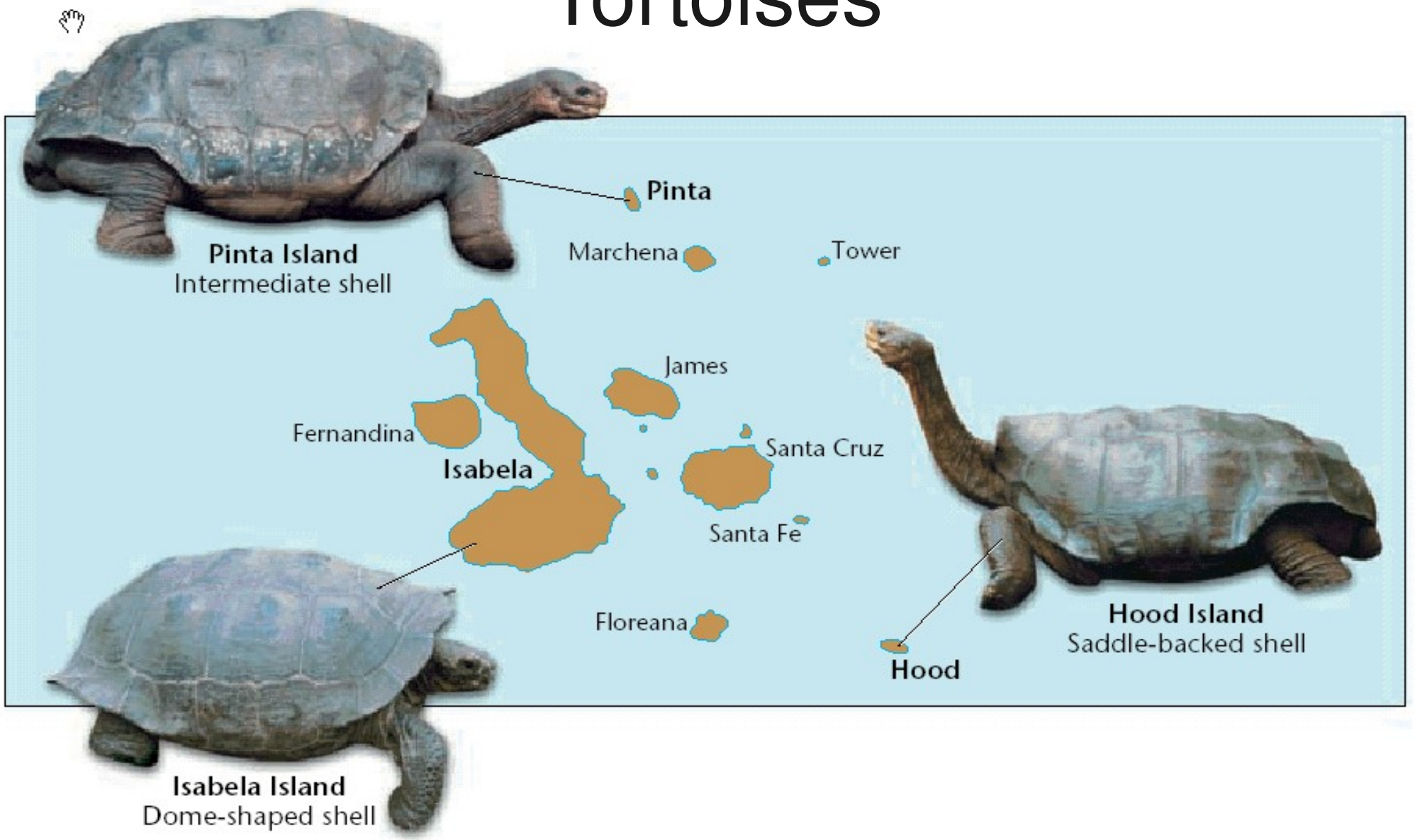
- Variation of species in space at the same time. (Gradual change in forms of animals Southwards in South America).
- Variation of species in time at the same place. (Fossil remains of Armadillos in Pampas).
- Variation at the same time and almost the same place with special local conditions. (Finches in Galapagos islands.)

Variations with respect to special local conditions (Finches)



Iguanas

Tortoises


Pinta
Pinta Island
Intermediate shell
Marchena
Tower
James
Fernandina
Isabela
Santa Cruz
Santa Fe
Floreana
Hood
Hood Island
Saddle-backed shell
Isabela Island
Dome-shaped shell
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Darwin's Theory of Evolution

- **"Struggle for existence among individuals"- Due to production of more individuals that can be supported by the environment.**

.....Darwin's Theory of Evolution

- **"Survival of the fittest"- Only a fraction of offspring survive in each generation.**

....Darwin's Theory of Evolution

- **"Variations in population"- No two individuals being alike in population due to variations that are inheritable.**

....Darwin's Theory of Evolution

- **"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.**
- **"Evolution of new species"**

