

Introduction to Biology. Lecture 6

Alexey Shipunov

Minot State University

September 10, 2014



Outline

1 Where we are?

2 Origin of life

- Proofs of evolution



Outline

- 1 Where we are?
- 2 Origin of life
 - Proofs of evolution

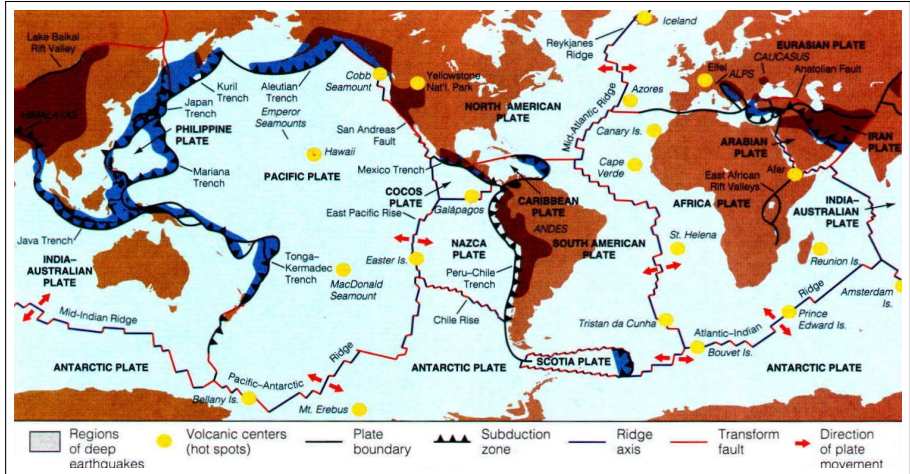


Continental drift and plate tectonics

- Continents of Earth are constantly changing their position due to the mantle convection (“plate tectonics”)
- In the past (Permian period) all continents formed super-continent Pangaea, which then broke into Laurasia and Gondwana
- Two living examples of continental drift on U.S. territory: Yellowstone hotspot and Hawaiian hotspot



What is going on now



Origin of life

Proofs of evolution



Evolution is a working research program

“Nothing in Biology Makes Sense Except in the Light of Evolution”

Theodosius Dobzhansky
1973

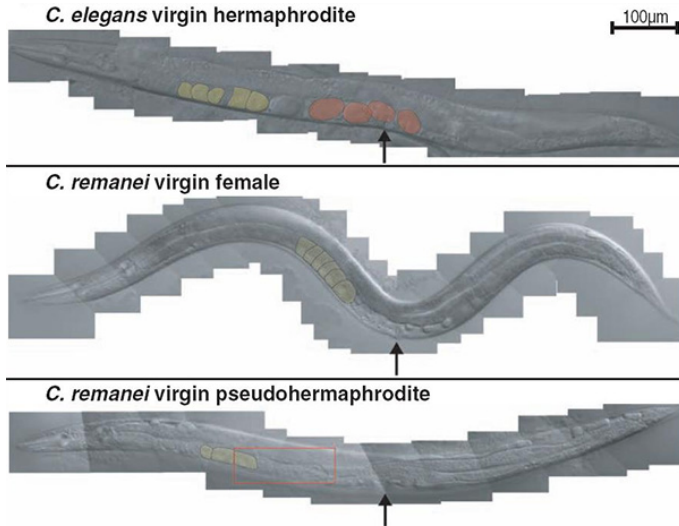


New useful characters appear as a result of mutations

- Wild rice evolved into domesticable by one mutation: <http://www.sciencemag.org/content/311/5769/1936.short>
- Malaria parasite became resistant to drugs due to one mutation: <http://www.sciencemag.org/content/325/5948/1680.abstract>
- Two mutations may turn worms into hermaphrodites: <http://www.sciencemag.org/content/326/5955/1002.abstract>
and so on



Hermaphroditic worms



Artificial selection is a bridge to natural selection

- Artificial selection is a full analog of natural selection
- Animals are also doing “artificial” selection
- Results of artificial selection may be called “new species”



Cabbages

2



What artificial selection can do in a very short time: wild cabbage (a) and its useful (b) and monstrous (c) descendants.

