



## Life

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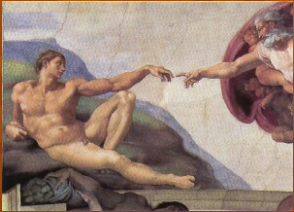
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## What is Life?

- Problems:
  - Complexity
  - Replication
  - Anthropocentrism



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## Life: The Viewpoint of the Three Traditions

- Organic:
  - Aristotle's Sublunar World
    - Earth like a living being
    - Everything *grew* and *decayed*
    - Rocks and minerals took longer
- Magical:
  - Secret or supernatural powers
  - Explains creation
- Mechanist:
  - Doesn't seem promising

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## The Problem of Time

- Anthropocentrism:
  - The Earth did not seem to have changed.
  - When did the Earth begin?
  - When did the heavens begin?
- The decline of Aristotle left a vacuum in satisfactory answers.

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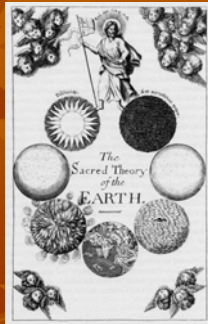
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## Revealed truth

- The Bible
  - Became the authority where science had no answers.
    - E.g., the Creation story in *Genesis*.
- Example of a popular work about nature, based on scriptural authority:
  - Thomas Burnet's *The Sacred Theory of the Earth*, 1684.



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## The Age of the Earth

- James Ussher (1581-1656)
  - Irish Archbishop
  - Fixed the date of creation at October 23, 4004 B.C.
    - 9:00 a.m. added later.
- Problems with the age of the Earth
  - Fossils – something dug up
  - Strata – layers, folding



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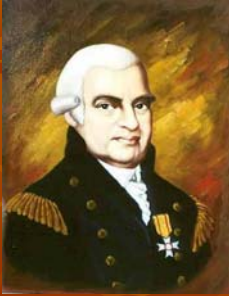
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## Theories of the Earth



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- Neptunism
  - Abraham Werner (1749-1817)
    - Professor of Mining at Freiberg Academy
    - Famous teacher
  - Stratigraphic Theory
    - Layers indicate age, oldest are lowest
  - Inclinations of strata due to precipitation on sides of containing vessels
  - Later strata horizontal because waters less turbulent

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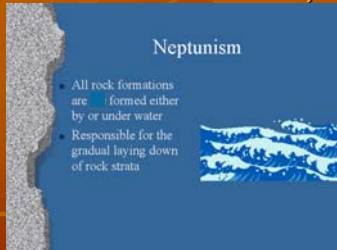
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## Theories of the Earth, 2



- Neptunism (contd.)
  - Called "Neptunist" because of the role of water.
  - Problem: Where did all the water go?

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## Theories of the Earth, 3



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- Plutonism (early Uniformitarianism)
  - James Hutton (1726-1797)
    - *Theory of the Earth*, 1785
  - Grand design in nature, but through natural processes.
  - Very Newtonian in conception.
  - "No Vestige of a Beginning, no Prospect of an End."

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## Theories of the Earth, 4

- Plutonism (contd.)
- Actualism – present day processes explain all.
  - Strata formed by wind and water, sedimentation.
  - Broken strata due to volcanic activity, earthquakes.



Watercolour by Hutton showing strata formation and deformation due to volcanic activity.

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## Theories of the Earth, 5

- Catastrophism
  - Cataclysmic events due to *different forces* in the past.
  - Georges Cuvier (1769-1832)
    - Natural History Museum, Paris
    - Founded *comparative anatomy*
      - Technique: *correlation of parts*



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## Theories of the Earth, 6



- Catastrophism & Cuvier (contd.):
  - Found that some organisms had become extinct.
  - Above is Cuvier's reconstruction of *Palaeotherium* ("ancient beast").
  - From such reconstructions, Cuvier concluded that there had been a succession of distinct fossil faunas, the more ancient were more removed from present day species.

