ORGANISM AND POPULATION

INTRODUCTION

- The study of interaction or inter-relationship of living organisms with their environment is called **ecology.**
- Organisms and environment are always interdependent, interrelated or mutually reactive.
- The term ecology was coined and described by **E. Haeckel.**
- The term ecology was first authentically used by Reiter (Father of ecology).
- **Autecology** is the study of the inter-relationship of organisms of a species.
- **Synecology** is the study of the relation of the group of different species with their environment.

ECOLOGICAL HIERARCHY

- The hierarchy in the levels of organisms connected with ecological grouping of organisms is called **ecological hierarchy.**
- An **organism** is the **smallest unit** of ecological hierarchy and **basic unit of ecological study.**
- It may be microscopic (e.g., Amoeba, Chlorella, bacterium) or macroscopic (e.g., Rose, Mango, Crocodile, Dog, Human being).
- An organism can be **unicellular** (e.g., Amoeba, Euglena, Chlamydomonas), **colonial** (e.g., Volvox) or **multicellular** (e.g., Fish, Lizard, Mango tree).
- Each organism is capable of growth, self repair, movement and self regulation of its activities.
- A group of individuals (members) of the same species living at one place (specific geographical area) constitute a **population.**
- **Biotic community** is a group of organisms of different species that live in common area and which are interrelated and interdependent. It is a natural aggregation of plants and animals in the same environment.

Biotic community = Animal community + Plant community + Microbial community

ECOSYSTEM

- **Ecosystem** is defined as the segment of nature consisting of biological community and its physical environment both interacting and exchanging material.
- **Landscape** is a unit of land with natural boundary having a mosaic of patches. These patches generally represent different ecosystems.
- Biome is a major ecological community or complex community that extends over a large geographical area characterized by a dominant type of vegetation.
- **Biomes** are classified in seven categories – tropical rainforest, savannahs, deserts, temperate grasslands, temperate
deciduous forests, taiga & tundra.
- The major forest biomes in India are – tropical rainforests, tropical deciduous forest, temperate broadleaf forest and temperate needle leaf (coniferous) forest biome (taiga).
- **Biosphere** is the biologically inhabited part of earth along with its physical environment consisting of lower atmosphere, land and water bodies.
- **Environment** is the sum total of all the biotic and abiotic
factors, substances and conditions that surround and potentially influence organisms without becoming their constituent parts.

ORGANISMS AND ITS ENVIRONMENT

- The constituents of the environment which directly or indirectly influence the form and functioning of organisms in any specific way are known as **environmental factors**.
- **Climate** is the characteristic pattern of weather elements in an area over a period of time with regard to temperature, rainfall, pressure, humidity, wind etc.
- **Habitat** is the physical area covered by any organism.
- **Microclimate and Microhabitat :** Sub-division of habitat is called **microhabitat**. It is an immediate climate (real climate) of an organism which is different from the average climate of the region.

E.g., Forest floor, burrow and surface of desert

- **Ecological niche** word is given by **Grinnel.** It is a specific part of habitat occupied by individuals of a species which is circumscribed by its range of tolerance, type of food, range of environment, microclimate, shelter etc.
- Organisms that occupy the same or similar ecological niche in different geographical regions are known as **ecological equivalents.**

E.g., Arctic fox and African Jackal, both are scavengers. Grazers of North America and Kangaroos of Australia.

- The environmental factors are divided into two categories on the basis of their nature – **abiotic & biotic factors.**

ABIOTIC FACTORS

- Abiotic or non-living factors affect the structure, behaviour and life history of an organism.
- Major abiotic factors are – temperature, water, light & soil.

TEMPERATURE

- Temperature or the degree of hotness/coldness of a place influences the climatic conditions, soil conditions, activities of organisms and growth responses of plants because it influences the rate of all physiological processes.
- A few organisms can tolerate and thrive in a wide range of temperatures (**eurythermal**) but the vast majority of them are restricted to a narrow range of temperatures (**stenothermal**).
- On the basis of temperature vegetation is divided into four groups:
  - **Megatherms :** The plants growing in high temperature throughout the year, e.g., tropical rainforest.
  - **Mesotherms** : The plants growing in alternate high and low temperature, e.g., deciduous tropical forest.
  - **Microtherms :** Plants growing in low temperature, e.g., coniferous forest
  - **Hekistotherms :** Plant growing in very low temperature, e.g., alpine vegetation.

WATER

- Water is an **important component of protoplasm.**
- Water is a **resource**, a **condition** and a **habitat** in itself.
- The productivity and distribution of plants is dependent on water.
- Some organisms are tolerant of a wide range of salinities **(euryhaline)** but others are restricted to a narrow range **(stenohaline).**

LIGHT

- Light intensity, light direction and light quality control a number of processes of organisms as photosynthesis, growth, movements, photoperiodism, etc.
- In deep lake, zonation or stratification may be according to the need of light. The different zones of light in aquatic habitat are-
  - **littoral zone** : shallow coastal region producers occur throughout.
  - **limnetic zone** : open water zone; oxygen and light decreases with depth.
  - **photic zone** : light can penetrate.
  - **aphotic zone** : light does not penetrate
  - **benthic zone** : bottom zone.