There are dozens of observed and documented cases of evolution

- Bacteria make major evolutionary shift in the lab (40,000 generations experiment): <http://www.newscientist.com/article/dn14094-bacteria-make-major-evolutionary-shift-in-the-lab.html>
- Harmful insects escaped from viral biological weapons: <http://www.sciencemag.org/content/317/5846/1916.abstract>
- Maggot flies and their parasitic wasps formed several new species for 150 years: <http://www.sciencemag.org/content/323/5915/776.abstract>
- Accidental hybridization turned black chokecherry into delightful fruit (*Aronia melanocarpa* to *Aronia mitchurinii*)
- American evening primrose gave birth to new species, red-stem evening primrose in Europe (*Oenothera biennis* to *Oenothera rubricaulis*) in 100 years



Apple maggot fly: new species



Black choke cherry and Russian *Aronia mitchurinii* (new species)



Evening primroses: American and European (new species)

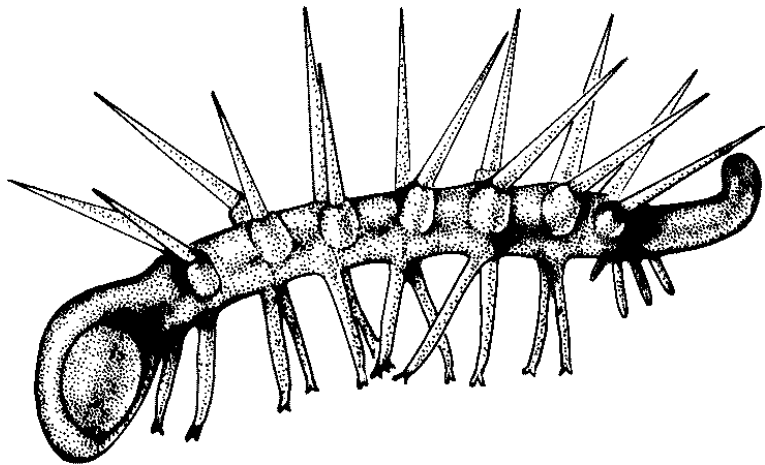


Fossils are direct evidence of evolution

- The older fossils are, the more unusual are they
- Many fossils are transitional forms (see http://en.wikipedia.org/wiki/List_of_transitional_fossils)
- Many fossils could be arranged in well-documented “evolutionary chains”



