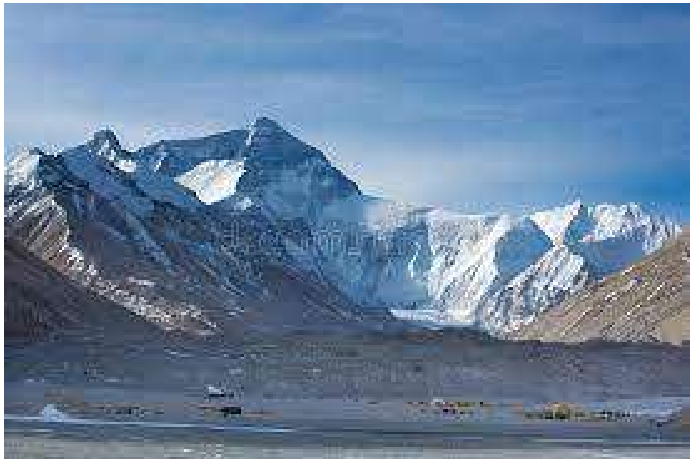
Zoogeography

Lesson 8

Limits of Distribution

- *physical barriers* prevent the spread of an organism. High mountain chains, expanses of water or areas of arid desert may confine a species to one particular region

(i.e. The Himalayan mountain chain is a formidable barrier to most animals, but the barheaded goose (*Anser indicus*) is able to migrate over the Himalayas)



Range and microhabitat

- Distribution and range (the area within which the species is found)

→careful about the spatial scale we are considering

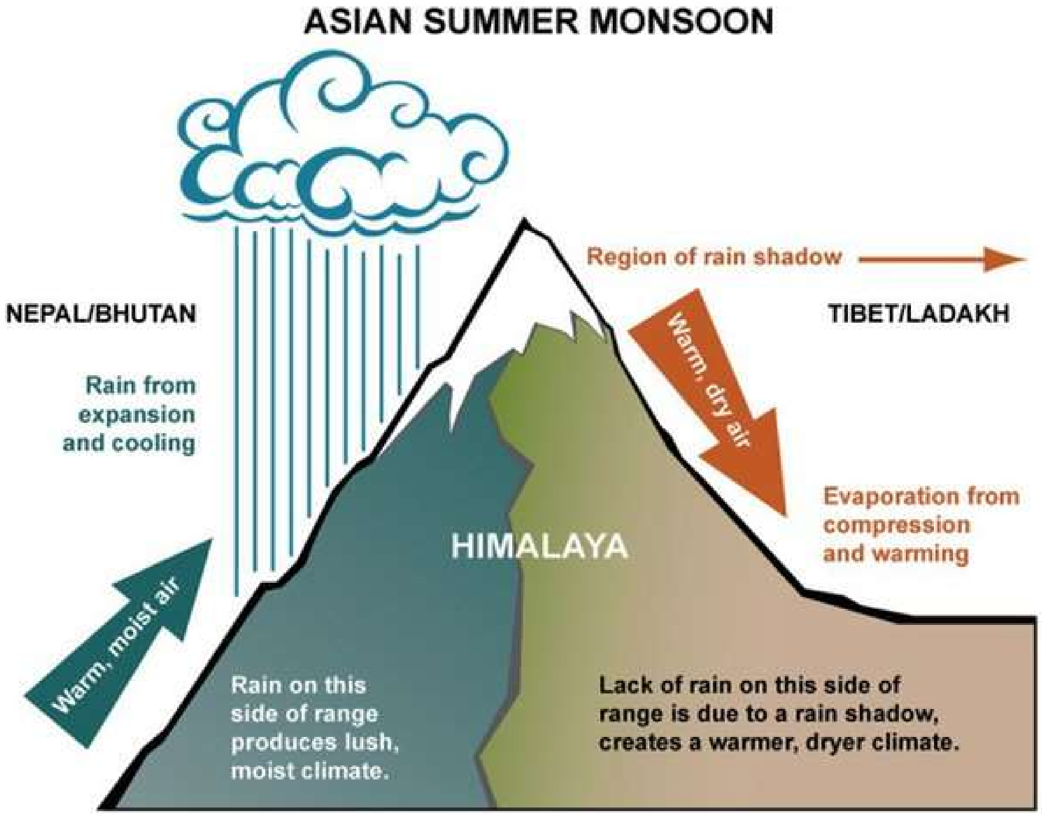
1) Two species may be widespread within a given area, and yet occupy different types of habitats (such as woodland or grassland).
2) Species may occupy different microhabitats, such as forest canopies or forest floors (e.g. kiwi and fantail in New Zealand)

scale, in both horizontal and vertical dimensions, is an important consideration when studying distribution patterns

