Notes

4

PRINCIPLES OF ECOLOGY

In the previous module (module-1) you have learnt about the origin and evolution of the environment. You have also learnt how humans have been interacting with the environment. In this lesson, which is the first one in the module-2, you will learn some important concepts of ecology which is an established branch of science.

OBJECTIVES

After completing this lesson, you will be able to:

- *define the term ecology;*
- *explain the relationship between organism and its habitat with a special mention of the human species;*
- *recognize the levels of ecological organizations from organism (individual) to population, community, ecosystem, biome and biosphere;*
- *differentiate between habitat and niche;*
- *describe the concept of species and explain the basic idea of adaptation, evolution and extinction;*
- *explain the concept of population with reference to organisms;*
- *highlight the characteristics of size, growth, density and dispersion of population;*
- *analyze the demographic factors influencing the changes in population of organisms;*
- *explain community structure with reference to species diversity, interspecific interactions and ecological succession.*

4.1 DEFINITION OF ECOLOGY

'Ecology may be defined as the scientific study of the relationship of living organisms with each other and with their environment.'

The term ecology was first coined in 1869 by the German biologist Ernst Haeckel. It has been derived from two Greek words, 'oikos', meaning home or estate and 'logos' meaning study. The emphasis is on relationships between organisms and the components of the environment namely abiotic (non-living) and biotic (living).

4.2 LEVELS OF ECOLOGICAL ORGANIZATION

Ecology not only deals with the study of the relationship of individual organisms with their environment, but also with the study of populations, communities, ecosystems, biomes, and biosphere as a whole (see Fig. 4.1)

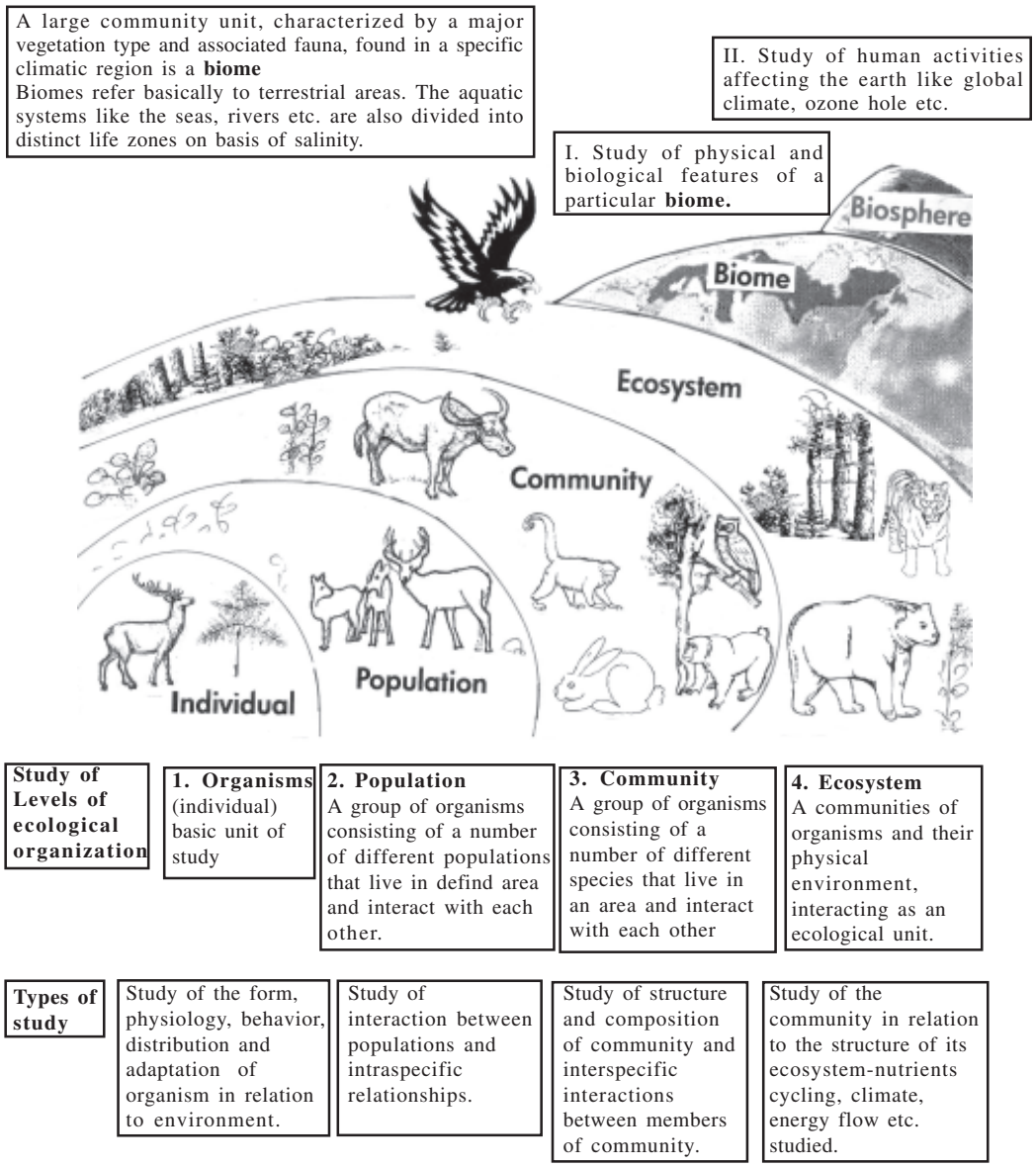

Fig. 4.1: *Levels of ecological organization and types of ecological studies*

4.3 HABITAT AND ORGANISM

Habitat is the physical environment in which an organism lives. Each organism has particular requirements for its survival and lives where the environment provides for those needs. The environmental requirement of an elephant would be a forest. You would not expect an elephant in the ocean nor would you expect a whale in the forest? A habitat may support many different species having similar requirements. For example, a single ocean habitat may support a whale, a sea-horse, seal, phytoplankton and many other kinds of organisms. The various species sharing a habitat thus have the same 'address'. Forest, ocean, river etc. are examples of habitat.

The features of the habitat can be represented by its structural components namely (1) space (2) food (3) water (4) and cover or shelter (Fig. 4.2).

Earth has four major habitats-(1) **Terrestrial** (2) **Freshwater** (3) **Estuarine** (Where rivers meet the ocean) and (4) **Ocean**. The human gut is the habitat of a tapeworm and the rotting log a habitat of a fungus.

