Monday 13 February 2006, 13th class meeting
(Miller Chapters 3 & 4; Quammen; RedSky2)

Environmental Biology (ECOL 206)
U. Arizona, spring 2006

Kevin Bonine, Ph.D.
Alice Boyle, Kristen Potter, Graduate TAs

1. Evolution
2. Quammen 1985, Red Sky Ch. 2
3. 206 Lab Website for handouts and assignments
4. Thank Taylor Edwards
5. Exam I Wed 15 Feb

Guy McPherson

"Threats to Biological Diversity in the Sky Islands: Can an Informed Citizenry Overcome Society?"

Sky Island Alliance and the Environmental Law Society are hosting a speaker series that will run January-May 2006 with one speaker event each month. Our second event will be held on:

Wednesday, February 15, 2006
at the University of Arizona Rogers College of Law
1201 E. Speedway Blvd. Room 140

The presentation will begin at 6 p.m. with an opportunity to ask questions and interact with our speaker afterward. Free. Call Sky Island Alliance 624-7080 x209 for more information.

Abstract:
Development of a just, sustainable human enterprise requires us to acknowledge and account for the explicit links between environmental protection, social justice, and the human economy. This will require contributions from virtually every segment of society, and, while striving for global ideals, we must start with local actions. I describe historical and contemporary "drivers" behind relatively coarse-scale ecosystems in the Sky Islands of the American Southwest. Cursory inspection of factors such as fire, livestock grazing, urbanization, biological invasions, and regional climate change indicate the important role played by the current generation of decision-makers in creating a just, sustainable future. I provide a general template and some specific examples that may facilitate the transition to sustainability.

Biographical sketch:
Guy R. McPherson is a professor in the University of Arizona School of Natural Resources, and he holds an adjunct appointment in the Department of Ecology & Evolutionary Biology. He is an award-winning researcher, teacher, and mentor.


We hope to see you there!

Our March speaker event will be on March 9th with speaker Bruce Babbitt.
Modern Synthesis (Evolutionary Synthesis), 1930s

Mendel
   (genetics, 1865)
   +
Darwin
   (natural selection, 1859)
   +
Paleontology
   (speciation, extinction, plate tectonics [Lyell Geology])
   +
   etc.

- Ernst Mayr (1942 *Systematics and the Origin of Species*)
- Theodosius Dobzhansky
- George Gaylord Simpson
- G. Ledyard Stebbins

Species = ?

**Biological Species Concept (Mayr)**
“a group of interbreeding populations that are reproducively isolated from other such groups”

2-morphological/typological species concept (plants)
3-evolutionary species concept
4-genetic species concept
5-paleontological species concept
6-cladistic species concept
Ernst Mayr is one of the greatest influences on evolutionary biology since Darwin. Mayr was one of the architects of the evolutionary synthesis of the 1930s and 1940s, which unified biology by integrating Darwin's theory of natural selection with new discoveries in genetics, paleontology, and taxonomy. Mayr based his views on evolution mainly on relationships among bird species that he studied on Pacific islands. Now 89 years old, Mayr, Professor Emeritus at Harvard, is still going strong and generating exciting new ideas. His latest book, One Long Argument (Harvard University Press, 1991), analyzes Darwin's theories. I interviewed Professor Mayr at his summer cottage in New Hampshire.

Ernst Mayr (1904-2005)
Published papers for > 80 years

You've also written that we humans have extraordinary responsibility because of our uniqueness as a species. Yes, humans are basically responsible for all the bad things that at the present time happen to our planet, and we are the only ones who can see all these things and do something about them. If we would stop the human population explosion, we would have already won two-thirds of the battle. That we live here just as exploiters of this planet is an ethic that does not appeal to me. Having become the dominant species on our planet, we have the responsibility to preserve the well-being of this planet. I feel that it should be a part of our ethical system that we should preserve and maintain and protect this planet that gave origin to us.

