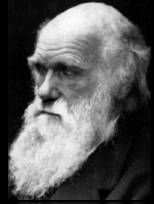


Evolution



# WHY

Evolution matters ?

Evolution

Nothing in biology makes sense except in the light of

# EVOLUTION

Conferência Europeia  
sobre a  
Teoria do Design Inteligente  
(TDI Europa)

23 de outubro de 2017  
Campus Penha, Universidade do Algarve  
Faro, Portugal

Palestrantes Convidados

 <b>Dr. Paul Nelson</b> Professor Adjunto de Ciências da Vida e Colaborador Sênior de Engenharia de Bios	 <b>Dr. Marcos Eberlin</b> Professor Emérito de Sociologia e Teoria do Design Inteligente e Professor titular de Ciência da Tecnologia de Computação, Brasil	 <b>Dr. David Saravia</b> Professor Adjunto na Universidade do Algarve, Portugal
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Organização: NUBRA

Parceiros: TDI, UAlg

Página oficial do evento: <https://facebook.com/tdi.org.br>

Evolution



Theodosius Grygorovych  
Dobzhansky  
(1900-1975)

Born in Ukraine, studied and worked  
in the USSR, before moving to the US  
in 1937, where he died.

He worked in *Drosophila*

## Evolution

### Nothing in Biology Makes Sense Except in the Light of Evolution

THEODOSIUS DOBZHANSKY

As recently as 1966, sheik Abd el Aziz bin Baz asked the king of Saudi Arabia to suppress a heresy that was spreading in his land. Write the sheik:

"The Holy Koran, the Prophet's teachings, the majority of Islamic scientists, and the actual facts all prove that the sun is running in its orbit . . . and that the earth is fixed and stable, spread out by God for his mankind. . . . Anyone who professed otherwise would utter a charge of falsehood toward God, the Koran, and the Prophet."

The good sheik evidently holds the Copernican theory to be a "mere theory," not a "fact." In this he is technically correct. A theory can be verified by a mass of facts, but it becomes a proven theory, not a fact. The sheik was perhaps unaware that the Space Age had begun before he asked the king to suppress the Copernican heresy. The sphericity of the earth had been seen by astronauts, and even by many earth-bound people on their television screens. Perhaps the sheik would repeat that those who venture beyond the confines of God's earth suffer hallucinations, and that the earth is really flat.

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## Evolution • Fact or theory?

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**Colloquial or everyday speech:** "conjecture" or "speculation" (e.g., my favorite theory for...)

## Evolution • Fact or theory?

The term “theory” has very a different meaning in colloquial speech than in science

**Colloquial or everyday speech:** “conjecture” or “speculation” (e.g., my favorite theory for...)

**Science:** “a statement of what are held to be general laws, principles, or causes of something known or observed”

## Evolution • Fact or theory?

### Darwin's **theory** of evolution by natural selection

theory |ˈTHɛərɪ, ˈTHi(ə)rɪ|  
noun ( pl. **theories** )

A scheme or system of ideas or statements held as an explanation or account of a group of facts or phenomena; a hypothesis that has been confirmed or established by observation and experiment, and is propounded or accepted as accounting for the known facts.

(Oxford English Dictionary)

## Evolution

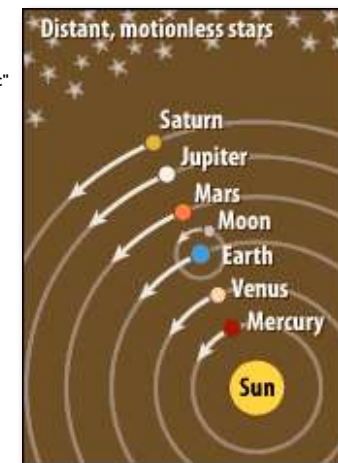
The good sheik evidently holds the Copernican theory to be a "mere theory" not a "fact."

In this he is technically correct (it is the word mere... that overturns the meaning). A theory can be verified by a mass of facts, and it becomes a **proven** theory but not a fact. Open to arguments and discussion on the basis of EVIDENCE.

