UNIT 15 COMPONENTS OF ENVIRONMENT

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15.1 INTRODUCTION

In Unit 14 you have studied some basic aspects of existence of life on earth. You have seen that the living beings together with their environment constitute an ecosystem. In this unit, we shall discuss three important components of earth's environment, namely: oceans, atmosphere and forests. Each of these components constitutes an ecological system having distinctive features. Their environmental conditions are very different, accordingly the forms of life occurring in these systems are also unique. We shall also discuss how, over the years, these systems have been affected by several of the human activities.

Objectives

After studying this unit you should be able to :

- describe three components of the earth's environment, that are: oceans, atmosphere and forests; and compare their features,
- explain some of the salient ecological processes associated with oceans, atmosphere and forests,
- identify and list the kind of damage done to the above mentioned environmental components by industries, transport, agriculture and other human activities.

15.2 THE OCEANS

Every year, millions of people all over the world make their way to the sea-shore to enjoy the cool sea breeze, to bathe and swim. Ecologically speaking, oceans are the oldest and the largest ecosystems of the earth. The Atlantic, the Pacific, the Indian, the Arctic and the Antarctic are the major oceans of the world. Though they cover varying geographical areas, these are all interconnected and have certain common features. Before discussing these features, we would like to point out that in this unit, we would be using the terms sea and ocean interchangeably.

15.2.1 Some Physical Features of the Oceans

The oceans are so vast that they stagger one's imagination. They cover more than 70 per cent of the earth's surface. The depth of oceans varies, from shallow near the coasts to deep in the middle. There are trenches, valleys, and what may be called hills under the ocean waters. The deepest part happens to be in middle Pacific Ocean and its depth is greater than the height of Mount Everest—the highest peak in the world.

Ocean waters are never still. Wind exerts frictional force on the surface of water and generates waves that keep the surface water in motion. Tides are another type of movement of the oceanic water, noticeable in coastal regions. Water level of sea rises and falls twice a day. The gravitational pull of the sun and the moon, is the principal cause of the formation of tides. Coastal waters rise to a high point called the high tide, when the sun and the moon are on the same side of the earth, and the tide is low when the sun and the moon happen to be on the opposite sides. Ocean currents are yet another form of water movement. Currents are generated in several ways : by changes in the density of sea water, due to temperature differences, by the effect of earth's rotation and also prevailing winds. These currents transport sea water over long distances, more or less like rivers on the surface of the earth.

Ocean water is salty. It has about 35 parts of salt (by weight) per 1000 parts of water. Ordinary salt or sodium chloride is the major salt component of the oceanic water. Salts of magnesium, calcium and potassium are also present. This substantial amount of salt in sea water, is the result of accumulation of small bits of salt that are carried by rivers from the lands they drain.

Oceanic waters have a minimum temperature well below zero Celsius, near the poles, and a maximum of about 28 Celsius in the tropics.

Another aspect of marine environment is pressure. The atmosphere exerts a pressure of about 1 kilogram per square cm (= 1 Atmosphere Pressure) at the surface of the sea or land. This pressure increases due to the weight of water by 1 Atmosphere, for every 10 metres of the depth of water. Thus, if you are at a depth of 3000 metres in the ocean, the pressure there would be 300 times that at the earth's surface. It would be quite impossible for human beings to survive at this depth without very special equipment.

15.2.2 Life in the Oceans

Oceans are known as the largest and the thickest ecosystem. Tiny plants and animals exist in it, in immense numbers. A cubic meter of sea water may contain as many as 200,000 organisms. Living forms occur, more or less, throughout the depth of the oceans, but they are more dense around the margins of continents and islands.

