EEB 2245/2245W

Lecture 1. Introduction. The uses of evolutionary biology. Evolution vs. Creationism

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Evolution: Patterns and Processes …

- Patterns
  - How many species are on earth? What are they?
  - How are species related to each other?
  - How is biodiversity distributed across the earth?
- Processes:
  - How do populations evolve?
  - How does genetic variation shape evolution?
  - How is variation among populations translated to variation among species? i.e., How do species form?
  - Once formed, how do species interact genetically? Evolutionary consequences of cross-species gene exchange (hybridization).

Lecture Topics

- Definition of Evolution
- Uses for Evolutionary Biology
- Evolution vs. Creationism

Remainder of semester: Population biology
Hardy-Weinberg
Violations of H-W
Inbreeding, drift, gene flow, natural selection
Geographic variation
Speciation
Hybridization

Definitions…

Evolution

- Definition:
- Raw material:

Evolution

- Allele frequencies change over time
- influenced by chance, gene flow, and/or natural selection

Speed of allele fixation

- Influenced by population size
- Rate of immigration of alleles
- Strength of natural selection

i.e., drift, gene flow, natural selection

Adaptations

- characteristics favored by selection
- e.g., woodpeckers- strong pointed beak, long probing tongue, heavy skull, stiff tail w/central feathers last to molt

woodpecker convergent evolution

Akia'pola'au

Galapagos woodpecker finch

Red-bellied woodpecker

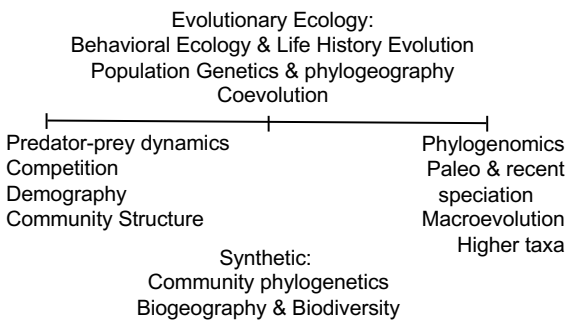
http://www-tc.pbs.org/lifeofbirds/brain/03finch.jpg;
http://www.pinebarrensanimals.com/web_images/pix1/redbelliedwoodpecker1.jpg
http://www.hawaii-forest.com/_img/natural-history/essays/bird2_lg.jpg

Avoid teleological thinking

Evolution can lead to the formation of new species and higher taxa

Can be depicted in an evolutionary tree/phylogenetic tree

The Continuum between Ecology & Evolutionary Biology



Uses of Evolutionary Biology

New course: Evolutionary Medicine EEB 3245

Gluckman, Beedle, and Hanson. 2009. Principles of Evolutionary Medicine, Oxford University Press.

Stearns and Medzhitov. 2015. Evolutionary Medicine. Sunderland: Sinauer Associates, Inc.

- Heterozygous Advantage: Favism
- Evolutionary of Fever
- Evolution of Virulence
- Evolution of resistance: Malarial parasite

Emerging Diseases: virulence

The evolution of virulence in viruses and other pathogens –e.g., virulence of the pathogen is related to "the cost of transmission."

Virulence evolves differently depending on mode of transmission (e.g., person to person vs contaminated water sources).

i.e., is the pathogen in danger of going extinct by killing hosts and are live hosts necessary for transmission?

Emerging diseases: fever

- Hypothesis 1. Fever favors pathogen. (high temperature raises reproductive rate of virus or bacteria)
- Hypothesis 2. Fever favors host (person infected)- the host immune system may be more effective at high temperature or pathogen may reproduce slower at high temperatures.

Emerging diseases: fever in Iguanas

- behavioral thermoregulation
- choice experiment
- iguanas with naturally occurring bacterial disease given a choice of different temperature environments
- choose body temperatures 2 degrees C higher.
- Discussion question: What do you predict happened when inguanas were injected with the same bacteria but killed?

Emerging diseases: fever in Iguanas

- Second experiment…
- Iguanas injected with live viruses
- kept at different fixed temperatures.
- Warm temperature dramatically increased lizard survival.