## Evolution • Fact or theory?

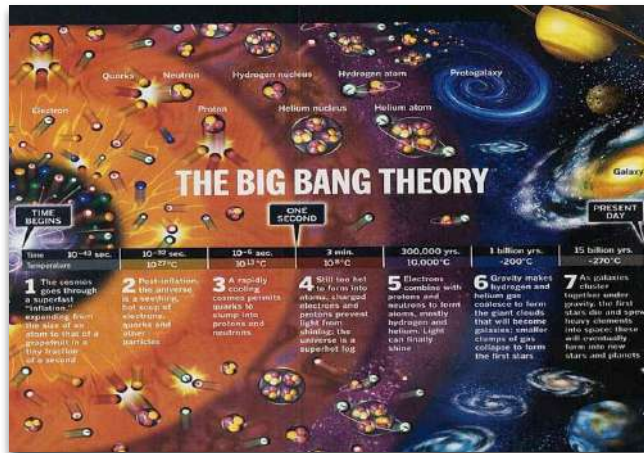
### Heliocentric theory

Copernicus' model: "Suncentered," or "heliocentric"



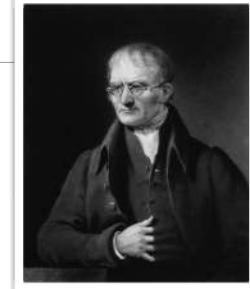
## Evolution • Fact or theory?

### Big Bang theory



## Evolution • Fact or theory?

### Atom theory (1803)



John Dalton  
1766-1844

- determines that each element corresponds to a unique atom
- develops system of chemical symbols based on atomic mass
- compounds = atoms linked as molecules

## Evolution • Fact or theory?

### Examples of scientific theories

- Heliocentric theory
- Big Bang theory
- Atom theory
- Giant impact theory
- Quantum theory
- Plate tectonics theory
- Special theory of relativity
- Cell theory
- The theory of evolution

## Evolution

Parts of the Copernican world model, such as the contention that the earth rotates around the sun, and not vice versa, have not been verified by direct observations even to the extent the sphericity of the earth has been. Yet scientists accept the model as an accurate representation of reality. Why? Because it makes sense of a multitude of facts which are otherwise meaningless or extravagant. **To nonspecialists most of these facts are unfamiliar.** Why then do we accept the "mere theory" that the earth is a sphere revolving around a spherical sun? Are we simply submitting to authority? **Not quite: we know that those who took the time to study the evidence found it convincing.**

## Evolution

The good sheik is probably ignorant of the evidence. Even more likely, he is so hopelessly biased that no amount of evidence would impress him. Anyway, it would be sheer waste of time to attempt to convince him. The Koran and the Bible do not contradict Copernicus, nor does Copernicus contradict them. It is ludicrous to mistake the Bible and the Koran for primers of natural science. They treat of matters even more important: the meaning of man and his relations to God. They are written in poetic symbols that were understandable to people of the age when they were written, as well as to peoples of all other ages. The king of Arabia did not comply with the sheik's demand. He knew that some people fear enlightenment, because enlightenment threatens their vested interests. Education is not to be used to promote obscurantism.

## Evolution

The origin of life on earth is dated tentatively between 3 and 5 **billion** years ago.

Manlike beings appeared relatively quite recently, between 2 and 4 **million** years ago.

## Evolution

Shiek bin Baz and his like refuse to accept the radiometric evidence, because it is a "mere theory." What is the alternative? One can suppose that the Creator saw fit to play deceitful tricks on geologists and biologists. He carefully arranged to have various rocks provided with isotope ratios just right to mislead us into thinking that certain rocks are 2 billion years old, others 2 million, which in fact they are only some 6,000 years old. This kind of pseudo-explanation is not very new. One of the early antievolutionists, P. H. Gosse, published a book entitled *Omphalos* ("the Navel"). The gist of this amazing book is that Adam, though he had no mother, was created with a navel, and that fossils were placed by the Creator where we find them now – a deliberate act on His part, to give the appearance of great antiquity and geologic upheavals. It is easy to see the fatal flaw in all such notions. They are blasphemies, accusing God of absurd deceitfulness. This is as revolting as it is uncalled for.

