# ORGANISMS AND ENVIRONMENT

## 1. Ecology

It is the branch of biology which studies the interactions among organisms and between organisms and its physical, i.e. abiotic environment. The term 'ecology' was first described by Ernst Haeckel.

## 2. Organisational Levels of Ecology

Ecology is basically concerned with four levels of organisation

(i) Organisms Living and basic unit of ecology at individual level is called an organism.

(ii) Population It refers to the sum total of all organisms having similar features and potential to interbreed among themselves and produce fertile offspring.

(iii) Communities These refer to the assemblage of all the populations of different species in a specific geographical area.

(iv) Biome It is a large unit which consists of a major vegetation type and associated fauna in a particular climatic zone. e.g. tropical rainforest, deciduous forest, etc.

- Habitat It is a place, where an organism lives and represents a particular set of environmental conditions suitable for its successful growth.

- Ecological Niche It is the place occupied by an organism, the resources utilised by it and functional role played by it in ecosystem.

## 3. Environment

It is termed as the sum total of all external conditions (biotic and abiotic) which influences the organisms in terms of their survival and reproduction.

## 4. Major Abiotic Factors

These are non-living conditional factors of the environment that influences the survival and reproductive functions of an organism. Some important factors are

(i) **Temperature**It is the most ecologically significant environmental factor. Organisms which can tolerate and thrive in wide range of temperature are called eurythermal, e.g. most mammals and birds, while organisms which are restricted to

a narrow range of temperature are called stenothermal, e.g. polar bear, amphibians.

(ii) **Water** The productivity and distribution of plants are dependent on the availability of water. Aquatic organisms survive in water and they are affected by pH, chemical composition and temperature of water. Organisms which can tolerate a wide range of salinity are called euryhaline, while organisms which are restricted to a narrow range of salinity are called stenohaline.

(iii) **Light**It is the source of energy used to prepare food by photosynthesis in plants which releases oxygen. The availability of light on land is closely linked with that of temperature of the Sun.

(iv) **Soil** The nature and properties of soil is affected by climate, weathering process, whether soil is transported or sedimentary and by soil development process. Water holding capacity and percolation of the soil is determined by various characteristics, such as soil composition, particle size and aggregation.

## 5. Responses to Abiotic Factors

The abiotic factors are highly variable. An organism can achieve the constancy by regulating optimum temperature and osmotic concentration of body fluids, i.e. homeostasis, in accordance to external environmental conditions. The following methods help organisms to cope up with stressful conditions

(i) **Regulate** Homeostasis is maintained by ensuring constant body temperature and constant osmotic concentration, etc., by physiological and behavioural means. All birds, mammals and few lower vertebrates and invertebrates are **endotherms** as they have mechanisms of thermoregulation and osmoregulation for maintaining their homeostasis.

(ii) **Conform** About 99% of animals and almost all plants cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature, i.e. they are ectotherms. Some species are partial regulators, which have the ability to regulate body functions to a limited extent. Beyond that limit, they become **conformers**.

(iii) **Migrate**If an organism moves away temporarily from a stressful habitat to a more hospitable area and return, when the stressful period is over. The phenomenon is called **migration**.

(iv) **Suspend**Some bacteria, fungi and lower plants form thick-walled spores to overcome stressful conditions. During unfavourable conditions, plants reduce their metabolic activity and enter into state of dormancy. Organisms like bear sleep in winters which is called as hibernation and some snails and fish sleep in summers which is called as aestivation. Many zooplanktons enter diapause as a stage of suspended development.

## 6. Adaptation

Any attribute of an organism (morphological, physiological or behavioural) that enables it to survive and reproduce in its habitat can be referred to as adaptation. It is of following types

A. **Adaptations in Plants** Few examples are given below

(i) **Xerophytic plants** are found in water deficient regions like the desert and rocks. Leaves are small and modified, and stems are flat, fleshy and green called phylloclades (Opuntia).

Roots are highly modified and grow very deep in search for the availability of underground water. Cuticle is very thick in xerophytes.

(ii) **Hydrophytic plants** are present in aquatic environment, either submerged or floating. Root system is absent. Leaves are thin and ribbon-shaped, e.g. Vallisneria.

B. **Adaptations in Animals** Few examples are given below

(i) **Kangaroo Rat**It is found in North America and capable of meeting its water requirement by internal oxidation of its body fat.

(ii) **Mammals** from colder climates generally have shorter ears and limbs to minimise heat loss. This is called Allen's rule. In polar regions, aquatic mammals like seals have a thick layer of fat (blubber) below their skin that acts as an insulator and reduces the loss of body heat.

(iii) **Humans at High Altitudes** At high altitude places like Rohtang Pass near Manali (> 3500 m) and Mansarovar (in China occupied Tibet) people suffer from altitude sickness. The body copes up with the low oxygen stress by

(a) increasing red blood cells production.

(b) decreasing the binding affinity of haemoglobin.

(c) increasing the breathing rate.

## 7. Population

A group of organisms living in the same area at the same time and can interbreed is called a population. **Population Attributes**

Main attributes of the population are as follows

(i) **Density** Total number of individuals present in a unit area or volume at a specific time, is called density. Its formula is D = N/ S

where, D = Density,

N = Total number of individuals in a region and S = size of unit area in the region

(ii) **Birth Rate or Natality** It is the production of new individuals in a population over fixed time period.

