01 Organisms and Populations

01. INTRODUCTION

The term ecology was coined and described by – **E. Haeckel**

Father of ecology – **Reiter**

Father of Indian Ecology – **Prof. Ramdeo Misra**

First of all term ecology was employed for study of plant by – **Warming**

Definition:

The study of interaction or inter-relationship of organisms with their environment is called ecology.

Organism $\rightleftharpoons$ **Environment**

Organism and environment are interdependent, inter-related or mutually reactive.

Ecology is a subject which studies the interactions among **organisms** and between the organism and its physical (abiotic) environment.

Branches of Ecology – It is based on organisation level.

(a) Autecology – Study of the relation of a single species with its environment is known as autecology (Here unit of study is a single species). It is also called species ecology.

(b) Synecology – Study of the relation of the group of different species with their environment is known as synecology. (Here unit of study is community.)

02. ECOLOGICAL HIERARCHY

Our living world is fascinatingly diverse and amazingly complex. We can try to understand its complexity by investigating processes at various levels of **biological organisation– macromolecules, cells, tissues, organs, individual organisms, population, communities, ecosystems and biomes**. At any level of biological organisation we can ask two types of questions – for example, when we hear the bulbul singing early morning in the garden, we may ask – 'How

does the bird sing?' Or, 'Why does the bird sing ?' The 'how-type' questions seek the *mechanism* behind the process while the 'whytype' questions seek the *significance* of the process. For the first question in our example, the answer might be in terms of the operation of the voice box and the vibrating bone in the bird, whereas for the second question the answer may lie in the bird's need to communicate with its mate during breeding season. When you observe nature around you with a scientific frame of mind you will certainly come up with many interesting questions of both types - *Why are night-blooming flowers generally white?*

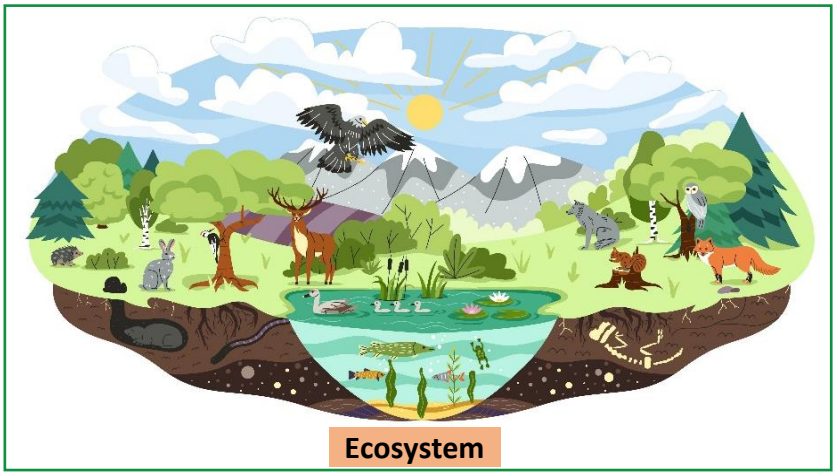
How does the bee know which flower has nectar? Why does cactus have so many thorns? How does the chick spures recognise her own mother ?, and so on.

You have already learnt in previous classes that Ecology is a subject which studies the interactions among organisms and between the organism and its physical (abiotic) environment. Ecology is basically concerned with four levels of biological organisation – organisms, populations, communities and biomes. In this chapter we explore ecology at population levels.

Organism → Population → Community → Ecosystem → Biome → Biosphere

Size → Increase

Complexity → Increase



Ecosystem

- **Landscape :** It is a unit of land with a natural boundary having a mosaic of patches. These patches generally represent different ecosystem.

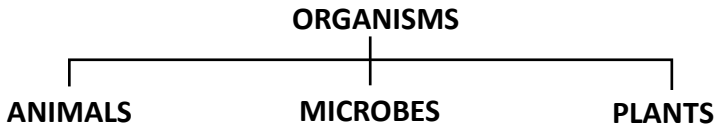
  In ecological hierarchy landscape can be present between Ecosystem and Biomes.
- **Habitat :** Physical area where an organism lives. The physico-chemical (abiotic) components (mainly temperature, water, light and soil) alone do not characterise the habitat of an organism completely; the habitat includes biotic components also – pathogens, parasites, predators and competitors – of the organism with which they interact constantly.

Ecological Niche : It is the functional role of any species in a ecosystem or community. In other words it is a occupational address or profession of a species it means it is a functional position or status in an ecosystem. Each organism has an invariably defined range of conditions that if can tolerate, diversity in the resources it utilises and a distinct functional role in the ecological system, all these together comprise its niche.

e.g. Ecological Niche of tiger : To predate on herbivores (work) under environmental conditions (abiotic and biotic factors) of forest where it resides.

(1) ORGANISM :

- An organism is the smallest unit of ecological hierarchy and basic unit of ecological study.
- It may be small/large, unicellular/multicellular.
- Fixed life span (birth to natural death) and organized life cycle.
- Ecology at the organismic level is essentially **physiological ecology**. An organism adapts its physiology to its surrounding environment.



NCERT Question :
Define population and community.

(2) POPULATION :

A group of Individuals (members) of same species living at one place (specific geographical area) constitute a population.

(A) Species :

Definition - Species is a basic unit of classification, defined as the group of living organisms similar in structure, function and behaviour and produced by similar parents, have common gene pool, can inter breed under natural conditions and reproductively isolated from other group of organism.

Some terms related to species :

- **Endemic Species or Endemism :** A species which is found only in a particular area is known as endemic species.

  e.g. *Metasequoia* is found only in valley of China, Kangaroo in Australia.


Kangaroo (Mammalia)


Metasequoia (Gymnosperm)

- **Key-stone Species :** The species which have great influence on the community's characteristics relative to their low abundance or biomass are called key-stone species. The activities of key-stone species determine the structure of the community.

  e.g. Lion in forest, Kangaroo rat in desert, Fig tree in tropical forest, *Pisaster* in American pacific coast.


Lion in forest


Kangaroo rat in desert


Fig tree in tropical forest

- **Critical Link Species :** The species which establishes an essential link with other species to help the latter in some vital activity is called critical link species.

  e.g. Mycorrhizal fungi, many insect species which works as pollinators of flowers.

Mycorrhizal fungi and plants


Bees and plants

BEGINNER'S BOX-1 — ECOLOGICAL HIERARCHY

1. A group of Individuals (members) of same species living at one place (specific geographical area) constitute a _____.

(1) Species (2) Population (3) Community (4) Biome

BOP176

2. Kangaroo rat in desert is an example of :

(1) Keystone species (2) Critical link species

(3) Endemic species (4) Dominant species

BOP177

3. *Pinus* community at Himalayas is an example of :

(1) Endemic species (2) Rare species

(3) Dominant species (4) Keystone species

BOP178

4. Metasequoia which is found in valley of china is example of which type of species?

(1) Critical link species (2) Key stone species

(3) Endemic species (4) Dominant species

BOP179

5. Ecology at organismic level known as -

(1) Physiological ecology (2) Artificial ecology

(3) Morphological ecology (4) Physical ecology

BOP180

6. Individuals of the same species inhabiting a particular locality constitute -

(1) Community (2) Flora (3) Fauna (4) Population

BOP181

(3) POPULATION ATTRIBUTES :

(A) INTRODUCTION :

- Scientific study of human population is called demography.
- Population is defined as the total number of individual of a species present in a particular area at a given time.
- The population have specific character different from the character of individual.

