به نام یگانه آفریننده دانا

دانشگاه حکیم سبزواری

جغرافیای جانوری

تهیه کننده

علیرضا کیخسروی

نیمسال دوم ۱۳۹۷

منابع:

1- Cox C. B. and P. D. Moore (2010) Biogeography , an ecological and evolutionary approach. 8th edition, Wiley, Hoboken.
2- Brown J. H, and M. V. Lomolino (2010) Biogeography. 4th edition. Sinauer Associates Inc. Sundeland.
3- Craw R. C. , J. R. Grehan and M. J. Heads (1999) Panbiogeogry (Tracking the history of life). Oxford University press, NewYork.
4- Ekman, S. (1967) Zoogeography of the Sea. Sidgwick and Jackson , London

On pages 4 and 5 of the opening chapter, the authors list some of the types of questions posed by biogeographers:

1. Why is a species or higher taxonomic group confined to its present range?
2. What enables a species to live where it does, and what prevents it from colonizing other areas?
3. What role does geographic variation in climate, topopgrahy and interactions with other organisms play in limiting the distribution of a species?
4. How do different kinds of organisms replace each other as we go up a mountain or move from a rocky shore to a sandy beach nearby?
5. What are a species closest relatives, and where can they be found? Where did its ancestors live?
6. How have historical events – such as continental drift, Pleistocene glaciation, and recent climatic change – shaped a species' distribution?
7. Why are animals and plants of large, isolated regions so distinctive?
8. Why are some groups of closely related species confined to the same region while others are found on opposite sides of the world?
9. Why are there more species in the tropics than at temperate or arctic regions?
10. How are isolated oceanic islands colonized, and why are there nearly always fewer species on islands than in the same kinds of habitats on continents?

سولات رایج در جغرافیای زیستی

1. Why are different regions of the globe, even those with similar soils, climates, and other environmental conditions, inhabited by distinct biotas?
2. What abiotic factors (e.g., water chemistry and temperatures) and what biological processes (e.g., predation, competition, and mutualism) limit species distributions, and how does the relative influence of these factors vary across geographic regions, taxa, and time periods?
3. How do the size, shape, and patterns of overlap of geographic ranges vary among taxa, over evolutionary history of particular lineages, or across geographic regions and realms (e.g., among the continents and across ocean basins)?
4. How have historical events such as continental drift, mass extinctions of the dinosaurs and other once-dominant life forms, glacial episodes of the Pleistocene Epoch (all but the most recent 10,000 of the past 2 million years), and more recent periods of climate change (natural or anthropogenic) shaped distributions and patterns of geographic variation of extant biotas?
5. How do the characteristics of entire communities, including their diversity, species composition, and rates of total production and decomposition, vary across the globe?

6. How are isolated oceanic islands colonized, why are there nearly always fewer species on islands than in the same kinds of habitats on continents, and why are these islands often inhabited by evolutionary marvels—flightless birds, "daisies" and other typically herbaceous plants the size of trees, or elephants no larger than domestic pigs?
7. Does the diversity and species composition of relatively recently discovered communities—such as those of hydrothermal vents and cold seep communities of the deepest reaches of the marine realm—exhibit biogeographic patterns similar to those of islands, mountaintops, and other isolated, terrestrial communities?
8. How do the physiological, genetic, morphological, and behavioral characteristics of individuals and populations of a species vary across its geographic range and along geographic gradients such as those of latitude, elevation, and depth?
9. How have the distributions of species—from primordial, unicellular life forms to *Homo sapiens* and its direct ancestors—developed over evolutionary time, and how has the evolution of these lineages been influenced by geographic variation in environments and interactions with regional biotas?
10. How have the geographic dynamics of human civilizations influenced the distributions, evolution, and extinctions of other species, and finally, how will our unrivaled abilities to modify the natural world influence the distributions, diversity, and geographic signature of nature long into the future?

مقدمه

- تعریف علم جغرافیای زیستی
  - منشاء جغرافیای زیستی در زمین شناسی، دیرینه شناسی، بیولوژی، اکولوژی و جغرافیا می باشد.
  - چرایی پراکنش موجودات و عدم یکنواختی موجودات زنده به روی کره زمین؟
  - مطالعه الگوهای پراکنش در زمان و مکان

انواع زیستگاه ها

- کوچک
  - میمون های عنکبوتی
- کلان

رئوس مطالب

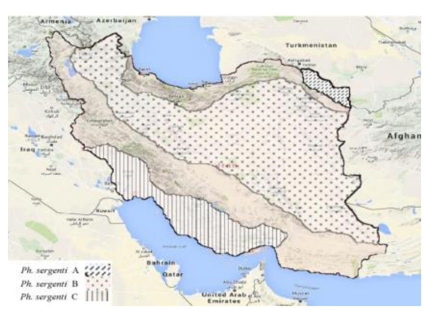
- تعریف و جایگاه جغرافیای زیستی
- مطالعات آب و هوایی دیرینه
- نحوه پراکندگی یک گونه
- پراکنش جوامع جانوری (نقش تکتونیک و یخبندان)
- تقسیم بندی نواحی جغرافیایی جانوران خشکی
- پراکندگی جانوران و انقراض دوره ای گونه ها
- مدل های پراکنش جانوران
- جهان وطنی و بومی شدن
- جغرافیای جانوری جزایر
- جغرافیای جانوری در گذشته، حال و آینده

Limits of distribution

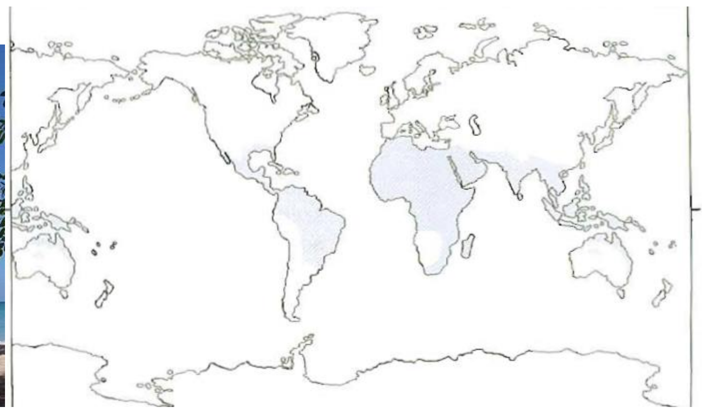
- Why a species can not disperse to other favorable habitat?
  - Species is limited because of its evolutionary history (physiology)
  - Native species and limited distribution
  - Small habitat and limits of distribution

Limits of distribution

- Why a species can not disperse to other favorable habitat?
  - *sandflies in Iran*



پراکنش گونه ***Ph. sergenti*** در کشور ایران بر اساس کلاد های درخت

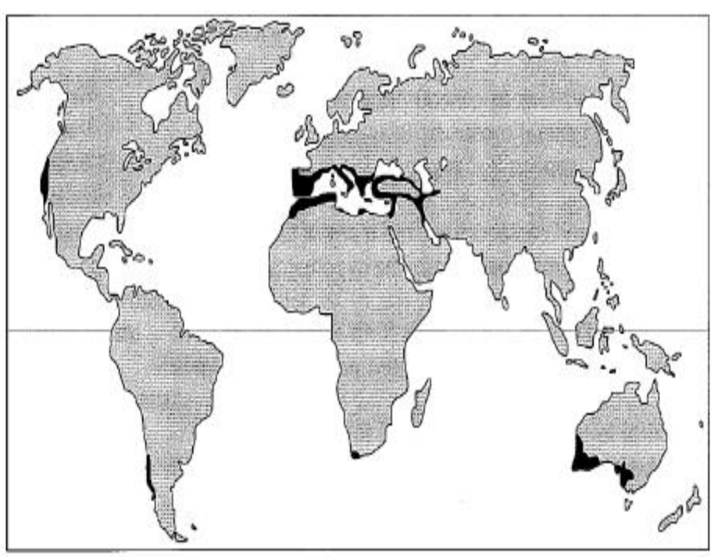


How to overcome the barriers?

