Biogeography & Biodiversity 19 February 2007
17th class meeting

Pimm et al. 2005
(26 Feb Creativity Topic)

READINGS, Monday 19 Feb:
Biodiversity (on website)
Wed 21 February:
Conservation Genetics (see web link)

Environmental Biology (ECOL 206)
University of Arizona, spring 2007
Kevin Bonine, Ph.D.
Anna Tyler, Graduate TA


Department of Planetary Sciences
Lunar and Planetary Laboratory
University of Arizona

LPL Evening Lecture Series
Presents

"Global Warming: Global Climate Change and the Human Condition"

Professor Emeritus Robert Strom
Lunar and Planetary Laboratory

Tuesday, February 27, 2007, 7:30 PM
Kuiper Space Sciences Lecture Hall (room 308)

Global warming is extremely complex because it deals with so many different
characteristics of the Earth and their complex interactions. It is addressed
by almost all sciences including many aspects of astronomy, geosciences,
atmospheric, the biological and planetary sciences. It has recently become
the concern of other diverse disciplines such as economics, agriculture,
medicine and engineering. This talk will address these complex interactions,
integrate them, and derive meaningful conclusions and possible solutions.

http://www.lpl.arizona.edu/COLPL
Environmental science explores interactions between humans and our environment

Our environment (a term that comes from the French environner, “to surround”) is more than water, land, and air; it is the sum total of our surroundings. It includes all of the biotic factors, or living things, with which we interact. It also includes the abiotic factors, or nonliving things, with which we interact.

Withgott and Brennan 2007
ECOLOGY

Ecology is the scientific study of the distribution and abundance of organisms and how the distribution and abundance are affected by interactions between the organisms and their environment. The environment of an organism includes both physical properties, which can be described as the sum of local abiotic factors such as insolation (sunlight), climate, and geology, as well as the other organisms that share its habitat. The term oekologie was coined in 1866 by the German biologist Ernst Haeckel the word is derived from the Greek οικος (oikos, "household") and λόγος (logos, "study"); therefore "ecology" means the "study of the household [of nature]".

The word "ecology" is often used in common parlance as a synonym for the natural environment or environmentalism. Likewise "ecologic" or "ecological" is often taken in the sense of environmentally friendly.

Darwin’s Finches

Evolution by Natural Selection
Figure 3-11 Phylogenetic relationships and patterns of colonization of vertebrates in the Galapagos Islands. Left: The location of the Galapagos Islands and the junction of the Humboldt Current, which presumably helped transport colonizers to the islands. Right: Three major patterns of relationships of Galapagos vertebrates. The time scale is arbitrary. The arrow on the horizontal axis indicates the time of origin of the present archipelago and the initial radiation of each group. Solid lines indicate the radiation of the endemic Galapagos taxa; dashed lines indicate the relationship of these taxa to their closest living mainland sister group. (A) Patterns of relationships for the land and marine iguanas (Conolophus and Amblyrhynchus), which show minimal differentiation within species, but share a remote common ancestor considerably earlier than the origin of the islands. (B) The giant tortoises (Geochelone) and Darwin’s finches are endemic radiations within the archipelago stemming from a single colonization event. In the case of the tortoises, the mainland ancestral group appears to be extinct. (C) The ground-finch (Geospiza), lava lizard (Tropidurus), and rodent radiations appear to have resulted from multiple introductions from species mainland species already differentiated to some degree. (Source: Pough et al. 2004.)
Wallace's Line
→
Weber's Line

Dispersal Ability

Figure 5-13: Patterns of faunal resemblance among areas of the Sunda Shelf in their frog (top) and snake (bottom) faunas. The numbers reflect the number of shared species between areas, calculated as index of faunal similarity, where Similarity = (Q X number of species in common) / (number of species in area A + number of species in area B). Note that snakes share a much greater proportion of species among these areas than do frogs. This very likely results from differing dispersal capabilities as well as differences in the potential for population isolation and speciation. (Source: Hager and Vrba 2001.)
Dispersal Ability (Isolation by Distance)

Lissamphibia

Urodela
(salamanders)

10 families, 60 genera, 516 spp.