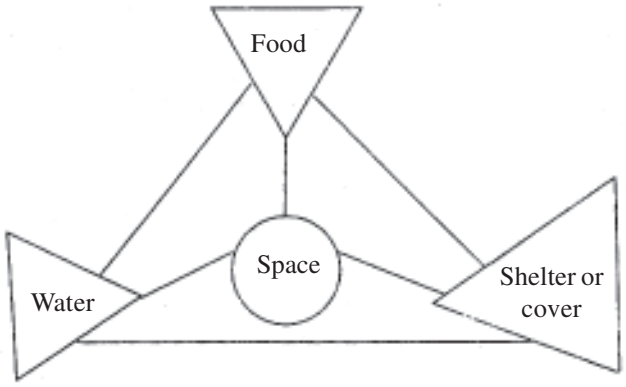

Fig. 4.2: *Structural components of a habitat*

4.4 NICHE AND ORGANISM

In nature, many species occupy the same habitat but they perform different functions. The functional characteristics of a species in its habitat is referred to as "**niche**" in that common habitat. Habitat of a species is like its 'address' (i.e. where it lives) whereas niche can be thought of as its "profession" (i.e. activities and responses specific to the species). **The term niche means the sum of all the activities and relationships of a species by which it uses the resources in its habitat for its survival and reproduction.**

A niche is unique for a species while many species share the habitat. No two species in a habitat can have the same niche. This is because if two species occupy the same niche they will compete with one another until one is displaced. For example, a large number of

different species of insects may be pests of the same plant but they can co-exist as they feed on different parts of the same plant. (Fig. 4.3).

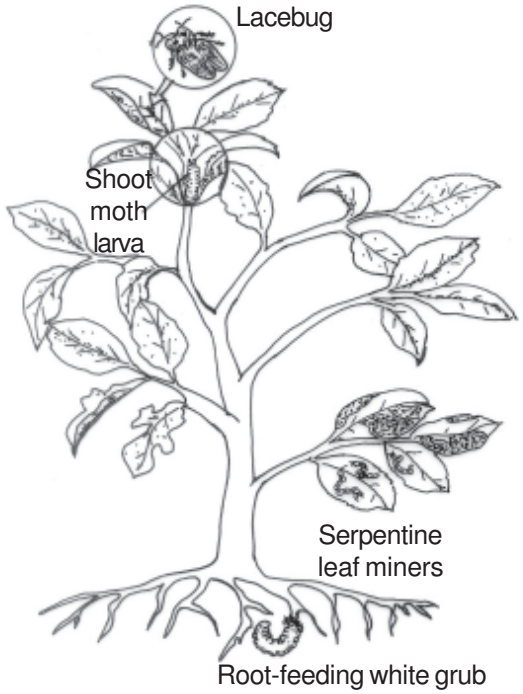

Fig. 4.3: *Different species of insects feeding on different parts of the same plant*

Another example is the vegetation of the forest. The forest can support a large number of plant species as they occupy different niches: the tall trees, the short trees, shrubs, bushes and grasses are all part of the forest but because of varying heights they differ in their requirements for sunlight and nutrients and so can survive together (Fig. 4.4)

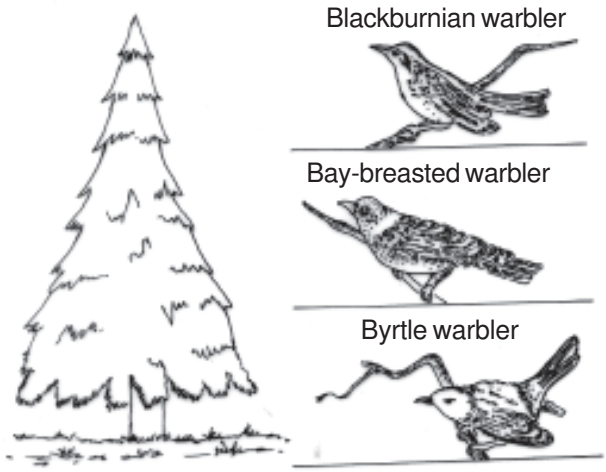

Fig. 4.4: *The three species of warbler birds search for insects as food in the forest at different levels in the tree and so occupy different niches*

The most important resources in the niches of animals are food and shelter while in case of plants, they are moisture and nutrients (phosphorous and nitrogen).Fig. 4.5 shows the niche of human beings.

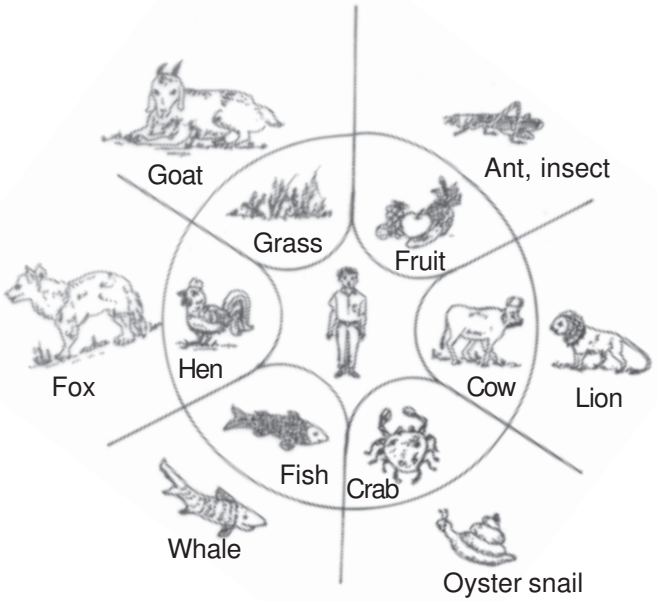

Fig. 4.5: *The ecological niche of human being*

INTEXT QUESTIONS 4.1

1. What does the term ecology mean?

   _____

2. Define the term niche.

   _____

3. Give one point of difference between habitat and niche.

   _____

4.5 ADAPTATION

Every organism is suited to live in its particular habitat. You know that the coconuts cannot grow in a desert while a camel cannot survive in an ocean. Each organism is adapted to its particular environment. **An adaptation is thus, "the appearance or behaviour or structure or mode of life of an organism that allows it to survive in a particular environment".** Presence of gills and fins are examples of adaptation in fishes to aquatic habitat. In aquatic flowering plants absence of wood formation and highly reduced root

system are adaptations to aquatic environment. Adaptations that can be observed in structure (Fig. 4.6) or behaviour or physiology of an organism. Adaptations have genetic basis and have been produced and perfected through evolution. This means that the adaptions have developed over many generations to help a species survive successfully in its environment.

Examples of basic adaptations that help animals and plants to survive in their respective environments.

- Shape of bird's beak.
- The thickness or thinness of fur.
- Presence of feathers and wings in birds.
- Evergreen and deciduous nature of trees.
- Presence and absence of thorns on leaves and stems.

