

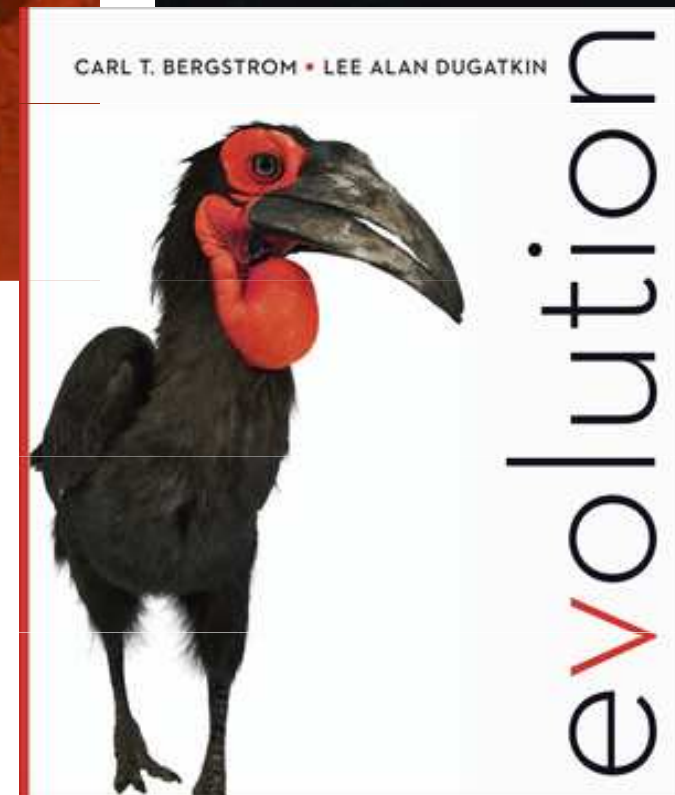
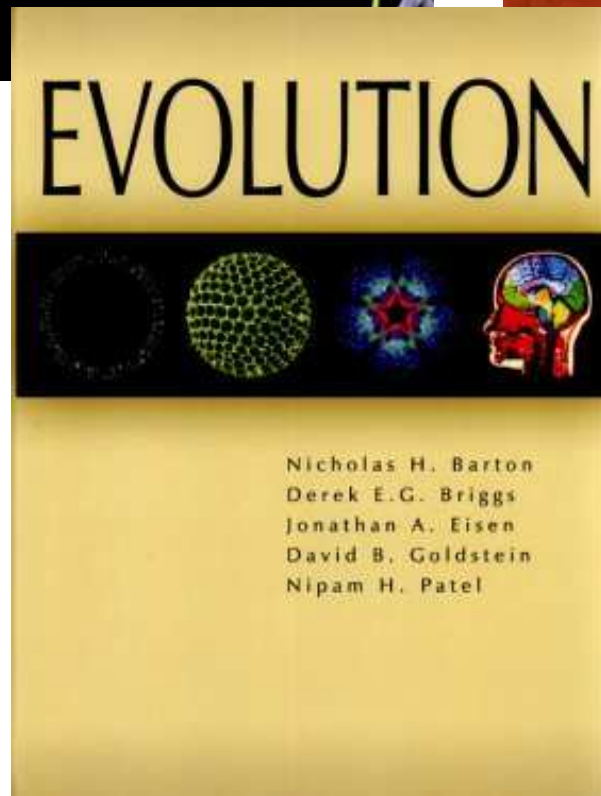
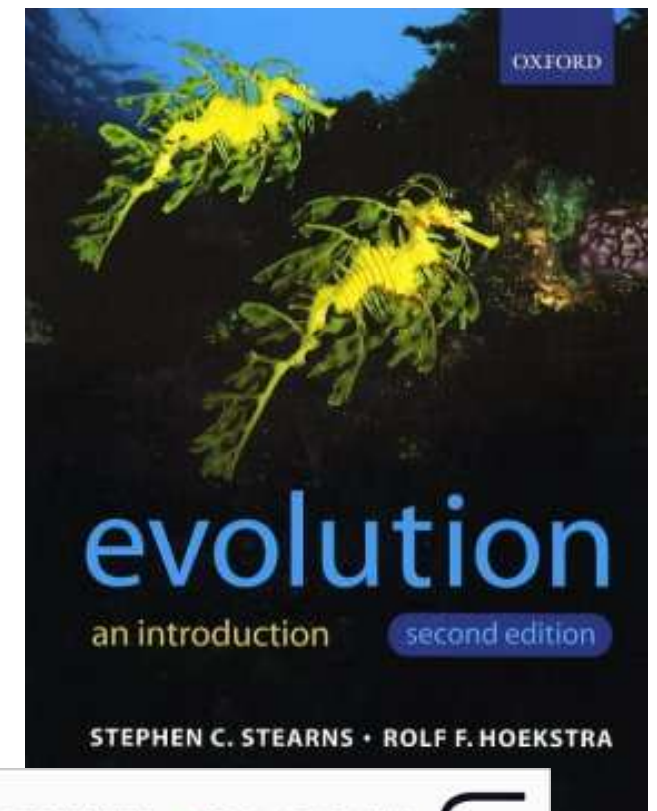
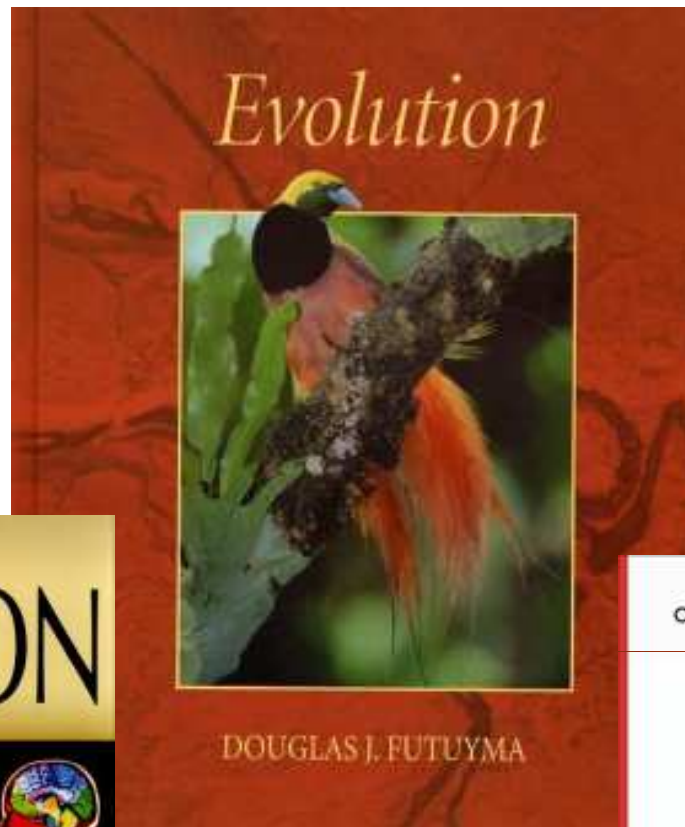
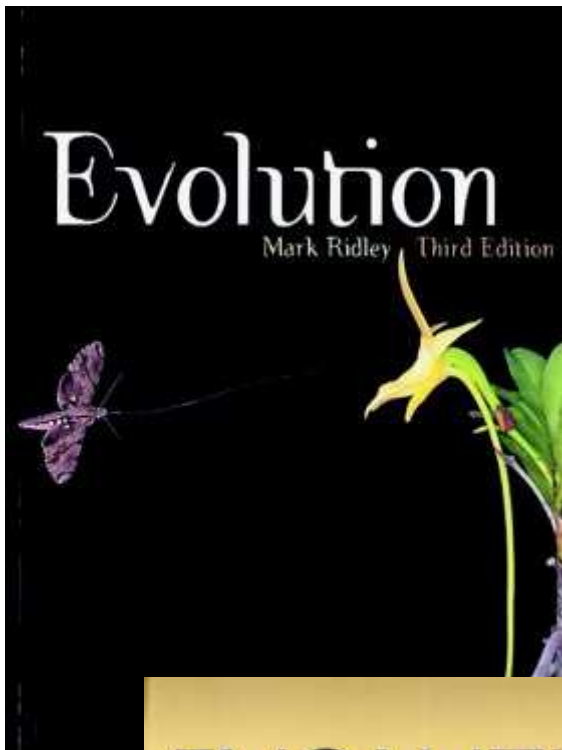


# EVOLUTIONARY BIOLOGY

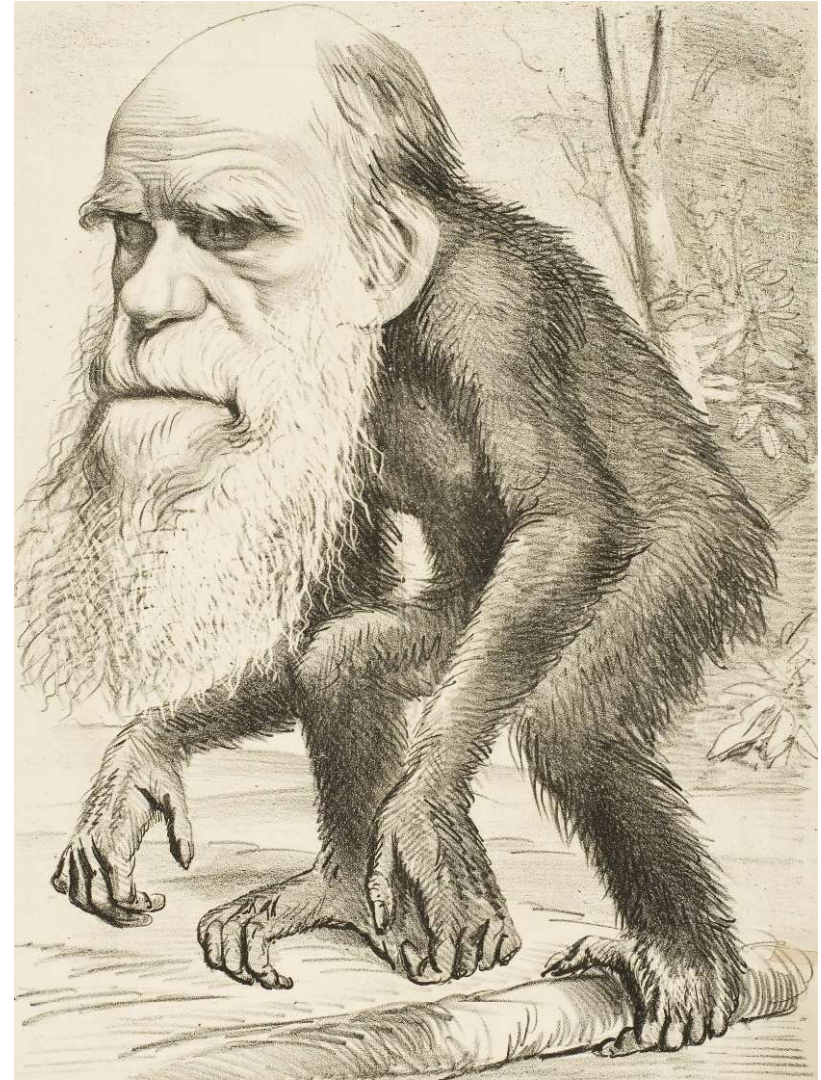
**Miloš Macholán**

Laboratory of Mammalian Evolutionary Genetics  
Institute of Animal Physiology and Genetics, CAS  
Veveří 97, 602 00 Brno  
e-mail: [macholan@iach.cz](mailto:macholan@iach.cz)