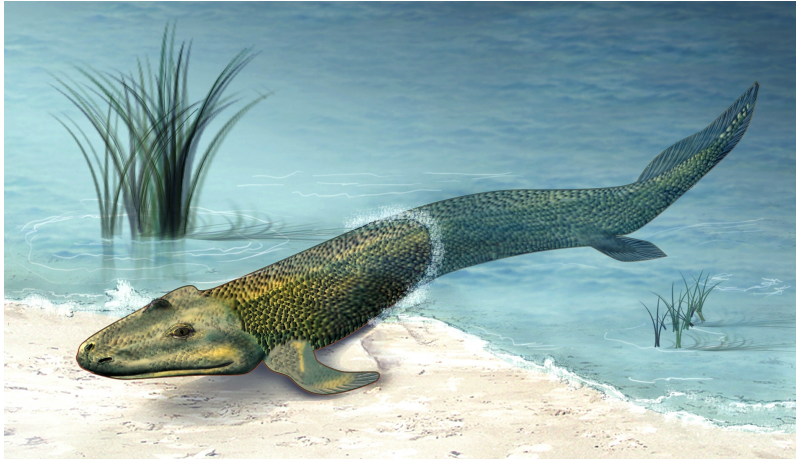
Hallucigenia—mysterious Cambrian fossil



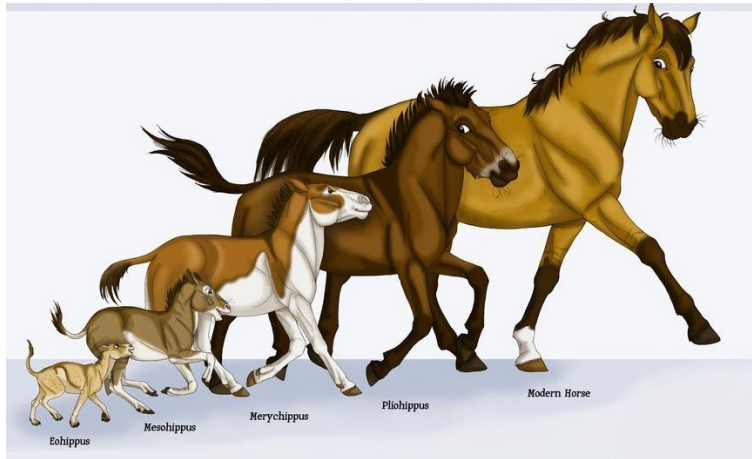
Hallucigenia in stone



Tiktaalik—half-fish, half-salamander



Evolution of horses

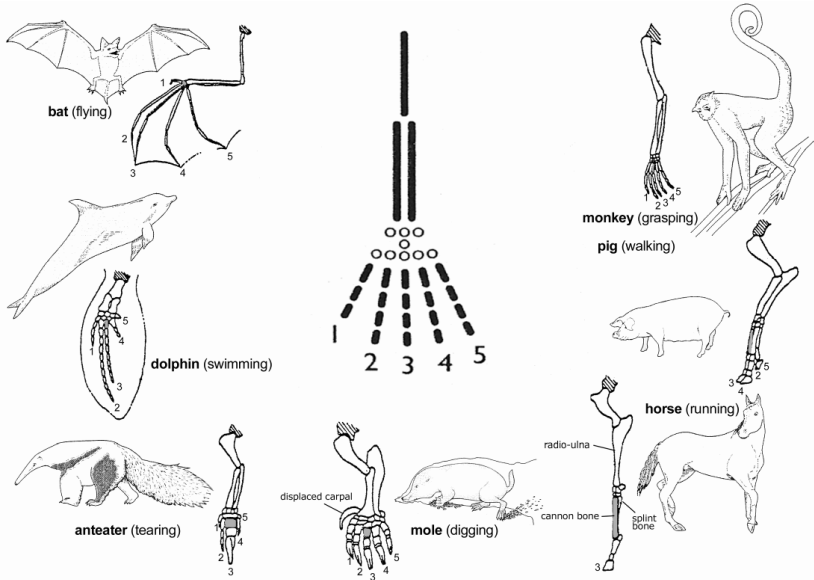


Similarities in structure (morphology) prove evolution

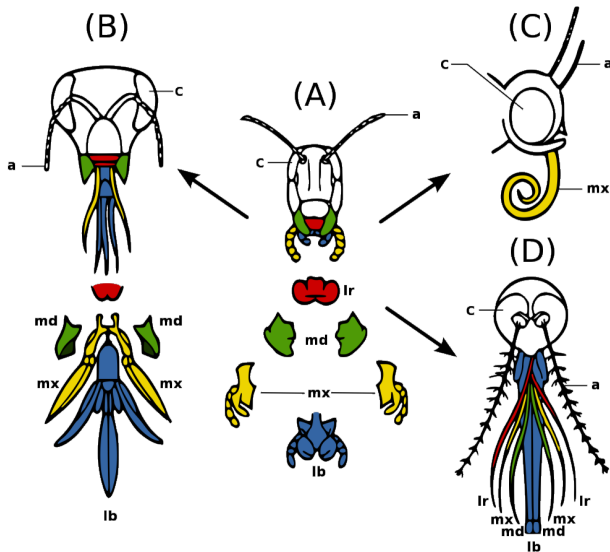
- So-called homological structures are descendants of one ancestral structure
- Vestigial organs remind us of the past
- Reversion organs demonstrate ancestral states
- Analogous structures demonstrate how evolution led to the same outcome