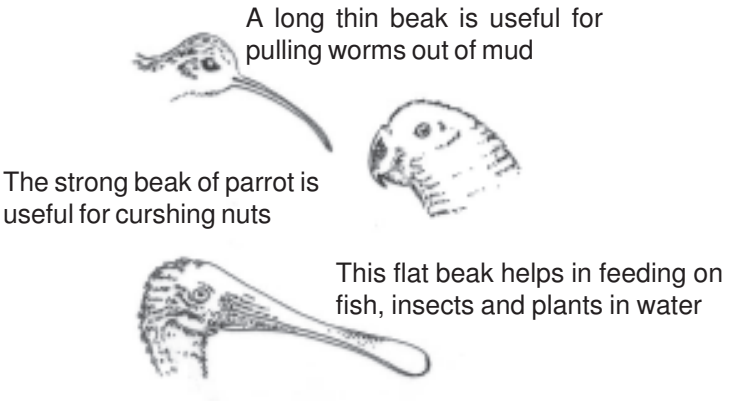

Fig. 4.6: *Adaptation in the types of beaks in birds: The beaks of different birds are adopted for feeding on different kinds of food*

• What is a Species

A species is defined as; "a group of similar populations of organisms whose members are capable of interbreeding, and to produce fertile offspring (children)". A tiger, a lion, a lotus and a rose are examples of different species. Every species has a scientific name, understood by people of all over the world. Humans belong to species of *Homo sapiens*. Only members of the same species can interbreed to produce fertile offspring. Every species has its own set of genetic characteristics that makes the species unique and different from other species.

• Variation

However, species are generally composed of a number of distinct populations which freely interbreed even though they appear to be different in appearance.

Difference in colour of skin, type of hair; curly or straight, eye colour, blood type among different ethnic groups represent variation within human species. Similarly, different shape and size of cows, dogs and cats etc. are examples of variation with in each of these species (Fig. 4.7). In plants, tall and short pea varieties, various shape and size of brinjals exhibit variation among these plant species. Variations are produced as a result of chance mutation. Competition and natural selection determines as to which variation will succeed and survive. Those variations that enable a species to survive in the struggle for existence are encouraged and promoted.

In plants one can observe wide variation in size and shapes of mangoes, brinjals etc.

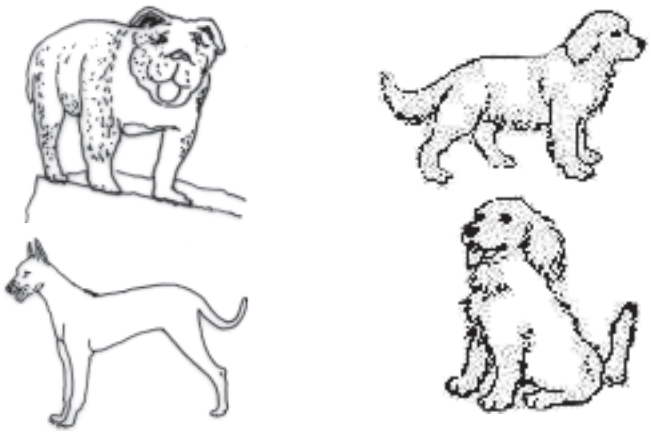

Fig 4.7: *The populations of these four types of dogs look different but all are capable of breeding among themselves and capable of producing fertile offspring. All four belong to same species Canis lupus.*

Evolution

A valid theory of evolution was propounded by Charles Darwin and Alfred Wallace in 1859. This theory has been extended in the light of progress in genetics and is known as **Neo-Darwinism**. It has the following features:

1. Organisms tend to produce more off springs that can be supported by the environment.
2. **Mutation** (a change in genetic material that results from an error in replication of DNA) causes new genes to arise in a population. Further, in a sexually reproducing population, meiosis and fertilization produce new combination of genes every generation, which is termed **recombination.** Thus members of the same species show 'variation' and are not exactly identical. Variations are heritable.
3. An evolutionary force which Darwin termed **natural selection**, selects among variations i.e. genes that help the organism to adopt to its environment. Such genes are reproduced more in a population due to natural selection.

4. Those offspring which are suited to their immediate environment have a better chance of surviving, reaching reproductive age and passing on the suitable **adaptations** to their progeny.

5. Evolution thus results in **adaptation** and **diversity of the species**.

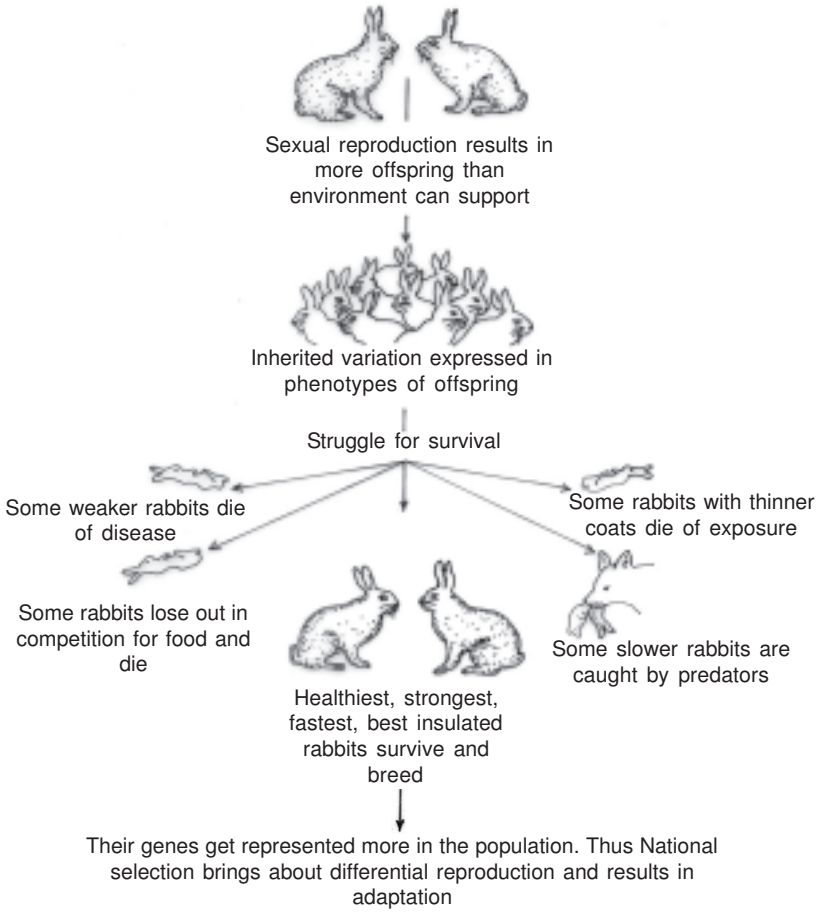

Fig 4.8: *Process of natural selection*

4.6 SPECIES FORMATION: SPECIATION

The number of species surviving in the world today is the outcome of two processes-speciation and extinction.

Speciation is the process by which new species are formed and evolution is the mechanism by which speciation is brought about.

A species comprises of many populations. Often different populations of a species remain isolated due to some geographic barrier such as mountain, ocean, river, etc. Geographic

isolation occurs when a physical barrier develops between two populations of a species as you can see in fig. 4.8**.** The most common way a population undergoes speciation is by geographic isolation.