The major factors that limit the quantity, and type of life in oceans are energy and nutrients. You have already studied that for all forms of life, energy is provided by sunlight either directly as in the case of plants, or indirectly to other forms of life via the plants. In oceanic waters, the intensity of light decreases rapidly with depth. Even in the clearest and the purest water, there is hardly any light available at a depth of 200 metres, and photosynthesis cannot be sustained. Therefore, plants are only found in under water zones where light is available. You must be wondering as to how do the plants keep themselves in the lighted zone? They have developed certain floating devices such as oil droplets in their cells or air filled sacs that help them to float in the upper layers of water. These plants are of numerous kinds, some are tiny and microscopic, free floating (see Fig. 15.1) and they drift with water, whereas others are comparatively large and are fixed to the substratum. One of the factors governing their distribution, is the quality of light. We have just seen that sunlight penetrates to only a certain depth in water. In the spectrum of colours which sunlight has, red is absorbed in the top layers of water, and then green; blue penetrates farthest. Naturally algae of complementary colours exist at various depths in water. Green is complementary to red, hence green algae predominates in the upper layers of water; similarly brown algae are a little deeper down, and red algae prevail in regions reached by blue light.

What about the animal life? They too exhibit zonation, i.e., they are also distributed zone-wise (also see Fig.15.1). In the upper layers, small animals (zooplankton) co-exist with phytoplankton and derive energy from them. A little below, the energy for animal life is obtained from wastes and dead bodies of organisms that sink, or from the living animals that swim down.

The dead bodies that drift down from above, fall very slowly. For example, a small shrimp may take a week to reach 3000 metres. The rate of descent of organic matter, except for larger ones, is so slow that it is either consumed, decayed or dissolved before it reaches the deep waters or the bottom of the sea. Thus, as we go down in the ocean, the food becomes scarce. Beyond the depth of 200 metres or so, light does not penetrate and plants do not grow there. Hence the plant feeders have to be good swimmers, to get their food. Some of them come to the upper layers of water, take their food and go back. As you descend further, or below 600 metres, not only is sunlight absent but also the temperature drops, and the