(B) CHARACTER OF POPULATION :

(a) POPULATION DENSITY (POPULATION SIZE) :

- It is measured as total number of individual present in unit area or unit volume.
- The size of a population for any species is not a static parameter. It keeps changing in time depending on various factor including food availability, predation pressure and reduced weather.
- For human population density is officially counted in first four month of 1^{st} year of each decade is called census.

- For human population density is calculated as number of person living in per square km area.
- The tiger census in our national park and tiger reserves is often based on pug marks and fecal pellets.

Note : Ecological effects of any factors on a population are generally reflected in its size which may be expressed in numbers, biomass, percent cover etc. depending on the species.

(b) BIRTH RATE / FERTILITY / NATALITY :

- Birth rate is defined as total number of birth in a population with respect to total number of individual of the population in a year.
- Birth rate is represented as per capita birth rate

Per capita birth rate (b) = $\frac{\text{Total number of birth in a year}}{\text{Initial population}}$

Q. If in a pond there are 20 lotus plant last year and through reproduction 8 new plant are added, then the birth rate during the year is calculated as :	**Solution :** $b = \frac{\text{Total number of birth in a year}}{\text{Initial population}}$ $= \frac{8}{20}$ b = 0.4 offspring per lotus per year.

- Birth rate varies from region to region
- Developed country have lower birth rate.
- Developing or poor country have higher birth rate than developed countries.
- Higher fertility in developing world is partially explained by large number of hand needed to perform work.

Note: Biotic potential (Reproductive potential or potential ability)

Under most favourable environmental conditions the maximum reproductive capacity of a species is known as biotic potential.

Vitality – Capacity of normal growth and reproduction for survival of a species. It depends upon weight of plant, stem height, root length, leaf number etc.

(c) DEATH RATE / MORTALITY :

- Death rate is defined as total number of death in a population with respect to total number of individual of the population in a year.
- Death rate is represented as per capita death rate $d = \frac{\text{Total number of death in a year}}{\text{Initial population}}$

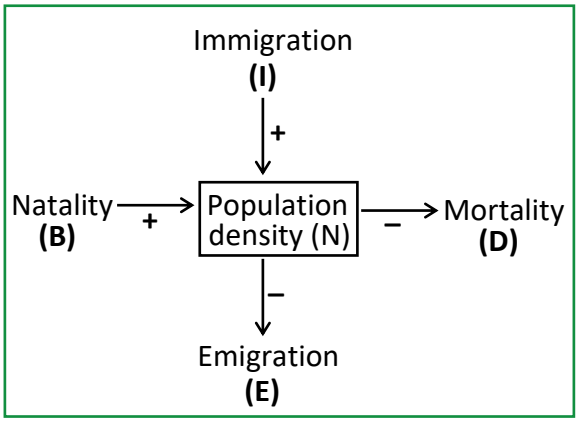
Q. If 4 individuals in a laboratory population of 40 fruit fly died during week. The death rate is calculated as:	**Solution :** $d = \frac{\text{Total number of death in a year}}{\text{Initial population}} = \frac{4}{40}$ d = 0.1 individual per fruit fly per week.

(d) GROWTH RATE :

Intrinsic growth rate (r) = b – d

Growth rate = $\left(\frac{\Delta N}{\Delta t}\right)$

Percent growth rate = $\frac{\left(\frac{\Delta N}{\Delta t}\right)}{N_0} \times 100$



Note : Natality, Mortality, Immigration and Emigration are the basic process responsible for fluctuation in population size under normal conditions, Natality and Mortality are the most important factors influencing population size than other two factor i.e., Immigration and Emigration.

$N_{t+1} = N_t + [(B + I) – (D + E)]$

Where:

N_{t+1} = Density at time t+1 N_t = Density at time t

B = Natality I = Immigration

D = Mortality E = Emigration

(e) AGE-SEX STRUCTURES :

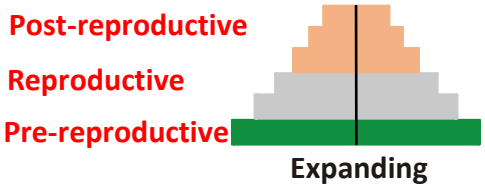
- The age structure of a given population refers to the proportion of individuals of different age. This is important aspect because **many functional aspect of individuals are related to age**. (Like Reproduction)
- Age structure of a population can be depicted in the form of a pyramid diagram.
- Diagram is particularly important in **understanding future growth.**
- Population has 3 age groups.

  Pre-Reproductive individuals – < 15 yr

  Reproductive individuals – 15 – 44 yr

  Post-Reproductive individuals – > 45 yr

(i) **Expanding population:** A **higher number of pre-reproductive** individuals, moderate number of reproductive individuals and fewer post reproductive individuals will form **young population** it shows **rapid growth.**



(ii) **Stable population:** An **equal number** of pre-reproductive and reproductive individuals will constitute a **mature population** or **stable population.**

(iii) **Declining population: Fewer number of pre-reproductive** individuals as compared to reproductive ones will make **population aged**. It shows **negative growth.**

Note : Developed countries have a steeper pyramid which represent nearly a stable population.

(C) POPULATION GROWTH MODELS / CURVE :

There are two type of growth curve.

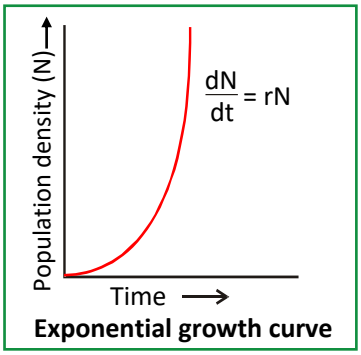
(a) Exponential (b) Logistic

NCERT Question :

If a population growing exponentially double in size in 3 years, what is the intrinsic rate of increase (r) of the population?

(a) EXPONENTIAL GROWTH (GEOMETRIC GROWTH CURVE OR J-SHAPED CURVE) :

- Any species growing exponentially under **unlimited resource conditions** can reach enormous population densities in a short time. If in a population of size "N", the birth rates are represented as b and death rates as d, then the increase in N during a unit time period $t\left(\frac{dN}{dt}\right)$ will be.



$$\frac{dN}{dt} = (b-d) \times N \quad \text{Let } (b-d) = r, \text{ then}$$

$$\frac{dN}{dt} = rN$$

r = Intrinsic rate of Natural increase or Fitness or growth rate.

The integral form of the exponential growth equation as :-

$$N_t = N_0 e^{rt}$$

Where :

N_t = Population density after time t

N_0 = Population density at time zero

r = intrinsic rate of natural increase

The magnitude of r-values for the Norway rat is 0.015 and for the flour beetle it is 0.12. In 1981, the r-value for human population in India was 0.0205.

e = the base of natural logarithms (2.71828)

NCERT Question:
With the help of suitable diagram describe the logistic population growth curve.