- The members of a population of a species live in a particular environment and are capable of breeding with the member of another population of the same species.
- The population then becomes separated into two completely isolated populations by a barrier which prevents their interbreeding and gene exchange. The isolating mechanism may be a physical barrier like water, mountain, ocean represent geographical isolation. (Fig. 4.9)

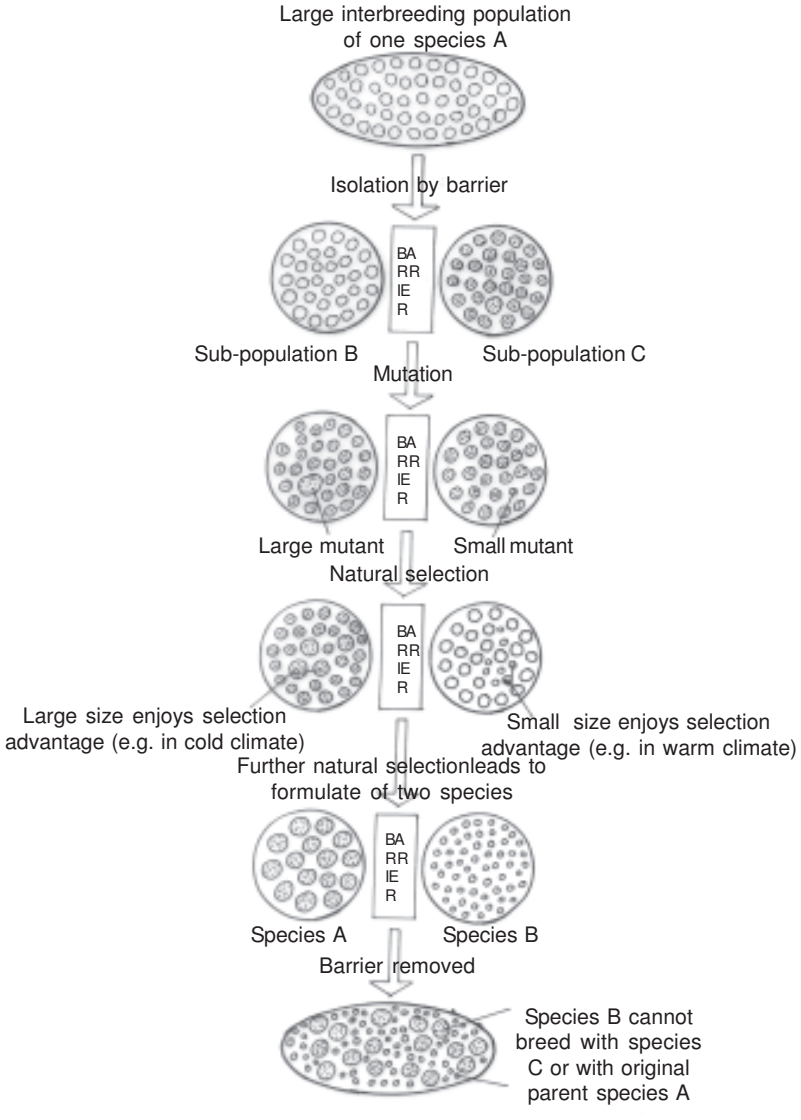

Fig. 4.9: *Geographical isolation*

- Ecological isolation caused by differences in temperature, humidity, pH etc. in the environment of the two populations.
- Reproductive isolation caused by interference in interbreeding between members of different populations of species i.e. species. When two populations of a species are unable to interbreed due to reproductive barrier.
- Reproductive isolation may occurs due to any one or more of the following reasons:

  (i) When two different populations become sexually receptive at different times of the year. For example a population of frogs that breeds in May is effectively isolated from one that breeds in July, though both populations may occur in the same area.

  (ii) Members of different populations are not attracted by courtship behaviour towards one another.

  (iii) Pollination mechanism fails, between flowers of two populations.

  (iv) Cross fertilization is prevented as sex organs of different populations of a species do not match.
- Mutations occur randomly in isolated populations giving rise to new variation within each sub-population of these mutations those that help to adapt to the environment are reproduced in greater numbers in the next generation due to natural selection.
- In other words since no two environments are identical, natural selection pressures that occur on each separate sub-population are different, depending on local conditions such as climate, disease, predators etc. Natural selection affects each sub-population differently and so different 'variations' caused by nutrition or recombination in different subpopulations get established. With the passage of time, the sub populations become more and more different from each other.
- After a long period of time, the sub-populations become very different and get isolated, reproductively, i.e. they no longer interbreed.
- Later even when the barrier is removed the sub-populations are unable to interbreed and thus subsequently the sub-populations become two different species.

An example of formation of new species

A current example of speciation can be seen in the two species of squirrels Kaibab squirrels and Abert squirrels that live on opposite sides of the Grand Canyon. Biologists assume that the two squirrel populations became separate species when about one million years ago, the Colorado river changed its course, splitting the original population of squirrels into two. Since the environment on opposite sides of the canyon is different, different characteristics were favoured on each side of the canyon, by natural selection. After many years of separation, the genetic differences between the populations became so large that the two squirrel populations became two separate species. They look different and can no longer interbreed (Fig 4.10).

Fig. 4.10: *The Kaibab squirrel of the north rim and the Abert squirrel of the south rim had common ancestors*

4.6.1 Extinction

Ever since life evolved on earth, new species better suited or adapted to the environment have appeared and older less successful forms have died or become extinct. Extinction is generally a natural occurrence. It means the dying out of a variety of or a species. The primary reason for these extinctions is environmental change or biological competition. Extinction occurs when species cannot evolve fast enough to cope with the changes taking place in their environment. (Fig. 4.11). Many species have gone extinct during geological history of the earth. Fossils are, the preserved remains of animals, plants, and other organisms that lived in the geological past.

(a) (b)

Fig. 4.11: *(a) Fossil of fern plant. (b) Fossil fish*

Extinction may take place due to catastrophic natural phenomena such as tsunami, volcanoes etc. In recent time, human activities such as deporation, over exploitation, environmental

Notes

pollution and environmental change are other factors responsible for extinction. Deforestation for expansion of industries and human settlements has promoted economic growth but at the same time it has resulted in habitat loss for many wild plants and animals. Pollution has killed many an aquatic species.

INTEXT QUESTIONS 4.2

1. What is meant by the term adaptation? Answer in one sentence.

   _____

2. Define : (i) species (ii) variation

   _____

3. Name two sources of variation.

   _____

4. Name the evolutionary force which brings about greater reproduction of adaptive variation.

   _____

5. Explain the term (i) speciation and (ii) extinction.

   _____

4.7 POPULATION

'Population' is defined as a group of freely interbreeding individuals of the same species present in a specific area at a given time. For example, when we say that the population of a city is 50,000, we mean that there are 50,000 humans in that city. However, all populations of humans living in any part of the world constitute the species ***Homo sapiens.***

A population has traits of its own which are different from those of the individuals forming the population. An individual is born and dies but a population continues. It may change in size depending on birth and death rates of the population. An individual is either female or male, young or old but a population has a sex ratio and age structure, which means, the ratio of male to female in the population and the various age groups into which the population may be divided.

The characteristics of any population depends on:

(i) density of the population, (ii) natality (birth rate), (iii) mortality (death rate), (iv) dispersal, (v) biotic potential (vi) age distribution (vii) dispersion and (viii) growth form.