## Evolution

### ***Diversity of Living Beings***

The only explanation that makes sense is that the organic diversity has **evolved** in response to the diversity of environment on the planet earth.

***Diversity of Living Beings***

The environment presents challenges to living species, to which they may respond by adaptive genetic changes.

***formulation of Darwin's theory***

“The organic diversity becomes, however, reasonable and understandable if the **creator** has **created** the living world not by caprice but by **evolution** propelled by natural selection.”

“The organic diversity becomes, however, reasonable and understandable if the **creator** has **created** the living world not by caprice but by **evolution** propelled by natural selection.”

So now the creator allowed evolution?

Read next sentence

“It is wrong to hold creation and evolution as mutually exclusive alternatives.”

## Evolution

“It is wrong to hold creation and evolution as mutually exclusive alternatives.”

“I am a **creationist** and an **evolutionist**.”

## Evolution

“It is wrong to hold creation and evolution as mutually exclusive alternatives.”

“I am a **creationist** and an **evolutionist**. Evolution is God’s, or Nature’s method of creation.”

## Evolution

“It is wrong to hold creation and evolution as mutually exclusive alternatives. “

“I am a **creationist** and an **evolutionist**. Evolution is God’s, or Nature’s method of creation.”

“Creation is not an event that happened in 4004 BC; it is a process that began some 10 billion years ago and is still under way.”

## Evolution

### ***Diversity of Living Beings***

“The environment presents challenges to living species, to which the later may respond by adaptive genetic changes.”

***formulation of Darwin’s theory***



## Evolution

Does the evolutionary doctrine clash with religious faith? It does not. It is a blunder to mistake the Holy Scriptures for elementary textbooks of astronomy, geology, biology, and anthropology. Only if symbols are construed to mean what they are not intended to mean can there arise imaginary, insoluble conflicts. As pointed out above, the blunder leads to blasphemy: the Creator is accused of systematic deceitfulness.

## Evolution

One of the great thinkers of our age, Pierre Teilhard de Chardin, wrote the following: "Is evolution a theory, a system, or a hypothesis? It is much more it is a general postulate to which all theories, all hypotheses, all systems much henceforward bow and which they must satisfy in order to be thinkable and true. Evolution is a light which illuminates all facts, a trajectory which all lines of thought must follow this is what evolution is." Of course, some scientists, as well as some philosophers and theologians, disagree with some parts of Teilhard's teachings; the acceptance of his worldview falls short of universal. But there is no doubt at all that Teilhard was a truly and deeply religious man and that Christianity was the cornerstone of his worldview. Moreover, in his worldview science and faith were not segregated in watertight compartments, as they are with so many people. They were harmoniously fitting parts of his worldview. Teilhard was a creationist, but one who understood that the Creation is realized in this world by means of evolution.

## Evolution

"I submit that all these remarkable findings make sense in the light of evolution: they are nonsense otherwise."

## Evolution

"This is not to imply that we know everything that can and should be known about biology and about evolution."



## Evolution • Fact or theory?

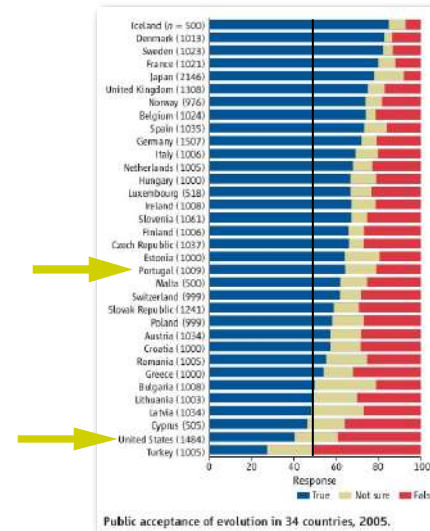
### Public acceptance of evolution

Is the following statement:  
true,  
false, or  
are  
not sure or don't know?

“Human beings, as we know them, developed from earlier species of animals”.

See Miller *et al.* 2006, Science 313: 765.

## Evolution • Fact or theory?



See Miller *et al.* 2006, Science 313: 765

## Evolution • Fact or theory?



## Evolution • Fact or theory?

**Can you tell how old this fossil is?**

Fossils don't come with tags on them that tell us how old they are. We have to study the clues we find to try to figure out their ages. Using the Bible as your starting point, see if you can figure out about how old this fossil is.