SOIL

- Soil is the upper weathered part of earth's surface having **mineral particles** (45%), **water** (25%)**, air** (25%), **living organisms** and **humus** (5%) which can sustain terrestrial plant life.
- The study of soil is called **edaphology or pedology.**
- It is derived from rocks by weathering which is of three types:
  - **Chemical weathering** caused by oxidation, hydrolysis or carbonation.
  - **Mechanical weathering** caused by living organisms, e.g., lichens, grazing animals or earthworm.
  - **Physical weathering** caused by water, wind, gravity, glaciers, etc.

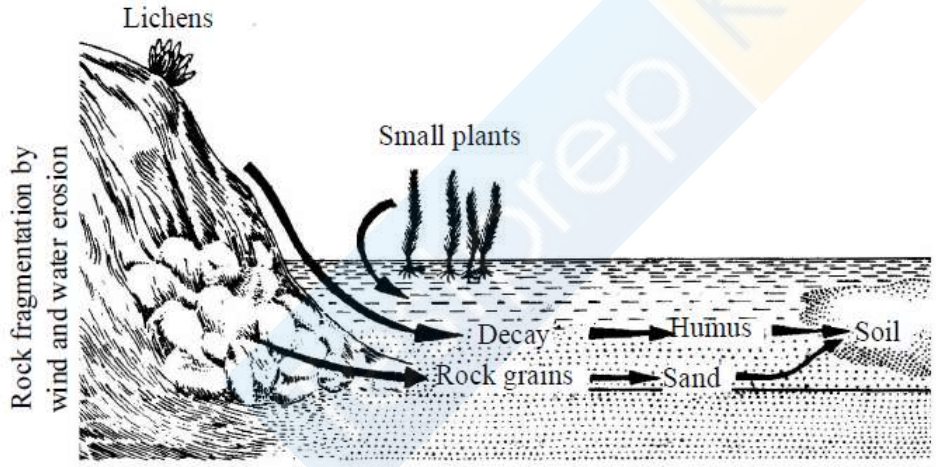

Fig. : The formation of soil

- A fully formed soil shows different layers called **horizons**. The sequence and nature of these layers is called **soil profile.**

Cross section of soil consists of following horizons :

- **Horizon 'O' :** It is the uppermost horizon made of organic matter. It has both fresh or non-decomposed as well as partially decomposed matter.

It consists of the following two sub-layers-

- (i) O_1 region (Aoo) : It is uppermost layer which consists of freshly added organic matter such as dead leaves, branches, flowers and fruits.
- (ii) O_2 region (Ao) : Present below O_1 region, it consists of organic matter which is in different stages of decomposition.

- **Horizon 'A' :** It is rich in mineral elements. A large amount of completely decomposed organic matter is present in this region.

- **Horizon 'B' :** It is dark in colour due to accumulation of leached substances like clay, iron and aluminium from horizon. So it is called the zone **of accumulation or zone of illuviation.**

Horizon 'O', A and B are together called as **top soil**.

- **Horizon 'C'** : It consists of partially weathered parent rock material. It is called as subsoil.
- **Horizon 'R' :** It is the lowermost layer of soil which consists of bed rocks (unweathered).

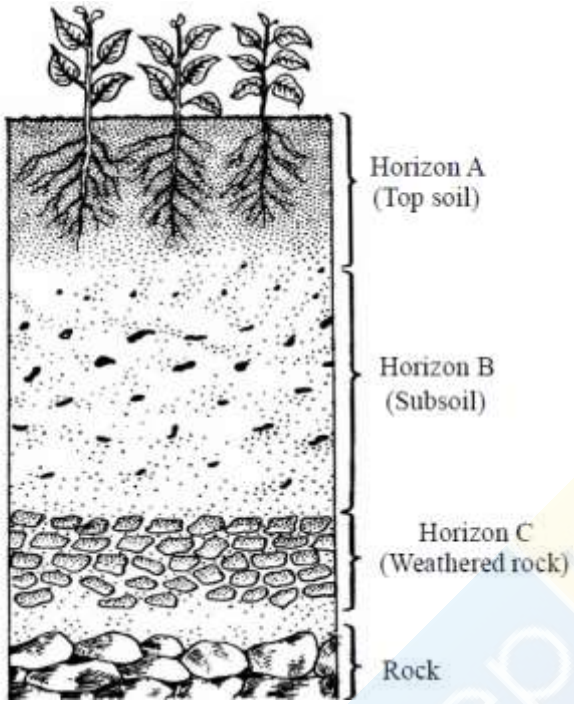

Fig. : Soil profile

- Various characteristics of the soil such as soil composition, grain size and aggregation determine the percolation and water holding capacity of the soils.
- **Soil is of two types :**
  - **Residual soil :** If the soil remains at the same place where it is formed.
  - **Transported soil :** If the soil is brought from their place of origin to other place by some agents. It may be : **alluvial soil** [carried by running water (rivers)], **colluvial soil** (carried by gravity); **eolian soil** (carried by wind) and **glacial soil** (carried by glacier).