Density: The number of individuals per unit area at a given time is termed as **population density**. The density of species varies from time to time and from one place to another. For example, you may notice more plant and animal species in the garden during the monsoon season. Density of a particular organism in a region is determined by selecting random samples of a particular dimension size called quadrat from that region.

In case of large, mobile animals like tigers, leopards, lions, deer etc, the density may be determined by counting individual animals directly or by the pugmarks (foot imprints) left by the animals in a defined area (Fig. 4.12). Pugmarks of each individual animals are unique and different from one others. Study of pug marks can provide the following information reliably if analyzed skillfully:

- Presence of different species in the area of study.
- Identification of individual animals.
- Population of large cats (tigers, lions etc.).
- Sex ratio and age (young or adult) of large cats

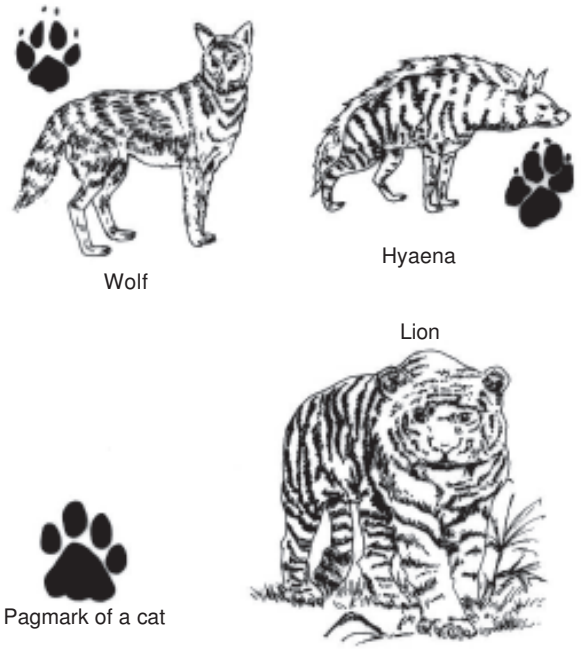

Fig. 4.12: *Pugmark of a lion/cat (Foot prints) of soft padded wild animals*

Counting of human population is called **census** and is carried out by the Indian government every 10 years. In census however each individual is physically counted.

- **Natality:** The rate at which new individuals are born and added to a population under given environmental conditions is called **natality**. Birth, hatching, germination and vegetative propagation cause an increase in the number of individuals in a population.

In case of humans, natality or birth rate is usually expressed in terms of births per thousand per year.

- **Mortality:** Loss of individuals from a population due to death under given environmental conditions is called **mortality**. The number of individuals dead in a year is calculated for obtaining the mortality rate or death rate. Mortality rate in human population may be expressed in terms of number of persons dead per thousand per year.
- **Dispersal:** The movement of individuals of a population out of a region on a permanent basis is termed emigration while immigration refers to the movement of individuals into a new area where dispersal includes both emigration and immigration of individuals. The population of a region is affected by dispersal. Active migration is not possible in plants though seeds may be dispersed over long distance by wind, water and animals.

The density of a population thus basically depends on four factors: i) natality, ii) mortality, iii) immigration and iv) emigration (Fig. 4.13)

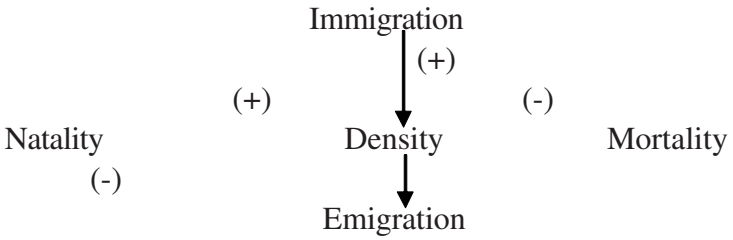

Fig. 4.13: *Parameters of population*

Age distribution

Natural populations include individuals of all age groups. It, therefore, becomes necessary for us to consider age distribution of a population. Age distribution refers to the proportions of individuals of different age groups in a population.The population may be broadly divided into three age groups:-

- pre-reproductive group: comprising of juvenile individuals or children,
- reproductive group: consisting of individuals capable of reproduction ,
- post-reproductive group: contains aged individuals who are incapable of reproduction.

A rapidly growing population will usually contain a large proportion of individuals in the reproductive age group; a stationary population (where there is no increase or decrease in population) contains an even distribution of all age groups, and a declining population contains a large proportion of old or post-reproductive age of an individuals.

• Sex ratio

Sex ratio is an important aspect of population. It refers to the ratio between female and male individuals in a population

4.8 POPULATION GROWTH

The growth, stability or decline in number of individuals in a population is influenced by its relation with the environment.

Populations have characteristic patterns of growth with time, which is depicted by population growth curves. Two basic forms of population growth curves can be identified. (i) 'J' shaped growth curve and the (ii) 'S' shaped or sigmoid growth curve.

Density independent population growth

A forest fire may reduce a dense or scanty population drastically. Extreme weather conditions like drought, rains, floods, storms and sudden rise or fall in temperatures all act as density independent factors as they tend to cause sudden reduction in population numbers. The population growth that is depicted by a 'J' shaped growth curve is called density independent growth.

Generally the 'J' shaped growth curve is typical of the species which reproduce rapidly and which are greatly affected by seasonally fluctuating environmental factors such as light, temperature and rainfall. In this type of curve, population density increases rapidly in exponential (geometric) progression (total number doubles at regular intervals of time) like this:

×2	×2	×2	×2	×2	
8	16	32	64	128	till a peak is reached.

This type of exponential growth occurs in nature when a population has abundant supply of resources. After reaching a peak there is a sudden crash or decline due to environmental or other factors. Such type of growth may be exhibited by insect populations which show explosive growth during the monsoon season and then abruptly disappear at the end of the season.

INTEXT QUESTIONS 4.3

1. Define population.

   _____

2. Name at least three characteristics of population.

   _____

3. What are the factors on which density of a population depends?

   _____

Notes

4.9 COMMUNITIES AND THEIR CHARACTERISTICS

In ecology the term community, or more appropriately 'biotic community, refers to the populations of different kinds of organisms living together and sharing the same habitat.

4.9.1 Organization of a biotic community

The characteristic pattern of the community is termed as structure of the community and is determined by:

- the roles played by its various populations;
- the range of its various populations;
- the type of area that is inhabited by the populations of the community;
- the diversity of species in the community;
- the interactions between various populations of the community inhabiting the area.

Members of a community also actively interact with their environment. In a community only those plants and animals survive which are adapted to a particular environment. The climate determines the type of environment, hence, the type of organisms in a community. For example, it is the climate of the area which determines whether a given area becomes a desert or a forest.

Communities created by human such as lawns or crop communities are such man made communication are crop communities are relatively simple and consists of only one species as opposed to a natural community characterized by a large number of species. Man made communities are very unstable and require great deal of care and constant manipulation and maintenance.