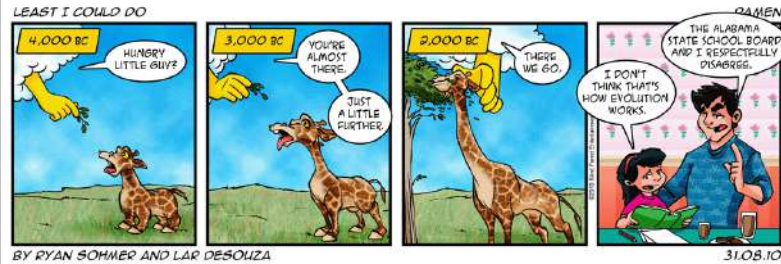
**CLUE #1**

God was there from the beginning and He wrote down in the Bible when and how He made everything.

**So, could this dinosaur fossil be millions of years old?**

**No!** The earth is just thousands of years old, so the fossils cannot be millions of years old.

## Evolution • Fact or theory?



## Evolution • Fact or theory?

### How the USA Teach Evolution

The science standards that govern how public schools teach biological evolution — the idea that life in all its forms has evolved over billions of years through mutation and natural selection — have improved in many states since 2000, according to the National Center for Science Education. But most states' standards do not explicitly require teachers to explain that humans evolved from earlier life forms.

### States where biological evolution is ...

Not mentioned in standards | Mentioned briefly, unclearly | Treated straightforwardly and/or thoroughly



### States where human evolution is ...

Not mentioned in standards | Mentioned briefly, unclearly | Mentioned directly



Note: Based on 101 state curriculum standards of the 50th level.  
Sources: National Center for Science Education, Thomas E. Fogarty Foundation, *Over Science: Bad Science, Resisting Evolution in the States*, by Lawrence E. Letter. THE NEW YORK TIMES

## Evolution • Fact or theory?



Scopes Trial

- Despite the achieved **scientific consensus** on evolution, some Christian groups continued to oppose the concept.
- In 1925, the teaching of evolution was outlawed in Tennessee, USA, resulting in the infamous **Scopes Monkey Trial**

## Evolution • Fact or theory?



Scopes Trial

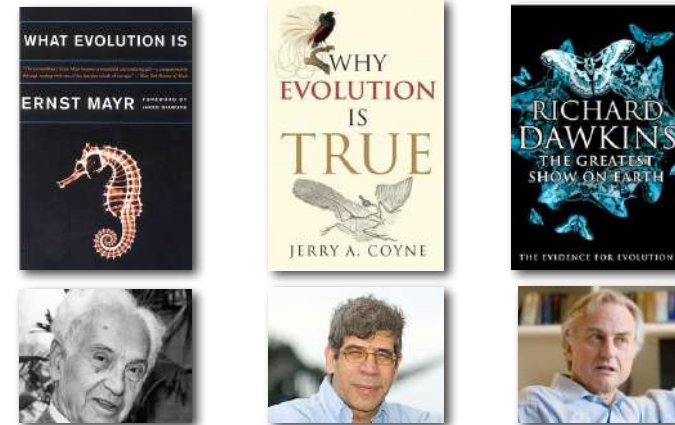
Scopes was found guilty and fined \$100 (equivalent to \$1395 in 2017), but the verdict was overturned on a technicality.

## Evolution • Fact or theory?



## Evolution • Fact or theory?

### What is Evolution?



## Evolution • Fact or theory?

### What is Evolution?

- in general usage "evolution" = "change"
- origin from Latin "evolvere" meaning to "unfold or disclose"
- first biological use of "evolution" was by embryologists in the 18th century (e.g., Haller, Bonnet).

## Evolution • Fact or theory?

### Definition 1 (from Ernst Mayr)

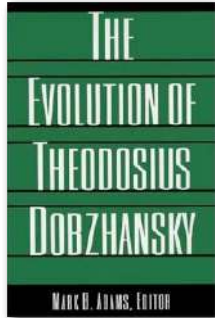
"change in a population over time of the proportions of individual organisms that differ in one, or more, genetically-determined traits".



