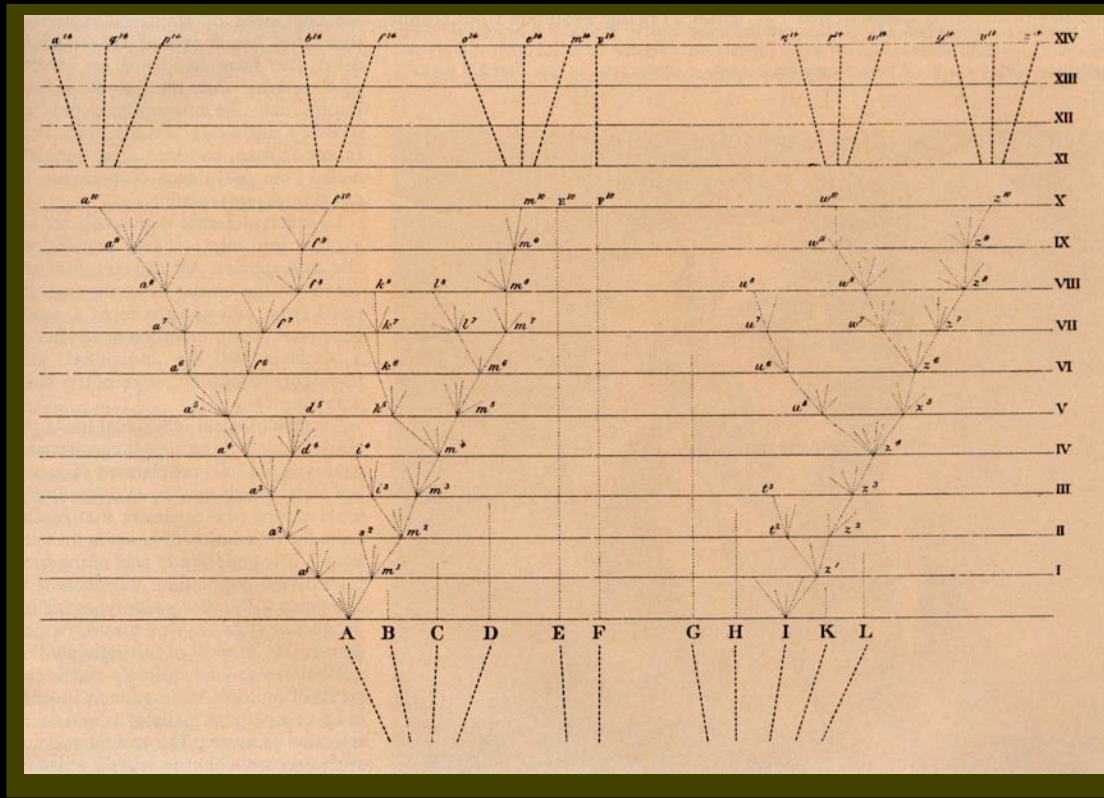


Charles Darwin: Evolutionary Theory, Past and Present

Reactions to Darwin's Theory



from C. Darwin, 1859, *Origin of Species*...

OUTLINE - Reactions to Darwin's Theory

Introduction - understanding & misunderstanding of science
ideas that bear on origins - *particularly touchy*
nature of scientific v. non-scientific knowledge

History of thought in natural science

Explanations of Nature - *Morphic Spiritualism*
Natural Theology
Materialism

Two major themes - The Ruse Hypothesis, modified

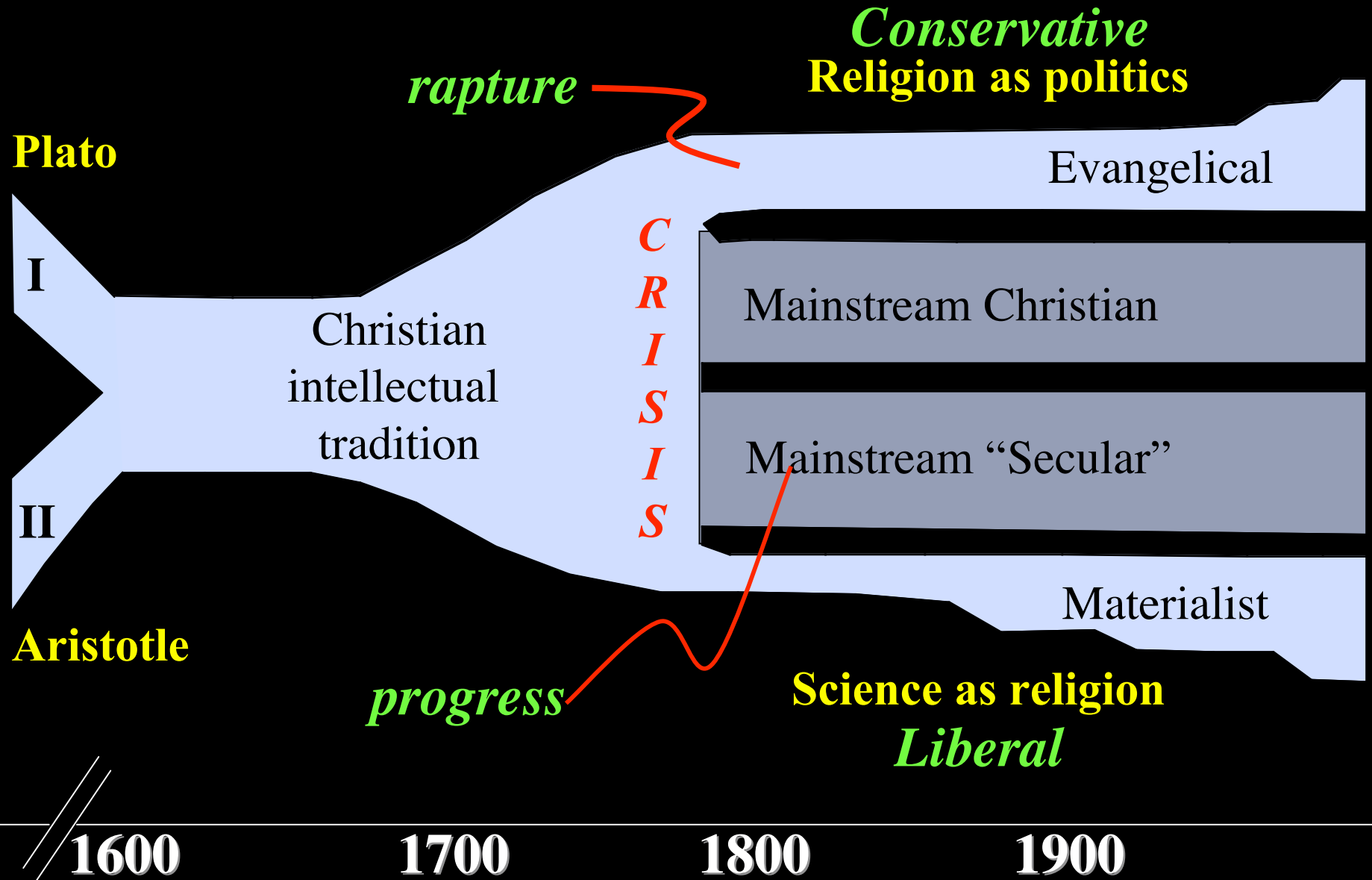
Tracing the Themes - from Greeks to Darwin to early 1900's

Darwin's Dangerous Idea - *Descent with Modification...*

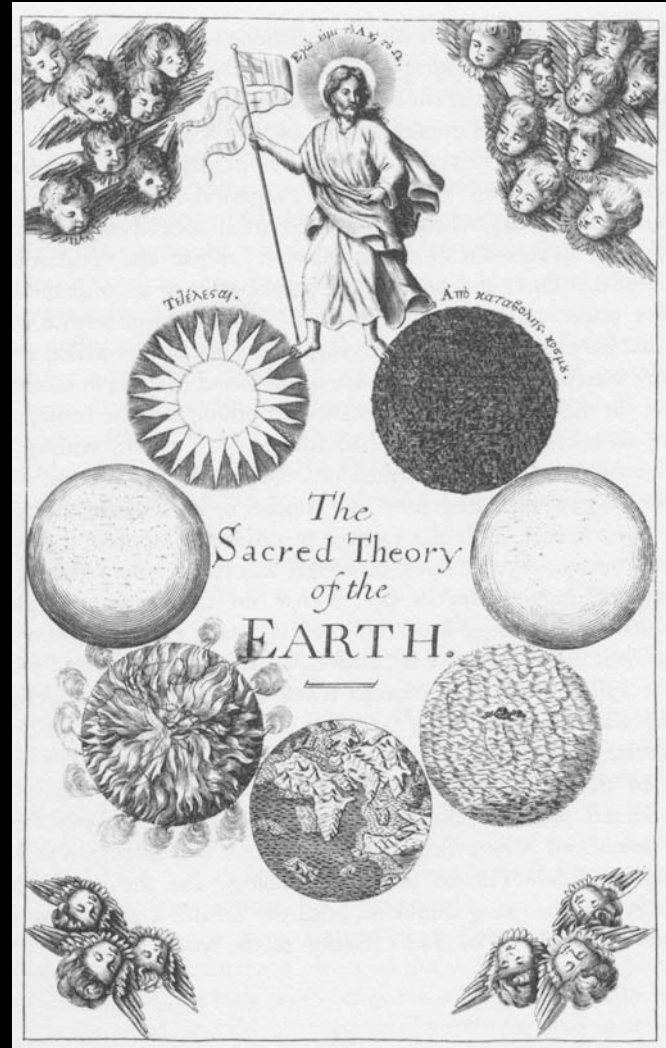
Victorian Reactions to Natural Selection - *many of which persist*

Conclusions - understanding & misunderstanding of science

Michael Ruse: the EVOLUTION-CREATION struggle



TRACING THEME I



The Greeks



1200 - 404 BCE

First to attribute natural phenomena to matter governed by physical laws rather than the acts of gods.

- Astronomy and Mathematics (after the Egyptians)
- Biology - organizing plants and animals
- Physics and chemistry - postulated existence of atoms
- Medicine - Hippocrates
- Philosophy and logic - Plato and Aristotle in Athens
- First Universities - the Academy and the Lyceum

Plato (427 BC – 347 BC)

Aristotle (384 BC – 322 BC)

- Essentialism: reality is founded on a finite # of 'natural kinds,' archetypes of entities seen in the world, discrete and *immutable*; physical objects = inexact manifestations of these ideal forms.
- Species are immutable, unchanging, always breed true to form.
- Recognition of similarities among different taxa (classification)
- Recognition of a gradation of complexity among organisms (progression)
- Recognition that fossils represent ancient marine life (antiquity)
- Recognition that uplift or sea level rise (dynamic Earth system)
- Philosophy of Causality:
 - Material - what is it made of?
 - Formal - what is its underlying plan?
 - Essential - what caused it to be?
 - Final - what is its *purpose (telos)*



Plato (427 BC – 347 BC)

Aristotle (384 BC – 322 BC)

Theme I

- Species are fixed, **immutable, unchanging**
- Life is organized in a linear plan = Chain of Being
- Life exists for a purpose

STABLE, STATIC, SECURE



Theme II

- Living things are organized in a hierarchy of relationships that suggest progression of complexity (progress)
- Living things existed in a remote past, now observed as fossils (antiquity)
- The Earth has undergone significant environmental change through time

***UNSTABLE,
CHANGING,
DYNAMIC,
EVOLVING***

Tracing Theme I.....