- Finally a habitat occupied with a species become unsuitable since old one become exhausted
- Flying, resistant stage and seeds and etc
  - e.g. Eurasian collared dove (what reasons may cause this?)
  - Example of crossing barrier: freshwater crab *Potamon fluviatile*

Ways to spread from one area to another

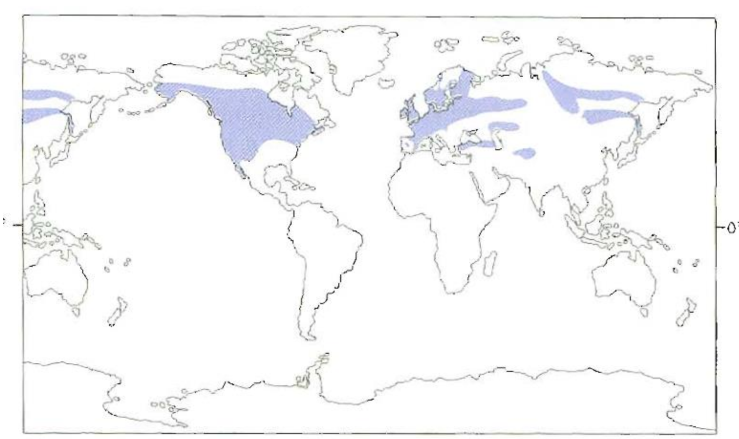
- Corridor (variety of habitat)
  - e.g. Eurasia, Europe and China
  - Iran
- Filter (more limited variety of habitat)
  - Only species live in these habitat can cross
  - e.g. Tropical lowland of Central America
- Sweepstakes route (Surrounding by totally different environment)
  - Not able to spend their life *en route*
  - Birds and insects are exception ; disharmonic



Continues pattern of distribution

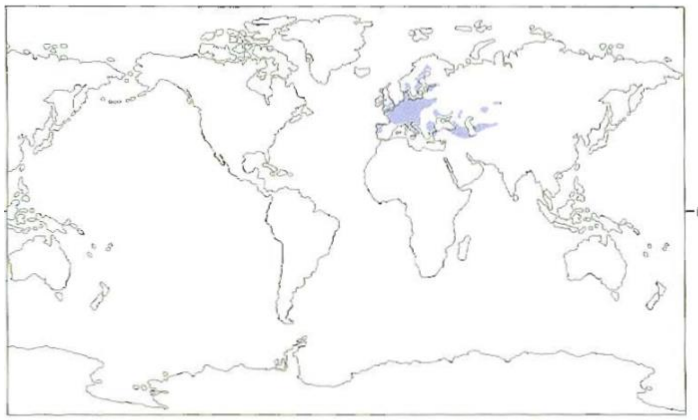
- Damsel fly (*Enallagma cyathigerum*)
- *Symetrum Sanguineum*
  - Stenotopic species

Enallagma cyathigerum



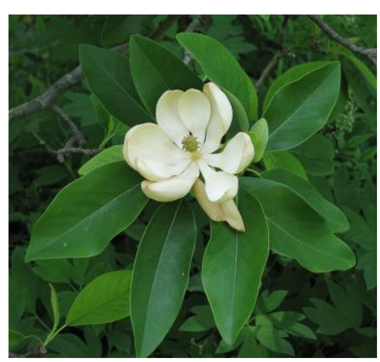
(a)

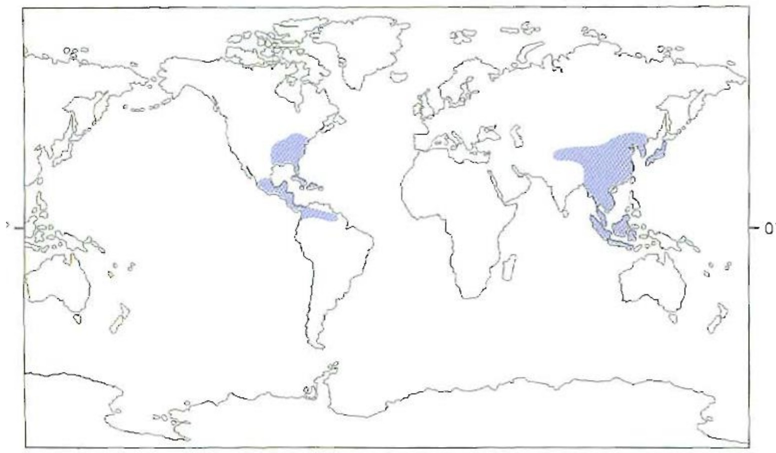
Symetrum Sanguineum



Evolutionary relict

- Magnolias
  - Distribution can not be explained by climate sensitivities of the plant.
  - Answer is to look at their evolutionary history



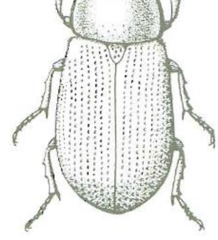


Climatic relict

- *Tetracanthella arctica*

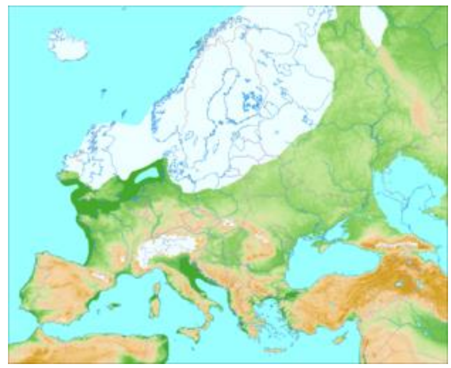
Aphodius holdereri

- Current distribution ends at the northern slopes of the Himalaya Mountains



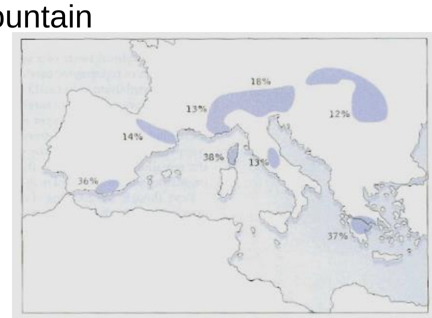
What happened to Different taxa after glaciations?

- In island
- In mainland



Endemic species

- Staying in the area on origin
- Endemic species rate is a good value for determining the time length of isolation of area.
- The longer time of isolation = the higher taxonomic level endemicity
- Northern and southern mountain

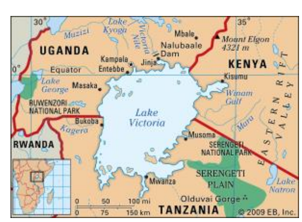


What effect the endemicity?

- Isolation
- Stability

Victoria lake

- Haplochromis sp.
  - Almost all 500 species are endemic (adaptive radiation)



Endemicity in Iran

- 36 endemic species in Iran
- that 14 species (%38.8) belonging to Zagros mountains (Gholamifard, 2011).

Endemicity in Iran

- 32 species of tooth-carp fish of the genus *Aphanius* within the Irano-Anatolian hotspot.
- Of these 14 species are found in Iran, 12 of which are endemic to the country.
- Most of these endemic species consist of small populations in the mountainous Zagros (Esmaeili et al. 2016).

Aphanius arakensis

Endemicity in Iran by climate fluctuation

- Considerable genetic diversity within the lacertid lizards of the genus *Iranolacerta*
- Past climatic fluctuations driving the speciation process in the Zagros regions (Ahmadzadeh et al., 2013).

Iranolacerta brabdtii brandtii

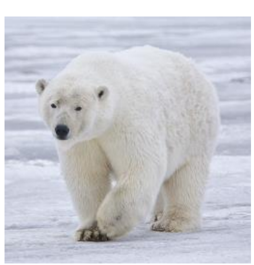
Endemicity in Iran by climate fluctuation

- Quaternary refugia in Southwest of Iran have been conducted on the basis of the study of two sympatric moth species (Insecta, Lepidoptera, *Gnopharmia colchidaria and G. kasrunensis*). The presence of a wide refugial area in the southeastern Zagros Mountains can be expected. Consequently, this region could well have served as the source population for the detected postglacial expansion events in both moth species (Rajaei et al

Physical setting in distribution

- Living organisms are found in virtually every habitat on the planet.

Caribou



- However, no single type of organism is found EVERYWHERE.
- Each has its own, restricted, geographic range.
- Exceptions!!!!!!
  - Peregrin falcon
  - *Homo sapiens*

Physical limitation

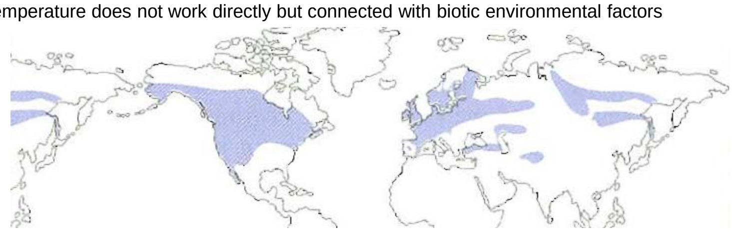
- Species is not always limited by topographical barriers:
  - Abiotic factors: temprature, wetness, …
  - Biotic factors: competition …..