## Evolution • Fact or theory?

### Definition 2 (from Theodosius Dobzhansky)

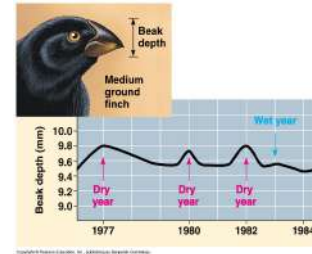
“the transformation of genetic variation originally present *within* populations into variation *between* populations in both space and time”.



## Evolution • Fact or theory?

What is the “theory” of evolution?

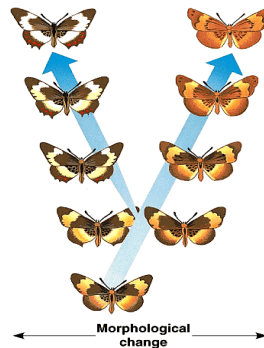
Evolution happens i.e. populations change over time



## Evolution • Fact or theory?

What is the “theory” of evolution?

Evolution usually happens *gradually* (populations change over hundreds to thousands years)



## Evolution • Fact or theory?

What is the “theory” of evolution?

Speciation occurs: one species split into one or more species



Anagenesis



Cladogenesis



## Evolution • Fact or theory?

### What is the “theory” of evolution?

All species share *common ancestry* (as a result of splitting of lineages from one ancestral life form)

#### Evolution: life on Earth is one big extended family



In 1859, Charles Darwin and Alfred Russel Wallace independently proposed a theory of biological evolution to explain the diversity of life on Earth. Since then the fossil record and DNA

evidence have added and continue to add overwhelming support for the view of life's history. Evolution today is one of the best documented and widely accepted principles of modern science.

Life on Earth has changed dramatically through time. The theory of evolution proposes that through the process of natural selection and other natural events, stretching over millions of

generations, living things (broadly, including non-living species) are passing on to their offspring. This means that all living things are related to each other, through common ancestry with various different

lineages. In other words, if you follow your family tree far enough back in time, you will find a common ancestor not only with every other living thing, but with every living thing that ever lived.

#### Life's Family Tree

Time and branch back through time to see how organisms in any other of life's major branches. Use the current tree as a guide to find when their common ancestor lived. The time relationships are marked by an orange line on the left, showing the time relationships between the major branches.

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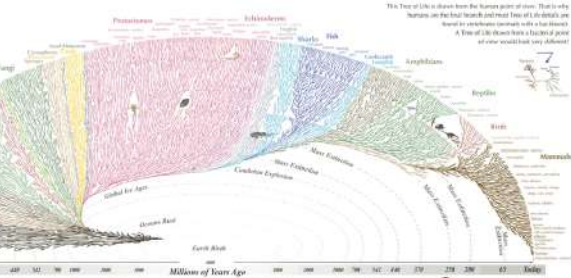
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<http://evogeneo.com/tree.html>



## Evolution • Fact or theory?

### What is the “theory” of evolution?

- Evolution happens (populations change over time)
- Evolution usually happens *gradually* (populations change over hundreds to thousands years)
- Speciation occurs: one species split into one or more species
- All species share *common ancestry* (as a result of splitting of lineages from one ancestral life form)
- Much of the evolutionary change is caused by *natural selection*, which is the sole process producing *adaptation*

## Evolution • Fact or theory?

- Part 1: How was evolution discovered?
- Part 2: What is the evidence for evolution?
- Part 3: How does evolution work?
- Part 4: Darwin observations

## Evolution • Part 1: How was evolution discovered?

Evolution • Part 1: How was evolution discovered?

Evolução: um debate antigo

- Platão, Pitágoras, Sócrates e Aristóteles: **idealistas**.

**Terra estática**

os organismos encaixam no seu ambiente de forma perfeita por desígnio e não por alteração.

Plato



Pithagoras



Socrates



Aristotles



Evolution • Part 1: How was evolution discovered?

Evolução: um debate antigo

- Democrates, Arquimedes e Anaximandre – **realistas**.

**Terra mutante**

a terra formou-se de forma lenta, a vida apareceu na água e gradualmente evoluiu a partir de formas simples.