(b) LOGISTIC GROWTH CURVE (SIGMOID CURVE/S-SHAPED) :

- Since resources for growth for most animal population are finite and become limiting sooner or later, the logistic growth model is considered more realistic.
- The S-shape sigmoid growth form is represented by the **Verhulst - Pearl logistic growth** equation:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

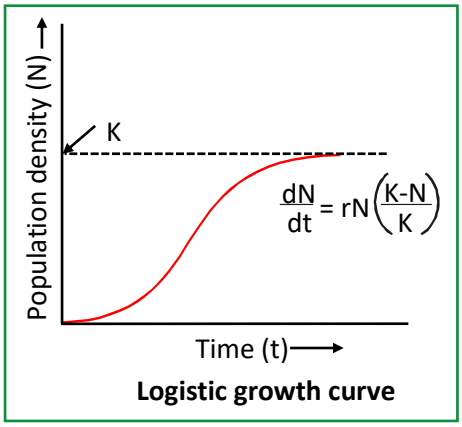
where : $\frac{dN}{dt}$ = Rate of change in population size

r = Intrinsic rate of natural increase

N = Population size at time t

K = Carrying capacity

$\left(\frac{K-N}{K}\right)$ = Environmental resistance



Logistic growth curve

(D) LIFE HISTORY VARIATION :

- Population evolve different strategy to maximise their reproductive fitness.
- Some organisms breed only once in their life time like **Pacific salmon fish, Bamboo** etc.
- Some produce small sized offspring like **Oyster, Pelagic fishes** etc. maximise their fitness by producing large number of offspring.
- Some organisms breed many times in their life and produces a small number of large sized offspring **(Birds, Mammals)**.

BEGINNER'S BOX-2 POPULATION ATTRIBUTES

1. _____ contribute to an increase in population density.

(1) Natality and emigration (2) Mortality and emigration

(3) Mortality and immigration (4) Natality and immigration

BOP182

2. Which of the following factor would not limit the growth of population?

(1) food scarcity (2) Immigration

(3) Parasites (4) Catastrophe

BOP183

3. Carrying capacity is denoted as -

(1) r (2) N (3) K (4) I

BOP184

4. Which growth model is considered as more realistic one?

(1) Exponential growth (2) Constant growth

(3) Logistic growth (4) None of these

BOP185

5. To calculate the current r value for human population we need to know about -

(1) Birth rate (2) Death rate

(3) Carrying capacity (4) Both (1) and (2)

BOP186

6. Find out the incorrect match w.r.t. age-pyramid -

(1) Triangular pyramid – Young growing population

(2) Bell shaped pyramid – Stable mature population

(3) Urn shaped pyramid – Positive growth

(4) Urn shaped pyramid – Declined negative growth

BOP187

7. Which of the following will have a negative effect on the population density of a particular area?

(1) Natality (2) Immigration

(3) Emigration (4) High natural resources

BOP188

8. If 6 individuals in a laboratory population of 24 mice died in one week. What will be the mortality rate per mice per week ?

(1) 0.4 (2) 0.1 (3) 0.25 (4) 0.18

BOP189

9. Which is a correct formula for Verhulst-pearl logistic growth?

(1) $N_t = N_0e^{rt}$ (2) $\frac{dN}{dt} = rN$ (3) $\frac{dN}{N} = r.dt$ (4) $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$

BOP190

10. Asymptote in a logistic growth curve is obtained when-

(1) K = N

(2) K > N

(3) K < N

(4) The value of 'r' approaches zero

BOP191

03. COMMUNITY

Groups of organisms of different species that live in common area, which are interrelated and interdependent. It is a natural aggregation of plants, animals and microbes (biotic community) interacting in the same environment/area.

Biotic Community = Animal community + Plant community + Microbial community

(A) CHARACTERISTICS OF A COMMUNITY :

(i) Species Diversity :- There are different types of population (species) found in community, this is called species diversity. It depends on size of the area, type of area, type of soil, altitude, climate.

(ii) Dominance :- The highest number of organisms of a species present in community, is called as the dominant species. Whole community is known by the name of that particular dominant species. ***e.g.*** *Prosopis* in Aravalli hills, *Pinus* in Himalaya and mangrove forest.

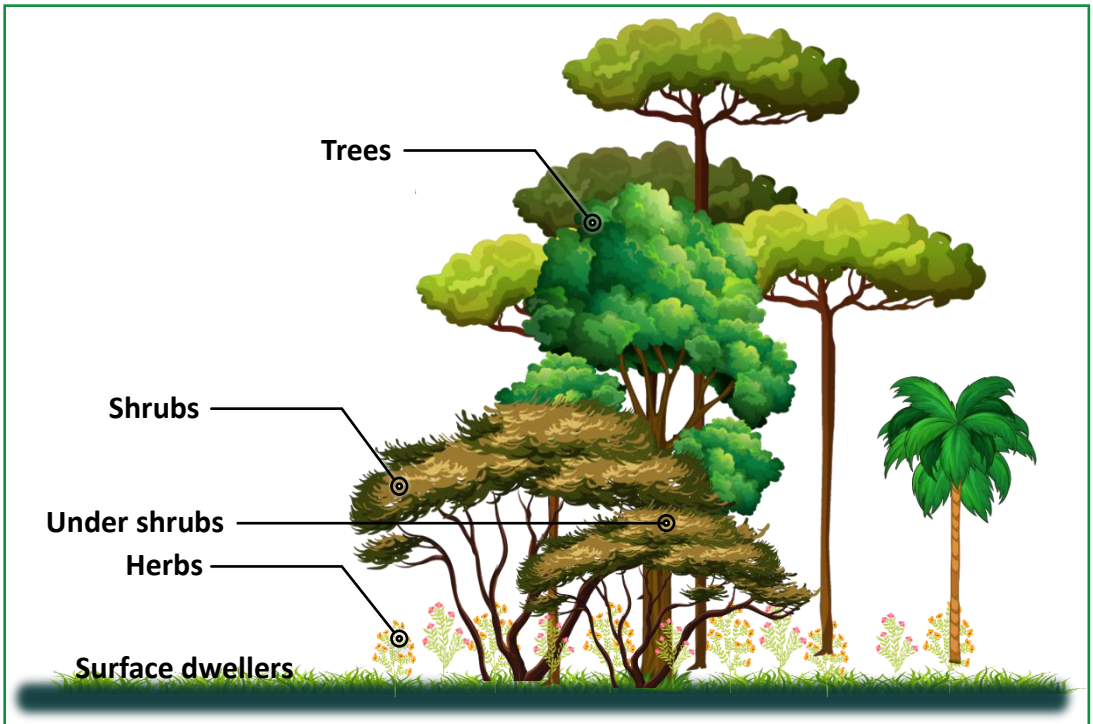
Pinus in Himalaya

Mangrove forest

(iii) Stratification :– The different growth form (trees, shrubs, under shrubs, herbs) determines the structure of a plant community.

Stratification in forest :–The clear stratification (vertical arrangement) in various growth forms of plants according to the need of light in any dense forest.