4.9.2 Stratification

Stratification of a community refers to the vertical layers of the vegetation. Tropical forests represent a good example of vertical stratification. In moist tropical rain forests up to five distinct strata or layers of vegetation can be formed. These include from the forest floor to the top (Fig. 4.14):

(i)	Ground layer of mosses and liverworts associated with dead leaves and other substances rich in organic matter.	**The bottom layer**
(i)	Herb or grass layer,	} **The lower layer**
(ii)	Short shrub layer	**The middle layer**
(iii)	Tall shrub layer	
(iv)	Layer of under storey of short trees,	
(v)	Layer of canopy of lower tress and	**The upper layer**
(vi)	Over storey or emergent tree layer formed by tall trees.	

Fig. 4.14: *Stratification in a biotic community*

As you can see in the fig. 4.14 the tropical forest the **canopy** dominates the area. They modify the light and moisture conditions for the shorter trees growing under them, which in turn determine the conditions for the ground vegetation. The vertical stratification of the plant community determines the structure of the community. The vegetation provides a number of habitats for the various organisms. Different layers of the community are occupied by different species of plants and animals. Plants and animals of each layer differ in size, behaviour and adaptation from those of other layers. The different layers of organisms minimize competition and conflict among the members of the community. The various species in the community compete with each other for nutrients, space, light and other resources. (refer again to Fig 4.4). Stratification is a practical strategy to minimize interspecific competition.

• Community Characteristics

Species diversity

An important attribute of a community is its species diversity.

The different kinds of organisms present in a community represent its species diversity. The species composition or diversity differs from one community to another. Even in the same community, there may be seasonal variation in species composition.

Species diversity also influences the stability of the community. A stable community is one which is able to return to its original condition after being disturbed in some way. Communities with high species diversity have been found to be comparatively more stable.

The diversity is calculated both by the number of species (richness) and the relative abundance of each species (evenness). Relative abundance is measure of relative proportion of different species occurring in a community. The greater the number of species and more even their distribution the greater is the species diversity.

4.10 ECOLOGICAL SUCCESSION

Biotic communities are dynamic in nature and change over a period of time. The process by which communities of plant and animal species in an area are replaced or changed into another over a period of time is known as **ecological succession**. Both the biotic and abiotic components are involved in this change. This change is brought about both by the activities of the communities as well as by the physical environment in that particular area. The physical environment often influences the nature, direction, rate and optimal limit of changes. During succession both the plant and animal communities undergo change. There are two types of successions (i) Primary succession and (ii) Secondary succession.

4.10.1 Primary succession

Primary succession takes place an over a bare or unoccupied areas such as rocks outcrop, newly formed deltas and sand dunes, emerging volcano islands and lava flows as well as glacial moraines (muddy area exposed by a retreating glacier). where no community has existed previously. The plants that invade first bare land, where soil is initially absent are called pioneer species. The assemblage of pioneer plants is collectively called pioneer community. A pioneer species generally show high growth rate but short life span (Fig 4.15)

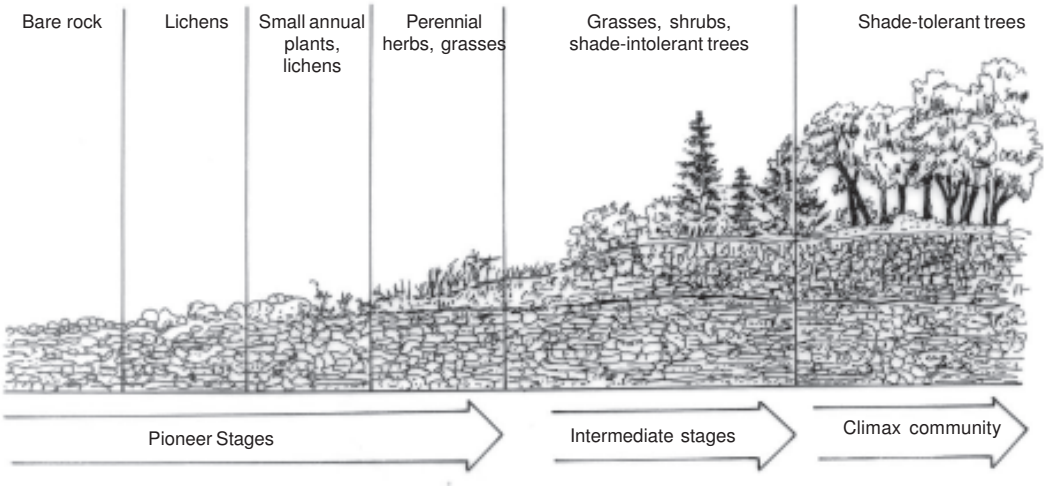

Fig 4.15: *The orderly sequence of primary succession*

Primary succession is much more difficult to observe than secondary succession because there are relatively very few places on earth that do not already have communities of organisms. Furthermore, primary succession takes a very long time as compared to secondary succession as the soil is to be formed during primary succession while secondary succession starts in an area where soil is already present.

The community that initially inhabits a bare area is called **pioneer community**. The pioneer community after some time gets replaced by another community with different species combination. This second community gets replaced by a third community. This process continues sequence-wise in which a community replaced previous by another community. Each transitional (temporary) community that is formed and replaced during succession is called a stage in succession or a seral community (Fig. 4.16). The terminal (final) stage of succession forms the community which is called as **climax community**. A climax community is stable, mature, more complex and long lasting. The entire sequence of communities in a given area, succeeding each other, during the course of succession is termed **sere** (Fig 4.16).

The animals of such a community also exhibit succession which to a great extent is determined by plant succession. However animals of such successional stages are also influenced by the types of animals that are able to migrate from neighbouring communities. A climax community as long as it is undisturbed, remains relatively stable in dynamic equilibrium with the prevailing climate and habitat factors.

Succession that occurs on land where moisture content is low for e.g. on bare rock is known as **xerarch**. Succession that takes place in a water body, like ponds or lake is called **hydrarch**.

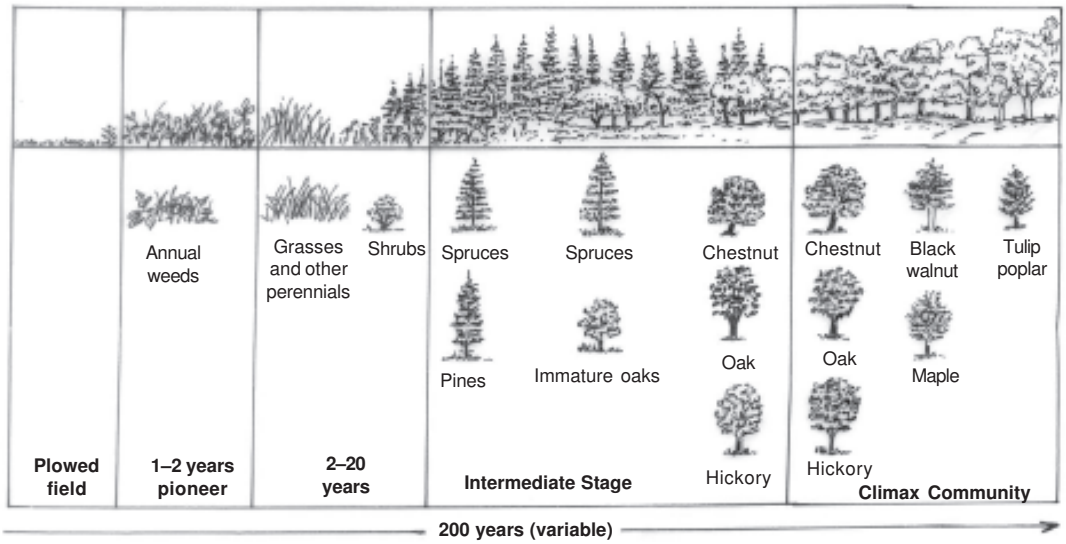

Fig. 4.16: *Secondary succession on land*

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4.10.2 Secondary succession

Secondary succession is the development of a community which forms after the existing natural vegetation that constitutes a community is removed, disturbed or destroyed by a natural event like hurricane or forest fire or by human related events like tilling or harvesting land.