NOTES

- Best pH of the soil for cultivation of plant is 5.5 – 6.5.
- Excess water produces salinity problem in soil.
- Calcifuge plants : Those plants which can grow in little amount of calcium in soil (pH - 3.8 to 4.0). E.g. Rhododendron, Rumex etc.
- The soils of planes of India is mainly alluvial. **In India, the principal residual soil types are** :
  - **Reddish soil** of Vindhyas and South.
  - **Black soils** of South West India.
  - **Calcareous soil :** With 20% $CaCO_3$.
  - **Laterite soil :** Oxides of iron and aluminium.
  - **Peat soil :** With high percentage of humus 90%.
  - **Black soil :** Predominantly with clay and humus (very fertile because most of the minerals are present in it).

- Alkaline soil can be corrected by adding gypsum ($CaSO_4$) and heavy irrigation whereas acidic soil can be corrected by adding lime $Ca(OH)_2$.
- Availability of nutrients from the soil is related to pH of soil.

RESPONSES TO ABIOTIC FACTORS

- Homeostasis is the maintenance of a constant internal environment in response to changes in –
  - the changing conditions of the external environment.
  - the changing conditions of the internal environment.
- The various responses to abiotic factors are regulated, conform, migrate & suspend.
- **Regulators** are organisms that try to maintain the parameter at a constant level regardless of what is happening in its environment.
- All birds and mammals and a very few lower vertebrate and invertebrate species are capable of regulation (thermoregulation and osmoregulation).
- **Conformers** are organisms that allow the environment to determine the parameter for instance, ectothermic animals exhibit wide variation in body temperature. Most of the animals and nearly all plants cannot maintain a constant internal environment.
- **Migrate :** The organism can move away temporarily from the stressful habitat to a more hospitable area and return when stressful period is over. Migration involves long distance or short distance movements of animals from one region to another. Like, every winter the famous Keoladeo National Park (Bharatpur) in Rajasthan hosts thousands of migratory birds coming from Siberia and other extremely cold northern regions.
- **Suspend :** Dormancy is a period of arrested plant growth. It is a survival strategy exhibited by many plant species which enables them to survive in climates where a part of the year is unsuitable for growth, such as winter and dry seasons.
- **Hibernation** is a mechanism used by many animals to escape cold weather and food shortage over the winter.
- **Aestivation** is a state of dormancy induced in some animals by the heat and dryness of the summer.
- **Diapause** is a period of inactivity and cessation of growth or development, accompanied by greatly reduced metabolic activity.

ADAPTATION

Plants and animals undergo special characteristic changes in order to live and adjust under prevailing environmental conditions which is called **adaptation.**

PLANT ADAPTATION

According to various modes of adaptations, plants are grouped into the following major types:

- **Hydrophytes,** water plants (aquatic plants).
- **Xerophytes** or plants growing in xeric (dry) conditions.
- **Mesophytes** or plants growing in mesic (normal water) conditions.

Hydrophytes are divided into **five main types:**

- **Free floating :** They are not rooted in soil, and float freely on the surface of water.

E.g., Wolffia - (Smallest Angiosperm, 1mm) - root less
Pistia - Water cabbage has roots.

Lemna - Duckweed - Lemna contains unbranched roots.

Eicchornia - Water hyacinth (Sorrow of Bengal). Its native place is South America. It was brought from Australia to India

Salvinia - Water Fern.

- **Suspended hydrophytes :** It remains underwater, and are not rooted in mud.

E.g., (i) Utricularia - Bladderwort. It is a rootless plant. Leaves of this plant is converted are pocket like apparatus to catch the insect.
(ii)Ceratophyllum

(iii) Najas

- **Submerged and Rooted hydrophytes** remain underwater, and are rooted in mud.

E.g., Hydrilla, Vallisneria, Potamogeton, Elodea.

- **Fixed floating hydrophytes** : These have fixed roots in mud but the leaves keep floating on the water surface.

E.g., Trapa, Nymphaea, Victoria (water lily), Nelumbium.

- **Emergent hydrophytes/Amphibious plants** : In these plants, the root is fixed in soil and the stem remains partly or completely exposed to air.

E.g., Jussaea, Juncus, Typha, Sagittaria, Limnophila, Scripus, Ranunculus. Largest group of Hydrophytes.