Climatic barriers

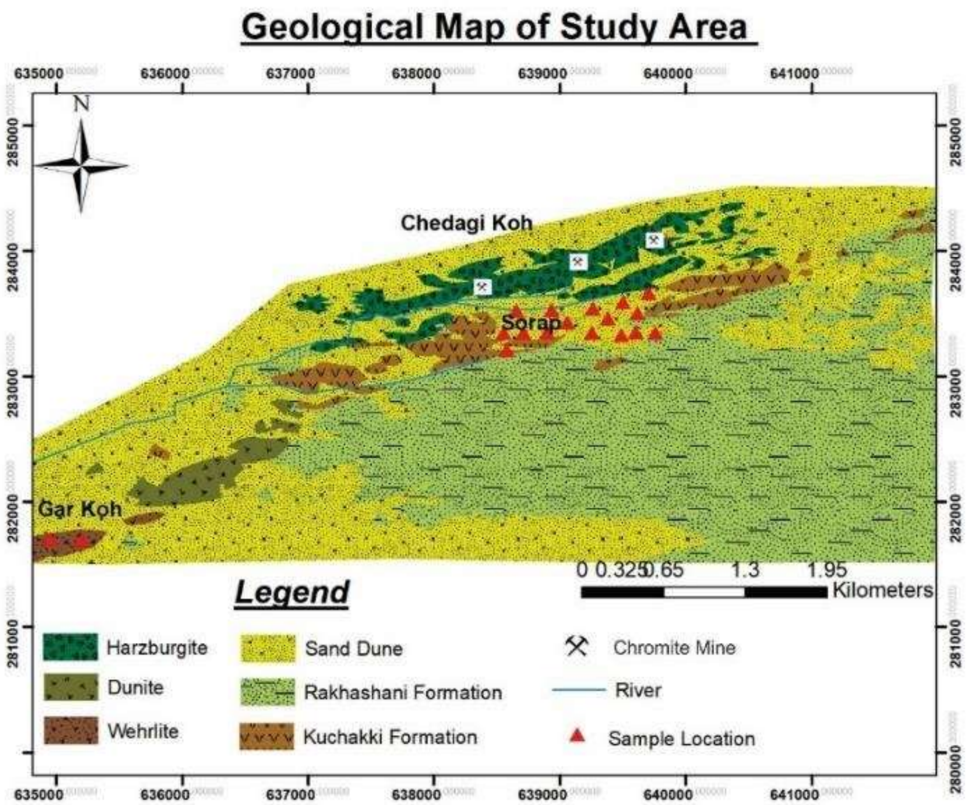
- Frost can prove fatal to many tropical plants because the formation of ice within the cells of the plant, followed by melting, disrupts the cell membranes and results in death.

- Drought can similarly cause problems of desiccation in many plants and animals that have limited capacity for water conservation.



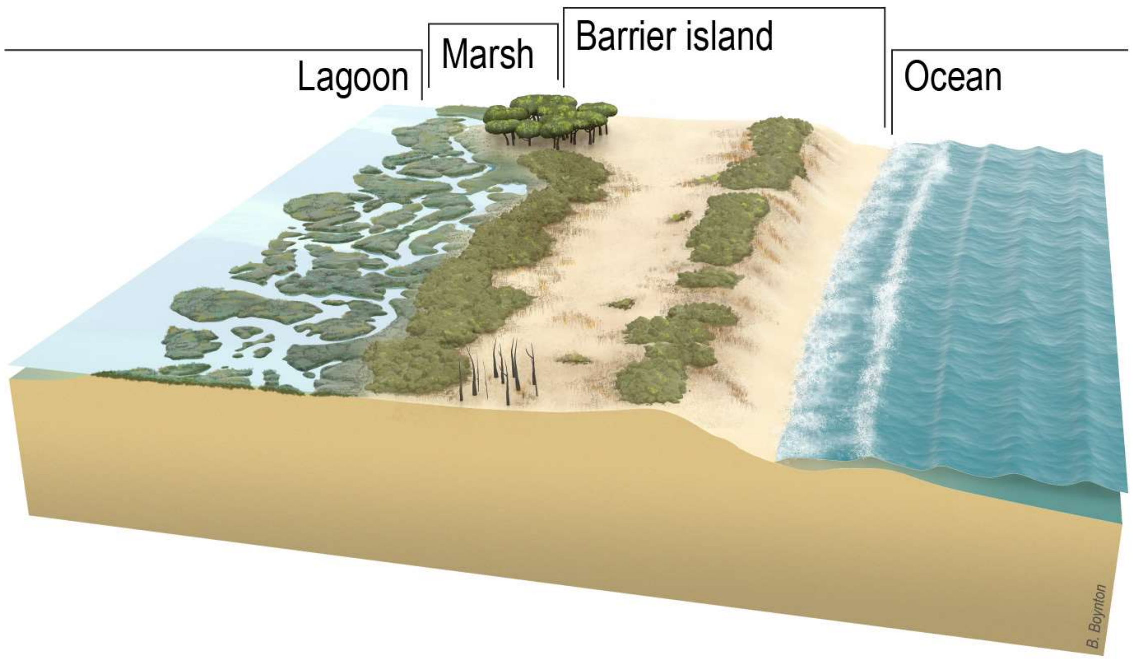
Geological barriers

- Geology, and its effect on soil chemistry and structure, is often limiting for plants and for soil-inhabiting invertebrate animals and microbes.
- Overcoming such geological barriers demands effective dispersal strategies, either by aerial transport in the case of some fruits, seeds and very small animals like spiders, or by hitching a ride with more mobile organisms, as adhering to fur or feather.

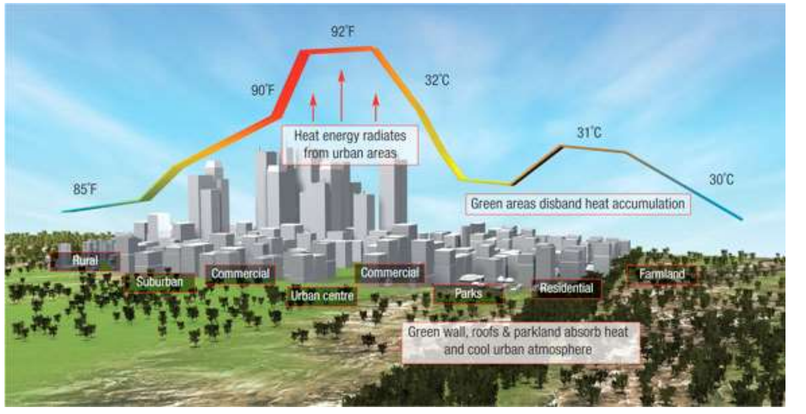


Nature of the habitat

- A forest species may be deterred from crossing an area of grassland; or a marsh organism may fail to travel across dry habitats to reach the next area of wetland



Nature of the habitat



- Distribution patterns may derives from habitat mosaics. (i.e. regions highly modified by human activity).
- At a lower level of scale, organisms may occupy different microhabitats that are subjected to small-scale variations in physical conditions, or microclimate.