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## Theories of the Earth, 7

- Catastrophism (contd.)
  - Folded Strata due to catastrophes.
  - More recent strata closer to the surface. Strata could be dated.
  - Different mountain ranges associated with different (now extinct) fauna.
  - However, catastrophism was not an actualist theory—it assumed forces at work in the past unlike those of the present.

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## Theories of the Earth, 8



- Catastrophism (contd.)
  - William "Strata" Smith
    - British land surveyor
    - Used fossils to date Strata

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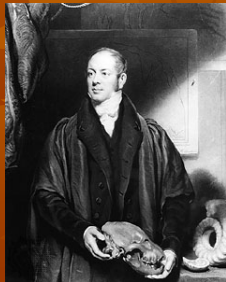
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## Theories of the Earth, 9

- Diluvialism
  - All explained by Noah's Flood
  - William Buckland (1784-1856)
    - Oxford professor
    - Eccentric
    - Very popular lecturer



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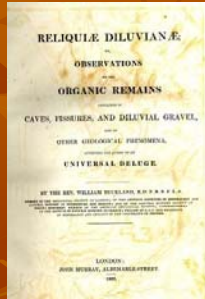
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## Theories of the Earth, 10

- Diluvialism (contd.)
  - Geology is visible proof of the Creation and the Flood
    - The six "days" of Creation to be taken figuratively
  - Buckland's book, *Relics of the Flood*
    - Argued that geological evidence is proof of Noah's Flood.



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## Theories of the Earth, 10



Kirkdale Cave



Fossilized hyena jaw bones found in the cave.

- Diluvialism (contd.)
  - Buckland found fossils of hyenas in Kirkdale Cave in Yorkshire.
  - Hyenas were not native to Britain, so, he concluded, these had drowned in the Flood, being God's way to make Britain suitable for people.

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## Theories of the Earth, 11

- Uniformitarianism
  - Charles Lyell (1797-1875)
    - Became interested in geology from Buckland's lectures.
    - Decided to investigate Strata near volcanoes.
    - Chose Etna on Sicily.
      - At right, Lyell's drawing of Etna.



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## Theories of the Earth, 12

### ■ Uniformitarianism (contd.)



A house on the side of Mt. Etna, recently buried by a volcanic eruption.

### ■ Etna

- Etna is a huge, still active, volcano on Sicily.
- It is not just a single volcano. Its main crater is surrounded by many minor "parasitic" cones.

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## Theories of the Earth, 13

### ■ Uniformitarianism (contd.)



Lyell's drawing of parasitic cones.

### ■ Parasitic Cones.

- Of Etna's parasitic cones, only 1 of 80 visible had erupted within written history of the area.
- At that rate, 200,000 years were needed for all 80
- But even these were only the most recent.

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## Theories of the Earth, 14



### ■ Uniformitarianism (contd.)

- Below Etna was a huge stratum of limestone with marine shells, which necessarily predated Etna.
- This suggested a very slow build-up.

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## Theories of the Earth, 15

- Uniformitarianism (contd.)
  - Lyell returned from Sicily and over several years wrote and published his *Principles of Geology*, 3 volumes (1830-1833)
    - Subtitle: “*Being an Attempt to Explain the Former Changes of the Earth’s Surface by Reference to Causes Now in Operation*”
  - Volume 1 attacks attempts to reconcile geology with Scripture by ascribing *different causes* to events in the past
  - Lyell allows for gradual change and *local violent* eruptions.

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## Taxonomy



- The Classification of Species
  - What *is* a species?

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## Taxonomy, 2

- Aristotle on Classification
  - Classification identifies the *nature* of living things
    - Their nature is the *purpose* (or function) they serve
  - Use of 2-valued logic to create a classification system:
    - Group together creatures with similar features, and then subdivide on differences.
    - Absurdity results if wrong common feature is chosen, e.g. *featherless bipeds* = human beings!