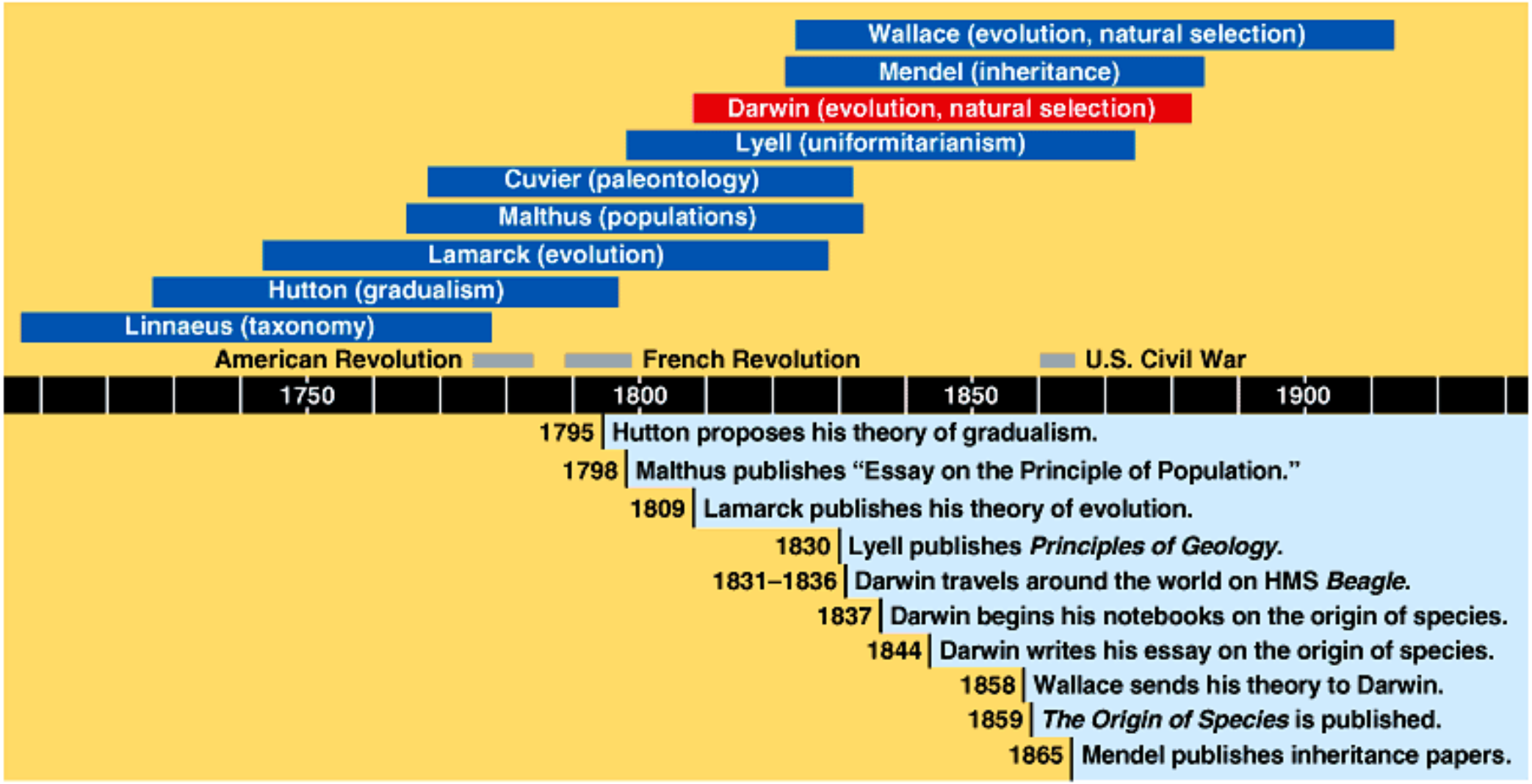
....Darwin's Theory of Evolution

- "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.
- "Evolution does not have any intrinsic direction".

Contributors to Darwin's thinking

- Charles Lyell – **"Uniformitarianism"** (geological processes still changing Earth).
- Georges Cuvier – **"Catastrophism"** (species extinction).
- Thomas Malthus – **"Struggle for Existence".**
- James Hutton - **"Gradualism".**
- John Baptiste Lamark - **"Inheritance of Acquired Characters and Law of Use and disuse of Organs".**
- Alfred Russel Wallace – **"Organisms evolved from Common Ancestors".**

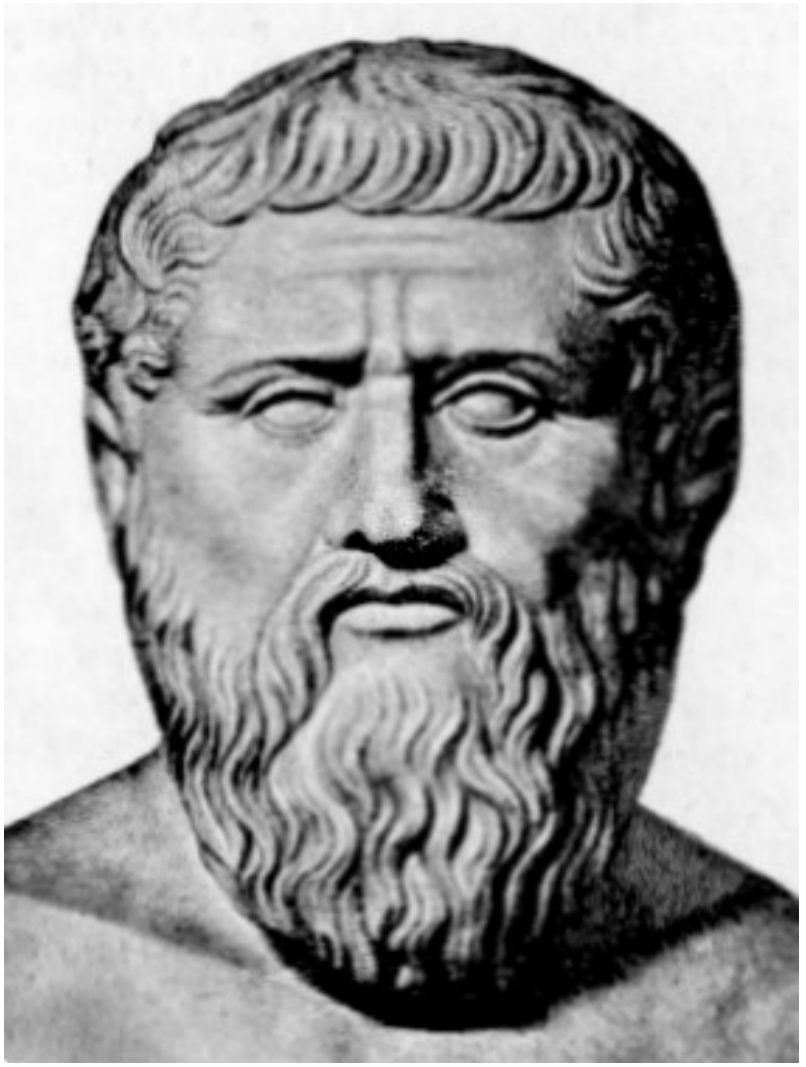
Evolutionary Timeline



Inspirations to Darwin's theory of Evolution

- Philosophy
- Astronomy
- Geology
- Economy
- Physics
- Embryology
- Palaeontology
- Genetics
- Mathematics

