CHAPTER 13

# Organisms and Populations

## Organisms and Their Environment

Ecology is a branch of biology, which gives us holistic perspective to biology. It is the study of relationships of living organisms with their environments abiotic and biotic components.

### Organism and its environment

Physiological ecology is important as it explains how organisms adapt to their environment for survival and reproduction. Major abiotic or physical factors that affect the adaptation of the organisms are temperature, water, soil and light.

### Major Abiotic Factors

- **Light:**

➢ Species of small plants like herbs and shrubs that grow in forests can photosynthesize optimally under very low light conditions.

➢ Some plants depend on sunlight to meet their photoperiodic requirement for flowering.

➢ Animals need light for timing their foraging, migratory and reproductive activities.

➢ Some plants present at the bottom of the ocean does not get sunlight so some of the color components are not available to them.

- **Temperature**:

➢ The average temperature decreases continuously as we move from plains to hilly areas and from the equator towards the poles.

➢ In some unique habitats like thermal springs, deep sea hydrothermal vents the average temperature exceed 100°C.

➢ Some factors like kinetics of enzymes, physiological functions, basal metabolism of the organism are affected by the temperature.

➢ The geographical distribution of different species is determined by the levels of thermal tolerance of the species. Some species are called eurythermal which can survive in wide range of temperatures while species called stenothermal can survive only in narrow range of temperatures.

- **Soil**

➢ The nature and properties of soil depend on the climate, weathering process, transportation of soil and the development of soil.

➢ Vegetation in an area is determined by the mineral composition, topography, pH of the soil.

➢ Water holding capacity of the soil is determined by the soil composition, grain size and aggregation.

- **Water**

➢ The amount of water available in a particular area determines the distribution and productivity of plants.

➢ Salt concentration in water varies for different areas like less than 5 in inland waters, 30 – 35 in the sea and more than 100 in hypersaline lagoons.

➢ Some aquatic organisms can grow in wide range of salt water, such aquatic organisms are called euryhaline and other can tolerate salinities in a narrow range, called stenohaline.

### Responses to Abiotic Factors

- **Homeostasis**:

  A process of maintaining the constancy of its internal environment by the organism besides experiencing different external environmental conditions.

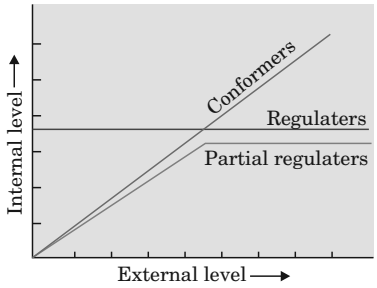


**Fig.:** Diagrammatic representation of organismic response

The various possibilities by which various organisms deal with the external environmental conditions are **regulate, conform, migrate** and **suspend**.

- **Regulate**
  - Constant body temperature, constant osmotic concentrations are the physiological means by which some organisms maintain homeostasis.
  - Success of mammals is largely due to their ability to maintain a constant body temperature and thrive whether they live in poles or in the arid deserts.
  - Humans maintain a constant body temperature of 37°C
  - In summers sweat cool due to evaporation and brings down the body temperature.
  - In winters we shiver which produces heat and raises body temperature.
- **Conform**
  - A constant internal environment cannot be maintained by plants and animals.
  - With change in water osmotic concentration, body temperature of aquatic animals also changes.
  - The animals and plants whose body temperature changes with ambient temperature are called conformers.
  - Thermoregulation is expensive energetically for many organisms that includes small birds like shrews and humming birds, because of which such organisms are conformers.
- **Migrate**
  - Some organisms move to favorable or more hospitable areas temporarily and return back once the stressful period is over in their own area this is called migration.
  - Many Siberian birds migrate from Siberia to Rajasthan in winters.
- **Suspend**
  - To help bacteria, fungi and lower plants to survive in unfavorable conditions various kinds of thick walled spores are formed that generate on availability of suitable environment.
  - Some organisms escape time to avoid stress like bears goes into hibernation in winters and fishes and snails go into aestivation to avoid summer.
  - Under unfavorable conditions many zooplankton species in lakes enter diapause, a stage of suspended development.

