"PRINCIPLES OF PHYLOGENETICS: ECOLOGY AND EVOLUTION"
Integrative Biology 200B Spring 2009
University of California, Berkeley Ackerly/Lindberg/Mishler

April 30, 2009. **Assembly of biomes and biota**

Research in comparative biology asks questions about groups of taxa, looking at similarities and differences between taxa *within* groups, or comparisons *between* groups. There are three main approaches to constructing those groups, depending on the questions at hand: 1) phylogeny (i.e. the study of clades), 2) geography (the study of co-occurring species, from communities to continents), and 3) traits (the study of functional groups, guilds, etc.). Frequently, we use combinations of these criteria, sometimes all three, e.g. a study of small-bodied (guild) mammals (clade) of southwestern deserts (geography). Much biogeographic research is conducted primarily from a clade-based approach, examining the biogeographic history of particular groups. In contrast, the assembly of biomes or biota starts with a region, and examines the historical processes underlying the assembly of all the taxa within that region (or at least all the taxa in a certain clade, e.g., the plants).

Studies of biotic assembly address questions such as:

- where did the taxa in a region come from?
- when did the lineages arrive in the region?
- when and where did the taxa in a region evolve? (a very slippery question!)
- how old are the taxa in a region? (also tricky!)
- how much has in situ diversification contributed to modern diversity?
- do patterns of distribution and diversity within a region reflect biogeographic origins of taxa?
- what is the role of adaptive evolution vs. niche conservatism in the assembly of biota?
- does contemporary functional diversity reflect biogeographic history?

One thing you'll notice in these questions is the distinction between phylogenetic and biogeographic history. Questions about phylogenetic signal focus on the associations of traits, or other features, with the position of taxa on a phylogenetic tree. In contrast, the questions above ask whether traits are associated with biogeographic history. These may seem similar, but as we will discuss the role of biogeography tends to focus on the geographic history of clades in the past 5-50 Ma; on that time scale, distantly related taxa may have similar histories and fairly close relatives may have different histories.

My own focus in this area has been an effort to conceptually integrate space, time and environment. This is a difficult multivariate problem, with one dimension of time, two (or maybe three) dimensions of space, and many dimensions of the environment. Our visualization abilities are usually limited to 2-D space, or 3-D by using contour diagrams. Depending on the question, we can mix and match which dimensions we place on the axes and which are represented by contours. For example, I'll show many examples today with time on one axis, one-dimension of space on another, and contours showing the environment. This allows us to conceptualize the movement of taxa in space and how they parallel or cross contours showing the environments they occupy, but we're limited to only one dimension of space and one for the environment - don't forget how complicated the real world is!

Citations for today's lecture - the literature on this topic overall is huge!

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SPECIAL ISSUE OF Phil. Trans. Roy. Soc. London B.: *Plant phylogeny and the origin of major biomes*
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Introductory essay:

Pennington, R.T., Cronk, Q.C.B. & Richardson, J.A. (2004) Introduction and synthesis: plant phylogeny and the origin of major biomes. *PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES,* **359,** 1455-1464.