What is limiting factor

It is not necessary lethal but less efficient physiology and behavior

1-Example of dragonfly: time shift in metamorphosis

Temperature does not work directly but connected with biotic environmental factors

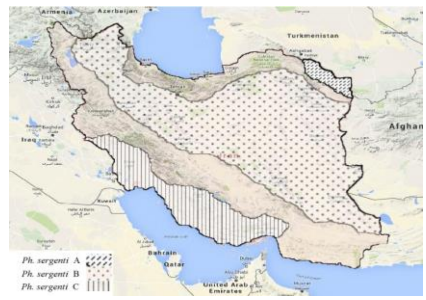


- It is well documented that:
  - environmental variables vary in a nonrandom manner.
  - more distant sites tend to be more different than closer sites.

This relates to distributions in that, as the distance between locations grows, we might expect the environmental conditions to differ.

Sand fly

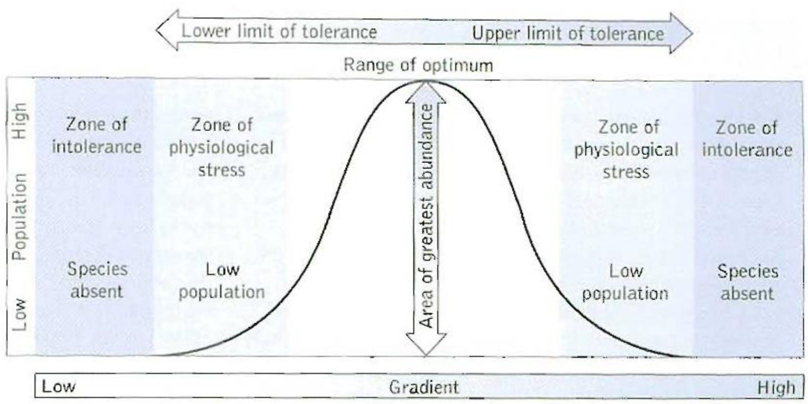
- Why a species can not disperse to other favorable habitat?
  - *sandflies in Iran*

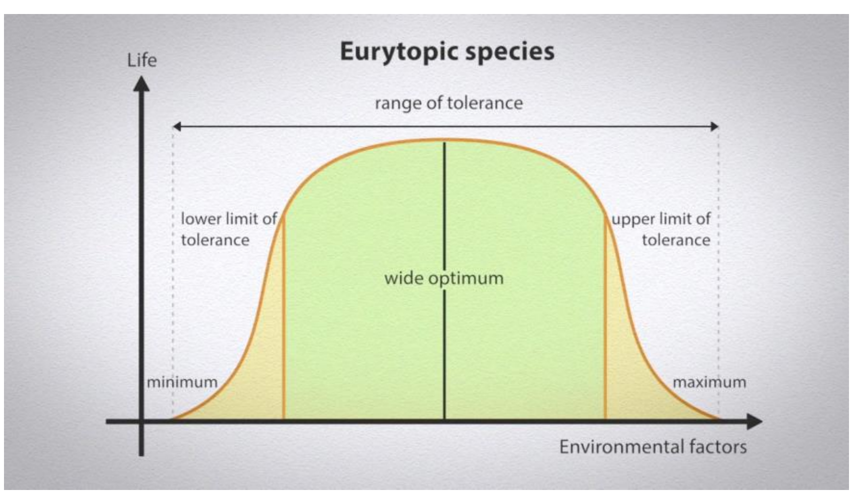


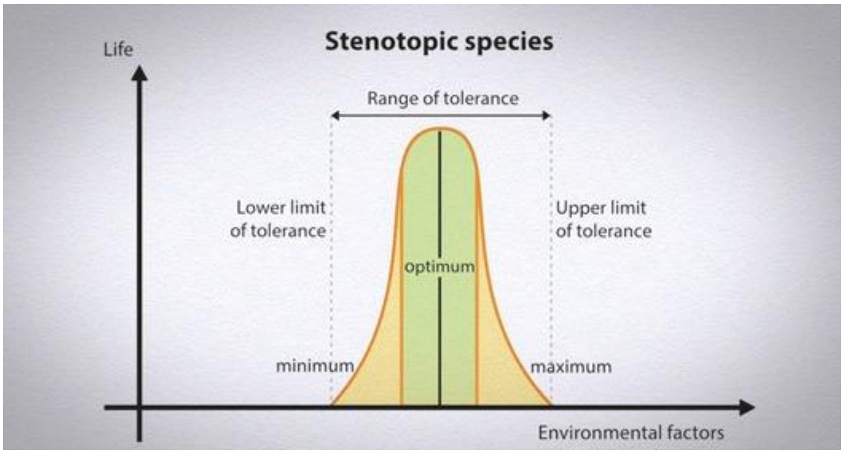
در کشور ایران بر اساس کلاد های درخت ***Ph. sergenti*** پراکنش گونه

Environmental gradients

- It is considered for each factor separately
- Species have different tolerant to environmental factors
  - Ecologically tolerant (eurytopic)
  - Ecologically intolerant (Stenotopic)
    - Very typical example is the universal temperature gradient
    - In birds eastern phoebe: winter distribution confined to parts of the united states that minimum January temperature above -4 degree


Lower limit of tolerance
Upper limit of tolerance
Range of optimum
High
Population
Low
Zone of intolerance
Zone of physiological stress
Area of greatest abundance
Zone of physiological stress
Zone of intolerance
Species absent
Low population
Low population
Species absent
Low
Gradient
High


Eurytopic species
Life
range of tolerance
lower limit of tolerance
upper limit of tolerance
wide optimum
minimum
maximum
Environmental factors



Temperature gradient

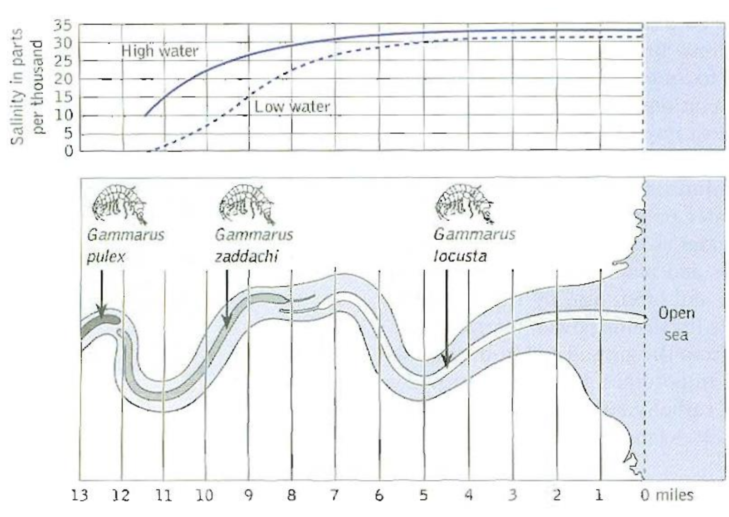
- Very typical example is the universal temperature gradient
- In birds eastern phoebe: winter distribution confined to parts of the united states that minimum January temperature above -4 degree

Other limiting factors

- Light
- Oxygen
- Wetness
- Salinity in marine

Estuaries with very unique condition

- Salinity varies in space and time



r/K selection theory

- Relates to the selection of combinations of traits in an organism that trade off between quantity and quality of offspring.

A North Atlantic right whale with solitary calf. Whale reproduction follows a *K*-selection strategy, with few offspring, long gestation, long parental care, and a long period until sexual maturity.

A litter of mice with their mother. The reproduction of mice follows an *r*-selection strategy, with many offspring, short gestation, less parental care, and a short time until sexual maturity.

Stenotopic≠Eurytopic

- Tolerance of stenotopoic and eurytopic species and their advantage and disadvantage
- Last slide comparing *G. duebeni and ocianicus* with in contrast to two species mentioned before.

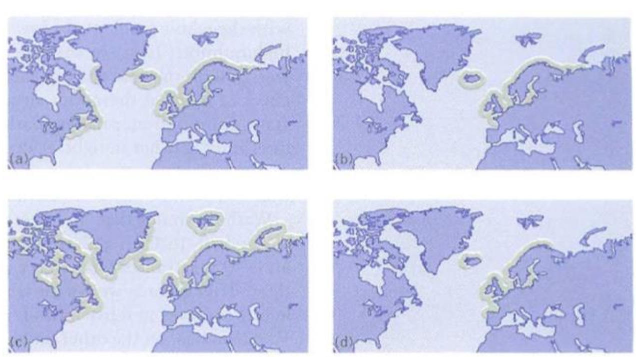


Fig. 4.24 Distribution maps of four species of the amphipod *Gammarus*: (a) *G. duebeni* (b) *G. zaddachi*, (c) *G. oceanicus*, and (d) *G. locusta*. From Gaston & Spicer [27].