## Adaptation

- It is any attribute of the organism (morphological, physiological, and behavioral) that enables the organism to survive and reproduce in its habitat. For example people living in higher altitudes have higher Red Blood Cell count because the oxygen level in higher altitudes is low because of which body produces more Red Blood Cells to allow increased level of transportation of gases.
- **Allen's rule:** According to Allen's rule, the limbs, ears and other appendages of the animals living in cold climates tend to be shorter than the animals of the same species living in warm climates to prevent loss of heat.
- Some dessert plants perform their photosynthetic function by stems are the leaves are reduced to spines. Some aquatic animals survive in hot springs while others may survive in Antarctic waters where the temperature is very less. These plants and animals adapt according to the conditions.

# Population

- **Population**
  - When a group dwells in a well defined geographic area, share or compete for similar resources and interbreed, this represents a population.
  - A population has different attributes that an individual organism does not possess like birth rates, death rates and sex ratio.
  - The growth status of the population can be reflected by the shapes of the pyramids.

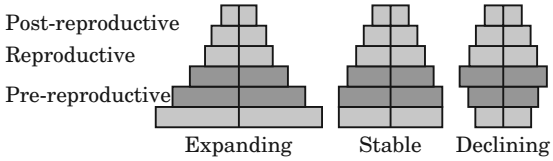


**Fig.:** Representation of age pyramids for human population

- **Population density**: Also known as population size, is the measurement of population per unit area or unit volume.
- **Population Growth**: The size of a population is not always constant, it varies with factors like food availability, adverse weather, predation pressure these factors provide insight into whether the population is declining or flourishing, these

variations in size of population is called population growth. The population fluctuations take place due to four basic processes.

- Natality- Number of births during a given period
- Mortality- Number of deaths in a given period
- Immigration- Number of individuals of the same species that have come into the habitat from some other place.
- Emigration- Number of individuals of the same species that left the habitat and shifted to a new place.

- **Growth models**

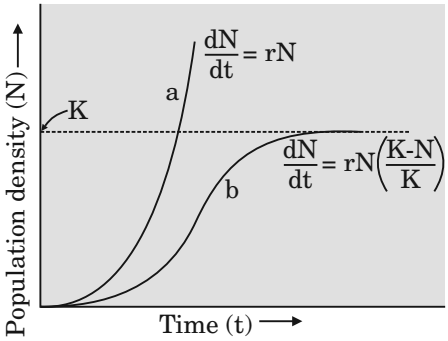


**Fig.:** Population growth curve

- Exponential growth: When the resources are unlimited population has exponential growth. If in a population of size N the birth rates are represented as b and death rates as d then the increase or decrease in N in a unit time period t will be

$$\frac{dN}{dT} = (b - d) \times N$$

Let $(b - d) = r$ then, $\frac{dN}{dT} = rN$

- Logistic Growth: When the resources are limited exponential growth is not possible, leading to competition between individuals for limited resources and only the fittest will survive and reproduce.

Verhulst-Pearl Logistic growth is given by

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

- **Life History Variation: Population Interactions**

- The various species of a habitat depend on each other for their survival. There is always a minimal requirement for any species to have one or more species on which it can feed. The populations interact with each other to survive in this ecology. Various population interactions can be understood by this table,

| Species A | Species B | Name of Interaction |
|---|---|---|
| + | + | Mutualism |
| – | – | Competition |
| + | – | Predation |
| + | – | Parasitism |
| + | 0 | Commenalism |
| – | 0 | Amensalism |