# Textbooks



# EVOLUTION AND EVOLUTIONARY BIOLOGY



**EVOLUTION** (*evolvere, evolutio*) = unfold, unfolding (of a scroll of papyrus)

Albrecht von Haller (1774):

development of individual embryo

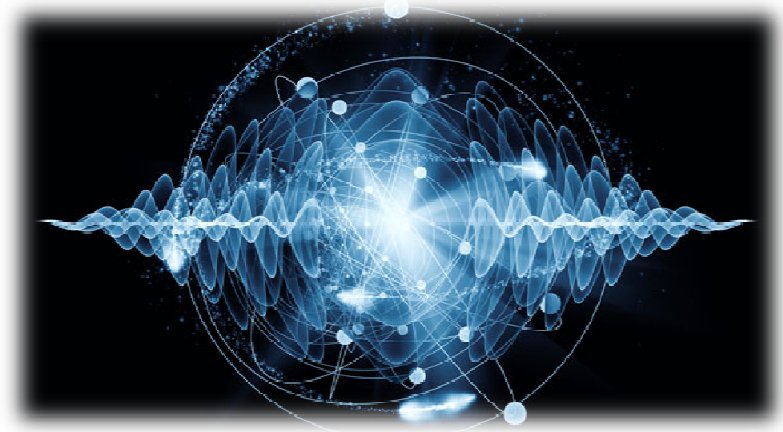
essentially ontogenetic development  
according to a preset programme  
(~ preformationism)



embryo

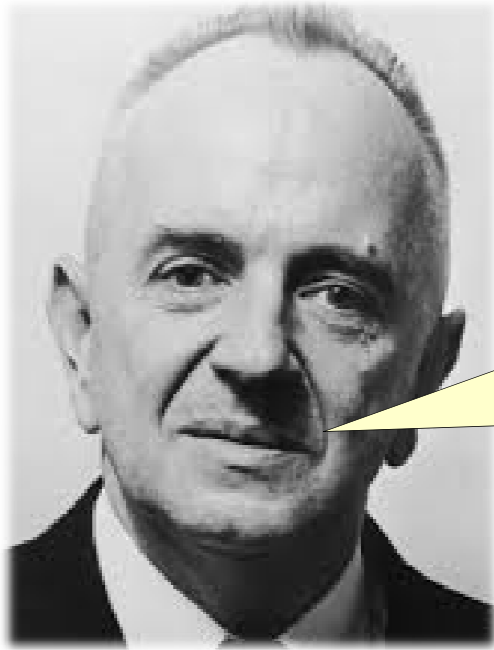
spermatozoon

in a broad sense = **change**  
(politics, economy, technology, scientific theories etc.)



**BIOLOGICAL EVOLUTION** = heritable change in the properties of populations of organisms over the course of generations  
structure, function and organization of organisms or their parts,  
behaviour and mutual relationships

**CULTURAL EVOLUTION**



Nothing in biology makes sense except in the light of evolution.

T. Dobzhansky (*American Biology Teacher*, 1973)

# EVOLUTIONARY BIOLOGY

= scientific field studying principles of  
**biological evolution**

properties and mechanisms of evolutionary process

# PROPERTIES OF BIOLOGICAL EVOLUTION

living systems (reproduction, variability, inheritance)

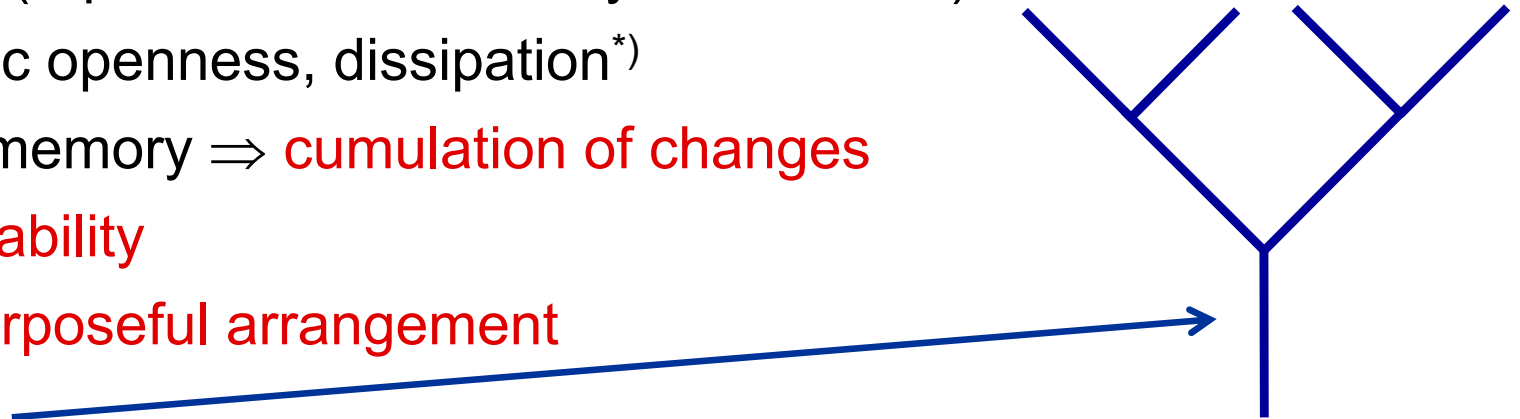
thermodynamic openness, dissipation<sup>\*)</sup>

systems with memory  $\Rightarrow$  cumulation of changes

unlimited heritability

adaptation, purposeful arrangement

cladogenesis



<sup>\*)</sup> = irreversible change of energy

**teleology:** everything has its purpose

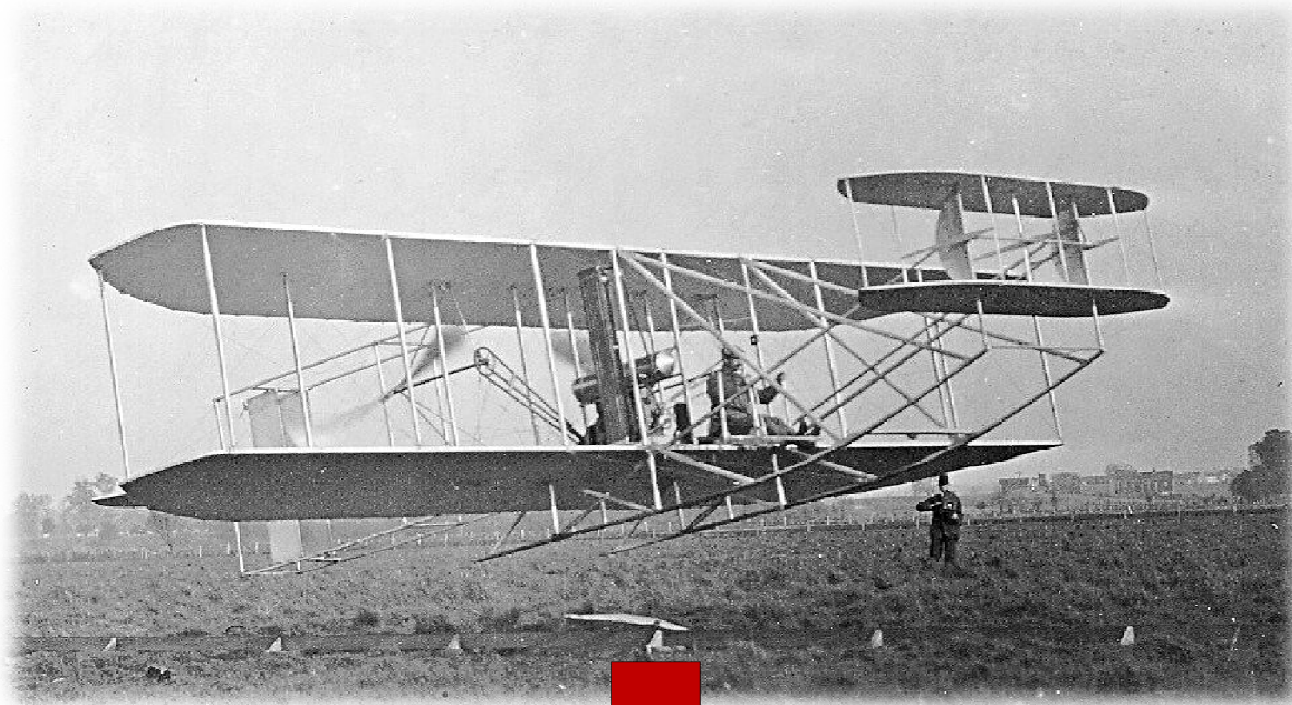
**finalism:** the doctrine that final causes determine the course of all events -

Teilhard de Chardin: „Omega Point“



# PROPERTIES OF BIOLOGICAL EVOLUTION

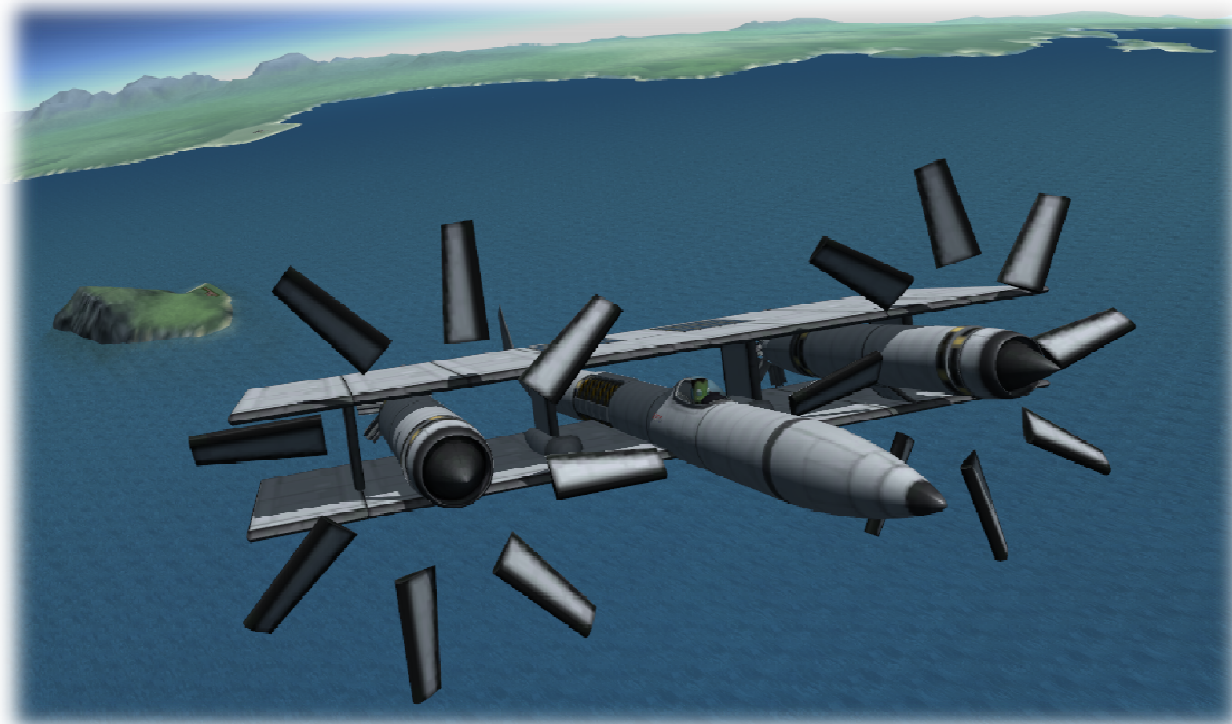
- IS random (both deterministic and stochastic processes and mechanisms)
- IS opportunistic, ie. doesn't find global optima