The Romans.....origin of 'Natural Theology'

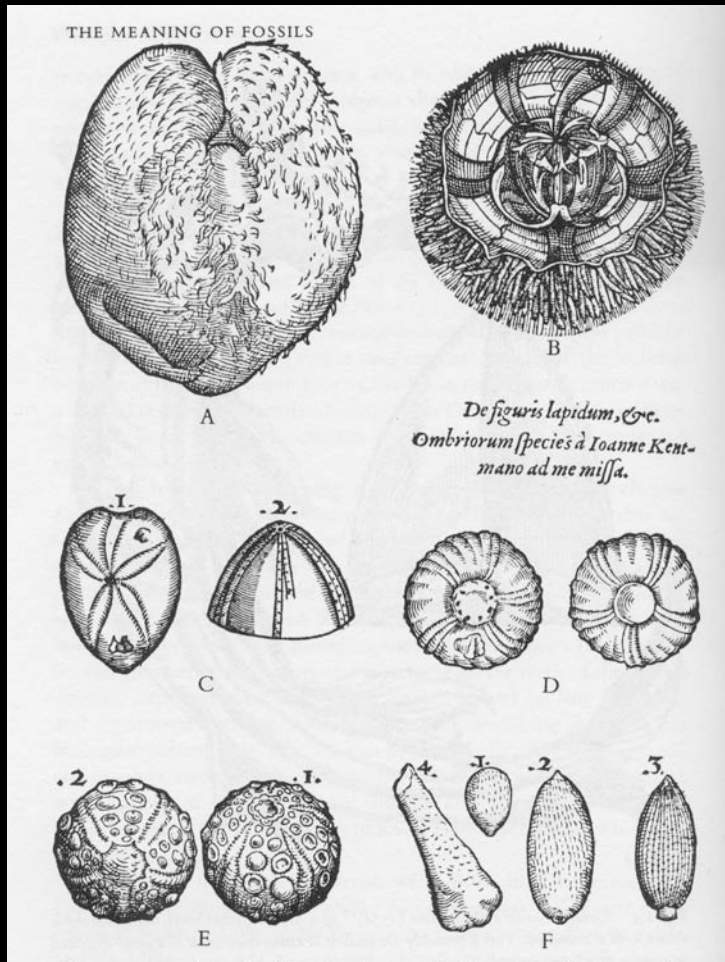
Marcus Terentius Varro (116 BC – 27 BC)

...in his (lost) *Antiquitates rerum humanarum et divinarum* established a distinction of three kinds of theology: civil (political) (theologia civilis), natural (physical) (theologia naturalis) and mythical (theologia mythica).

- **Theologians of civil theology are "the people", asking how the gods relate to daily life and the state (imperial cult).**
- Theologians of natural theology are the philosophers, asking for the nature of the gods - *causality of natural phenomena*
- **Theologians of mythical theology are the poets, crafting mythology.**

The “Dark Ages”

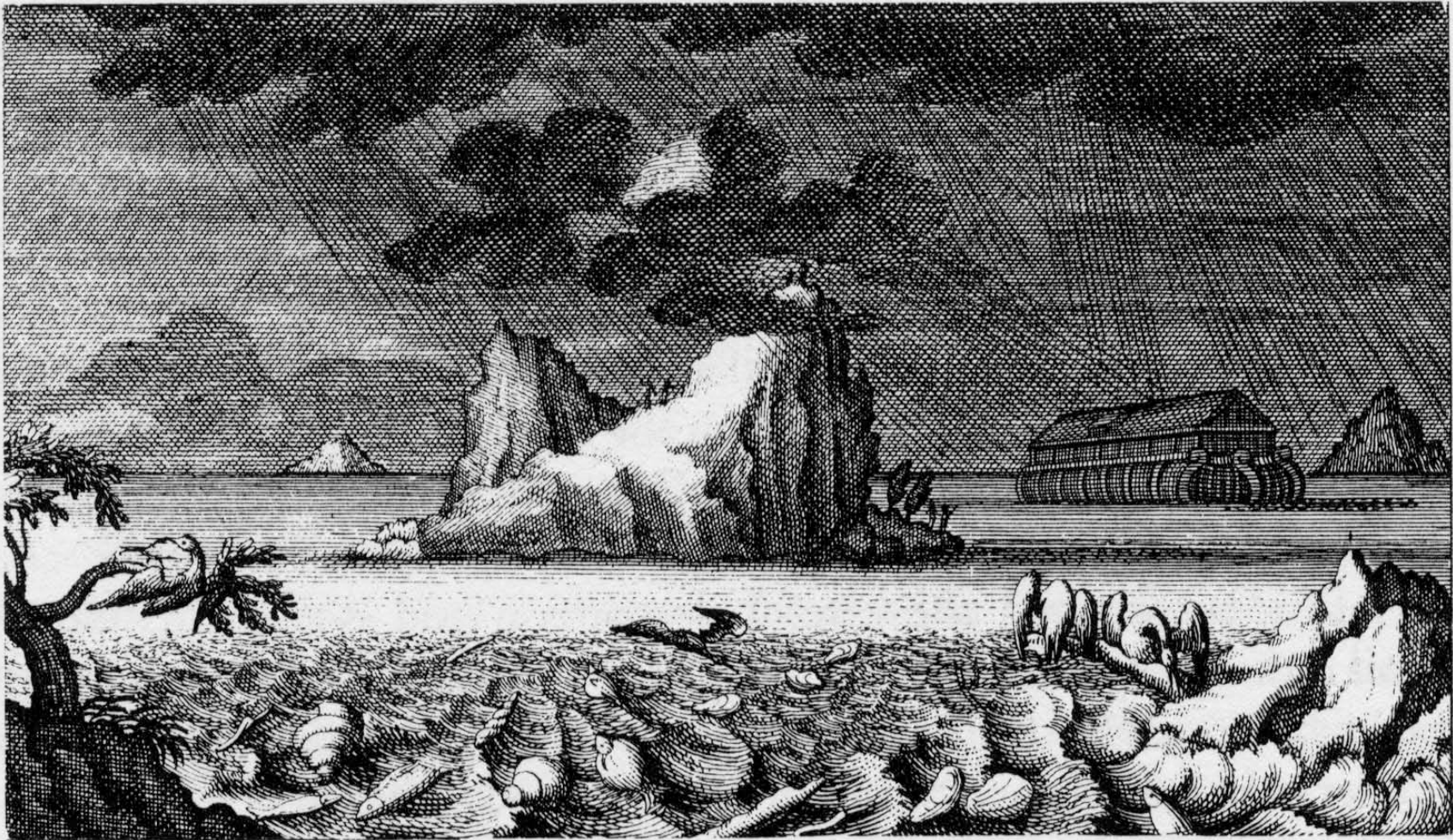
Alternate explanations for fossils were common



“vis plastica”
“lusi naturae”

The “Dark Ages”

Alternate explanations for fossils were common



Noah's flood

Tracing Theme I.....

Thomas Aquinas (1225-1274)

*Italian Catholic preist; the foremost classical proponent of natural theology; Aristotelian ideas combined with some empiricism + **revelation***



James Ussher (1581–1656)

Anglican Archbishop of Armagh (Ireland); author of the definitive biblical chronology (creation: 4004 BC)



John Ray (1627 –1705)

‘Father of English natural history’; contributed to development of taxonomy (coined ‘species’);



‘Wisdom of God manifested in the works of Creation’

Tracing Theme I.....

Thomas Burnet (c. 1635? - 1715)

English theologian and writer on cosmogony; wrote “Sacred Theory of the Earth” (1681), linking observations of nature with the Deluge.



John Woodward (1665 - 1728)

English naturalist, antiquarian, and geologist.; wrote *Essay Toward the Natural History of the Earth* (1695); sought to reconcile problems with the Deluge Hypothesis.



Tracing Theme I.....

William Paley (1743-1805)

English geologist, paleontologist and Dean of Westminster; wrote *Natural Theology* in 1802.



The Argument from Design

Problems:

Who designed the designer?

Why would God *design* pain and suffering?

Why would God *design* organisms that go extinct?

Contributions

Extensive catalogue of cases of adaptation

Tracing Theme I.....

William Whewell (1794-1866)

English English polymath, scientist, Anglican priest, philosopher, theologian, and historian of science; wrote *Natural Theology* in 1833.



- Invented the English word “scientist” as well as many others (e.g., anode, cathode, ion, etc.).
- Argued that the laws of nature provide a foundation for love and hope.
- Wrote *Philosophy of the Inductive Sciences*...championed the (Baconian) inductive method, which unites separate facts and renders them capable of being expressed by a general law.

Tracing Theme I.....