Surface dwellers → Herbs → Under shrubs → Shrubs → Trees



STRATIFICATION IN FOREST

Note : The **clear stratification** is found in tropical rain forest. So it is known as **multistoried forest**.

Ecotone – The transition zone in between two communities is called ecotone or tension zone. It has greater number of species & density or it is a transition zone between two communities where one type of community is modifying into another type of community is known as ecotone.

Edge effect – Species which occur most abundantly and spend their time in ecotone are called edge species. The tendency to increase variety and density of some organism at the community border is known as edge effect.

★ Golden Key Points ★

- Ecology at the organismic level also known as Physiological ecology.
- The activities of key-stone species determine the structure of the community.
- The clear stratification is found in tropical rain forest.

(B) INTER-SPECIFIC INTERACTIONS / POPULATION INTERACTIONS :

Due to increase in different species in community, interaction for food, habitat and light etc. also starts between them.

Species A	Species B	Name of Interaction
+ Mutualist	+ Mutualist	Mutualism
– Competitor	– Competitor	Competition

+ Predator	– Prey	Predation
+ Parasite	– Host	Parasitism
0 Host	+ Commensal	Commensalism
0 Host	– Amensal	Amensalism

(i) Positive or beneficial interaction :- Member of one or both the interacting species are benefitted but neither is harmed. It is a wide spread phenomenon, it includes → mutualism, commensalism, protocooperation

NCERT Question :
An orchid plant is growing on the branch of mango tree. How do you describe this interaction between the orchid and the mango tree?

(a) Mutualism (+, +) or Obligate mutualism :-

co-evolution, co-existence and co-extinction are observed with mutualists.

Positive inter specific interaction in which members of two different species completely depend on each other for growth and survival. It is obligatory relationship.

(1) Mutualism between animal and animal – ***e.g.*** Termites and Flagellates (*Trichonympha*) Where termites get benefit for food (Cellulose) digestion and *Trichonympha* obtain food and shelter.

(2) Mutualism between plant & animals – ***e.g.*** *Yucca* plant flowers and female *Pronuba* moth Pollination of *Yucca* plant by *Pronuba*.

(3) Mutualism between photosynthesising algae or cyanobacteria and fungi – Lichens

(4) Mutualism between fungi and the roots of higher plants – Mycorrhiza. The fungi help the plant in the absorption of essential nutrients from the soil while the plant in turn provides the fungi with energy-yielding carbohydrates.

(5) Mutualism between Fig tree and wasp species – In many species of fig trees, there is a tight one to one relationship with the pollinator species of wasp, It means that a given fig species can be pollinated only by its partner wasp species and no other species. The female wasp uses the fruit not only as an oviposition (egg-laying) site but uses the developing seeds with in the fruit for nourishing its larvae. The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. In return for the favour of

pollination the fig offers the wasp some of its developing seeds, as food for the developing wasp larvae.

(a) **(b)**

Fig. : Mutual relationship between fig tree and wasp: (a) Fig flower is Pollinated by wasp; (b) Wasp laying eggs in a fig fruit

(6) Mutualism between Bees and Orchid flower –Orchids show diversity of floral patterns, which have evolved to attract the right pollinator insect (bees and bumblebees) and ensure guaranteed pollination by it.

The Mediterranean orchid *Ophrys* employs "sexual deceit" to get pollination done by a species of bee, One petal of its flower bears resemblance to the female of the bee in size, colour and markings. The **male bee** is attracted to what it perceives as a female, **pseudo copulates with the flower** and during that process is dusted with pollen from the flower, it transfers pollen to it and thus, pollinates the flower.

Fig. : Showing bee-a pollinator on orchid flower

NCERT Question :
Define Mutualism and give one example.

(b) Commensalism (+, 0) :-

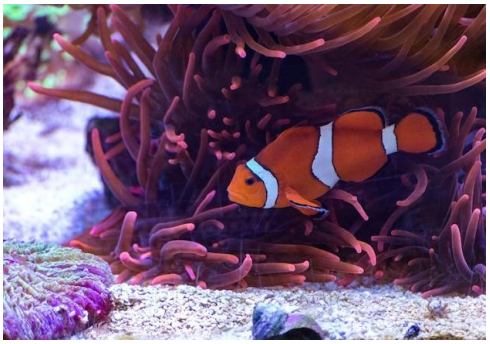
Association between members of two different species in which one is benefitted while other is almost unaffected.

- **Lianas** – are woody plants. Their roots are present in soil but their stem use other plant or object for support to get better light. They are found in dense forest. No nutritional relationship. Lianas are the speciality of tropical rain forest. ***e.g.*** *Bauhinia*, *Tinospora*
- **Epiphytes** – Small plants grow on other plants in tropical rain forest. They utilise only the space of host plant for light & humidity.
  e.g. Orchids, Hanging mosses
- **Epizoons** – Those animals that depend on other animals.

Commensal	Host
Sucker fish (*Echeneis*)	Shark
Pilot fish	Shark
E.coli (bacteria)	Intestine of man
Clown fish	Sea anemone
Barnacles	Whale
Cattle egret birds	Cattle


Barnacles on whale

Orchid on mango tree



Clown fish with sea anemone

Sucker fish on shark

Pilot fish with shark

NCERT Question :
Define commensalism and give one example.

(c) Proto-cooperation (+,+) :-

Association in which both organisms are benefited but can live separately, it is a facultative or optional or occasional association also called as non-obligatory relationship.

- Hermit crab – Sea anemone
- Tick bird (Red-billed or yellow billed) – Rhinoceros
- Crocodile – Bird


Sea anemone o Hermit crab

Scavenging – Association in which one partner called scavenger, eats the dead bodies of other animals, which have died naturally or killed by another animal
e.g. Jackal, Vulture, Ant, Crow
Helotism – Association in between two organisms, where one behaves as a master and another as slave. ***e.g.*** Lichen

(ii) Negative Interaction (Antagonism/Detrimental) :- One or both interacting species is harmed.

Three type of negative interaction

(a) Exploitation (b) Amensalism (c) Competition

(a) Exploitation : One species harms the other by making its direct or indirect use for support, shelter or food.

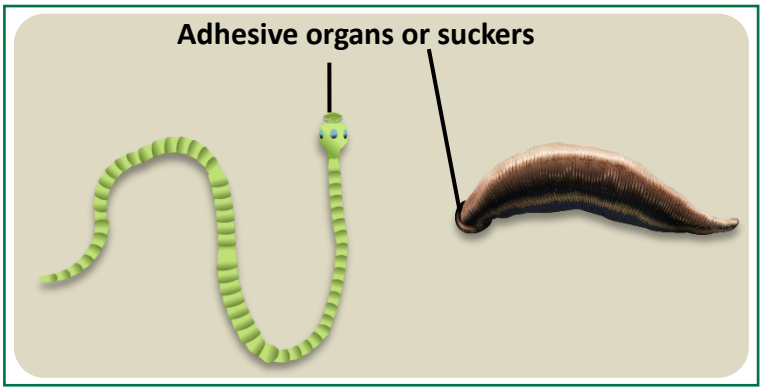
It is of two types – Parasitism & Predation

NCERT Question :
Define the following terms and give one example of Parasitism.