A secondary succession is relatively fast as, the soil has the necessary nutrients as well as a large pool of seeds and other dormant stages of organisms.

INTEXT QUESTIONS 4.4

1.Explain in brief (one to two sentences) the following ecological terms:

(i) Succession._____

(ii) Pioneer species. _____

(iii) Climax community _____

(iv) Secondary succession _____

4.11 BIOTIC INTERACTION

The biological community of an area or ecosystem is a complex network of interactions. The interaction that occurs among different individuals of the same species is called **intraspecific interaction** while the interaction among individuals of different species in a community is termed as **interspecific interaction**.

Interactions between organisms belonging to the same trophic level often involve competition. Individuals of population may compete for food, space and mates. For example if a mouse has been eaten by a cat, other cats competing for this resource would have one less mouse to prey on. The snake another predator of the mice would also have fewer mice to eat during the night if the cat has succeeded. Direct competition though, between the cat and snake is not much as they prey at different times. They also eat a variety of different foods. So competition may be intraspecific as well as interspecific.

Interspecific relationship may be direct and close as between a lion and deer or indirect and remote as between an elephant and a beetle. This is because interactions between two species need not be through direct contact. Due to the connected nature of ecosystems, species may affect each other through intermediaries such as shared resources or common enemies. Specific terms are applied to interspecific interactions depending upon whether the interaction is beneficial, harmful or neutral to individuals of the species. The various possible interactions between two species are given in Table 4.1.

Table 4.1: Possible biological interactions between two species.

S. No.	Type of interaction	1 Result of species 2		Effects of interaction
I.	**NEGATIVE INTERACTIONS**			
i.	Amensalism	0		one species is inhibited while the other species is unaffected
ii.	Predation	+		Predator–prey relationship: one species (predator) benefits while the second species (prey) is harmed and inhibited.
iii.	Parasitism	+		Beneficial to one species (parasite) and harmful to the other species (host).
iv.	Competition	0		Adversely affects both species
II.	**POSITIVE ASSOCIATIONS**			
i.	Commensalism	+	0	One species (the commensal) benefits, while the other species (the host) is neither harmed nor inhibited
ii.	Mutualism	+	+	Interaction is favourable to both species
III.	**NEUTRAL INTERACTIONS**			
i.	Neutralism	0	0	Neither species affects the other

+ =beneficial; – = harmful, 0 =unaffected or neutral

- Some types of interactions listed by the effects they have on each partner. 'O' is no effect, – is detrimental and + is beneficial.

4.11.1 Types of Interactions

From the table you can see that in certain types of interspecific associations at least one of the species is harmed by the other. Such associations are termed as negative, in case where both the associated species are benefited is a positive association and when the associated species are neither benefited nor harmed represents a neutral interaction and include:

1. **Amensalism**: This is a negative association between two species in which one species harms or restricts the other species without itself being adversely affected or harmed by the presence of the other species. Organisms that secrete antibiotics and the species that get inhibited by the antibiotics are examples of **amensalism**. For example the bread mould fungi *Pencillium* produce penicillin an antibiotic substance which inhibits the growth of a variety of bacteria. *Pencillium* benefits apparently by having greater availability of food when the competition because of the bacteria is removed.

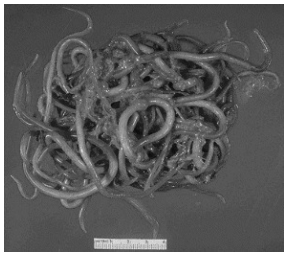
2. **Predation:** In this type of interaction **predator** captures, kills and eats an animal of another species called the **prey**. The predator naturally benefits from this relationship;

while the prey is harmed. Predators like leopards, tigers and cheetahs use speed, teeth and claws to hunt and kill their prey.

3. **Parasitism:** In this type of interaction, one species is harmed and the other benefits. Parasitism involves parasite usually a small size organism living in or on another living species called the **host** from which the parasite gets its nourishment and often shelter. The parasite is benefited and the host is harmed. Many organisms like animal, bacteria and viruses are parasites of plants (Fig. 4.18a) and animals (Fig. 4.18b). Plants like dodder plant (*Cuscuta*) (Refer again to fig. 4.18a) and mistletoe (*Loranthus*) are parasites that live on flowering plants. Tap worm, round worm, malarial parasite, many bacteria, fungi, and viruses are common parasites of humans.

(a) (i) Dodder, a parasitic plant is eating up a bush

(ii) Dodder, a leafless parasitic plant, growing on the leaf of a grass tree



(b) *Ascaris lumbricoides* infections. A mass of large round worms from a human infestation.

Fig. 4.17: *Parasite-host relationship (a) Plant parasite: Dodder (Cuscuta) plant is a parasitic weed that obtains moisture and nourishment by attaching to a green, living plant. (b) Animal parasite: Ascaris or round worms are internal parasites found in the human intestines*

4. **Competition**: This is an interaction between two populations in which both species are harmed to some extent. Competition occurs when two populations or species, both need a vital resource that is in short supply. The vital resource could be food, water, shelter, nesting site, mates or space. Such competition can be: (i) interspecific competition-occurring between individuals of two different species occurring in a habitat and (ii) intraspecific competition-occurs between individuals of same species.

Intraspecific competition occurs between members of the same species and so it is very intense.

5. **Commensalism:** In this relationship one of the species benefits while the other is neither harmed nor benefited. Some species obtain the benefit of shelter or transport from another species. For example sucker fish, remora often attaches to a shark by means of its sucker which is present on the top side of its head. This helps the remora get protection, a free ride as well as meal from the left over of the shark's meal (Fig. 4.18). The shark does not however get any benefit nor is it adversely affected by this association. Another example of commensalisms is the relationship between trees and epiphytic plants. Epiphytes live on the surface of other plants like ferns, mosses and orchids and use the surface of trees for support and for obtaining sunlight and moisture. The tree gets no benefit from this relationship nor are they harmed.

