EEB 2245/2245W

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

Chris Simon
Professor, Ecology & Evolutionary Biology
Spring 2017

Question

Answer anonymously on the quarter sheet of paper you just received…..

In your opinion, what are the five greatest threats facing the world today?

List five. The order does not matter.

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? What are the 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: The study of changes in the characteristics of populations of organisms (allele frequencies) over time (over generations);
- Darwin's "descent with modification."
- Raw material: variation caused by mutations (allele [DNA base] substitutions)

Evolution

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

Speed of allele fixation

- Influenced by population size (strength of drift)
- Rate of immigration of alleles (strength of gene flow)
- Strength of natural selection

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

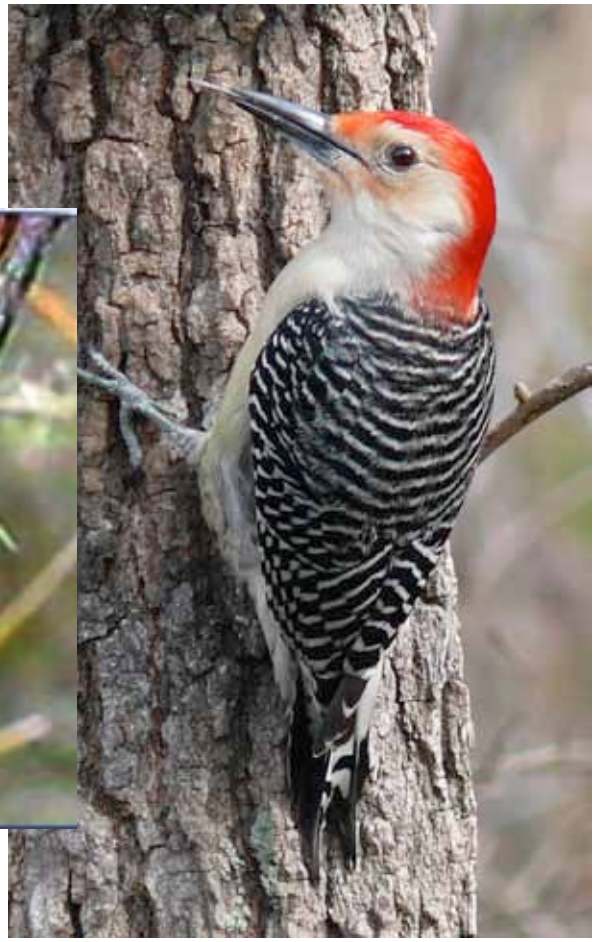
Adaptations

- = 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

This is the key to understanding natural selection.

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

Evolutionary Ecology:
Behavioral Ecology & Life History Evolution
Population Genetics & phylogeography
Coevolution

Predator-prey dynamics
Competition
Demography
Community Structure

Phylogenomics
Paleo & recent speciation
Macroevolution
Higher taxa

Synthetic:
Community phylogenetics
Biogeography & Biodiversity

EEB 2244 F 2016
partial Syllabus

Ecology & Evolution topic overlaps *

Th, September 15	Adams	**Evolution and ecology** *
Su, September 18		**Online Quiz 1 due**
Tu, September 20		**Exam 1**
Th, September 22	Adams	**Life history** *
Tu, September 27	Adams	**Behavioral ecology** * 3rd edition: Chapter 8. This chapter is missing in the 1st and 2nd editions.
Th, September 29	Adams	**Population distribution and abundance**
Tu, October 4	Adams	**Population growth and regulation**
Th, October 6	Adams	**Population dynamics**
Tu, October 11	Adams	**Competition**
Su, October 9		**Online Quiz 2 due**
Th, October 13	Adams	**Exam 2**
Tu, October 18	Turchin	**Predation and herbivory** *
Th, October 20	Turchin	**Parasitism** *
Tu, October 25	Turchin	**Mutualism and commensalism** *
Th, October 27	Turchin	**The nature of communities**
Tu, November 1	Turchin	**Change in communities**
Th, November 3	Turchin	**Biogeography** *