Ernst Mayr interviewed in Campbell 1993
Biological Species Concept
1. Testable and operational
2. Definition compatible with established legal concepts
3. Focus on level of biodiversity that agrees with tradition of conservation

Conserve Species as
TYPES
or as
EVOLUTIONARY UNITS

David Quammen 1985
Is Sex Necessary?
Natural Acts

- Parthenogenesis (“virgin birth”)
- Asexual vs. Sexual Reproduction
- Recombination

Aphids are excellent opportunists (v. equilibrium ‘K’ species)
- Asexual (rapid, exploitation)
- Then Sexual (shuffle the genes once/year)

Maintain
- variability
- diversity
- adaptability

1 aphid, 6 generations, \( \rightarrow 318,000,000 \)
Campbell 1993

Mendelian Genetics

Figure 13.1
Gregor Mendel (1822–1884). Based on his experiments with garden peas, Mendel built a model of inheritance that became the foundation of modern genetics. His published records of these experiments provide a window into a great scientific mind. This chapter examines Mendel’s experiments and conclusions and applies Mendelian concepts to human heredity.

Campbell 1993

Figure 13.2
A genetic cross. To hybridize between pea varieties, Mendel used an artist’s brush to transfer pollen. In this case, the character of interest is flower color, and the two varieties are purple versus white flowers. Seeds develop within the female organ, or carpel, which develops into the fruit (pod). Determination of the seeds produces the first generation hybrids, which all have purple flowers. The result is the same for the reciprocal cross, the transfer of pollen from purple flowers to white flowers.

Campbell 1993

Chapter 20: Descent with Modification: A Darwinian View of Life
**Mendelian Genetics**

**One gene**

**Two alleles**

**Dominant (purple)**

**Recessive (white)**

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**Figure 13.3**

Mendel tracked heritable characters for three generations. When F1 hybrids were allowed to self-pollinate, or when they were cross-pollinated with other F1 hybrids, a 3:1 ratio of the two varieties occurred in the F2 generation. An "X" sign signifies a genetic cross, or mating.

Campbell 1993

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**Figure 13.6**

A testcross. A testcross is designed to reveal the genotype of an organism that exhibits a dominant trait, such as purple flowers in pea plants. Such an organism could be either homozygous or heterozygous for the dominant allele. The most efficient way to resolve the genotype is to cross the organism with an individual expressing the recessive trait. Since we know the genotype of the white-flowered parent (it must be homozygous for this trait to be expressed), we can deduce the genotype of the purple-flowered parent by observing the phenotypes of the offspring.

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**Figure 13.19**

Incomplete dominance in snapdragons color. When red snapdragons are crossed with white ones, the F1 hybrids have pink flowers. Segregation of alleles into the gametes of the F1 plants results in an F2 generation with a 1:2:1 ratio for both genotype and phenotype.
DNA sequence Codes for Proteins etc.

Genetic Code
A (adenine), T (thymine), [U(uracil)], C (cytosine), G (guanine)

(Coding, sense strand)
ATGGAATTCGCTC
(Template, antisense strand)
AGCAUGAGCGAG

(3' -> 5')

1-Transcription
2-Translation

Proteins of amino acids
Result of **Disruptive Selection** *(Favors Both extremes)*

**Figure 4.5** Experimental disruptive selection on omphalophoral bristle number in the fruitfly *Drosophila melanogaster*. Individuals with many or few bristles were allowed to breed, while those with intermediate numbers were not. The population rapidly diverged. Adapted with permission from Thoday and Gibson (1962). Copyright 1962 Macmillan Magazines Limited.

**Drosophila Bristle Count**

**Disruptive Selection** *(Favors Both extremes)*
Selection for Human Birth Weight

Figure 6.24 Stabilizing selection on birthweight in humans. The histogram shows the distribution of birthweights in a sample of 5,720 babies. The average birthweight is about 7 pounds. The right vertical axis and the data points with best-fit curve show mortality rate as a function of birthweight (in a logarithmic scale). The mortality rate is much higher among very small and very large babies than among babies of average size. (Note that the figure, shows the probability of survival, whereas in Figure 6.33, it shows the probability of surviving.) The optimum birthweight is that with the lowest mortality rate. It is very close to the population average. Manual selection on birthweight in the population tends to hold the population average at a constant value. From Calabrese and Bachrach (1972) and references therein.
Speciation often result of:
1. Geographic Isolation
2. Reproductive Isolation

(Genetic Drift)

Stalk Eyed Flies

Sexual Selection
Evolution by **Natural Selection**

**vs. Lamarck**

*Galapagos Finches*

*Brassica oleracea*

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Figure 37–8. A number of common vegetables are members of the same species, *Brassica oleracea*, including cauliflower, broccoli, cabbage, Brussels sprouts, and kohlrabi. Artificial selection is responsible for the variation shown within this species.

