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)

Lab 21/23 Feb: Meet in lab
Plants, Keys, Library
See assignment on webpage
Lab 28Feb/02Mar: Meet AT VAN
Tumamoc Hill
See reading assignment and handout on webpage

Environmental Biology (ECOL 206)
University of Arizona, spring 2007

Kevin Bonine, Ph.D.
Anna Tyler, Graduate TA

http://eebweb.arizona.edu/courses/Ecol206/206_Page2007.html

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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

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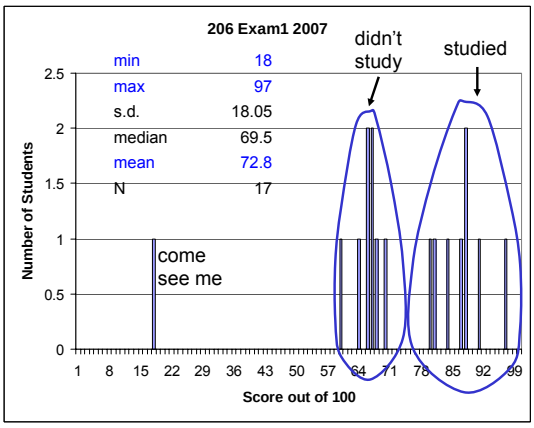

Environmental science explores interactions between humans and our environment

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

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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.

http://en.wikipedia.org/wiki/Ecology

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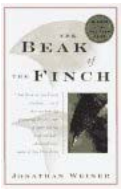

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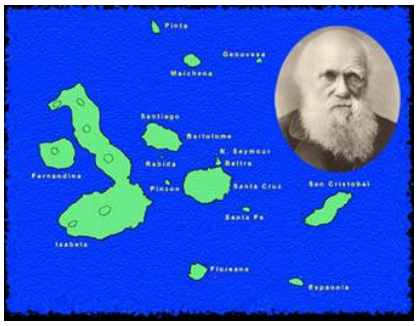

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http://www.rit.edu/~rhrsbi/GalapagosPages/DarwinFinch.html

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http://www.rit.edu/~rhrsbi/GalapagosPages/mockingbird.html

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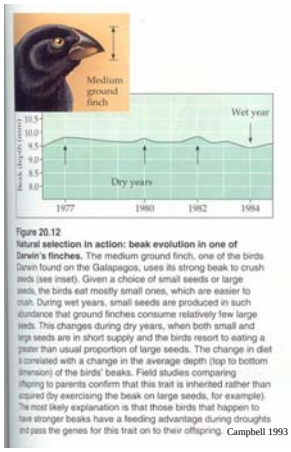

Figure 20.12
Natural selection in action: beak evolution in one of Darwin's finches. The medium ground finch, one of the birds Darwin found on the Galapagos, uses its strong beak to crush seeds (see inset). Given a choice of small seeds or large seeds, the birds eat mostly small ones, which are easier to crush. During wet years, small seeds are produced in such abundance that ground finches consume relatively few large seeds. This changes during dry years, when both small and large seeds are in short supply and the birds resort to eating a greater than usual proportion of large seeds. The change in diet is correlated with a change in the average depth (top to bottom dimension) of the birds' beaks. Field studies comparing offspring to parents confirm that this trait is inherited rather than acquired (by exercising the beak on large seeds, for example). The most likely explanation is that those birds that happen to have stronger beaks have a feeding advantage during droughts and pass the genes for this trait on to their offspring. Campbell 1993

Darwin's Finches

Evolution by Natural Selection

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Galapagos

Humboldt Current

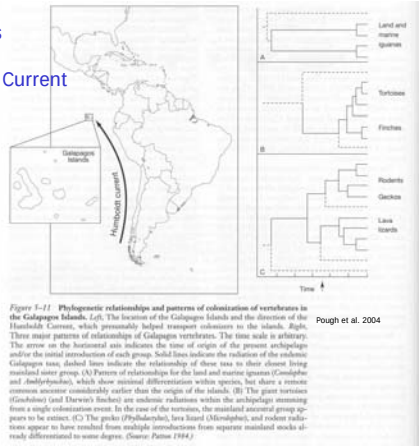

Figure 5–11 **Phylogenetic relationships and patterns of colonization of vertebrates in the Galapagos Islands.** *Left.* The location of the Galapagos Islands and the direction of the Humboldt Current, which presumably helped transport colonizers to the islands. *Right.* Three major patterns of relationships of Galapagos vertebrates. The time scale is arbitrary. The arrow on the horizontal axis indicates the time of origin of the present archipelago and/or the initial introduction 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) Pattern 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 geckos (*Phyllodactylus*), lava lizard (*Microlophus*), and rodent radiations appear to have resulted from multiple introductions from separate mainland stocks already differentiated to some degree. *(Source: Patton 1984.)*