Also, conservation biology

Previous Classes Answers to the "Most Serious Threats"

1) Emerging diseases
2) Loss of biodiversity, ecosystem services, food
3) Loss of abiotic resources clean water, air, minerals, soil
4) Terrorism, Intolerance, war (racism, religious persecution)
5) Climate Change (intensifying earth processes)
6) Overpopulation

Most Serious Threats 2016, 2015, 2013, 2011, 2010, 2009, 2008, 2006, 2004

- **1) Pollution/loss of resources** (air, water, drought, solid waste, nitrification, nuclear accidents, nuclear waste, industrialization, overconsumption, loss of fossil fuels)

[**25%, 39%, 24%, 39%, 26%, 31%, 30%,** 22%, 23%]

= percent of answers that were in this category in each year listed above.]

- **2) Cultural conflict:** (intolerance, ignorance, racism, religious fundamentalism, repression of women, homophobia; Politics- corruption, greed, unequal distribution of wealth, globalization, corporate corruption, poverty, hunger, War/Terrorism)
- [18%, 17%, **23%, 25%,** 26%, 15%, 20%, **33%, 27%**]
- **3) Climate Change** (global warming, sea level rise, severe weather, greenhouse gasses)
- [**23%,** 15%, **20%,** 17%, 20% **27%,** 20%, 12%, 10%]
- **4) Loss of biodiversity** (extinction, habitat conversion, deforestation, poaching, urbanizationinvasive species, invasive genes,, over-fishing, famine, bee decline).
- [**21%,** 09%, **23%,** 08%, 12%, 07%, 18%, 12,% 16%]
- **5) Overpopulation-** This influences many of the other categories.
- [07%, 14%, 11%, 09%, 09%, 16%, 08%, 09%, 11%]
- **6) Emerging diseases** (AIDS and other new viruses, Cancer from cigarettes/ozone depletion, obesity, lack of access to medical care, antibiotic resistant staph & other deadly bacteria, medical law suits, lack of sanitation, HVNI bird flu, and their spread due to globalization, epidemics)
- [06%, 09%, 00%, 03%, 07%, 04%, 04%, 12%, 12%]

Uses of Evolutionary Biology to address threats

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?

Two hypotheses: Evolution of fever

- Hypothesis 1. Fever favors pathogen. (high temperature raises reproductive rate of virus or bacteria) [Suppress it]
- 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. [Do not suppress]

Emerging diseases…

Experiment: 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: Second experiment: What do you predict happened when iguanas were injected with the same bacteria but killed?

Emerging diseases…

Experiment: fever in Iguanas

- Third experiment…
- Iguanas injected with live bacteria
- kept at different fixed temperatures.
- What you do think happened?

Emerging diseases…

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.

- Evolution of virulence and fever (above slides)
- Heterozygous Advantage: favism and malaria
  - Show & tell: tonic water and fava beans
- Evolution of resistance: malarial parasite

Threats: Loss of biodiversity

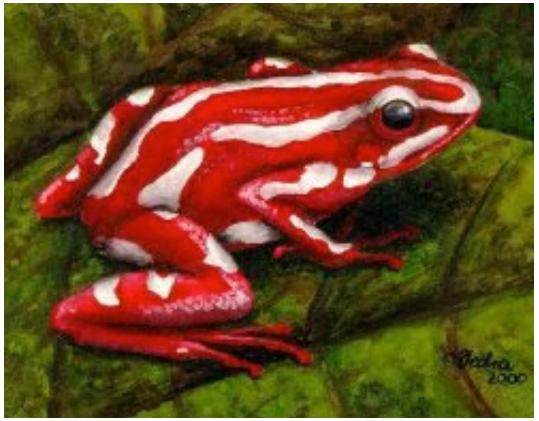
Solution: Phylogenetic Search for Natural Products

- 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)

Threat: Loss of biodiversity

Case Study: Natural Products

- Chemists work 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

End of Lecture 1

7 March 17