Democrates



Arquimedes



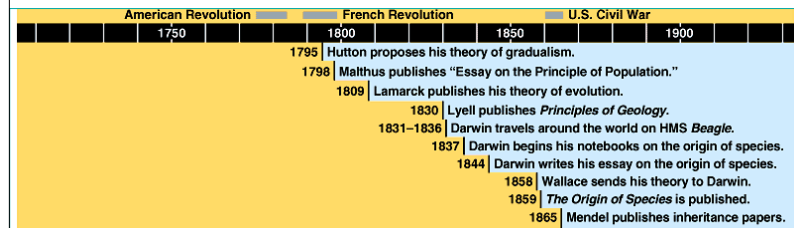
Anaximandre



Evolution • Part 1: How was evolution discovered?

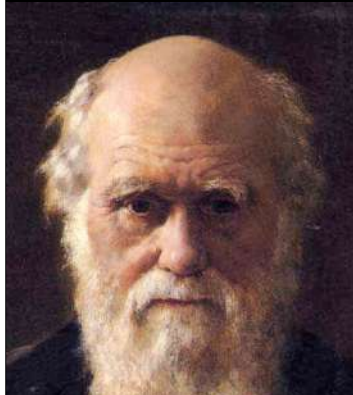

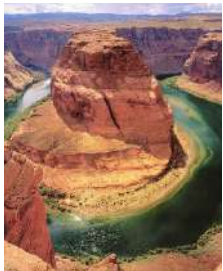

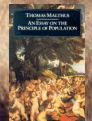




As opiniões de Platão e Aristóteles dominaram a filosofia natural e teologia até meados de 1800.

Evolution • Part 1: How was evolution discovered?



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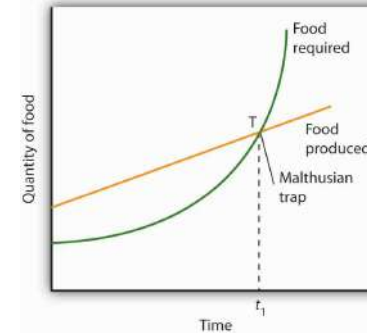
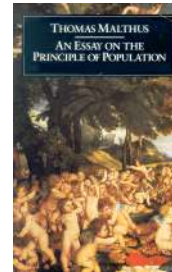
Evolution • Part 1: How was evolution discovered?

Lyell Malthus Cuvier Lamarck Hutton Linnaeus

Evolution • Part 1: How was evolution discovered?

Malthus (1766-1834) ecologia populacional



Evolution • Part 1: How was evolution discovered?

Cuvier (1769-1832) paleontologia



- Fósseis – Restos ou impressões de organismos em rochas sedimentares.



- Fósseis mais antigos encontram-se em camadas mais profundas



- Muitas espécies encontradas em fósseis estão extintas.

- Cuvier propôs que a extinção e a alteração geológica são causadas por catástrofes súbitas (por exemplo, inundações).

Evolution • Part 1: How was evolution discovered?

Three views of geology

**Gradualism** (Hutton)

Alterações profundas podem ser resultantes de pequenas alterações ocorridas em longos períodos de tempo.



**Catastrophism** (Cuvier)

Recurrent catastrophic events causing widespread extinction and resulting in sharp boundaries between fossil layers.



**Uniformitarianism** (Lyell)

The same processes we see today also acted in the past





## Age of the Earth

The depth of the sedimentary column implies that the Earth is old (it took a long time to accumulate these layers gradually)



## Early ideas

### Two camps: Fixity of species or change?

350 B.C. Aristotle:  
individuals in a "Species" are identical and unchanging

1749 Buffon *Histoire Naturelle* encyclopedia:  
The earth is very old. Species change.

1785 Hutton. Geologist:  
Uniformitarianism: Changes in nature are gradual.

1798 Cuvier:  
Fossils show extinct species (due to catastrophe).  
Species do not change.

## Bishop James Ussher (1581-1656)

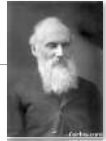


First day of creation:

Sunday 23 October 4004 BC

(calculated the dates of other biblical events, concluding, that Adam and Eve were driven from Paradise on Monday 10 November 4004 BC, and that the ark touched down on Mt Ararat on 5 May 2348 BC on a Wednesday).