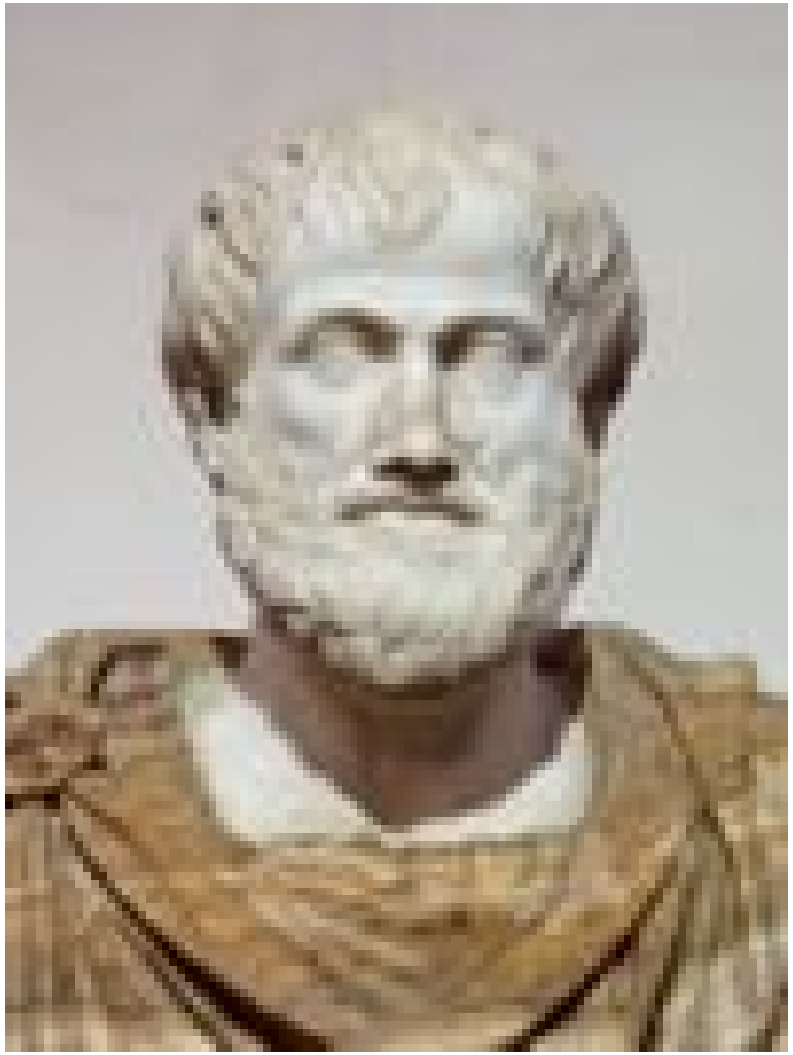
Philosophy



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".

Philosophy



Aristotle
384-322 B.C.

- As described by Aristotle - "Species were fixed creations arranged by their complexity." (**Creationism**)

Astronomy and Physics

Buffon
1707-1788 A.D.

- 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.
- Rejected Aristotelian 'final cause'.
- All things that can exist do exist regardless of their usefulness to organism.

Geology

James Hutton
1726-97 A.D.

- James Hutton, Father of modern Geology proposed the theory of 'Plutonism' and 'Uniformitarianism' related to geology and geological time.

Geology and Palaeontology

Georges Cuvier
1769-1832 A.D.

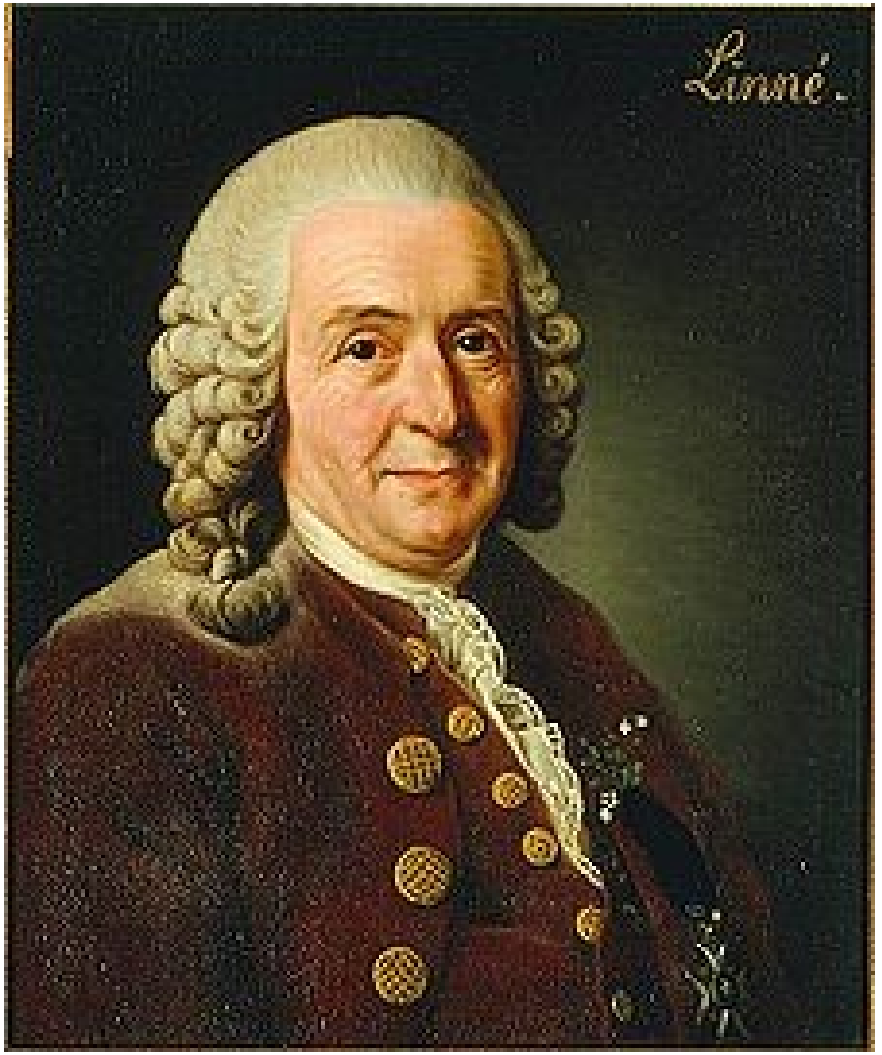
- Georges Cuvier worked in Anatomy and Palaeontology comparing living animals and fossils.
- Proponent of Catastrophism in Geology, established that extinction was a fact.