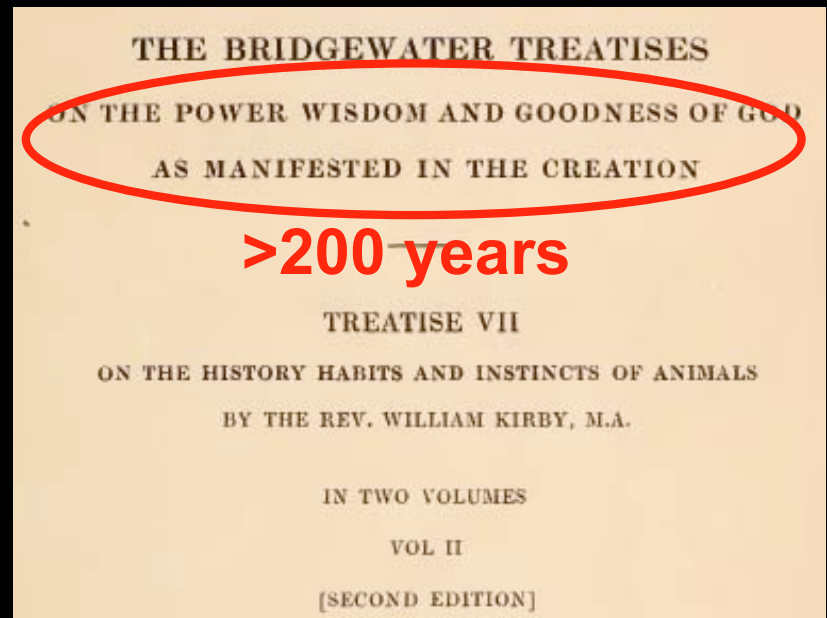
Rev. Dr. William Buckland (1784 –1856)

*English geologist, palaeontologist and
Dean of Westminster*

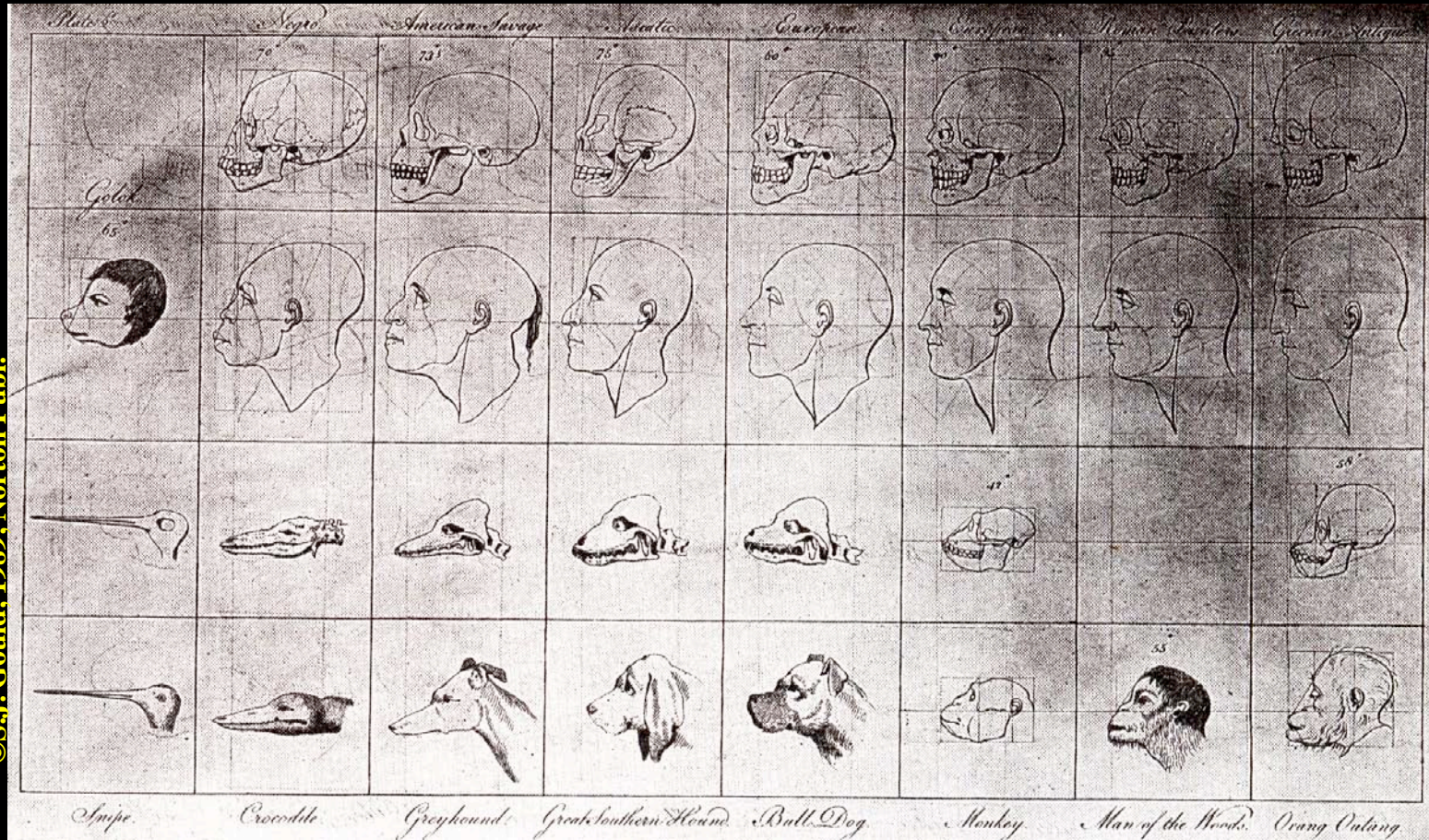
-wrote the first full account of a fossil dinosaur.
-strong proponent of Old Earth creationism.

-developed new hypothesis that the word
"beginning" in Genesis meant an
undefined period between the origin of
the Earth and the creation of its current
inhabitants, during which a long series
of extinctions and successive creations
of new kinds of plants and animals had
occurred.

Bridgewater Treatise author, 1836
in addition to Whewell, Chalmers,
and others



Natural Theology - and its disturbing implications....



©S.J. Gould, 1989, Norton Publ.

C. White, 1799

Special Creation

Fixity of species

The Great Chain of Being

Young Earth (6000 yr)

No Extinction

Tracing Theme I.....

Georges Cuvier (1769-1832)

French comparative anatomist/paleontologist, superb scientist, but ardent creationist; wrote *Essay on the Theory of the Earth* in 1813.

- Integrated modern and fossil data
- Expanded Linnaean taxonomy (to phyla)
- Proposed four main branches for the “tree of life; demonstrated DIVERGENCE.
- Recognized SUCCESSION in fossil record
- Proved the reality of EXTINCTION
- Recognized RADIATIONS in fossil record
- Proposed THEORY of CATASTROPHISM to explain these observations.
- Recognized no fossil intermediate forms
- Deplored social disorder (French Revolution) and opposed organic evolution to the end

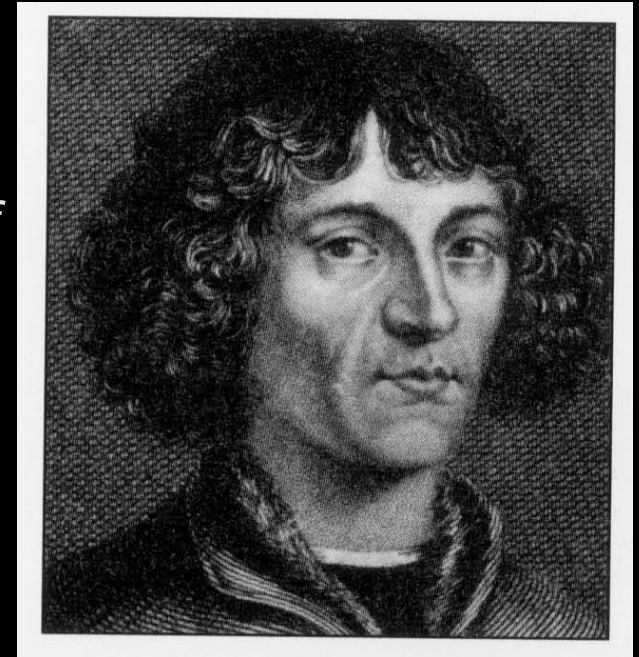


Tracing Theme II....

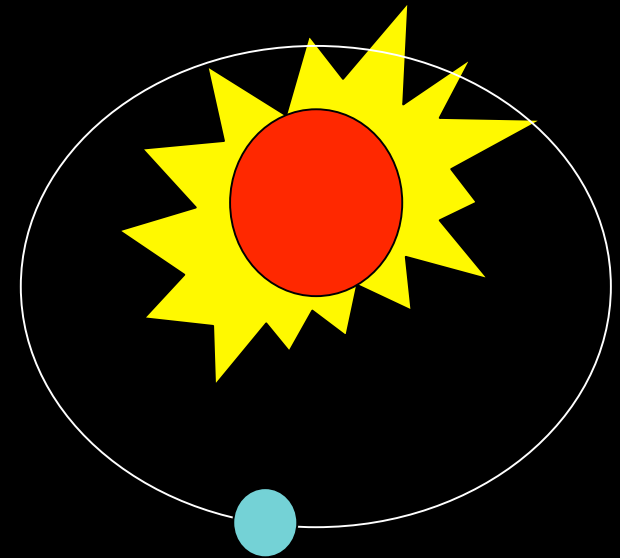
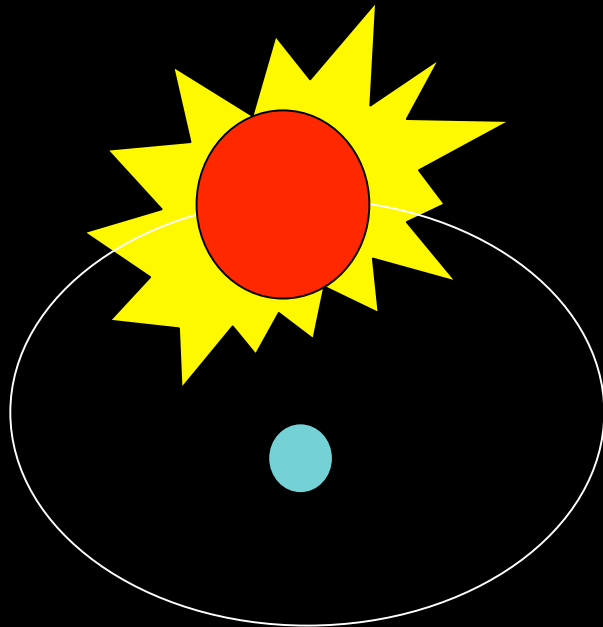
Nicolaus Copernicus (1473 –1543)

*Polish polymath who wrote *On the Revolutions of the Celestial Spheres* in 1543, often regarded as the starting point of modern astronomy and the defining epiphany that began the Scientific Revolution.*