Adaptations in hydrophytes are

- Presence of aerenchyma which help in buoyancy or floating. It stores O_2 released from photosynthesis. This O_2 helps in the plant respiration.
- Well developed chlorenchyma. All parts of plant take part in photosynthesis except root.

Exception : In Trapa, roots are photosynthetic.

- Vascular tissue is poorly developed.
- Mechanical tissue is less developed.
- In suspended and submerged plants, leaves are dissected. E.g.,
  - Hydrilla - leaves are genetically dissected.
  - Ceratophyllum - ecologically leaves are dissected.
  - Vallisneria - leaves are ribbon like.

- In free floating and fixed floating plants, leaves are broad with entire margin, thick largest leaf, [thickest leaf in Victoria regia (1 m in diameter)]. Rigidity of leaves is due to presence of sclereids (trichosclereids and astrosclereids).
- Plants grow in dry or xeric conditions are called xerophytes.
- **Dryness is of two types :**
  - **Physical dryness :** Physically low water quantity in plant habitat. E.g., Psammophytes, Lithophytes, Chasmophytes.
  - Physiological dryness : Optimum water is present in plant habitat but due to some reason, plants can not absorb water. E.g. High salinity, low temperature.
- **Xerophytes is divided into different types :**

Name	Character	Example
Psammophyte	It grows in dry sandy soil near the river bank mesophytes.	*Prosopis, Acacia*
Lithophytes	They grow on rock soil, slope of Aravali hills.	*Aloe, Agave, Opuntia*
Chasmophyte	Grow in rock slit.	*Aloe, Agave, Poa, Aristida*
Halophyte	Grow in salty soil.	*Rhizophora, Avicennia, Sonneratia*
Epiphytes	They grow on other plant.	*Orchids*
Psychrophyte	They grow in cold soil.	*Rhododendron*

- A weedy plant growing on the road side or fields where natural vegetation has been disrupted by man is called **aletophyte.**
- **Helophyte** is a marsh plant. It buds over winter under water.
- **Geophyte** is a perennial plant that is deeply embedded in the soil substrata.

ANIMAL ADAPTATION

- Animals adapt themselves for protection from predators, feeding habits, camouflage, mating, adjust to environmental stress conditions.
- Desert lizard keep their body temperature fairly constant by behavioural means. They bask in the sun and absorb heat when their body temperature drops below the comfort zone, but move into shade when the ambient temperature starts increasing.
- Kangaroo rat excretes solid urine & can live from birth to death without drinking water thereby, conserving water.

POPULATION

POPULATION ATTRIBUTES

- Some significant attributes that populations possess are – **birth rate / natality, population density, death rate/ mortality, sex ratio, age distribution.**
- **Birth rate or natality** refers to the average number of young ones produced by birth, hatching or germination per unit time (usually per year). In the case of humans, it is commonly expressed as the number of births per 1000 individuals in the population per year.

The maximum birth rate that a species can achieve under ideal environmental conditions called **potential natality.** However, the actual birth rate under the existing conditions is much less. It is termed as **realized natality.**

- **Death rate or mortality** is the average number of individuals that die per unit time (usually per year). In humans, it is commonly expressed as the number of deaths per 1000 persons in a population per year. Lowest death rate for a given species in most favourable conditions is called **potential mortality**, while the actual death rate being observed in existing conditions is called **realized mortality.**
- The death rate of a population can be easily represented by **survivorship curve**. In this curve, time is plotted against the number of survivors.

There are three kinds of survivorship curves–

- **Diagonal curve :** If the death rate of different age groups of organisms are equal, then the curve is represented or plotted as a straight line.

e.g., Hydra, mice and many adult birds.

- **Convex curve :** When organisms have completed their potential life span and died in old age then the curve is convex, the curves goes horizontal till potential life span and then declines rapidly. e.g., Man, rabbit and many mammals.
- **Concave curve :** This kind of curve is mostly found in such organisms who die before their potential life span. e.g., Fish, Oysters and Invertebrates.

- **Sex ratio** is the ratio of males to females in a population.
- **Age distribution :** Various age groups in a population determine its reproductive status. The three ages referred to as ecological ages in a population are – **pre-reproductive**, **reproductive** and **post-reproductive**. Population with more young members grow rapidly, while the declining populations have a large proportion of older individuals.