Pough et al. 2004

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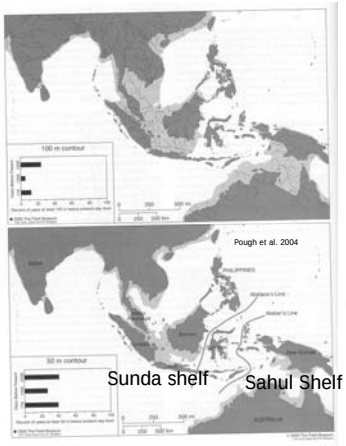
Alfred Russel Wallace
(1823 - 1913)



Pough et al. 2004

Wallace's Line
→
Weber's Line

Sulawesi

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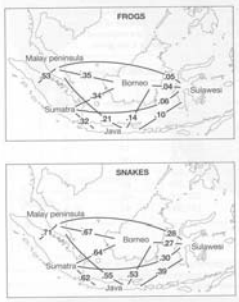
Dispersal Ability



Pough et al. 2004

Figure 5–13 **Patterns of faunal resemblance among areas of the Sunda Shelf in their frog (top) and snake faunas (bottom).** The numbers reflect the number of shared species between areas, calculated as indexes of faunal similarity, where Similarity = (2 × number of species in common)/[(number of species in area A) + (number 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: Inger and Voris 2001.)*

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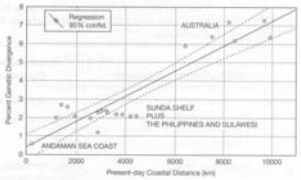
Dispersal Ability (Isolation by Distance)

Figure 5–15 **Correlation between genetic divergence and geographic coastline distance separating populations of *Cerberus rynchops* (linear regression with 95 percent confidence limits).** *(Source: Karns et al. 2000.)*

Pough et al. 2004



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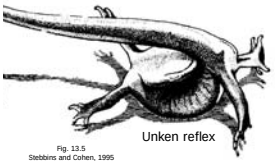
Lissamphibia

Urodela
(salamanders)

10 families, 60 genera, 516 spp.

Ambystoma tigrinum



Unken reflex

Fig. 13.5
Stebbins and Cohen, 1995

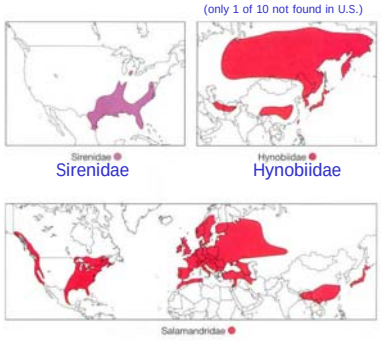
Ambystoma californiense

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

Urodela families

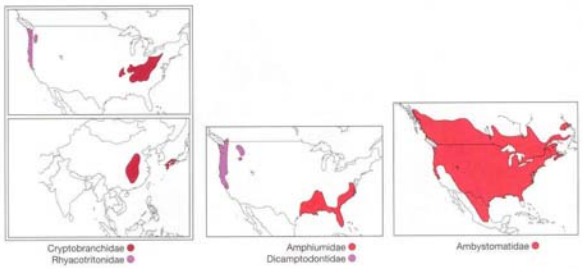


Figure 3–4 **Distribution of salamander families Cryptobranchidae, Rhyacotritonidae, Amphiumidae, Dicamptodontidae, and Ambystomatidae.**

Pough et al. 2004

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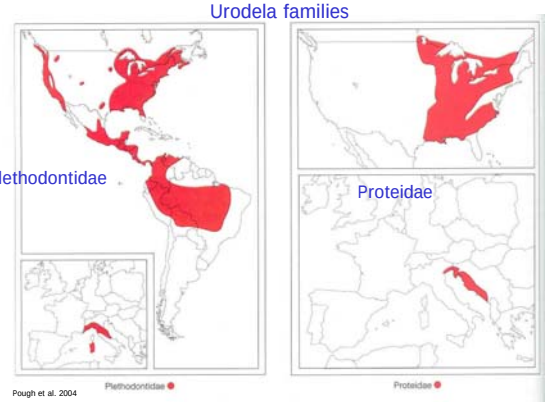
Urodela families

Plethodontidae

Proteidae



Pough et al. 2004

Figure 3–7 **Distribution of the salamander families Plethodontidae and Proteidae.**

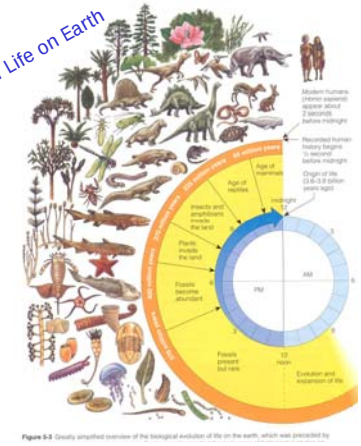
Nothing in biology makes sense except in the light of evolution.

