I. Introduction. The BIG QUESTION: Why are species of limited distribution (this is also the big question of community ecology). That is, why aren't all species everywhere?

A. First of all, how similar are the species compositions in different areas? Simpson's measure of community similarity is: Similarity = # taxa two areas have in common divided by the number of taxa in the area with the fewer taxa. This works at any taxonomic level

II. Answers to THE BIG QUESTION in general:

A. Ecology

1. physiological adaptation to the environment. The fundamental niche -- set by physiological limits of the species and physical factors of the environment -- these set where an organisms CAN live. For instance, Laelia orchids cannot survive in Chicago (outdoors) -- they freeze solid during the winter and DIE.

2. interactions with other species— realized niche - the part of the fundamental niche really occupied by the species. The difference between the fundamental and realized niches is due to interspecies interactions. A species may be able to grow somewhere in the absence of competition from another species, but in the presence of the other species, it is excluded. For instance, in the redwood forests of Marin County, almost any plant that can tolerate a little cold could grow -- toyon, ceanothus, madrone, -- all sorts of chaparall species. However, because of the competition for water and especially for light, they are excluded by the redwoods.

B. Historical. Many patterns of species distribution cannot be explained only by ecological parameters. For instance, 300 years ago, the United States didn't have house finches, Med flies, killer bees, or tumbleweeds. WHY? Well, it wasn't due to ecological factors, obviously (and unfortunately). Instead, it was due to historical accident -- those species just hadn't made it to North America. So, HISTORY also plays a large part in species distributions.

There are two kinds of historical patterns, dispersal and vicariance. Dispersal refers to a taxon migrating from one area to another, vicariance refers to a splitting of a taxon's range, usually by geological forces (mountain building, canyon building, continental drift).

1. Dispersal -- kinds (after GG Simpson)

a. corridor - wide area of species exchange (California to and from Oregon)

b. filter bridge - dispersal path limited in time and or geographical extent such that many species don't make it across in the time it exists — Bering strait, Panama strait

c. sweepstakes - hazardous or accidental dispersal to new land — Hawaii, Krakatoa

2. Climate — another historical factor. Ice ages influence distribution — some species pushed to extinction at Med sea by southward moving ice, some species found refugia (small unglaciated areas) and the refugia populations underwent allopatric speciation, thus providing species richness when ice retreated (one theory of amazonian diversity)

3. Vicariance — splitting of a range of a taxon by geological forces. Examples are not only continental drift, but also the Kaibab squirrel in northern Arizona, where the deepening of the Grand Canyon split one population of squirrels from the rest of the species.

III. The BIG QUESTION: Is dispersal or vicariance the MODE of explanation of historical biogeography? And at what taxonomic levels?

If vicariance is the explanation, then cladograms of taxa should be congruent with cladograms of geology. See whether one can overlay a taxonomic cladogram with a geological cladogram. One can also construct AREA CLADOGRAMS, which show the relation of the phylogeny and the geography. If geography and phylogeny are congruent for many taxa, then vicariance is a better explanation. Otherwise, one must postulate separate dispersal events occurring in many different groups, which is more implausible.

For many taxa on a large scale, we do indeed find matching patterns of phylogeny and geography. Your book (Ridley) gives examples in figures 18.8, 18.9, and 18.11.

However, neither dispersal nor vicariance seems to be especially favored. Some patterns are explained by dispersal, some by vicariance. The larger the taxonomic level being considered (such as class and order) the more likely (in general) that vicariance is the explanation for the observed distribution. This is primarily because of continental drift, which works on the same time scale more or less as the artificial classifications of class and order.

IV. The Great American Interchange happened when South America and North America were joined about 3 million years ago. South America was largely populated by marsupial mammals, while North America was largely populated by placental mammals. The basic story is that the placental mammals generally took over in South America, while only a few marsupial mammals invaded North America. The most successful marsupial invader of North America is the marsupial rat, commonly called the opossum.