Geology

Charles Lyell
1797-1875 A.D.

- According to Lyell's Uniformitarian theory- “laws of nature always remain the same”.
- “Magnitude of geological forces have never been significantly different than at present age”.
- He excluded cooling Earth theories.

Biology



Carl Linnaeus
1707-1778 A.D.

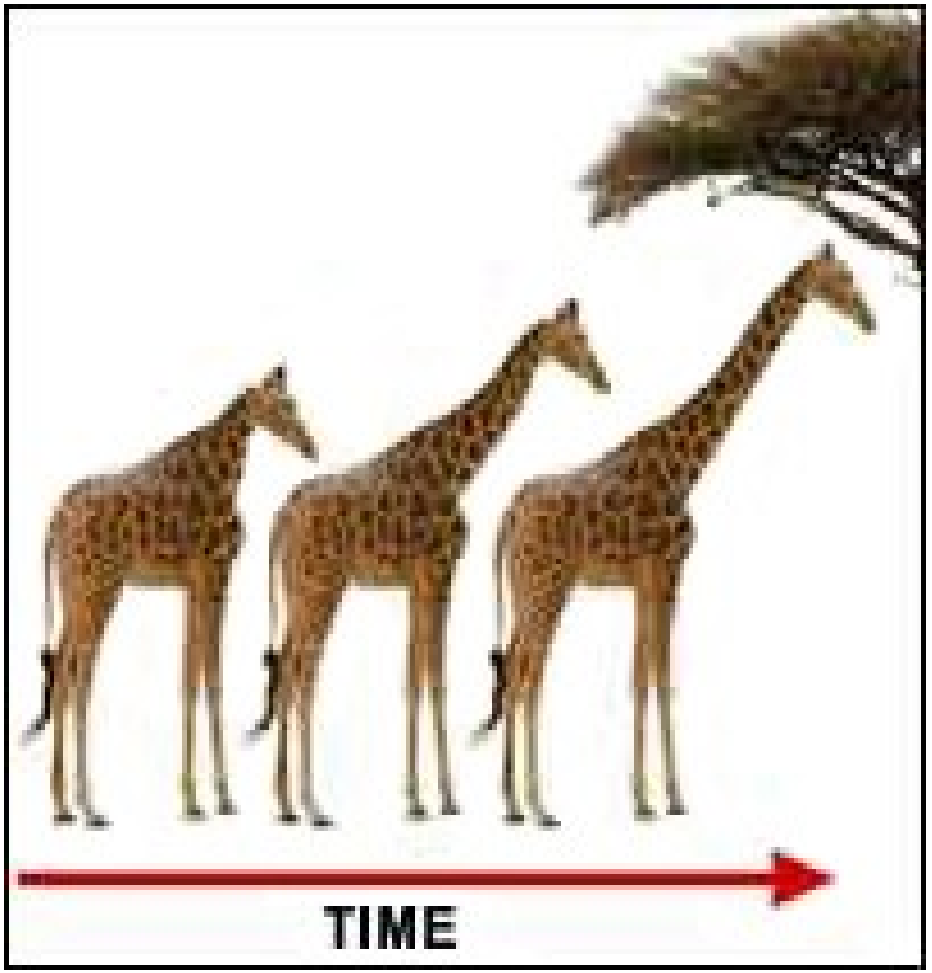
- Carl Linnaeus, (1735) "System of Nature".
- "Each species was created in its present form by God for definite purpose and is immutable".
- Suggested the possibility of hybridization in later works.
- Included Man with apes and Sloths in the same Order in the Class "Quadrupeds."

Biology

Jean-Baptiste Lamark
1744-1829 A.D.

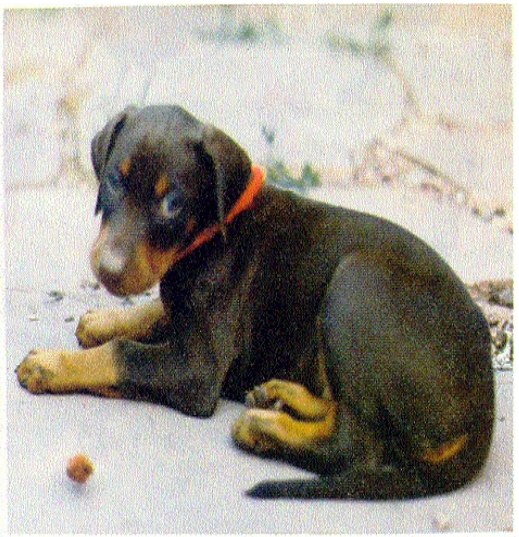
- In his theory Lamark laid down following postulates-
- “Nature tends to increase the size of living individuals to a predetermined limit”.
- “Tendency towards perfection”- Organisms are continually changing and acquiring features that help them live more successfully in their environments.