Interaction of factors

- Series of interacting factors have more extreme effect on behavior and physiology than any factor alone
- Warburg study on two isopod species using preferendum apparatus. Example *A.vulgare* and *V. arizonicus*.

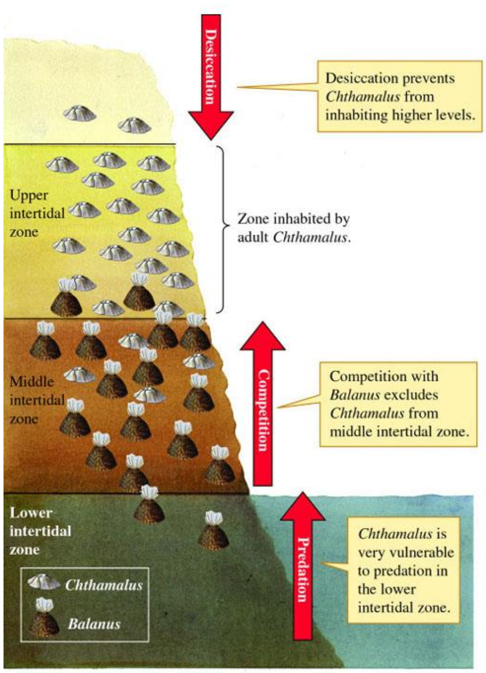
Species Interaction
(Biotic factors)

- Depending to another species:
  - For food predators, parasite, compete with other species….
  - Competitive exclusion e.g. barnacles

Hakim Sabzevari University, Dr. Alireza Keikhosravi

Connell performed a series of experiments:

1. He moved rocks bearing Chthalamus from the upper to the lower intertidal to see whether the species could survive in the low intertidal zone. He also moved rocks bearing Balanus from the low intertidal to the high.
2. He removed Balanus from rocks in the low intertidal and Chthalamus from rocks in the high intertidal. These experiments were designed to show whether each could grow in the other tidal zone if its competitor were absent.

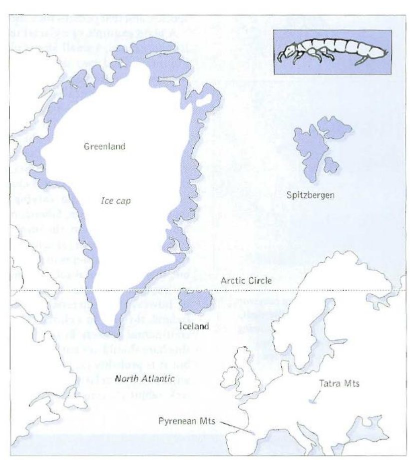


Species Interaction
(Biotic factors)

- Depending to another species:
  - For food predators, parasite, compete with other species….
  - Competitive exclusion e.g. barnacles
  - Invasion
  - Habitat loss

Invasion

- Habitat loss
  - Moving to new habitats by overcoming physical barrier



Invasion

- Habitat loss
  - Moving to new habitats by overcoming physical barrier
  - Competing with native species that needs:
  - Reproduction for long term success

The role of human in invasion

Ecological imperialism

tichberry

Example

- *Sturnus vulgaris*
  - Native to Europe but introduced to the USA and now has displaced Bluebird
    - Because of food and nest competition

Example

- Grey was introduced to British Isles in 1920 because of competition for food and habitat

Grey squirrel

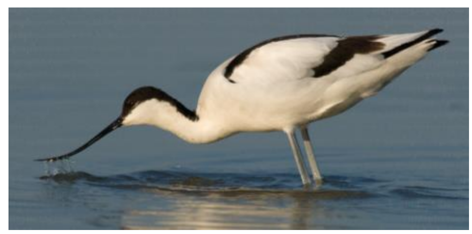
Red squirrel

Reducing competition

- When using the same food resources
  - Temporal separation
    - Owl and falcons
    - Grazing community (East African Savana)
- Same space requirements
  - Spatial separation

Example of spatial separation

- *Phoenicopterus ruber and tadorna tadorna or Recorvirostra avosetta*



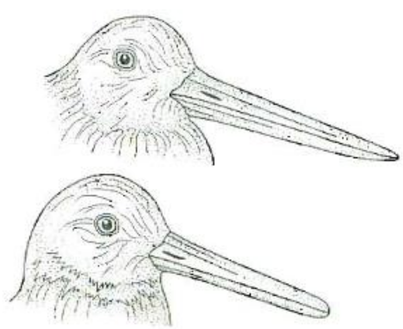


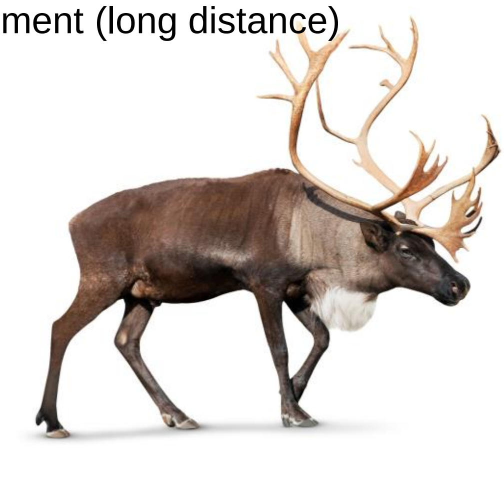
Fig. 4.30 Bill size variation within one species, the oystercatcher (*Haematopus ostralegus*). The upper bird is a 'stabber', and extracts its shellfish prey by pushing the bill between the valves of the shell and prising it open. The lower bird is a 'hammerer' and breaks the shell by violent blows of the bill on one of the valves [43].

Example of spatial separation

- Although Eucalyptus leaves are very fibrous and low in nutrition, and to most animals are extremely poisonous, Koala survive on a diet of eucalyptus leaves.

Migration

- Alteration of environmental condition with seasons (temporary occupation).
  – Latitudinal movement (long distance)
  – Short distance



Cost and advantageous

- Resources
- Nesting abundance

Migration and genetic structure

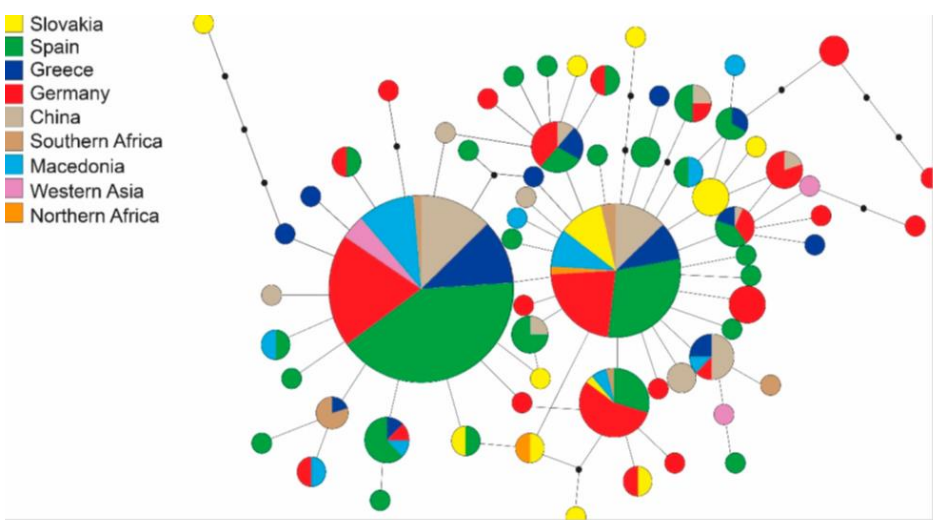
- Long-distance cyclic migrants:
  - can display patterns of genetic structure or panmixia dependent on behavioral and/or environmental drivers.
  - some bird species are shown to exhibit “flyway permeability,” in which birds switch between flyways in response to social cues, or environmental pressure

Merops apiaster

- Palearctic distribution

Moura et al., 2019. Pliocene origin, ice ages and postglacial population expansion have influenced a panmictic phylogeography of the European bee eater

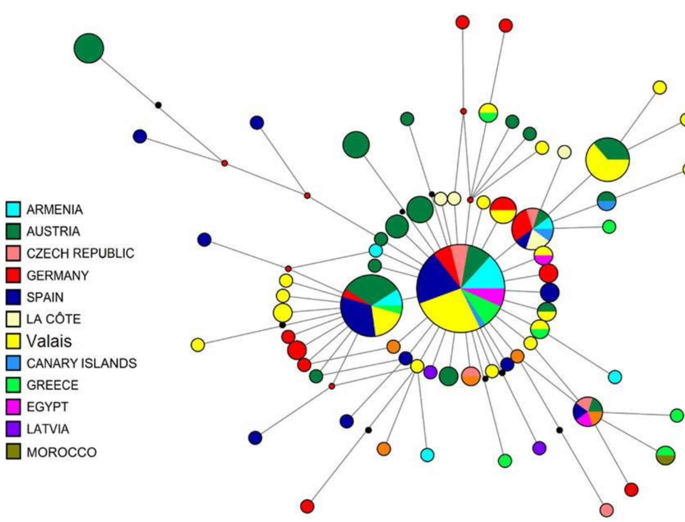
Merops apiaster



Upupa

Wand et al., 2017. Gene flow and genetic drift contribute to high genetic diversity with low phylogeographical structute in European *Upupa epops*