NCERT Question :
Select the statement which explains best parasitism.
(a) One organism is benefited.
(b) Both the organisms are benefited.
(c) One organism is benefited, other is not affected.
(d) One organism is benefited, other is affected.

Parasitism (+,–) : This association involves individuals of two species of different size in which smaller (Parasite) is benefitted and larger (host) is harmed. The parasite gets nourishment and shelter from host but do not kill the host.

- Majority of the parasites harm the host; they may reduce the survival, growth and reproduction of the host and reduce its population density. They might render the host more vulnerable to predation by making it physically weak.
- Many parasites have evolved to be host-specific (they can parasitise only a single species of host) in such a way that both host and the parasite tend to co-evolve; that is, if the host evolves special mechanisms for rejecting or resisting the parasite, the parasite has to evolve mechanisms to counteract and neutralise them, in order to be successful with the same host species. In accordance with their life styles, parasites evolved special adaptations such as the loss of unnecessary sense organs, presence of adhesive organs or suckers to cling on to the host, loss of digestive system and high reproductive capacity.



Type of Parasite :

(i) Ectoparasite - lives on the body of host.

- **Ectozooparasite :** Leech on cattle, ticks on dogs, copepods on marine fish and lice on human.
- **Ectophytoparasite :** Aphids, Lac insects, Red cotton bug live on plants.

Lice on human hair

(ii) Endoparasites : live in the body of host at different sites (liver, kidney, lungs, red blood cells, etc.). **The life cycles of endoparasites are more complex because of their extreme specialisation.** Their morphological and anatomical features are greatly simplified while emphasising their reproductive potential.

- **Endozooparasite :** Present into the animal body.

  Tapeworm, *Taenia*, *Ascaris*, *Entamoeba* $\rightarrow$ live in intestine of man

  Plasmodium $\rightarrow$ live in R.B.C. of human.
- **Endophytoparasite :** Present into the plant body.

  e.g. *Agrobacterium tumifaciens*, *Meloidogyne incognita*.

Note : The life cycle of parasite are often complex, involving one or two intermediate host or vectors to complete their life cycle.

For example : The human liver fluke (a trematode) depends on two intermediate host (snail and fish) to complete its life cycle.

- **Hyper parasitism** → A parasite living on another parasite.
  e.g. Rat (Host) → Rat flea (Parasite) → *Yersinia pestis* Bacteria (Hyper parasite)
- **Brood parasitism** → Parasitism in which the parasitic bird (cuckoo) lays its eggs in the nest of its host (crow) and lets the host incubate them, this relation is known as brood parasitism.


Cuckoo egg in the nest of crow

- **Holoparasite** → Parasite which are totally dependent upon the host for their requirement.
  e.g. A total root parasite - *Rafflesia*
  Total stem parasite (*Cuscuta*) – A parasitic plant that is commonly found growing on hedge plants, has lost its chlorophyll and leaves in the course of evolution. It derives its nutrition from the host plant which it parasitises.
- **Hemiparasite** → Parasite which partially depend on the host.
  e.g. *Viscum*, *Loranthus*


Dodder (*Cuscuta*) on sedge plant


Mistletoe (*Viscum*) on host plant

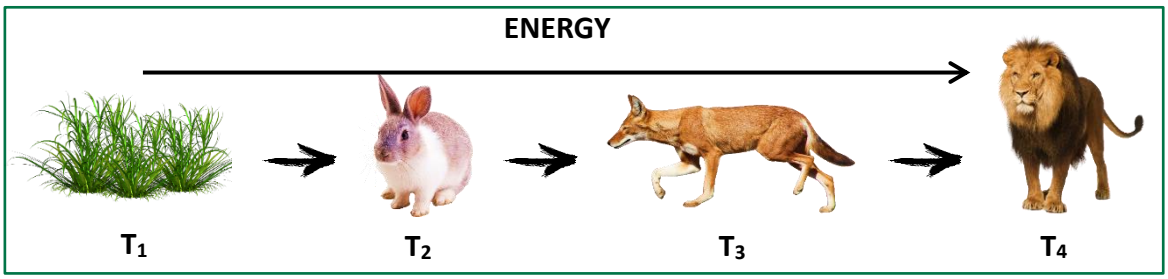
Note : (1) Female *Anopheles* mosquito is not considered as parasite.
(2) Foetus is not considered as parasite on mother.

Predation (+,–) : A free living organisms which catches and kills another species for food.

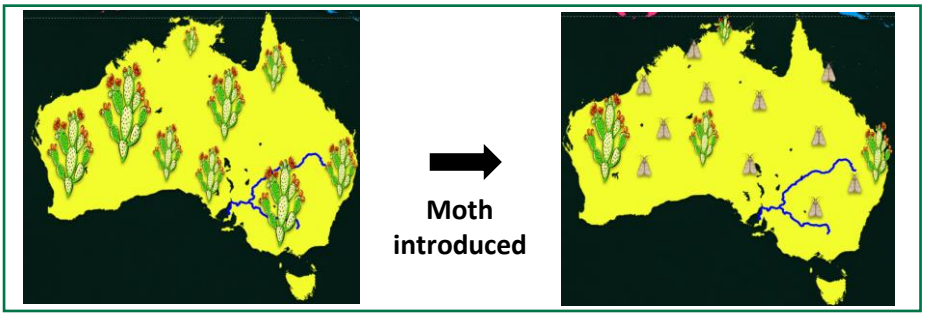
- When we think of predator and prey, most probably it is the tiger and the deer that readily come to our mind, but a sparrow eating any seed is no less a predator.

(1) Predators acting as **'conduits'** for energy transfer across trophic levels, also play other important roles.

(2) They keep prey populations under control. In the absence of predators, prey species could achieve very high population densities and cause ecosystem instability. When certain exotic species are introduced into a geographical area, they become invasive and start spreading fast because the invaded land does not have its natural predators.

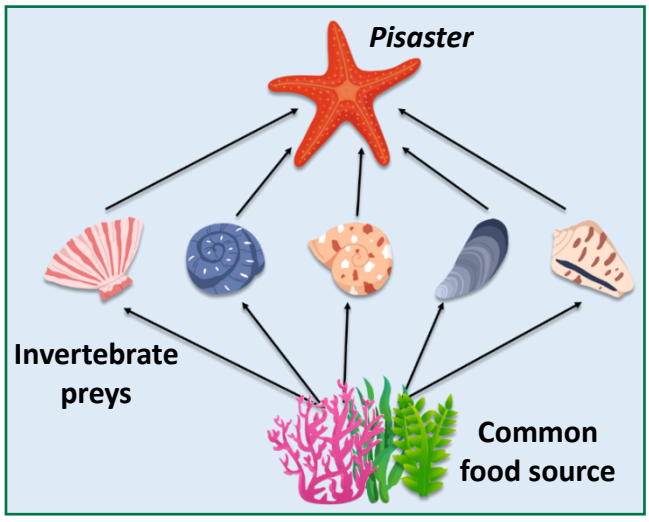


(3) The prickly pear cactus introduced into Australia in the early 1920's caused havoc by spreading rapidly into millions of hectares of rangeland (grassland). Finally, the invasive cactus was brought under control only after a cactus-feeding predator (a moth) from its natural habitat was introduced into the country.