...Lamark's theory of Evolution



- "Use and disuse of organs"- The development reached by the organs is directly proportional to the extent to which they are used.
- "Inheritance of acquired characters"- Everything acquired by the individual is transmitted to its offsprings.

...Lamark's Theory of Evolution



- Progressive development of species from simple to complex form, branching off in different directions depending on local environmental conditions.
- Over time this leads to new species.

Biology

Erasmus Darwin
1731-1802 A.D.

- Erasmus Darwin examined about how living things had acquired their manifest adaptations to their environment.
- Changes by- development, artificial cultivation, climate, before birth changes by crossing.
- "All animals undergo perpetual transformations; which are in part produced by their own exertions and many of these forms are transmitted to their posterity".

Mathematics

Joseph Fourier
1768-1830 A.D.

- Joseph Fourier derived equation for the time required to cool down to the present temperature.
- The numerical value obtained- 130-300 million years.
- Rate of degrees of temp. only fractions of degrees per century.

Economy

Thomas Malthus
1766-1834 A.D.

- Malthus postulated in his essay "Population" that the population tends to grow geometrically (2,4,8,16....)
- Food supply cannot grow more than arithmetically at best (1,2,3,4...).
- There is an inevitable competition for food among the members of the human race, and population is limited by famine, disease or war.

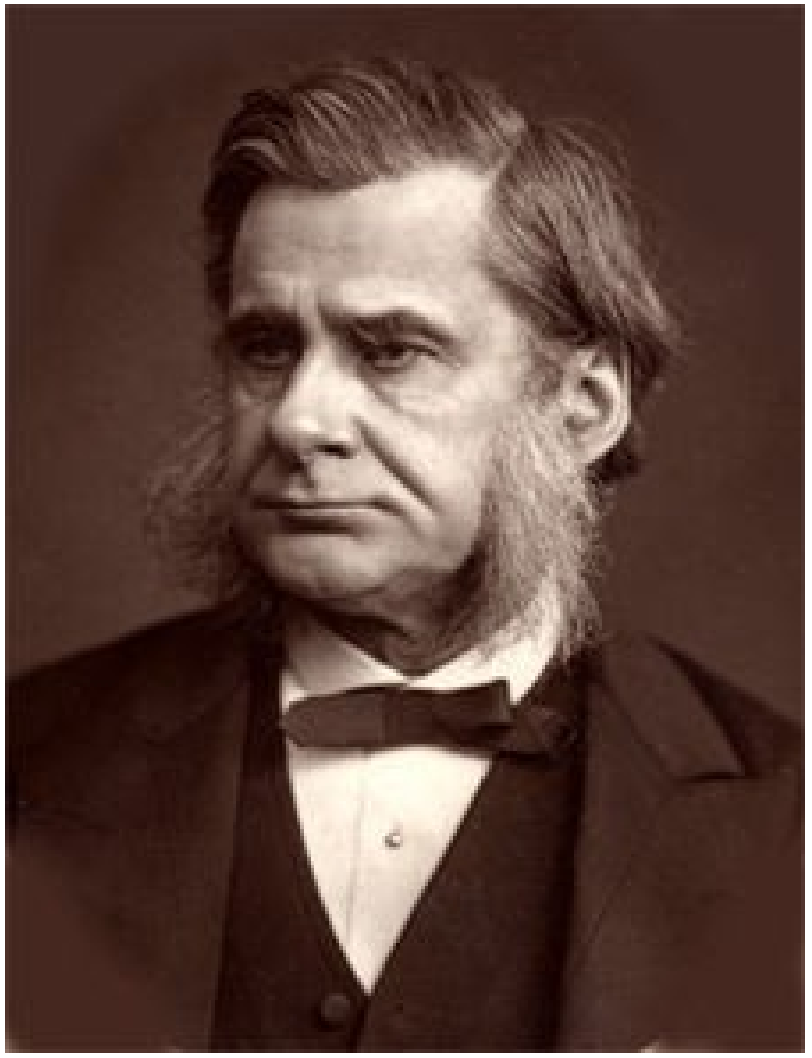
Biology

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.