Phylogenetic Search for Natural Products

- Natural products used in medicine, food production, biotechnology, pest control
- Millions of potentially useful natural products yet to be screened or discovered
- Phylogenetic search for organisms related to those already known to be useful (e.g., taxol from Pacific Yew rather than rare relative)

Loss of biodiversity

Case Study: Natural Products

- Chemists working closely with evolutionary biologists /systematists who locate, identify, and describe new species of poison-dart frogs, new compounds identified
- E.g., epibatidine, alkaloid from the skin of South American poison-dart frog, *Epipedobates tricolor*, 200 x's more powerful than morphine

http://www.fedragonzalez.com/online/images/glry15_jpg.jpg

Phylogenetic Solutions related to Wildlife & Fisheries

- Understanding population structure helps predict probability of extinction
- Hybridization can cause extinction
- Genetic identification of stocks aids management
- Understanding natural selection: Artificial selection by human fishing results in stocks w/ small body size (early reproduction)

Evolutionary Solutions for Endangered Species Conservation

- Case Study: Phylogenetic analyses based on molecular genetic data- important in the detection of illegal hunting of wildlife

Detecting Sale of Protected-Whale Meat

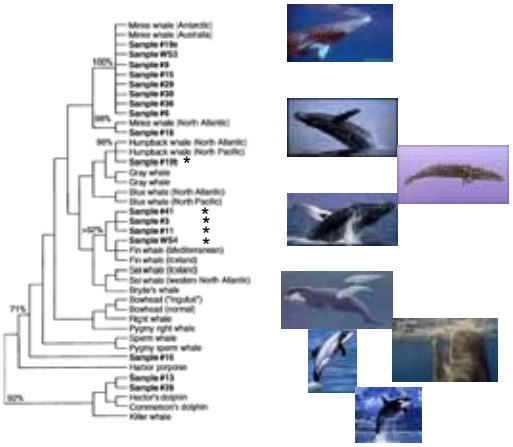
- Global moratorium on commercial harvest of endangered cetaceans- International Whaling Commission, 1985
- Whaling of non-endangered species still allowed in eastern Asia and Scandinavia
- Small cetaceans like porpoises or dolphins are legal to harvest but some whale species are protected

Detecting Sale of Protected-Whale Meat

- In the early 1990's Baker and Palumbi began purchasing "whale products" from Asian markets for mtDNA analysis
- By comparing unknown samples against a reference database of cetacean mtDNA sequences, they were able to identify species and sometimes geographic source of each sample

Detecting Sale of Protected-Whale Meat

- By 1999, 954 samples of "whale meat" had been purchased in Japan and Korea
- 773 were from whales, 9% were from protected whale species (including blue, humpback, fin and Bryde's whales)
- Samples that were not from whales included dolphins, porpoises, sheep and horses
- Led to demands that whales be genetically typed to monitor distribution



Genetically Engineered Organisms

- Risk assessment issues have shifted from concern over transgenic organisms to concern over the long-term effects of hybridization with wild relatives
- E.g., introgression of genes for herbicide resistance, into wild relatives of cultivated plants could create problem weeds; any engineered traits could pass from crops to wild relatives that are storehouses of genetic diversity.

Case Study: Risk of Transgene Spread from *Brassica napus* to *Brassica campestris*

- hybridization and introgression studies of herbicide (glufosinate) tolerant genes from oilseed rape (*B. napus;* mustard family) to its wild relative *B. campestris*
- Produced fertile transgenic weed-like plants after just two generations of hybridization and backcrossing under field conditions
- Suggests a possible rapid spread of transgenes from oilseed rape to its weedy relative

No genetic basis for racism

Studies of genetic variation demonstrate …

•There is much more genetic variation within races than among races

•Human populations have experienced admixture throughout their histories

•All humanity is a single lineage sharing a common evolutionary fate.

A belief in religion does not rule out a belief in evolution

- An understanding of evolutionary principles leads to a predictive understanding of the natural world.
- An understanding of the history of evolutionary biology, specifically the debate between creationists and evolutionary biologists, reveals the fallacy of fundamentalism.

True or False: The Catholic Church supports the teaching of Evolution.



Your text, Futuyma 3e, points out…..

In the history of evolutionary biological thinking, what were the two major shifts in worldview that took place in the 1700's to 1800's?

1)

2)

According to a 2012 survey what percent of the American public believes that humans were created in their current form by a supreme being less than 10,000 year ago?

1. **6%**
2. **16%**
3. **26%**
4. **36%**
5. **46%**

More 2012 Gallop Poll Results

"Which of the following statements comes closest to your views on the origin and development of human beings?"

a) Human beings have developed over millions of years from less advanced forms of life but God guided this process

b)Human beings have developed over millions of years from less advanced forms of life but God had no part in this process

c)God created human beings pretty much in their present form at one time within the last 10,000 years or so.