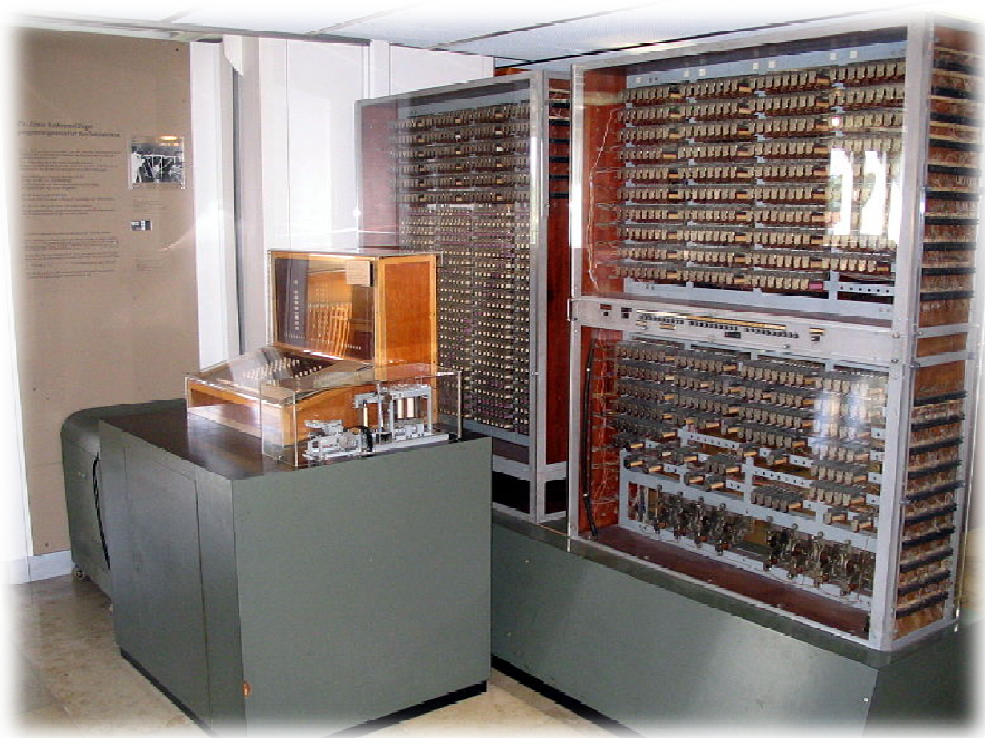
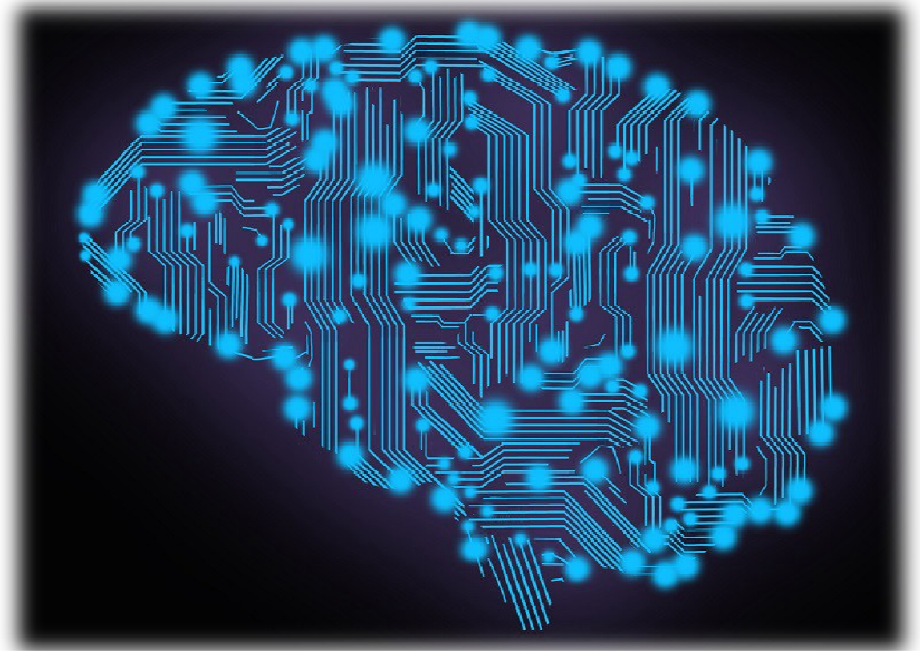


human  
design  
engineer



natural  
selection





1939

2018

# PROPERTIES OF BIOLOGICAL EVOLUTION

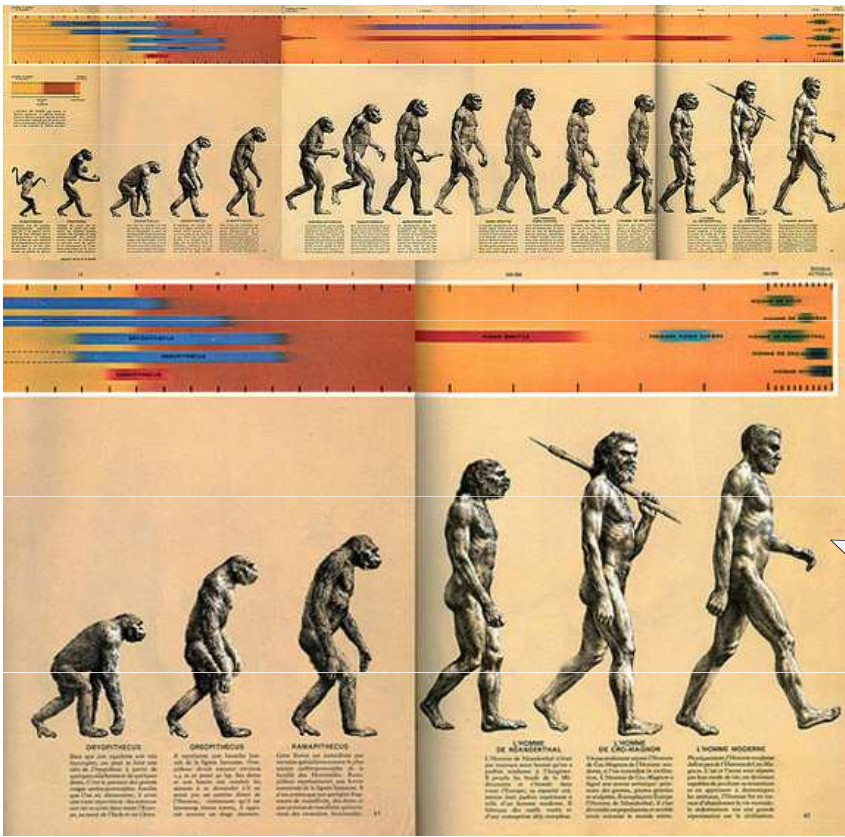
IS random (both deterministic and stochastic processes and mechanisms)

IS opportunistic, ie. doesn't find global optima

HAS NO purpose or goal (nor survival of species!)

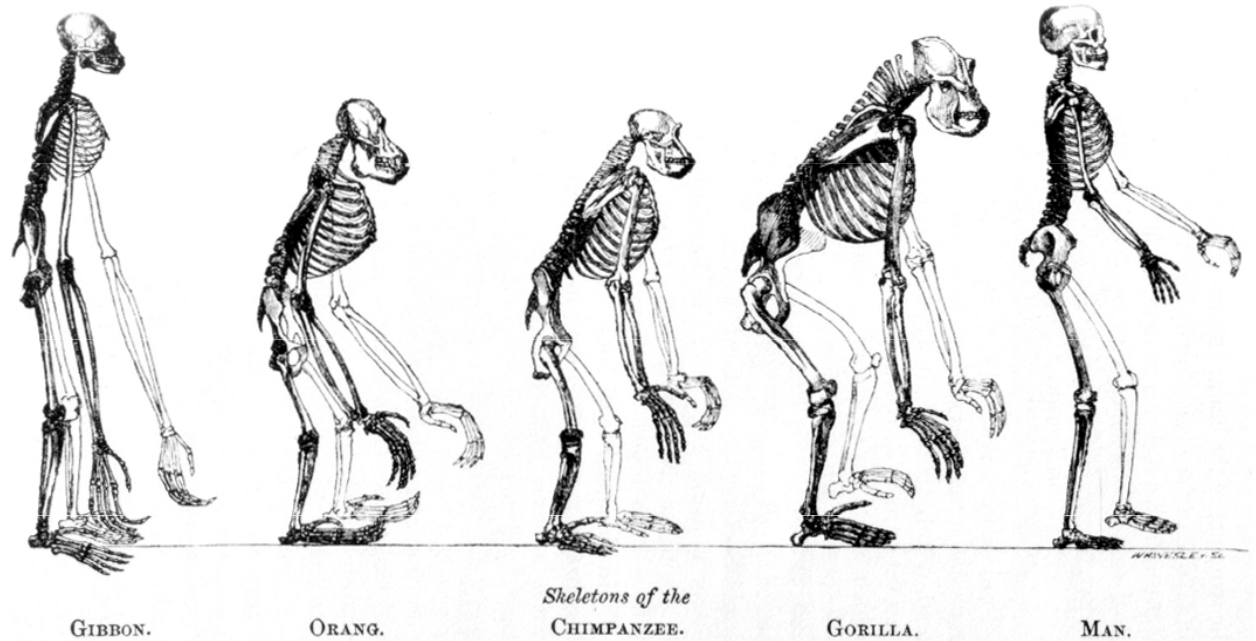
IS neither moral nor amoral

IS NOT progressive



„march of progress“

T. H. Huxley (1863): *Evidence as to Man's place in Nature*



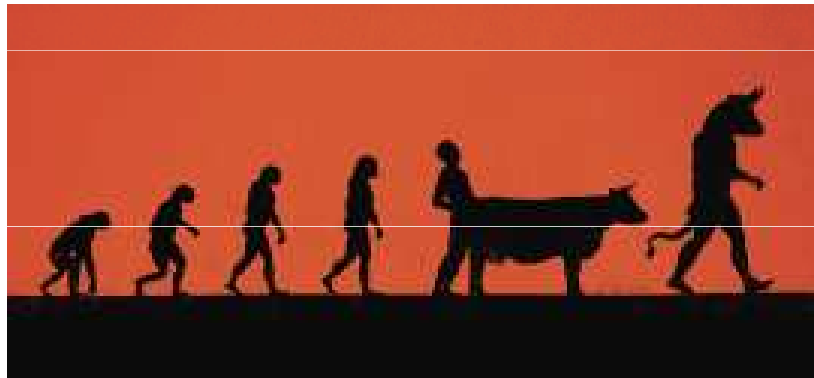
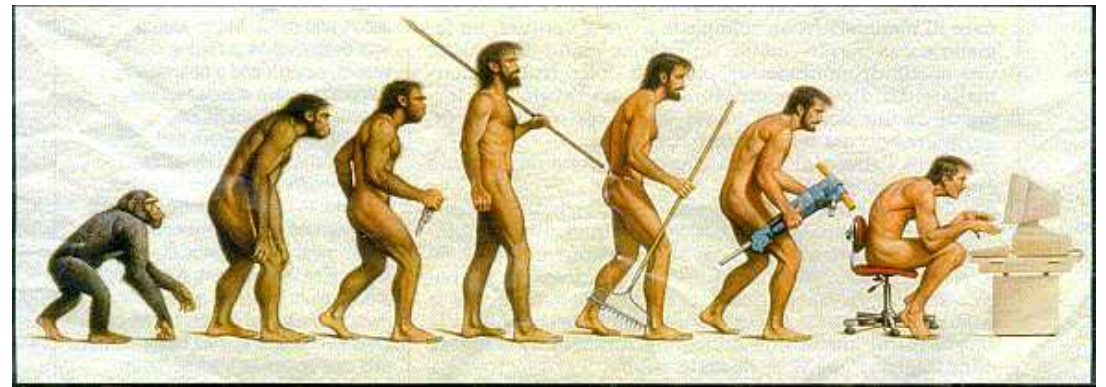
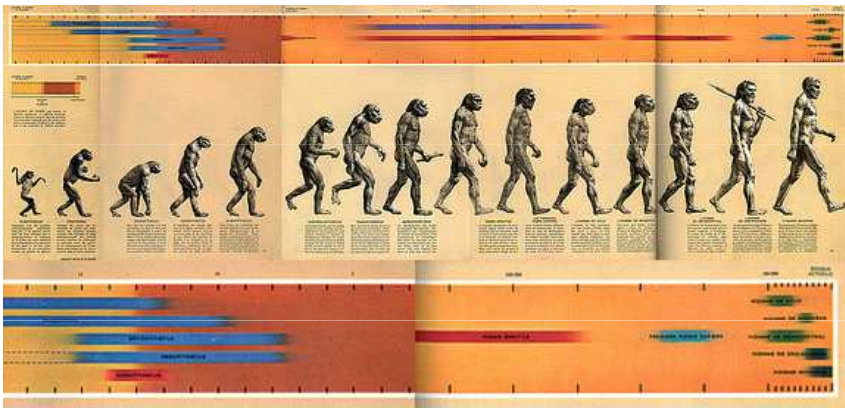
GIBBON.