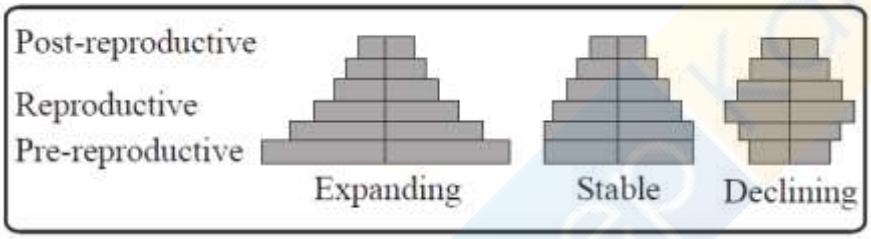

Fig. : Representation of age pyramids for human population

POPULATION GROWTH

- **Population density** is the number of individuals present per unit area or volume at a given time. For instance, the number of animals per square kilometer, number of trees per area in a forest, or number of planktonic organisms per cubic meter of water.
- The population density is determined by four basic processes-**natality, mortality, immigration and emigration.**
- The percentage ratio of natality over mortality is known as **vital index** i.e., natality / mortality × 100. It determines the growth of a population.
- **Immigration** is the number of individuals of the same species that have come into the habitat from elsewhere during the time period under consideration.
- **Emigration** is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.
- **Change in population size during time interval**

= (Birth + **Immigration** during time interval) – (Death + **Emigration** during time interval)
The above expression in words may be represented in a simple way by a mathematical model.

Suppose, N = population size and t = time. The Greek letter delta, (Δ), indicates change. We can now represent change in population as ΔN, and time interval as Δt.

The verbal equation can be written as

$\Delta N/\Delta t = (B + I) – (D + E)$ in which, B = absolute number of births in the population during the time interval, D = the absolute number of deaths during that interval; I = immigrants and E = emigrants.

I and E , being insignificant, may be ignored. Then the equation simplifies to $\Delta N/\Delta t = B - D$.

MALTHUS THEORY OF HUMAN POPULATION GROWTH

- Thomas Malthus, a British political economist, put forward a **theory of human population growth** in 1778. Malthus in his "Essay on the principle of population" pointed out that population tends to increase in geometric progression while food supply increases only in arithmetic progression. Faster growth of population than of its requirements causes an imbalance between the two. When this imbalance reaches a certain limit, environmental factors like famine, epidemic of a disease, earthquake, flood, war etc. reduce the population to a size, the available resources can support. The factors that control the population size were called positive checks by Malthus.
- Growth of a population is controlled by an interaction between three factors : **biotic potential**, **environmental resistance** and **carrying capacity of the environment**.
- **Biotic or reproductive potential** is the natural capacity of a population to increase at its maximum rate under ideal environmental conditions and stable age and sex ratios. Biotic potential in the human female is estimated to be about 12 per female during its reproductive period between puberty and the menopause period.
- **Environmental resistance :** In nature, full biotic potential of an organism or population is never realized, since conditions are rarely ideal. Various harmful environmental (abiotic) factors like non-availability of food and shelter, natural calamities like drought, cloud bursts, floods, fires, temperature fluctuations, accidents, etc. and certain biotic factors like pathogens, parasites, predators etc. check the biotic potential from being realized. The sum of all these inhibitory factors is called environmental resistance.
- **Carrying capacity** is defined as the "feeding capacity of an environment of an ecosystem for a population of a species under provided set of conditions". When a population reaches the carrying capacity of its environment, the population has zero growth rate. So the population generally stabilizes around the carrying capacity. The carrying capacity of the earth for human population is considered to be about 8 to15 billions.

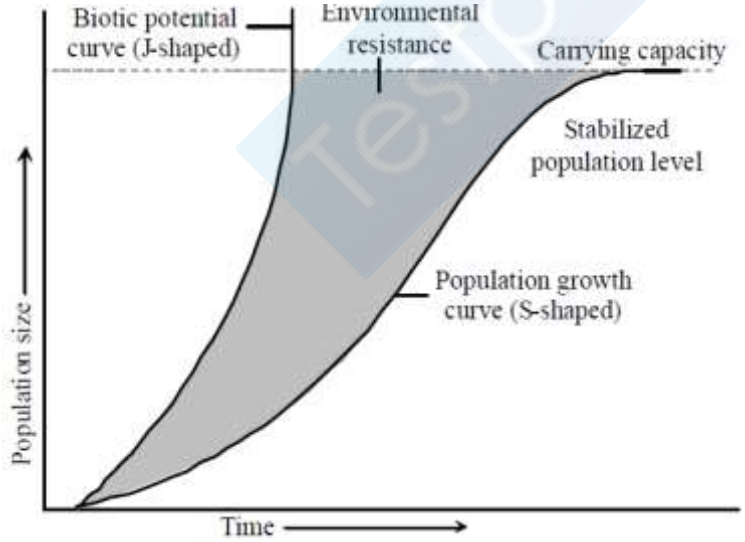

Fig. : The theoretical relationships between biotic potential, environmental resistance and carrying capacity

- The populations are not stable and do change due to a number of extrinsic as well as intrinsic factors.