Biology

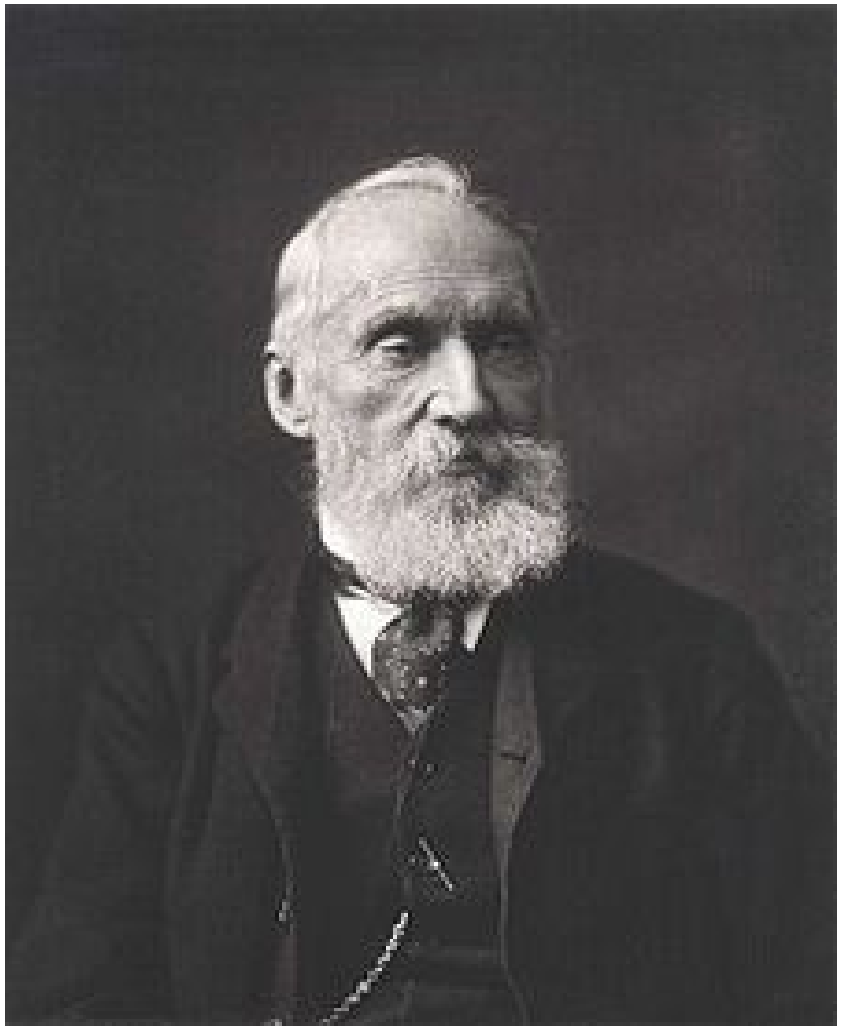


Thomas Henry Huxley
1825-1895 A.D.

- Huxley English Geologist and Biologist defended Darwin's theory of natural Selection.

Objections and Supports

Physics (Objection)



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.

Radioactivity (Support)

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).

Engineering (Objection)

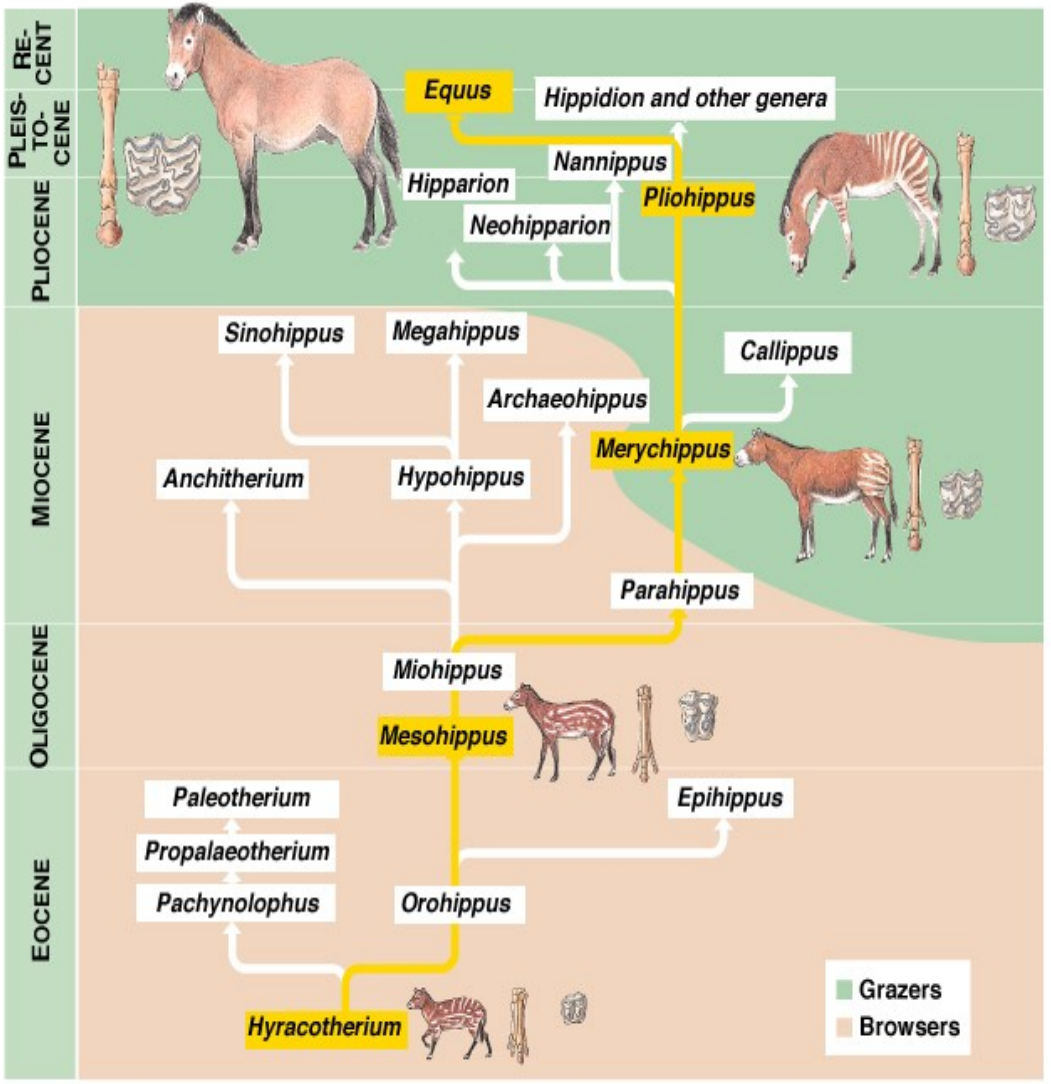
- Fleeming Jenkin (1867), British engineer pointed out that single chance variation, even if favourable to survival had infinitesimal chance of being adopted by population.
-
- This made Darwin to assume that habits or environmental factors common to an entire population would produce variations that would then be inherited.