Solomon et al. 1993
Alfred Wegener, winter 1912-1913

Crustal Plates moving 1-12 cm / year

Plate Tectonics
Pangea 200 million years ago
Figure 19.3 This shows the best fit of South America and Africa along the continental slope at a depth of 500 fathoms (about 900 meters). The areas where continental blocks overlap appear in brown. (After A. G. Smith, "Continental Drift." In Understanding the Earth, edited by I. G. Cass. Courtesy of Artemis Press)

Figure 19.4 Fossils of Mesosaurus have been found on both sides of the South Atlantic and nowhere else in the world. Fossil remains of this and other organisms on the continents of Africa and South America appear to link these landmasses during the late Paleozoic and early Mesozoic eras.
Convergent Evolution

Giant Armadillo
North America

Giant Anteater
South America

Giant Pangolin
Africa

Spiny Anteater
Oceania

Convergence
Convergent Evolution

In many instances, animals which live in similar habitats resemble each other in outward appearance. These similar looking animals may, however, have quite different evolutionary origins.

Swifts, swallows and martins all hunt for insects while they fly. They have streamlined bodies with long wings.

Hummingbirds and sunbirds feed on nectar from flowers. They have long bills to reach the nectar at the base of flowers.

Based on appearance only we would conclude that sunbirds are related to hummingbirds and that swifts are related to swallows and martins. In reality, genetic techniques have shown that swifts are related to hummingbirds, while sunbirds are related to swallows and martins.

In 1982, testifying before Congress in support of the Endangered Species Act, biologist E. O. Wilson offered his oft-quoted defense: “The worst thing that can happen during the 1980s is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us.”

Speth
Red Sky at Morning
Chapter 2, Lost in Eden
Biologists

Harold Mooney and Paul Ehrlich correctly observe that “ignorance of the services that natural ecosystems supply to the human enterprise—of the reasons that the economy is a wholly owned subsidiary of those systems—amounts to a condemnation of schools, colleges, universities and the print and electronic media.” This area is one of many where we are paying a high price for our neglect of environmental education at all grade levels.

Biophilia (Kellert & Wilson)

Threats:
1. Land Use Conversion (1/3 forests gone, ½ wetlands)
2. Land Degradation
3. Freshwater Shortages
4. Watercourse Modifications
5. Invasive Species
6. Overharvesting
7. Climate Change
8. Ozone Depletion
9. Pollution

Only need ~$30 billion/year to set aside 15% land area
EVOLUTION: A Series of Seven Lectures Exploring our World and Ourselves

Location: Center for Creative Photography Auditorium, 1030 North Olive Road
Parking is available in the Park Avenue Garage

Time: All lectures begin at 7:00 pm

All the sciences, from astronomy to biology, have worked together to discover the processes that create the current state of our universe, our world and ourselves. These evolutionary processes define the origin of the atoms that make up all matter, the origin of stars and planets, and the development of life itself.

The University of Arizona College of Science is proud to present these seven lectures. Each will illustrate this vision of evolution and demonstrate how we know that evolution represents reality.

Tuesday, February 21. Biological Evolution: What It Is and What It Isn't (Joanna Masel, Assistant Professor, EEB)
Tuesday, March 7. Cosmic Evolution: From Big Bang to Biology (Chris Impey, Distinguished Professor, Astronomy)
Tuesday, March 21. Earth Evolution: The Formation of Our Planet (Joaquin Ruiz, Dean of COS and Professor, Geosciences)
Tuesday, March 28. Social Evolution: Cooperation and Conflict From Molecules to Society (Rick Michod, Professor, EEB)
Tuesday, April 11. Animal Evolution: Recycling Ancient Genes For New Uses (Lisa Nagy, Associate Professor, MCB)
Tuesday, April 18. Human Evolution: Tracking Our Origins with DNA (Michael Hammer, Research Scientist, ARL/EEB)
Tuesday, April 25. Disease Evolution: The Example of HIV (Michael Worobey, Assistant Professor, EEB)

Call 520.621.4090 or go to cos.arizona.edu for more information.