He developed the heliocentric world view, overturning the Ptolemaic system



©Natl. Acad. Sci., 1998



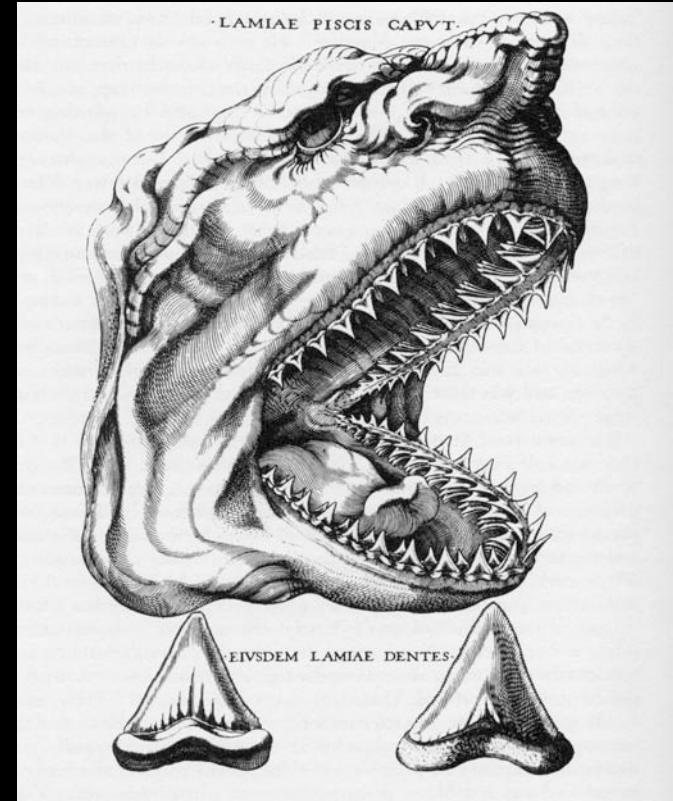
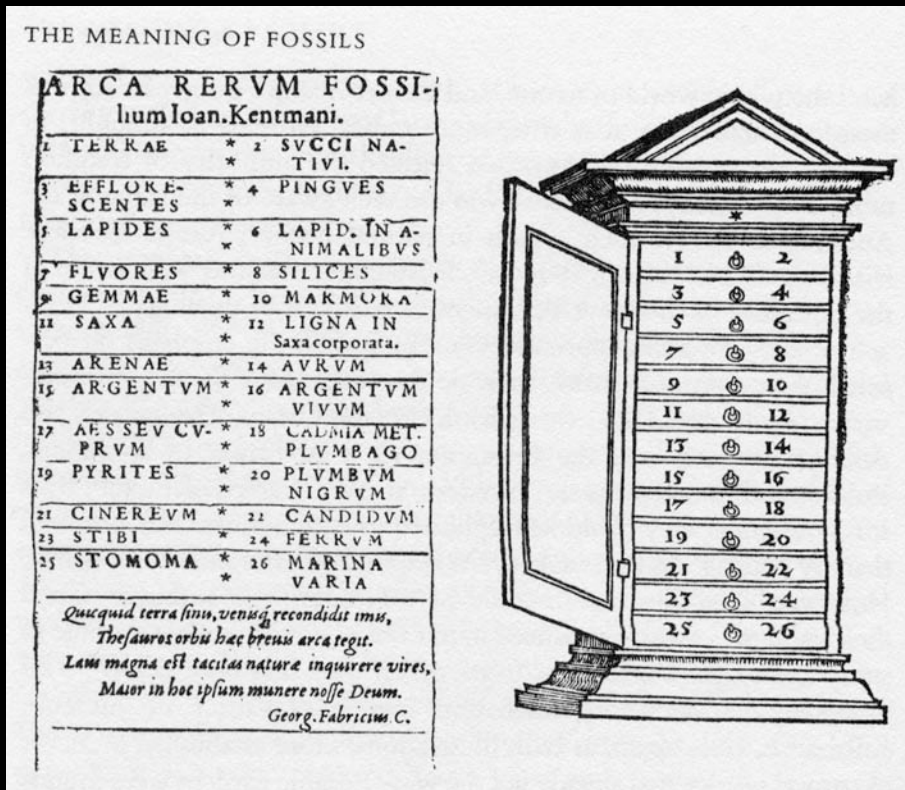
Tracing Theme II....

Empiricists

The Renaissance

C. Gesner (1516 - 1565)

N. Steno (1683 - 1686)



©Rudwick, 1976, Watson. Acad. Publ.

©Rudwick, 1976, Watson. Acad. Publ.

- Established fixed collections
- Published with illustrations
- Initiation of museum “holotypes”

- Documentation of fossils
- Fossil-modern comparisons
- Laws of stratigraphy

Tracing Theme II....

Age of Enlightenment - 1700's

French Philosophers

Radicals



Diderot



Maupertius



Montesquieu

Gradational series of species

Appearance of new varieties of domesticated plants/animals

Hereditary sports (6-fingered humans)

The correlation of parts among different animals

Developmental features such as metamorphoses

Tracing Theme II....

James Hutton (1726-1797)

Scottish geologist, physician, naturalist, chemist and experimental farmer. He is considered the father of modern geology. Wrote *Theory of the Earth* in 1785.



©S.J. Gould, 1987, Harvard Univ. Press.

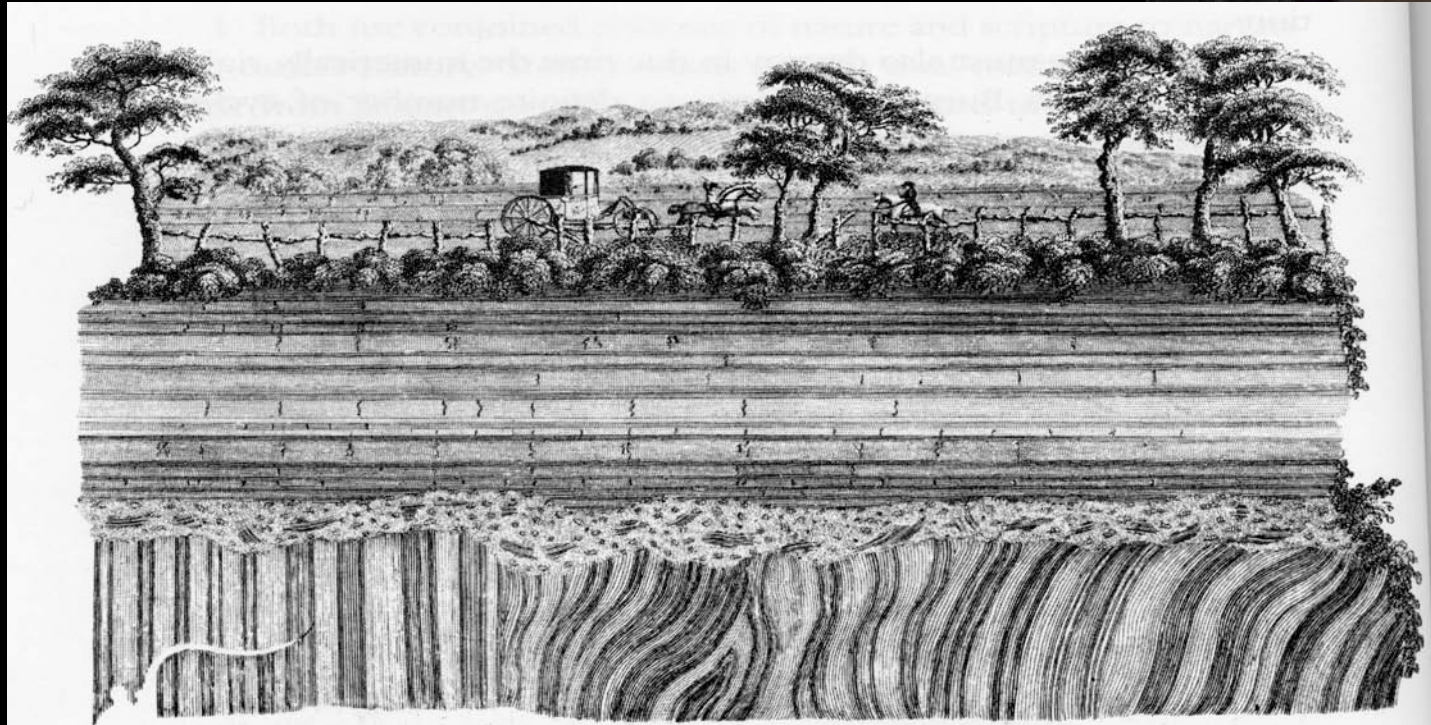


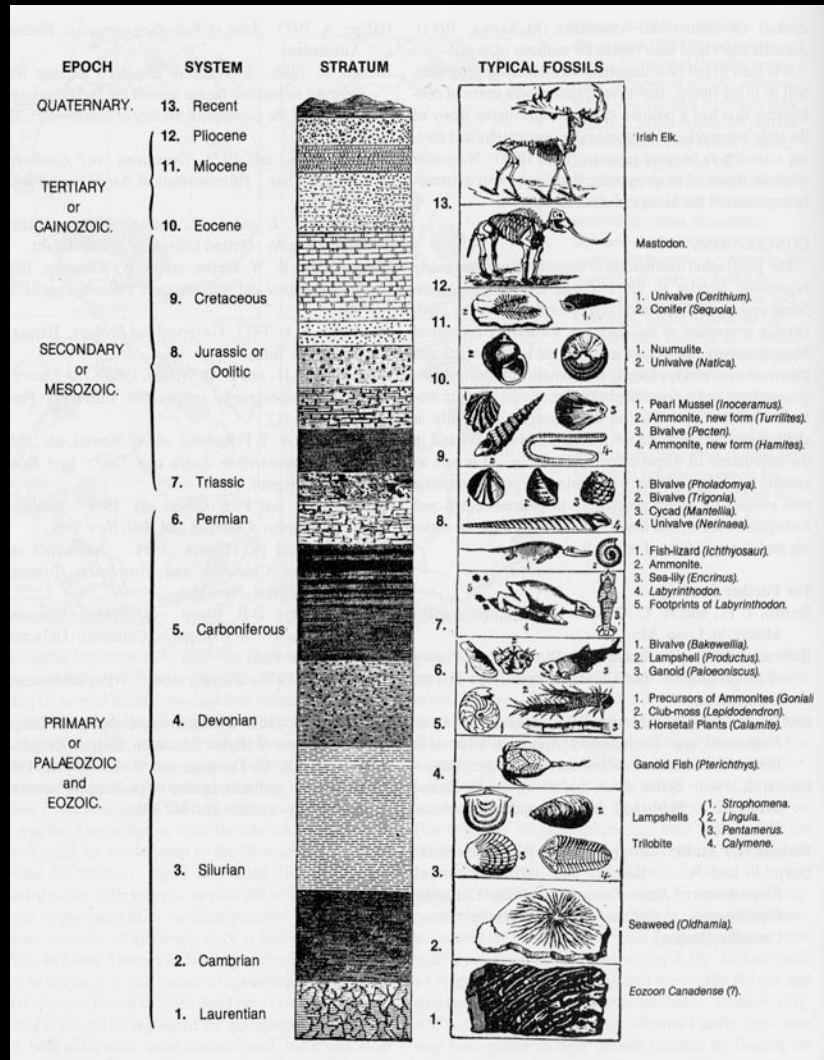
Figure 3.1

John Clerk of Eldin's celebrated engraving of Hutton's unconformity at Jedburgh, Scotland.

Tracing Theme II....

William Smith (1769 - 1839)

English geologist, credited with creating the first nationwide geological map...