'+' for beneficial interaction

'–' for detrimental interaction

'0' for neutral interaction

- **Types of Interactions**

- **Mutualism**: This interaction benefits both the interacting species such as the plant-animal relationship. Plants offer pollen and nectar for pollinators and juicy and nutritious fruits for seed dispersers, for e.g. relationship between female wasp and fig species.
- **Competition**: It occurs when closely related species compete for same resource but sometimes totally unrelated species also compete for same resource. For example flamingoes and resident fishes compete for common food, i.e. zooplanktons in some shallow South American lakes. In this process, fitness of one species is lower in presence of the other. Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resource cannot coexist indefinitely and the inferior one is eliminated.
- **Predation**: When one species is benefited harming the second species as it preys on it. For example for plants herbivores are predators. Predators maintain the species diversity in a community. If the predator makes the prey extinct then there are possibilities of predator becoming extinct as well.
- **Parasitism**: It is similar to predation where one species is benefited and the second species gets detrimented. The parasite obtains food and shelter from the host. For example lice on humans and ticks on dogs. Parasites have a complex life cycle as parasitisation of primary host is facilitated by one or two intermediate hosts. Ectoparasites are those parasites which feed on the external surface of host organism while endoparasites live inside the host body. An example of parasitism in birds is Brood parasitism where parasitic bird lay its eggs in the nest of the host.
- **Commensalism**: In this interaction one species is benefited while the other is neither harmed nor benefited. For example an orchid growing on a mango branch.
- **Amensalism**: In this interaction one species is detrimented/inhibited or destroyed while the other species is unaffected. For example bread mold penicillium and black walnut trees.

## EXERCISE

1. The branch of Botany dealing with the distribution of plants on the earths surface is called
   (*a*) Ecology (*b*) Phytology
   (*c*) Phytogeography (*d*) Phytosociology
2. Biotic Potential refers to
   (*a*) Increase of population under optimum conditions
   (*b*) Increase of population under given conditions
   (*c*) Increase of population under natural conditions
   (*d*) Increase of population under climatic conditions.
3. Ecology takes into account only
   (*a*) Environmental factors only
   (*b*) Plant adaptations only
   (*c*) Effect of environment on plants
   (*d*) All of the above.
4. They plants and animals living in a given area form.
   (*a*) Biological community
   (*b*) Ecotone
   (*c*) Biome
   (*d*) Consociation
5. The term 'niche' of a species refers to
   (*a*) Specific and habitual function
   (*b*) Specific place where an organism lives
   (*c*) Competitive power of an organism
   (*d*) Specific function of organism
6. Which of the following statement is true regarding individuals of same species
   (*a*) They are interbreeding
   (*b*) They live in same niche
   (*c*) They live in different niche
   (*d*) They live in different habitate
7. Species are considered as.
   (*a*) Real units of classification devised by taxonomists
   (*b*) Real basic units of classification
   (*c*) They lowest units of classification
   (*d*) Artificial concept of human mind which cannot be defined in absolute terms.
8. Name the term used to describe a single dominant species that dictates community structure.
   (*a*) Pioneer species
   (*b*) Transitional species
   (*c*) Key stone species
   (*d*) Indigenous species
9. Habitat together with functions of species constitute its
   (*a*) Trophic level (*b*) Boundary
   (*c*) Topography (*d*) Niche
10. They organisms spending most of the time in transitional area between two communities are called.
    (*a*) Exotic species (*b*) Edge species
    (*c*) Keystone species (*d*) Critical link species
11. Population whose members reproduces asexually are termed as _____.
    (*a*) Panimictic (*b*) Amphimictic
    (*c*) Apomictic (*d*) Ecotype
12. The study of inter-relationship between living organisms and their environment is called
    (*a*) Ecosystem (*b*) Phytogeography
    (*c*) Ecology (*d*) Phytosociology
13. The carrying capacity of a population is determined by its _____.
    (*a*) Birth rate
    (*b*) Death rate
    (*c*) Limiting resource
    (*d*) Reproductive status
14. A Community is defined as
    (*a*) A group of birds
    (*b*) A collection of species
    (*c*) Interacting populations
    (*d*) An interactive ecosystem
15. Which of the following isolation is important for speciation
    (*a*) Seasonal (*b*) Tropical
    (*c*) Behavioural (*d*) Reproductive
16. Which one of the following is the most significant feature of the Indian population?
    (*a*) Declining birth rate
    (*b*) Improvement in the literacy level
    (*c*) The size of its adolescent population
    (*d*) Improvement in health condition
17. What was the population density of India according to 2001?
    (*a*) 124 Person/$km^2$ (*b*) 244 Person/$km^2$
    (*c*) 324 Person/$km^2$ (*d*) 424 Person/$km^2$