Pentadactyl limb of terrestrial vertebrates



Insect mouth



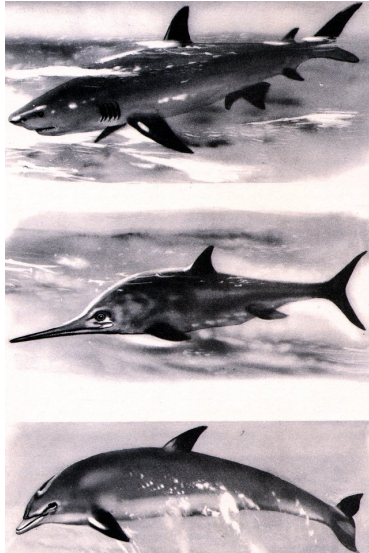
Vestigial hind legs of python



Reversal hind legs in dolphin



Analogous structures help shark, ichthyosaur and dolphin to swim



Embryonic development is another proof

- Embryos retain ancestral characters
- We may now switch development programs and uncover hidden structures



Mammal embryo with gills



Switching fly back to four wings



Molecular biology tells about common roots

- All living things have same molecular base
- Genetic distance between close species is small
- Human DNA contains “fossil” viruses:
<http://www.biomedcentral.com/1471-2148/8/266> and
silenced genes (pseudogenes, e.g., olfactory receptor genes in humans)



Chimpanzee and human: only 1% difference

```

M T P T R K I N P L M K L I N H S F I D
ATGACCCCGACACGCAAAATTAACCCACTAATAAAATTAATTAATCACTCATTATCGAC 60
||||||| | ||||||| ||||| ||||||| ||||||| ||||||| |||||||
ATGACCCCAATACGCAAAACTAACCCCTAATAAAATTAATTAACTCACTCATTCATCGAC 60
M T P M R K T N P L M K L I N H S F I D

L P T P S N I S A W W N F G S L L G A C
CTCCCCACCCCATCCAACATTTCCGCATGATGGAAGTTCGGCTCACTTCTCGGCGCCTGC 120
||||||| ||||||| ||||||| ||||||| ||||||| || || |||||||
CTCCCCACCCCATCCAACATCTCCGCATGATGAAGTTCGGCTCACTCTTGGGCGCCTGC 120
L P T P S N I S A W W N F G S L L G A C

L I L Q I T T G L F L A M H Y S P D A S
CTAATCCTTCAAATTACCACAGGATTATTCCTAGCTATACACTACTCACCAGACGCCTCA 180
|| ||||| ||||| ||||||| ||||||| || || ||||||| ||||||| |||||||
CTGATCCTCAAATCACACAGGACTATTCCTAGCCATGCACTACTCACCAGACGCCTCA 180
L I L Q I T T G L F L A M H Y S P D A S

```



Biogeography shows why species evolve

- Isolated islands and small continents facilitate analogous forms (parallel evolution and radiation)
- Many groups of animals and plants now reflect Gondwanan distribution



Can you distinguish Australian sugar glider from American flying squirrel?



Araucaria in growing only in South America, New Zealand and Australia



Evolution evolved from hypothesis to the fact and then to research program

- Ⓐ Hypothesis
- Ⓑ Theory
- Ⓒ Fact
- Ⓓ Research program



Questions before exam 1?



Summary

- Given the amount of evidence presented, evolution is a fact
- Evolution is also an extremely useful, working research program, both in biology and medicine



For Further Reading



Evolution.

<http://en.wikipedia.org/wiki/Evolution>



Evidence of common descent.

http://en.wikipedia.org/wiki/Evidence_of_common_descent