Fig. 13.5
Sloboda and Cohen, 1995

Unken reflex

Amphibian species:

Ambystoma tigrinum

Ambystoma californiense

Stebbins and Cohen, 1995
Urodela families

Figure 3–3  Distribution of salamander families Sirenidae, Hynobiidae, and Salamandridae.

Pough et al. 2004

(only 1 of 10 not found in U.S.)

Sirenidae

Hynobiidae

Salamandridae

Figure 3–4  Distribution of salamander families Cryptobranchidae, Rhyacotritonidae, Amphiumidae, Dicamptodonidae, and Ambystomatidae.

Pough et al. 2004
Nothing in biology makes sense except in the light of evolution.

Theodosius Dobzhansky
**Sarcosuchus imperator**, (‘flesh crocodile emperor’) was a super-crocodile that lived in Africa some 100 million years ago. It was up to 12 metres in length, as long as a bus, and weighed 8 metric tonnes.

Sarcosuchus was not a dinosaur, although it lived in the same era. In fact, it is not even a direct ancestor of modern crocodiles and alligators ... crocodiles and dinosaurs had a common ancestor some 250 million years ago, but soon diverged into two separate groups. The giant Sarcosuchus imperator appeared about 110 million years ago, but died out. Today’s 23 species of crocodiles and alligators took a separate path.

*Figure 5.5: Slightly simplified overview of the biological evolution of life on the earth, which was preceded by...*
Define Evolution...

Change in gene frequencies across generations (in a population).

Population Size
and
Genetic Variability
Adaptive Radiation

Figure 5-10 Adaptive radiation of mammals began in the first 10-12 million years of the Cenozoic era (which began about 65 million years ago) and continues today. This evolution of a large number of new species is thought to have resulted when huge numbers of new and vacated ecological niches became available after the mass extinction of dinosaurs near the end of the Mesozoic era. (Used by permission from Francis E. T. S. and Ralph M. Taggart, Ecology: The Unity and Diversity of Life, 5th ed., Belmont, Calif.: Wadsworth, 1986)

Adaptation depends on Environment

Figure 20.1 Material selection in action: industrial melanism. The English peppered moth, Biston betularia, occurs in a light gray variety and a dark variety. In regions where the landscape was darkened when industrial pollution killed lichens, dark moths increased in relative number and light moths nearly disappeared. The two varieties are shown on (a) a tree trunk covered with lichens and (b) a dark tree trunk lacking lichens due to pollution. In either case, birds find and eat a greater proportion of conspicuous moths than camouflaged individuals (although other factors probably contribute to the comparative success of the two varieties of moths).
Evolution by Natural Selection

1. Trait must be variable
2. Trait must be heritable
3. Trait must differentially affect fitness

Adaptation

1. Trait must be heritable and differentially affect fitness
2. Adaptation implies a comparison
3. Adaptation depends on environment

Ear lobes
Mid-digital hair
Tongue rolling
Mini-thumbs?
Other more important traits/characteristics...
Sickle-cell Anemia:

Change of one nucleotide in human hemoglobin gene:
- One copy may be resistant to malaria
- Two copies leads to anemia (inability to transport sufficient O₂)

Origin of all variation is genetic mutations

In the context of biological evolution:
(each of these does what over time?)

Genes... Mutate (neutral/harmless, detrimental, beneficial)
Individuals... are Selected
Populations... Evolve
How would you respond to the statement: “We should not worry about air pollution because through natural selection the human species will develop lungs that can detoxify pollutants.” - Miller 2005 p.62

- Generation time
- Variability
- Strength of selection

Define FITNESS.
How many species on earth?

~12-14 million total species (50-90% in tropical forests)
~1.7 identified

most

least

~12-14 million total species (50-90% in tropical forests)
~1.7 identified

Scientific American
November 2001
What is biodiversity?

What factors correlated with high diversity?

- Energy
- Precipitation
- Temperature
- Area
- Habitat heterogeneity (e.g., foliage height and birds)
- Stable environment?
- Moderate (intermediate) disturbance level
  (shifting mosaic, no climax)