## Lord Kelvin and the Age of the Earth (1824-1907)



Kelvin calculou a idade da Terra a partir da temperatura de fusão das rochas e da taxa de perda de calor.

Concluiu que a Terra teria entre 20 e 400 MA.

A discrepância tem a ver com o facto de a Terra ser constituída por distintos materiais com distintos pontos de fusão.

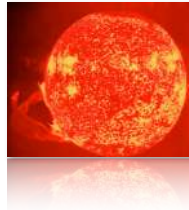


## Evolution • Part 1: How was evolution discovered?

### What Kelvin didn't know



Kelvin não sabia que a Terra tem uma fonte interna de calor – o núcleo mantém-se no estado líquido devido ao decaimento radioactivo. Este facto permitiu a manutenção de uma temperatura relativamente constante ao longo do tempo.



A sua teoria colapsou quando se descobriu a radioactividade no final do séc. XIX.

## Evolution • Part 1: How was evolution discovered?

### Transmutation



Jean Baptiste de Lamarck

- Around 1800, scientists began to wonder whether species could change or **transmute**.
- Lamarck thought that if an animal acquired a characteristic during its lifetime, it could pass it onto its offspring.
- Hence giraffes got their long necks through generations of straining to reach high branches.

## Evolution • Part 1: How was evolution discovered?

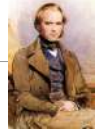
### Fossils and Strata



**William Smith**, his geology map & some of his fossil specimens  
At about the same time, geologists like William Smith were mapping the rocks and fossils of Britain. He and others showed that **different species existed in the past** compared with today.

## Evolution • Part 1: How was evolution discovered?

### Darwin's Voyage



Voyage of the Beagle

- From 1831-1836, a young naturalist called Charles Darwin toured the world in HMS Beagle.
- He was dazzled by the amazing diversity of life and started to wonder how it might have originated

## Evolution • Part 1: How was evolution discovered?

### Survival of the Fittest

- In his **Origin of Species**, published in 1859, Darwin proposed how one species might give rise to another.
- Where food was limited, competition meant that only the **fittest** would survive.
- This would lead to the **natural selection** of the best adapted individuals and eventually the **evolution** of a new species.

Natural Selection explains adaptation



en.wikipedia.org/wiki/Image:Darwin%27s\_finches.jpeg

## Evolution • Part 1: How was evolution discovered?

### Huxley v. Wilberforce



Bishop Wilberforce

T. H. Huxley

- Darwin's idea of Evolution by Natural Selection was met with **huge controversy**.
- A famous debate in 1860 pitted Bishop Wilberforce against Darwin's bulldog, Thomas Henry Huxley.

Evolutionists got the better of the debate, but few were convinced by Darwin's idea of Natural Selection.

## Evolution • Part 1: How was evolution discovered?

### Genetics



Mendel



- From 1856-63, a monk called Gregor Mendel cultivated **29,000 pea plants** to investigate how evolution worked i.e., how characteristics were passed down the generations.
- He figured out the basic principles of genetics. He showed that offspring received characteristics from both parents, but **only the dominant characteristic trait was expressed**. Mendel's work only came to light in 1900, long after his death

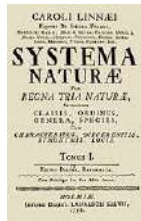
## Evolution • Part 1: How was evolution discovered?

### 3 Schools of evolutionary thought

1. **Linnaeus: 1700s**
2. **Lamarck: 1744—1829**
3. **Darwin & Wallace: 1800s**

## Evolution • Part 1: How was evolution discovered?

Carolus Linnaeus (1707–1778)



Swedish  
180 books classified nature:  
“revealing the order of life  
created by God.”  
“God created, Linnaeus  
arranged”.

Devised the binomial naming  
system: Genus + species

But... thought that species did  
not change, fixed

## Evolution • Part 1: How was evolution discovered?

3 Schools of evolutionary thought



Linnaeus: each species was  
separately created and do not  
change.