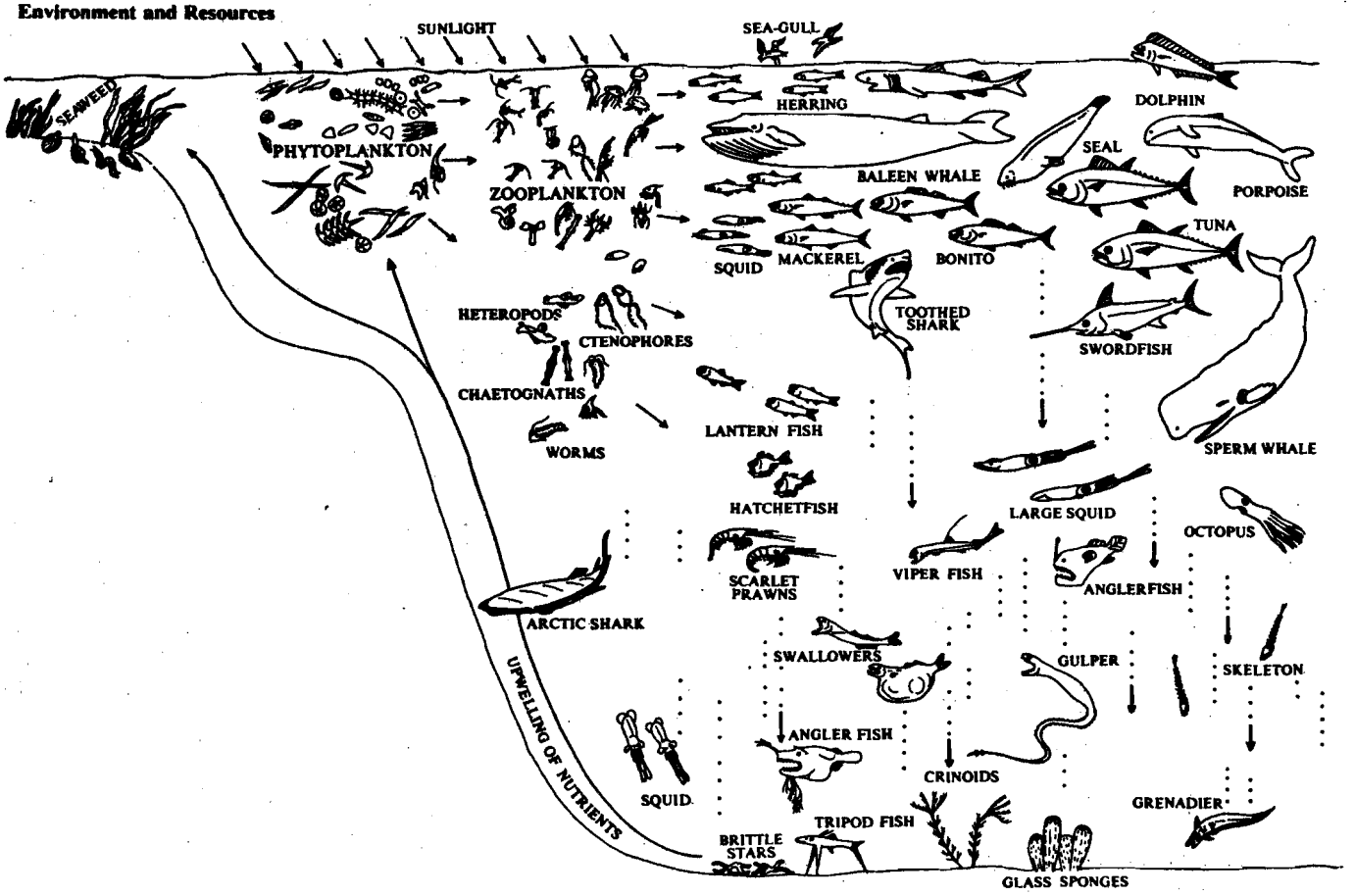

Fig.15.1: Life in ocean. Most of the basic organic material, 'food', that fuels and builds life in the sea is synthesised by phytoplankton (phyto=plant; plankton=wandering) within the surface layers of sea water where light is available. These microscopic plant cells are eaten by the herbivorous zooplankton (zoo=animal; plankton=wandering) and by some small fishes, which in turn are eaten by the other carnivores. The 'rain' of the wastes and dead bodies of organisms occurring in the upper layers of water, shown by dots and short downward arrows, serves as the principal source of food for the varied inhabitants of the lower oceanic depths. In the shallower zone, food is available from the growing, large, fixed plants, and the drainage from the land. The typical coastal upwelling (long arrows at left) refertilises the surface waters with nutrients of organic matter, by the decomposer organisms such as bacteria etc., from near the bottom. This process keeps the surface waters continually supplied with nutrients, leading to the survival and growth of phyto-, and zoo-plankton in the upper layers.
Note: the organisms, and depths are not drawn to the same scale.

pressure increases. Here too, life exists. There are more than 2000 species of fish and other animals living at this depth. Let us see how these organisms have adapted to these difficult conditions.

In this totally dark zone, many organisms produce their own light and this phenomena is known as biolumninescence. This helps them to capture their prey or lure the opposite sex. Certain sponges, jellyfish, combjellies, snails, worms, brittlestars, squids, deep-sea shrimps and prawns emit light. These light emitting organisms harbour certain bacteria, which are the source of light. Colonies of these bacteria live in special pouches on the organism's body. For example, in a fish, they exist on the side of the head, at the end of their tail or on the sides of their body. When light is not required, the fish raises opaque shutters, or restricts the supply of blood to the light-producing bacteria. The light produced by these bacteria are usually of blue, green or yellow colour.

Besides the adaptations to cope with the scarcity or absence of light, some of the organisms have also developed ways for counteracting high pressure at greater depths. At such high pressure, bones and shells containing mainly calcium, like in the surface animals, would disintegrate. So, the skeleton of organisms is made up of silica which enables them to withstand this high pressure. Ear bones of whales, jaws of squids and teeth of shark contain silica, so that they are more sturdy.

In a world that lacks any sort of protection, or defense against predation, the living beings have acquired various bodily features and means of self defense as well as means for securing prey. Among them, are the remarkably stream-lined body that enables them to move with speed both for escape and pursuit, unusual colouration and highly developed sense of smell and hearing.