Genetics (Support)

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".

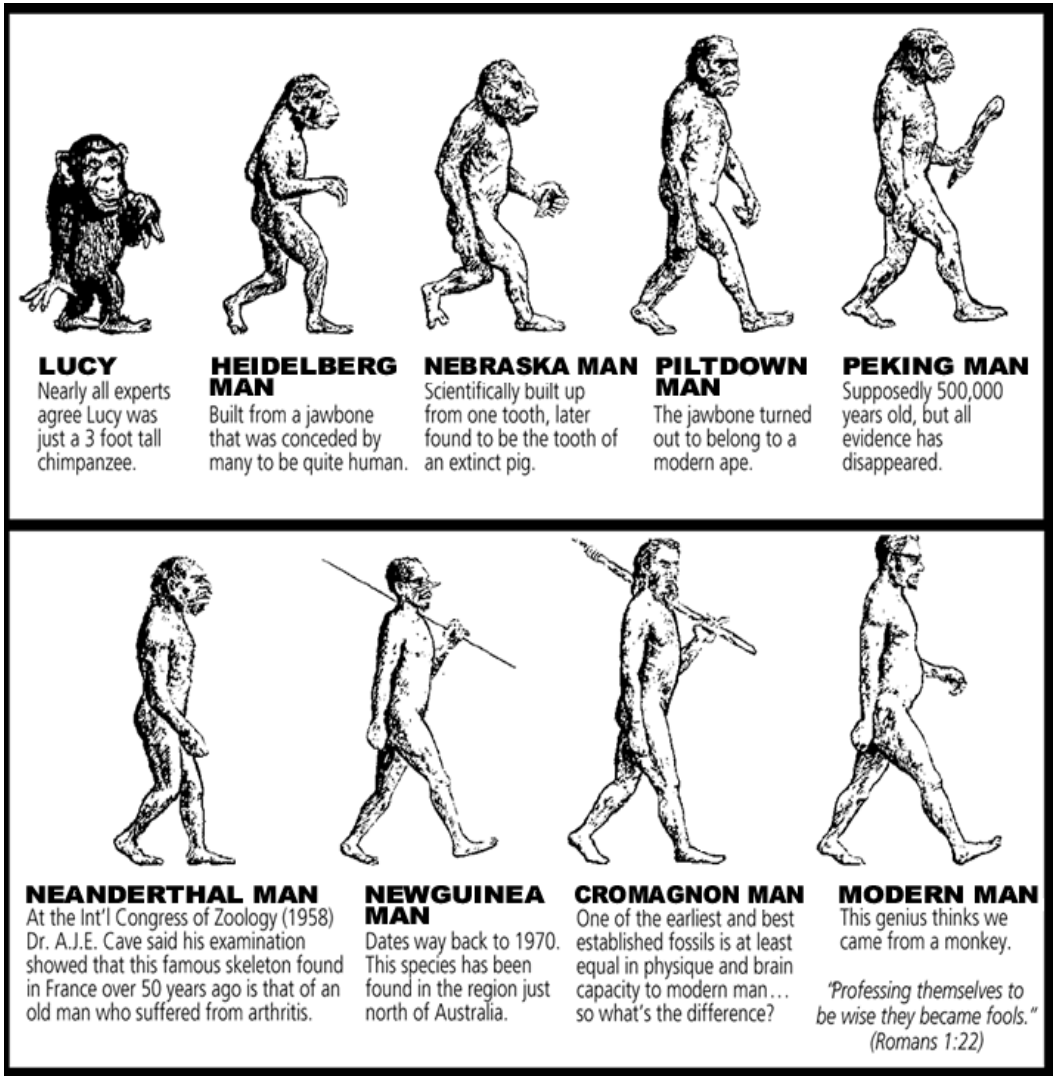
Palaeontology (Support)



- 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.

Archaeopteryx (Support)

Palaeontology (Support)



- 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.

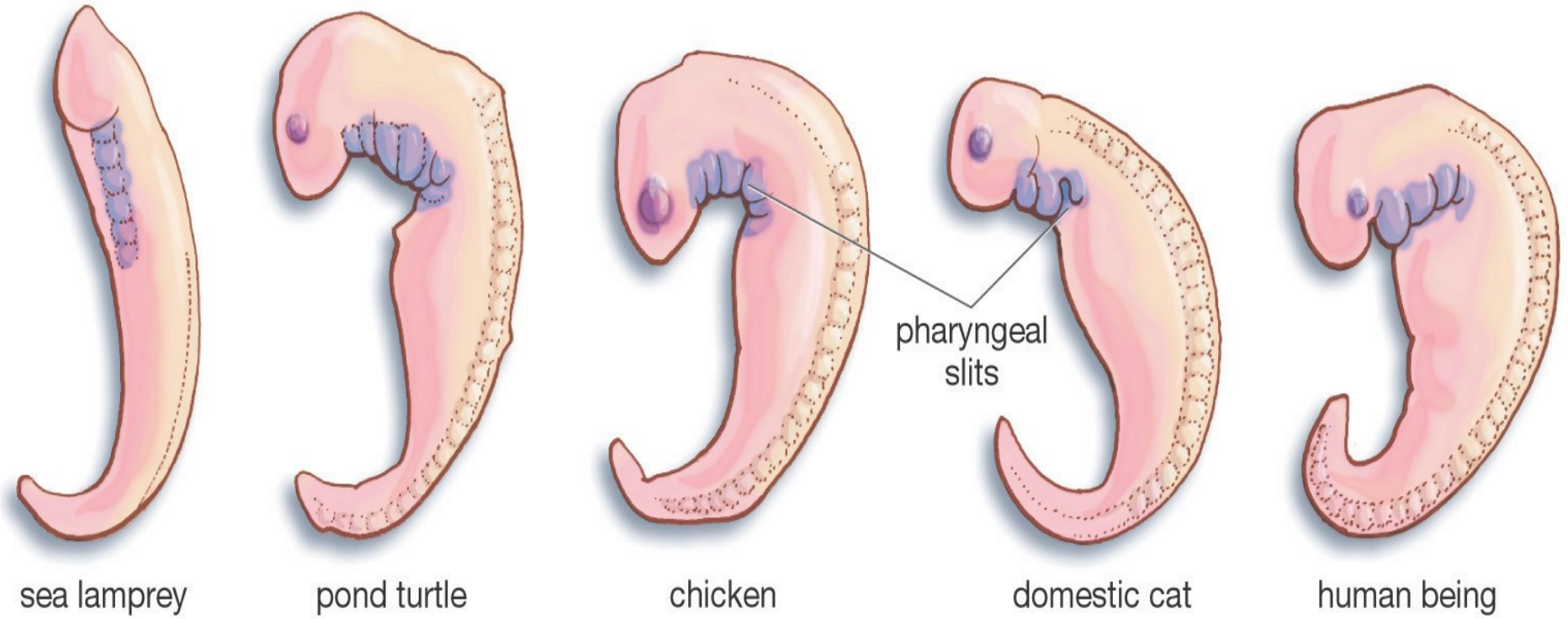
Embryology (Support)