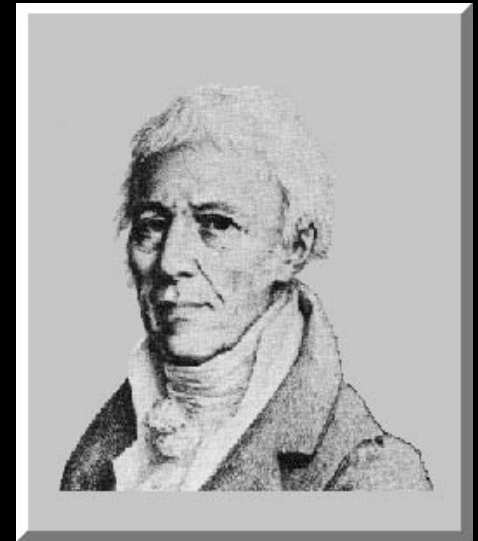


In the course of making his map, he developed the *Law of Faunal Succession* which stems from the extinction of old taxa and origination of new taxa throughout the geologic record: concept of *progression*.

Tracing Theme II....

J.B. de Lamarck (1744-1829)

French soldier, naturalist, academic and an early proponent of the idea that evolution occurred and proceeded in accordance with natural laws; violently opposed by Cuvier when he published his views in *Philosophie Zoologique* in 1809.



Proposed the first “full theory of transmutation”

- Doctrine of use/disuse
- Inheritance of acquired characters
- No extinction-only transmutation
- Hierarchy of increasing complexity
- *Adaptation based on environmental needs*



Bitterness of criticism directed at Lamarck may have influenced Darwin.

Tracing Theme II....

Erasmus Darwin (1731-1802)

English physician, natural philosopher, physiologist, inventor and poet; Charles Darwin's grandfather.



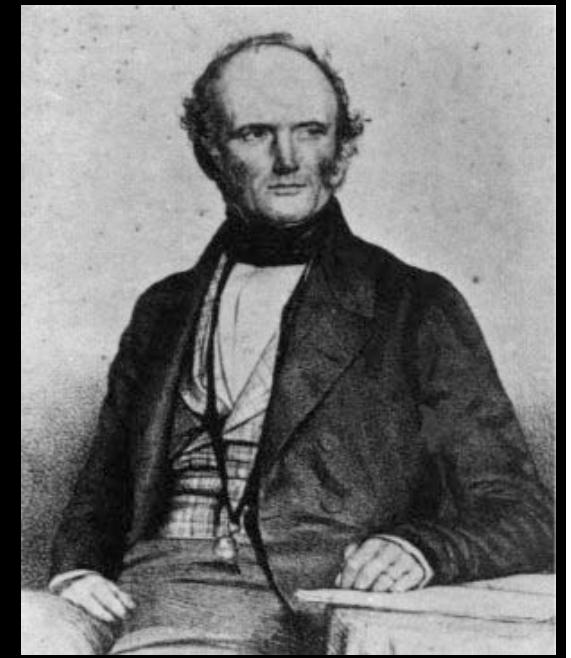
Zoönomia-The Laws of Organic Life (1794)

Accepted species mutability based on these observations:

- Trends in embryonic development
- Domestic hybridization results
- Significance of “monstrous births”
- Similarities in vertebrate anatomy
- Significance of vestigial organs
- Recognized importance of the struggle for existence

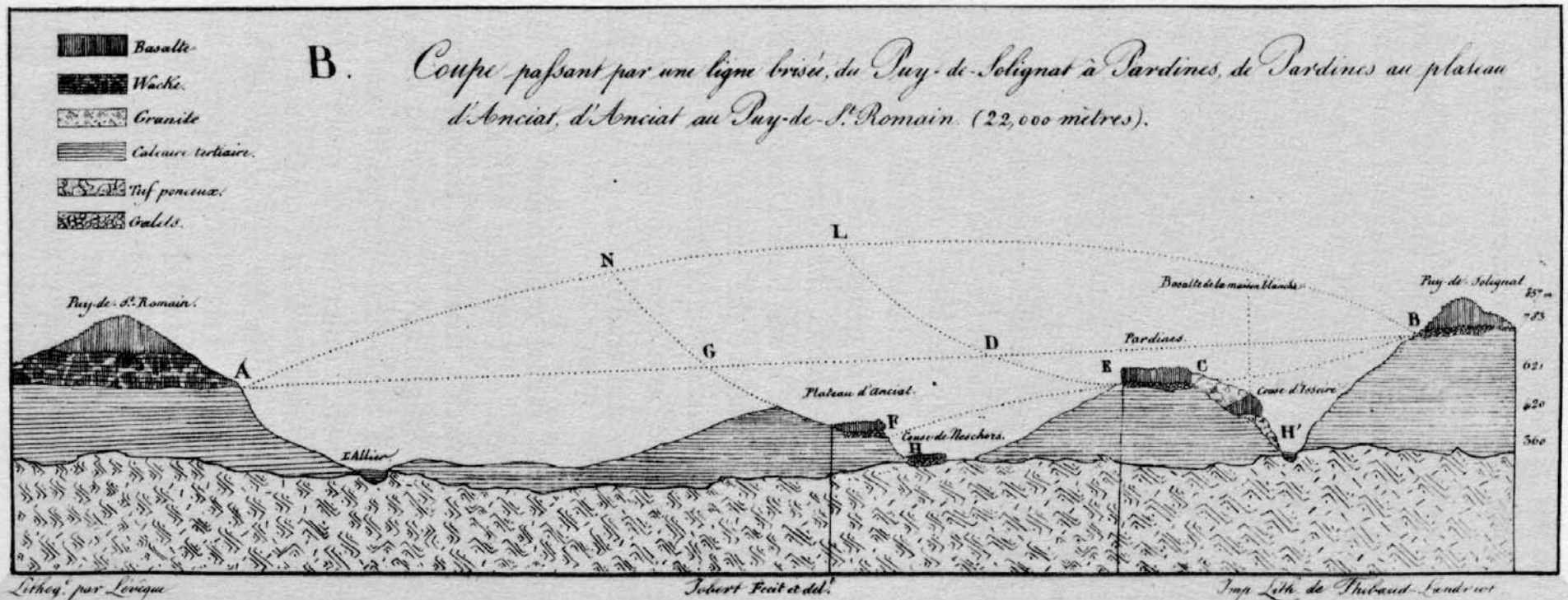
C. Lyell (1797 - 1875)

English geologist, champion of Hutton's Theory of Uniformitarianism; wrote influential book - Principles of Geology (1830); collegial friend of Darwin.