ORANG.

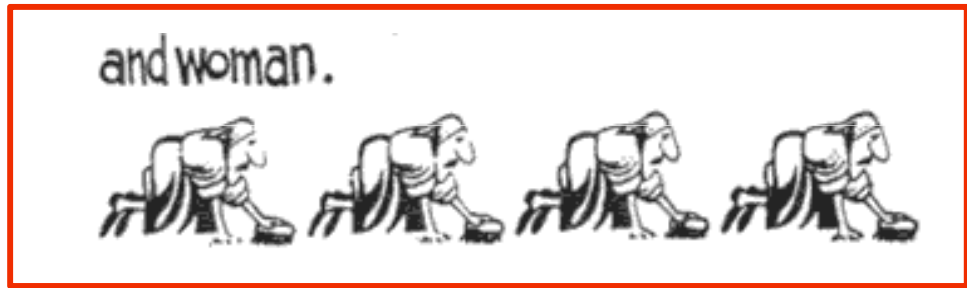
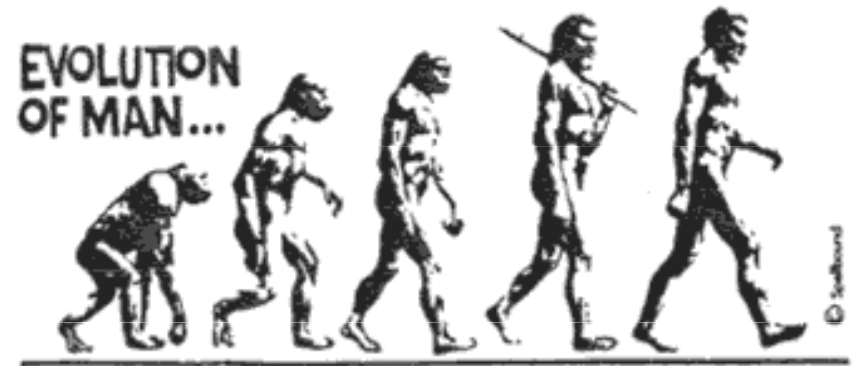
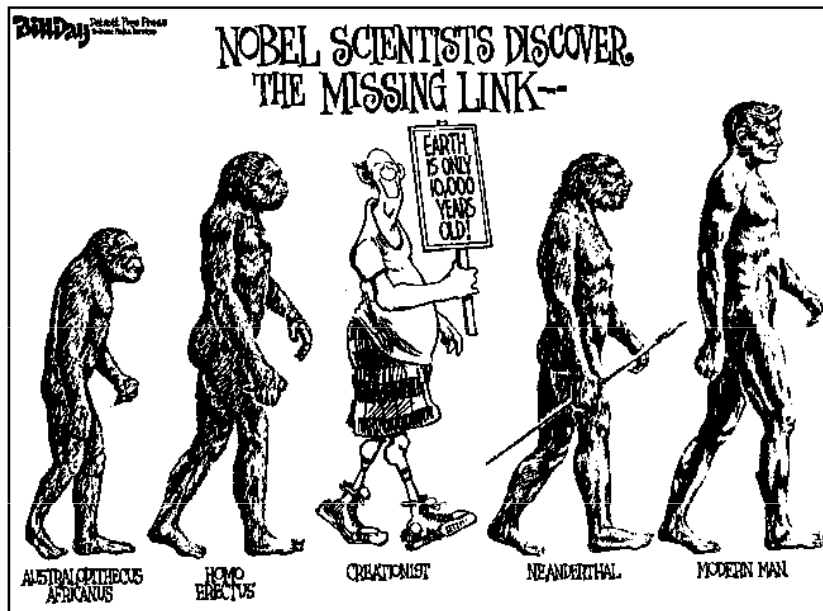
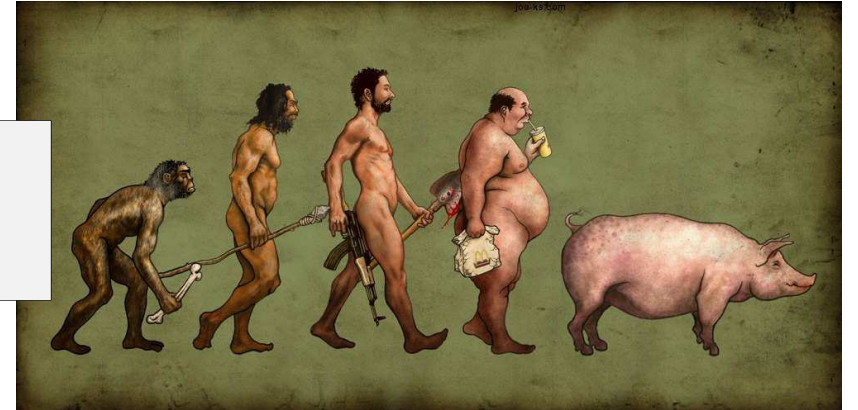
Skeletons of the  
CHIMPANZEE.

GORILLA.

MAN.

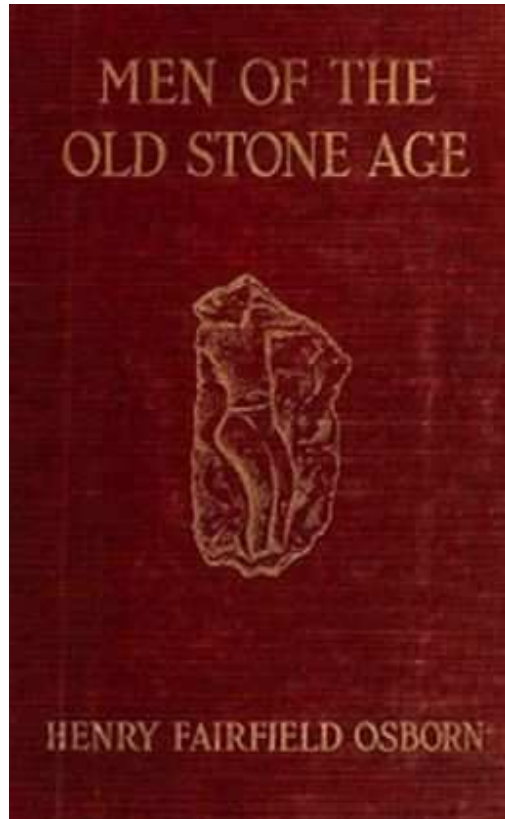
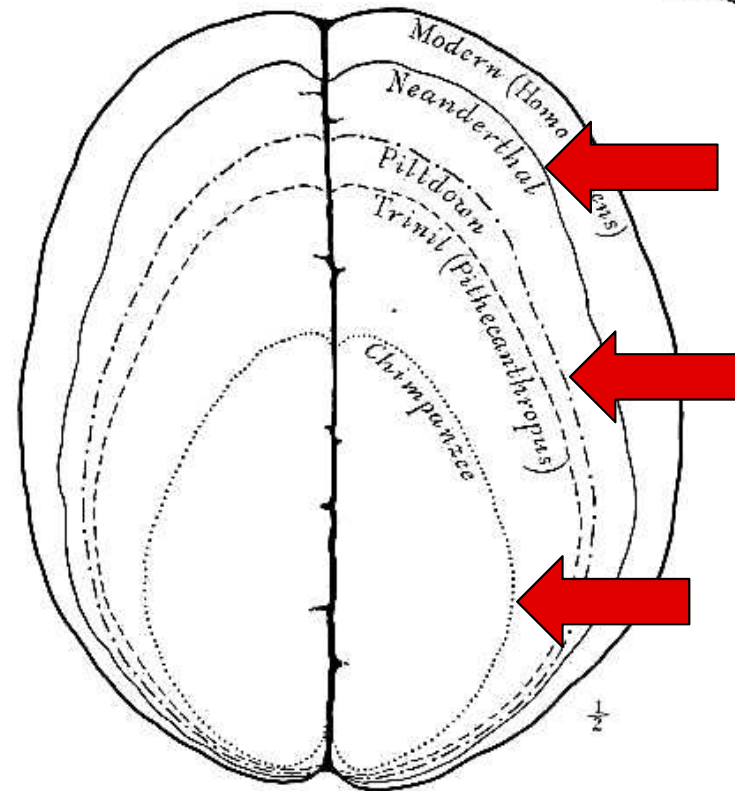
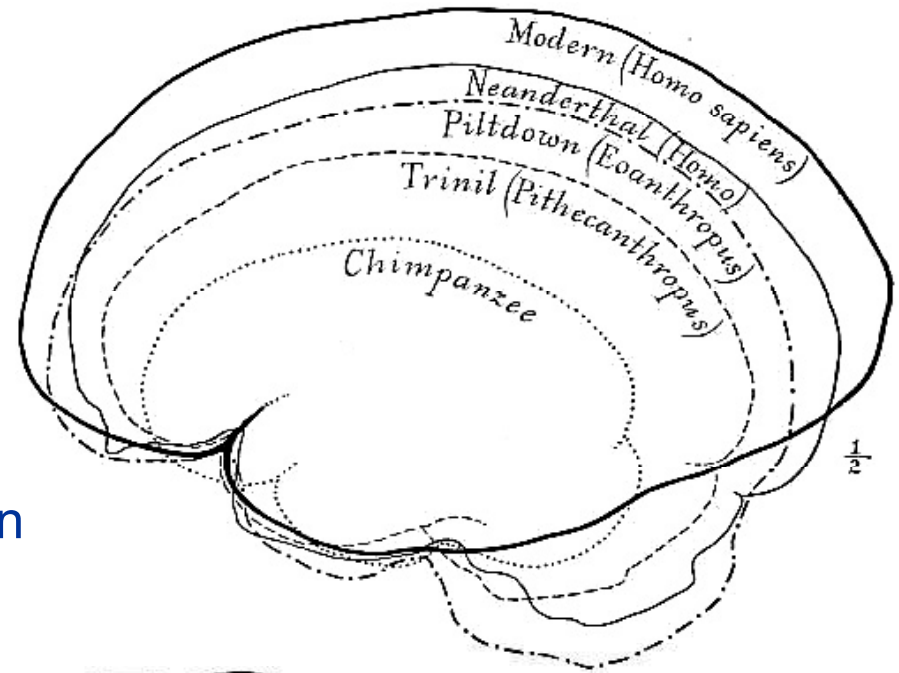