Availability of Nutrients

The nutrients in the upper layers of water are constantly being taken up by the phytoplankton, who are the producers, and then these pass on to the herbivores, and the carnivores. When these latter organisms die, they are either eaten up by other animals or they get decayed by the decomposers. Some of the decomposed matter sinks to the ocean floor. It means, the nutrients taken up by the producers from the upper layers of sea water are constantly being drained to the lower layers of sea water. Do you know what would happen if the nutrients in the upper layers of water are not replenished? There would be no phytoplankton and photosynthesis; no production of food to sustain other animal life. Hence all the organisms would die. Actually, in nature such a situation does not arise. Let us see how a constant supply of nutrients in the upper layers of water is ensured. There are two ways: (i) As rivers end in the seas, they bring along a lot of refuse and nutrients from the land to the water. (ii) 'Upwelling' takes place, which is a process by which deep, nutrient rich waters are brought to the surface. What actually happens is that wind blows surface water on to the shores. The water which now comes to the surface is from below. It is cold and high in nutrient content. Regions where upwelling takes place are very productive. That's why important commercial fisheries in the world are situated in such regions.

Do you know why some oceanic waters appear blue and other green? The clear, blue waters are usually poor in nutrients and hence there is less concentration of plankton in the water. Nutrient-rich waters that support a large plankton community are greenish and relatively murky, as sunlight is scattered by the microscopic bodies of numerous, small living beings in water.

15.2.3 Ecological Crises in Oceans and Coasts

Coastal and marine areas all over the world including those in India are under stress, because two thirds of the world's population lives near the coasts, and 60% of the marine food is harvested from the zone near the coasts. Most of the sewage, garbage and industrial wastes find their way into the sea. Ever since the Industrial Revolution, technology has been developed to increase production of various kinds of goods, without regard to where the smoke from the chimneys would go, or where various kinds of washed chemicals—many of them poisonous would flow to. So industry produces massive amounts of "waste" which is allowed to reach the sea. It was also thought in earlier times that the sea is so big, you can throw anything into it without affecting it. Now, however, even in India, it has come to pass that huge quantities of dead fish were found floating in the Arabian sea on the western coast, due to poisonous outflows from a fertiliser factory. Such happenings are not rare, and industrial wastes must be treated to remove harmful chemicals, before allowing them to go into the sea. The same should be done to sewage, which carries harmful chemicals and bacteria into sea water.

The rivers, which join the seas, bring sand from the hills and plains, and thus lot of silt gathers near the coasts. Rivers also bring to the sea water, runoff from the fields, which, today, means a certain amount of fertilisers and pesticides.

A new factor has recently come to light and that is chemicals from nuclear power plants and nuclear industry. This waste has radioactive chemicals which can demolish and destroy living organisms in ocean waters. Huge amounts of such waste is generated every year, particularly, in the advanced countries of the world, who have found ways of dumping this waste in the coastal areas of the poor countries.

A number of times it has been reported that ships, particularly tankers, transporting oil leave a trail of oil along their routes. A thin layer of oil thus covers wide areas of the surface sea water, depriving living organisms of oxygen. We mention below in Table 15.1, the position in this respect on the Indian Coast.

Table 15.1: Marine Pollution in India

S.No:	Area	Type of pollution
1.	Gulf of Kutch and coast of Gujarat	Natural sedimentation due to erosion of coast. Deposition of wind-borne sand. Pollution from salt-making industry. Destruction of plants growing on coasts, for firewood and fodder.
2.	Western Coast (from Bombay to Kerala)	Oil drilling and oil spilling from tankers. Pollution from factories. Runoff from uplands. Invasion of weeds like *Salvinia* which is common in Kerala. Destruction of mangroves, exploitation of fossil fuels, and dredging for deepening the navigation channel.
3.	Gulf of Mannar and Palk Bay along the southeast coast	Quarrying of corals for industrial uses.
4.	Lakshadweep	Excessive siltation in lagoons. Construction along the coast. Deforestation as in Minicoy. Increase in predators like *Acanthaster planci* on coral polyps.
5.	Hoogly Estuary	Untreated industrial wastes from more than 150 major factories around Calcutta, including 87 Jute mills, 12 Textile mills, 7 Tanneries, 5 Paper and Pulp factories and 4 Distillaries, pours into the river continuously.

We must remember that the seas are precious ecosystems for marine life and they provide food and livelihood to millions of people in the world. Medicines are also being developed from ocean flora. It is natural, therefore, that every step be taken to protect marine life and reduce pollution going into the sea. Recently large ball-like concentrates of minerals called nodules have also been found on sea bed. Some of these nodules are rich in economically important minerals like nickel and chromium. However, 'mining' for these nodules at these great depths needs high technology. India has already started taking initiative in this area.