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## Taxonomy, 3

- The Great Chain of Being
  - Or *Scala Natura*
  - Medieval idea of a single ordering of all living things:
    - God, Angels, Humans, Birds, Fish, Land Animals, Plants, Rocks
  - Species were immutable; extinction impossible.



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## Linnaeus and Taxonomy

- Carl von Linné (1707-1778)
- Swedish Botanist
- The most famous scientist of the 18<sup>th</sup> century.
  - People sent him specimens from all over the world.



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## Linnaeus and Taxonomy, 2

- *Systema Naturae*
  - (*The System of Nature*), 1st edition, 1735, had all of 12 pages.
  - Many editions in Linnaeus' lifetime.
  - Linnaeus sought to classify every species sent to him in a single coherent system.



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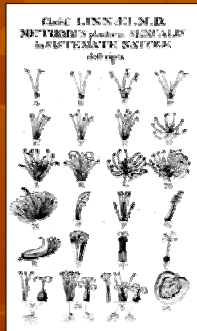
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### Linnæus and Taxonomy, 3

- Artificial system
  - Based on a single feature
  - E.g., for plants, used the stamens and pistils
- A natural system takes into account *all* similarities and differences.



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### Linnæus and Taxonomy, 4

- Linnæus established the system of *binomial classification*
  - “Two name” – Genus and Species
  - Genus – an artificial grouping on a visible characteristic. E.g., *canis* = dog family
  - Species – grouped “by descent” (i.e., those that breed together). E.g., *lupus* = wolf
  - Hence: *canis lupus* – the official name of the wolf.
- Linnæus believed each species descended from an originally created pair.

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### Le Comte de Buffon



- 1707-1788
- Georges Buffon
  - French naturalist and Linnæus’ greatest rival
  - Worked at the *Jardin du Roi* in Paris.
  - Like Linnaeus, he set out to classify and catalogue all life forms brought to him.

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## Le Comte de Buffon, 2



- *Histoire Naturelle*
  - Unlike Linæus, who revised and reissued his major work, Buffon continued to just add additional volumes.
  - Buffon's *Histoire Naturelle*, ran to 44 volumes in total.

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## Le Comte de Buffon, 2

- An evolutionary view
  - Buffon saw species blending together.
  - Postulated some kind of degeneration (evolution) over vast amounts of time.
  - He figured 72,000 years were needed for the Earth to cool enough for life.
  - Maybe a million years altogether.
  - Creation's "six days" were really six epochs.

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## Jean Baptiste Lamarck



- 1744-1829
- French naturalist
- Proposed a true evolutionary theory
  - Mechanical
  - Huttonian
  - Newtonian
  - Assumed great age to the Earth
  - No extinctions

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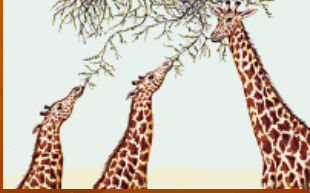
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## Jean Baptiste Lamarck, 2



- The Inheritance of Acquired Characteristics
  - The essential explanatory mechanism in Lamarckian evolution
  - Characteristic example: How the giraffe got a long neck
  - Organisms strive to fit environment

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## Evolution: 19<sup>th</sup> century pop science

- A popular book throughout the 2<sup>nd</sup> half of the 19<sup>th</sup> century was *Vestiges of the Natural History of Creation*.
  - Written by Robert Chambers; published anonymously in 1844.
- Thesis: God established two principles of action:
  - Gravitation (inorganic)
  - Development (organic) – A driving force in living things toward evolution.
- It was highly criticized by scientific community as totally unscientific.

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## Summary

- Scientific thinking about life after the Scientific Revolution of the 17<sup>th</sup> century took two major forms:
  1. An offshoot of thinking about the constitution of the Earth itself, including its life forms, both those presently existing and the different forms that apparently lived in the past.
  2. A systematic cataloguing and classifying of plants and animals making comparisons and interrelations easier.
- These came together in mid-19<sup>th</sup> century with an abundance of *evolutionary theories*, that proposed the development of life with quasi-scientific reasoning.

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