



GATE- Ecology -II

Special class



Ecology **(Basic Concepts)**

Ishan Saini

PhD (Mycorrhiza + Flowering plants), M.Sc. (Botany), PG Diploma (Floriculture), B.Ed., CSIR (JRF), UGC (Net), GATE, HSBB, FCI, ARS (PhD)

GATE 2021 XL-R Botany Syllabus

- **Section 1: Plant Systematics** – Major systems of classification, plant groups, phylogenetic relationships and molecular systematics.
- **Section 2: Plant Anatomy** – Plant cell structure and its components; cell wall and membranes; organization, organelles, cytoskeleton, anatomy of root, stem and leaves, floral parts, embryo and young seedlings, meristems, vascular system, their ontogeny, structure and functions, secondary growth in plants and stellar organization.
- **Section 3: Plant development** – Cell and tissue morphogenesis Life cycle of an angiosperm, development of male and female gametophyte; cell fate determination and tissue patterning; spacing mechanisms in trichomes and stomata. Embryogenesis, organization and function of shoot and root apical meristems. Transition to flowering: photoperiodism and vernalization, ABC model of floral organ patterning, pollen germination, double fertilization, seed development; Xylem and phloem cell differentiation, photomorphogenesis; phytochrome, cryptochrome, phototropin. Role of auxin, cytokinin, gibberellins, and brassinosteroids on plant development.

- **Section 4: Physiology and Biochemistry** – Plant water relations, transport of minerals and solutes, stress physiology, stomatal physiology, signal transduction, N₂ metabolism, photosynthesis, photorespiration; respiration, Flowering: photoperiodism and vernalization, biochemical mechanisms involved in flowering; molecular mechanism of senescence and aging, biosynthesis, mechanism of action and physiological effects of plant growth regulators, structure and function of biomolecules, (proteins, carbohydrates, lipids, nucleic acid), enzyme kinetics.
- **Section 5: Genetics and genomics** – Cell cycle and cell division. Principles of Mendelian inheritance, linkage, recombination, genetic mapping; extra chromosomal inheritance; Introduction to epigenetics; gene silencing- transgene silencing, post transcriptional gene silencing, miRNA and siRNA; evolution and organization of eukaryotic genome structure, gene expression, gene mutation and repair, chromosomal aberrations (numerical: euploidy and aneuploidy and structural: deletion, duplication, inversion, translocation), transposons. Model organisms for functional genetics and genomics; Introduction to transcriptomics, proteomics and metabolomics.

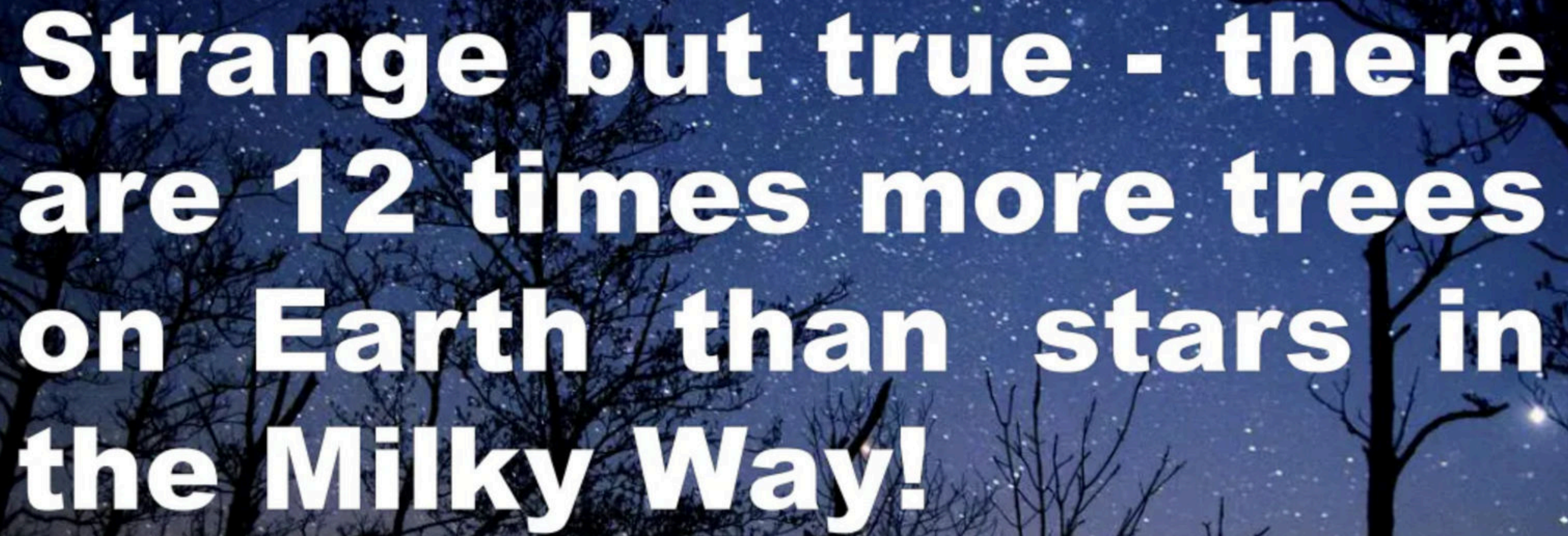
- **Section 6: Plant Breeding, Genetic Modification, Genome Editing Principles, methods** – selection, hybridization, heterosis; male sterility, genetic maps and molecular markers, embryo rescue, haploid and doubled haploids, plant tissue culture: micropropagation, embryo culture and in vitro regeneration, somatic embryogenesis, artificial seed, cryopreservation, somaclonal variation, somatic cell hybridization, marker-assisted selection, gene transfer methods viz. direct and vector-mediated, generation of transgenic plants; Introduction to genome editing: CRISPR/Cas9, Cre-Lox system to generate chimeras; plastid transformation; chemical mutagenesis.
- **Section 7: Economic and applied Botany** – A general account of economically and medicinally important plants- cereals, pulses, plants yielding fibers, timber, sugar, beverages, oils, rubber, pigments, dyes, gums, drugs and narcotics. Economic importance of algae, fungi, lichen and bacteria. Major Indian cash crops. Effect of industrialization on agricultural botany such as plastic on fiber economy. Genetically modified crops and its regulation eg. Bt cotton, Bt brinjal golden rice etc.

- **Section 8: Plant Pathology** – Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria, nematodes and viruses, and their control measures (chemical and biological) mechanism(s) of pathogenesis, resistance: basal, systemic, induced systemic resistance, gene for gene concept. Molecular detection of pathogens; plant-microbe interactions: symbionts and mycorrhiza, pathogens and pests. Signaling pathways in plant defence response; salicylic acid (SA) and jasmonic acid (JA) in plant-pathogen and plant-herbivore interaction, necrosis; host-parasitic plant interaction (such as *Cuscuta*).
- **Section 9: Ecology and Environment** – Ecosystems – types, dynamics, degradation, biogeochemical cycles, ecological succession; food webs and energy flow through ecosystem; vegetation types of the world, Indian vegetation types and biogeographical zones, climate and flora endemism; pollution and global climate change, speciation and extinction, biodiversity and conservation strategies, ecological hotspots, afforestation, habitat restoration; plant interactions with other organisms; epiphytes, parasites and endophytes.

TAIZ N ZIEGER

Books Name	Author/Publication
A Text Book of Botany	Singh Pandey Jain/ Vashishta
Ecology	Pandey/ Smith/ Odum
Principles of Genetics	Gardner/ Gene X

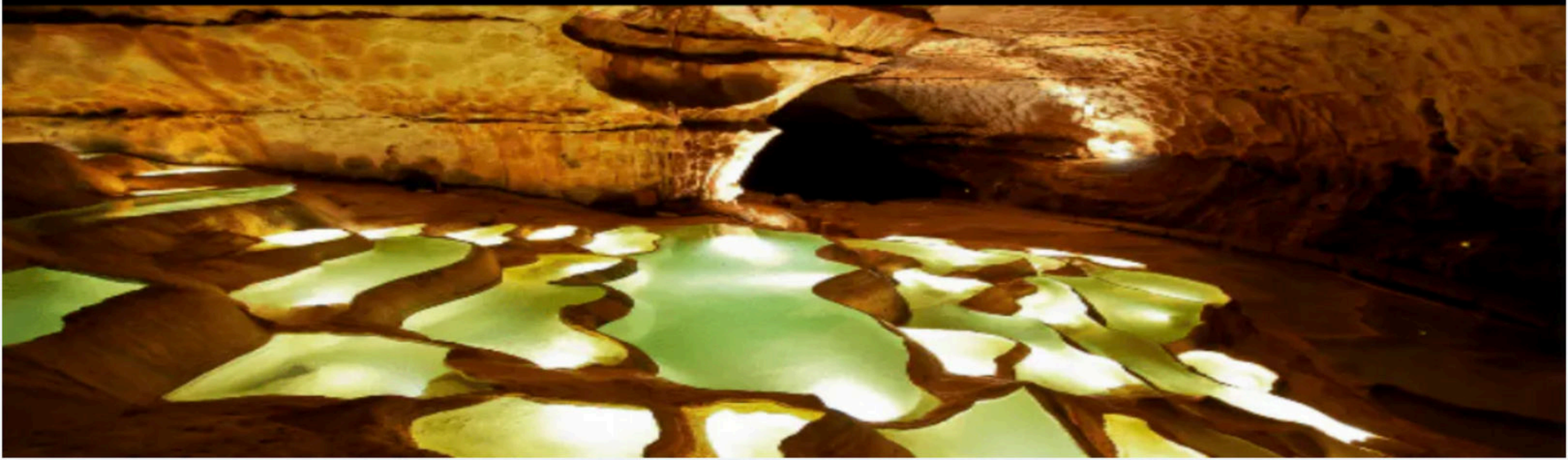
Saini I. – notes

A night sky filled with stars, with the silhouettes of trees in the foreground. The text is overlaid on the image.

**Strange but true - there
are 12 times more trees
on Earth than stars in
the Milky Way!**

did you know?

The cave pools at La Grotte de St Marcel d'Ardèche in France were discovered by a hunter in 1836 when his ferret fell through a crack. Their damn-like terracing is created when rimstone forms from the minerals in the water.





Cows kill more people than sharks.

~~3~~). According to Shelford's law of tolerance, an organism with wide tolerance limit for environmental factor usually show:

- a. Wide distribution with low population size
- b. Wide distribution with high population size ✓
- c. Narrow distribution with low population size
- d. Narrow distribution with high population size

(1). The natural place where the organism or communities live is

known as:

a. Niche

b. Habit

c. ~~Habitat~~

d. Biome

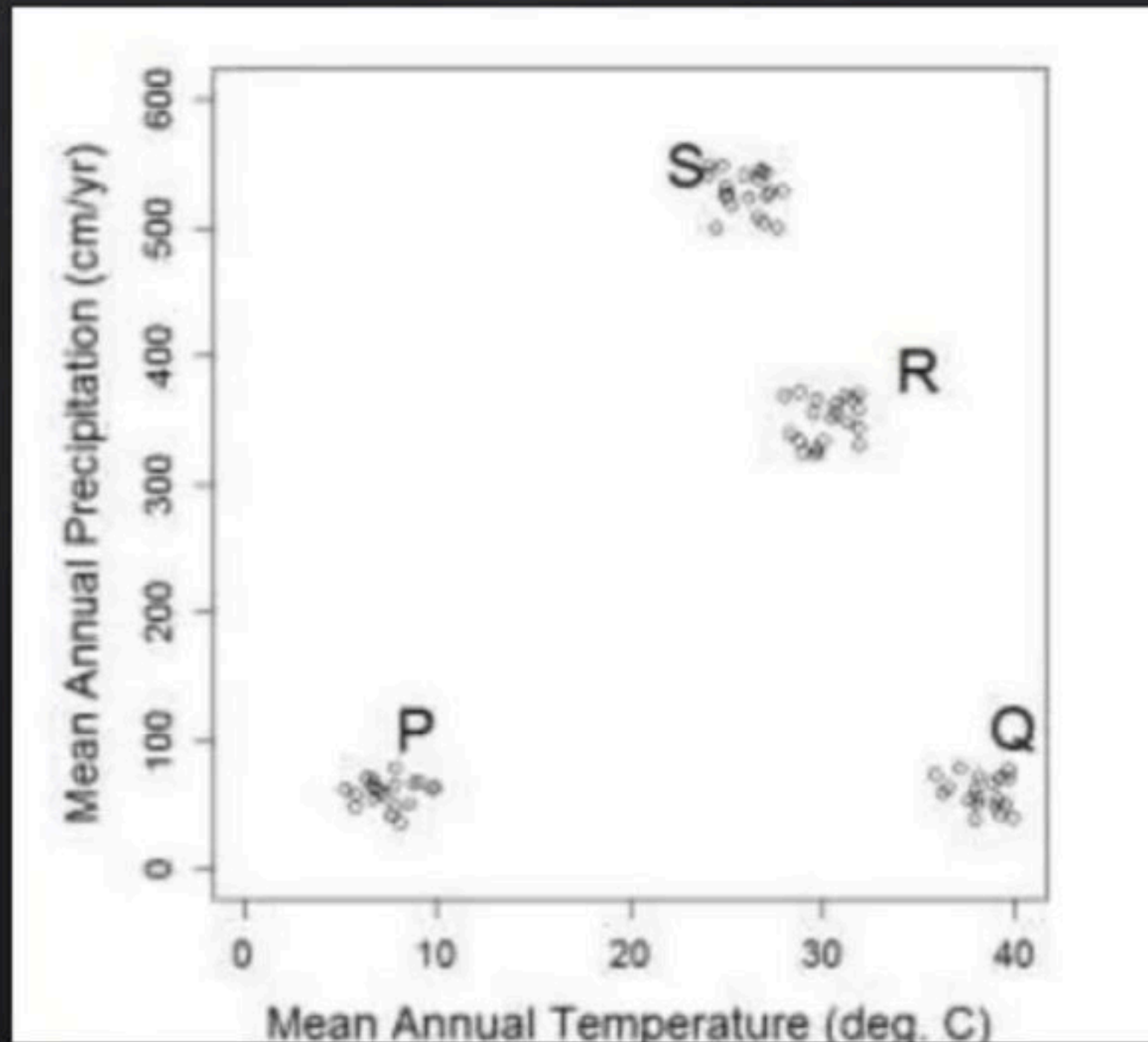
(8). The plant of cold or temperate habitat require low temperature for their growth are called:

- a. Megatherms
- b. Mesotherms
- c. Microtherms
- d. Ekistotherms

◆ For a species, assuming a relatively short time scale and no evolution, increased interspecific competition will result in a

- (A) larger fundamental niche (B) larger realized niche
(C) smaller realized niche (D) smaller fundamental niche

The figure below shows mean annual temperatures ($^{\circ}\text{C}$) and mean annual precipitation (cm per year) from multiple sites in four regions in India.



From this climatic information, we can infer that P, Q, R, and S are **LIKELY** to be located in:

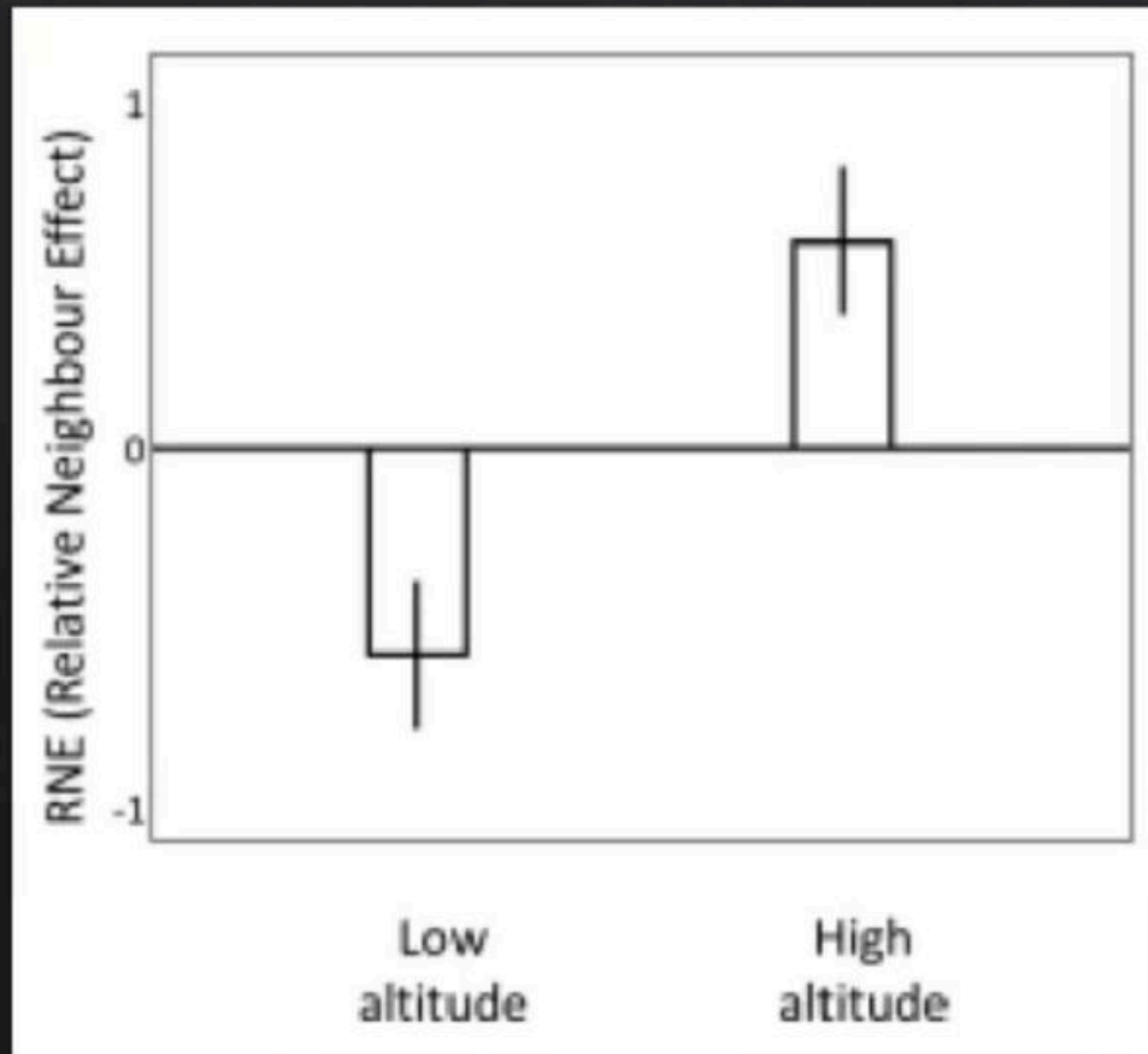
(A) P: Andaman, Q: Meghalaya, R: Ladakh, S: Rajasthan

(B) P: Ladakh, Q: Rajasthan, R: Andaman, S: Meghalaya

(C) P: Meghalaya, Q: Ladakh, R: Rajasthan, S: Andaman

(D) P: Rajasthan, Q: Andaman, R: Meghalaya, S: Ladakh

A study examined the effect of neighbours on plants when grown at low or high altitudes. The researcher measured Relative Neighbour Effect (RNE), defined as: $RNE = \text{Biomass with neighbours} - \text{Biomass without neighbours}$.



The results shown above demonstrate

(A) competition at both altitudes

(B) competition at high altitudes, and facilitation at low altitudes

(C) competition at low altitudes, and facilitation at high altitudes

(D) facilitation at both altitudes

◇ For a pair of interacting species, increased specialization and decreased niche breadth in both species would result in

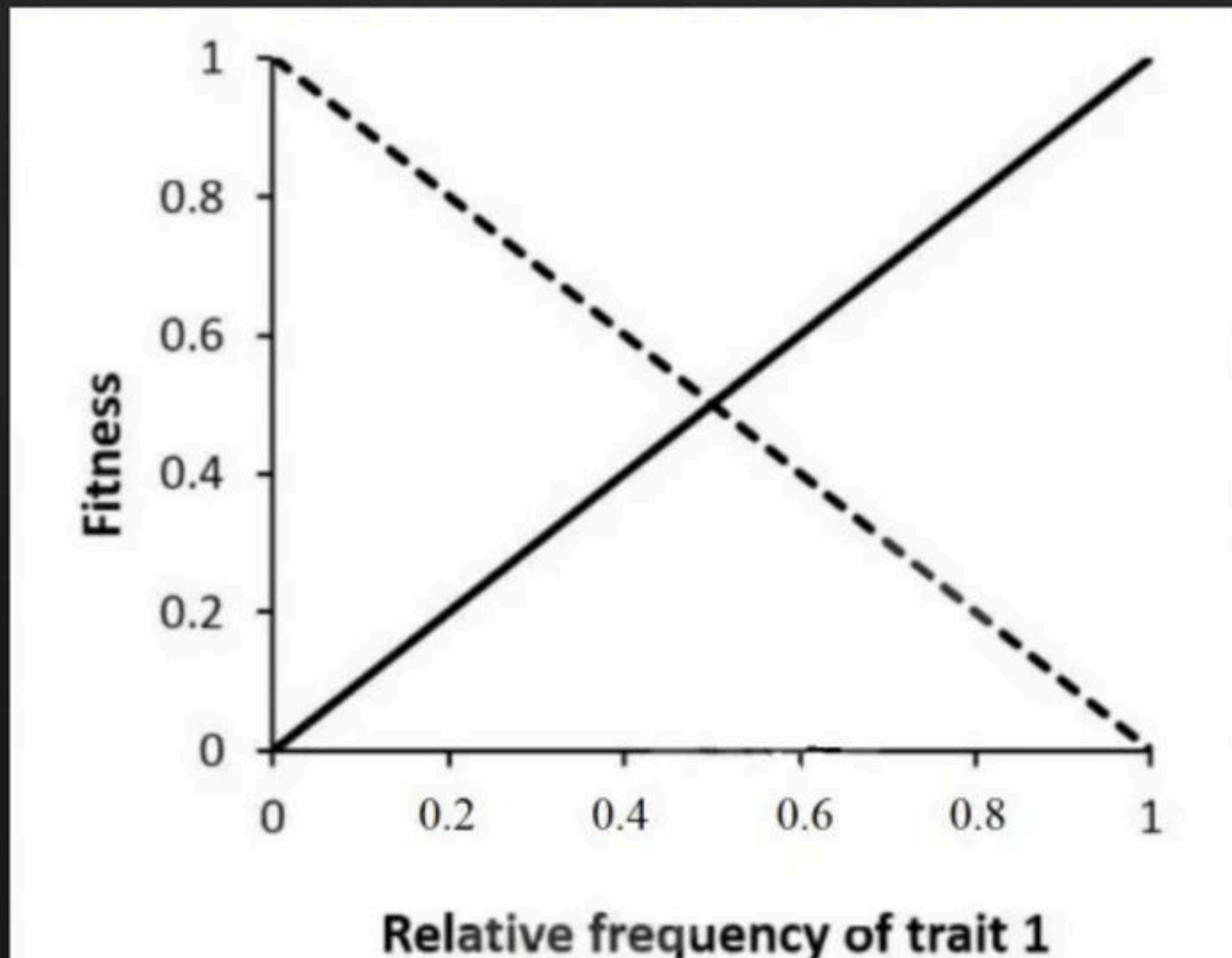
(A) decreased intraspecific competition and increased interspecific competition

(B) decreased intraspecific competition and decreased interspecific competition

(C) increased intraspecific competition and increased interspecific competition

(D) increased intraspecific competition and decreased interspecific competition

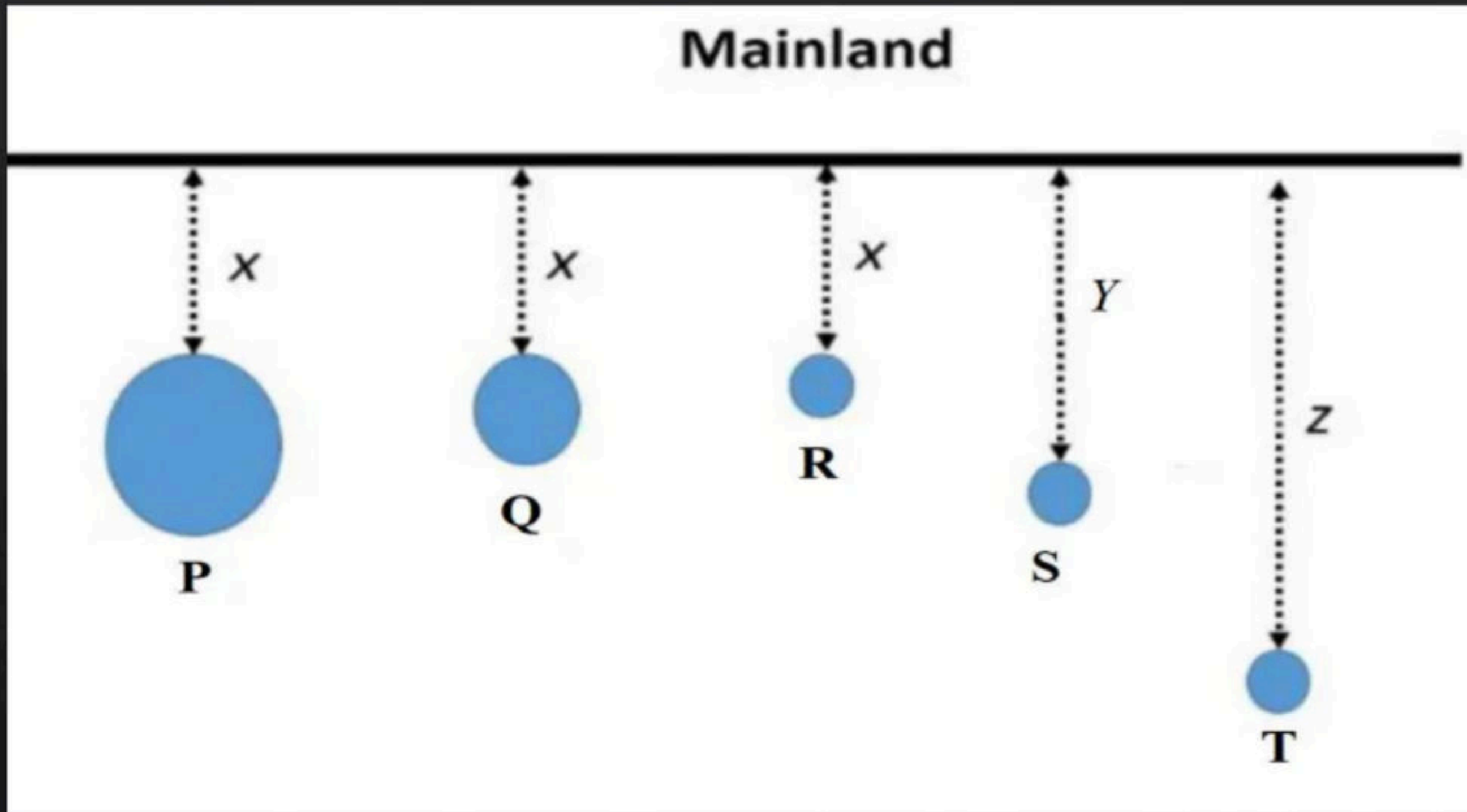
The plot below shows the fitness of two traits as a function of relative frequency of Trait-1 in the population. The solid line represents the fitness of Trait-1 and dotted lines represents the fitness of Trait-2.



Which of the following is most likely to be true?

- (A) Either Trait-1 or Trait-2 will take over the population.
- (B) Only Trait-1 will take over the population.
- (C) Trait-1 and Trait-2 will always reach a coexistence equilibrium.
- (D) Trait-1 and Trait-2 will oscillate over time.

P to T are islands of different sizes at different distances from the mainland, where the distance $X < Y < Z$. The area of island $P > Q > R = S = T$. Assuming that there is migration only from the mainland to islands and not between islands, which of the following is NOT true about the species richness on these islands?



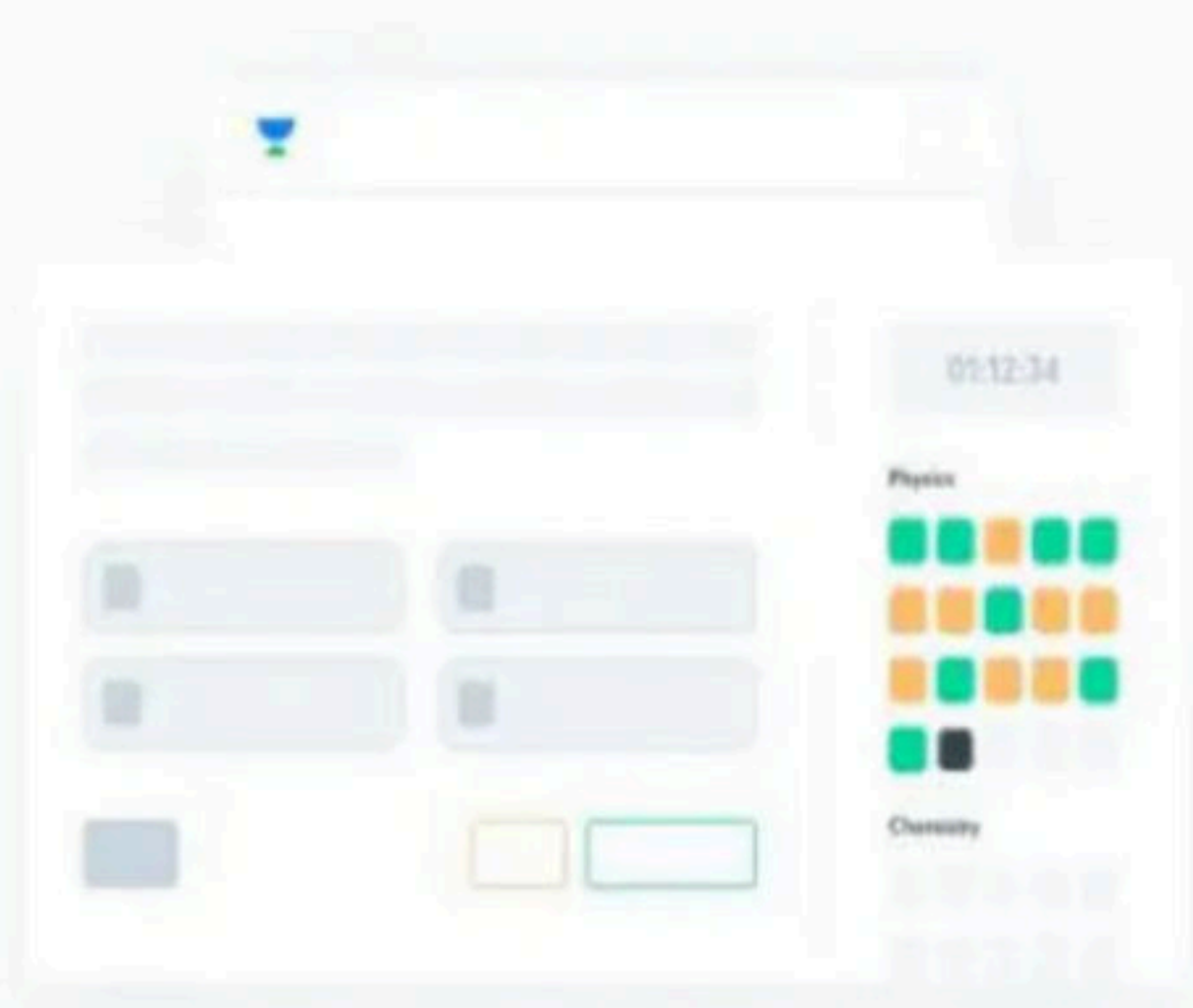
- (A) $P > Q > R$
- (B) $R > S > T$
- (C) $Q > T > S$
- (D) $S < Q < P$

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Ecology

◆ Home

◆ Term- Haeckel (German)

To study

Study of biotic and abiotic components

Study of organism and its environment

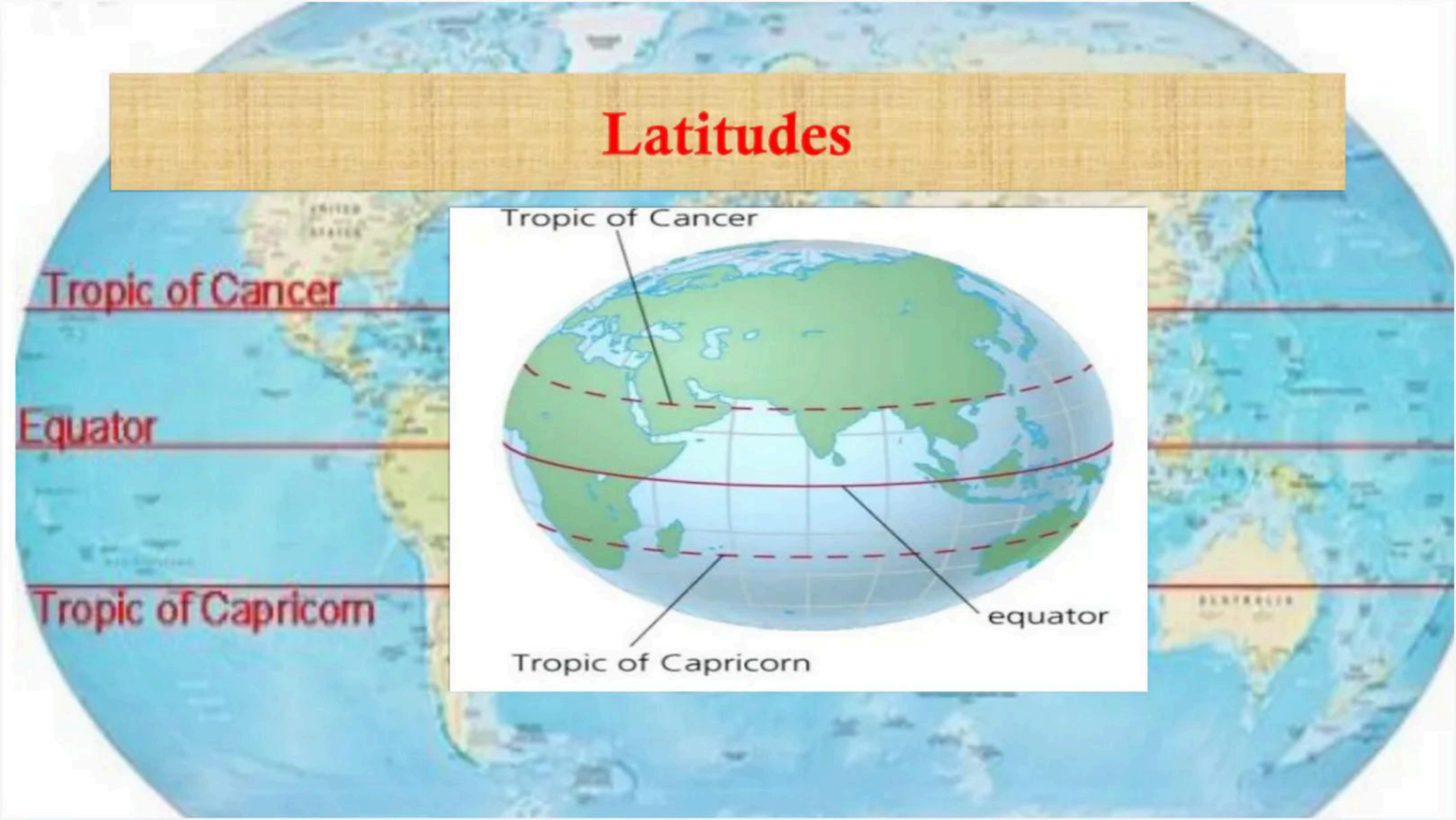
Study of relationship between living and non-living factors

Study of FACTORs, FORMs and FUNCTIONs

Biotops – Living organism + Position

Earth – shape Geoid

Latitudes



Tropic of Cancer

Equator

Tropic of Capricorn

Tropic of Cancer

equator

Tropic of Capricorn



Zones

- ◆ Tropical – between tropic of Cancer and tropic of Capricorn
- ◆ Temperate – extends from tropic of Cancer to Arctic circle in Northern Hemisphere and from tropic of Capricorn to Antarctic circle in Southern Hemisphere
- ◆ Polar – extends upto North Pole from Arctic circle and up to South Pole from Antarctic circle

Solistis

Summer solistis 21st June

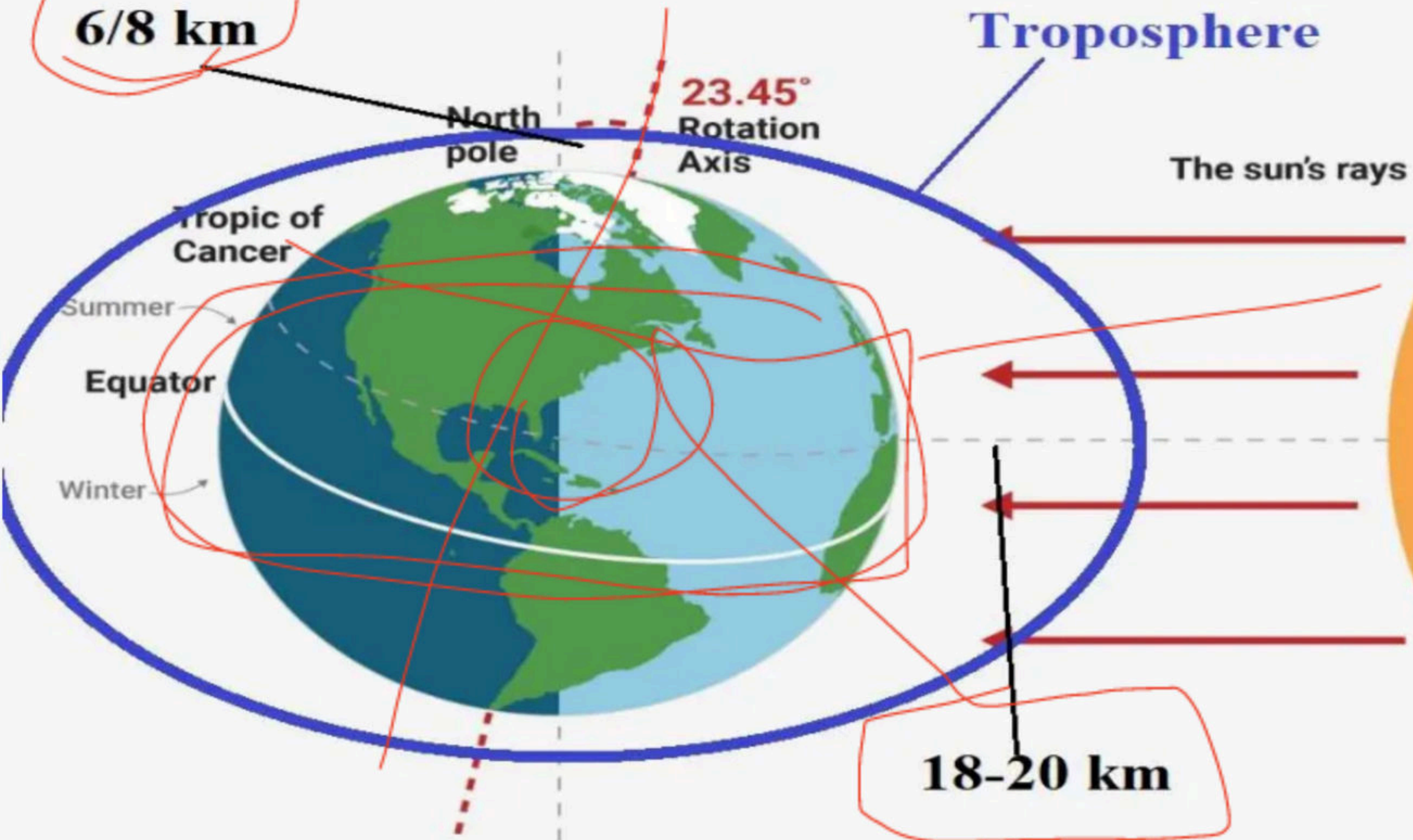
Winter solistis 22nd December

Equinox 21st Marrch and 23rd September

Earth during the June solstice

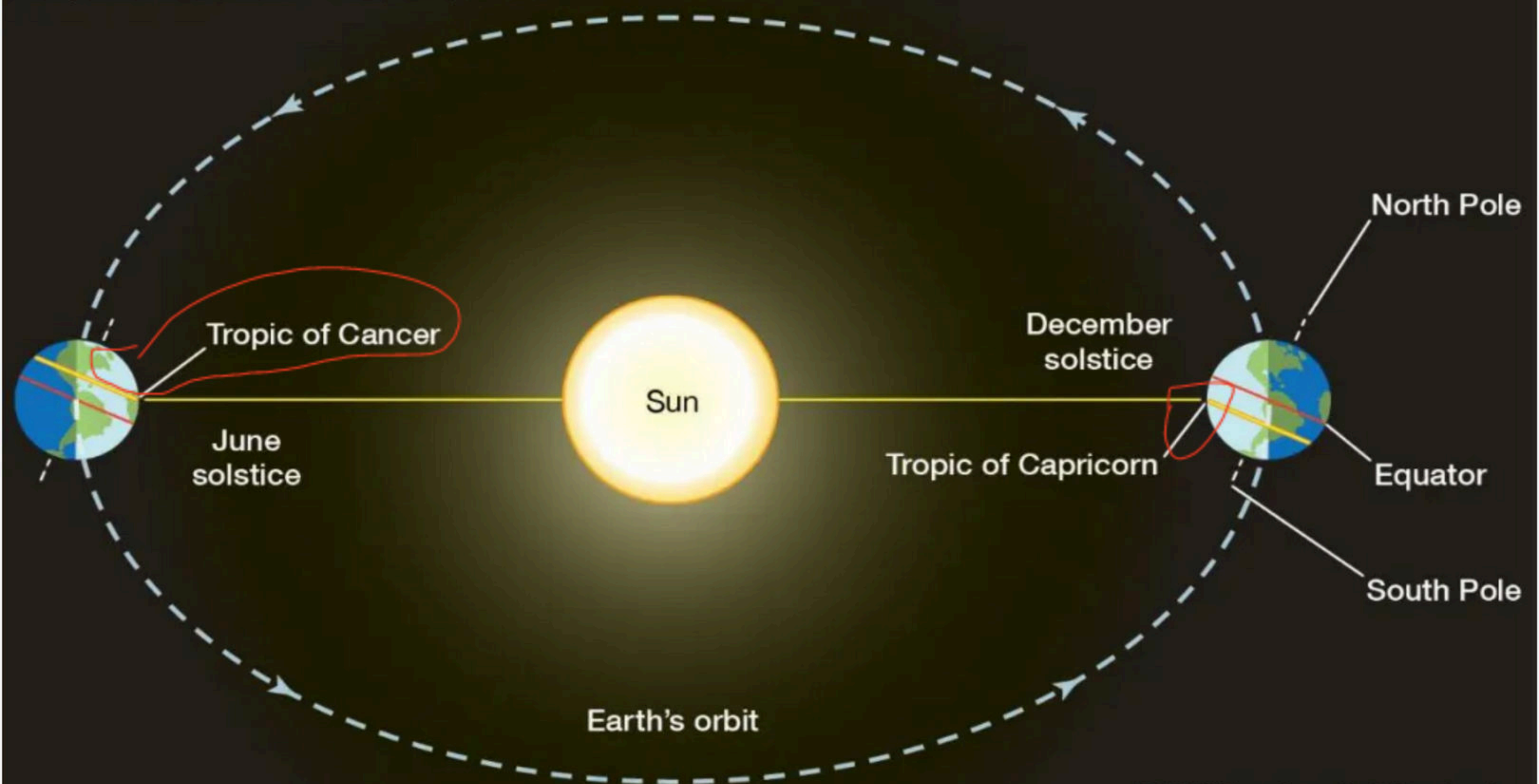
6/8 km

Troposphere



18-20 km

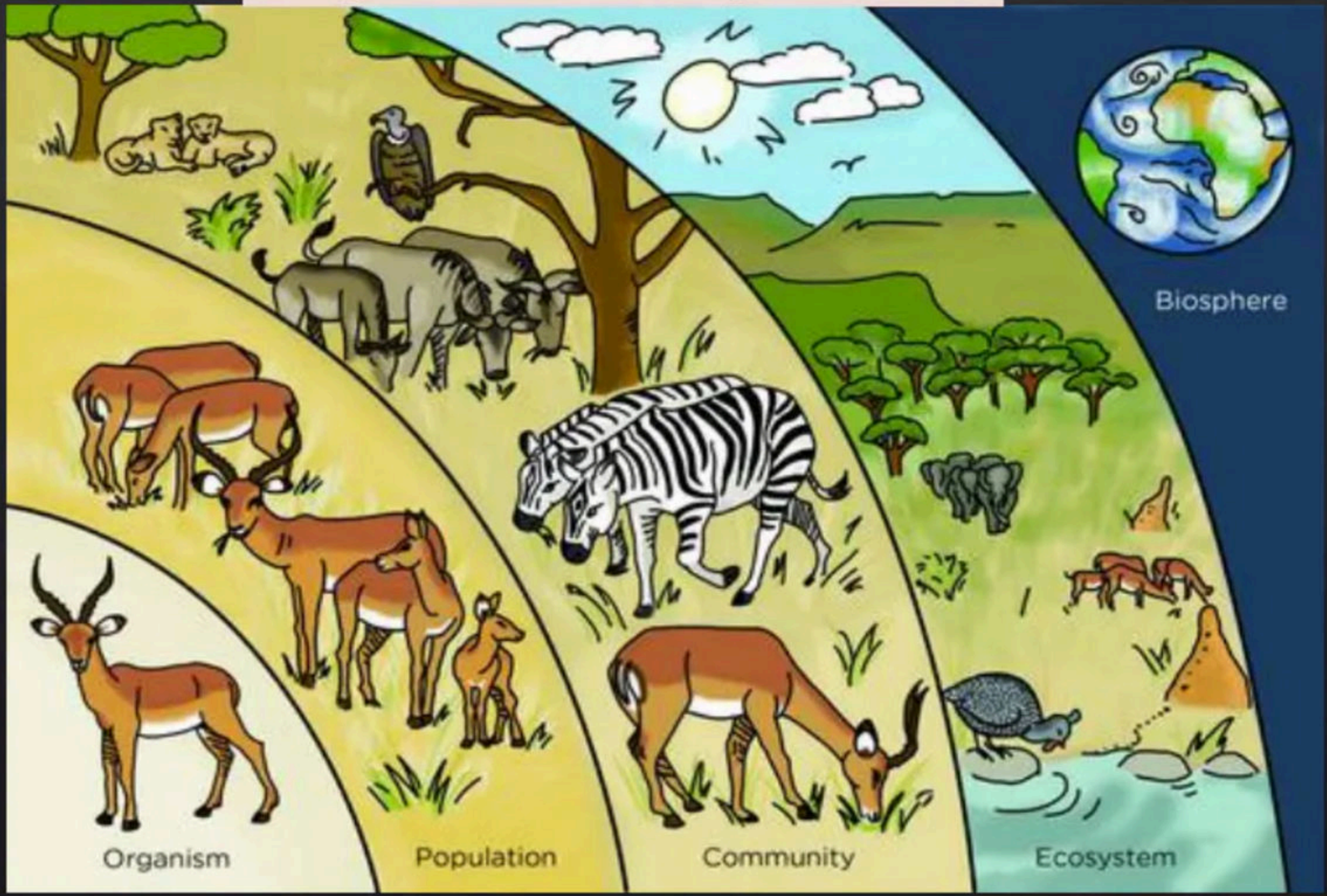
Tropics of Cancer and Capricorn



General terms

- ◇ **Species** – individuals can interbreed and forms fertile offsprings
- ◇ **Population** – sum of all the individuals that belongs to particular species living in an area per unit time.
 - ◇ Endemic population
 - ◇ Pandemic population
- ◇ **Community/Biocenosis** – Group of individual living in a same area over a given time but belongs to different species.
- ◇ **Ecosystem/Geobiocenosis** – Tansley (Term). interaction of biotic and abiotic components.
 - ◇ Autecology
 - ◇ Synecology
- ◇ **Biosphere** – wherever life is present
- ◇ **Biome** – largest geographic biotic unit, a major community of plants and animals with similar life forms and environmental conditions.

Trophic levels of organization



- Biosphere**
- Ecosystem**
- Community**
- Population**
- Organism/Species**
- Group of cells**
- Cells**
- Molecules**

To study ecosystem

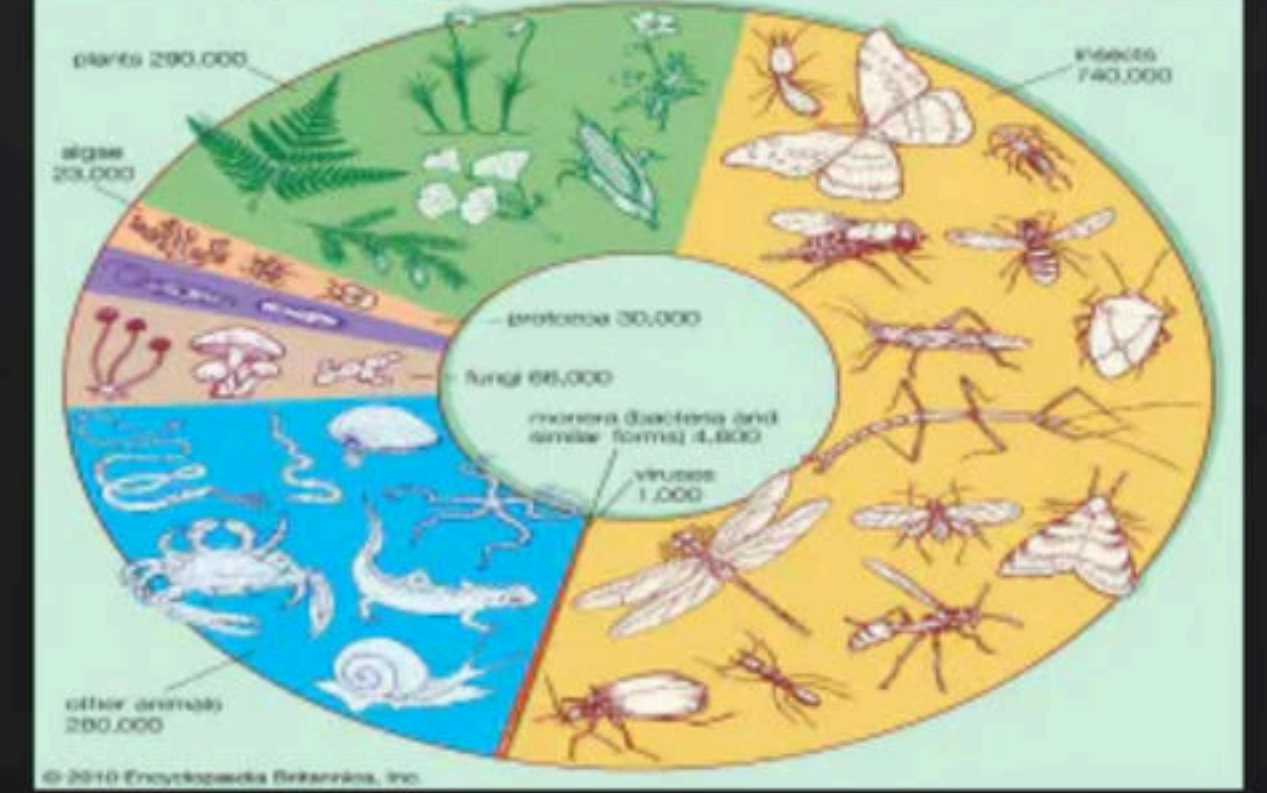
Microcosm



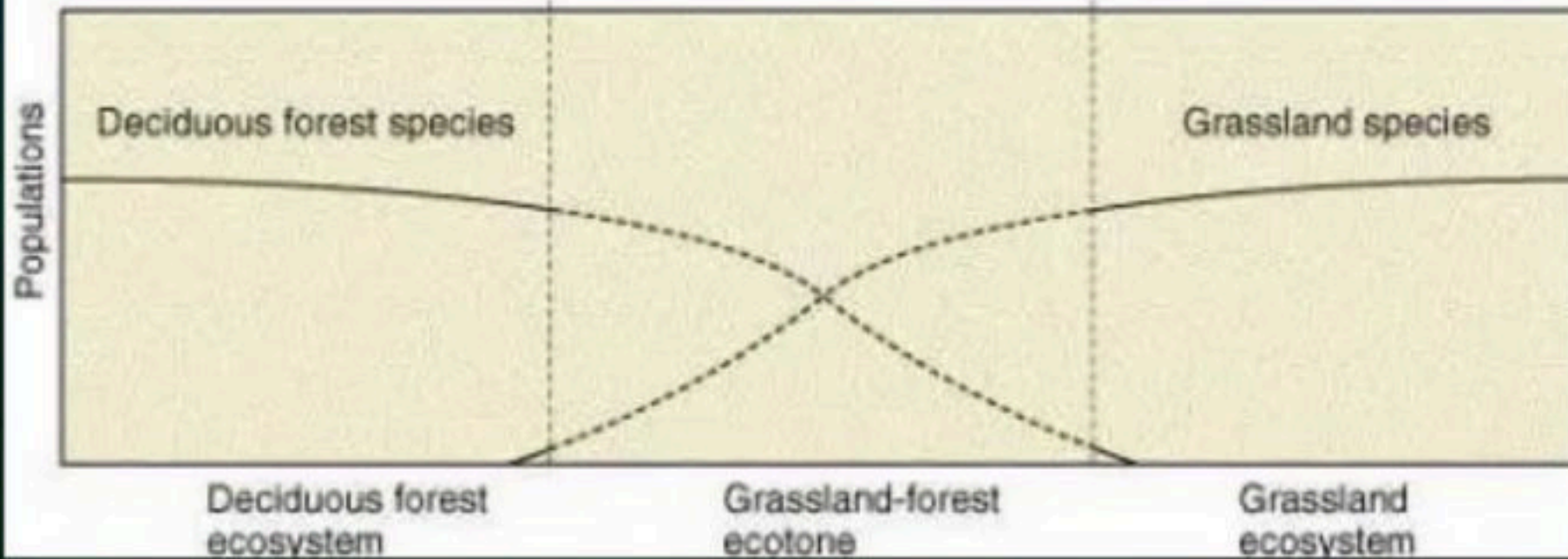
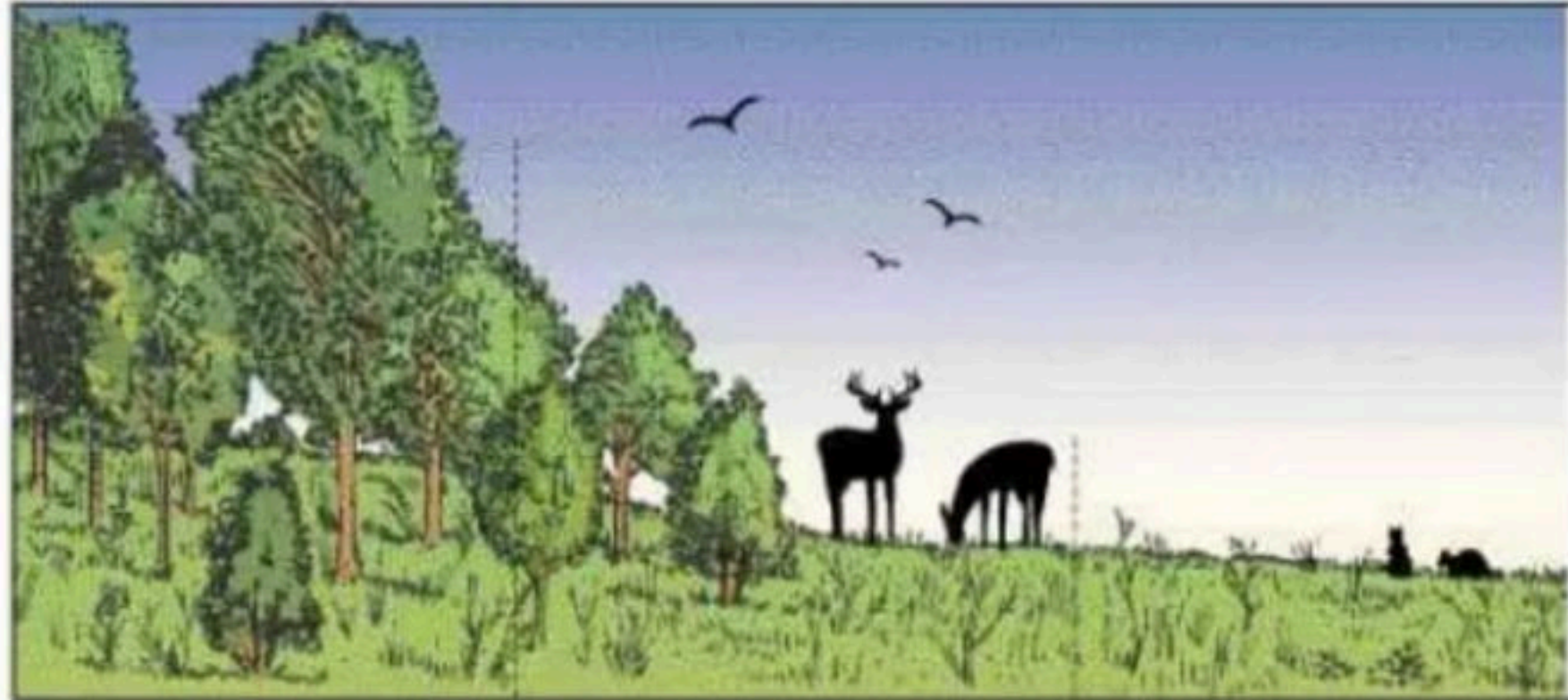
Mesocosm



Macrocosm



Ecotone – zone of adjacent ecosystem



Ecological Equivalent – organism having same ecological position/trophic level/functional role in ecosystem but belongs to different taxonomic position and are geographically separated.



Australia

Kangaroo



grassland

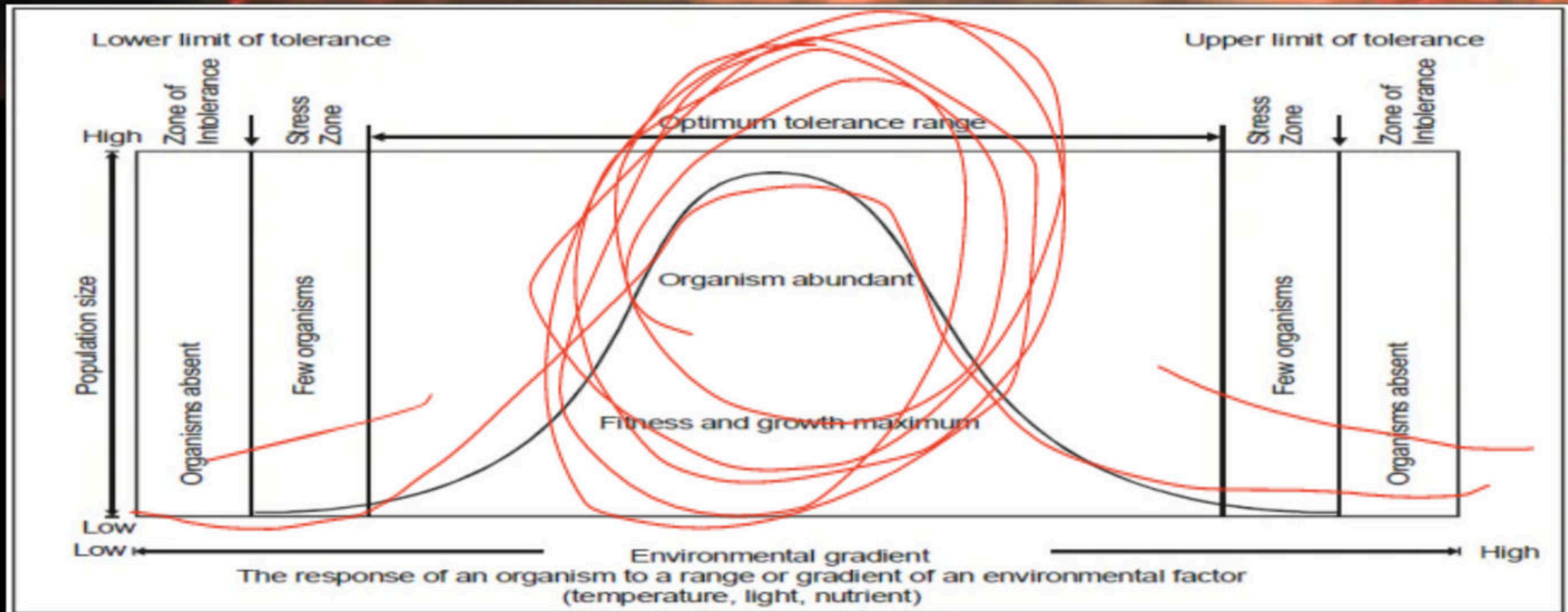
North American

Bison

Cow

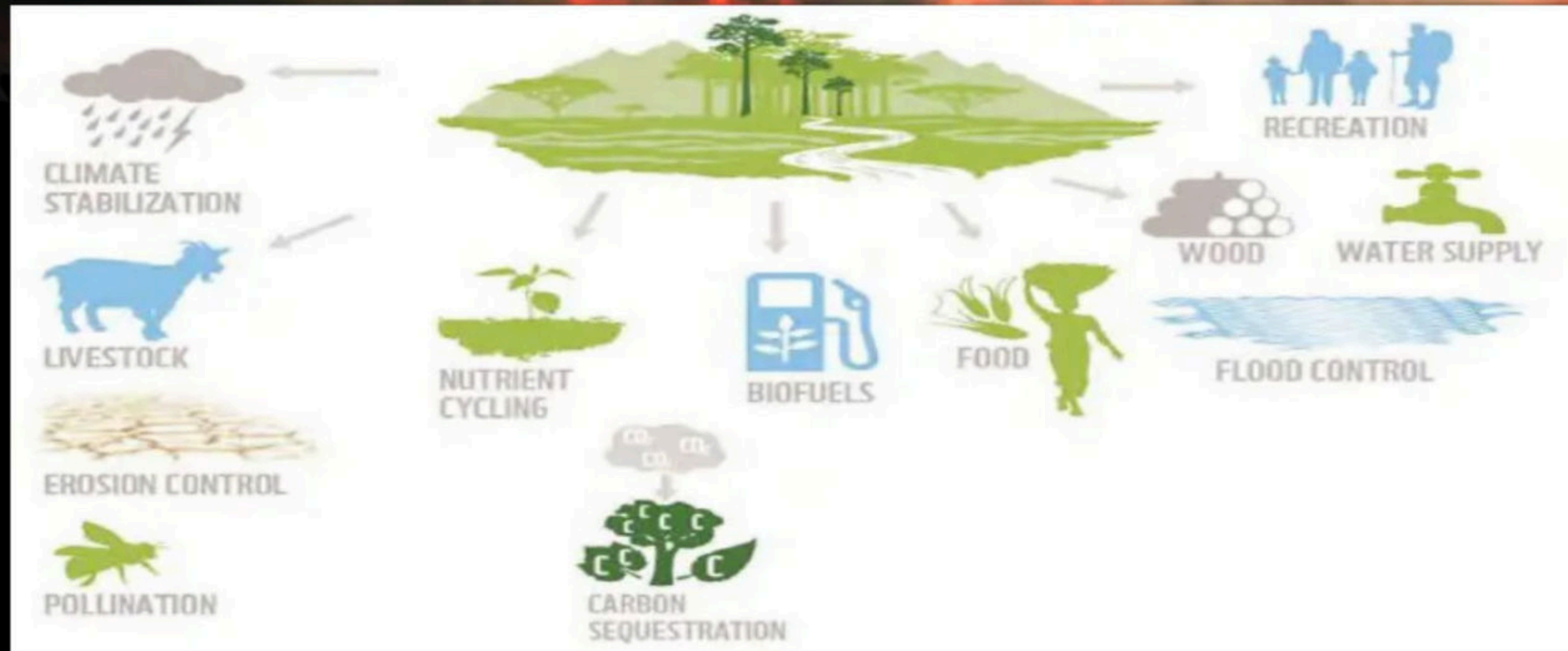
Ecological Amplitude – Range of tolerance.

Eury (Broad) Steno (Narrow)



Natural Capital - Benefits and services provided to humans by nature.

Pollination, Decomposition, Purification of air and water, C sequestration, etc.



◇ **Home range** – area which is under reach of an organism (normally travels in its daily activity).

Can change during different climatic conditions, availability of food and reproductive conditions.

◇ **Territory** – protected area by an organism which is under defense.

Subset of home range (area of home range which is under defense).

Protected for food, space and mate. **Home range can overlap but normally territory cannot. Eg. Wolves (packed territory)**

◇ **Guild** – formed by group of different individuals that belong to different species but exploit same class of resources almost in a similar manner.

✓ **Niche overlapping**

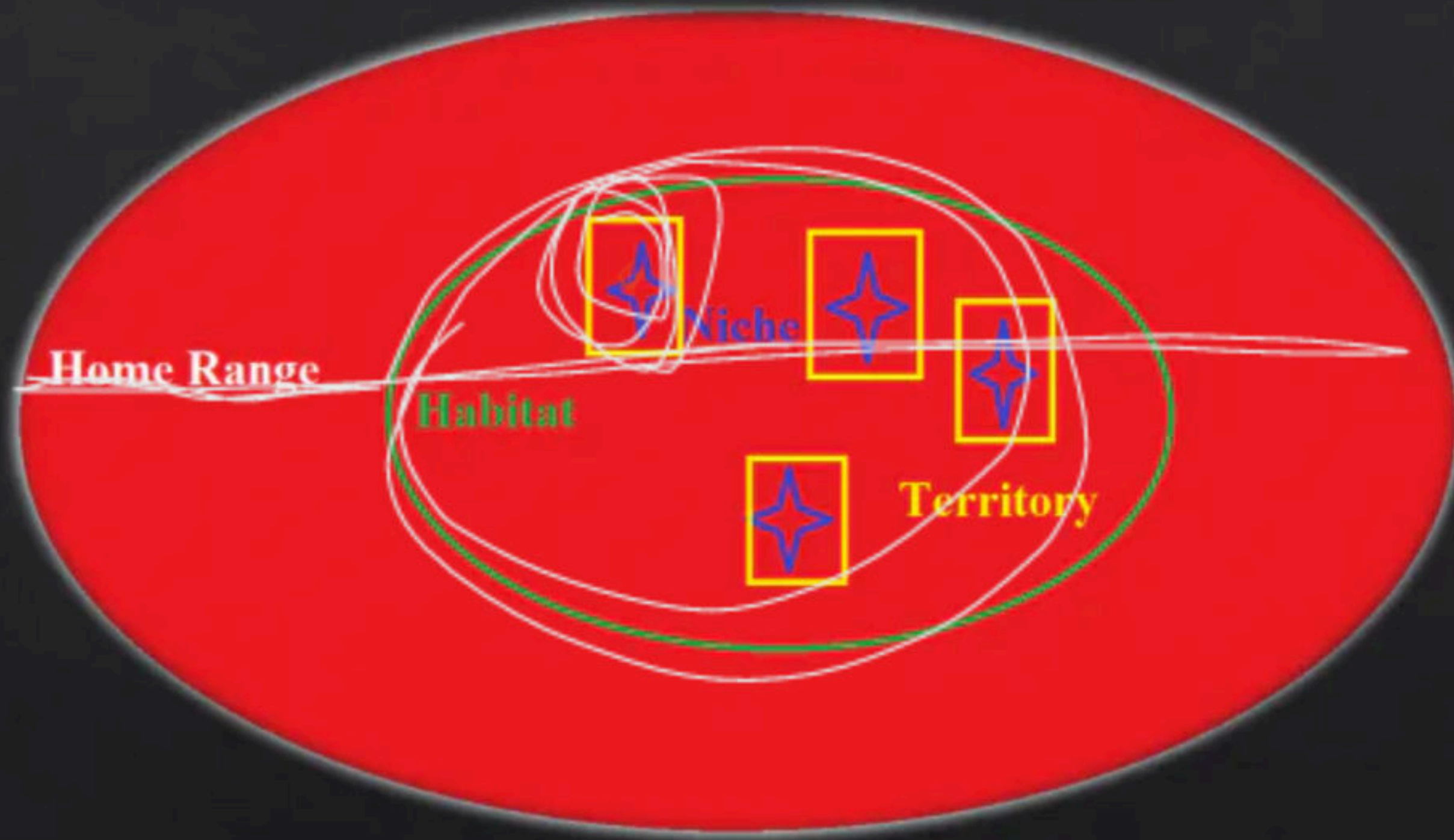
❖ **All nectar feeding insects**

✓ **High competition**

❖ **Snails living in forest floor, feeds on litter**

❖ **Insects performing entomophily**

Home range, Habitat, Territory, Niche



Difference Between

- HABITAT
- NICHE

A habitat is where you live. I live in Asia, which is where our natural habitats are. We are found in grasslands and rain forests of Southeast Asia, China, Korea and Russia.



A niche is the physical and biological conditions in how I can get resources to reproduce and survive.



- Habitat: All of the biotic & abiotic factors in the area where an organism lives (i.e. grass, trees, watering hole)
- Niche: All of the physical, chemical, and biological factors that a species needs to survive, stay healthy, and reproduce (i.e. type of food species eats, temperature it can tolerate, time of day it is active)
- Habitat is **where** a species lives ("address"), niche is **how** it lives there ("job")

Habitat/Living place/Dwelling place

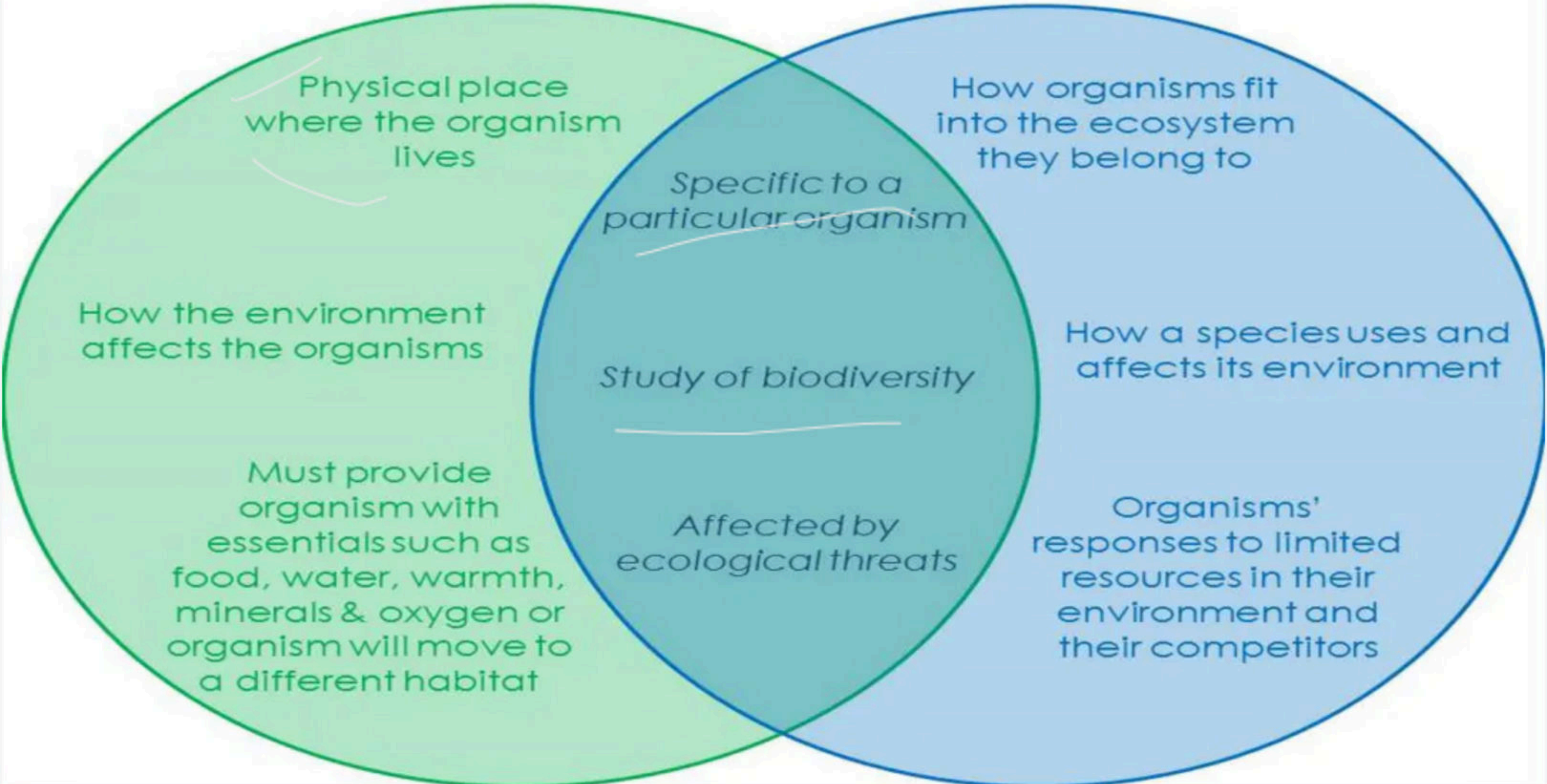
- ◆ The place where an organism lives in favorable conditions and that provides food, shelter, moisture, and temperature needed for the survival.
- ◆ Area in which an organism is best adapted due to natural selection.
- ◆ Area where basic demand of an organism is fulfilled.
- ◆ No organism can survive outside its habitat.
- ◆ Sometimes one habitat may contain many niches and support different species
- ◆ Habitat can be living or non living ??????
- ◆ Eg- Forest, Pond, Dessert, Ocean, etc.

Niche

- ◆ The place where an organism play its functional role.
- ◆ Role of an organism where it interacts with the environment.
- ◆ Include unique ways an organism survives under all the pressures – competition, predation, diseases, etc.
- ◆ Organism can change their niche with time and season.
- ◆ According to Grinnel (term) – {Microhabitat}, niche is ultimate distributional unit in which each species is held by its structural and instinctive limitations.
- ◆ Eg- Pollinators, caterpillars on different parts of trees, etc.

Habitat

Niche



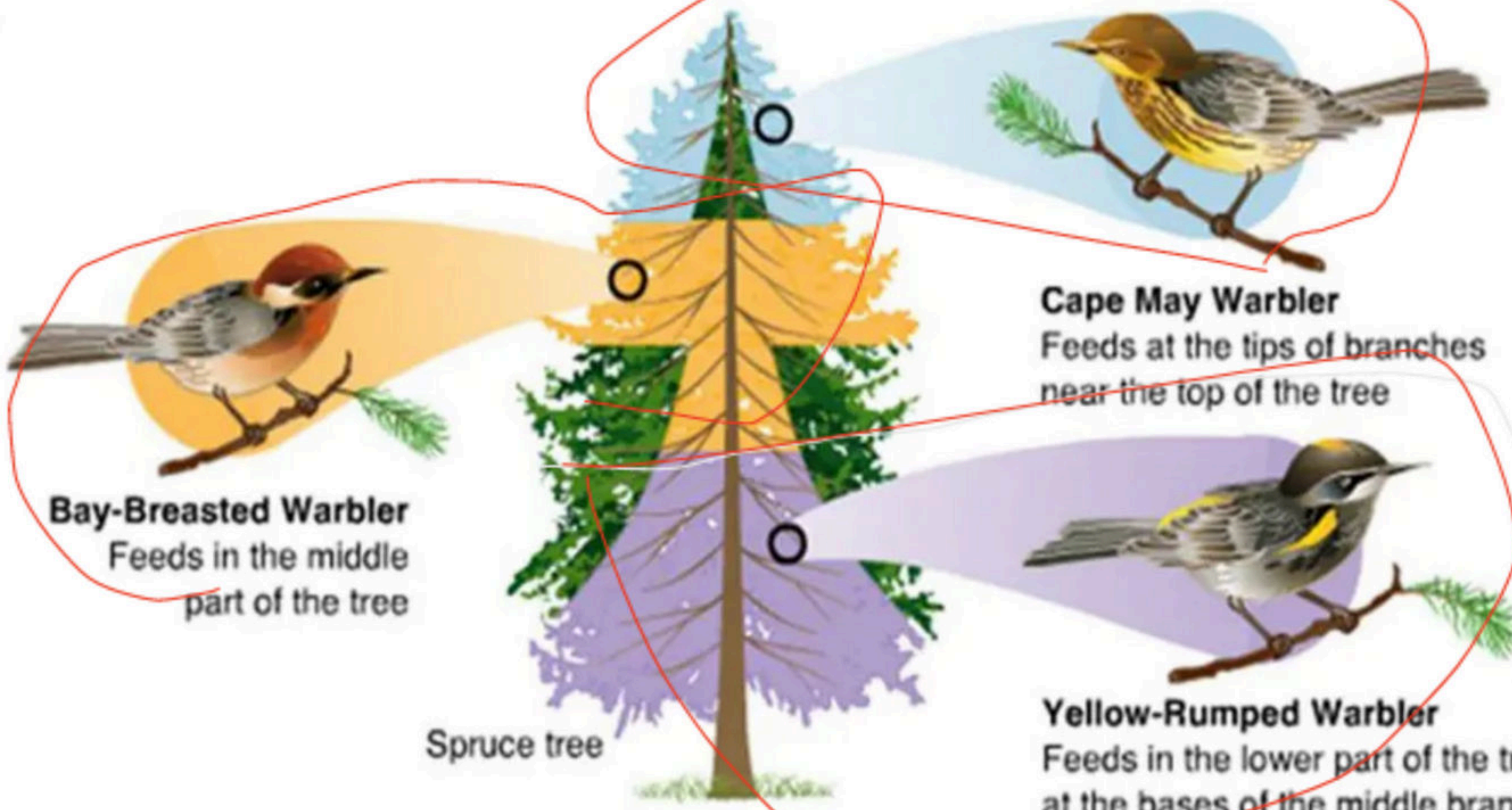
Feeding height (meters)

18

12

6

0



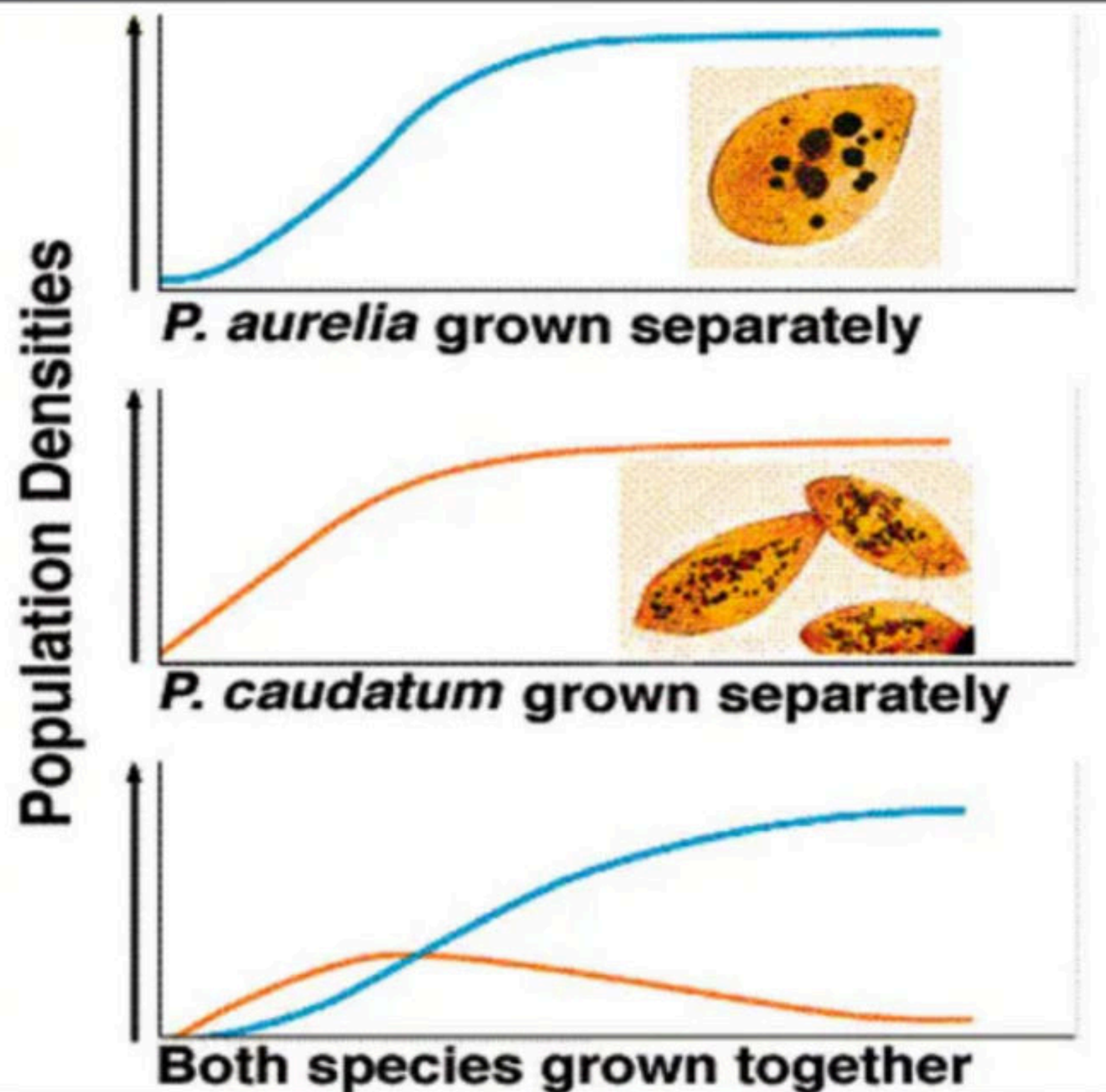
Bay-Breasted Warbler
Feeds in the middle part of the tree

Cape May Warbler
Feeds at the tips of branches near the top of the tree

Yellow-Rumped Warbler
Feeds in the lower part of the tree and at the bases of the middle branches

Spruce tree

Gauss's Exclusion Principal – Niche Concept



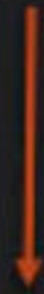
According to Gauss, No two organism/species can coexist in an identical same ecological niche for long.

This will lead to competition and thus decrease in biodiversity.

Experiment on two species of *Paramecium* in culture media and nutrients.

Niche segregation/Niche differentiation/Niche separation/Niche specialization/Resource partitioning

Promote coexistence in order to reduce competition



This will lead to increase the biodiversity

Tree (Habitat)→All species feeds on fruits→When fruits are limited→Competition increases→Niche segregation→Fruits, Leaves, Insects, Litter, Worms, Temporal, etc.→No competition→More survival→Biodiversity increases

Niche Concept

◆ Habitat/Spatial niche

Concerns with physical space occupied by any organism

Eg- 7-11 species of millepedes found in maple tree forests.

litter feeding, leaves feeding, fruit feeding, stem feeding, etc.

Different species of fungi feeding on *Setaria glauca*

node, internode, leave

◆ Trophic/Functional niche

Concerns with trophic position or functional role

Eg- *Notonecta* (active predator) and *Corixa* (Aquatic bug).

Fresh leaves and dead leaves predator

Darwin finches – Galapagos Island

Seed, fruit, leave

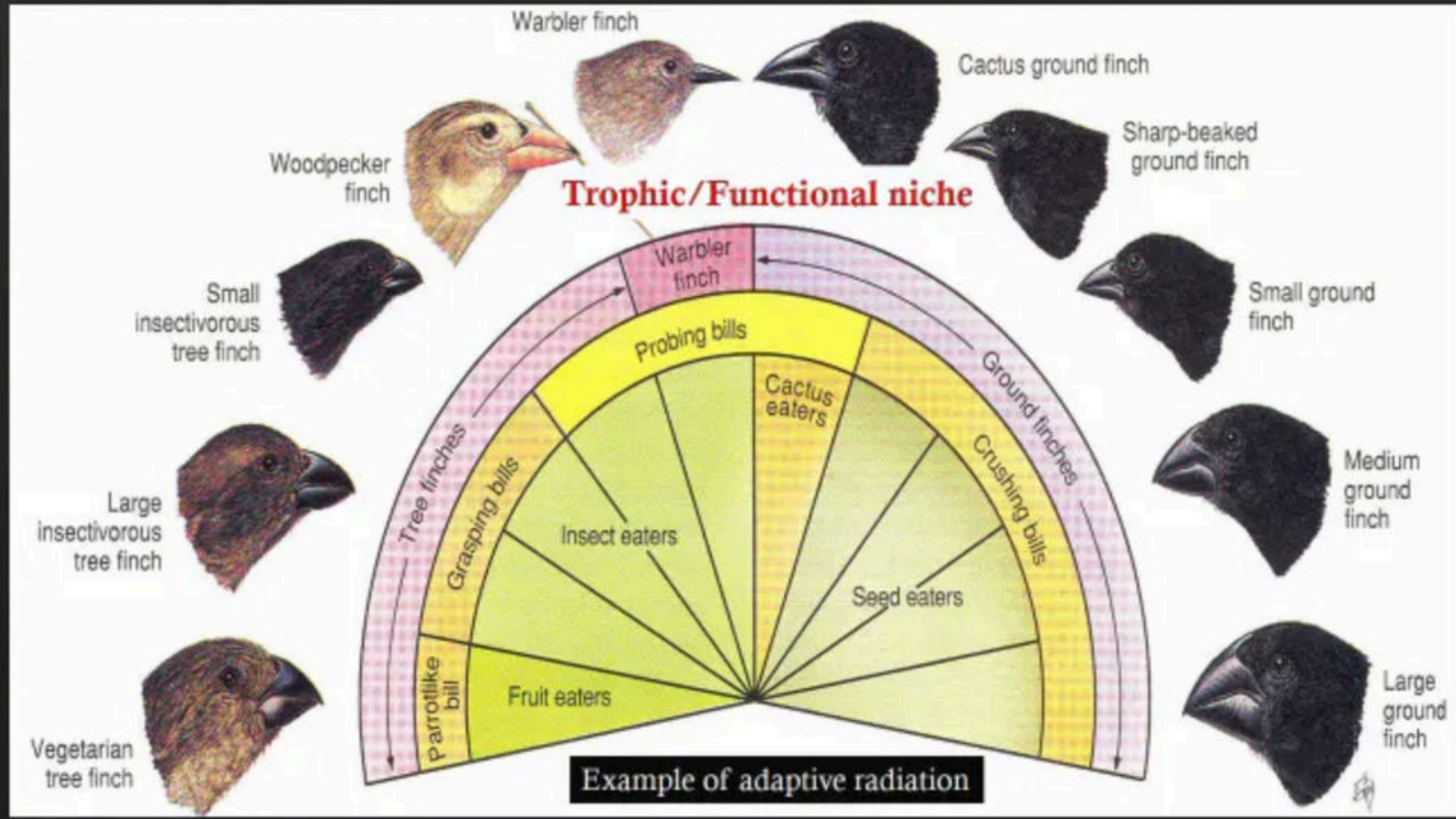
◆ Multifactorial/Hyper volume/Multidimensional/Hutchinson's Niche

Concerns with different factors required for survival of any given species.

Organism perform its functional role under the effect of all environmental factors

Spatial Niche Partitioning





Warbler finch

Cactus ground finch

Woodpecker finch

Sharp-beaked ground finch

Small insectivorous tree finch

Small ground finch

Large insectivorous tree finch

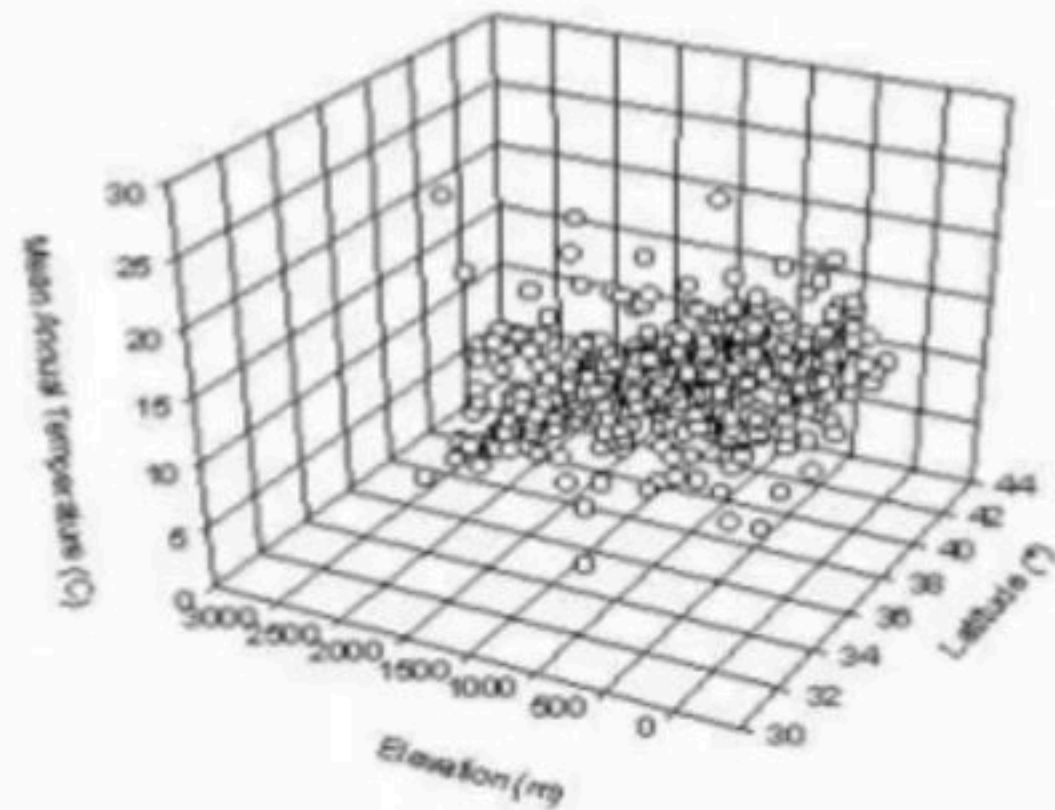
Medium ground finch

Vegetarian tree finch

Large ground finch

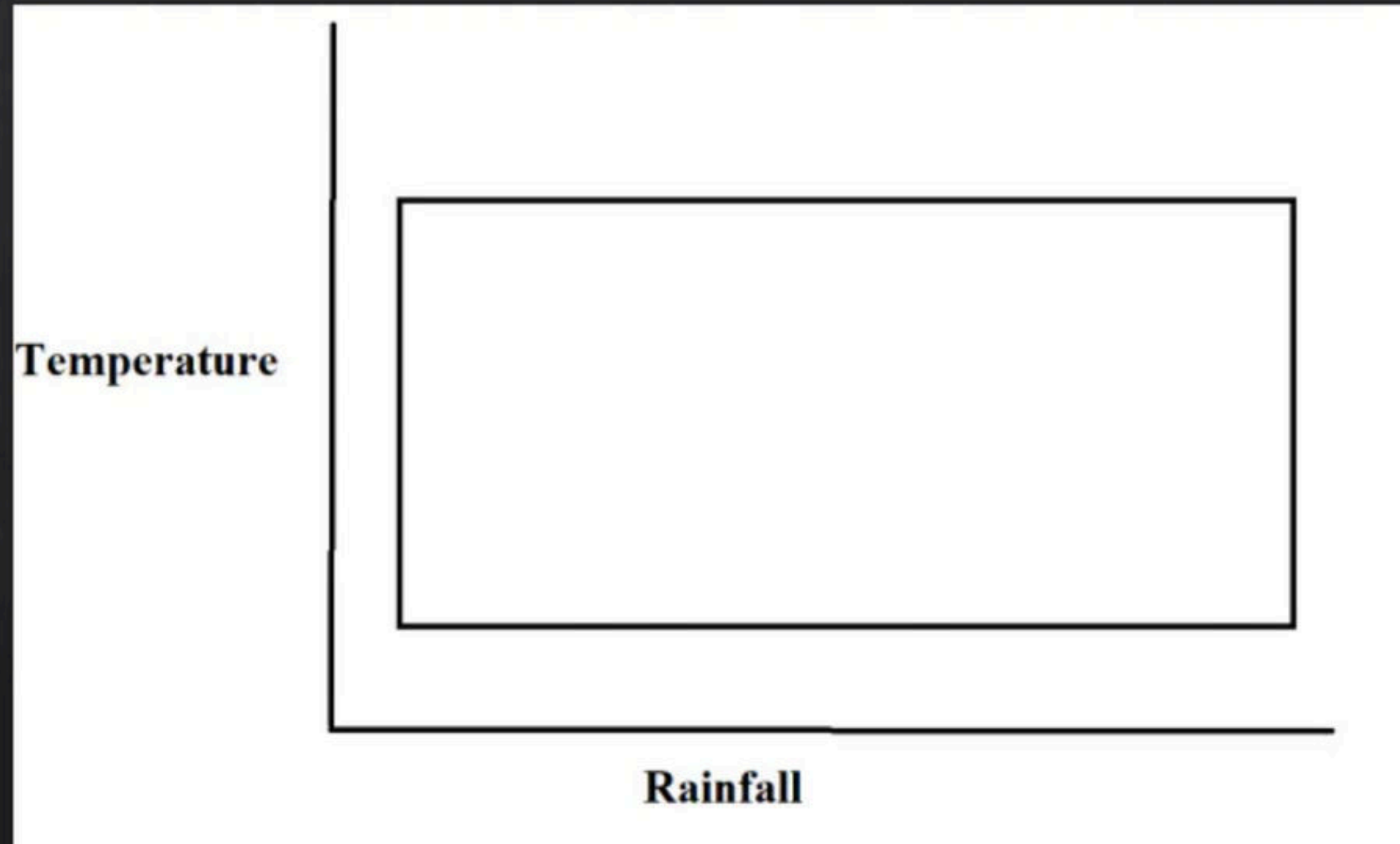
Example of adaptive radiation

Hutchinsonian niche

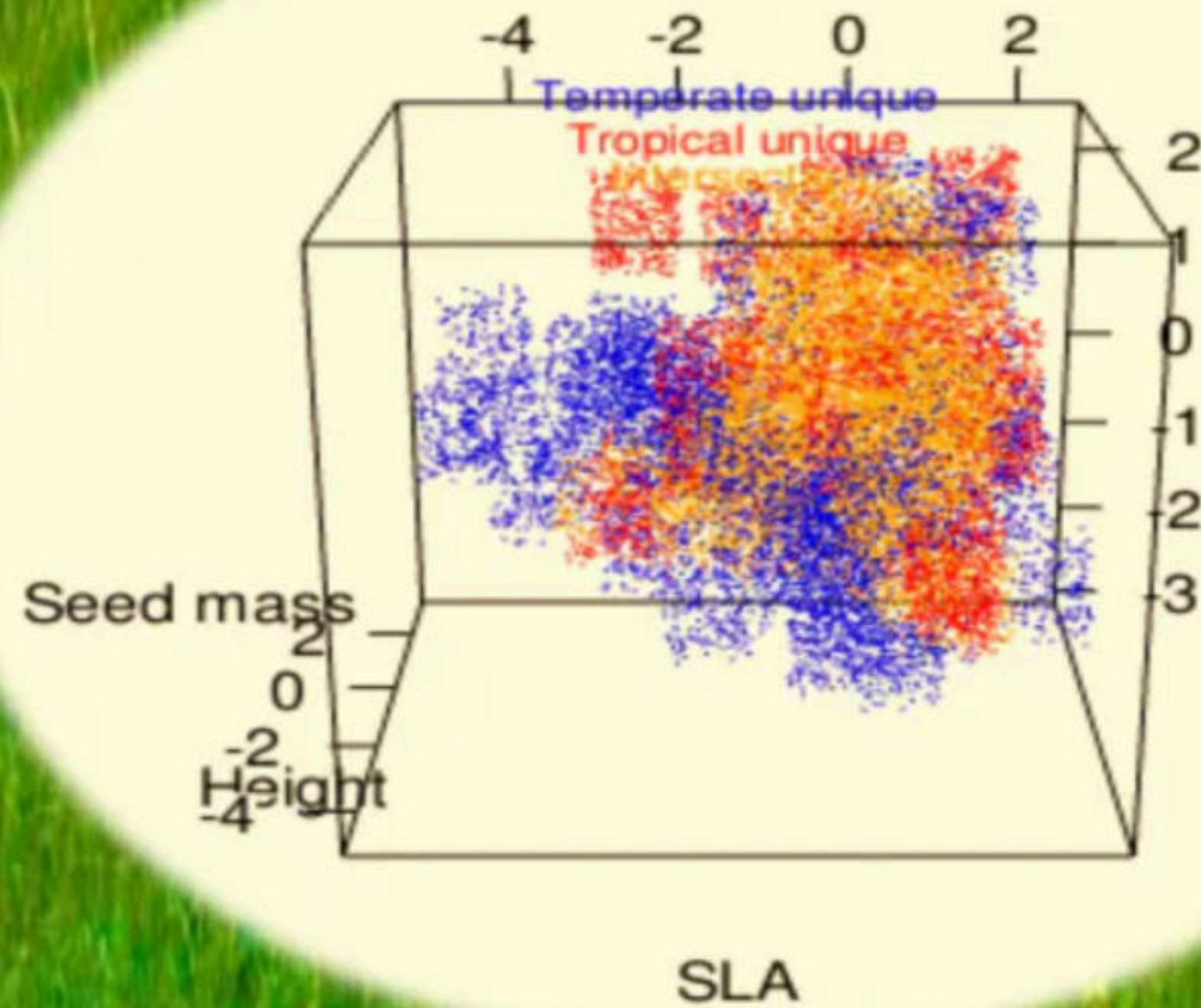


- **Hutchinsonian niche:** an n -dimensional hypervolume of conditions and resources
- **Fundamental niche:** what an organism's niche would be in the absence of competition from other species.
- **Realized niche:** The niche that a species actually inhabits, taking into account interspecific competition
- **How would you define the niche of the Lesser Goldfinch?**

2D box graph



Hutchinsonian niche





Question

from Rishav kundu

Sir the point u have mentioned in niche , organisms can change niche with time and season ... So can I tell migration under it ??

- ◆ **Ecads/Ecophene/Habitat form**
- ◆ **Ecotype**
- ◆ **Bergamann's Rule**
- ◆ **Allen's Rule**
- ◆ **Gloger's Rule**
- ◆ **Hesse's Rule**
- ◆ **Willistone Rule**
- ◆ **Cope's Rule**



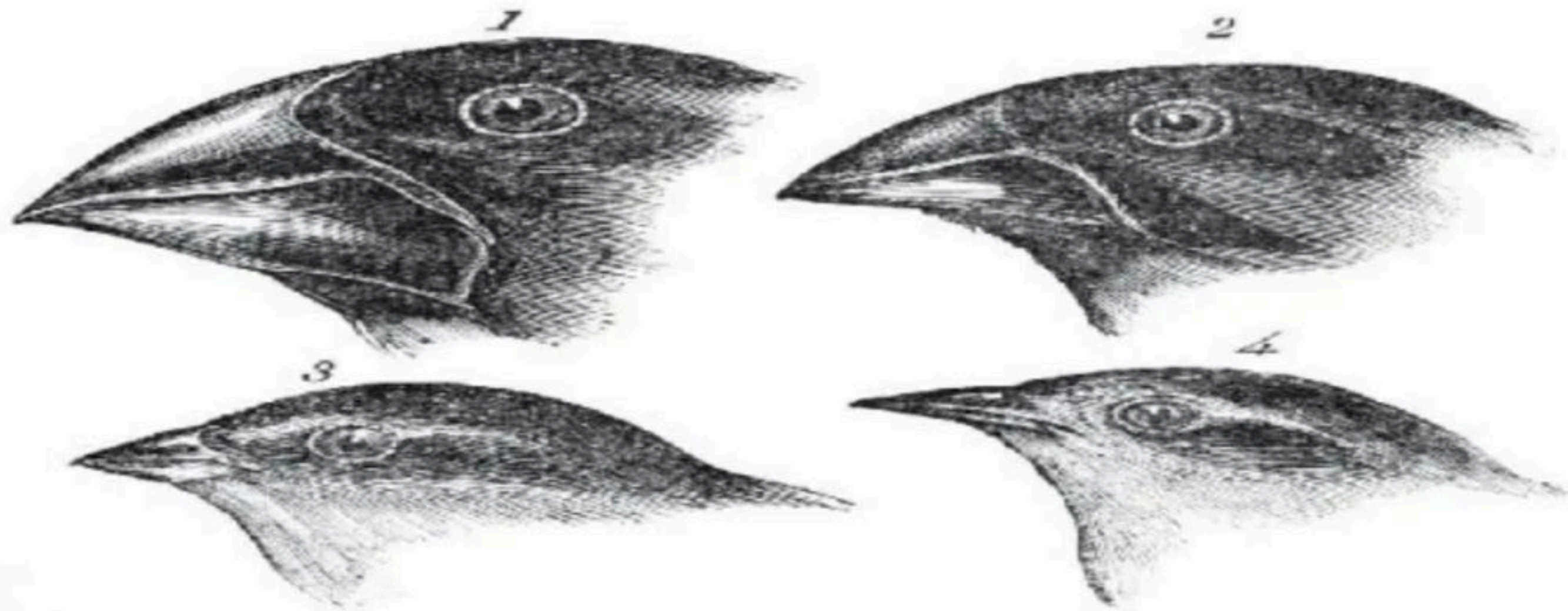
Character displacement

- ◇ Reduces niche overlapping
- ◇ Increases niche displacement
- ◇ Increases genetic segregation
- ◇ occurs when interspecific competition results in natural selection causing morphological diversity in species.
- ◇ Interspecific competition has been predicted to lead to directional selection for reduced niche overlap.



Darwin finches showing character displacement

It is an evolutionary process where niche contraction occurs due to competition results in change in morphological character.

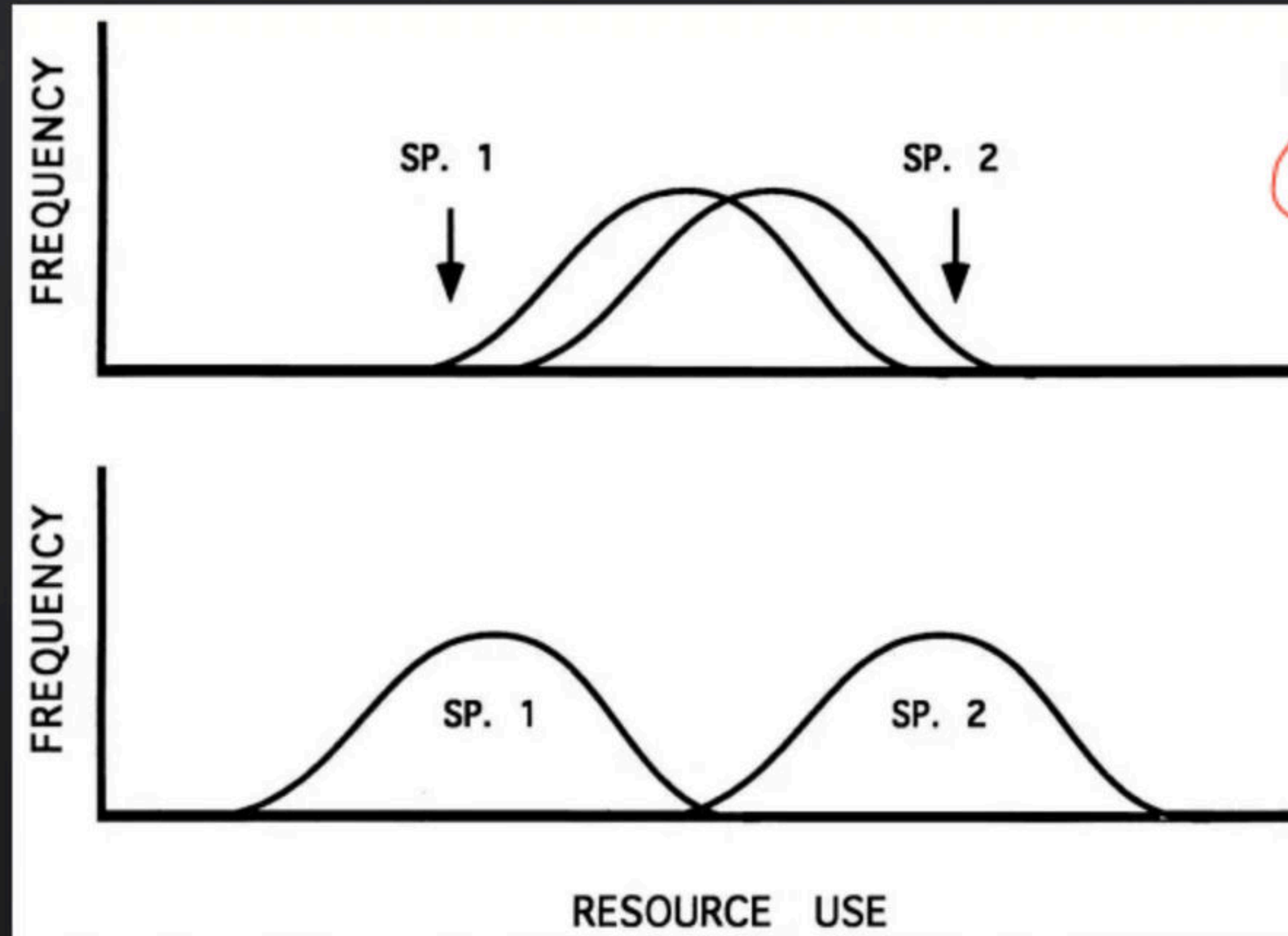


1. *Geospiza magnirostris*
3. *Geospiza parvula*

2. *Geospiza fortis*
4. *Certhidea olivacea*

Finches from Galápagos Archipelago

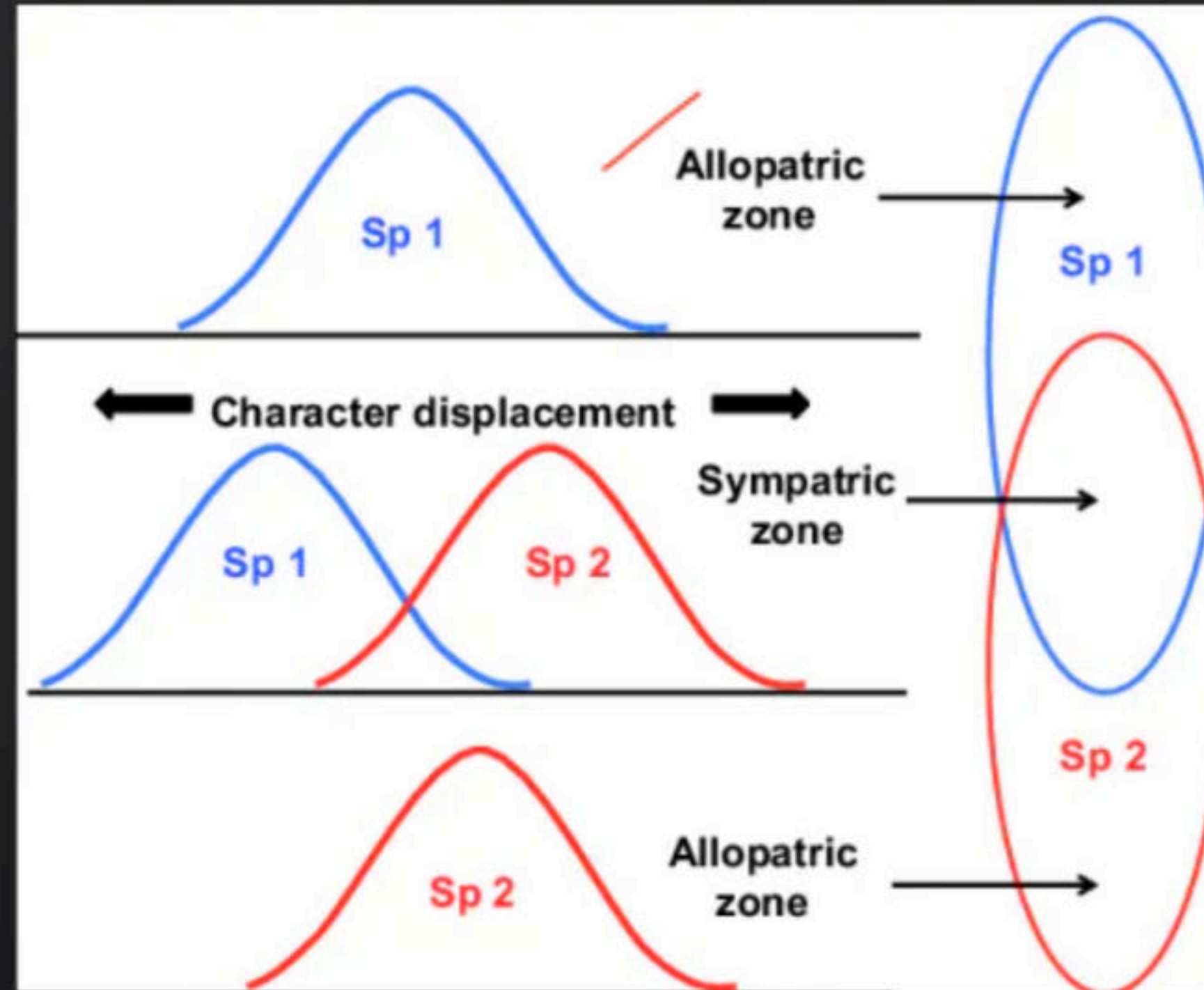
Which is correct for character displacement?

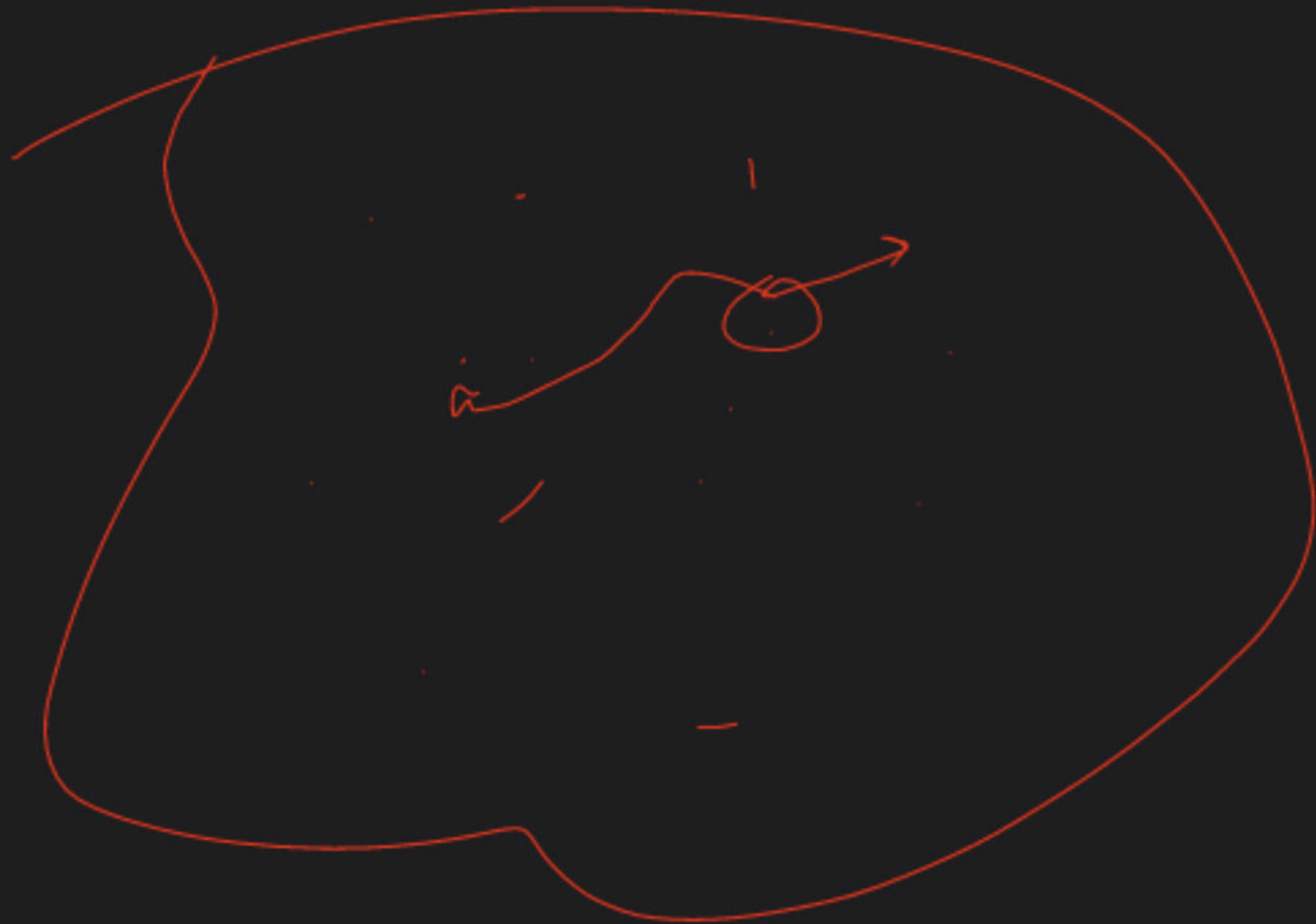


(Handwritten red mark)

(Handwritten red mark)

Sympatric zone will be created





Methods of character displacement

On the basis of reproductive isolation

Allopatric

- ◆ Reproduction isolation due to any barrier.

River, Mountain, Great wall of China, Volcanic eruption, etc.

- ◆ If allowed they can mate with each other
- ◆ Temporarily isolated

Sympatric

- ◆ Reproduction isolation due to physiomorphological differences.

Polyploidy, hybridization, Genetic mutation, etc.

- ◆ Permanently isolated



Which of the following is true regarding C.D.

- (1) Promotes co-existence
- (2) Reduces niche overlapping

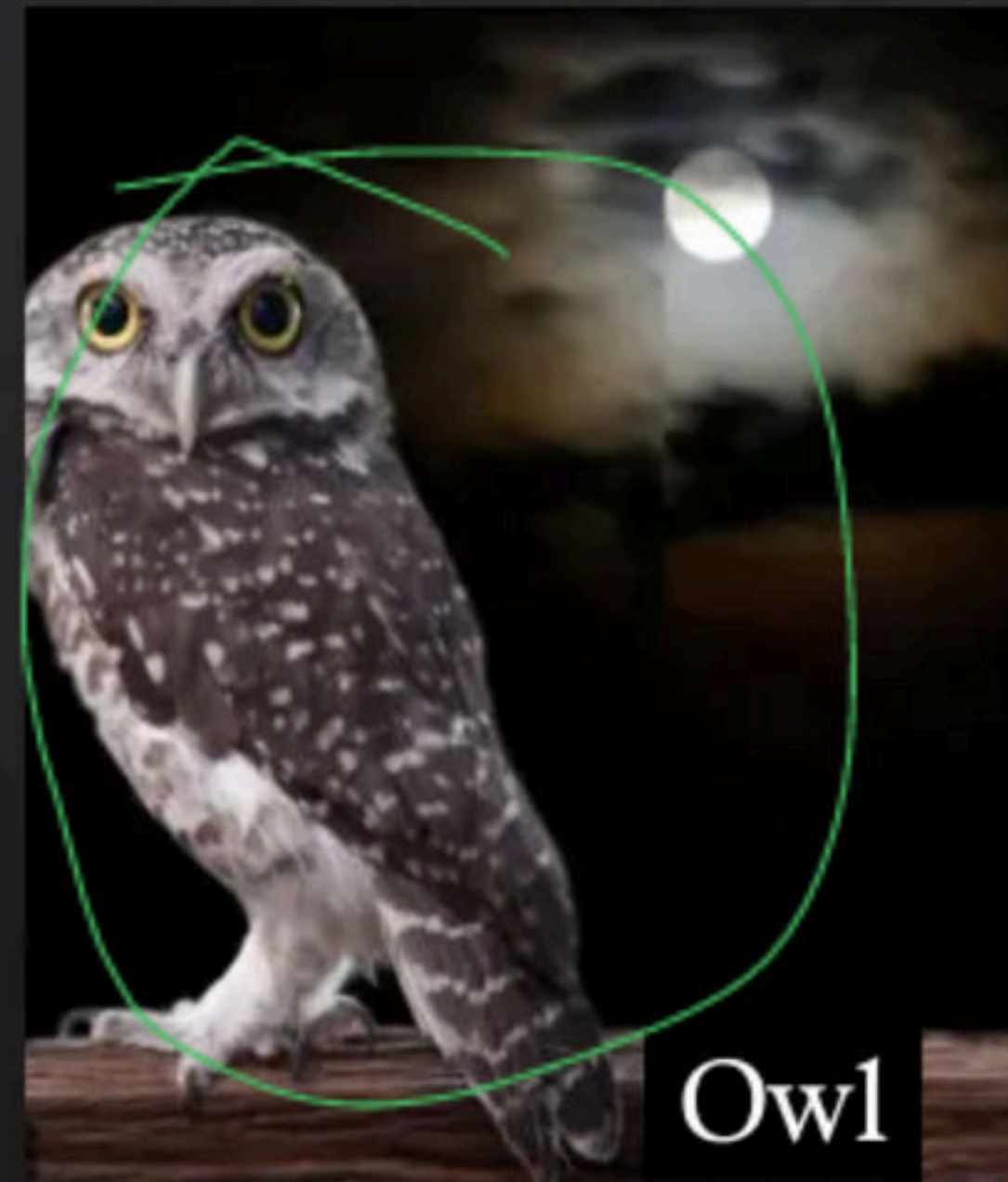
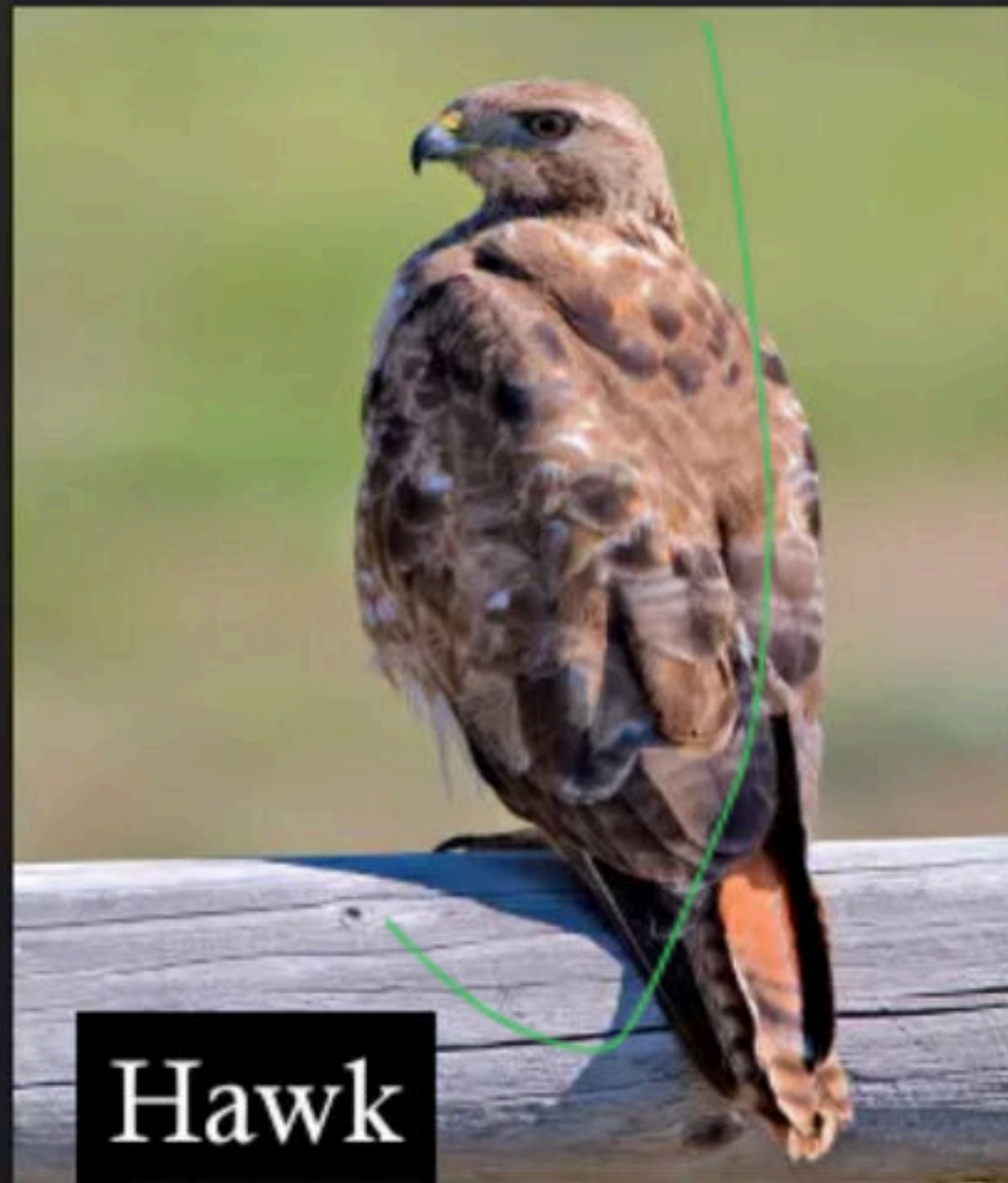
- A) 1, 2, 3, 4
- B) 2 and 3 only
- C) 3 only
- D) 1 and 2 only

(3) Enhances genetic segregation by maintains sp. distinctiveness by preventing hybridisation.

(4) C.D. occurs when intraspecific competition results in natural selecⁿ causing morphological to diversify a sp.

Methods of character displacement

On the basis of Temporal niche



Methods of character displacement

On the basis of conditional differentiation/Two source hypothesis/R* hypothesis/Resource ratio hypothesis/Tillman hypothesis

- ◇ Only one resource can be limiting for one species.
- ◇ Organism which are superior competitor for a given resources can be inferior competitor for another resources.

Desert – superior competitor: water; inferior competitor: space

Tropical rain forest – superior competitor: light/space; inferior competitor: resources (water, nutrients, etc.)

- ◇ According to Tillman, superior competitors for a given resources is one which has minimum requirement of a given resources that is limiting.

Desert – plants have water as superior competition

C3, C4, CAM ????????



Resource recruitment that species require to survive

Niche overlapping occurs

- ◆ When resources unlimited
- ◆ Territorial organism do not show terrestrial behavior
- ◆ Predator – prey pressure/Disease pressure

Which of the following true?

- (i) A good competitor for nutrient will be good competitor for light.
- (ii) A " " " light cannot be " " " nutrient.
- (iii) During early seral / Pioneer stages - Dominance of good competitor for nutrient.
- (iv) Late seral or Climax, there is ^{more} biomass allocation to shoots for proper light capture so that ~~good~~ it becomes ~~the~~ superior comp. for light.

- ◆ **Ecads/Ecophene/Habitat form**
- ◆ **Ecotype**
- ◆ **Bergamann's Rule**
- ◆ **Allen's Rule**
- ◆ **Gloger's Rule**
- ◆ **Hesse's Rule**
- ◆ **Willistone Rule**
- ◆ **Cope's Rule**

Fundamental and realized niche



Feedback and Hats