„march of progress“



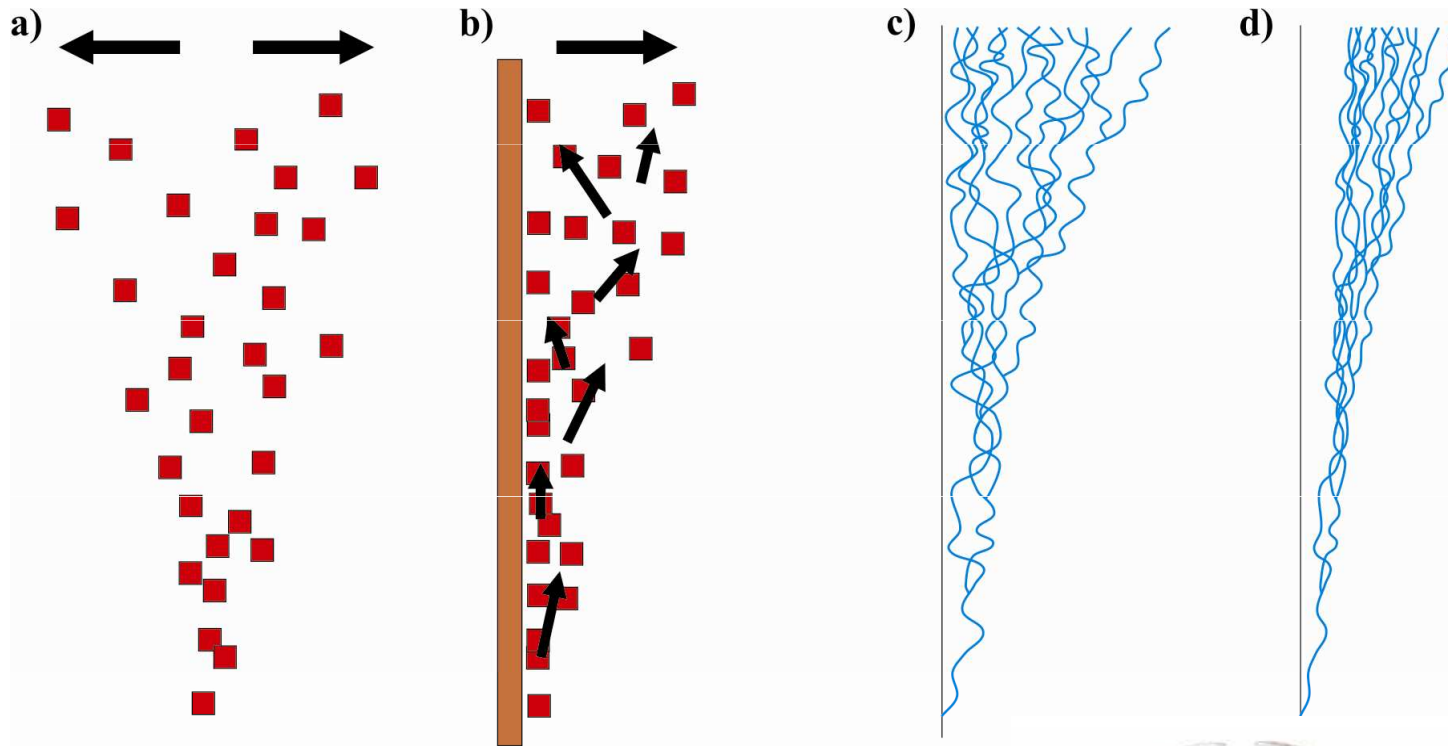


Henry Fairfield Osborn

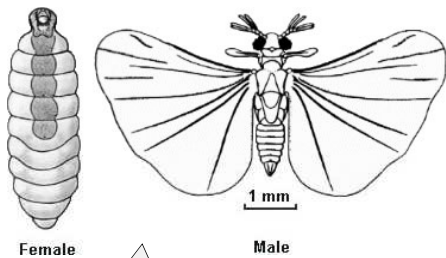




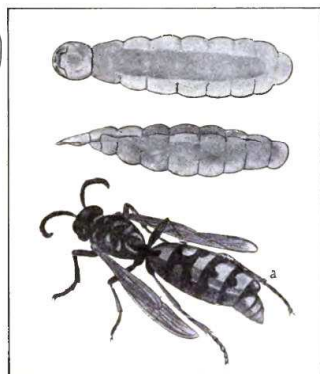
# Evolution and progress



„wall effect“

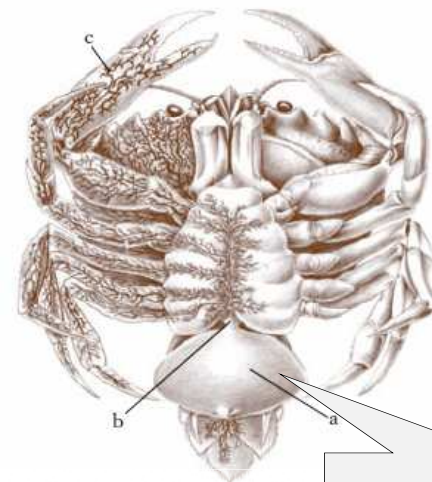
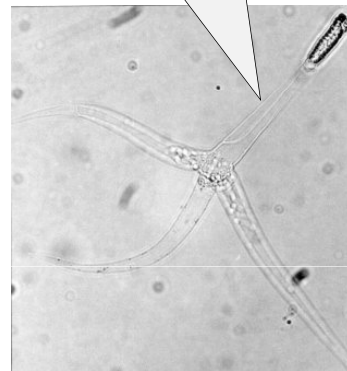


Strepsiptera

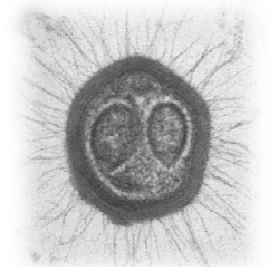


Female Strepsipteron, top and side views and a Stylized Wasp: a, end of the parasite projecting between the abdominal segments of the Wasp. (After Leuckart's Wandtafeln.)

Myxozoa

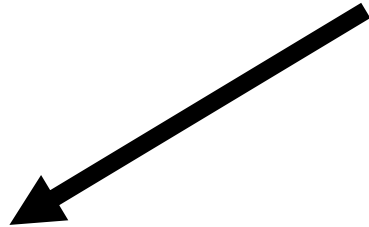


*Sacculina carcini*



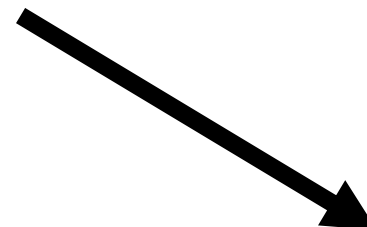
# STRUCTURE OF EVOLUTIONARY BIOLOGY

2 principal questions:



History of life?

systematics  
paleontology



Mechanisms of changes?

evolutionary genetics  
e. ecology  
e. developmental biology (evo-devo)  
behavioural ecology  
sociobiology, e. psychology  
e. physiology  
e. morphology

# HISTORY OF EVOLUTIONARY THOUGHTS

The beginning of evolutionary biology = 1859 (Darwin's *Origin of Species*),  
BUT:

evolutionary thoughts much older

only after the World War II evolutionary biology considered true science

History of evol. thoughts can be divided into the following stages:

before Darwin

Darwin's/Wallace's theory

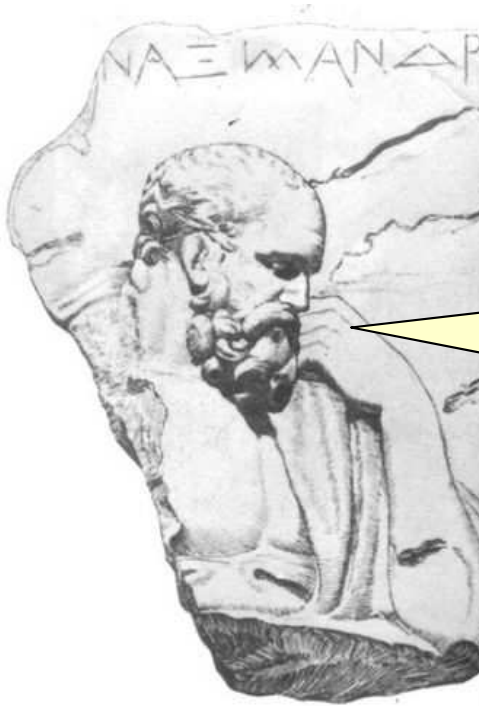
evol. theory at the turn of 19th and 20<sup>th</sup> century

Modern Synthesis and recent history

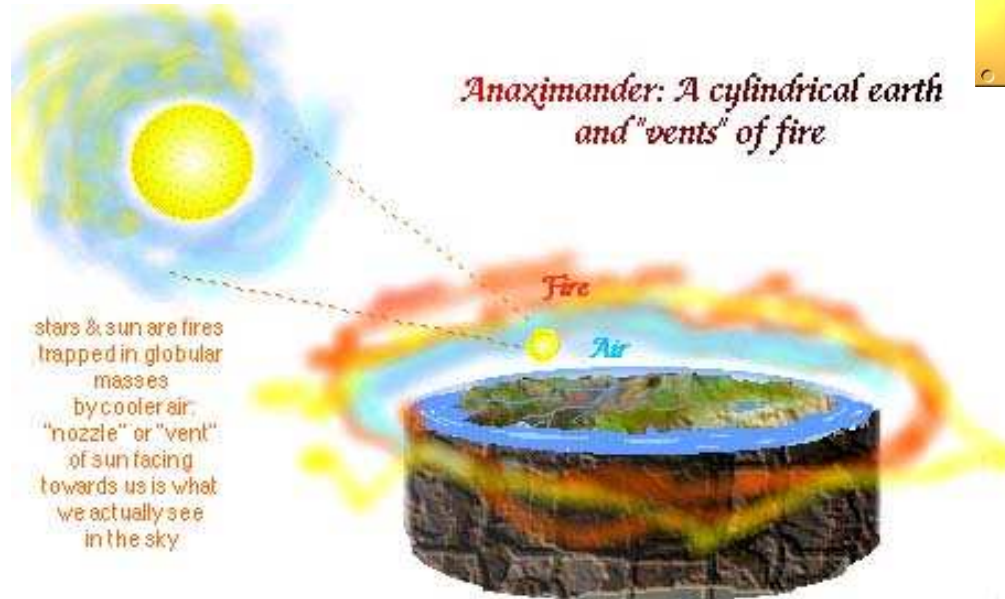
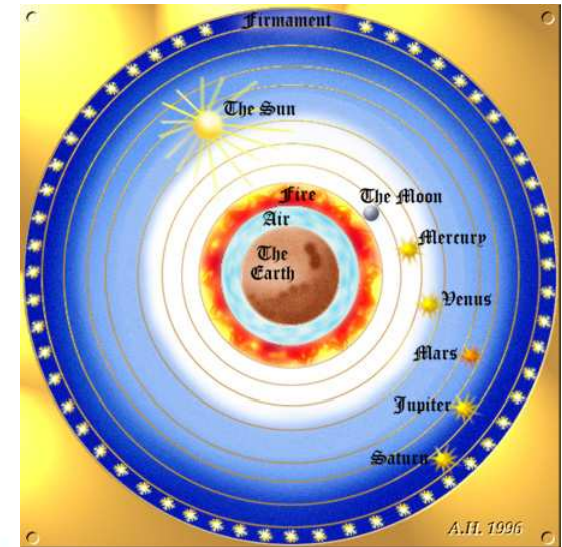
# 1. Before Darwin