↓

Microclimate is a term that covers temperature, humidity and light variations on a very small scale.

i.e. Animals may be restricted in their microhabitats because of limitations in their resistance to desiccation or temperature variation, but also in their dependence on food availability.

Biological barriers

- It occurs when an organism is subjected to increased predation, parasitism, disease or competition from more robust species if it were to move beyond specific area limits.

i.e. The northern subspecies of the spotted owl (*Strix occidentalis caurina*) has become endangered because of the fragmentation of the forests of the Pacific northwest of North America. Its main problem is that of predation when crossing open areas from one forest fragment another.

Historical factors

- barriers that confine species to a limited area. Changes in the pattern of land masses over the surface of the Earth have resulted in the creation of physical barriers, sometimes between closely related taxa.

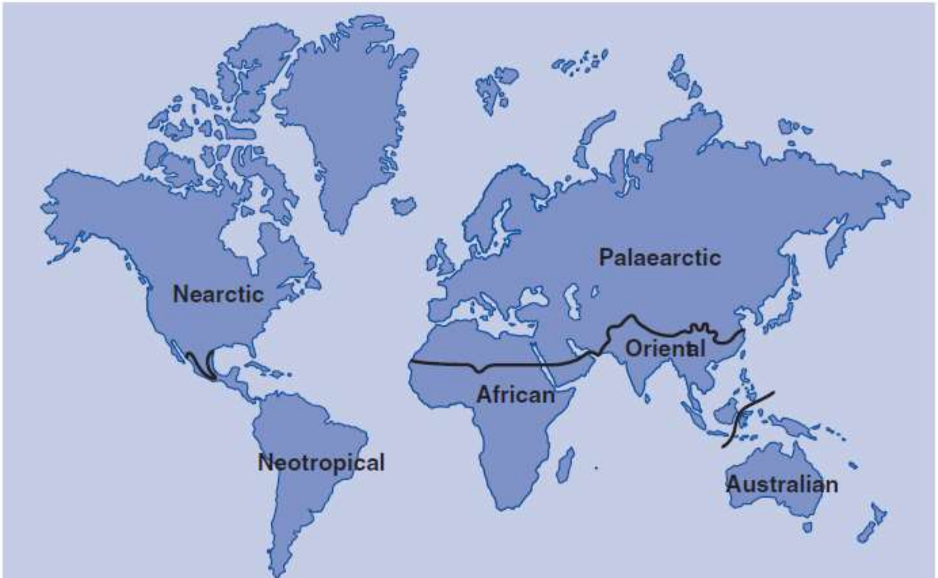
Po river delta

Chance

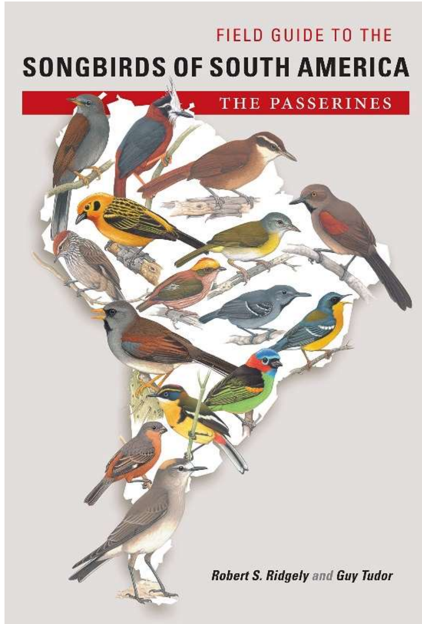
- Stochastic event: The arrival of a wind-borne insect or a seed at a particular point in space cannot be predicted with certainty, and the first arrival may well be at an advantage over those arriving later.
- Some plants and animals are confined in their distribution, sometimes (although not always) within the areas in which they evolved; these are said to be **endemic** to that region.
- Their confinement may be due to physical barriers to dispersal, as in the case of many island faunas and floras (termed **paleoendemics**)
- They have only recently evolved and have not yet had time to spread from their centres of origin (**neoendemics**)