18. Which is the most populous country of the world?
(*a*) India (*b*) United states
(*c*) China (*d*) Russia

19. In how many years is the official enumeration of population carried out for census.
(*a*) 1 year (*b*) 5 years
(*c*) 10 years (*d*) 2 years

20. Name the union Territory having the highest density of population?
(*a*) Chandigarh (*b*) Delhi
(*c*) Pondicherry (*d*) Daman and Diu

21. The most populous state of India is
(*a*) West Bengal (*b*) Kerala
(*c*) Uttar Pradesh (*d*) Bihar

## Answer Keys

**1.** (*c*) **2.** (*a*) **3.** (*d*) **4.** (*a*) **5.** (*b*) **6.** (*a*) **7.** (*b*) **8.** (*c*) **9.** (*d*) **10.** (*b*)
**11.** (*c*) **12.** (*c*) **13.** (*c*) **14.** (*c*) **15.** (*d*) **16.** (*c*) **17.** (*c*) **18.** (*c*) **19.** (*c*) **20.** (*b*)
**21.** (*c*)

## Solutions

**1.** Apomixis is the formation of new individuals directly through asexual reproduction without involving the formation and fusion of gameter. So, those population whose members reproduce by the process of apomixi's are called apomictic

**2.** Biotic potential is the maximum capacity of a population to reproduces under ideal conditions (environmental).

**3.** Ecology is the branch of biology that deals with the inter relationships amongst organisms and interactions between organisms and their environment.

**4.** Biological community is the assemblage of interdependent and interacting populations of different species present in an area.

**5.** Ecological niche is specific habitat where an specific species lives.

**6.** Uniform interbreeding population or group of individuals which freely interbreed among themselves, constitute a species.

**7.** Species is the basic unit of classification only the species has a real existence, other units of classification are man made artificial groups.

**8.** According to paine (1969), keystone species are those whose role or activities determine community structure.

**9.** Niche is specific part of habitat occupied by individuals of a species which is circumscribed by its range of to tolerance, range of movement microclimate, type of food and its availability.

**10.** The species which are found primarily, most of their time in ecotone or community boundary are known as edge species.

**11.** Term phytogeography is made up of two words phyton = plant and geography i.e. geography of plant distribution.

**12.** The term ecology is derived from two greek words namely oikos and Logos. Oikos means home or habitation or a place to live in Logos means study or discourse? Hence literally speaking, ecology is the study of organisms at home.

**13.** The carrying capacity of a population is determined by its limiting resources. Carrying capacity is the upper limit of an ecosystem up to which it can provide the basic needs to the population under given circumstances.

**14.** A community is an assemblage of population of organisms that live in an area and interact with each other.

**15.** The interruption of gene flow (reproductive isolation) between populations is a pre-requisite for the formation of new species

16. The most significant feature of Indian population is that India has high population of young people and they are the future of India.
17. The measurement of population per unit area is 324 person/$km^2$
18. China is the most populous country with nearly 1.4 billion residents.
19. In India the census has been undertaken every 10 year's
20. Delhi is the most populous union Territory having estimated population of 18.6 million in 2016.
21. Uttar Pradesh is the most populous state of India with the total population density of 828 person/$km^2$