Evolutionary Biology

BI 432

Dr. Craig Moyer

Textbook

- Barton et al., Evolution, 1st edition, 2007
- www.evolution-textbook.org

Readings and Studying

- Only material covered in lecture during exams.
- Textbook chapters listed in syllabus are intended as help for finding information and are not required reading.
- It is your responsibility to find and extract the necessary information for studying.

What is Evolution?

- Change over time via descent with modification and often diversification from common ancestors.
- Latin for unfold or unroll
- English for change
- Unifying theory of biology

The Universal Tree of Life

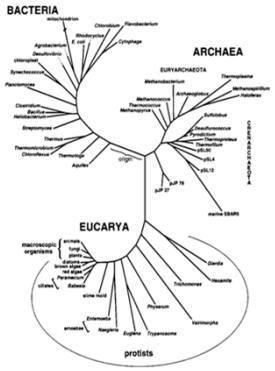


Figure 1. Diagrammatic "Universal" phylogenetic tree of life, based on small-subunit ribosomal RNA sequences. Based on analyses of Barns et al. (1996b), Olsen et al. (1994), and Sogin (1994).

Examples of the three Domains of Life

What is Evolutionary Biology, and Why Is It Important?

- Fundamental Observations: Diversity and Adaptation
- Evolution as Explanation of Biology
- Evolution as Fact and Theory

Fundamental Observations: Diversity and Adaptation

1. Diversity of all characteristics & forms
2. Changes in diversity
3. Apparent "good fit" of organisms to the environment

Courtesy of R.F. Denno

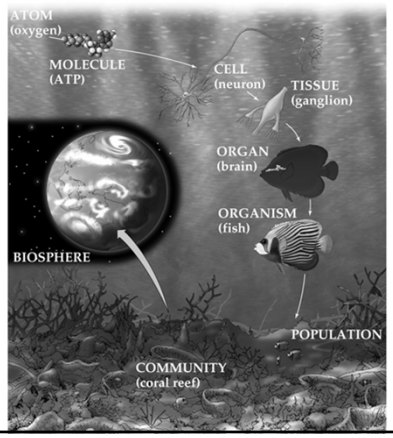
Why do some species vary so much from place to place, while others hardly vary at all?

Why do the form and function of organisms fit their environment so well?



Evolution as Explanation of Biology:

1. Levels of organization in biology: From molecules to populations and beyond
2. Proximate and ultimate causation
3. The concept of fortuitous contingency
4. Testable hypothesis using scientific method



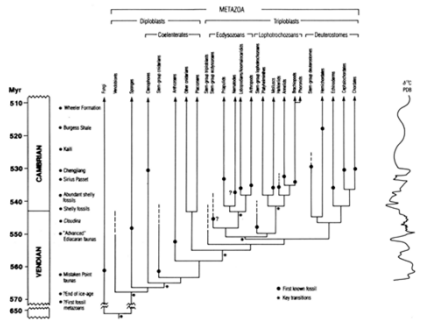
Proximate vs. Ultimate Causation

- **Why do birds sing in the spring?**

Proximate vs. Ultimate Causation

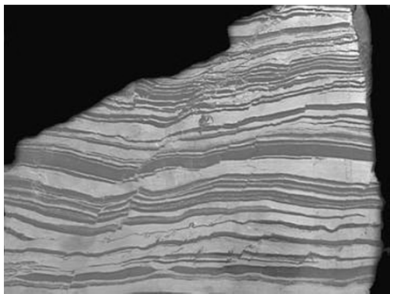
Proximate cause is the immediate trigger for a behavior. For example, if a zebra is drinking at a water hole, and all of a sudden it hears another zebra nearby make an alarm call, it may stop drinking immediately and start running away instead. The proximate cause of the zebra running away would be the alarm call. But the ultimate cause, or real reason why the zebra is running is survival. It is running away because it wants to survive. The alarm call is not the source of danger, but the alarm call alerts the zebra that danger, such as a lion, may be nearby and the lion can threaten the zebra's chance to survive.

