Diversity - latitudinal trends

Temperate forests

Tropical forests

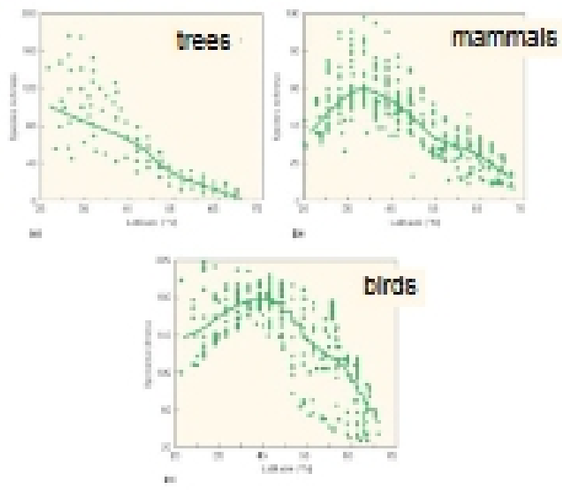
species:

Trees (per 10 ha)	15	450-700
Birds	20-30	>300
Insects	many	millions
Fish	many	4 times
Ants	entire Utah	= 1 tree

For most groups of organisms, the tropics is 10-100 times more diverse

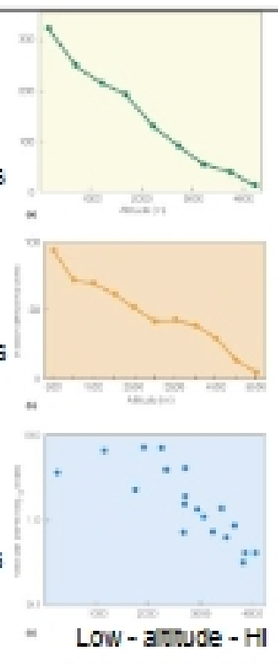
Diversity

1. Higher latitudes have lower diversity (data from N. America)



Diversity

2. Higher altitudes have lower diversity

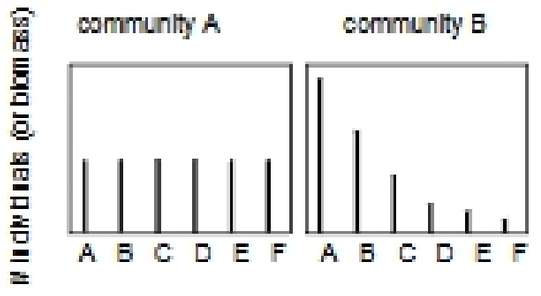


3. Islands have lower diversity

How do we measure diversity?

a. Species richness: total number of species
b. Species evenness: how evenly are the individuals distributed among species? [takes into account abundance]

Two hypothetical communities with the same species richness but different species evenness



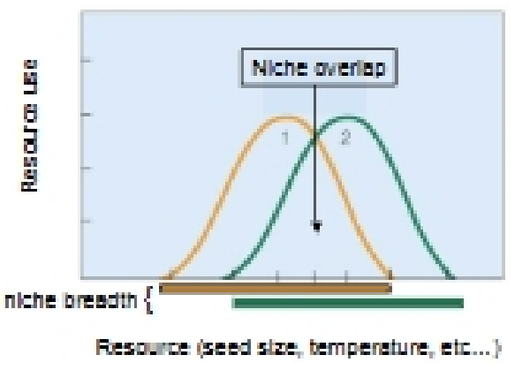
Scales of diversity?

a. Beta (β) diversity: diversity across habitats (mountains, valleys, swamps ....)
diversity can be high because there are lots of different habitats

b. Alpha (α) diversity: diversity within a single habitat

diversity can be high if more species can coexist in the same habitat

Higher alpha diversity reflects niche partitioning

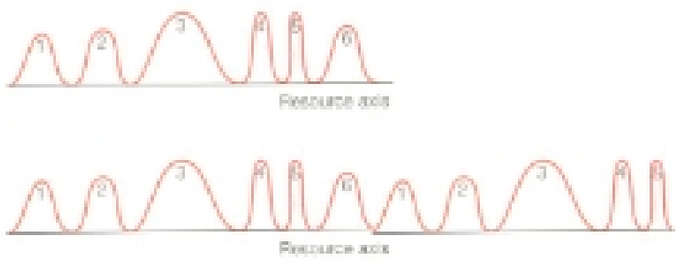


1. Narrower niches
2. Greater overlap
3. Extend the resource axis (greater range of available resources)

So can we explain the latitudinal gradient in diversity using factors that would affect niche partitioning?