(4) Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.

e.g. In the rocky intertidal communities of the American Pacific Coast the starfish *Pisaster* is an important predator. In a field experiment, when all the starfish were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year, because of interspecific competition.



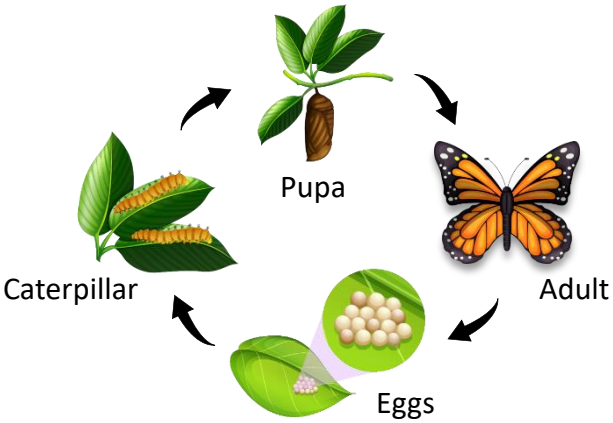
- If a predator is too efficient and overexploits its prey, then the prey might become extinct and following it, the predator will also become extinct due to lack of food. This is the reason why predators in nature are '**prudent'** (clever/wise).

NCERT Question :
Define camouflage and give one example.

ADAPTATIONS IN PREY :

- Prey species have evolved various defences to lessen the impact of predation. Some species of insects and frogs are cryptically-coloured (camouflaged) to avoid being detected easily by the predator. Some are poisonous and therefore avoided by the predators.

- The Monarch butterfly is highly distasteful to its predator (bird) because of a special chemical present in its body. This butterfly acquires this chemical during its caterpillar stage by feeding on a poisonous weed.



Life cycle of Monarch butterfly on milkweed plant

NCERT Question :
Name important defence mechanisms in plants against herbivory.

- For plants, herbivores are the predators. Nearly 25 per cent of all insects are known to be phytophagous (feeding on plant sap and other parts of plants). The problem is particularly severe for plants because, unlike animals, they cannot run away from their predators. Plants therefore have evolved an astonishing variety of morphological and chemical defences against herbivores. Thorns (*Acacia*, Cactus) are the most common morphological means of defence.

- Many plants produce and store chemicals that make the herbivore sick when they are eaten, inhibit feeding or digestion, disrupt its reproduction or even kill it. The weed Calotropis produces highly poisonous cardiac glycosides and that is why you never see any cattle or goats browsing on this plant.

Growth of bacteria is inhibited by fungus

(b) Amensalism (–,0) : In this interaction one species is inhibited by toxic secretion of other species. ***e.g.*** *Parthenium*

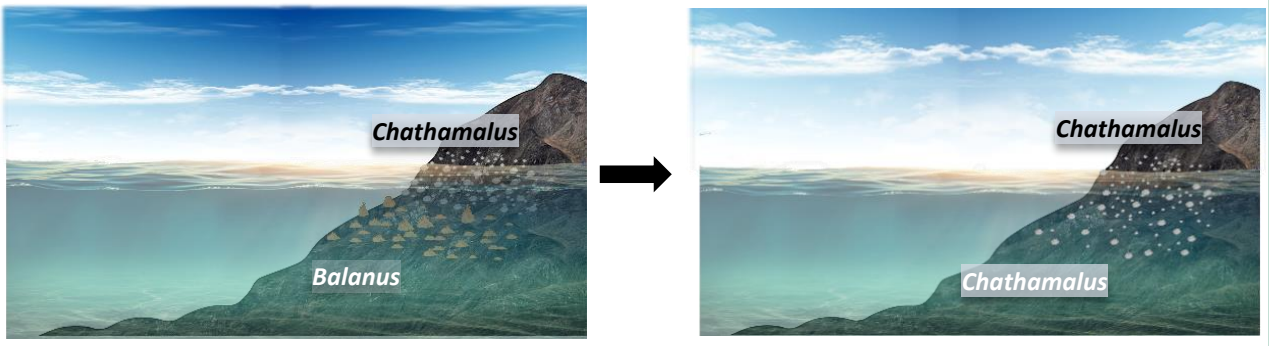
NCERT Question :
Define Interspecific competition and give one example.

(c) Competition (–,–) : Process in which the fitness of one species is significantly lower in the presence of another species.

- It is generally believed that competition occurs when closely related species compete for the same resources that are limiting, but this is not entirely true.
- Firstly, totally unrelated species could also compete for the same resource. For example in some shallow South American lakes, visiting flamingos and resident fishes compete for their common food, the zooplankton in the lake.

Flamingoes and resident fishes in a lake

- Secondly, resources need not be limiting for competition to occur; in interference competition, the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (food and space) are abundant e.g. Two deers fighting for mate.
- Therefore, competition is best defined as a process in which the fitness of one species (measured in terms of its 'r' the intrinsic rate of increase) is significantly lower in the presence of another species.
- It is relatively easy to demonstrate in laboratory experiments, as Gause and other experimental ecologists did, when resources are limited the competitively superior species will eventually eliminate the other species. The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats.
- **Gause's 'Competitive Exclusion Principle'** states that two closely related species competing for the same resources cannot co-exist long period and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting, but not otherwise.
- More recent studies do not support such gross generalisations about competition. While they do not rule out the occurrence of interspecific competition in nature, they point out that species facing competition might evolve mechanisms that promote co-existence rather than exclusion. One such mechanism is **'resource partitioning'**. If two species compete for the same resource, they could avoid competition by choosing, different times for feeding or different foraging patterns. MacArthur showed that five closely related species of warblers living on the same tree were able to avoid competition and co-exist due to behavioural differences in their foraging activities.
- Connell's elegant field experiments showed that on the rocky sea coasts of Scotland, the larger and competitively superior barnacle *Balanus* dominates the intertidal area, and excludes the smaller barnacle *Chathamalus* from that zone.



Connell's elegant field experiment

- Another evidence for the occurrence of competition in nature comes from what is called **'competitive release'**. A species whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its distributional range when the competing species (Superior species) is experimentally removed.

Note : Interspecific competition is a potent force in organic evolution.

Golden Key Points

- Mutualism is obligatory relationship, in which related species show co-evolution, co-extinction and co-existence.
- In parasitism both host and parasite tend to co-evolve. If the host evolves special mechanism for rejecting or resisting the parasite, the parasite has to evolve mechanism to counteract and neutralise them.
- Predators help in maintaining species diversity in a community.
- In competition fitness of one species is significantly lower in the presence of another species.
- Gause's competitive exclusion principle states that two closely related species competing for the same resources cannot co-exist long period and the competitively inferior one will be eliminated, but this may be true if resources are limiting, but not otherwise.
- Predation, parasitism and commensalism share a common characteristic - the interacting species live closely together.
- Herbivores and plants appear to be more adversely affected by competition than carnivores.