Principal events across the Vendian-Cambrian boundary, spanning an interval of approximately 60 Myr (570–510 Myr), in the context of the early evolution of metazoans.



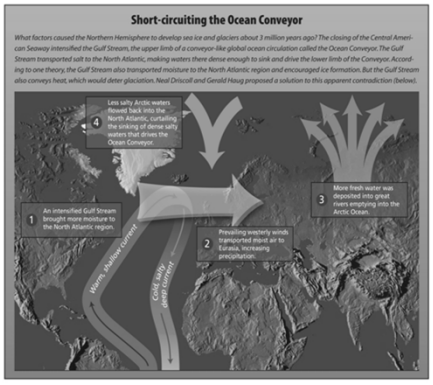
Conway Morris S PNAS 2000;97:4426-4429

Fortuitous Contingency



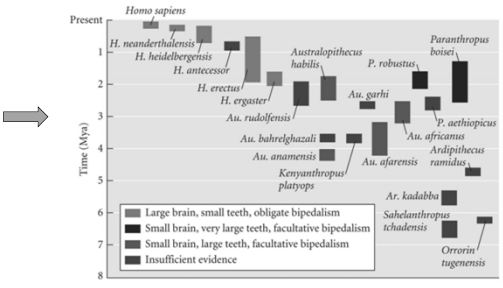
BIFs aka Banded Iron Formations

Fortuitous Contingency



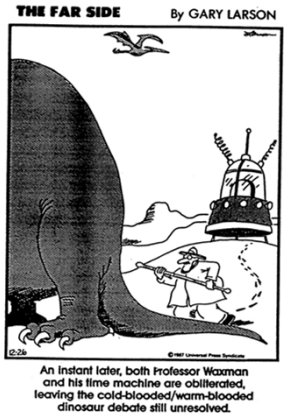
Fortuitous Contingency

The approximate temporal extent of named hominin taxa in the fossil record



Fortuitous Contingency

Scientific Method



Evolution as Fact and Theory:

1. Change over time
2. Descent with modification
3. Evolution by <u>natural selection</u>

N.S. = Mechanism of sorting individuals among hereditary variations.

The Logic of Darwin's Theory

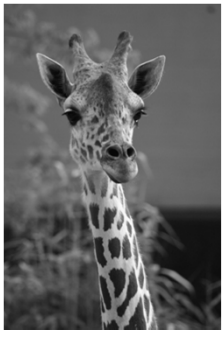
- **Some variants have traits that make them more likely to survive and/or reproduce than other variants, and will therefore produce more offspring than the other variants. This is natural selection.**

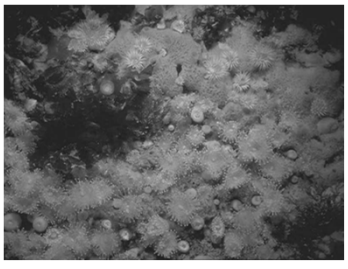
Why do fossils from different sedimentary layers differ as they do?

Why Should We Care about Evolutionary Biology?

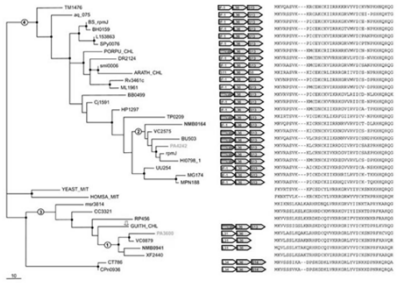
- It illuminates our understanding of nature.
- It illuminates our understanding of ourselves.
- It helps answer questions in conservation biology.
- An evolutionary understanding can be used to improve the human condition.

How have the various animal body forms evolved?



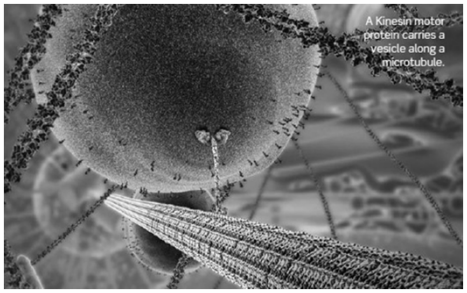


Why are some genes remarkably similar among organisms?



