Integrative Biology 200A "PRINCIPLES OF PHYLOGENETICS"
University of California, Berkeley Kipling Will- In revision 2014

Biogeography—from Area Homology and patterns to why organisms are where they are—

The field that attempts to document and understand the spatial patterns of organisms in the past and present and develop process explanations and historical scenarios for variation in distribution or seeks a natural classification of areas.

Areas:
-Nominal areas, often geopolitical, e.g. California or Yosemite National Park.
-Natural areas, either geological or ecological areas that can be treated as an individual with a part-whole relationship to the Earth and historical relationships to other such areas.
-Areas of endemism are circumscribed by shared ranges of some number of taxa, usually species, which do not have a worldwide distribution.

Dispersal:
-Ecological dispersal, the movement of individuals over the landscape. Not typically correlated with cladogenic events.
-Traditional dispersal, rare or one-time events that can be problematic as ad hoc explanations.
-Geodispersal is geologically mediated dispersal that produces congruent range expansion and subsequent vicariance that correlates to cladogenic events.

Centers of origin….
What are they?
Why are they important or are they important?
What criteria can, or at least has been used to detect centers of origin?

I. Ecological Biogeography: Looks at present distributions, or distributions at a point in time, and attempts to account for these by looking at interactions among the organisms and their biotic and physical environment.

A. Typically deals with essentially atemporal or relatively recent patterns (but not exclusively) and interactions with an ecological, physiological and phenological emphasis.

1. From this view questions addressed might be like "What allows a species to occur in one area and prevents it from expanding into other areas?"

B. Often ecosystem, community or population based, where the entities are part of an ecological hierarchy.

C. Can involve paleontological data, so is not restricted to currently extant populations. e.g., Elias, S.A., Berrnan, D., Alfimov, A. 2000. Late Pleistocene Beetle Faunas of Beringia: Where East meets West. Journal of Biogeography. 27:1349-1~63.

D. Can be over a large range, e.g. diversity over a latitudinal or elevational gradient.

E. Studies often involve the impact of human activities, succession theory, the dynamics of communities and populations, fire ecology, restoration ecology, invasive species, species pulses or waves, and island biogeography.

F. Dispersal is important, but not defining

II. Historical Biogeography: Attempts to reconstruct the patterns of the origin, dispersal and extinction of taxa and biotas.

A. Usually involves historical, typically older patterns inferred by looking at clades (often as species and higher taxa that are monophyletic)

1. How species accumulate (or are lost)
2. How biotas come into being
3. How are areas related

B. Focus on why lineages are represented in certain areas and not others and why is a pattern of distributions frequently repeated in different lineages.

C. Typically area relationships and general patterns of diversity are emphasized over single taxon distributions.

III. Brief Historical overview of "periods" and discoveries in historical biogeography

A. At the time of a limited view of dynamics and diversity

1. Creation myths, dispersal from Noah's ark, etc.
2. Little understanding beyond local flora/fauna

B. Age of exploration

1. 17th century led to discovery of too many species for the Ark
2. Realization that environmentally similar but distantly isolated regions have distinct assemblages of organisms (Buffon's Law)
3. Islands have lower lineage diversity
4. Similar floristic zonation (Humbolt)

C. 19th century, advances in geology and evolutionary theory

1. Lyell, Darwin, Wallace, Sclater, Hooker, etc.
2. Abandonment (by most) of the idea of static distribution and immutability of species.
3. Land bridges/megacontinents (e.g. Hooker, Wallace) vs. dispersal (e.g. Darwin)

D. 20th century

Darwin, in the Origin:

"When we feel assured that all the individuals of the same species, and all the closely allied species of most genera, have within a not very remote period descended from one parent, and have migrated from some one birth-place; and when we better know the many means of migration, then, by the light which geology now throws, and will continue to throw on former changes of climate and of the level of the land, we shall surely be enabled to trace in an admirable manner the former migrations of, the inhabitants of the whole world."

1. Continental drift (Wegener 1912)- but not really accepted until 1960s- (Dietz & Holder 1966) Persistent dispersalists like Simpson and Darlington maintained that even if continents moved dispersal was still more important.
2. Panbiogeography of Croizat, phylogenetics of Hennig and implementation Brundin (1966) for a trans-Gondwanan group of flies
    a. Start of phylogenetic biogeography
    b. similarity of phylogenetic and distributional patterns implies a shared biogeographical history.
3. Vicariance biogeography fully developed by Platnick & Nelson (1978)

4. Event based estimations of biogeographic history

IV. Generally used methods of Historical (Vicariance) Biogeography

A. Similar systems like parasites and their hosts can use the same or similar methods.

<u>Host - Associate</u>
Organism - genes
Host organism - parasite organism
Geographic area - organism

VII. Comparative Biogeography (sensu Parenti & Ebach 2009)

1. Focus is on homology of natural areas not on speciation or other diversity generation processes.
2. Defined as “the comparative study of biotic areas and their relationships through time”
3. Uses “paralogy-free subtree analysis”

VIII. Event based optimality methods for estimation of biogeographic history (you will do this in 200B and be sure to read Ronquist & Sanmartin, 2011 and Crisp et al., 2011)

1. Biogeographic history is another step of abstraction from phylogeny
2. Event-based methods is rapidly expanding due to advances in ML and Bayesian methods, parametric statistics, DNA data and fossil data.
3. Calibrated phylogenies
4. DIVA, DEC, HVM…