Earnst Haeckel
1834-1919 A.D.

- Haeckel (1868) postulated 'Biogenetic law' as "Ontology recapitulates phylogeny", this gave embryological evidences of evolution.
- "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".

Comparative Embryology

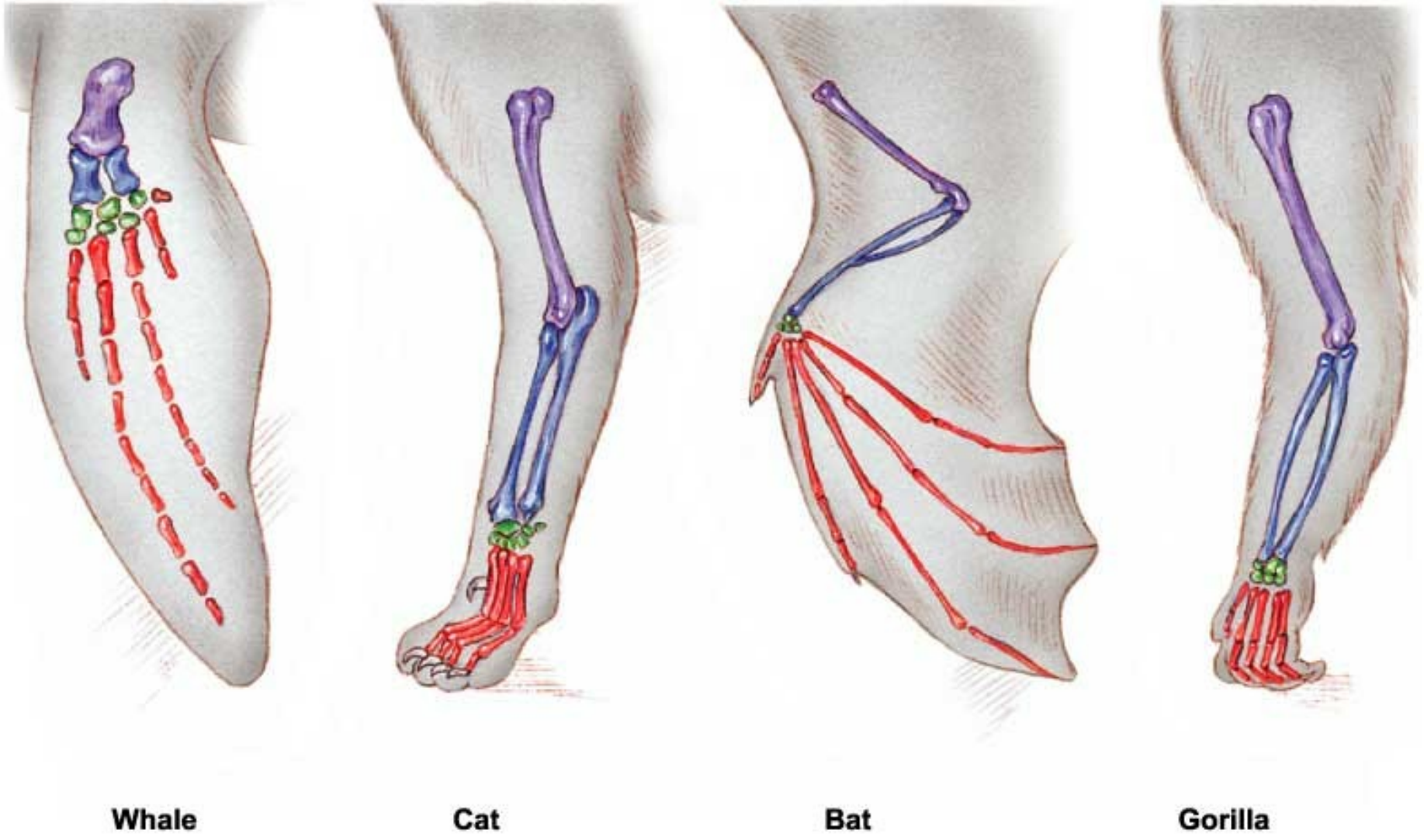
Pharyngeal slits exist in these five vertebrate animals ...



... evidence that all five evolved from a common ancestor.

Ontology Recapitulates Phylogeny

Homologous Organs



Predictions made

- 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

- 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

- **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.*

Thanks to All !!!!