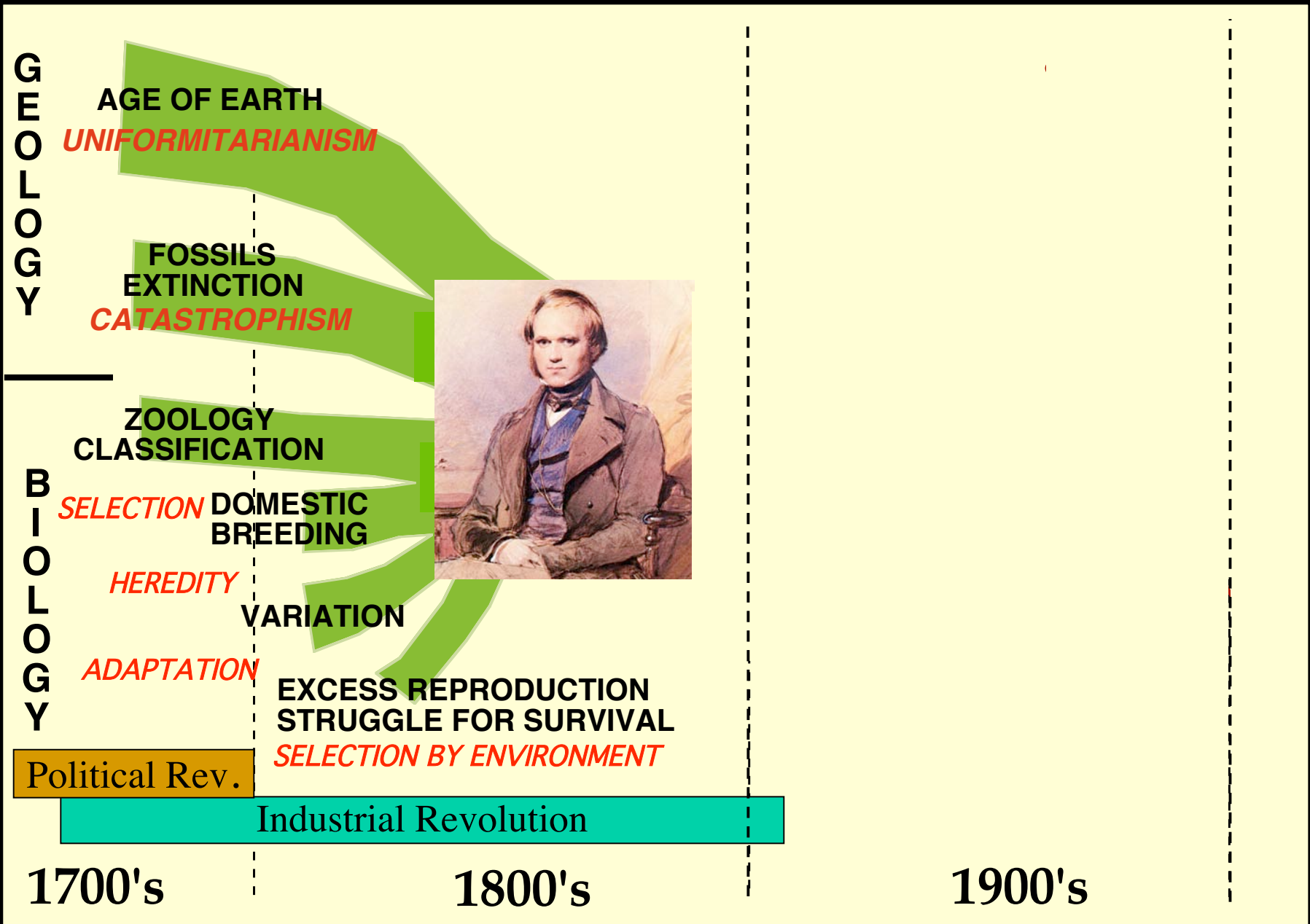
Theory of uniformitarianism

Earth processes require *immense time* to produce observed features



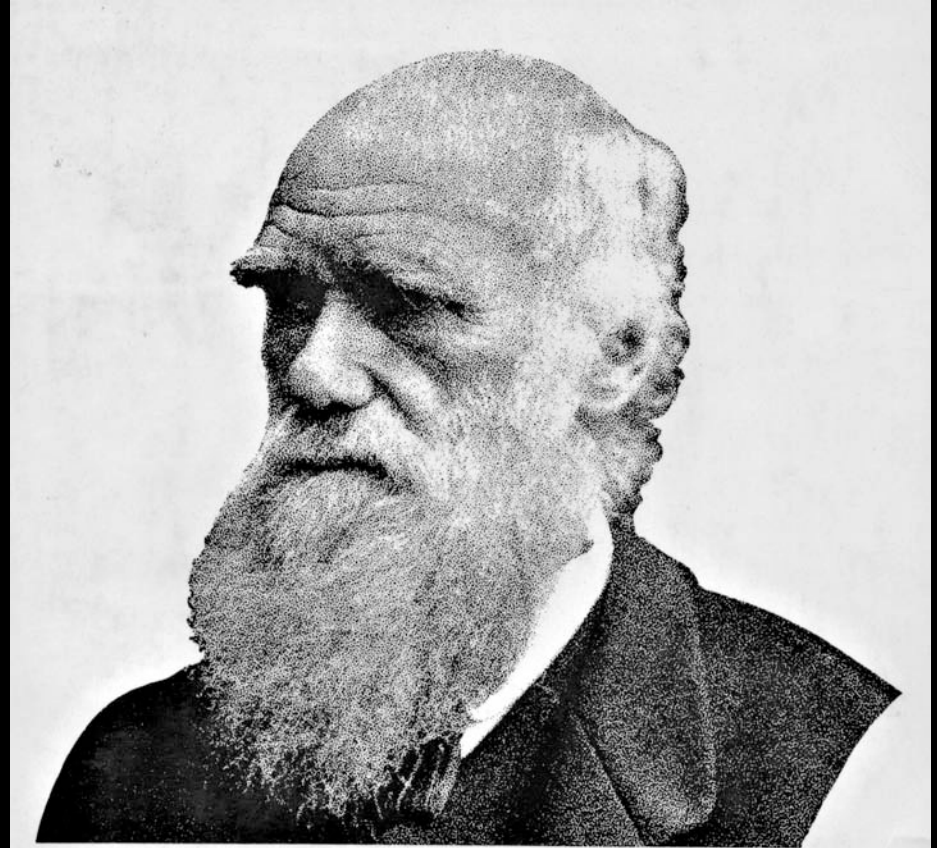
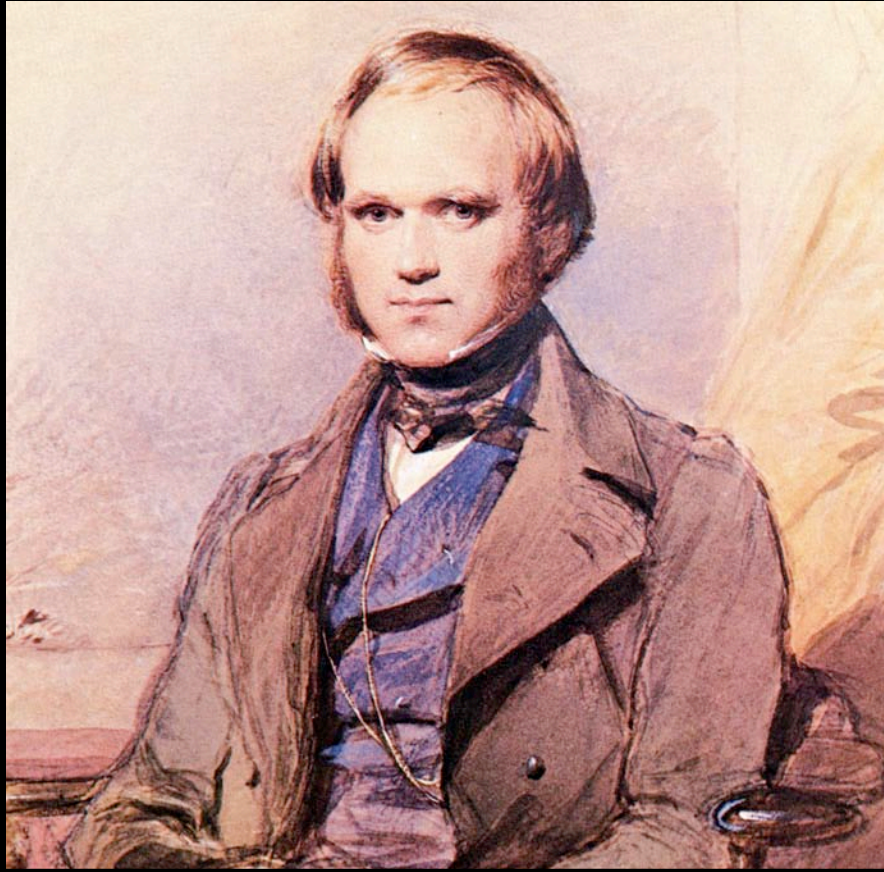
DEVELOPMENT OF DARWIN'S DANGEROUS IDEA

HISTORICAL DEVELOPMENT OF EVOLUTIONARY THEORY



Charles Darwin

1809-1882



©Norton & Co. Publ., 1970c

Inherited concepts: hierarchy of relationships (classification)
gradualness of processes & immensity of time (antiquity)
environmental change (dynamic planet)
plasticity of heredity (variation)

Voyage of the Beagle



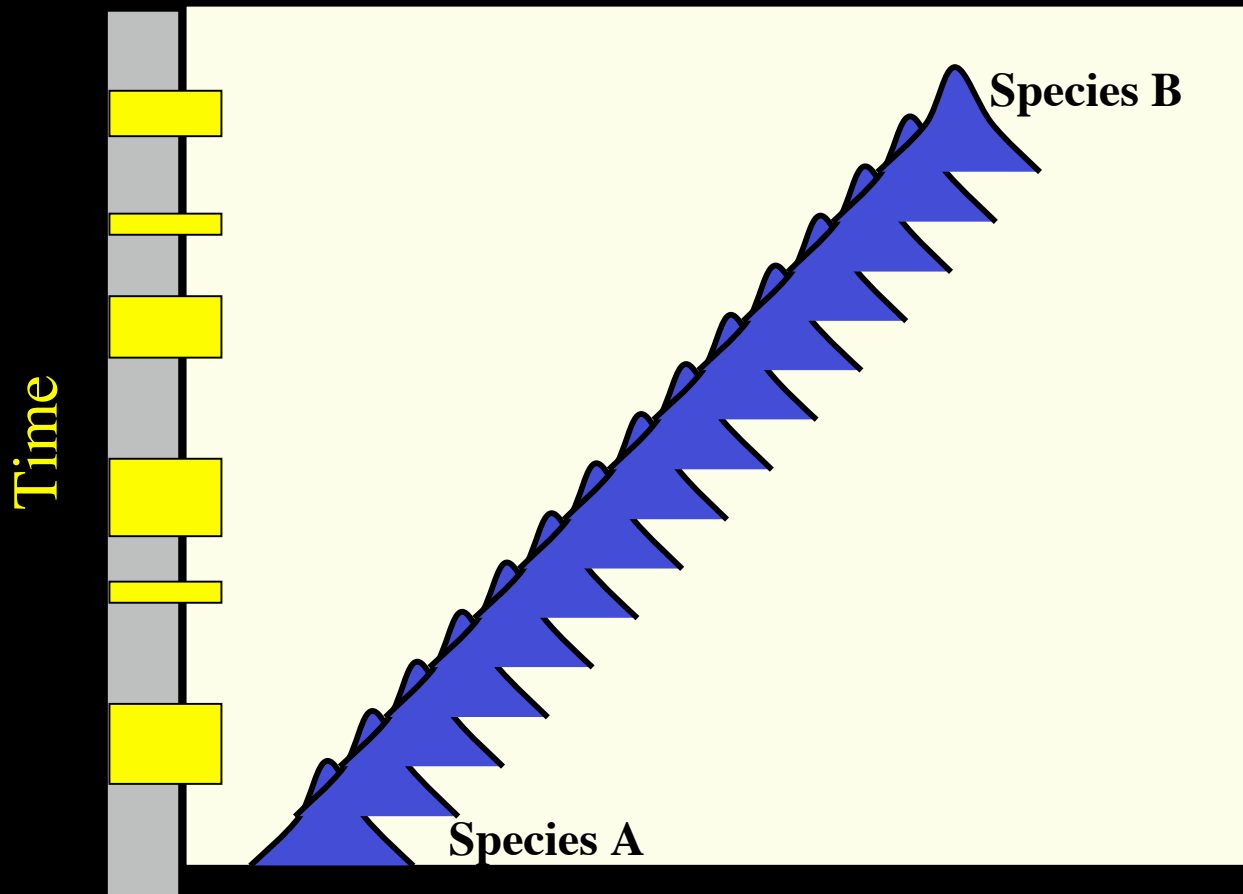
- Notebooks on transmutation started - 1837
- Read Malthus *On Population* - 1838
- Worked on many projects 1838-58, until...
- *Origin* published 1859

Descent with Modification by means of Natural Selection

- 1) If individuals vary (in traits or characters),
- 2) If variations are inherited by offspring,
- 3) And if more offspring are born than can survive, competition (for space, food, other resources) will be intense in the struggle for existence.

•As a result, those variations (traits) that confer adaptive advantage in the struggle for existence, will be favored (selected) by nature and accumulate via *differential reproductive success* through successive generations of a population. New species will thus arise from pre-existing ones in response to changes in environmental conditions that favor new traits.

Descent with Modification by means of Natural Selection



**Darwinian
Evolution**

Gradualism

Anagenesis

Morphology

REACTIONS TO DARWIN'S THEORY

Theme I - reactions to Darwin

Adam Sedgwick (1785-1873)

Cambridge Professor of Geology; among the key developers of the modern geologic column.