## A) Antient history and the Middle Ages:

Anaximander of Miletus (ca. 610–ca. 546 BC)



humans  
and animals  
have evolved  
from fish

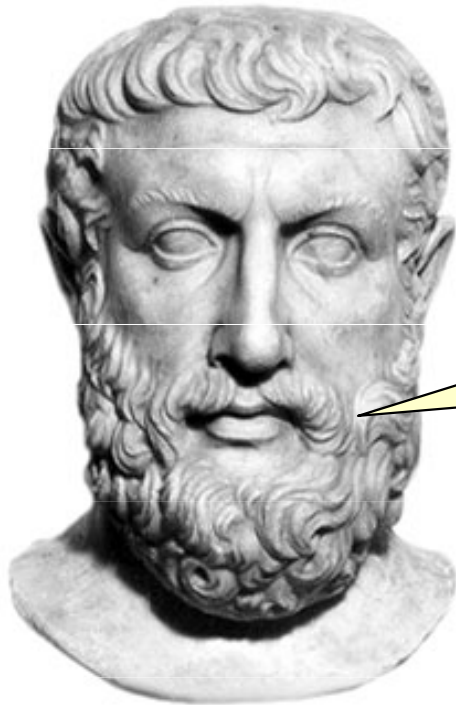


stars & sun are fires  
trapped in globular  
masses  
by cooler air,  
"nozzle" or "vent"  
of sun facing  
towards us is what  
we actually see  
in the sky

# 1. Before Darwin

## A) Antient history and the Middle Ages:

Xenofanes of Colofon (ca. 570–ca. 475 BC)



fossils found in  
sediments must  
formerly have been  
in water

# 1. Before Darwin

## A) Antient history and the Middle Ages:

Empedocles z Acragas (ca. 492–432 BC)

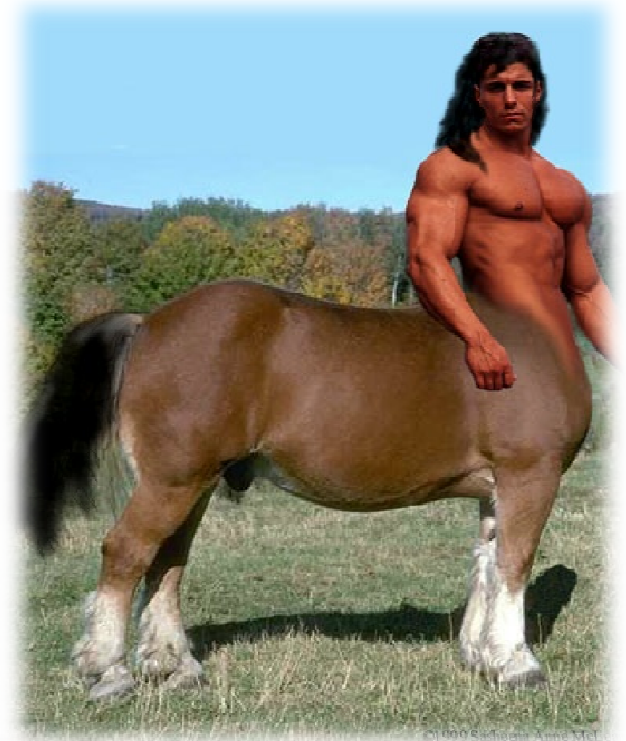
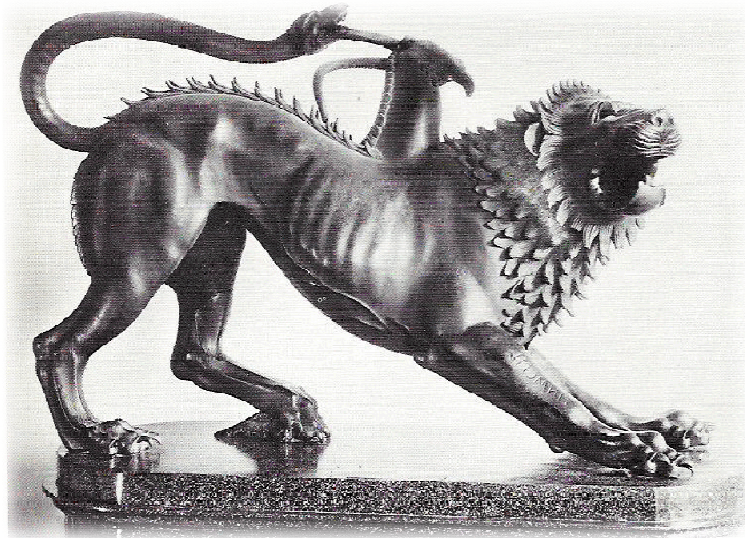


plants before  
animals

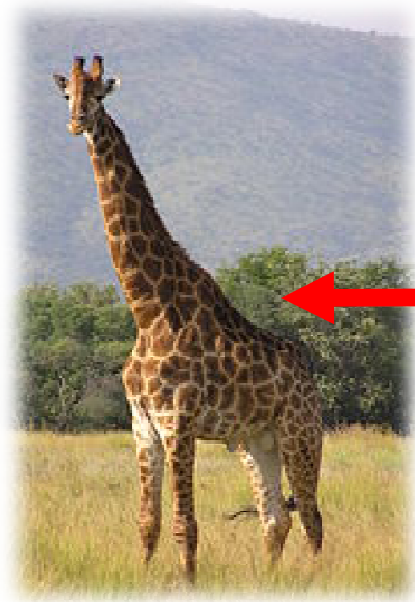
random  
combinations of  
parts of organisms











×



×



×



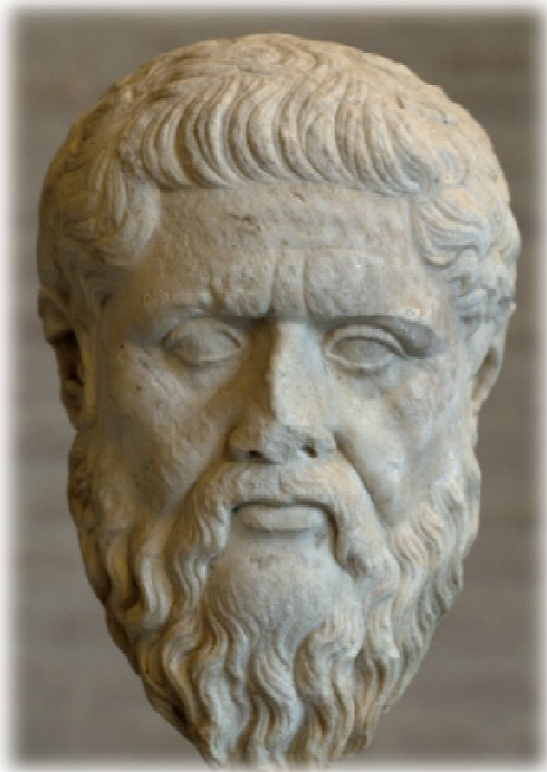
# 1. Before Darwin

## A) Antient history and the Middle Ages:

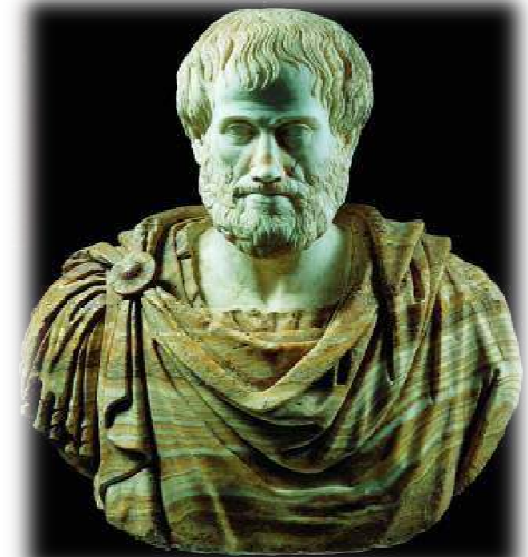
### Christian philosophy:

**Aristotle:** first classification of organisms, linear hierarchy (→ *Scala Naturae*)

**Plato:** theory of Ideas (→ Christian God)

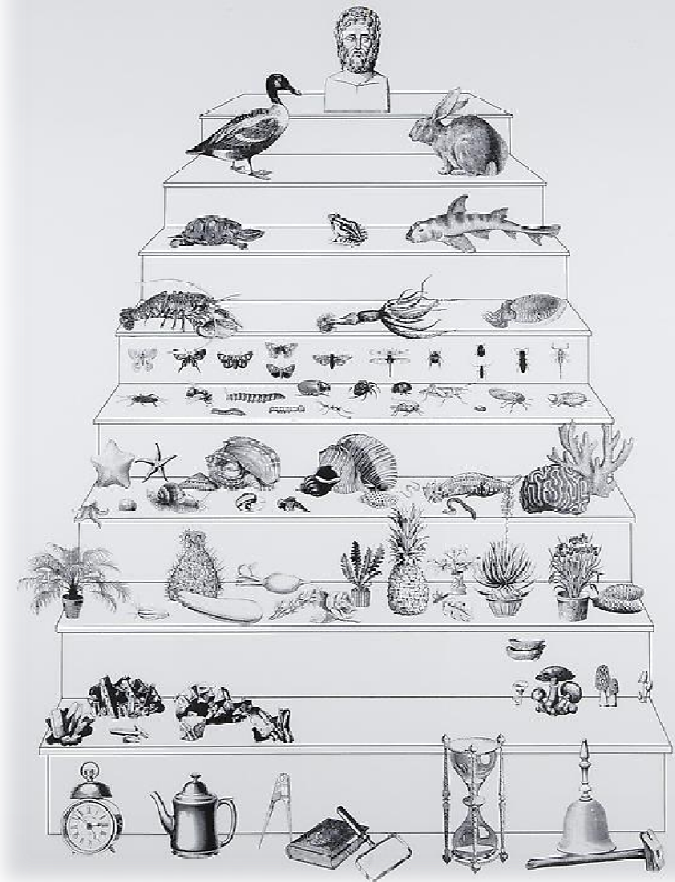
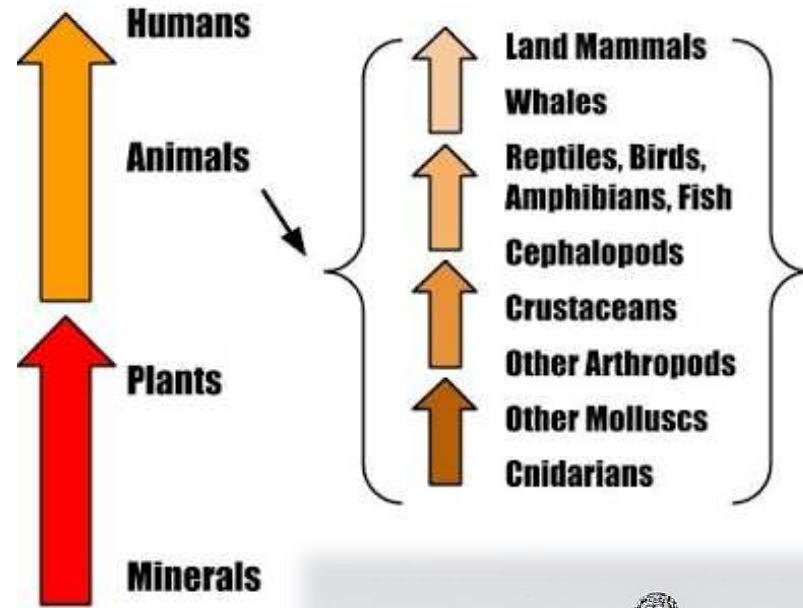
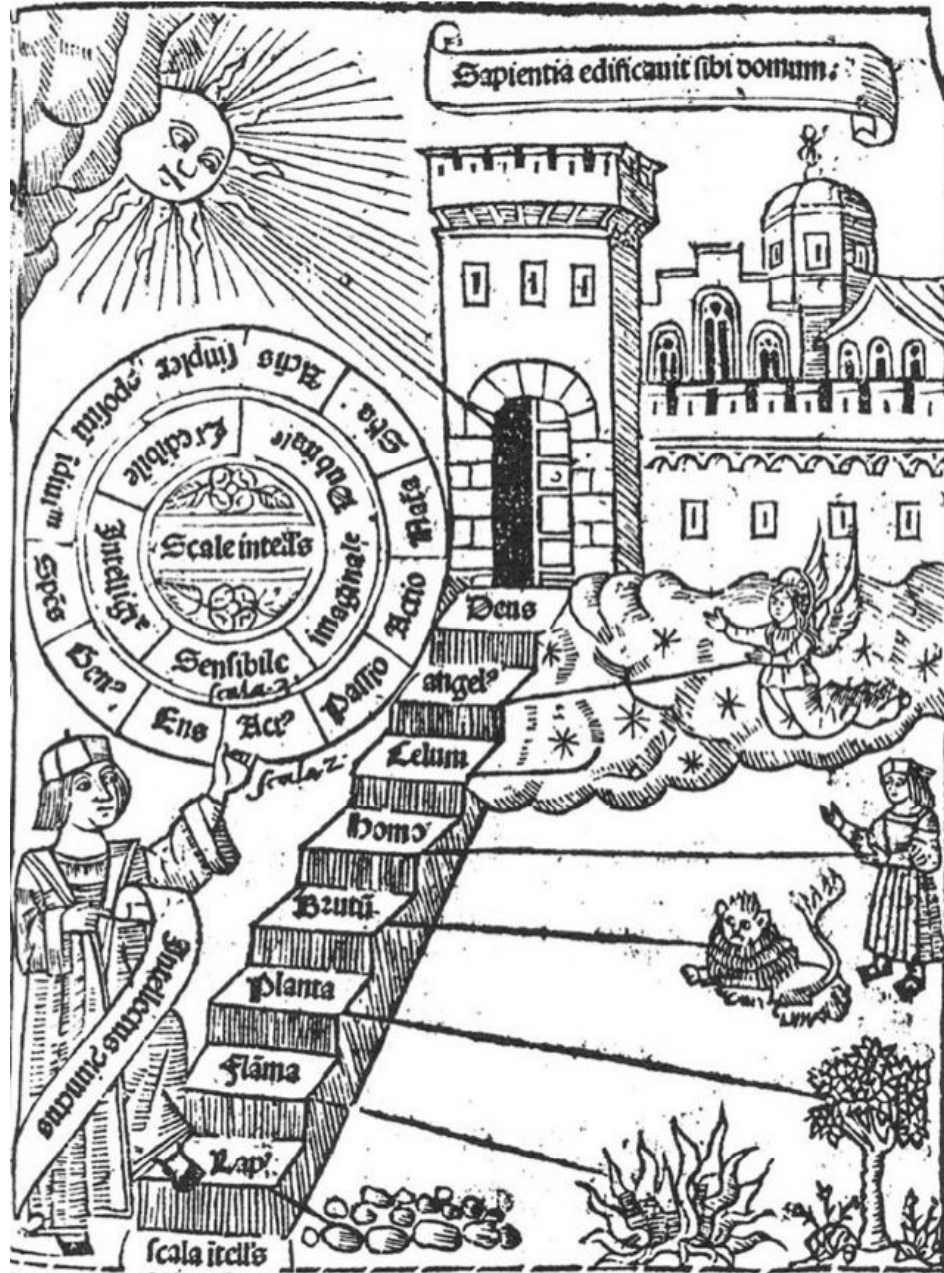


**Plato**  
(427–347 BC)



**Aristotle**  
(384–322 BC)

# Scala Naturae („Great Chain of Being“)

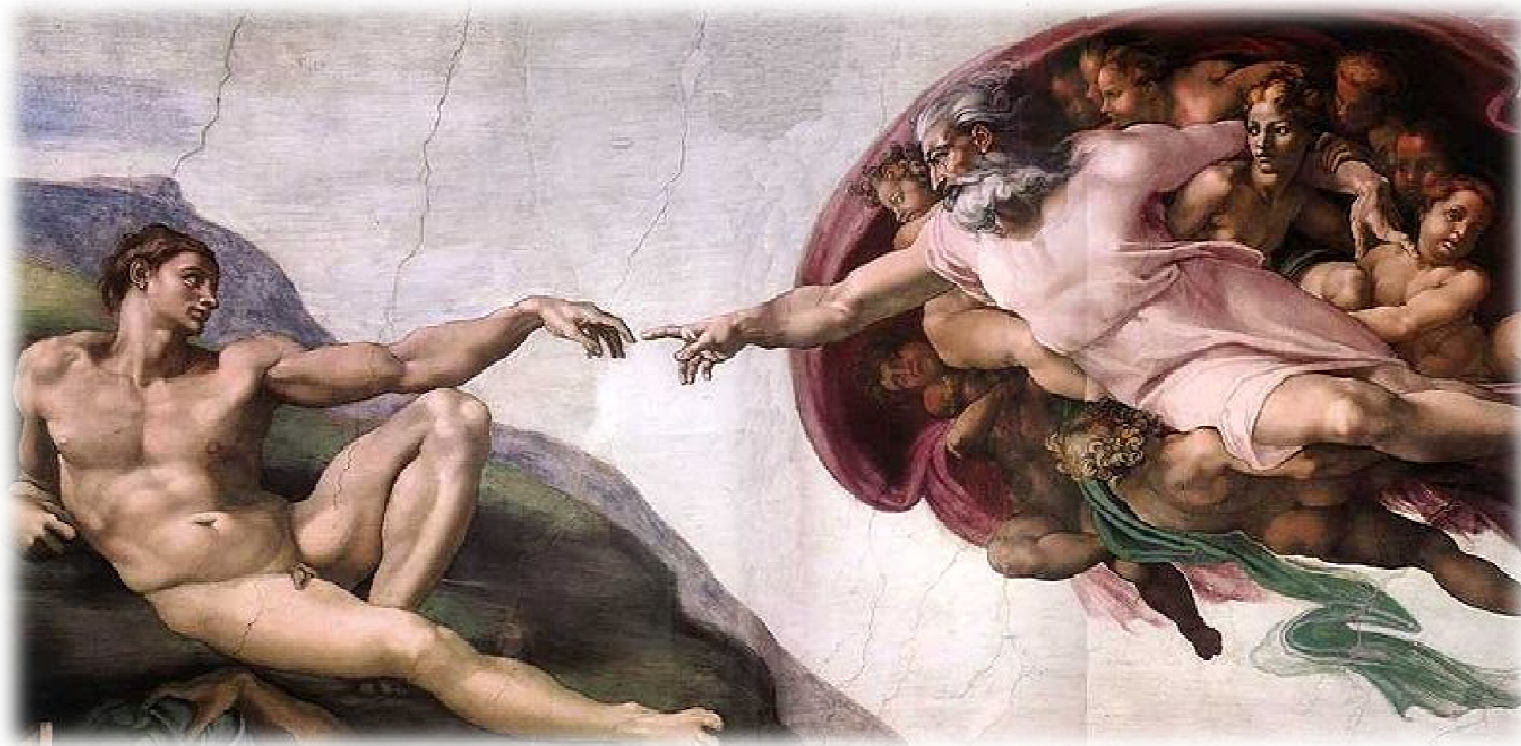




**James Ussher** – *Annalium pars posterior* (1654):  
World created at dusk preceding 23th October 4004 BC  
(~ 6000 years old)

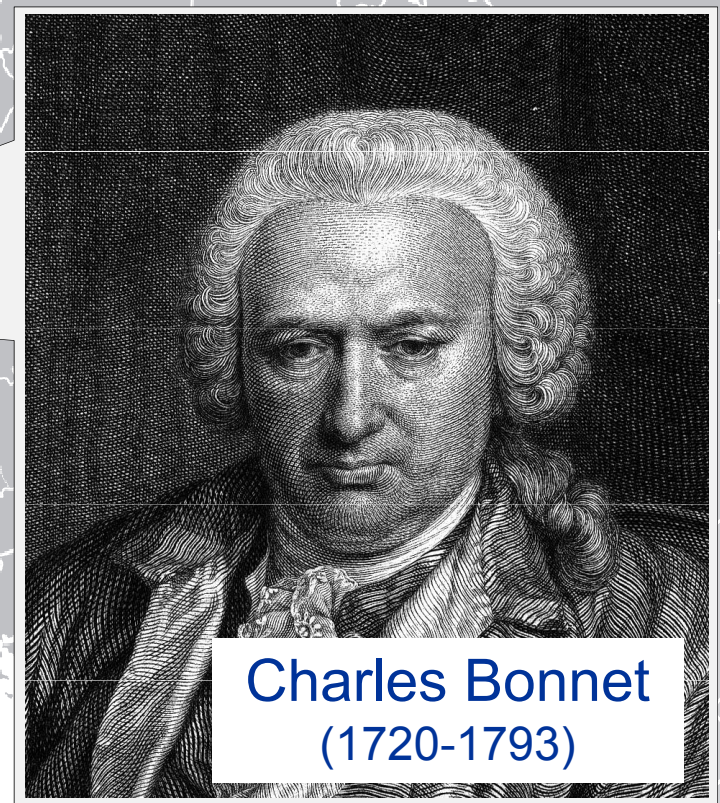
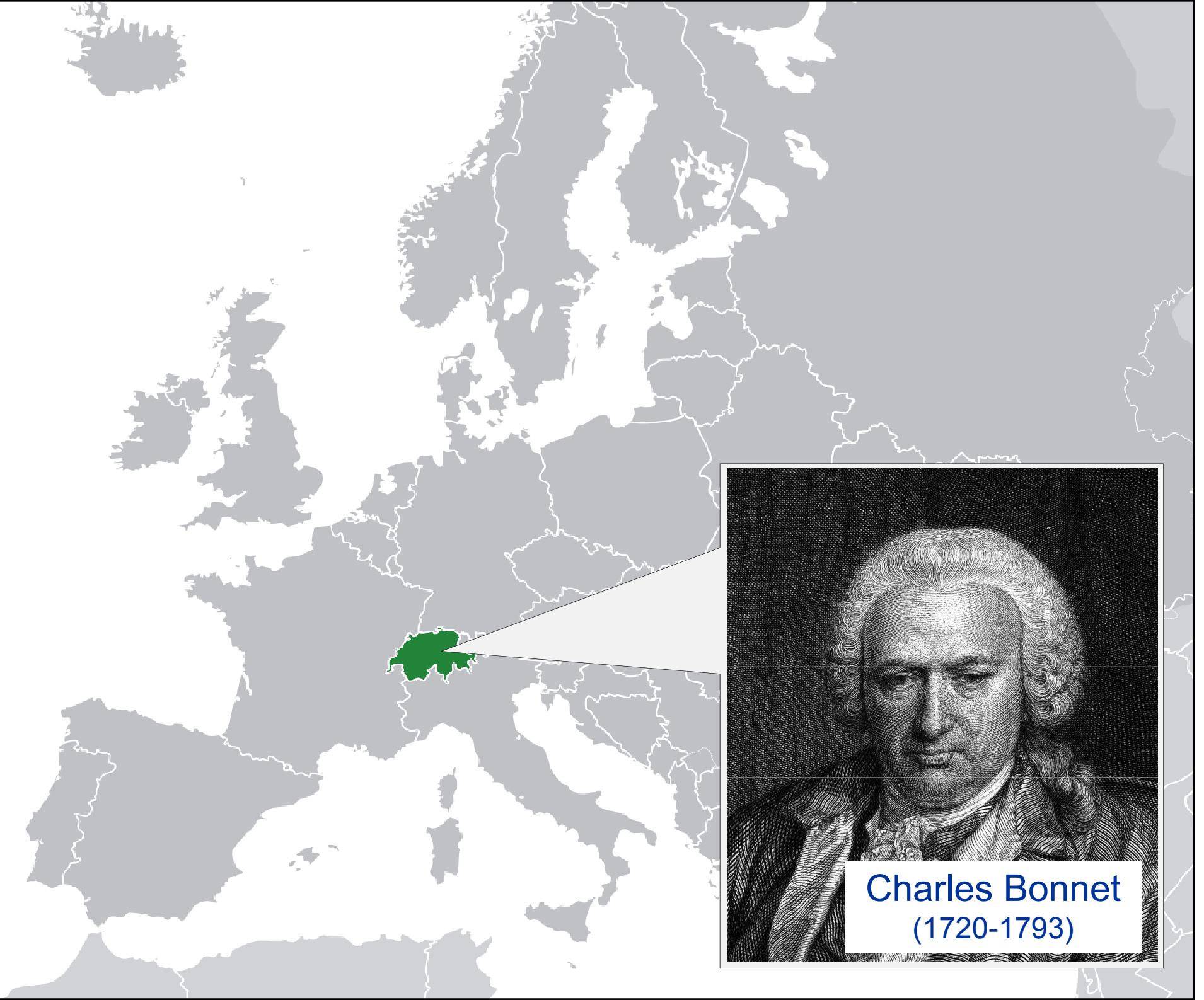
~ Isaac Newton: 3998 BC