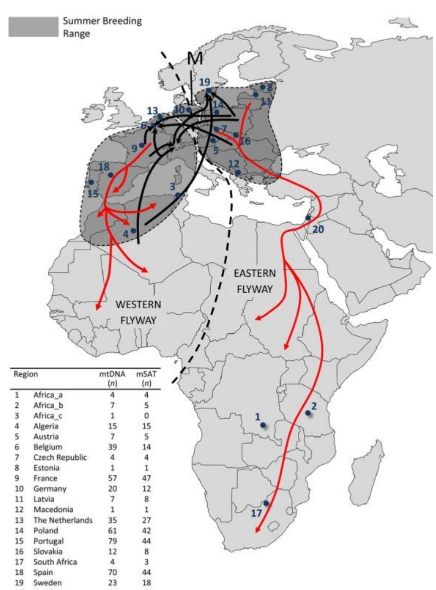
Upupa epops



Examples of migratory birds

White stork

Shephard et al., 2013. Is population structure of European white stork determined by flyway permeability rather than translocation history



Region		mtDNA (n)	mSAT (n)
1	Africa_a	4	4
2	Africa_b	7	5
3	Africa_c	1	0
4	Algeria	15	15
5	Austria	7	5
6	Belgium	39	14
7	Czech Republic	4	4
8	Estonia	1	1
9	France	57	47
10	Germany	20	12
11	Latvia	7	8
12	Macedonia	1	1
13	The Netherlands	35	27
14	Poland	61	42
15	Portugal	79	44
16	Slovakia	12	8
17	South Africa	4	3
18	Spain	70	44
19	Sweden	23	18
20	Israel	11	0

Shephard et al., 2013. Is population structure of European white stork determined by flyway permeability rather than translocation history

Divergent route

- *Anser anser*
- Palearctic distribution
- With eastern and western distribution with different wintering migration routes

Predators and preys

- Lynx and wolf in Newfound land
  - Prey caribou and introduced snowshoe hare

Controlling population size of prey

- bell miner; predator
- Psyllid bugs; prey

Competition between species can be terminate by predator as two species survive

- This means predator uses different sources, therefore by praying on dominant species and give an opportunity to recessive species
  - Seed-eating beetles and parasitic wasp
  - Sea urchins and algae
- One must be cautious applying this conclusion

Colonizing new habitat depend on the interaction of factors

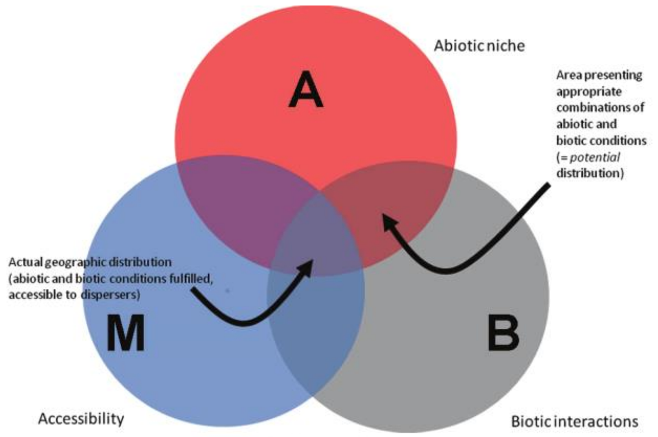


Figure 3. The "BAM diagram," showing a simplified framework for understanding where species will and will not be distributed. Distributions of species are seen as responding to three sets of factors: the abiotic niche (**A**, in red) and the biotic niche (**B**, in gray), which roughly correspond to the fundamental ecological niche (**A**) and the realized ecological niche (**A** ∩ **B**, here termed the potential distribution) of Hutchinson (1978). A further modification to distributional potential, however, is that of accessibility (here **M** for "movement," in blue), which may constrain species' distributions dramatically. Reproduced from Soberón and Peterson (2005).

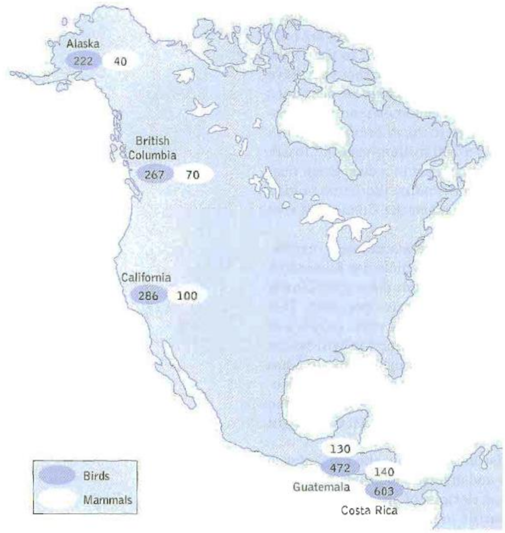
Peterson, 2008. Phylogeography is not enough: The need for multiple lines of evidence

Patterns of biodiversity

Group	Number of described species	Likely total	Percentage of group known
Insects	950 000	8 000 000	12
Fungi	70 000	1 000 000	7
Arachnids	75 000	750 000	10
Viruses	5 000	500 000	5
Nematodes	15 000	500 000	3
Bacteria	4 000	400 000	1
Vascular plants	250 000	300 000	83
Protozoans	40 000	200 000	20
Algae	40 000	200 000	20
Molluscs	70 000	200 000	35
Crustaceans	40 000	150 000	27
Vertebrates	45 000	50 000	90

Gradient of biodiversity

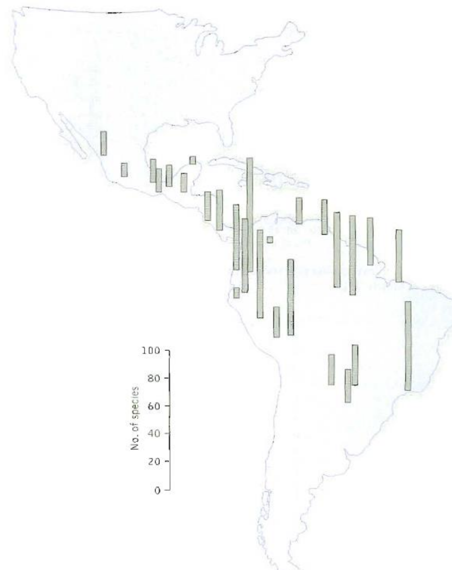
- Birds
- Mammals
- Frogs in lower latitude



Why such gradient?

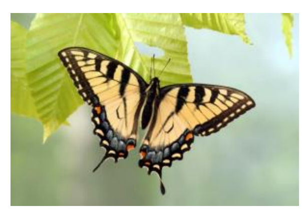
1-Diet
- Fruit eating mammals
- insectivores

frogs



Difficulties in insects

- Not well described group



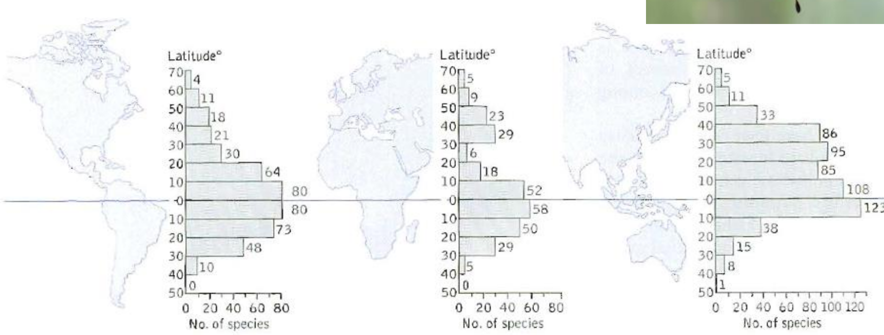


Fig. 3.5 Latitudinal gradients of species richness for swallowtail butterflies in three different parts of the world. Data from Collins & Morris [20].