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.

Evolution of Life on Earth



Miller 2003

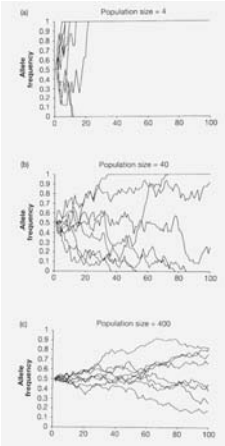
Define Evolution...

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

Population Size

and

Genetic Variablility



Adaptive Radiation

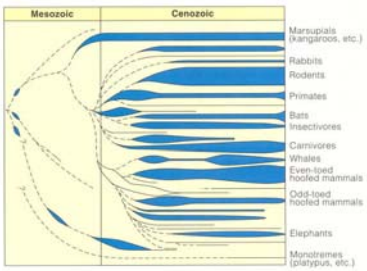


Figure 5-10 Adaptive radiation of mammals began in the first 10–12 million years of the Cenozoic era (which began about 65 million years ago) and continues today. This evolution of a large number of new species is thought to have resulted when huge numbers of new and vacated ecological niches became available after the mass extinction of dinosaurs near the end of the Mesozoic era. (Used by permission from Cecie Starr and Ralph Taggart, *Biology: The Unity and Diversity of Life*, 8th ed., Belmont, Calif.: Wadsworth, 1998)

Miller 2003

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Adaptation depends on Environment

Campbell 1993

Figure 20.10 Natural 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).

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Evolution by Natural Selection

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

Amblyrhynchus cristatus

Survival and Reproduction

Adaptation

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

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Ear lobes

Mid-digital hair

Tongue rolling

Mini-thumbs?

Other more important traits/characteristics…

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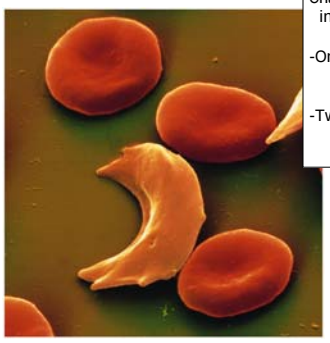
Sickle-cell Anemia:



Change of one nucleotide in human hemoglobin gene:

-One copy may be resistant to malaria

-Two copies leads to anemia (inability to transport sufficient O_2)

Origin of all variation is genetic mutations

Ricklefs 2001, Figure 16.2

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

Genes…	Mutate (neutral/harmless, detrimental, beneficial)
Individuals…	are Selected
Populations…	Evolve

30

8-9

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

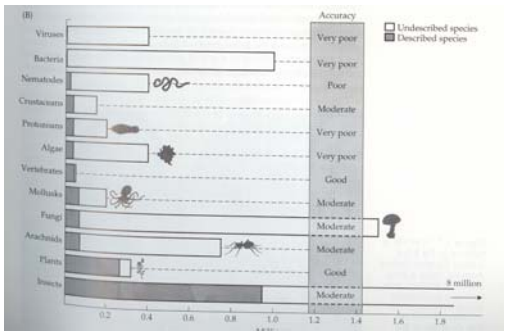
-Generation time
-Variability
-Strength of selection

Define FITNESS.

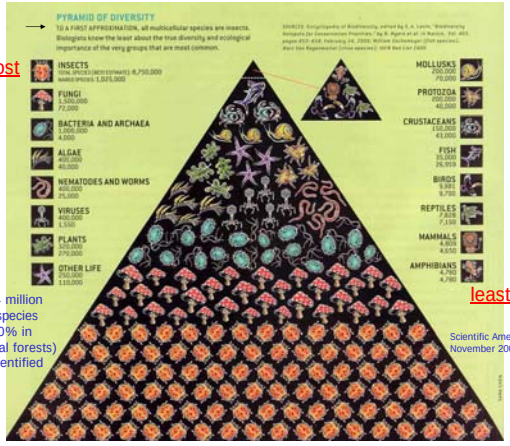
31

32

How many species on earth?



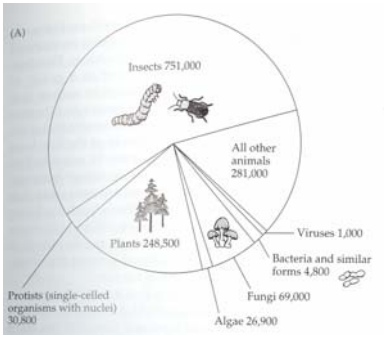
Primack 2006, Fig 3.6



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

Scientific American November 2001

What is biodiversity?



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Primack 2006, Fig 3.6

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)

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