## Evolution • Part 1: How was evolution discovered?

J.B. de Lamarck (1744–1829)



French

Worked most of his life at  
the Muséum d'Histoire  
Naturelle (Paris)

He promoted the idea that  
*species change*.

## Evolution • Part 1: How was evolution discovered?

3 Schools of evolutionary thought

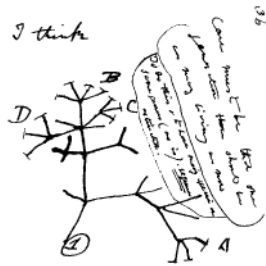


**Linnaeus:** each species was  
separately created.



**Lamarck:** characteristics  
acquired by an individual are  
passed on to offspring

## Evolution • Part 1: How was evolution discovered?



Case must be that one generation then should be as many living as now. To do this & to have many species in same genus (as is) requires extinction.

*I think*

Then between A & B. various  
size of extinction. C & B. the  
finest gradation, B & D  
rather greater distinction  
Then genera would have  
formed. - heavy extinction

Thus between A & B immense gap of relation. C & B the finest gradation, B & D rather greater distinction. Thus genera would be formed. - bearing relation [to ancient types with several extinct forms].

From Darwin's Notebook B now stored in Cambridge University library

## Evolution • Part 1: How was evolution discovered?

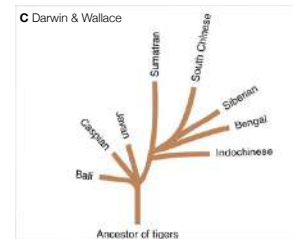
### 3 Schools of evolutionary thought



**Linnaeus:** each species was separately created.

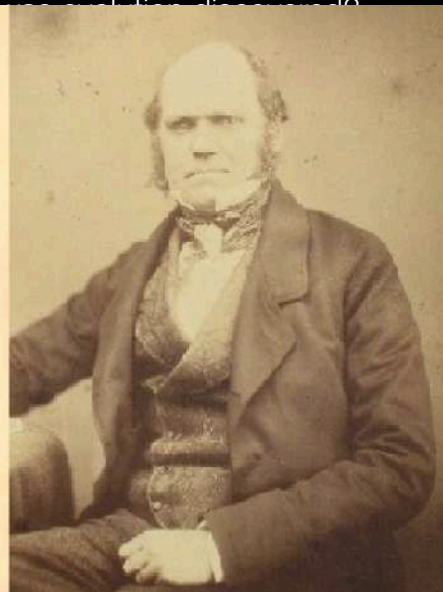
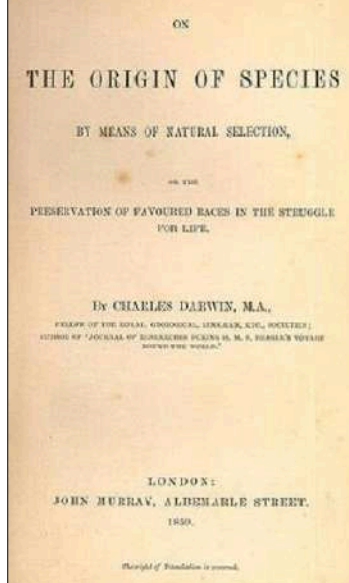


**Lamarck:** characteristics acquired by an individual are passed on to offspring



**Darwin & Wallace:** descent with modification.

## Evolution • Part 1: How was evolution discovered?



## Evolution • Part 1: How was evolution discovered?

### “Neo-Darwinism or “The Modern Synthesis”

The same thing...  
but with better understanding of how things work.

- Darwin's Theory of Evolution by Natural Selection (1859)
- Mendel's Laws of Heredity (1866, 1900)
- Cytogenetics (1902, 1904 →)
- Population Genetics (1908 →)
- Molecular genetics (1970s →)



## Evolution • Part 1: How was evolution discovered?

### Making Sense

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- In the early 20<sup>th</sup> century, scientist started to make sense of how evolution worked.
- Building on Mendel's genetics, studies showed how characteristics in a population could be selected by environmental pressures.
- This **Modern Synthesis**, as **Julian Huxley** called it, brought Darwin's Natural Selection back to the centre of evolutionary theory.