2- Hot, wet and relatively free from seasonal variation

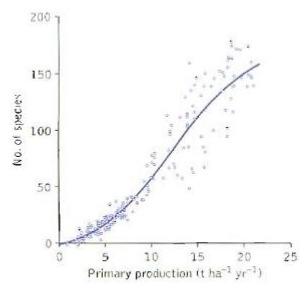
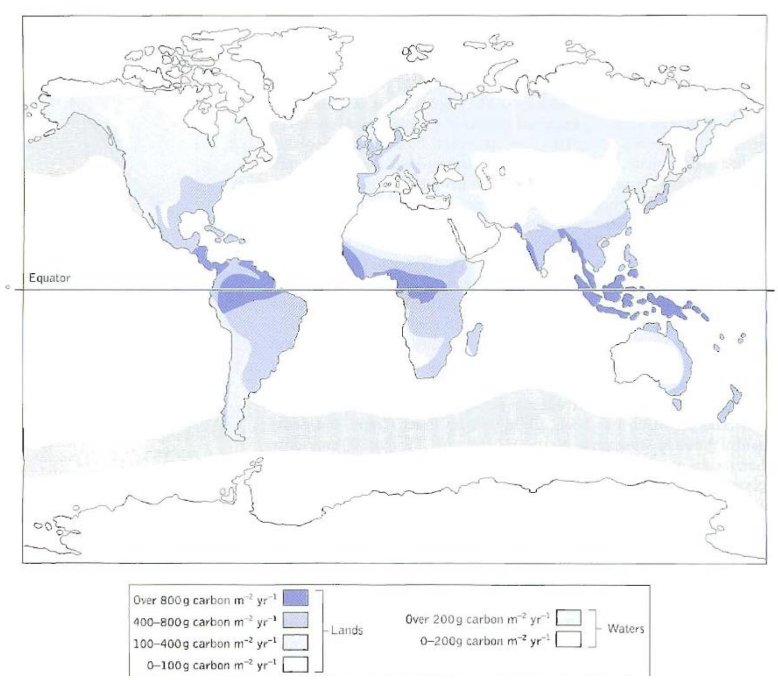
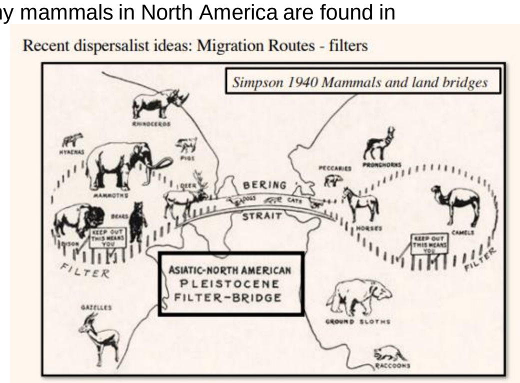


Fig. 3.8 Number of tree species in North American sites (see Fig. 3.7) plotted against the primary productivity of those sites. A distinct positive relationship can be observed. Data from Currie & Paquin [22].



Biogeographic regions

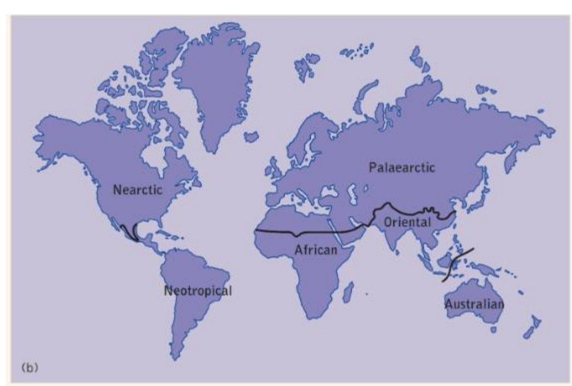
- Buffon's law (1761)
  - Inequality of large mammals fauna in two tropical regions; old world and new world
  - Many mammals in North America are found in



Cox, 2001. The biogeographic regions reconsidered

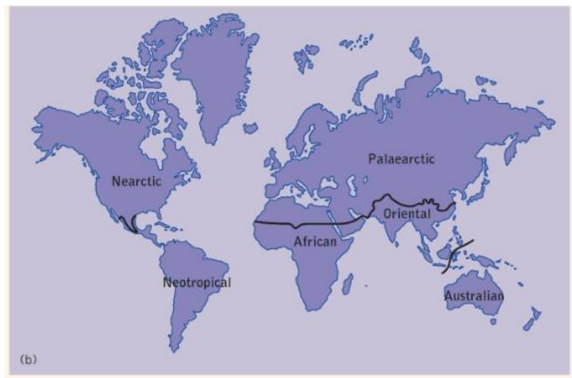
Biogeographic regions

- Sclatter (1858) recognized 6 regions based on passerine birds



Biogeographic regions

- Wallace (1876) applying the same 6 regions also to the distribution of other animals, especially mammals.



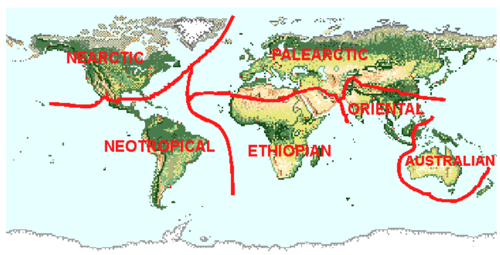
Wallace's Biogeographic regions

- Palaearctic (temperate Eurasia);
- Ethiopian (Africa south of the Tropic of Cancer);
- Oriental (tropical Asia, including the adjacent tropical Greater Sunda Islands);
- Australian (including New Guinea and adjacent islands);
- Nearctic (North America south to central Mexico) and
- Neotropical (South America and central America as far north as centralMexico)

Biogeographic regions

mainly to the distribution of mammals and birds

1. Nearctic—N. America including about 2/3 of Mexico and Greenland
2. Palearctic—Europe, northern Africa, and northern Asia--Nearctic and the Palearctic make up the Holarctic
3. Neotropical—lower 1/3 of Mexico, Central and South America
4. Ethiopian or African—Sub-Saharan Africa, adjacent Arabian Peninsula
5. Oriental—Indian subcontinent and adjacent regions of southern Asia
6. Australian—Includes Australia, Tasmania, New Guinea, and New Zealand.



- Wallace (1876) also described 21 continental sub regions.
- In the twentieth century, zoogeographers such as Simpson (1953) and Darlington (1957) ignored the subdivisions.

- Why?
- birds and mammals have physical and physiological features that insulate their bodies from the surrounding environmental conditions.
- Furthermore, as a result of the current pattern of barriers between the zoogeographic regions (see below), there is little overlap between the animals that characterize adjacent regions

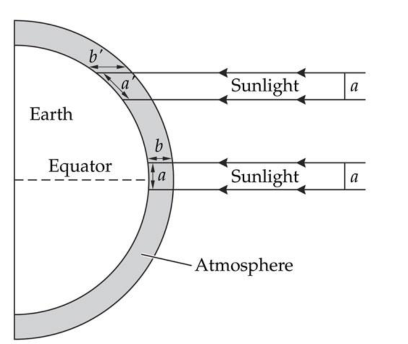
Only exception!!!!

between Southeast Asia and Australia

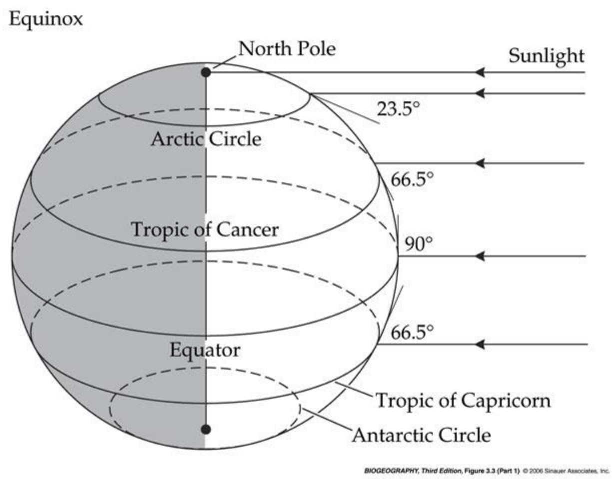
Climatic patterns in latitudes

(Abiotic interaction)

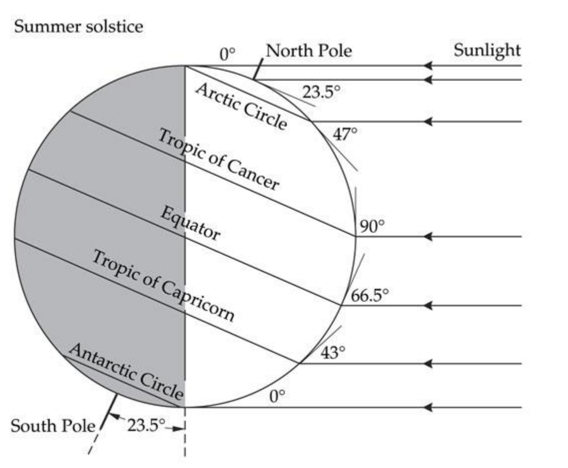
- **Solar energy**
  - Conduction , convection, radiation
  - A key factor in determining climate zones and, therefore, the distribution of habitat types is the angle of incident radiation. This is a function of latitude.



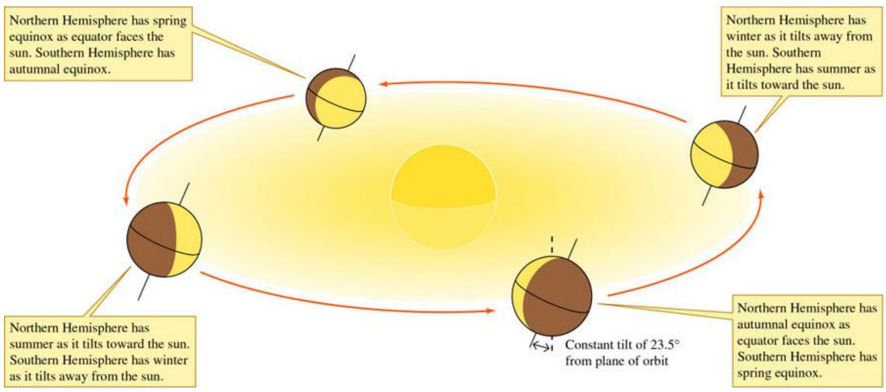
As the earth moves around the sun, the angle of incidence varies at different latitudes.



Further complicating matters is the fact that the earth's axis is tilted at an angle of 23.5° to the plane of the ecliptic.



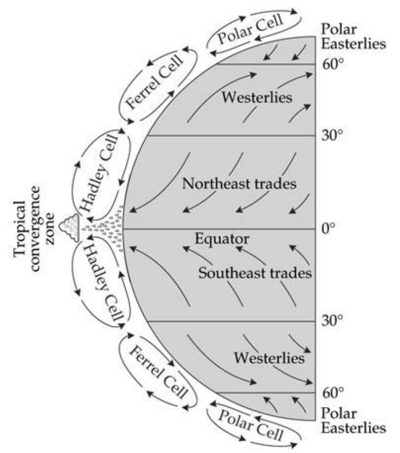
Because this tilted angle of rotation is maintained as the earth revolves around the sun, the amount of sunlight received by the Northern and Southern Hemispheres varies seasonally.



The cooling effect of elevation

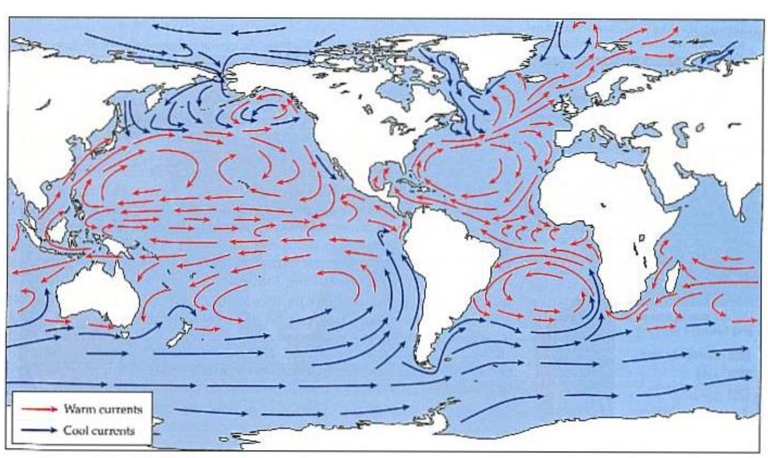
- **Adiabatic cooling**
- Less dense air act against **greenhouse effect**

- **Air movement pattern**
  - **Wind and rainfall**
    - The unequal heating of the earth's surface sets up a series of "cells" of rising and falling air as one moves from the equator to the poles.
    - **Corolis effect**

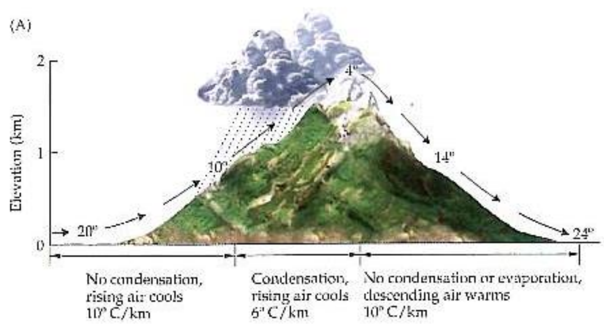


BIOGEOGRAPHY, Third Edition, Figure 3.4 © 2006 Sinauer Associates, Inc.

Ocean currents



Precipitation pattern



Rain shadow

Small scale spacial and temporal variation

- Alborz Mountains spacial
- ENSO temporal

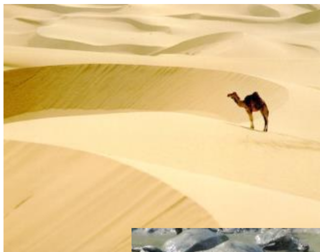
Life, death and evolution on islands

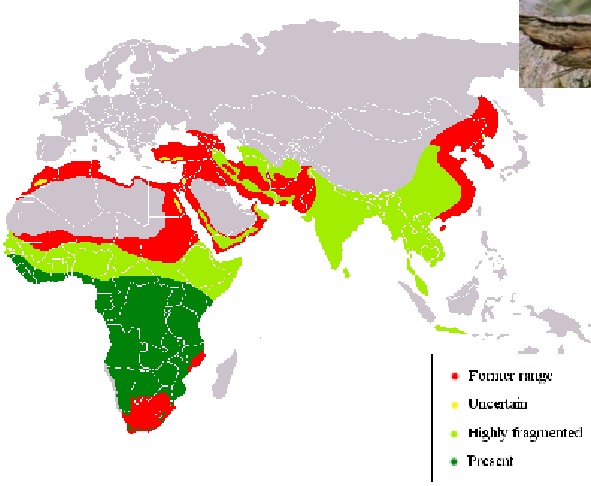
- In what ways island biota is different from that of the mainland?
- How did it arrive?
- How does the island community gradually establish itself and mature
- What can we learn about the processes and the rate of evolutionary change upon islands?

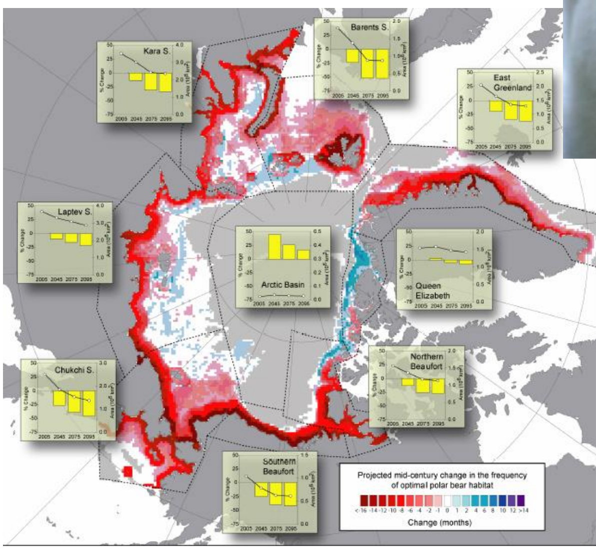
Occurrence in an island

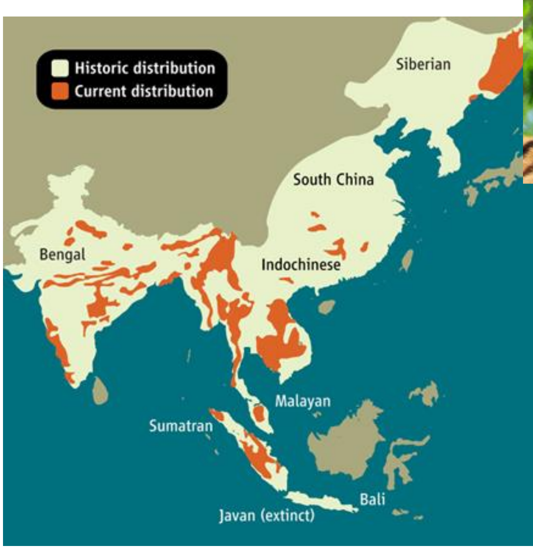
- Potential adaptation
- Dispersal ability for reaching an island

"Life varies from place to place in a highly non-random and predictable manner."



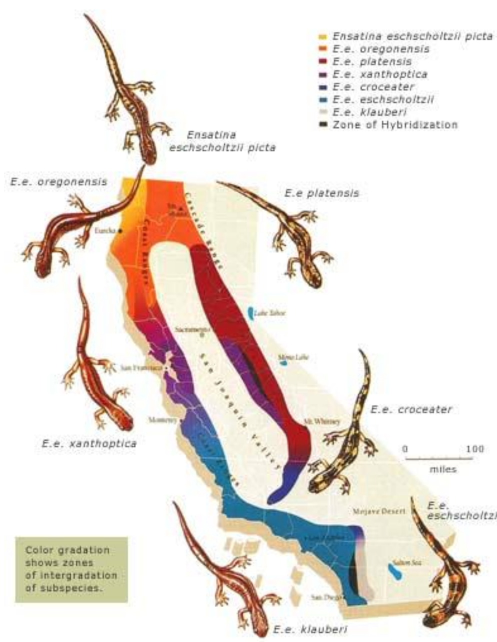



Kara S.
Barents S.
East Greenland
Laptev S.
Arctic Basin
Queen Elizabeth
Chukchi S.
Northern Beaufort
Southern Beaufort
Projected mid-century change in the frequency of optimal polar bear habitat
Change (months)


Historic distribution
Current distribution
Siberian
South China
Bengal
Indochinese
Malayan
Sumatran
Bali
Javan (extinct)

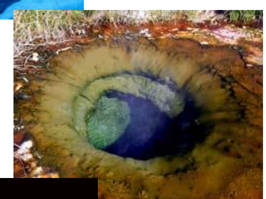

GANSU
Qinling Mountains
SHAANXI
Min Mountains
Qionglai Mountains
Chengdu
SICHUAN
Xiangling Mountains
Liang Mountains

"Few patterns in ecology, evolution, conservation biology – and for that matter, most studies of biological diversity – make sense unless viewed in an explicit geographic context."



We don't really know how many species of living organisms there are on the planet….

ScienceDaily: Just How Many Species Are There, Anyway?



Fewer than 2 million have been formally described, and they have been found in virtually every habitat imaginable.

Your text defines biogeography as….

"…the science that attempts to document and understand spatial patterns of biodiversity…"

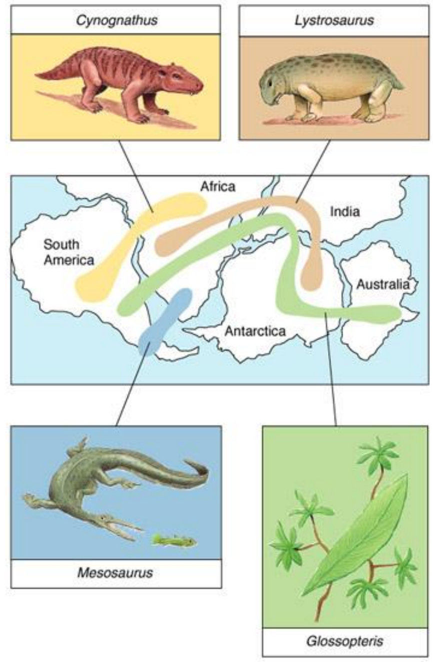
Could you put that definition in layman's terms?

Biodiversity at what level? Phyla? Species? Genes?

What type of "spatial pattern"? Large scale? Small scale? Microscopic?

These are all questions to be addressed?

I'm asking you to develop a course project related to a the biogeography of a particular taxonomic group or the biogeography of a particular area. Can you see how the questions posed in the text could relate to the subjects you choose?



Biogeographers, like most biologists, typically specialize in one way or another.

One form of specialization would be taxonomic. As a result we find:

a. Zoogeographers (animals)
b. Phytogeographers (plants).

Typically, we see even greater specialization, i.e., we might find one expert specializing on the zoogeography of viperid snakes.

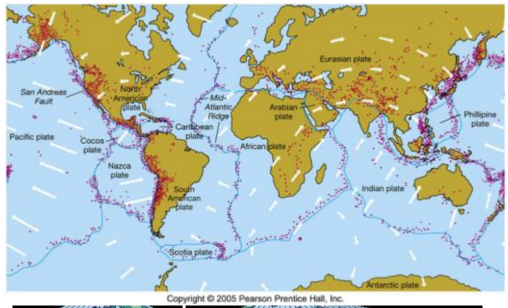
Biogeography can also vary in approach:

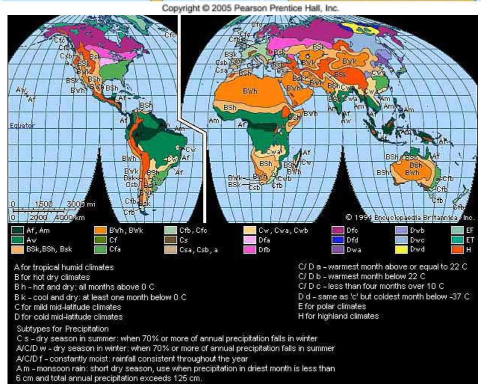
a. Historical biogeography focuses on the origin, dispersal, and extinction of taxa and biotas.
b. Ecological biogeography deals with present day abundance, distribution, and diversity.

A great many other scientific disciplines are intertwined with biogeography.

Among the biological disciplines, the most obvious are ecology and evolution.

Other sciences, most notably geography, geology, meterology, and climatology are also important.

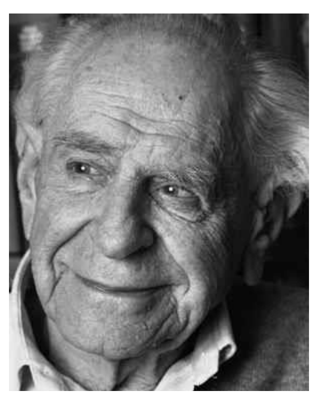




The authors distinguish inductive and deductive approaches. Be sure that you can do the same.

The hypothetico-deductive reasoning advocated by Karl Popper advocates testing a theory by setting up alternative, falsifiable hypotheses.

In this line of reasoning, a theory cannot be proven true. It can only be falsified.



Biogeography differs from other sciences in that it a primarily an observational science rather than an experimental one. The scale of time and space involved in most of the processes precludes experimentation.

As a result, biogeographers rely heavily on “natural experiments” and on the impact of anthropogenic changes.

The recolonization of a devastated island provides a biogeographic experiment that could never be created in a lab.

In , Edward O. Wilson and Robert Simberloff conducted one of the most ambitious experiments in history designed at understanding the biogeography of islands.

Wilson & Simberloff video

E. O. Wilson

In addition, biogeography typically relies on the cumulative contribution of many people working over long periods of time.

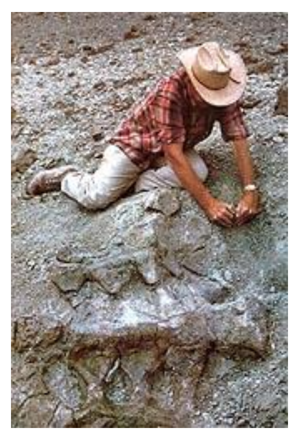
One scientist must rely on the work of his predecessors, and build on it.

William Bartram, 18th Century naturalist who wrote about the flora of the southeastern U.S.

Brian Keener, 21st Century plant systematist who studies the flora of the southeastern U.S.

Finally, biogoegraphy is typically a synthetic science.

This means that the work occurs at the interface of many different scientific disciplines, i.e. ecology, taxonomy, systematics, evolution, geography, geology, paleontology, etc.



Some of the greatest names of biology (both past and present) were, or are, biogeographers in the truest sense:

Charles Darwin

Alfred Russel Wallace

John Hooker

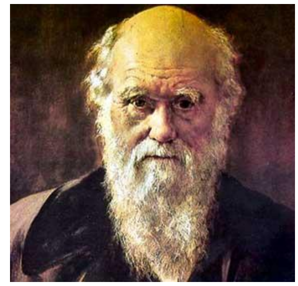
George Gaylord Simpson

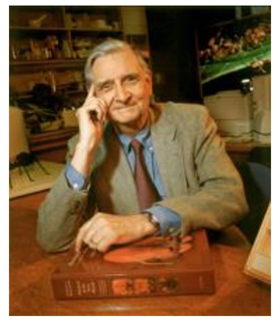
Ernst Mayr

Robert MacArthur

Edward O. Wilson

However, the science of biogeography (as a free-standing field) is relatively young.





Advances in technology promise to revolutionize biogeography in the coming decades.

These include:

Computing technology

GIS

Satellite data acquisition

Radioisotope dating

Many others…