Equilibrium hypothesis for latitudinal gradients in diversity:
(assume communities are at their equilibrium number of species)

1. Higher productivity will lead to higher diversity
   a) longer axis - more species can co-occur if using extreme ends of resource axis



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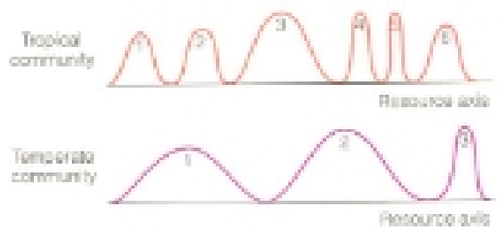

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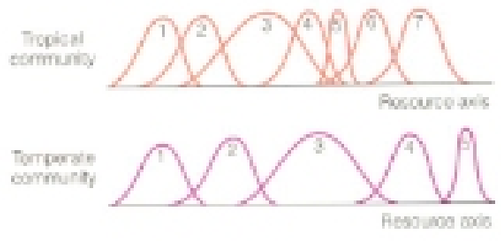
   c) species can have more niche overlap



The tropics are more productive (warm and wet year-round)

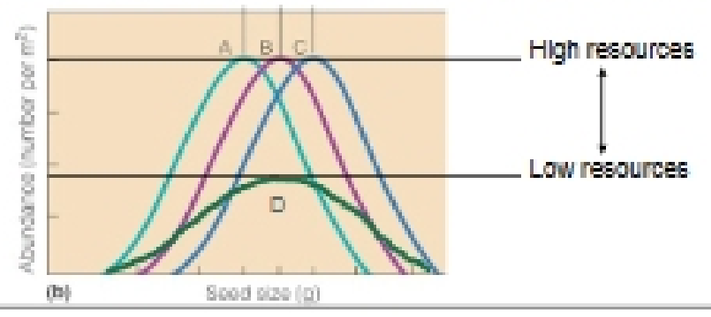
Greater plant productivity could lead to greater plant diversity will mean greater animal diversity

Equilibrium hypothesis for latitudinal gradients in diversity:

2. Climate or resource **stability** will lead to higher diversity

At high resource levels, species A, B and C can coexist and D will be excluded, but at low resource levels A, B and C will go extinct. Only a generalist (D) will have sufficient resources

- So variation in resources will favor increased niche breadth
- Species with too much overlap will be out competed during low resource periods
- the tropics are generally more stable than the temperate zone



Non-equilibrium hypothesis for latitudinal gradients in diversity:

(assumes that communities have not had enough time for diversity to reach maximum levels for that habitat)

Ecological time: communities may be young
e.g. there has not been enough time since a recent disturbance for species to recolonize the habitat.

Fire
Flood
Landslide
Abandoned agriculture
....

Non-equilibrium hypothesis for latitudinal gradients in diversity:

Evolutionary time: communities may not have had sufficient time or opportunity for speciation (but they could hold more species)

1. The tropics have remained near the equator for long periods of time while the temperate habitat is newer (tectonically)

2. The temperate zone has has less time since glaciations

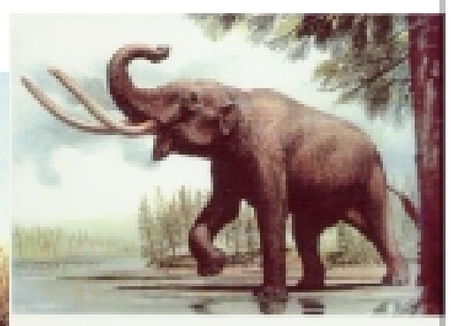
3. Rates of speciation may differ in different habitats. Are they faster in the tropics? (yes but under debate)

4. Rates of extinction may differ in different habitats. Are they slower in the tropics? (yes but under debate)

Human impact on biodiversity

Before humans arrived in North America about 12,000 yrs ago, what did the fauna look like?