PEW Trust Poll

- "Humans and other living things have evolved over time"
  - Scientists
  - General US public
- "Humans and other living things have existed in their present form since the beginning of time,"
  - Scientists
  - General US public

PEW Trust Poll

- "Humans and other living things have evolved due to natural processes such as natural selection"
  - Scientists
  - General US public
  - "A supreme being guided the evolution of living things for the purpose of creating humans and other life in the form it exists today."
  - Scientists
  - General US public

Presidential words on science, religion, and the teaching of evolution: Barak Obama, George W. Bush, Ronald Reagan, or Woodrow Wilson?

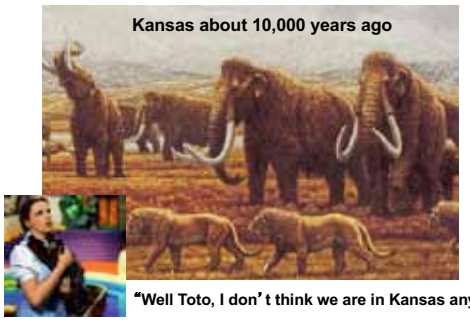
- "Of course, like every other man of intelligence and education I do believe in organic evolution.
- It surprises me that at this late date such questions should be raised.

Source: National Center for Science Education

In 1987, a US Supreme Court decision banned teaching of the biblical story of creation in public schools.

Did this stop proponents of creationism from attempting to insert their religion into the classroom?

Take a Guess: In 2003, in how many US states was legislation introduced to require teaching creationism alongside evolution?



"Well Toto, I don't think we are in Kansas anymore!"

Some well-known recent challenges to science education:

- 2004 Georgia State K-12 science education standards
- 2005 Kansas State Board of Education public school science standards
- 2005 Warning stickers on Georgia public school science textbooks "evolution is a theory, not a fact"

On 7 August 2012, voters in Missouri overwhelmingly approved an amendment to the state constitution regarding religious freedom.

"….no student shall be compelled to perform or participate in academic assignments or educational presentations that violate his or her religious beliefs."

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2012- TN passes "monkey bill" teach the controversy

Landmark trials

Clarence Darrow & William Jennings Bryan, 1925

http://law2.umkc.edu/faculty/projects/ftrials/scopes/scopes.htm

Are humans descended from monkeys?

"I believe in Genesis 1:1 -- God created the heavens and the earth…If the Governor wants to believe that he is the descendant of a monkey, then he has the right to believe that -- but I disagree with him on this and the many other liberal beliefs he shares with Democrats.

Statement by a Pennsylvania state senator in 2011

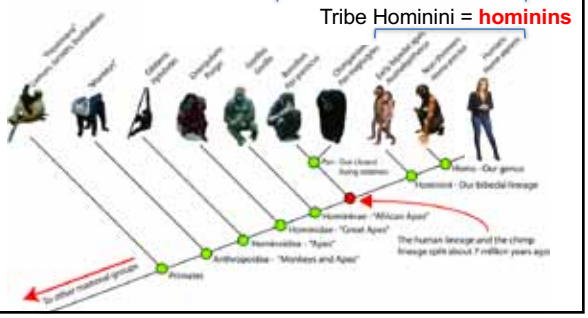
Superfamily Hominoidea= hominoids = apes

Family Hominidae = **hominids** = great apes

Subfamily Homininae = hominines = African apes

Supertribe

Tribe Hominini = **hominins**



Intelligent Design. A term that originated in the 19th century

Started to take its present form in the 1960's and 1970's; co-opted for political purposes more recently.

Argues that "irreducible complexity" is evidence for ID

Impossibility of evolution of complex organs or biochemical systems because, e.g., "half an eye would not work"

Uses reasoning by incredulity, "How could that be?"

Landmark trials

2005 Kitzmiller vs Dover

https://www.youtube.com/watch?v=7HZzGXnYL5I

NCSE Nov-Dec 2014

2014: state republican party platforms

Oklahoma: "We believe that the scientific evidence supporting Intelligent Design and Biblical creation should be included in Oklahoma public schools curricula. And where any evolution theory is taught both should receive equal funding, class time, and material."

Alaska: "We support teaching various models and theories for the origins of life and our universe, including Creation Science or Intelligent Design. If evolution outside a species (macro-evolution) is taught, evidence disputing the theory should also be presented."

Similar platforms can be found in Iowa, Kansas, Minnesota, Missouri, North Dakota, and Texas and probably others.

Posted 25 Feb 2016

Stop the Ohio anti-science bill

Submitted by Minda Berbeco on February 25, 2016 - 11:33

Ohio's HB 597 poses a threat to students and science education throughout the Buckeye State. Ohioans must reach out to their legislators now to urge that the anti-science provisions be blocked or removed.