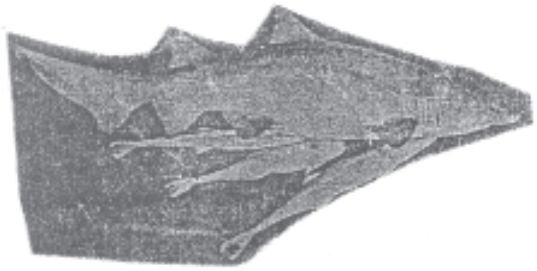


Fig. 4.18: *Commensalism: A shark with suckerfish*

6. **Mutualism:** This is a close association between two species in which both the species benefit. For example of protocorporation the sea anemone, a cnidarian gets attached to the shell of hermit crabs for benefit of transport and obtaining new food while the anemone provides camouflage and protection by means of its stinging cells to the hermit crab (Fig. 4.19).

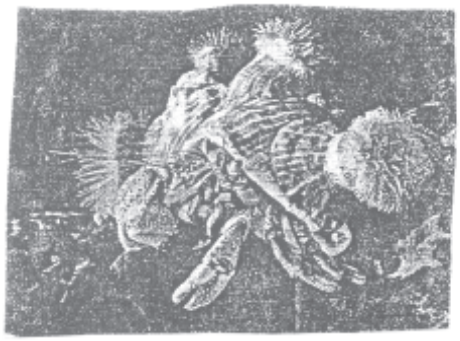


Fig. 4.19: *Sea anemone, attached to a shell inhabited by a hermit crab*

However, some mutualisms are so intimate that the interacting species can no longer live without each other as they depend totally on each other to survive. Such close associations

Notes

are called **symbiosis**. An example of such close mutualistic association is that of termite and their intestinal flagellates. Termites can eat wood but have no enzymes to digest it. However, their intestine contains certain flagellate protists (protozoans) that have the necessary enzymes to digest the cellulose of the wood eaten by termites and convert it into sugar. The flagellates use some of this sugar for their own metabolism while enough is left for the termite. Both termite and flagellates cannot survive without each other. Another familiar example of symbiosis is seen in pollination of flowers where flowering plants are cross pollinated by the bees which benefit by getting nectar from the plants and both cannot survive without the other.

7. **Neutralism:** Neutralism describes the relationship between two species which do interact but do not affect each other. It is to describe interactions where the fitness of one species has absolutely no effect what so ever on that of other. True neutralism is extremely unlikely and impossible to prove. When dealing with the complex networks of interactions presented by ecosystems, one can not assert positively that there is absolutely no competition between or benefit to either species. Since true neutralism is rare or non-existent, its usage is often extended to situations where interaction are merely insignificant or neglible.

INTEXT QUESTIONS 4.5

1. Define (a) ecological succession, (b) symbiosis

   _____

2. What type of competition exists between members of a deer herd in an area?

   _____

3. What type of relationship is represented by a garden spider feeding on a grasshopper?

   _____

4. What type of relationship is represented by a flower being pollinated by a butterfly?

   _____

5. Which term best fits the relationship of a person who has a lice feeding on his scalp?

   _____

6. Which term means two species live together with each providing a benefit to the other through the relationship?

   _____

WHAT YOU HAVE LEARNT

- Ecology may be defined as the scientific study of the relationships between each other and with their environment. The term ecology was coined by Ernst Harckel in 1869 .
- Ecology encompasses study of individual, organisms, population, community, ecosystem, biome and biosphere which form the various levels of ecological organization.
- Habitat is the physical environment in which an organism lives (it corresponds to address of an organism).
- Niche refers to the functional position of a species in its habitat.
- Species is a group of populations whose individual members are capable of interbreeding with each other to produce a fertile offspring.
- Evolution is the change which gives rise to new species. Mutation and recombination are sources of 'variation' or differences in the genetic make up or gene pool of a species. Natural Selection is the mechanism proposed by Darwin and Wallace which interacts with variation to cause greater reproduction of these genes which help in adaptive to the environment.
- Thus Evolution results in adaptation.
- Evolution leads to speciation or formation of new species. Isolation is the factor which supports specimen. Isolation is of two major types (i) geographical isolation (ii) reproductive isolation.
- Many species, however, have been lost forever and not a single individual belonging to these species which once existed are now present. Extinction may occur due to catastrophic events in nature or due to human activities.
- Population is a group of interbreeding individuals found in a specific time in a particular geographical area. The characteristics of a population become evident through the (i) population density (ii) birth rate or natality (iii) death rate or mortality (iv) dispersion (immigration and migration) (v) age distribution (vi) sex ratio.
- Ecological succession is the successive growth of primary succession occurs in an area where there is no previous community. Secondary succession forms on existing natural vegetation.
- Biotic interaction refers to the interaction taking place between individuals belonging to the same species (intra specific) or different species (interspecific). Examples are (i) competition (ii) predation (iii) parasitism (iv) mutualism (v) symbiosis (vi) commensalism (vii) neutralism

Notes

TERMINAL EXERCISE

1. Define the terms : Ecology, niche, species, extinction.
2. What do you understand by 'Variation and Natural Selection'? In what way do they interact to cause evolution?
3. What is the role of isolation in the formation of new species and keeping them distinct.
4. In what ways have humans caused the extinction of species?
5. What do you understand by (i) natality (ii) speciation (iii) mutation (iv) extinction
6. Explain 'ecological succession'.
7. State and explain community characteristics.
8. What are (i) climax community and (ii) pioneer species?
9. Write an essay on biotic interaction.
10. Define biotic Interaction. Describe any one type of positive, negative and neutral quotation.

ANSWER TO INTEXT QUESTIONS

4.1

1. Ecology means the scientific study of the relationship of living organisms with each other and with their environment.
2. The term niche means the sum of all activities and relationship a species has while obtaining and using the resources it needs to survives and reproduce.
3. Habitat is the physical environment where an organism lives while niche is the sum of all activities and relationship of a species

4.2

1. The appearance or behaviour or structure or mode of life of an organism that allows it to survive in particular environment.
2. Species – a group of similar populations of organisms whose members are capable of inter breeding to produce fertile offspring.

   Variation- differences in structure due to differences in gene combinations.
3. (i) Gene combination (ii) Mutation

4. Natural selection
5. Speciation- is the process by which new species are formed and extinction is dying out of a variety of or a species.

4.3

1. A Group of freely interbreeding individuals of the same species present in a specific area at a given time.
2. i) Density of the population

   ii) Natality

   iii) Mortality (any other)
3. Mortality, natility, immigration, emigration

4.4

1. (i) Succession is the orderly change of organisms in an environment over time.

   (ii) Pioneer species is the name use for the first time assemblage of plants that inhabit as area undergoing changes during succession. They are the first species in successional process.

   (iii) Climax community is the final stage of succession. It is a relatively stable, long lasting community.

   (iv) Secondary succession is the term used for the orderly series of change s that begins with the disturbance of an existing community and leads to a climax community

4.5

1. The interacting species can no longer time without each other as they depend totally on each other to survive.
2. Intraspecific competition
3. Predation as it is preying upon or eating the grasshopper.
4. Mutualism as both are helped by the relationship.
5. Host
6. Mutualism