Phylogenetic tree, conserved gene context and multiple alignment of L36 ribosomal proteins. A maximum-likelihood unrooted tree was built using the MOLPHY program. Those branches that were supported by bootstrap probability greater than 70% are marked by small black circles.

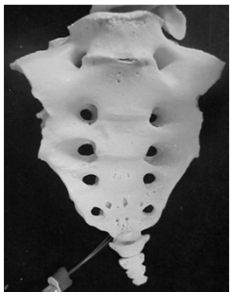
How did complex cell structures evolve?

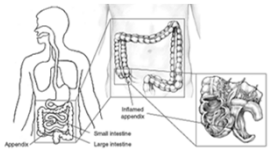


Why do organisms have sex - sometimes at great cost?

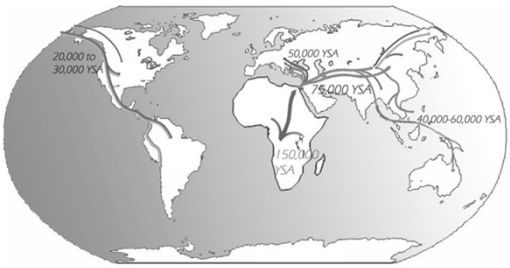
Why do organisms get old and die?

Evolutionary biology helps us understand our quirks...

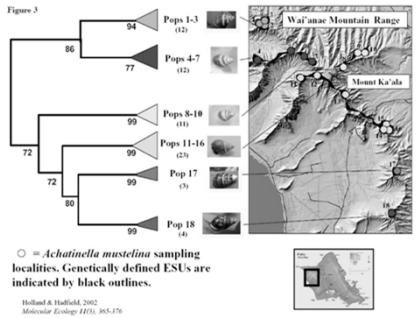




…and how we peopled the earth.



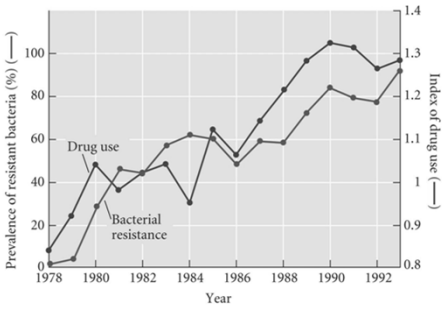
Which organisms are distinct enough to warrant protection?



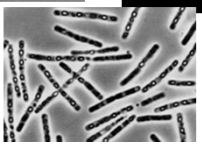
ESU = Evolutionary Significant Unit

How should we maintain genetic variation?

Evolutionary biology explains why *Moraxella* bacteria become resistant to antibiotics so quickly.



Similarly, evolutionary biology helps guide efforts to slow the evolution of pesticide resistance in insects.



Evolutionary biology may help minimize the risks of transgenic crops.

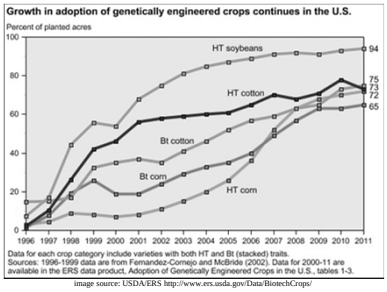


image source: USDA/ERS http://www.ers.usda.gov/Data/BiotechCrops/

herbicide tolerance (HT): most common inserted trait, makes the crop resistant to a particular herbicide (usually Roundup; different inserted genes encode resistance to different herbicides)
insect resistance (Bt): second most common trait, gene for Bt toxin (originally found in bacteria) is toxic to chewing insects
increased nutrients: researchers have explored many different methods of increasing production of vitamins and other nutrients in plants - some are currently on the market and some are in developmental stages (for example, "golden rice" produces 23 times more beta-carotene than normal rice)