World Maps: Biogeographical Regions of Animals

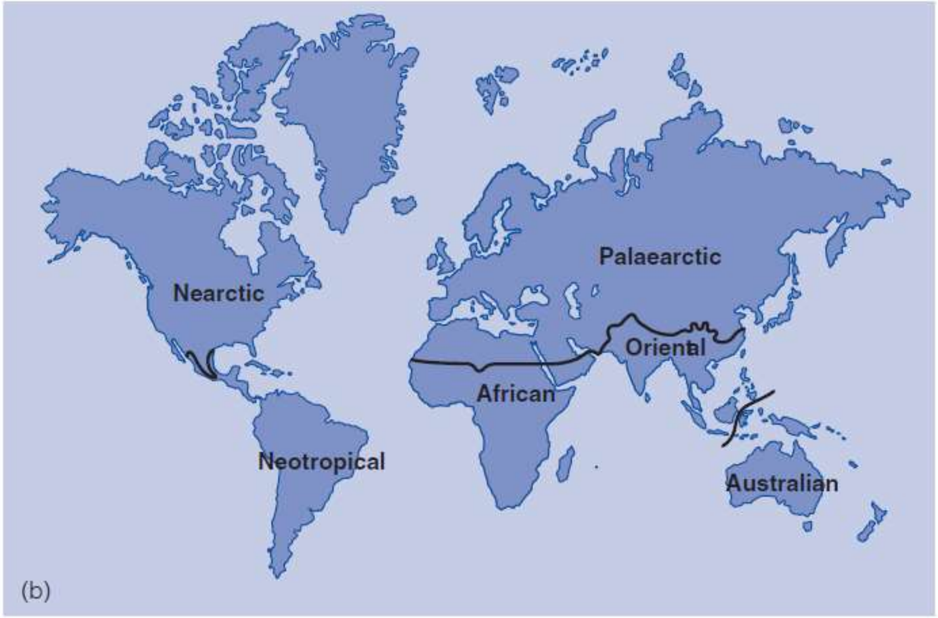
1858



(b) Zoogeographical regions, according to Sclater and Wallace. From Cox.

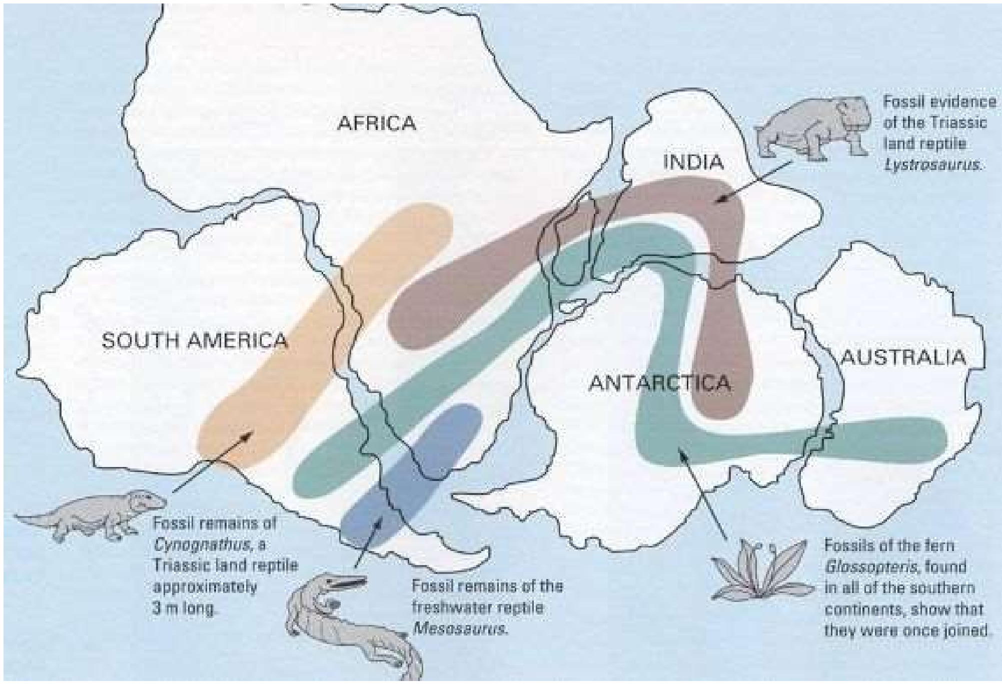


Wallace immediately accepted Sclater's scheme, including his names for the regions, and expanded it to include the distribution of mammals and other vertebrates.



Dispersalism: assumes that where a taxon or related taxa are found on either side of a barrier to their spread, this is because they had been able to cross that barrier after it formed.

Figure 1.4 How today's landmasses were originally linked together to form a single supercontinent, Pangaea, according to Wegener. (Compare this with Figure 10.1 to see the modern, plate tectonic reconstruction of Pangaea.)



Panbiogeography (1950)

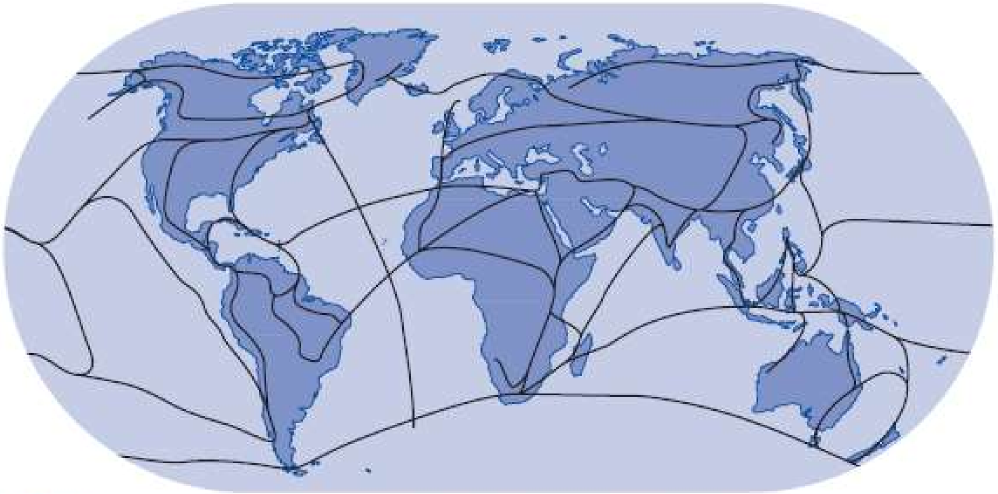
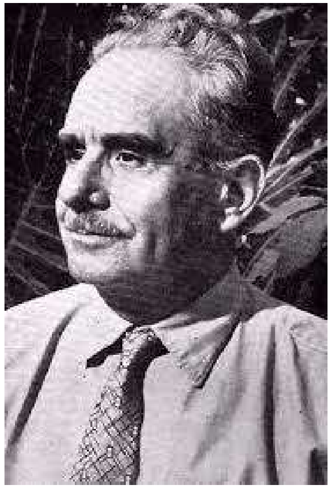