SAQ 1

Fill in the blanks selecting appropriate words given below:

i) ..... are the largest and the thickest ecosystems of the earth.

ii) ....., ... and..... are the types of water movements commonly seen in the seas.

iii) ..... and ..... are the major factors that govern the quantity and type of life occurring in oceans.

iv) The ..... bring minerals and essential substances from deep water to the surface.

v) Oceanic waters that have high nutrient content, and support large variety of planktons appear .....

(tides, energy, waves, greenish, nutrients, oceans, currents, upwellings)

15.3 THE ATMOSPHERE

Atmosphere is an envelope of the most useful gases that cover the planet earth. It makes our planet unique and enables life to prosper. If the earth did not have an atmosphere we wouldn't have oxygen to breathe, and the plants wouldn't have carbon dioxide to make food from. The rays from the sun would have scorched our planet during the day, and temperatures would have fallen far below the freezing point at night. No living organism would have survived in such a situation. You have already studied how earth's atmosphere has evolved. Let us see, what are the important features of the atmosphere.

15.3.1 Some Physical Features of the Atmosphere

i) The atmosphere is a mixture of gases. It is made up of 78.08% nitrogen; 21% oxygen by volume. There is only 0.03% of carbon dioxide, and small amounts of a few other gases. The presence of a thin layer of ozone is important for life on the earth. We also

find in the atmosphere, a considerable amount of water vapour that evaporates from oceans, lakes and rivers etc. Now, let us talk in detail about some of the important gases constituting our atmosphere.

Oxygen, a constituent of air is also called the breath of life. Without it, the chemical processes that sustain life are not possible. Human beings can live without food and water for some time, but not without oxygen for more than a few minutes. It is only oxygen in the air that makes combustion or burning possible. Burning of fuel produces heat, that is used for cooking food, for running automobiles, in industry and for various other purposes.

Nitrogen is another important constituent of the atmosphere, and forms the great bulk of air we breathe. We cannot breathe pure oxygen for any length of time. If fire ever breaks out in an atmosphere of pure oxygen, it would be difficult to put it off. Thanks to the presence of nitrogen in air, such disastrous situations do not arise.

Another very crucial constituent of the atmosphere is carbon dioxide. In Unit 14, you have already studied that plants utilise this gas in the manufacture of food through the process of photosynthesis. The food thus produced serves as a source of energy for other organisms.

The other gases, namely, argon, helium, krypton etc. are also present in the air. These are called inert gases, because they do not react with other substances.

As we have already said in Unit 12, there is an ozone layer about 25 kilometers above the earth's surface. Ozone is a form of oxygen. Each molecule of ozone contains three atoms of oxygen (0_3) while there are only two atoms in the ordinary oxygen (0_2) molecule. The ozone layer plays a protective role, as it absorbs a great deal of ultraviolet rays of sunlight coming to the earth, and saves us from skin burns and other harmful effects.

ii) Besides gases, dust particles and smoke there are numerous forms of life in the atmosphere (see Subsection 15.3.2 for more details).

iii) The density of the air decreases as one goes up from the surface of the earth and at around 4000 meters it is difficult for man and many other animals to survive without supply of additional oxygen.

15.3.2 Life in Atmosphere

Just like the earth, the atmosphere also sustains life. Various types of insects and mites, birds, bats and other organisms are some of the forms that you all might have seen. They effectively use air as a medium for several of their activities, such as, flying and catching their prey. Organisms like bats and birds are skilled aeronauts. In order to remain in the air, they have developed wings and powerful muscles to move them. Some of the birds have very good eyesight. They also have other well developed structures such as claws etc. for grabbing and holding their prey. Have you ever seen large birds like an eagle, catching small birds flying in the air? It is worth watching. The eagle comes flying from a distance, dives at great speed and pounces on the prey, holds it firmly in its claws and flies away to a quiet place, to sit and eat it. Birds usually fly too close to the land in search of food, but sometimes, they even fly at heights of about 1500 metres. The migratory birds that travel long distances while moving from one continent to the other, fly at an unbelievable height of about 6000 metres. They come to this height, to take advantage of the winds that are usually stronger and steadier there, than those at lower altitudes. These birds fly along the wind currents, and thus save a lot of energy and effort.

