Endemism, Provincialism, and Disjunction
Endemism, Provincialism, and Disjunction

Major kinds of distribution patterns:

Endemism: the occurrence of taxa with native distributions restricted to a particular geographic location (e.g., taxon X is endemic to location Y). Endemism can be variable in scale from a small area (e.g., a species of fish that is endemic to a specific lake) to whole continents (e.g., endemic to Australia).

Provincialism: geographic overlap of endemism across multiple taxa. Alternatively, the delineation of geographic areas with particular biotic characteristics based on the distinctiveness of species assemblages.

Disjunction: two or more related (usually monophyletic) taxa or populations occurring in geographically separated areas (and absent from intervening area).

A single species can be part of a disjunct distribution within its genus or family, can be endemic to a specific area, and along with other endemic taxa with similar distributions, can characterize provincialism for that area.

* Think about how these terms and patterns apply to focal groups in your term paper.
Endemism

Examples:

Olympic mudminnow (*Novumbra hubbsi*)

Pygmy rabbit (*Brachylagus idahoensis*)

Olympic mudminnow is confined to coastal lowland wetlands around the Olympic Peninsula.

Pygmy rabbit occurs throughout the Great Basin and neighbouring intermountain areas in sagebrush habitat with an isolated (disjunct) population in central Washington.
Endemism

Endemism is typically hierarchical (or nested):
Kangaroo rats, kangaroo mice, and pocket mice (family: Heteromyidae) are endemic to southwestern North America, Central America, and extreme northwestern South America.

Within Heteromyidae, kangaroo mice (genus: Microdipodops) are endemic to the Great Basin Desert region in western North America.

Within Microdipodops, the pale kangaroo mouse (M. pallidus) is endemic to sandy habitats of the Lahontan Trough in south-central Nevada.

Within M. pallidus, two separate mitochondrial DNA lineages are endemic to western and eastern portions of the range.

(Hafner et al. 2008)
Endemism

Endemics can be classified by their location of origin:

**Autoendemics:** evolved in an area within their current distribution.

**Alloendemics:** originated somewhere else, dispersed to their current locality and subsequently have gone extinct elsewhere. Also known as *relicts.*
Endemism can be related to long-term temporal patterns of diversity:

**Taxonomic relicts**: remnants of, at one time, a much more diverse taxon. (e.g., coelacanth, ginkgo)

**Biogeographic relicts**: taxa that at one time had much wider geographic distributions. (e.g., lungfish)

- **Ginkgo** is native to eastern China, now planted across the world, the sole survivor of primitive conifers that was diverse in Mesozoic.

- **Coelacanth** occurs in deep waters of tropical Indian Ocean but was once a diverse group found in freshwater, oceans and shallow seas during Paleozoic.

- **Fossil record of lungfish** suggests prior cosmopolitan distribution, but lineages went extinct following breakup of continents (currently 6 extant species in 3 families).
Endemism may have originated recently or long ago:

**Neoendemics:** endemics of recent origin (e.g., stickleback benthic and limnetic species pairs)

**Paleoendemics:** endemics that originated long ago (e.g., Olympic mudminnow)
Endemic taxa in different groups of organisms tend not to be randomly distributed, but rather tend to co-occur in specific areas.

**Provincialism**: geographic overlap of endemism across multiple taxa. Or, the delineation of geographic areas with particular biotic characteristics based on distinctiveness of species assemblages.

Generally, provinces fit into a hierarchy of areas of endemism:
Concordance suggests common historical events have shaped biotas within a given area (e.g., geological, climatological or oceanographic events).

Example: 91% of Australian mammal species are endemic to Australia (compared to 19% for the holarctic).

Long term isolation of Australia from other landmasses has likely driven high endemism.
Concordance suggests common historical events have shaped biotas within a given area (e.g., geological, climatological or oceanographic events).

Example: High degree of endemism in the North American Great Basin.