- These variations in the population size are of two types : **population fluctuation** and **population cycles.**
- **Population fluctuations or irruptive variations :** In these changes, population density tends to fluctuate irregularly above and below some steady-state level. These are characterized by sudden increase in population in a short time which is followed by equally quick decrease in population size. These are caused by random seasonal or annual changes in the availability of resources (food or energy) or extrinsic factors (E.g., temperature, rainfall etc.). E.g., more birds during early summer due to their hatching period, more insects during summer months and more weeds in the rainy season.

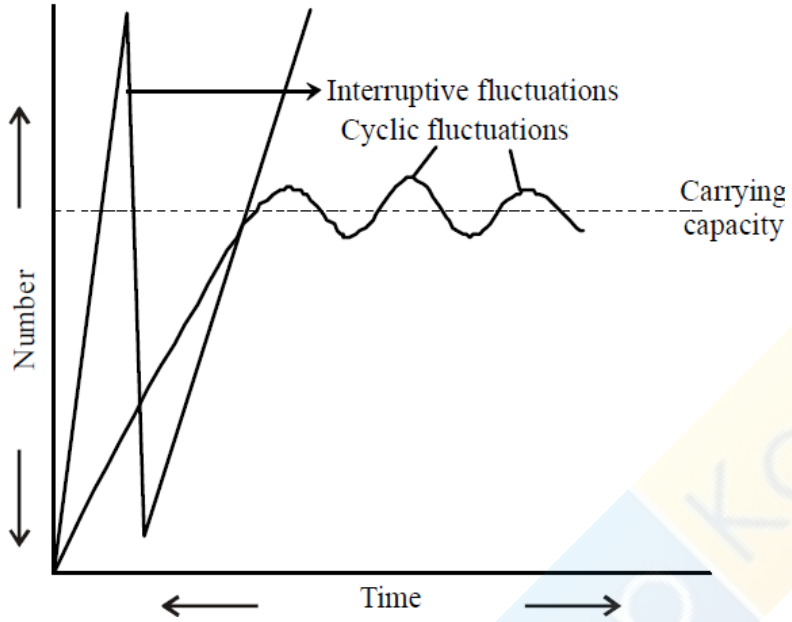

Fig. : Cyclic and interruptive fluctuations in populations

- **Population cycles :** These are regular changes in the population size. In these, population size is nearly constant over a long period of time. These are caused by seasonal changes in environment. E.g. population cycles (of 3 to 4 years) of lemmings of Tundras (Elton, 1942), Lemmings (Lemmus lemmus) (small mouse-like rodents found in arctic regions of Canada and Norway) increase in their number for a period of about 3 years when it reaches a peak beyond the carrying capacity of that area. They eat up all the available food. In the winter months, the lemmings migrate in large numbers in the sea and swim till they are drowned due to exhaustion. The surviving lemmings multiply and repeat the process.

GROWTH CURVES

(A) Sigmoid or S-shaped growth curve

It is shown by yeast cells and most of the organisms.

It is formed of five phases :

- **Lag phase:** In this phase, individuals adapt themselves to the new environment, so there is no or very little increase in population.
- **Positive acceleration phase:** It is the period of slow increase in population in the beginning.
- **Logarithmic or exponential phase :** It is the period of rapid rise in population due to the availability of food and the requirements of life in plenty and no competition.
- **Negative acceleration phase :** In this again, there is a slow rise in population as the environmental resistance increases.

- **Stationary (Plateau) phase** : Finally, growth rate becomes stable because mortality and natality rates become equal to each other. So, **there is zero growth rate**. A stable population is said to be in equilibrium, or at saturation level. This limit in population is a constant (K) and is imposed by the carrying capacity of the environment.

S-shaped curve is also called **logistic curve**. Sigmoid growth curve was described by **Verhulst, (1839).**