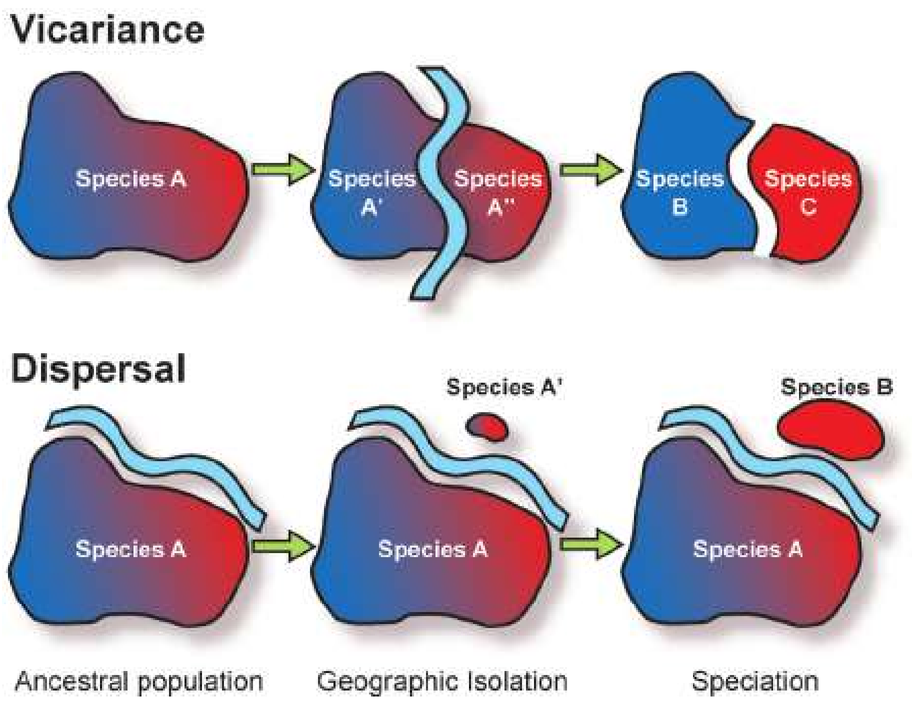
Figure 1.5 Croizat studied the distribution patterns of many unrelated taxa, and for each he drew lines or 'tracks' on the map linking the areas in which they are found. In many cases, these lines were similar enough in position to be combined as 'generalized tracks', shown here.



Leon Croizat
(1894-1982)

Croizat amassed a vast array of distributional data, representing each biogeographical pattern as a line, or **track**, connecting its known areas of distribution. He found that the tracks of many taxa, belonging to a wide variety of organisms, could be combined to form a **generalized track** that connected different regions of the world.
These generalized tracks did not conform to what might have been expected if these organisms had evolved in a limited area and had dispersed from there over the modern pattern of geography, as other biologists then believed

Vicariance: any barriers, such as mountains or oceans, that exist today within the pattern of distribution of the taxa had appeared <u>after</u> that pattern had come into existence, so that these taxa had never needed to cross them.



Dispersal vs Vicariance

Comparison Chart

Dispersal	Vicariance
Dispersal is the movement of a few members of a species from their birth or breeding site to a new geographical location.	Vicariance is the division of a population into distinct but related species due to the development of a geographical barrier.
Dispersal occurs on the onset of pre-existing geographical barriers.	Vicariance occurs in populations due to the development of new geographical barriers.
The geographic barrier is older than the geographic disjunction.	The geographic barrier cannot be older than the resulting speciation event.

DifferenceBetween.net

Migration

Latitudinal movements of animals in order to take advantage of long summer days and high productivity in the high latitudes, and then to retreat to lower latitudes to avoid the stresses of the winter season.

with the seasons.

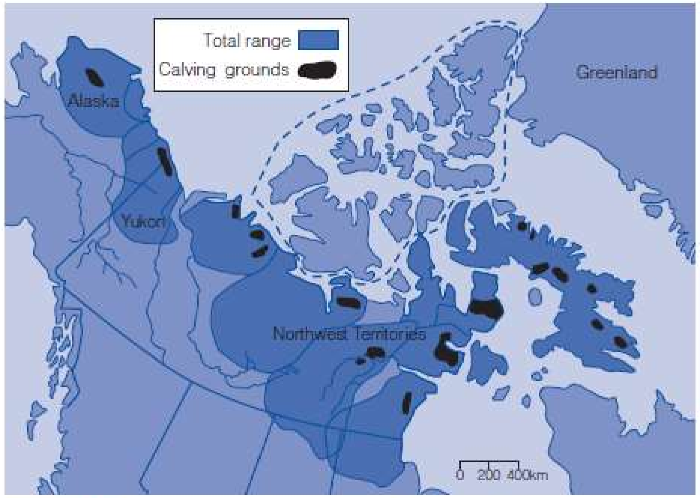


Figure 2.39 Ranges of caribou herds in North America, also showing their calving grounds to which they migrate each spring. Caribou are also located on the islands enclosed within the dashed line. From Sage [59].