Great Basin has large mountainous regions and high elevation “sky islands” surrounded by seas of desert.
Provinces may be separated by *biogeographic lines*

Distribution limits of freshwater fish families of North American (dashed) and South American (solid) origin. Two species of obligate freshwater fishes of South America have reached the US; North American forms extend no farther south than Costa Rica

(from Miller 1966)
Provincialism

Provinces may be separated by biogeographic lines

Freshwater fish provinces of Middle America, showing numbers of families, genera and species of freshwater fishes in each area (from Miller 1966).
Provincialism

Marine provincialism is generally less well developed than terrestrial provincialism. Higher connectivity among marine habitats, plus high dispersal potential for many marine organisms during particular life stages (e.g., planktonic larvae in fish and invertebrates).

Spalding *et al.* (2007) classified the world’s continental shelves into a nested system of 12 realms (colours), 62 provinces (numbers), and 232 ecoregions.
Marine provincialism is generally less well developed than terrestrial provincialism

As most coral reef organisms with a pelagic larval phase are presumed to be readily dispersed between distant populations, sea-surface current patterns should be crucial for predicting ecological and genetic connections among threatened reef populations. Here we investigate this idea by examining variations in the genetic structuring of populations of the mantis shrimp *Haplosquilla pulchella* taken from 11 reef systems in Indonesia, in which a series of 36 protected areas are presumed to be connected by strong ocean currents. Our results reveal instead that there is a strong regional genetic differentiation that mirrors the separation of ocean basins during the Pleistocene low-sea-level stands, indicating that ecological connections are rare across distances as short as 300–400 km and that biogeographic history also influences contemporary connectivity between reef ecosystems.

(Barber et al. 2000)
Provinces may be defined by geographic features and patterns of diversity, irrespective of endemism.

Fish faunal regions of Canada based on similarity of species between secondary watersheds (from N.E. Mandrak)

Search and download interactive maps for freshwater ecoregions of the world (feow)

http://feow.org/maps/biodiversity
Provinces may be defined by geographic features and patterns of diversity, irrespective of endemism.

Recall Amazonian ecoregions, which are divided by large river systems and also delineate range limits across species groups.
Relating Endemism and Provincialism

We can describe endemism and provincialism at various spatial scales (geographic, regional or local)

Provinces may be defined by geographic features and patterns of diversity and diversification, irrespective of endemism.
Disjunctions can occur at any spatial scale

e.g., Lepidosireniformes (lungfishes) in South America, Africa, and Australia.
Disjunction

Disjunctions can occur at any spatial scale

e.g., Cutthroat trout in western North America.
Three potential causes of disjunction:

1. Vicariance

Flightless birds

Tinamous

Rheas & Tinamous

Ostrich

Cassowary

Emu

Kiwi
Disjunction

Three potential causes of disjunction:

2. Extinctions

Tailed frog (*Ascaphus truei*)

Cutthroat trout (*Oncorhynchus clarkii*)

Both taxa associated with high-gradient streams in mesic forests. This habitat disappeared with climate change following glacial retreat (now xeric).
Disjunction

Three potential causes of disjunction:

3. Long distance dispersal

Galaxias, aka inanga (*Galaxias spp.*)

Origin likely in New Zealand 23 mya.

(from McDowall 2002)
Disjunction

The notion of disjunction relies on the idea that taxa are closely related.

e.g., Freshwater crayfish (from Crandall et al. 2000):
Why do we care about endemic species?


“Conservationists are far from able to assist all species under threat, if only for lack of funding. This places a premium on priorities: how can we support the most species at the least cost? One way is to identify ‘biodiversity hotspots’ where exceptional concentrations of endemic species are undergoing exceptional loss of habitat.”
Why do we care about endemic species?

Endemic species have spatially restricted distributions.

There is a positive correlation within most taxonomic groups between species’ abundance and distribution (e.g., bird species in Costa Rican cloud forest).

Could lead to a syndrome of rarity:

1) Restricted geographic distributions
2) Tend to be habitat specialists within their range
3) Occur at numerically low abundance

Three “strikes” increase a species’ risk of extinction

Figure from Jankowski & Rabenold 2007
Endemism, Provincialism, and Disjunction

References for this section: