GATE ECOLOGY AND EVOLUTION

QUICK ACHIEVER COURSE

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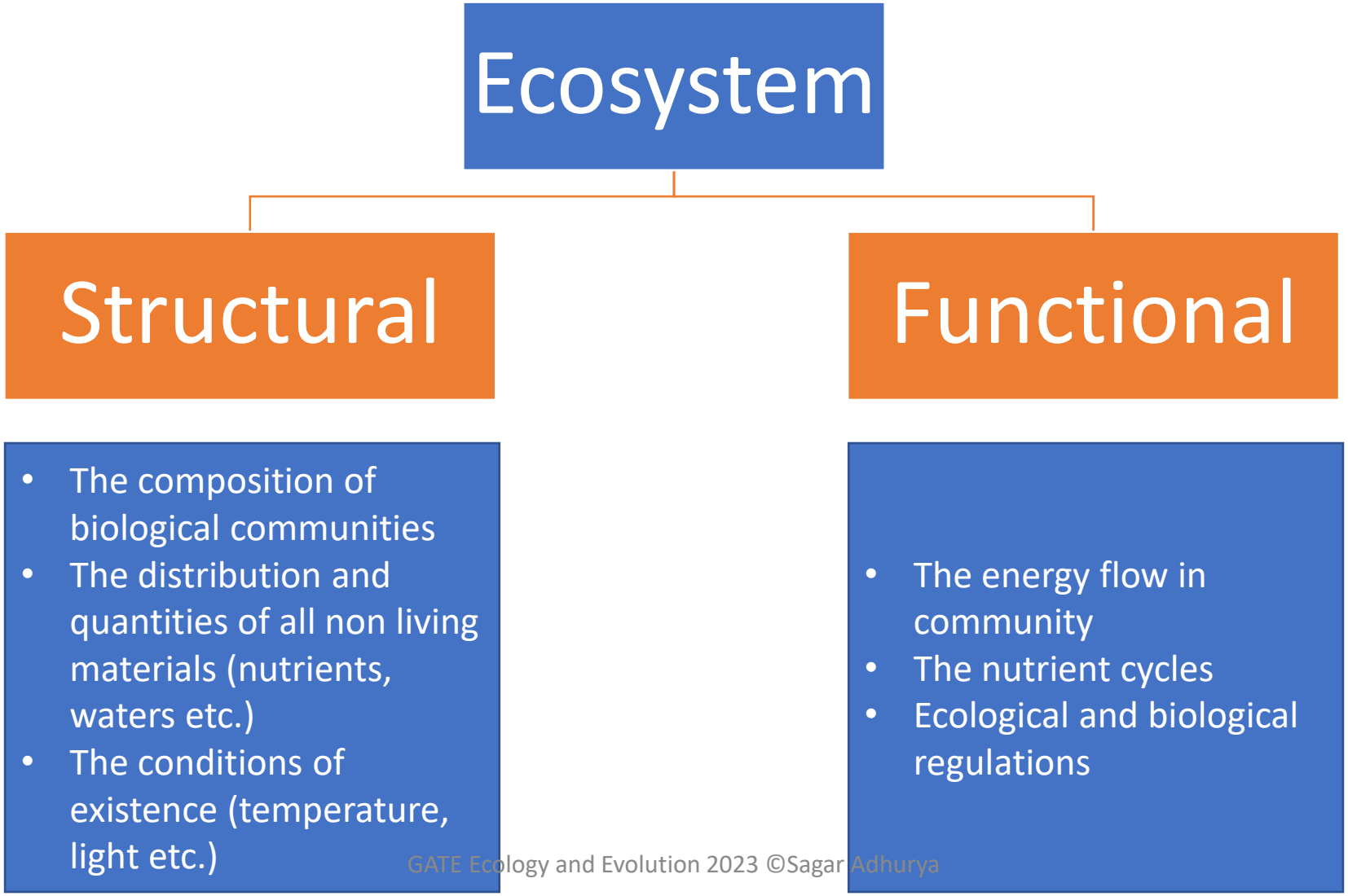
CLASS-I

FUNDAMENTAL CONCEPTS OF ECOLOGY

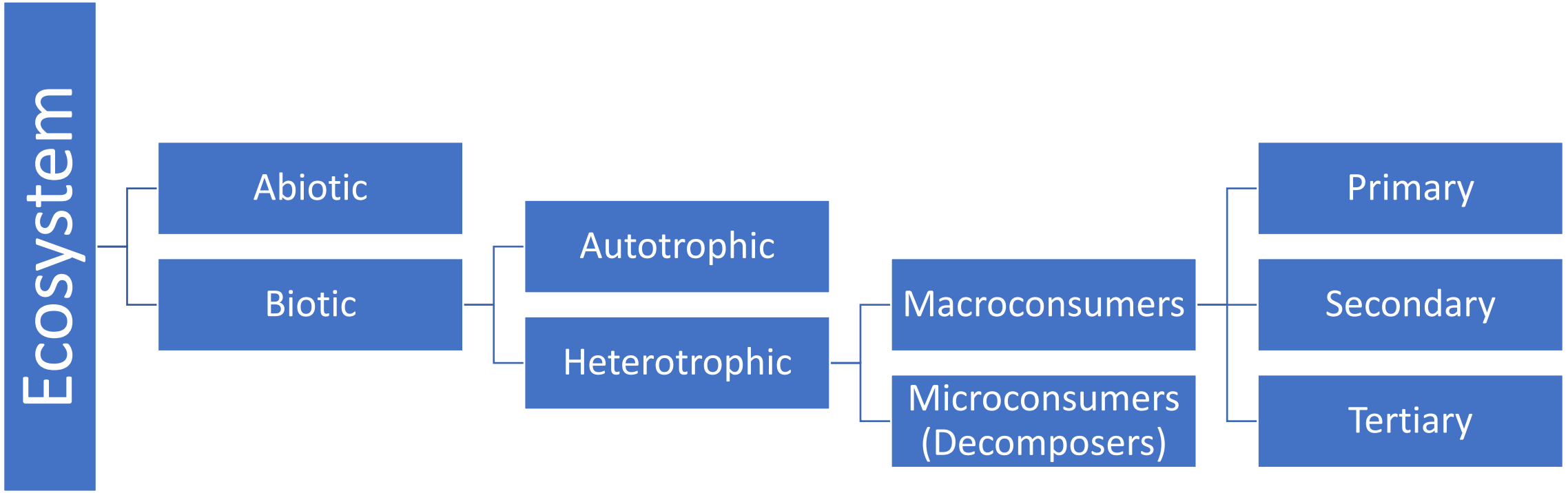
Ecology, Environment and Ecosystem

- The term ‘Ecology’ was coined by German biologist Ernst Haeckel in 1869.
- Gr. *oikos* = house, German. *logie* = to study
- **Ecology** is the study of natural environments including the relationship of organisms to one another and to their surroundings.
- **Environment** is the external surroundings in which an organism lives, which tend to influence its development and behaviour
- **Ecosystem** is a unit that includes all the organisms that functions together (the biotic community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined biotic structures and cycling of materials between living and non-living parts

Ecosystem properties

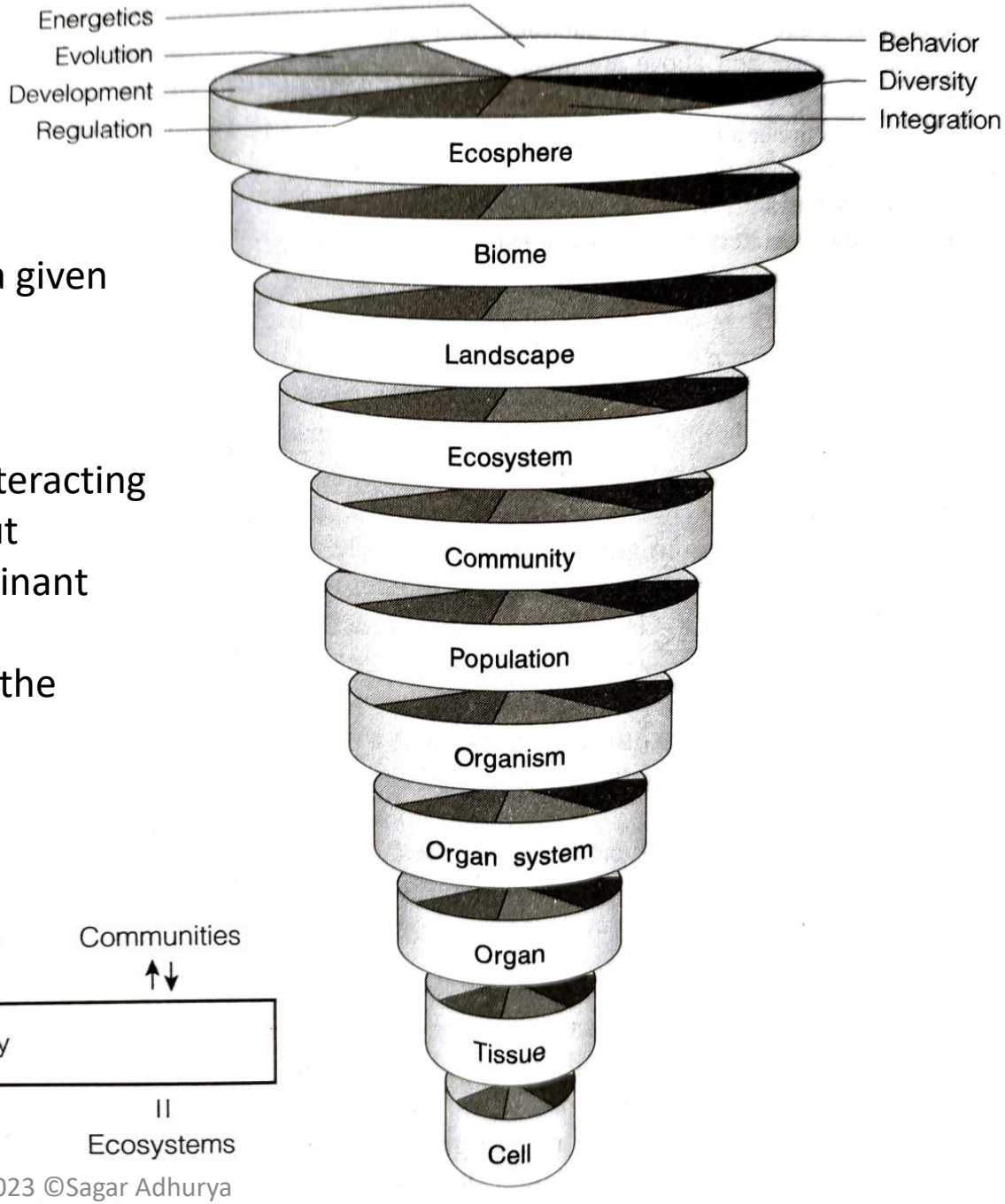


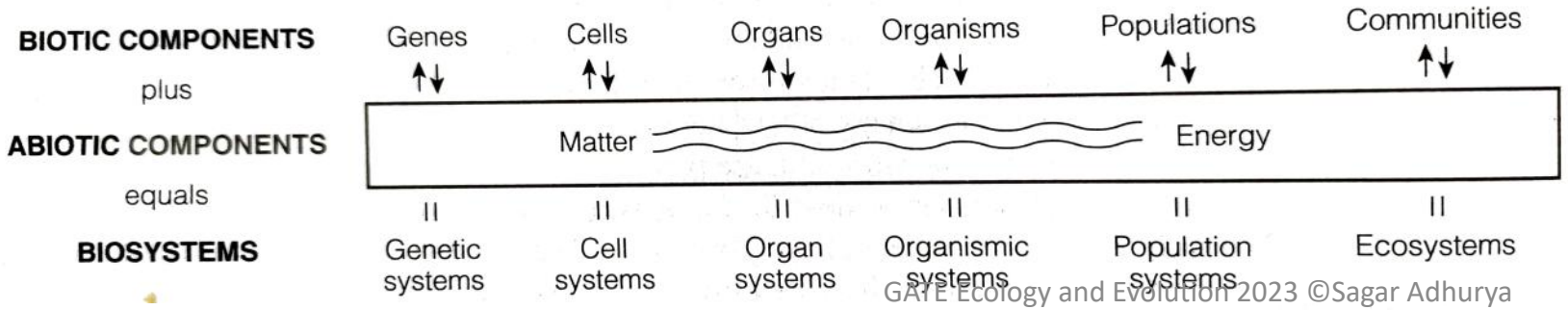
Components of an ecosystem



Levels of organisations

- **Population:** A group of organisms of same species found in a given area
- **Community:** All the populations occupying a given area
- **Ecosystem:** Community + Abiotic components
- **Landscape:** Heterogeneous area composed of a cluster of interacting ecosystems that are repeated in a similar manner throughout
- **Biome:** a major biotic community characterized by the dominant forms of plant life and the prevailing climate
- **Ecosphere:** All living organisms of the earth interacting with the physical environment as a whole





Source: Fundamentals of Ecology (Odum and Barrett, 2005)

Habitat

- **Habitat:** *Latin.* it inhabits, it dwells

It is ‘address’ of the organism, where it lives or can be found.

- **Microhabitat:** the smallest physical space that supports a distinct flora and fauna.
- **Microclimate:** Distinct environmental condition of the microhabitat is called microclimate

Niche

- The *ecological niche* of an organism not only includes its *physical space,* but also its functional position in community (*trophic position*) and its *conditions of existence* in environmental gradients.
- Ecological Niche = Physical space + Trophic Position + environmental conditions

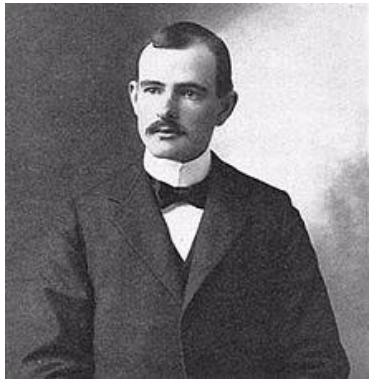
Habitat/spatial niche (Grinnell 1917, 1927)

Trophic niche (Elton 1927)

Hypervolume niche (Hutchinson 1957)

- It is ‘profession’ of the organism

Habitat or spatial Niche



Joseph Grinnell
(1877-1939)

- Niche of the species is delimited by its habitat and behavioural adaptations.
- Example:
- Seven species of millipedes in the maple oak forest (O'Neill 1967)

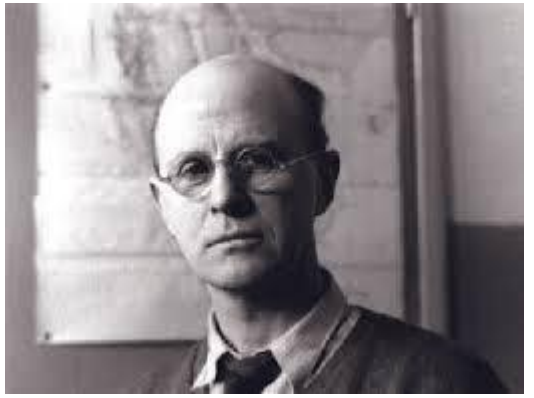
Microhabitats	MILLIPEDE SPECIES						
	Euryurus erythropygus	*Pseudopolydesmus serratus*	*Narceus americanus*	*Scytonotus granulatus*	*Fontaria virginiensis*	*Cleidogonia caesioannularis*	*Abacion lacterium*
Heartwood at centre of logs	*93.9	0	0	0	0	0	0
Superficial wood of logs	0	*66.7	4.3	6.7	0	14.3	0
Outer surface of logs beneath the bark	0	20.81	*71.4	0	0	0	0
Underlog, but on log surface	3.0	8.3	6.9	*60.0	0	0	15.8
Underlog, but on ground surface	3.0	4.2	12.5	0	*97.1	14.3	36.8
Within leaves of litter	0	0	0	26.7	0	*42.8	0
Beneath litter on ground surface	0	0	4.7	6.7	2.9	28.6	*47.4

*Predominates in this microhabitat.

(After O'Neill, 1967)

Trophic Niche

- The 'niche' of an animal means its place in the biotic environment, its relations to food and enemies.



Charles Sutherland Elton
(1900-1991)

Notonecta
Active Predator

Corixa
Decaying Vegetation

Habitat = Pond

Black-headed Weaver
Insectivore

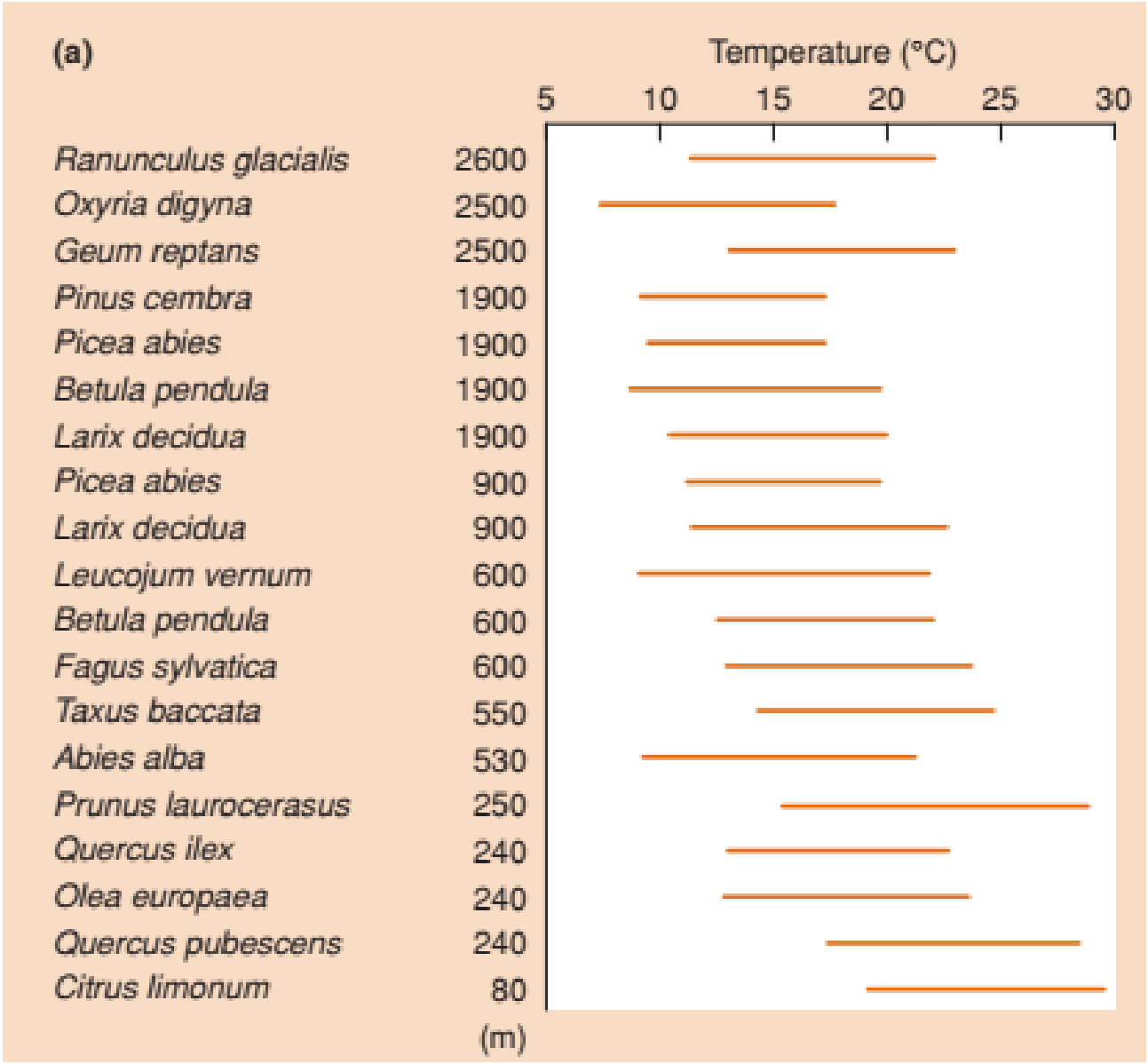
Village Weaver
Grainivore

Two weavers found around Lake Mweru, Africa use same nest

Hypervolume Niche

- The niche can be visualised as a multidimensional (*n*-dimensional) space of different environmental and biotic factors (light, nutrients, temperature, food etc.).

G. Evelyn Hutchinson
1903-1991



A niche in one dimension. The range of temperatures at which a variety of plant species from the European Alps can achieve net photosynthesis of low intensities of radiation (70 W m^{-2}). (After Pisek *et al.*, 1973.)

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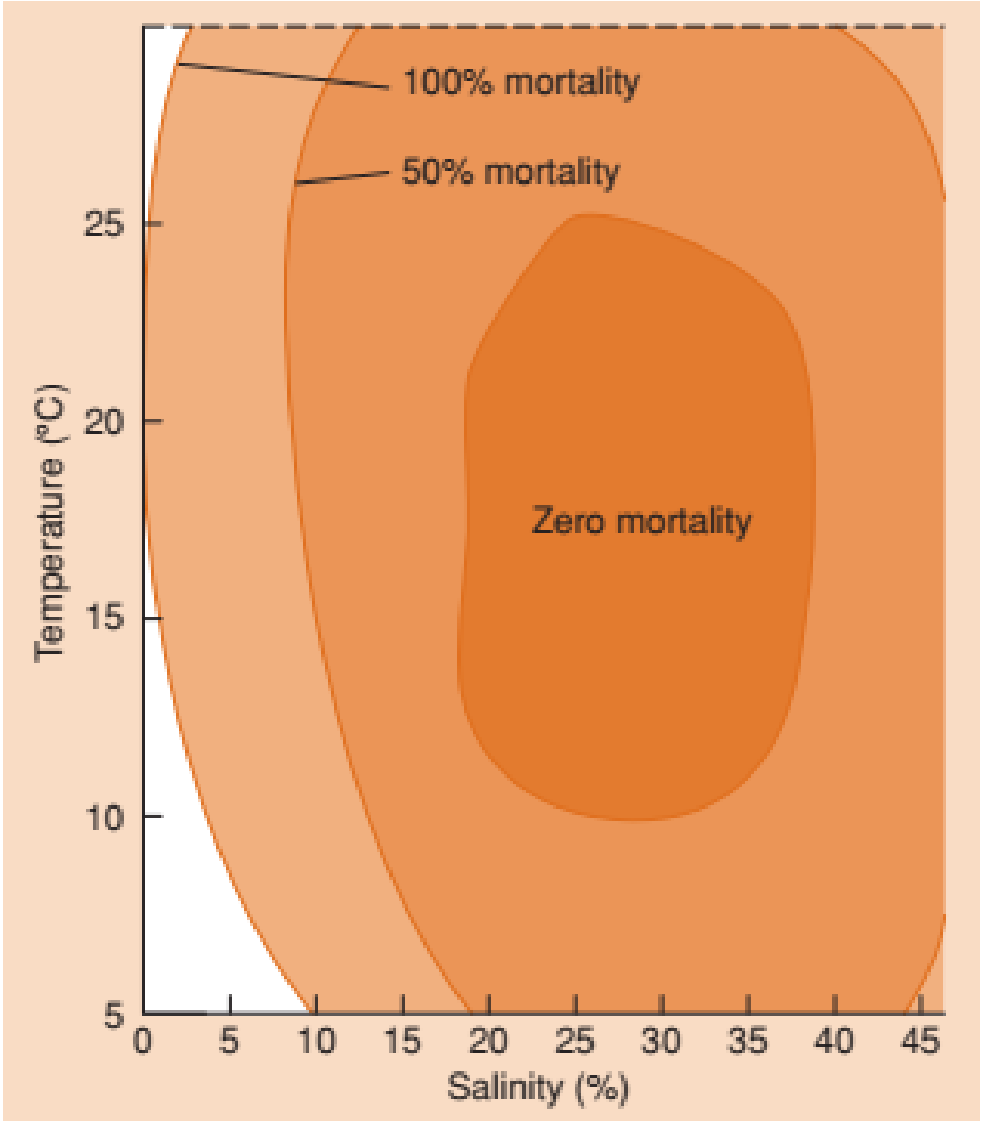

A niche in two dimensions for the sand shrimp (*Crangon septemspinosa*) showing the fate of egg-bearing females in aerated water at a range of temperatures and salinities.

Ecology: From individuals to ecosystem (Begon et al. 2006)

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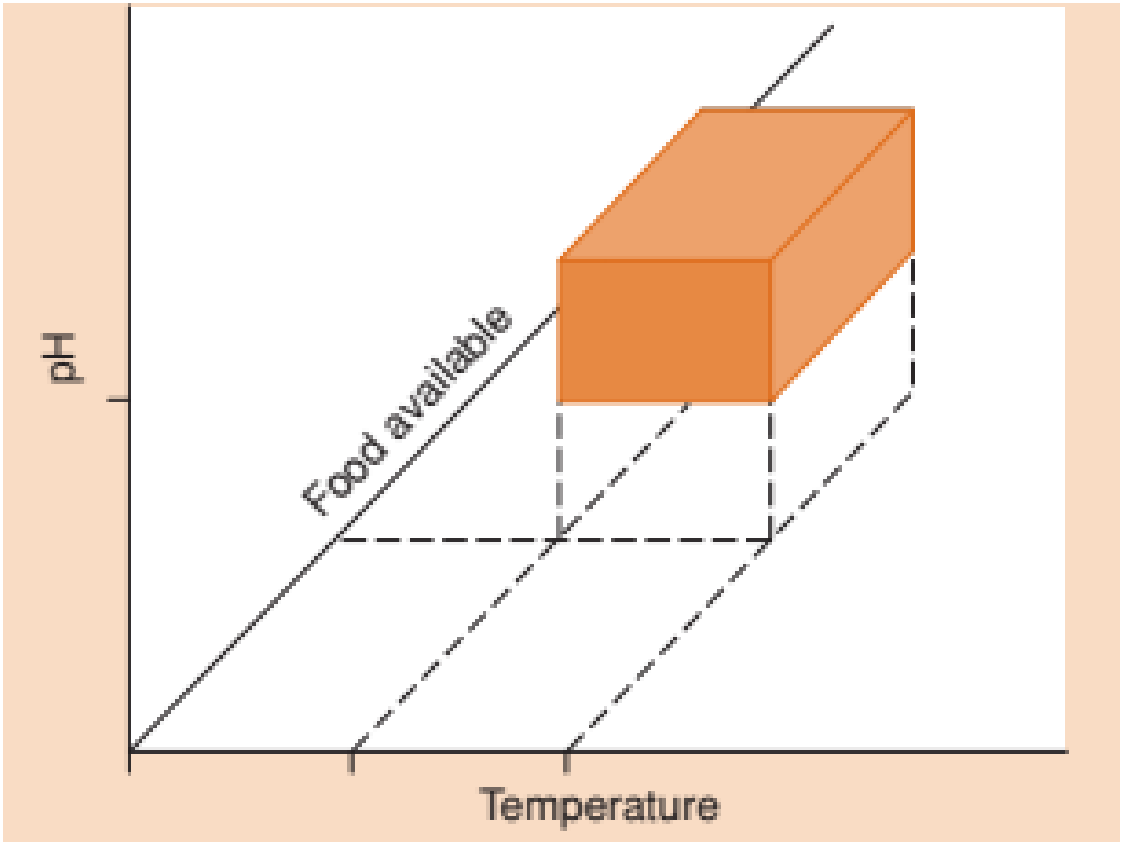
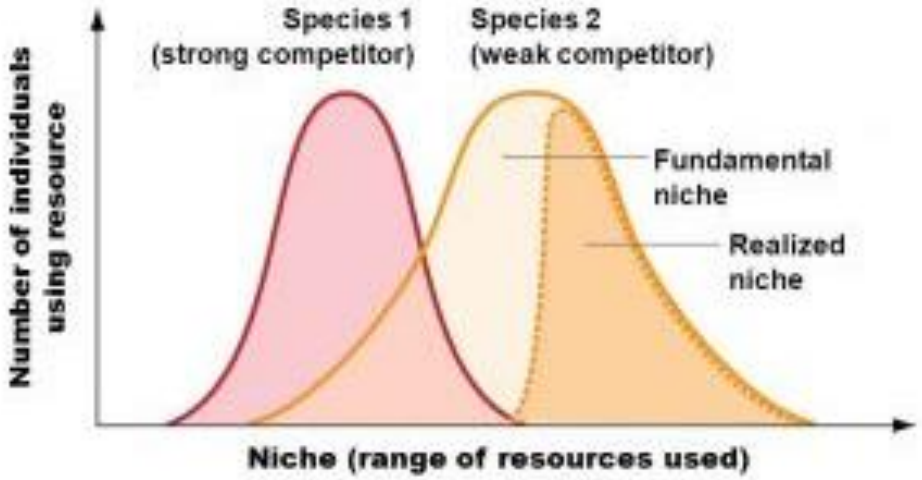


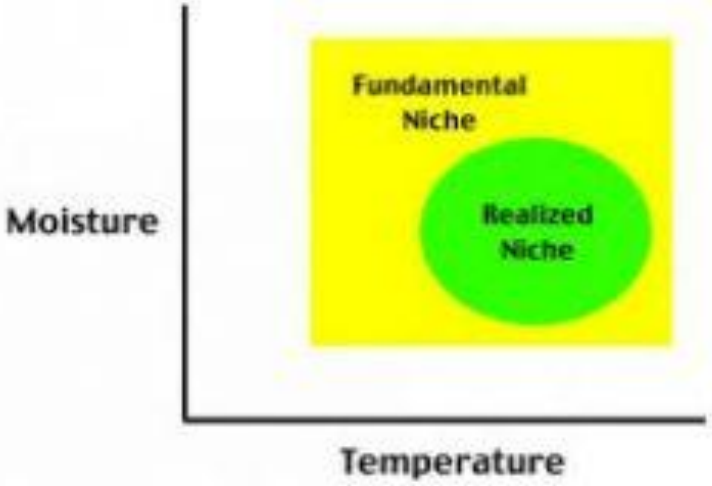
A diagrammatic niche in three dimensions for an aquatic organism showing a volume defined by the temperature, pH and availability of food.

Ecology: From individuals to ecosystem (Begon et al. 2006)

Fundamental and realised niche

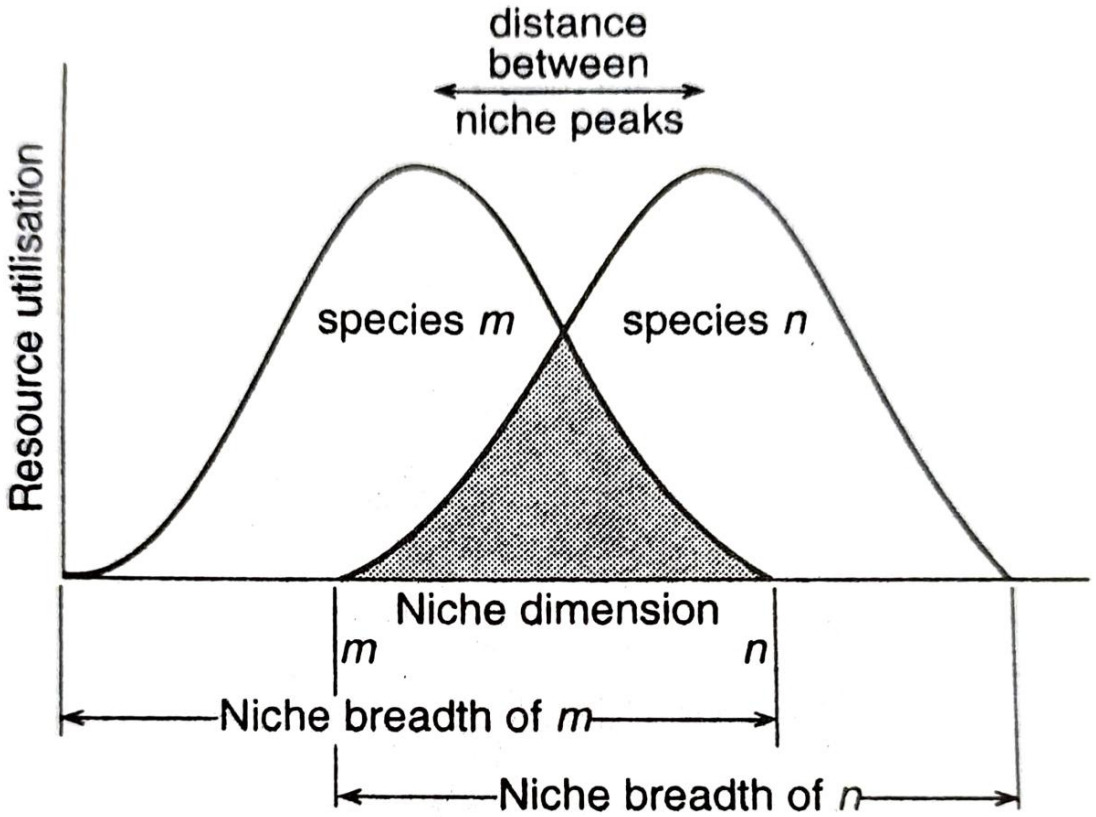
- The maximum size of theoretical hypervolume which a species can occupy without the presence of biotic constrains, called *fundamental niche.*
- The reduced hypervolume of an organism due to presence of biotic constrains is called *realised niche*.





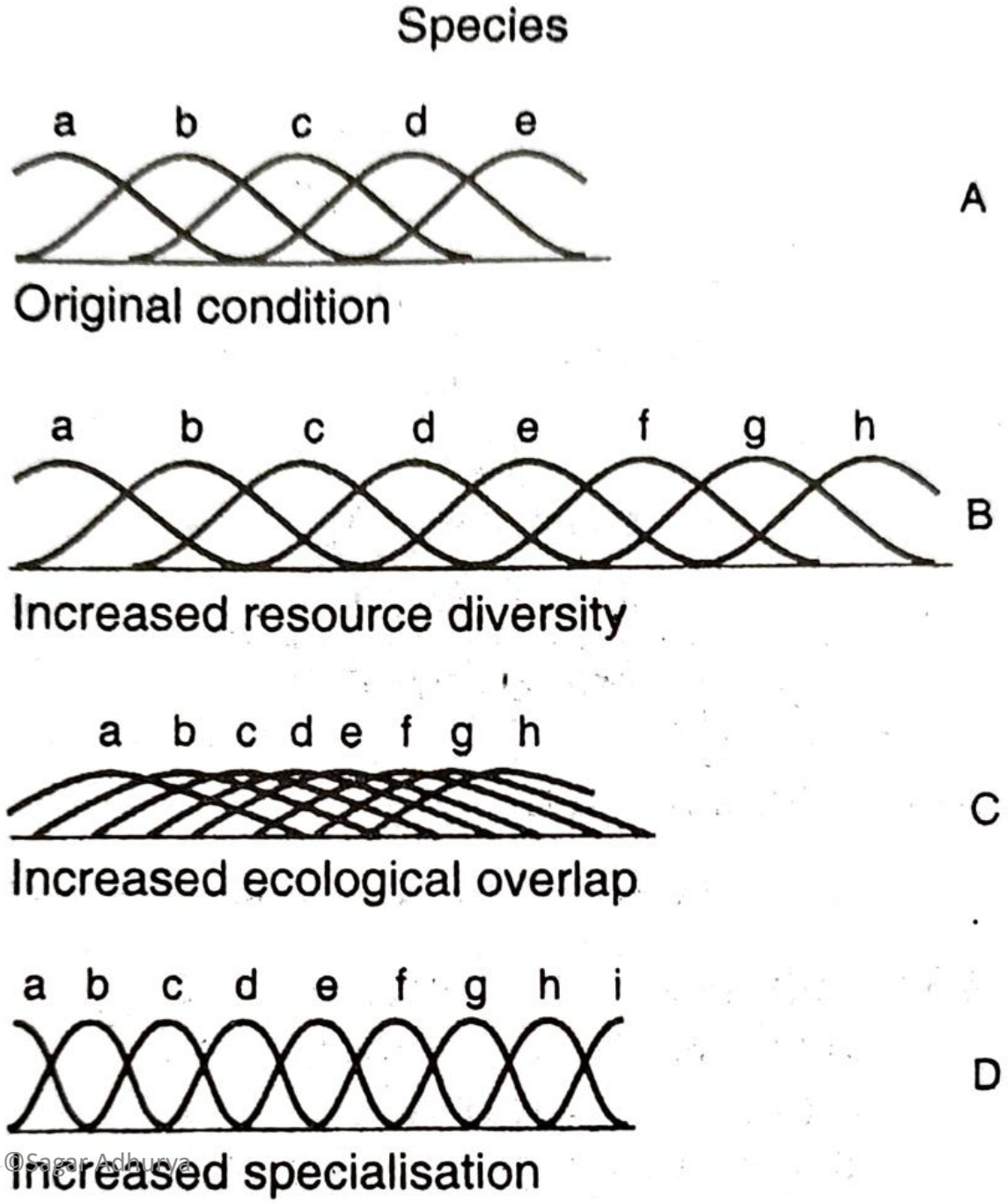
Niche breadth and niche overlap

- **Niche width/Niche breadth:** The range of niche dimension occupied by a species
- **Niche overlap:** Sharing of niche space by two or more species
- The degree of niche overlap helps to understand the competition between different species
- **Gause's principle:** Complete competitors cannot coexist
- **Limiting similarity:** If two species still coexist despite their similarity of resource use
- Sometime species may be too similar to coexist in one axis, but differ in another axis, called **niche complementarity**.
- **Ecological equivalent:** Species which occupy very similar niche in different geographical region
- **Guild:** Groups of species (usually ataxonomic) that exploit biotic/abiotic resources in similar way.



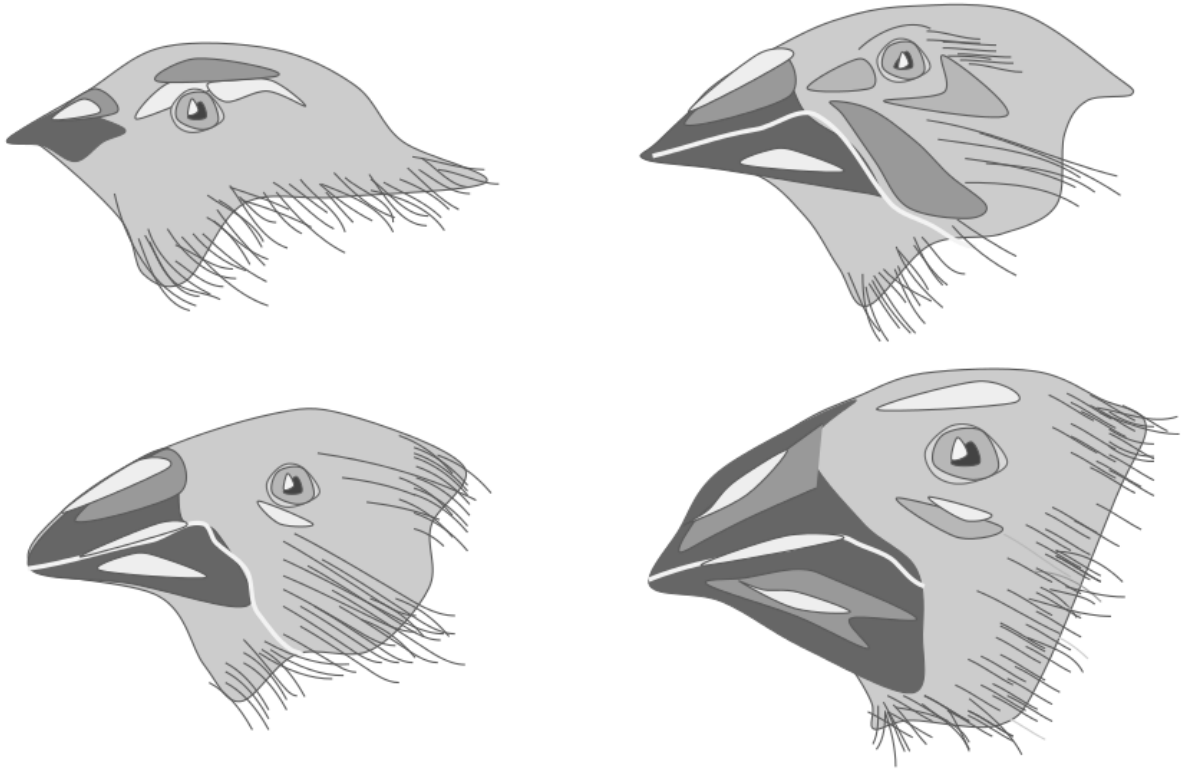
Niche and diversity

- **Species packing:** Increase in species richness without an increase of niche dimension.
- **Escape space:** Niche space, that is defined by adaptation (also behavioural adaptation) of a prey to avoid predation



Niche and diversity

- **Character displacement** occurs when similar species that live in the same geographical region and occupy similar niches differentiate in order to minimize niche overlap and avoid competitive exclusion.
- Adaptive values:
  - It enhances niche displacement and thus reducing competition
  - It enhances genetic segregation by maintaining species distinctiveness by preventing hybridisation



Several closely related species of Galapagos finches differs in beak size and beak depth, allowing them to coexist in the same region since each species eats a different type of seed: the seed best fit for its unique beak. The finches with the deeper, stronger beaks consume large, tough seeds, while the finches with smaller beaks consume the smaller, softer seeds.

Niche and diversity

- **Resource partitioning** is the division of limited resources by species to help avoid competition in an ecological niche. In any environment, organisms compete for limited resources, so organisms and different species have to find ways to coexist with one another.
- The resource partitioning can happen by both spatial and temporal variation of resource utilisation

Acomys cahirinus
Cairo Spiny Mouse
Nocturnal

Acomys russatus
Golden Spiny Mouse
Diurnal

Rocky deserts of Israel