Sedgwick's arguments:

The geologic record was not as incomplete as claimed;

Domestic hybrids are NOT separate species;

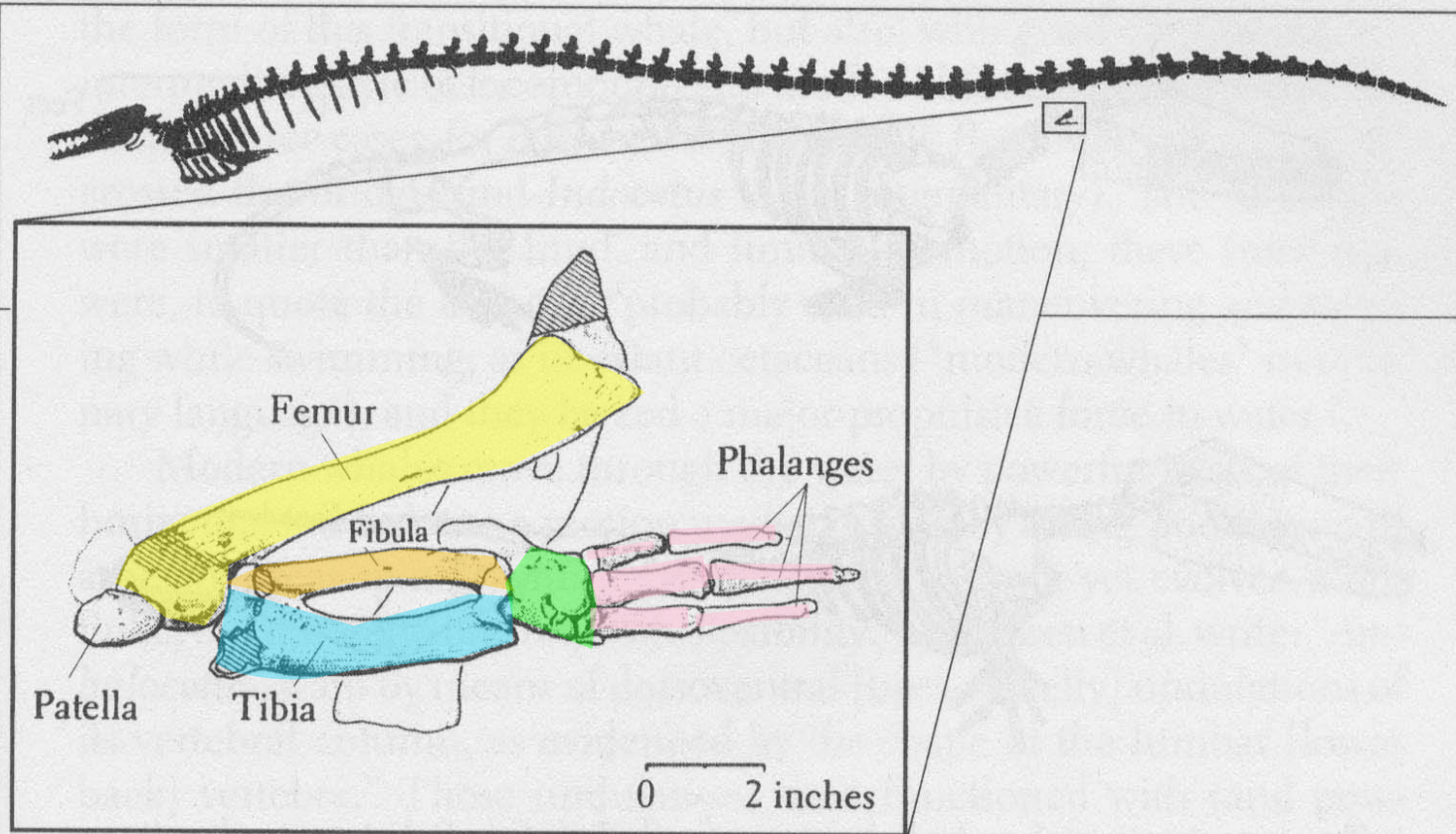
Darwin used terms like "believe," which imply too much subjectivity;

The theory is not properly inductive;

The theory repudiates *final causes*;

The theory is unflinchingly materialistic.

*“Darwin seems to believe that a white bear...
...might be turned into a whale.”*



*A fifty-foot Eocene whale, *Basilosaurus isis*, from the Zeuglodon Valley of Egypt, had tiny hind limbs, shown in detail here.*

Adapted from Science, vol. 249, 13 July 1990.

Richard Owen (1804-1892)

Pious & gifted English biologist, comparative anatomist, & paleontologist; coined the term “Dinosauria.” He was troubled by the link between evolutionary ideas and social radicalism. Identified the fossils Darwin collected in South America.



- Opposed to *succession* of taxa in fossil record (every taxon in its place);
- Insisted that species, such as apes and man, are separated by major “breaks”;
- Thought evolutionary concepts like natural selection blurred the concept of species as *essential entities*.
- Said varieties are never observed to become species.
- Argued that no transitional forms are found.

Theme II - reactions to Darwin

Sir Joseph Dalton Hooker (1817 –1911)

English botanist and explorer; classified the plants Darwin collected in the Galápagos and carried on a life-long friendship with him.

In a letter dated 1844 Darwin shared with Hooker his early ideas on the transmutation of species and natural selection. He was probably the first person to hear of the theory.

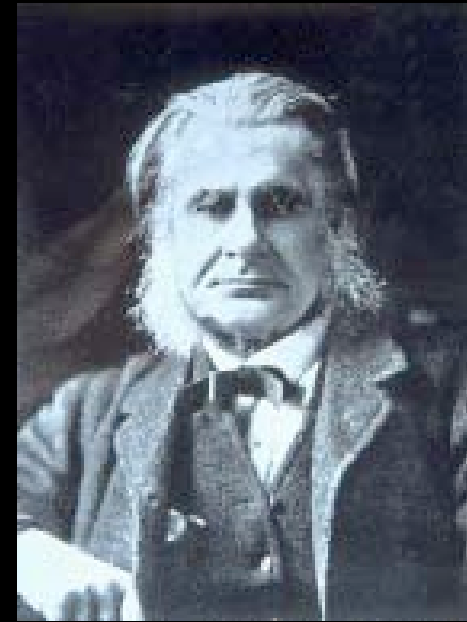
Their correspondence continued throughout the development of Darwin's theory and later Darwin wrote that Hooker was "the one living soul from whom I have constantly received sympathy".



Theme II - reactions to Darwin

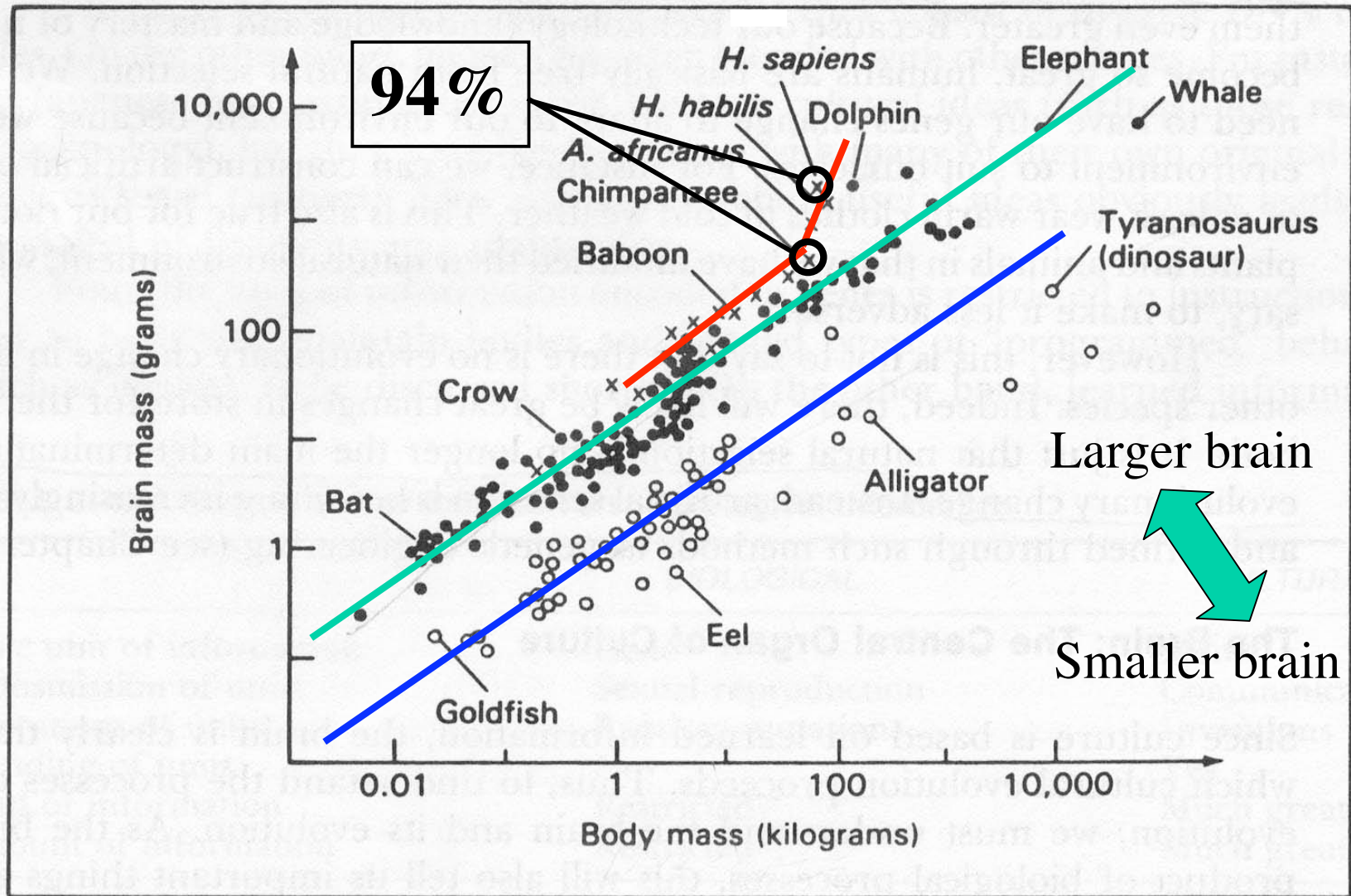
Thomas H. Huxley (1825-1895)

English biologist, known as "Darwin's Bulldog" for his advocacy of Charles Darwin's theory of evolution.