BEGINNER'S BOX-3 INTER SPECIFIC INTERACTIONS

1. Relation between fig tree and wasp species :
(1) Commensalism (2) Mutualism
(3) Parasitism (4) Amensalism

BOP192

2. Predators help in :
(1) Maintaining species diversity
(2) Reduce the competition between prey species
(3) Maintaining ecological balance
(4) All of these

BOP193

3. Which one is example of holoparasite ?
(1) *Cuscuta* (2) *Viscum* (3) *Loranthus* (4) Sea anemone

BOP194

4. Which one is example of ectoparasite :
(1) Ticks (2) *Plasmodium* (3) *Ascaris* (4) *Taenia*
BOP195

5. Relation between clown fish and sea anemone :
(1) Mutualism (2) Commensalism
(3) Parasitism (4) Amensalism
BOP196

6. The process employed by orchid to attract male bee for pollination is called -
(1) Sexual deceit (2) Pseudo copulation
(3) Brood parasitism (4) Resource partitioning
BOP197

7. Which adaptation of parasite does not help to sustain their life in host body?
(1) Loss of unnecessary sense organ.
(2) Loss of digestive system.
(3) Low reproductive capacity.
(4) Presence of adhesive organ or suckers to cling on the host.
BOP198

8. In which type of interaction both partners are adversely affected?
(1) Amensalism (2) Mutualism (3) Commensalism (4) Competition
BOP199

9. Connel's elegant field experiment demonstrated mainly -
(1) Competitive exclusion (2) Competitive release
(3) Resource partitioning (4) Niche specialisation
BOP200

10. Which of the following is an example of co-evolution?
(1) Barnacle & whale (2) Clown fish & Sea Anemone
(3) Hermit crab & Sea Anemone (4) Bees & orchid flower
BOP201

BEGINNER'S BOX — ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6
	Ans.	2	1	3	3	1	4

BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	2	3	3	4	3	3	3	4	1

BEGINNER'S BOX-3	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	4	1	1	2	1	3	4	2	4

⇒ Organism $\rightleftharpoons$ Environment
$\Downarrow$
Ecology

⇒ Ecology is basically concerned with four levels of biological organisation.

- Organism
- Populations
- Community
- Biomes

⇒ Ecology at the organismic level is essentially physiological ecology.

⇒ Population of organism inhabiting a particular area is called local population 'or' demes.

⇒ Biotic community = Animal community + Plant community + Microbial community

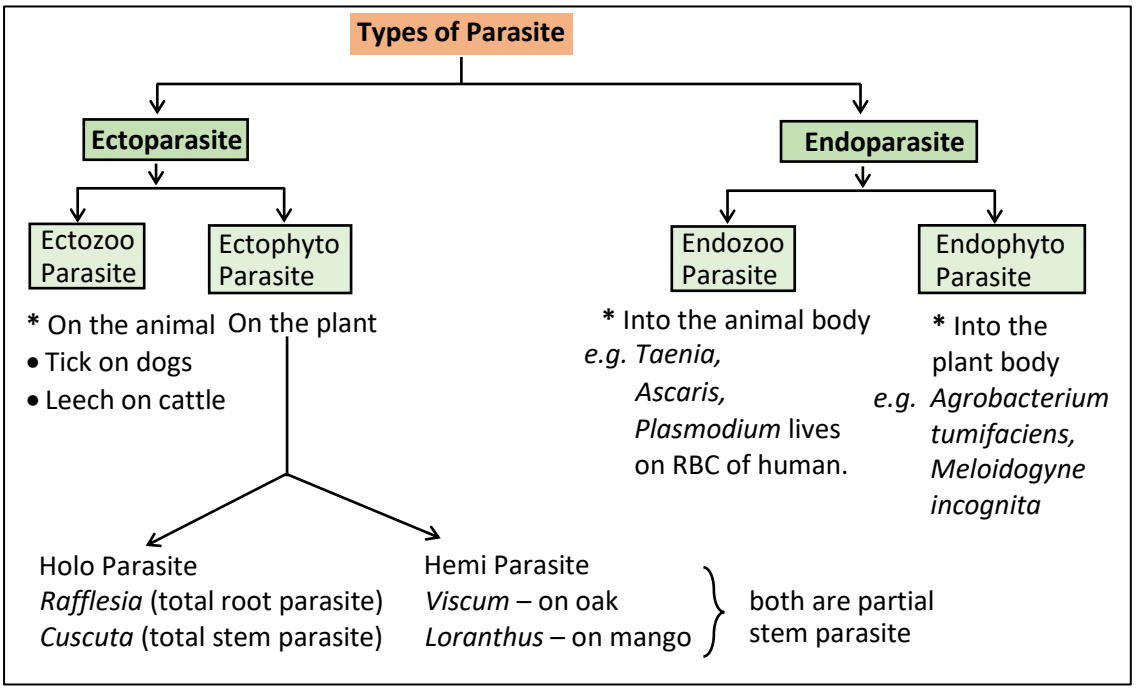
Characteristics of a community

1. Species diversity
2. Dominance
3. Stratification

Inter-Specific Interactions :

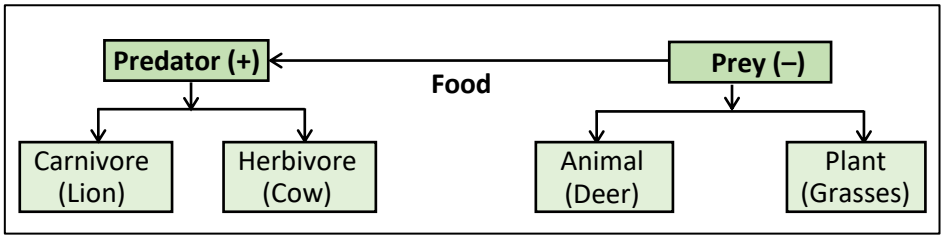
Mutualism	Commensalism	Protoco-operation
• Yucca and Pronuba moth • Lichen • Mycorrhiza • Fig tree and wasp species	• Orchid & Mango • Clown fish & Sea Anemone • Barnacles and whale • Cattle egret birds & cattle.	• Hermit crab-seaanemone • Tick Bird – Rhinoceros • Crocodile – Bird

Parasitism (+, –) : depends on its host for food and shelter.