(iii) **Death Rate or Mortality** Number of individual dying in a population over fixed time period is called death rate.

(iv) **Sex Ratio** An individual is either male or female. The number of females and males per 1000 individuals in a given time is called as sex ratio.

## 8. Age Pyramid

Population at any given time is composed of individuals of different ages. When the age distribution (per cent individuals of a given age or age group) is plotted for the population, this is called age pyramid. The age pyramids of human population generally show the age distribution of males and females. These are of three types

(i) Expanding (triangular)

(ii) Stable (bell-shaped)

(iii) Declining (urn- shaped)

## 9. Population Growth

The size of a population for any species is not a static parameter, it keeps changing with time. It depends on factors such as food availability, predation pressure and adverse weather.

The population growth can fluctuate due to the following four reasons

(i) **Natality** refers to number of births during given period.

(ii) **Mortality** defines the number of deaths during a given period.

(iii) Immigration is the number of individuals of the same species that have come in to the habitat from elsewhere.

(iv) Emigration is the number of individuals of the population who left the habitat and moved somewhere else.

So, if N is the population density at time t, then its density at time t + 1 is

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

where, N = Population density, t = Time,

B = Birth rate

I = Immigration,

D = Death rate

E = Emigration. From the above equation we can see that population density will increase, if (B + I) is more than (D + E ) .

## 10. Growth Curves

To study the behaviour and pattern of different human population, there are following two models of population growth.

(i) **Exponential growth** is calculated as

$$dN/dt = -(\ )\ b\ d\ N$$

Let, $(b - d) = r$,then $dN/dt = rN$

where, N is population size, b is birth per capita, d is death per capita, t is time period and r is intrinsic rate of natural increase.

r is an important parameter that assesses the effects of biotic and abiotic factors on the population growth.

Exponential growth curve is J-shaped and occurs when resources like food and space are unlimited.

(ii) **Logistic Growth** A given habitat has enough resources to support a maximum possible number. This is called carrying capacity (K) for that particular species.

The logistic growth shows sigmoid (S-shaped) curve and this type of growth is called **Verhulst-Pearl Logistic Growth**. It is calculated as

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

where, N is population density at time t, K is carrying capacity and r is intrinsic rate of natural increase.

## 11. Population Interactions

In nature, living organisms such as animals, plants and microbes, cannot live in isolation and therefore, interact in various ways to form a biological community. Interspecific interactions occur between the populations of two different species living together within a community.

A. Predation It is an interspecific interaction, where an animal (predator) kills and consumes the other weaker animal (prey). It is a biological control method, e.g. tiger (predator) and deer (prey). Roles of predators are

(i) Providing population stability.

(ii) Maintaining species diversity in a community.

Defences developed in prey species to avoid predation are as follows

(i) Preys are cryptically coloured, i.e. camouflaged, e.g. insects and frogs.

(ii) They produce poisonous toxins, e.g. monarch butterfly secretes chemical during caterpillar stage and Calotropis secretes cardiac glycosides.

(iii) 25% of insects are phytophagous, i.e. feed on plant sap. Therefore, plants evolved by developing thorns,e.g. Acacia and cactus.

B. **Competition**It occurs when closely related species compete for the same resources that are limited. **Gause's competitive exclusion principle** states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. This may hold true in case of limited resources. Resource partitioning is a mechanism evolved by competing species for their coexistence.

C. **Parasitism**It is the mode of interaction between two species in which one species (parasite) depends on the other species (host) for food and shelter and damages the host. In this process, one organism is benefitted (parasite), while the other is being harmed (host).

**Types of Parasites** Parasites are broadly divided into following main types

(i) Ectoparasites present on the external surface of the host organism for food and shelter, e.g. lice on humans, ticks on dogs, copepods in marine fishes, etc.

(ii) Endoparasites live inside the host's body at different sites like liver, kidney, lungs, etc., for food and shelter, e.g. tapeworm, liver fluke, Plasmodium, etc. The life cycles of endoparasites are more complex because of their extreme specialisation.

D. **Commensalism**It is the interaction between two species, where one species is benefitted and the other is neither harmed nor benefitted. Some examples of commensalism are

(i) An orchid growing as an epiphyte on a mango tree gets shelter and nutrition from mango tree.

(ii) Barnacles growing on the back of whale are benefitted by getting to move to different locations for food as well as shelter.

E. **Mutualism** It is an interaction that confers benefits to both the interacting species. Some examples of mutualism are

(i) Lichens represent an intimate mutualistic relationship between a fungus and photosynthesising algae or cyanobacteria.

(ii) Mycorrhizae show close mutual association between fungi Glomus genus and the roots of higher plants.

(iii) Mediterranean orchid Ophrys employs 'sexual deceit' to get pollinated by a species of bee.

F. **Amensalism** It is an interaction between different species, in which one species is harmed and the other is neither benefitted nor harmed, e.g. Penicillium, a mould secretes penicillin which kills bacteria, but the mould remains unaffected.