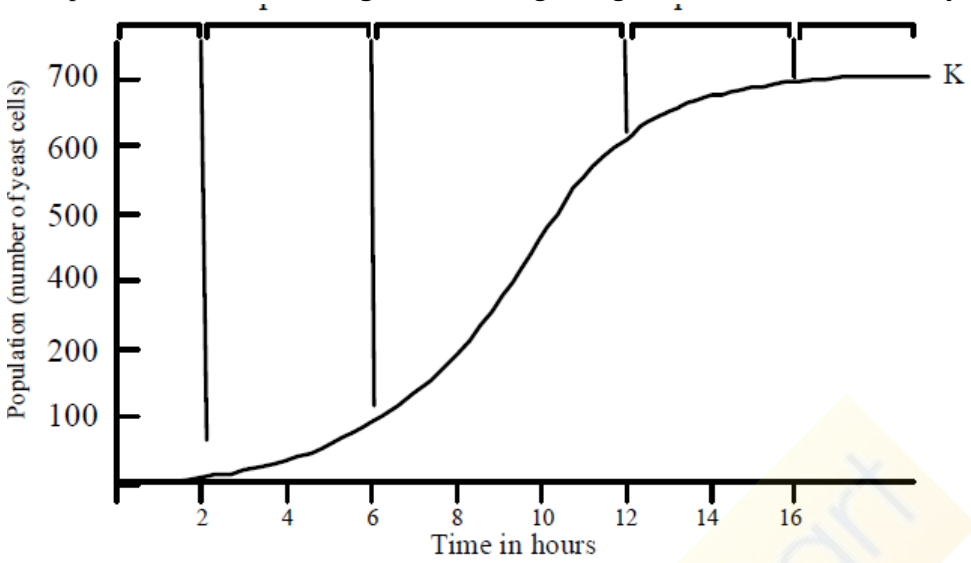

Fig. : The S shaped growth curve of Yeast cells

Population exponential growth equation is given below : $N_t = N_0\, e^{-rt}$

where,

N_t = Population density after time t.

N_0 = Population density at time zero.

r = intrinsic rate of natural increase.

e = the base of natural logarithms (2.71828).

The equation describes the exponential or geometric growth pattern of a population and results in a J-shaped curve. The J-shaped curve of exponential growth is characteristic of some population that are introduced into a new or unfilled environment or whose numbers have been drastically reduced by a catastrophic event and are rebounding.

(B) J-shaped Growth curve

It is shown by small population of Reindeer experimentally reared in a natural environment with plenty of food but no predators. This type of population growth is also called Verhulst Pearl Logistic growth.

It has only **two phases :-**

- **Lag phase** : It is period of adaptation of animals to new environment so and thus, is characterized by slow or no growth in population.
- **Logarithmic or Exponential phase :** It is characterized by rapid growth in a population which continues till enough food is available. But with the increase in reindeer population, there is a

corresponding decrease in the availability of food and space which finally becomes exhausted leading to mass starvation and mortality. This sudden increase in mortality is called **population crash**. Lemming of tundra, some insect, algal blooms and annual plants also show J-shaped curves. The population growth curve is S-shaped in most of the organisms. Human population also shows S-shaped curve.

Verhulst-Pearl Logistic Growth equation is given below–

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

Where, N = Population density at time t.

r = Intrinsic rate of natural increase.

K = Carrying capacity

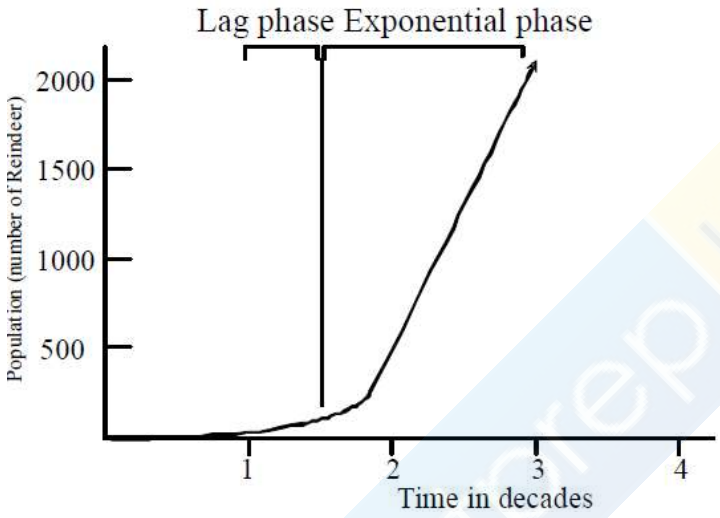

Fig. : The J- shaped growth curve of Reindeer

POPULATION INTERACTION

- Members of biotic community depends upon one another for food, reproduction, dispersal & production, the phenomenon is called **species interdependence interaction.**
- Types of interactions that occur amongst different members of biotic community are–positive and negative.
- **In positive or beneficial interaction,** members of one or both the interacting species are benefitted but neither is harmed.
- **In negative interaction**, one or both the interacting species is harmed.

POSITIVE OR BENEFICIAL INTERACTION

- It is a widespread phenomenon. It includes **mutualism**, **commensalism**, **proto-cooperation**, **scavenging** etc.
- **Mutualism (+/+) or Symbiosis** : (coevolution) :
  - It is a positive interspecific interaction in which members of two different species completely depend on each other for growth and survival.
  - Physical contact is present in between both the interacting species.
  - It is an obligatory relationship.

- Examples –
  - **Mutualism between animal and animal-**

E.g., Termites and aflagellates (Trichonympha)

  - **Mutualism between plant and animals**

E.g., (a) Zoochlorella and Hydra.
(b) Yucca plant flowers and Pronuba insects -Pollination of Yucca plant by pronuba (Female yucca moth)

  - **Mutualism between plant and bacteria**

E.g., legume plant and Rhizobium.

  - **Mutualism between algae and higher plant**

E.g., Nostoc, Anabaena and Anthoceros plant.