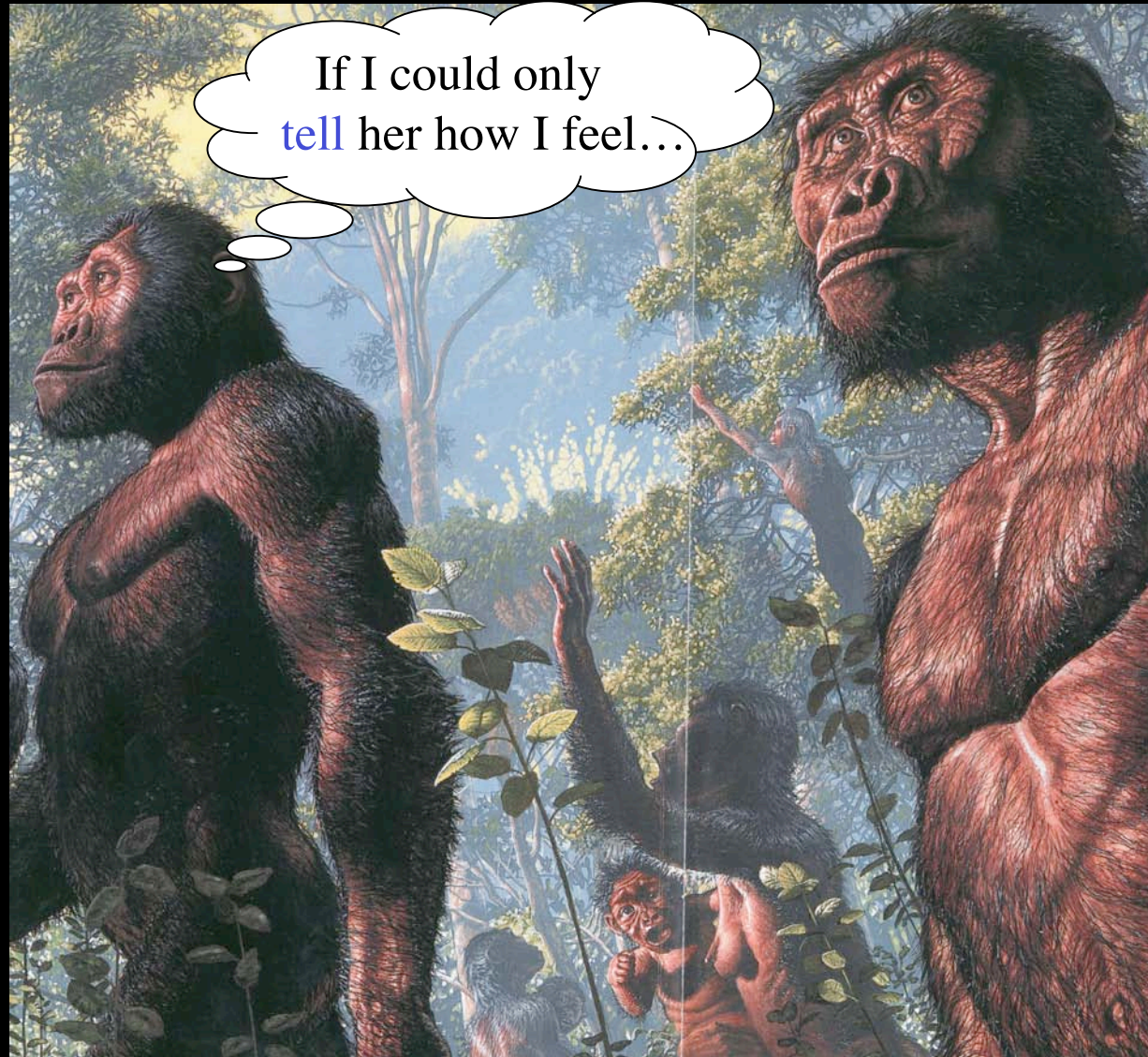


Huxley famously argued for natural selection, debating 'Soapy' Sam Wilberforce using examples from the evolution of humans.

Trends in brain size relative to body mass



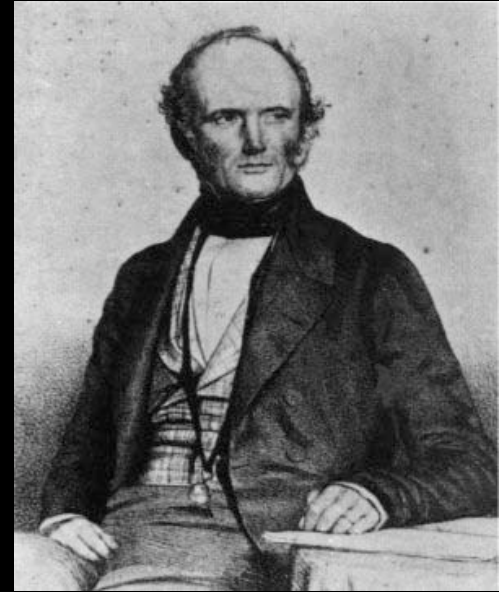
The characteristic Huxley believed most differentiated Man from the other primates?



Theme II - reactions to Darwin

Charles Lyell (1797 - 1875)

English geologist, champion of Hutton's Theory of Uniformitarianism; collegial friend of Darwin.



Lyell's specific contribution?

His eloquent defense of the Theory of Uniformitarianism established a great age for Earth History, in order to produce observed geological structures; this also provided ample time for small variations to be acted on by selection.

Interestingly, Lyell opposed organic evolution until the 1860's, when at last he argued that Darwin's theory unified the science of biology.

Theme II - reactions to Darwin

Alfred R. Wallace (1823-1913)

English naturalist, co-founder with Darwin of Natural Selection Theory

Wallace believed that science owed a great debt to Darwin...



Calling him the “archetypal student of nature,” he argued that Darwin engendered a revolution in scientific thought because he illuminated the biological universe as Newton had the physical.

Difficulties with Darwin's theory

- *Theory is not properly inductive...*
- *Theory proposes large jumps in morphology if new taxa arise from ancestors*
- *Theory predicts intermediate forms and common ancestors*
- *Natura non facit saltum* - changes are slight, and gradual; nature takes no leaps
- Changes among species occur slowly over great time spans
- Changes occur in small populations (e.g., islands)
- Imperfection of the geological record=GAPS

David Hull: *Darwin and his Critics*

Darwin expected theologians to reject his theory based on religious arguments.

What REALLY disturbed him, according to Hull, was the condemnation of his scientific method by many of the most respected scholars of the day (John Herschel, John Stuart Mill, William Whewell).

Debate was raging in the first half of 19th Century about the use of inductive and deductive methods. The take on Darwin was that the *Origin of Species* was just a mass of conjecture, not truly inductive; they said it was based on the *Method of Hypothesis* useful only in the logic of discovery, but not in the logic of proof. They said Darwin *had proved nothing*.

Descent with Modification by means of Natural Selection

- 1) Individuals vary (in traits or characters)
 - 2) Variations are inherited by offspring
 - 3) In the struggle for existence (competition for space, food, other resources), more offspring are born than can survive;
- Therefore... *differential reproductive success* leads to the origin of new species.

Darwin argued that direct proof of the theory would be hard to get; rather it should be judged based on how well it orders and explains phenomena.

Predictions:

divergence from common ancestors;
homologous structures; vestigial organs;
biogeographic patterns of species distribution;
extinction.



INDUCTIVE



DEDUCTIVE

Difficulties with Darwin's theory

Selection IS a brilliant idea, yet Darwin offered no credible mechanism for the sources of variation in natural populations

Gregor Johann Mendel (1822 –1884)

Austrian Augustinian priest and scientist, often called the father of genetics; worked out the laws of heredity by careful experimentation with pea plants.

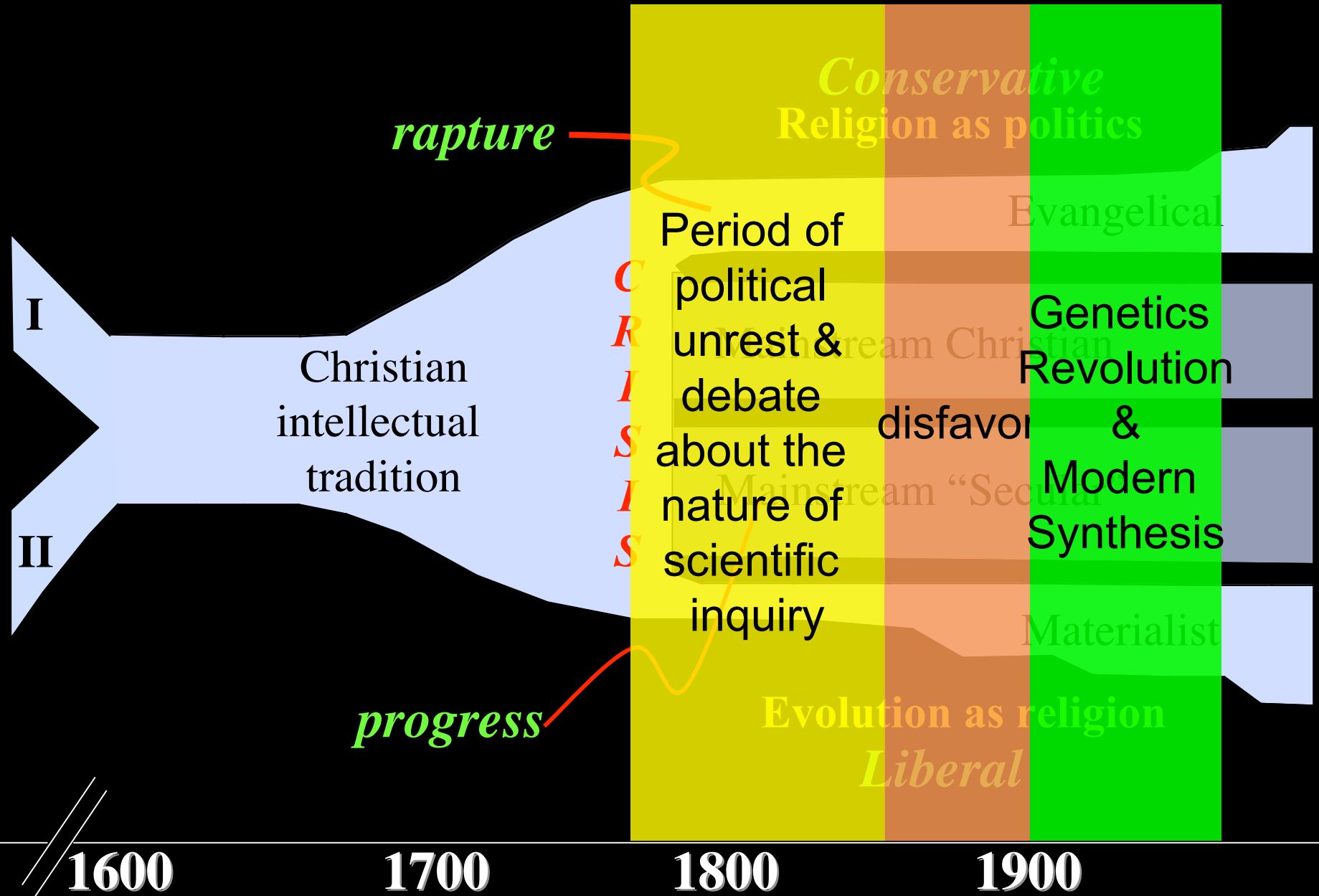


*One of the greatest ironies
in the history of science...
Mendel's book was found,
with uncut pages, on a
shelf in Darwin's Down
House library....*

CONCLUSIONS

- *Two themes persist through the history of scientific thought: STABILITY vs. CHANGE.*
- *One path of intellectual development has adhered to STABILITY, growing into the Christian tradition, the other aligned with CHANGE, growing into the empiricist/materialist tradition.*
- *Reactions to Darwin's theory of Natural Selection can be best understood in the context of these two traditions.*
- *As well as.....*

Michael Ruse: the EVOLUTION-CREATION struggle



Michael Ruse: the EVOLUTION-CREATION struggle