Migration

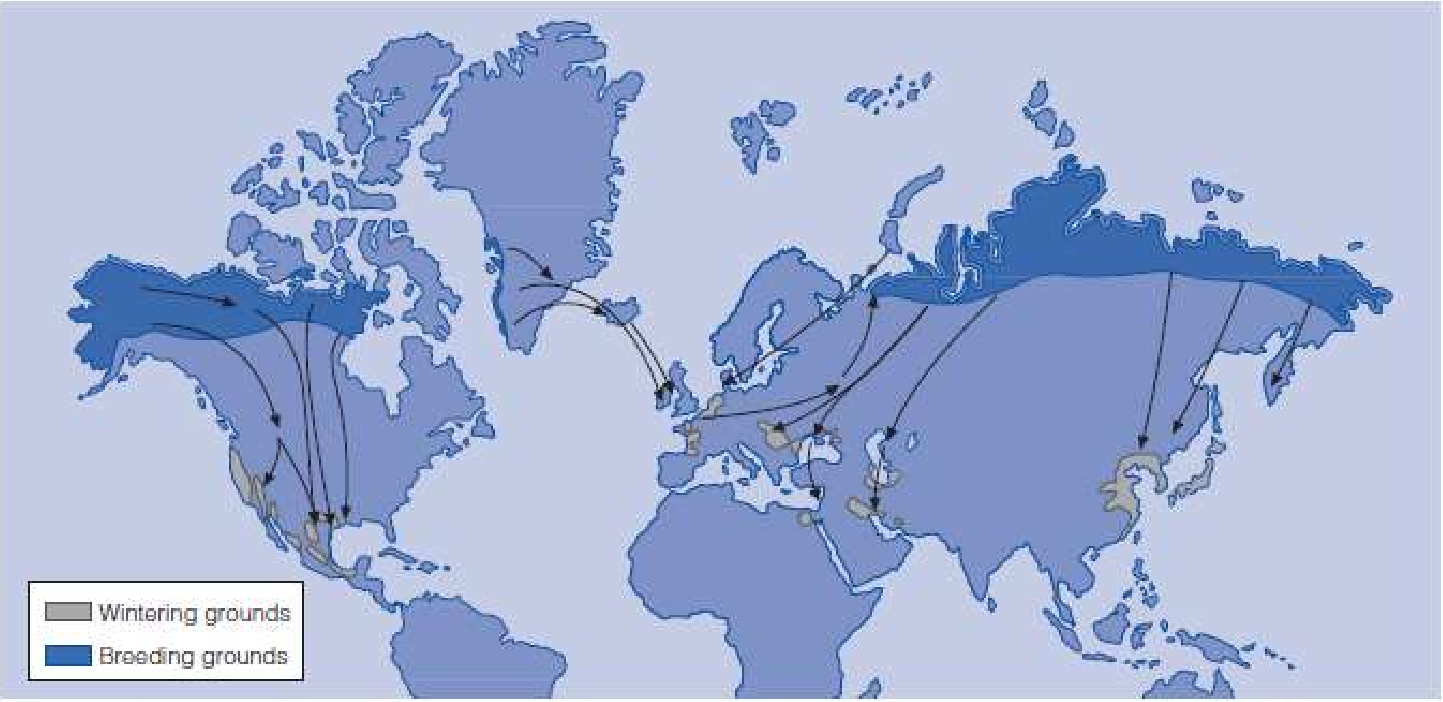


Figure 2.40 Breeding grounds, migration routes and wintering grounds of the white-fronted goose (*Anser albifrons*). From Mead [60].

- circumpolar distribution pattern, in summer breeding season.

- winter in southern parts of North America and Central America, in Europe and the Persian Gulf, and in Japan and eastern China, depending upon their breeding season.

Migration

- - nests in the Arctic

- - then it travels toward the
- Antarctic during the northern
- hemisphere winter.

- -This bird enjoys more daylight ir
- the course of its life than any oth
- organism.

