

# Science and Empire

# Catastrophe or Uniformity

- Geology – important area – development
- Why?
- Imperial competition – industrial development
- Coal, iron, etc.
- Major projects – geological surveys
- Neptunism vs. Volcanism debate of 18<sup>th</sup> century – shift – quantitative – rate/type of change

# Catastrophe or Uniformity

- Catastrophism
- Uniformitarianism
- Based on idea – geological formations – sudden or gradual change
- “...had the Earth once been hotter, had volcanic activity once been greater, or had the Earth always operated in the way it now did?” (Ede and Cormack, 225)
- Hutton – current forces – all geological change
- Radical – at time – most not did agree – only in 1830’s idea reemerged

# Catastrophe or Uniformity

- Georges Cuvier (1769-1832) – notable catastrophist
- Professor of anatomy – National Museum of Natural History – Paris
- Comparative anatomy
- Received fossils- Paraguay –modern sloth – giant/extinct species
- Elephant like remains – African/Indian elephants – different species
- Ohio river- entirely different - Mastadon
- Mammoth – Siberia
- Why died out?
- Argued – sudden revolution –flood?

# Catastrophe or Uniformity

- Gypsum quarries – progressive floods –catastrophes
- More fossils discoveries:
- Gypsum layer – under gravel pits – more different
- Tertiary rock – mammals
- Secondary rock- lizards
- Flying, swimming, walking
- Primary rock – nothing
- Progression – one life to next
- Forces – mass extinction – powerful/different

# Catastrophe or Uniformity

- Charles Lyell (1797–1875) – disagreed
- Principles of Geology – theory of uniformitarianism
- “...that gradual cumulative geological change could account for extinction and the progress of species in the fossil record.” (Ede and Cormack, 227)
- Research – own – mountains in Sicily, George Poulett Scrope (1797–1876), France – creation - valleys – lava flow
- Geological change – extintual of species – gradual
- Large mammals – not extinct – catastrophes – not only cause

# Catastrophe or Uniformity

- Lyell's theory:
- Actualism
- Uniformitarianism
- Steady state

# The Question of the Origin of Species

- Questions related to species – imperial expansion and exploitation
- Jean-Baptiste de Monet de Lamarck (1744–1829)
- Extinction
- “...one species transformed into another through evolution.” (Ede and Cormack, 229)
- 1809 - Philosophie zoologique
- Lamarckianism
- Importance of environmental influence – adaptation to new circumstances- changes inherited



# Darwin and Evolution

- Charles Darwin (1809-82)
- HMS Beagle (1831-6)
- Given –Lyell's Principles of Geology
- Acceptance – uniformitarianism and actualism - not steady-state
- Natural change – directional – earthquake – powerful/disruptive
- Galapagos islands – tortoises – different on each island
- Return – publishing papers – coral-reef formation
- 1838 – Thomas Malthus – An Essay on the Principle of Population (1798)
- Relationship – food supply and population – competition for resources

# Darwin and Evolution

- Mechanism for evolution
- Malthus – population crisis
- Darwin – plants/animals
- 1842-1844 – theory of evolution and natural selection
- Premise –evolution occurring
- Existence of variation – random/continuous/small
- “... certain variations turned out to be advantageous in particular environments, and nature selected those variations.” (Ede and Cormack, 232)
- Birds –sharp beaks – passed on- blunt beaks – replaced/extinct

# Darwin and Evolution

- Intraspecies struggle – scarce resources
- Emphasis – struggle/competition – capitalist/imperialist at time.
- Member of elite
- Theory – “Essay”
- Russel Wallace
- On the Origin of Species by Means of Natural Selection (1859)
- Darwinism (1889)

# Herbert Spencer

- Social Darwinism
- Major explanation - social growth development
- Social Statistics (1851), Social Psychology (1855)
- Human societal development – evolution
- Malthusian influence – strong survive
- “survival of the fittest”
- Applied to race – justified – segregation, subjugation
- Eugenics

# Opposition to Darwin's Theory

- Natural theology
- Fossil record – no gradual evolution – missing intermediate links
- William Thomson (1824–1907) , Lord Kelvin – physicist – 20-400 million years – too short
- Earth temp. and rate of cooling – 50 million
- Thermodynamics – Absolute (Kelvin) Scale of temperature