literal reading of Bible = **creationism**

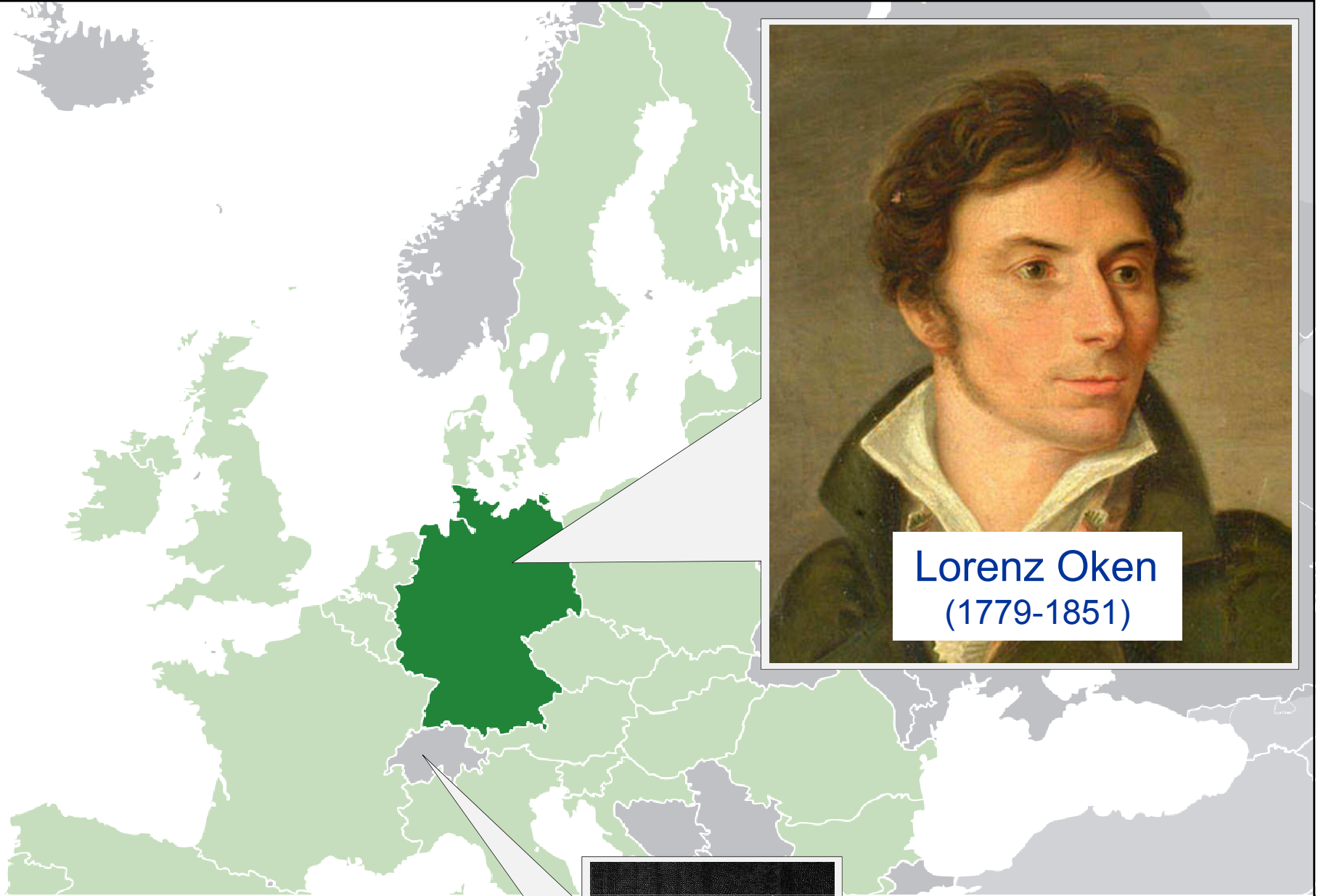


# 1. Before Darwin

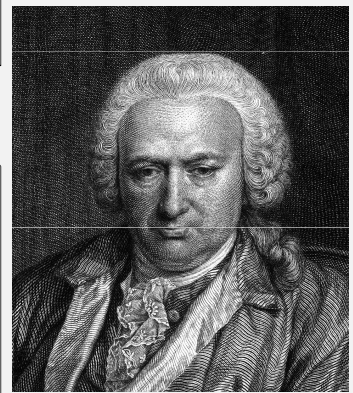
B) since the end of 17<sup>th</sup> century to the French Revolution:

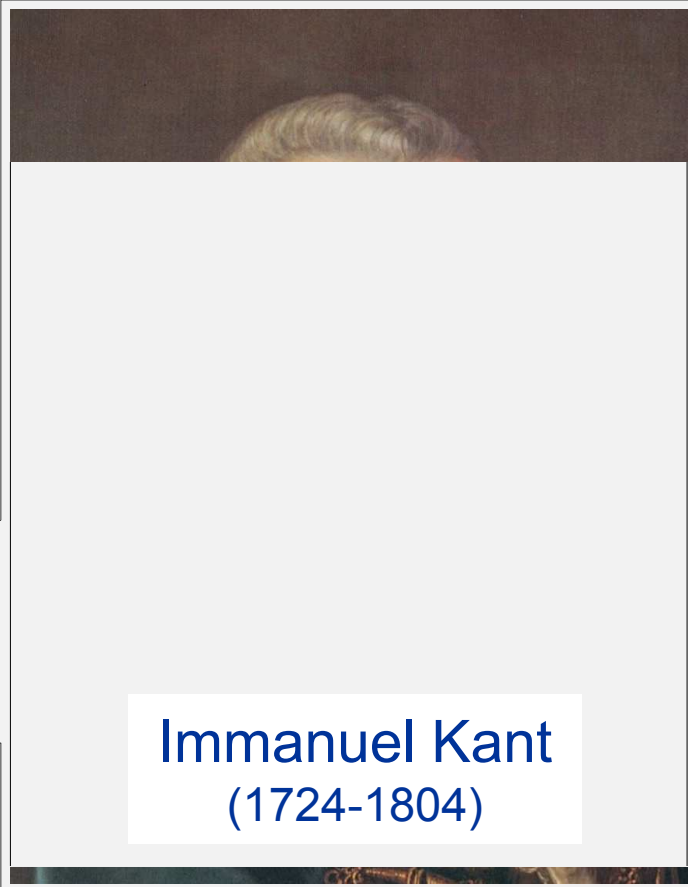


**Charles Bonnet**  
(1720-1793)

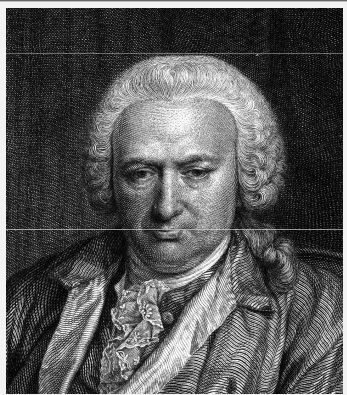


Lorenz Oken  
(1779-1851)





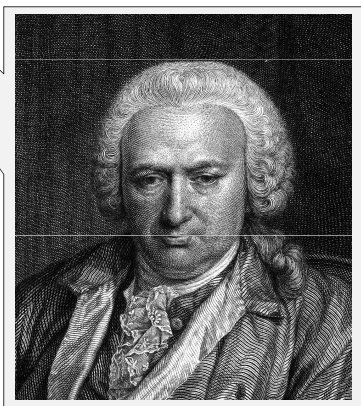
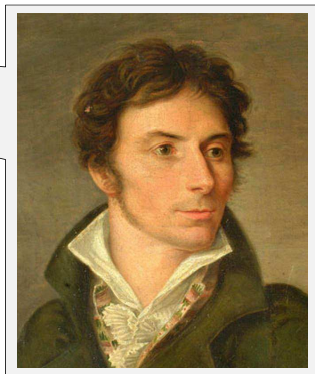
**Immanuel Kant**  
(1724-1804)







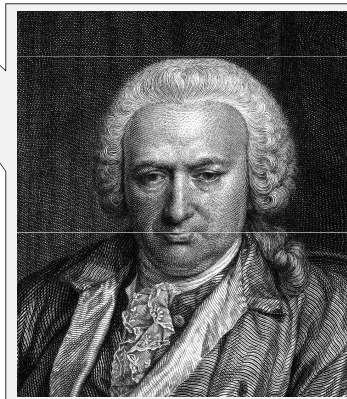
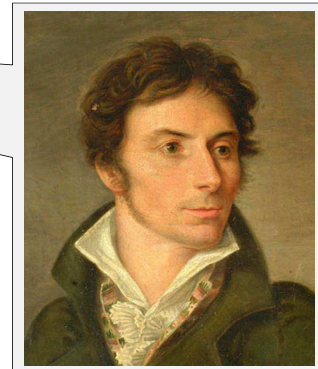
J. W. Goethe  
(1710-1782)



Zoönomia (1794):  
„E conchis omnia“  
(everything from  
molluscs)



Erasmus Darwin  
(1731-1802)





G.-L. L. de Buffon  
(1707-1788)