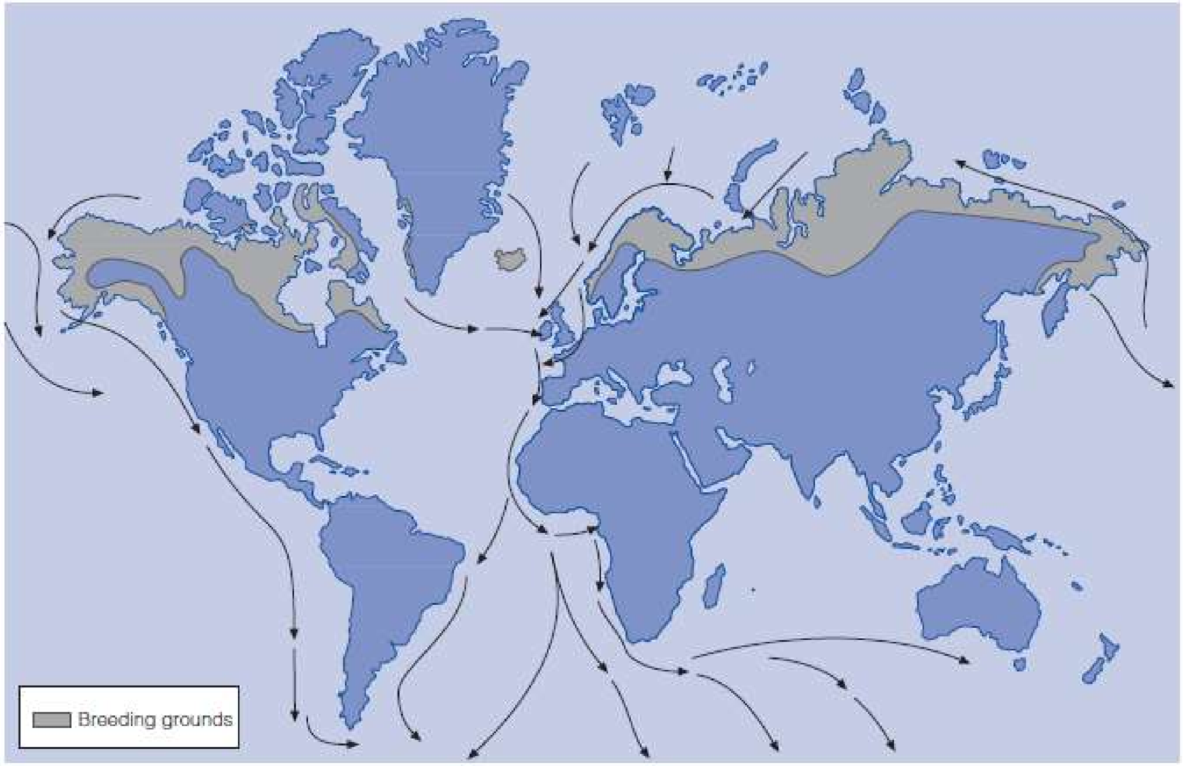


Figure 2.41 Breeding grounds, migration routes and wintering area of the Arctic tern (*Sterna paradisaea*). From Mead [60].

Migration

- - Migrates between Canada and the Pacific Northwest to Central and South America each fall, returning in the spring.
- - 42 days to fly from Panama to Canada (the actual travel involved consists of 18 nights of flying).
- - The rest of the time is taken up with resting at stopover locations along the route.
- Over the 4800 km journey, 4450 kJ of energy is expended (1 kJ/ each Km).
- - only 29% of the energy lost is expended on the actual flight; the remainder is lost during the stopover rests (recuperating and seeking food at these locations)

Invasion

- The success of a species can, in part, be measured by its geographical distribution, and the ability to move into new areas.

- introduced into Central Park, New York, in 1891. Since then, it has spread widely and is now present throughout the United States

- it has partially displaced the bluebird (*Sialia sialis*) and the yellow-shafted subspecies of the northern flicker (*Colaptes auratus*).

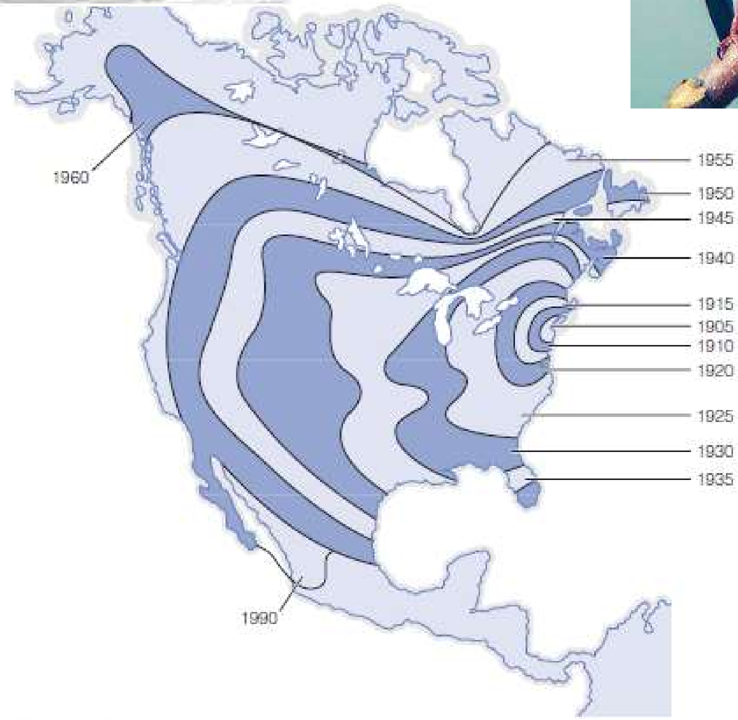


Figure 2.43 Map of North America showing the range extension of the European starling (*Sturnus vulgaris*) following its introduction to the continent late in the nineteenth century. Adapted from Baughman [12].

Invasion

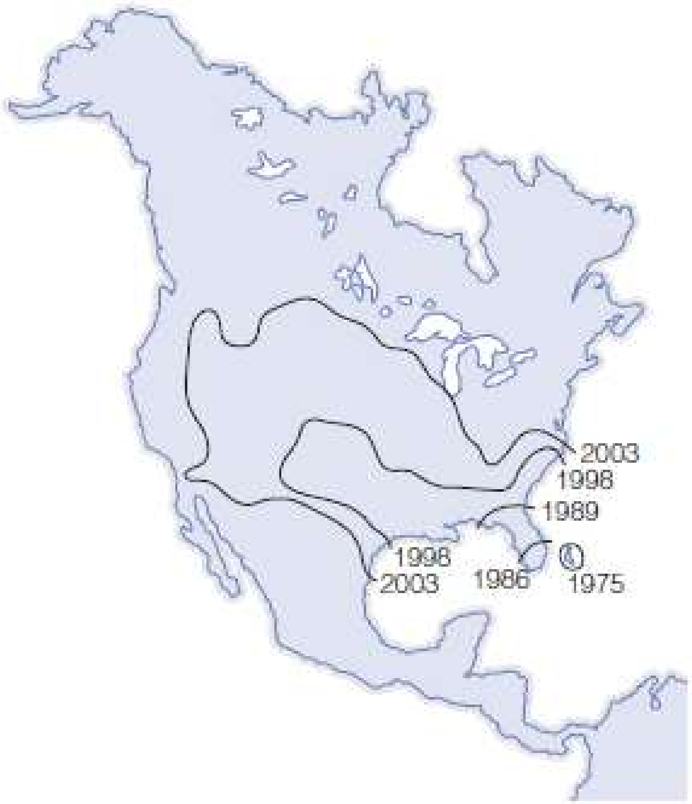


Figure 2.44 Map of North America showing the range extension of the Eurasian collared dove (*Streptopelia decaocto*) since its introduction to the Bahamas in the 1970s. Its spread in North America follows a similarly rapid extension of range in Europe over the last century.