  - **Mutualism between algae and fungi**

E.g., Lichens.

  - **Mutualism between fungi and higher plants**

E.g., Mycorrhizal association

- **Commensalism (+/0)**
  - It is an association between members of two species in which one is benefited while the other is almost unaffected.
  - Examples –
    - **Lianas :** Lianas are woody plants. Their roots are present in soil but their stem uses other plants or objects for support to get better light. They are found in dense forest. No nutritional relationship is present. Lianas are the speciality of tropical rainforest. E.g., Bauhinia, Tinospora
    - **Epiphytes :** Those small plants which grow on other plants in tropical rainforest. They utilize the only the space of host plant for light and humidity.

E.g., Orchids, hanging mosses.

    - **Epizones :** Those animals which depend on plants or other animals. E.g.,

Sucker fish (Echeneis) – Shark
Pilot fish – Shark

E. coli bacteria – Intestine of man

Clown fish – Sea anemone

Barnacles – Whale

Cattle ergot birds – Cattle

- **Proto-cooperation (+/+)**
  - It is an association in which both the organisms are benefited but can live separately.

It is a facultative or optional or occasional association. It is also called as **non-obligatory relationship.**

  - **Examples –**
    - Hermit crab – Sea anemone
    - Tick bird (Red-billed or yellow billed) – Rhinoceros
    - Crocodile – Bird
    - Plants with both self and cross fertilization.

- **Scavenging** is an association in which one partner (called scavenger or saprobiont), eats the dead bodies of other animals, which have died naturally or have been killed by another animal. E.g., Jackal, Vulture, Ant, Crow.
- **Helotism** is an association between two organisms, when one behaves as a master and another as a slave. E.g., Lichen.

NEGATIVE INTERACTION (ANTAGONISM)/DETRIMENTAL

- **Types of negative interaction** are exploitation, amensalism and competition.
- **Exploitation**
  - One species harms the other by making direct or indirect use of it for support, shelter or food.
  - It is of two types : parasitism and predation.
  - **Parasitism (+/–) :** This association involves individuals of two species of different sizes in which the smaller (parasite) is benefitted and the larger (host) is harmed. The parasite gets nourishment and shelter from host but does not kill the host.
  - **Types of parasite :**
  - **Ectoparasite :** Lives on the body of the host. E.g.,–
    - **Ectozooparasite :** leech on cattle, ticks on dogs, sandfly on man.
    - **Ectophytoparasite :** aphids, lac insects, red cotton bug
  - **Endoparasites :** Live in the body of the host. E.g., Tapeworm, Taenia, Ascaris, Entamoeba → Live in intestine of man.

    Plasmodium → Lives in R.B.C. of human.
  - **Hyperparasitism** : A parasite living on another parasite.E.g., Plasmodium on female Anopheles mosquito, bacteriophages on bacteria.
  - **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.
  - **Holoparasite :** Parasite which are totally dependent upon the host for their requirement

    E.g., Rafflesia (Total root parasite).
    Cuscuta (Total stem parasite).
  - **Hemiparasite :** Parasite which partially depends on the host.

    E.g., Viscum – on oak and Loranthus – on mango. Both are partial stem parasites. Santalum is a partial root parasite.

    Note : Arceuthobium is the smallest parasite.
  - **Predation (+/–) :** A free living organism which catches and kills another species for food.

    E.g.,

    Insectivores fungi : Dactylella, Dactylaria, Arthrobotrys

    Carnivores animals : Lion, snake

    Insectivores plants : Drosera, Utricularia, Nepenthes

- **Amensalism (–/0)**
  - In this interaction, one species is inhibited by the toxic secretion of another species. Inhibitor species is neither benefited nor harmed.
  - **Type of amensalism** are antibiosis and allelopathy.
  - **Antibiosis** – secretion of antibiotics E.g.,
    - Penicillium fungi secretes penicillin which inhibits the growth of Staphylococcus bacteria.
    - Chlorella algae secretes bacteriocytes which not only kill but also inhibit growth of the bacteria.
    - Microcystis (BGA) secretes hydroxyl amine which causes the death of fishes.
  - **Allelopathy** is the secretion of toxic chemicals and the plant is always harmed in this case. E.g.,

- Parthenium : Trans Cinnamic acid is secreted by Parthenium which inhibits the growth of some plants like Cassia tora and Vincaregia. This phenomenon is known as allelopathy.
- Sunflower, barley, sorghum, Occimum also show allelopathy.
- Silver oak shows autopathy - It destroys its own seed.

- **Competition**
  - Interaction between two species, where both suffer adverse effects is known as competition.
  - It is of 2 types – interspecific and intraspecific.
  - **Interspecific competition** occurs between two individuals of two different species occurring in the same habitat.
  - **Intraspecific competition** occurs between individuals of the same species for mating, food etc.