# Professionalization of Science and Science Education

- 19<sup>TH</sup> century – turning point
- Science – professional activity
- Separation between studying nature – philosophy
- Increase in specialized scientific organizations
- New institutions – education/research – focus – science
- Term “scientist” coined – 1833 - William Whewell (1794–1866)

# Louis Pasteur

- École Normale Supérieure
- Training – chemistry, physics, biology
- Vitalist – living organisms, different than nonliving
- Bacteriological work
- Fermentation process – microscopic animals rather than chemical reaction
- Micro-organisms- anerobic – killed by heat
- Pasteurization – kill microbes

# Louis Pasteur

- Germ theory of disease – extension
- Vaccines:
- Anthrax
- Rabies
- Pasteur Institutes



# Chemistry – Classification, Structure, Utility

- Own category – 18<sup>th</sup> century
- 19<sup>th</sup> century – flux
- New processes, discoveries
- Better lab techniques – new tools – Robert Bunsen, Henry Roscoe – Bunsen Burner
- Tools, material – but unifying theory?
- Order
- Relationship between elements

# Chemistry – Classification, Structure, Utility

- John Dalton
  - Johann Döbereiner
  - A.E. Béguyer de Chancourtois
- 
- Atomic weight
  - Reliable method– in order to classify
  - Stanislao Cannizzaro (1826–1910)
  - “...demonstrated that the density of gases and vapors could be compared with the density of hydrogen in order to determine the molecular weights of elements and compounds accurately.” (Ede and Cormack, 249)

# Chemistry – Classification, Structure, Utility

- Julius Lothar Meyer – 1864 – table of elements – similar properties – columns – atomic weights
- Alexander Reina Newlands – 1866- families and atomic weights
- Criticized
- “The Law of Octaves and the Causes of Numerical Relations between Atomic Weights” – rejected
- Looked like?

# Mendeleev and the Periodic Table

- Dmitri Ivanovitch Mendeleev (1834–1907)
- Order –elements
- Atomic weight and characteristic
- 1868 – nine columns –elements –similar characteristic-order based on atomic weight
- Mendeleev – textbook – classify known elements
- Card with properties for every element
- Pattern – atomic weight
- 1869 – table of elements (1871)

# Mendeleev and the Periodic Table

- Notable?
- Gaps for elements not yet discovered
- Brought together –ideas/information
- Blank spaces – prediction- aluminum
- Numerous medals

# Synthetic Materials

- William Perkin (1838–1907)
- Age 15 – Royal College of Chemistry
- Synthesis of natural materials – quinine
- Malaria treatment – bark of cinchona tree –South America
- Hofmann belief – naphthalidine – same basic compounds – convert
- Naphta – by-product of coal gas (50% hydrogen, 35% methane)
- Coal after gas extraction – solid fuel, viscous brown-black tar
- Coal tar – research/commercial – 200+ organic compounds

# Synthetic Materials

- Perkins – 1856 – quinine
- Followed Hofmann – experiment - sludge
- Rag to clean up?
- Artificial aniline
- Commercial potential
- Artificial dye plant
- Dying industries – natural sources
- Problems with natural sourced dyes?

# Synthetic Materials

- Quality
  - Changes
  - Cost
  - Reliable access
- 
- Perkins – domestic, uniform
  - Significance – colour photography, clothing, cars



# Synthetic Materials

- Economic-success – aniline, alizarin – research – real world applications
- From lab to marketplace – chemical companies – founded –dyes
- 1863-Friedrich Bayer and J. Weskott
- 1867-Paul Mendelssohn-Bartholdy and Carl Alexander Martius
- Perkin's work?
- Organic Synthesis
- Tool for aniline – tools for organic products

# Activity: Art and Engineering

- Go to: <https://theconversation.com/leonardo-joined-art-with-engineering-113967>
- Answer the following questions:
  - 1.) What subject areas were noted to be integrated within the context of Leonardo DiVinci's state of mind?
  - 2.) What artist-scientist's did Leonardo DiVinci's "integrative spirit" inspire?
  - 3.) Explain how arts training has a.) helped scientists excel b.) led to scientific development. Make note of the examples discussed in the article.