Invasion

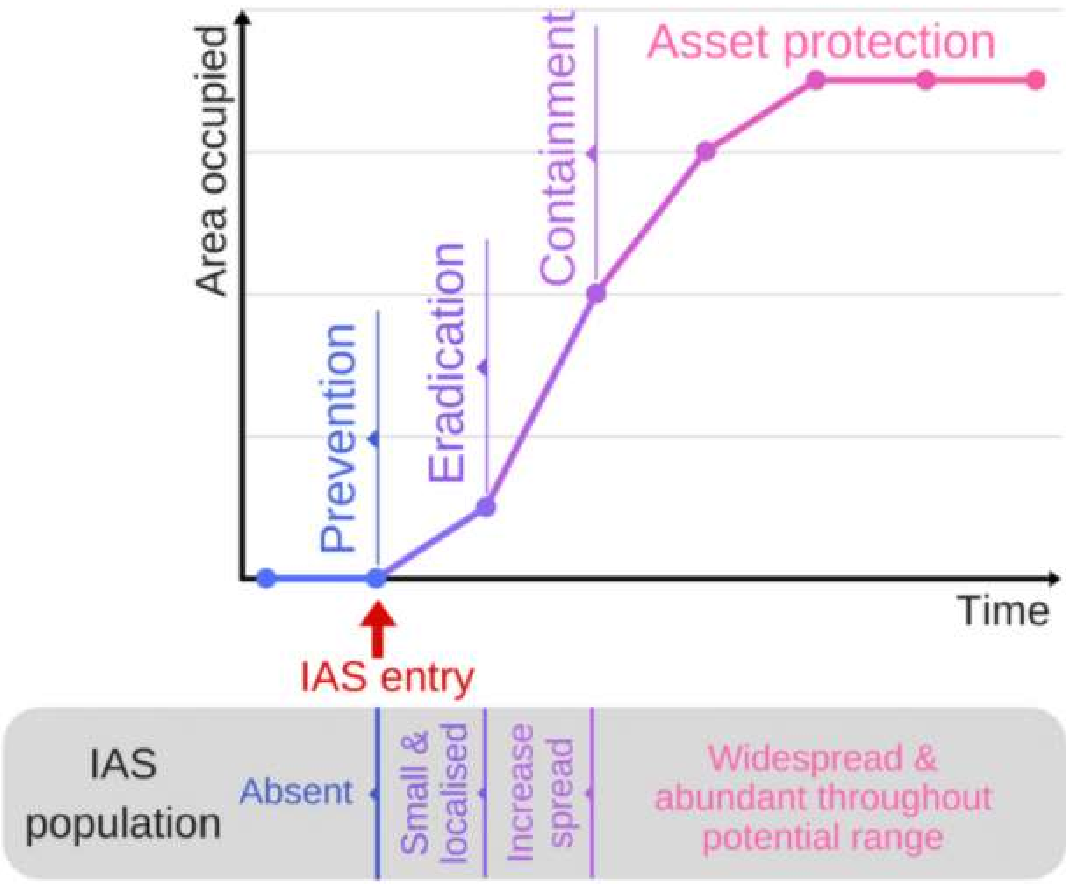
- An example is the American grey squirrel (*Sciurus carolinensis*), which was introduced into the British Isles in the nineteenth century.
- Between 1920 and 1925 the native red squirrel (*Sciurus vulgaris*) suffered a dramatic decline in numbers in Britain, largely due to disease.

! The invader must be able to survive the **pressures of predation** and **parasitism** in its new environment and to face biotic resistance of **local populations.**

Do not underevaluate the effects of an invader in a new ecosystem!!!

Invasion

- - **Eradication**
- - **Biological control**
- - **GMOs**



Adapted from the Invasive Plants and Animals Policy Framework, State of Victoria Department of Primary Industries, 2010

a quarter of a billion people around the world suffer from malaria each year.

Genetics and Genomics

Simple genetic modification aims to stop mosquitoes spreading malaria

Genetically modifying mosquitoes to express antimalarial genes and pass them on to their offspring is being tested as a new strategy to eliminate malaria.

Research Article

Genetics and Genomics

https://www.nature.com/articles/nbt.4245

Converting endogenous genes of the malaria mosquito into simple non-autonomous gene drives for population replacement

Astrid Hoermann, Sofia Tapanelli, Paolo Capriotti, Giuseppe Del Corsano, Ellen KG Masters, Tibebu Habtewold, George K Christophides, Nikolai Windbichler

Department of Life Sciences, Imperial College London, United Kingdom

Anopheles gambiae

dsx-female (*AgdsxF*) — exon 5 highly conserved

dsx-male (*AgdsxM*

CRISPR–Cas9-targeted disruption of the intron 4–exon 5

Sterile females

- https://vimeo.com/143428041