The bill's sponsor bragged, as the Cleveland Plain Dealer put it, that the bill "prevents teachers and schools from only presenting one side of a political and scientific debate — global warming, for example, without presenting the other side." As for "intelligent design" or other forms of creationism, sponsor Andy Thompson (shown at right) added, "I don't know that it needs to be treated on par [with evolution], but districts will be able to choose based on their judgment."

The bill is already being heard in committee! Ohioans should contact their legislators immediately, and urge that the bill be blocked or amended. Those living elsewhere should reach out to their friends and family in Ohio and urge them to do the same.

The bill prevents teachers from presenting only one side of a political and scientific debate.

Science denial spills over into other disciplines….

Climate change denial in Texas social studies textbooks

Submitted by Minda Berbeco on February 24, 2016 - 13:16

The Texas state board of education will adopt new social studies textbooks in November, 2014. The decisions they make will affect Texas classrooms for years to come, and are likely to change how textbooks are written for use in other states as well. In geography and economics classes, some of the textbooks discuss climate change in ways that are simply false, or even promote outright climate change denial.

Texans must **tell publishers and the state board of education** that climate change denial has no place in Texas classrooms, and the errors must be fixed immediately.

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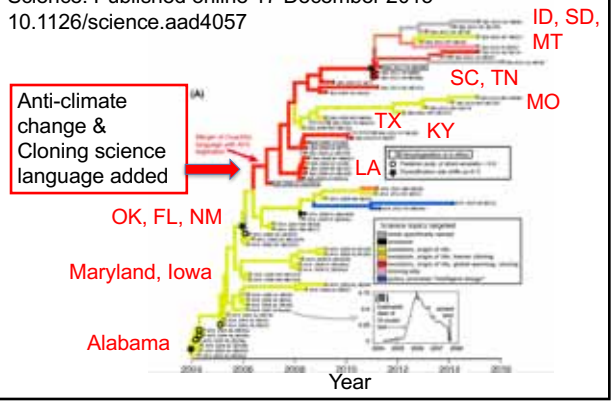
Stop climate change denial in West Virginia standards

Denial was added to state science standards

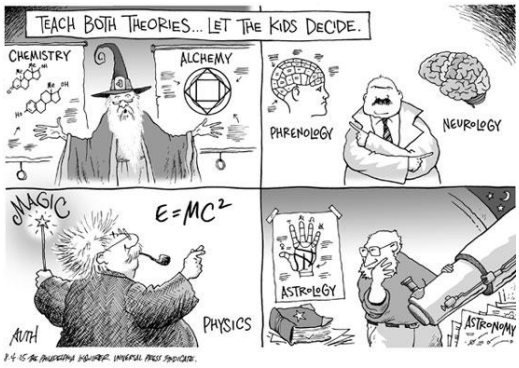
Submitted by Minda Berbeco on February 24, 2016 - 15:15

West Virginia state board of education members have added climate change denial to the state's science standards, overruling the scientists, educators, and state education leaders who drafted New Generation Science Standards. Concerned citizens must contact the board (email the superintendent or call the department of education to leave a comment) and the governor now, sign a petition opposing these misguided edits (and register below for action alerts), and plan to attend and testify at the public hearing on Wednesday, January 14. There is still time to reverse these changes.

Matzke, N. J. 2016. The Evolution of Antievolution Policies. Science. Published online 17 December 2015 10.1126/science.aad4057



Science versus Pseudoscience



Arguments against teaching creationism (or "Intelligent Design") in science class:

1) Creationism is not science. It is a belief based on faith. Science is based on facts and testable hypotheses.

Popular misconception of def. of "theory"

Popular def:

Science def:

Scientists test vs. prove hypotheses- gather data to support or refute- remain skeptical

Religion is a belief system; But "faith" does not mean unquestioning

Arguments against teaching creationism (or "Intelligent Design") or "the controversy" in science class:

2) Evolution is not controversial among scientists.

3) Fossil evidence inconsistent with literal interpretation of Christian bible.

4) Separation of church and state required by constitution.

Arguments against teaching creationism (or "Intelligent Design") or "the controversy" in science class:

5) There are many versions of creation? Which should be taught? Buddist, Native American, Muslim, Hawaiian, Christian, etc.

6) Religion should be taught by individual faiths outside of public school classrooms.

Religion and science not necessarily incompatible. Literal biblical creation held by few; most churches support evolution/ science.

The great schism is not between science and religion but rather between certainty and uncertainty, tolerance and intolerance.