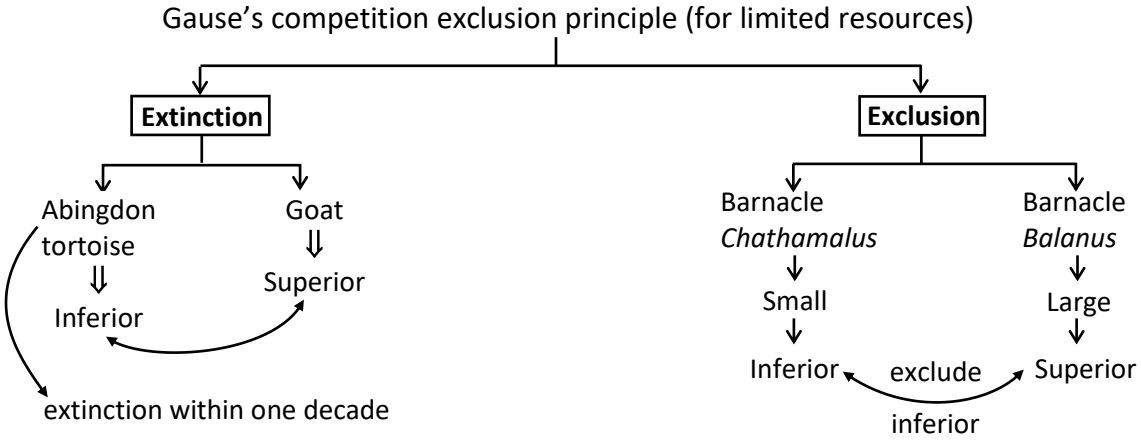


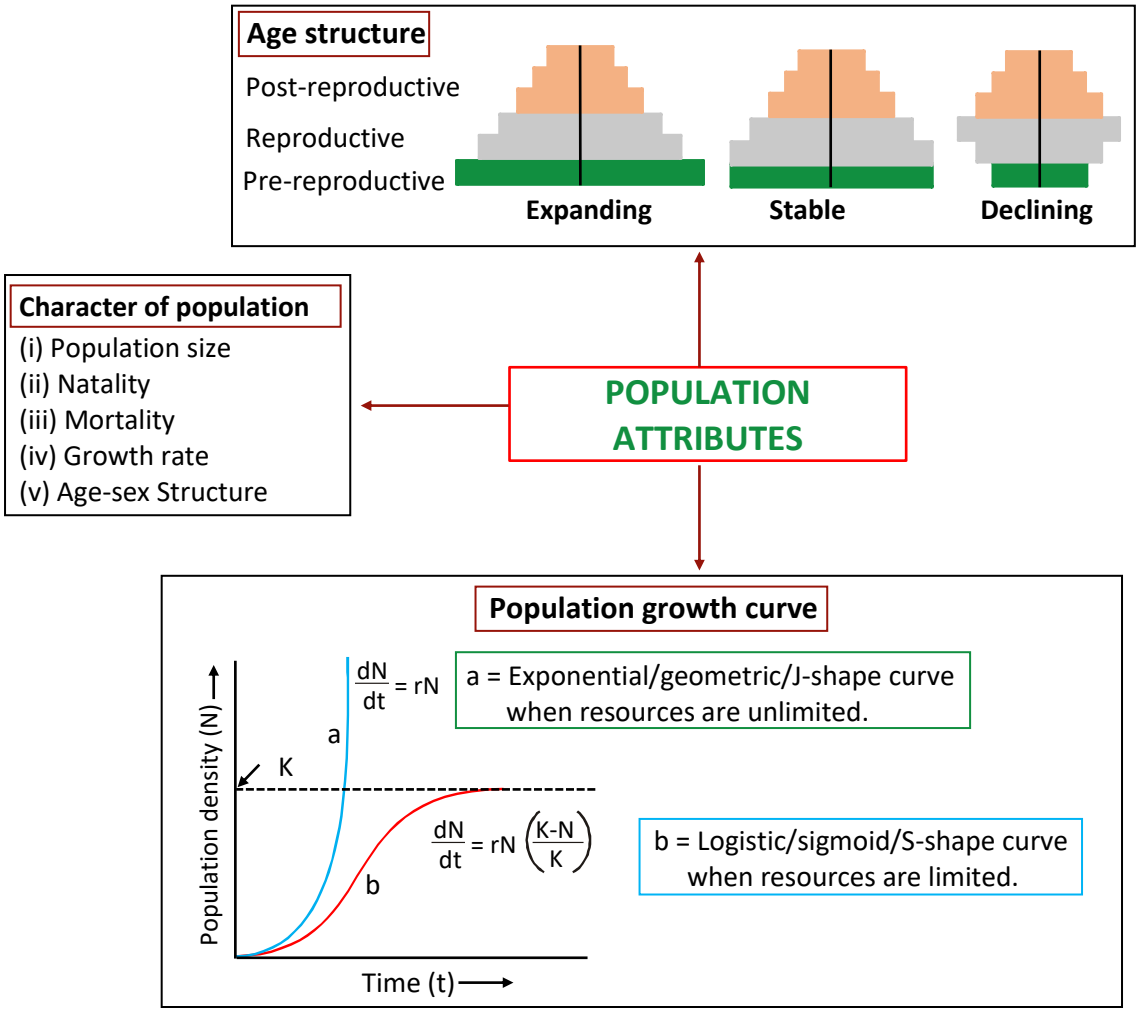
Brood Parasitism :- Parasite Bird (Cuckoo) ⟶ Lay egg in crow's nest → crow incubate.

Predation (+, –) :



Competition :-




Age structure
Post-reproductive
Reproductive
Pre-reproductive
Expanding
Stable
Declining
Character of population
(i) Population size
(ii) Natality
(iii) Mortality
(iv) Growth rate
(v) Age-sex Structure
POPULATION ATTRIBUTES
Population growth curve
dN/dt = rN
a = Exponential/geometric/J-shape curve when resources are unlimited.
a
K
dN/dt = rN (K-N/K)
b
b = Logistic/sigmoid/S-shape curve when resources are limited.
Population density (N)
Time (t)

NCERT SUMMARY

As a branch of biology, Ecology is the study of the relationships of living organisms with the abiotic (physico-chemical factors) and biotic components (other species) of their environment. It is concerned with four levels of biological organisation-organisms, populations, communities and biomes.

Evolutionary changes through natural selection take place at the population level and hence, population ecology is an important area of ecology. A population is a group of individuals of a given species sharing or competing for similar resources in a defined geographical area. Populations have attributes that individual organisms do not- birth rates and death rates, sex ratio and age distribution. The proportion of different age groups of males and females in a population is often presented graphically as age pyramid; its shape indicates whether a population is stationary, growing or declining.

Ecological effects of any factors on a population are generally reflected in its size (population density), which may be expressed in different ways (numbers, biomass, per cent cover, etc.,) depending on the species.

Populations grow through births and immigration and decline through deaths and emigration. When resources are unlimited, the growth is usually exponential but when resources become progressively limiting, the growth pattern turns logistic. In either case, growth is ultimately limited by the carrying capacity of the environment. The intrinsic rate of natural increase (*r*) is a measure of the inherent potential of a population to grow.

In nature populations of different species in a habitat do not live in isolation but interact in many ways. Depending on the outcome, these interactions between two species are classified as competition (both species suffer), predation and parasitism (one benefits and the other suffers), commensalism (one benefits and the other is unaffected), amensalism (one is harmed, other unaffected) and mutualism (both species benefit). Predation is a very important process through which trophic energy transfer is facilitated and some predators help in controlling their prey populations. Plants have evolved diverse morphological and chemical defenses against herbivory. In competition, it is presumed that the superior competitor eliminates the inferior one (the Competitive Exclusion Principle), but many closely related species have evolved various mechanisms which facilitate their co-existence. Some of the most fascinating cases of mutualism in nature are seen in plant-pollinator interactions.