Entelodont feeds on rhinoceros



Mastodon

Human impact on biodiversity

Before humans arrived in North America about 12,000 yrs ago, what did the fauna look like?

Titanus (3m, 400Kg predatory bird)

Human impact on biodiversity

Major extinctions of megafauna occurred 12,000 yrs ago

Extinct species include: lion, bison (different species), mastodon, mammoth, dire wolf, short-faced bear, giant ground slot, saber tooth cat, *Titanus* (3m, 400Kg predatory bird) …

North American survivors: ONLY mule deer and black bear

All other mega-mammals present in N. America today colonized from Asia (moose, bison, grizzly bear, elk, wolf …)

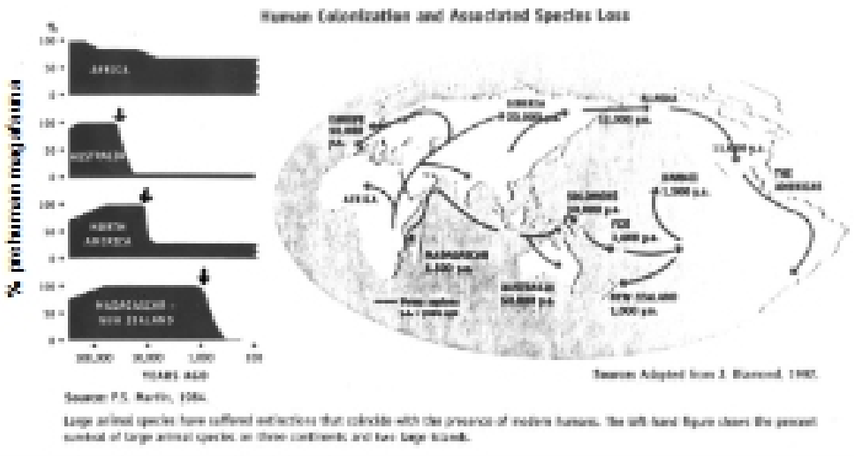
They had co-evolved with people and were better able to survive

There have been 17 glaciations and one human invasion, yet all the megafaunal extinctions are correlated with the human invasion

Tim Flannery "the Eternal Frontier"

Human impact on biodiversity

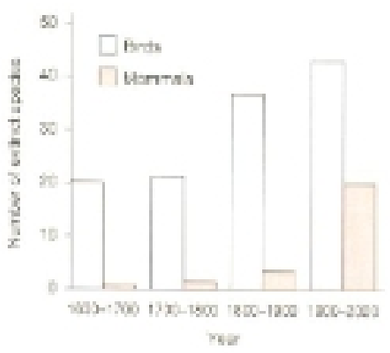
Major extinctions of megafauna occurred on all continents with the arrival of humans except Africa (where humans evolved)

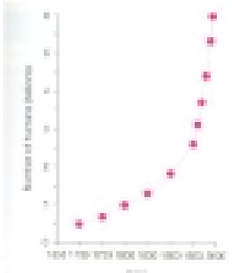


Large animal species have suffered extinctions that coincide with the presence of modern humans. The left-hand figure shows the percent survival of large animal species on three continents and two large islands.

Human impact on biodiversity - current rates of extinction

Current rates of extinction are enormous, rivaling the past 6 major events in terms of rate and possibly magnitude





Why is extinction so high?
- human population growth
- climate change
- habitat loss (50% land surface used by humans)

Human impact on biodiversity

Example of bird counts along the Mississippi and Atlantic flyways over the last 40 years