Besides the large organisms that we can see with our naked eyes, the air also carries a very large variety of life forms that we can only see with the help of a microscope. Spores of plants such as fungi, mosses, ferns, pollen grains of various types, bacteria and viruses are also found floating in the air. Also there are tiny seeds of many plants. The presence of fungal spores in the air can be demonstrated by leaving a piece of bread in open for a few days. It would show small, sometimes velvety patches of various colours. All these are fungi of various kinds, whose spores were floating in the air, and have started growing on the bread.

Similarly, in places, where there are no human settlements nearby, we find small plants of different types occurring in groups. And also, soon after volcanic eruption, when the lava cools, many kinds of plants appear on this lava. You may wonder how did these plants arrive here. Their seeds or spores that are present in air, establish on these new areas where favourable conditions for growth are available, and they form small groups.

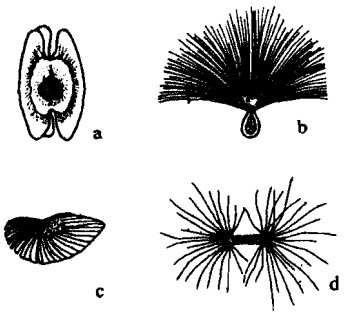

Fig.15.2: Seeds with wings (a, b) and hairs (c, d). (a) Drum stick, (b) Crepe tree, (c) Madar, (d) Devil tree.

The fungi and other plants whose spores or seeds are carried by the air, produce in huge numbers so that at least a few of them can reach places where the right kind of conditions for growth, such as water, sunlight etc. are available and these seeds or spores are able to develop into adult plants. This is an adaptation to ensure the survival of species. Seeds which are dispersed by wind have special features such as hairs on their surfaces, wing-like structures and light weight (see Fig.15.2). Having well developed mechanisms to float in air, some of the spores, seeds or pollen grains are taken to great heights by the air currents. So one can also find life forms even at great height.

You may have noticed sometimes, that some people are suddenly seized with a fit of sneezing, watery eyes, rash on the skin and even difficulty in breathing. This condition is referred to as allergy. What causes it? Some forms of allergy are caused by certain spores or pollen (see Fig.15.3) present in the air, that cannot be seen with unaided eye. Hay fever – a form of allergy, develops by inhalation of pollen of certain trees, grasses or weeds. All these are carried by wind and affect the sensitive persons.

Having talked of some physical features of atmosphere and the kind of life it sustains, we shall now briefly discuss the kind of damage done to this ecosystem.

15.3.3 Ecological Crises

The natural atmosphere which man has inherited from the past, with healthy and fresh air, shielding from excessive radiation of the sun, has been deteriorating both under the impact of increased population and industrialization. Factories pump millions of tons of dust and smoke into the air, cars and buses spread fumes and stir up dust from the roads into the air, and sprays used to kill agricultural pests all combine to change the ideal picture. The pollution of the air has become a matter of great concern because it continues to increase as "civilization" spreads. Near big cities and heavily industrialized areas, the situation has become so bad that the birds have become rare, and the air is not fit for breathing. Rural areas are beginning to be affected. Society will have to move towards strict pollution control, and protection of the atmosphere as it is a great and irreplaceable resource for living. In the next unit you would study in detail the type of damage done to this component of the earth's environment.

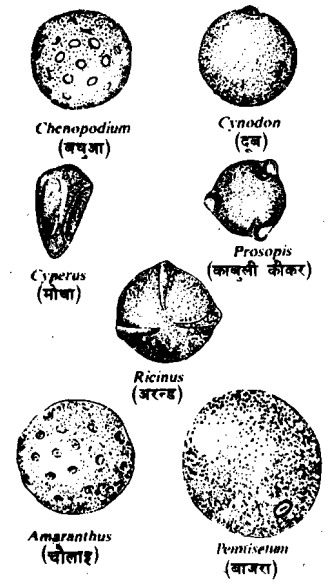

Fig. 15.3: Some pollen grains that cause allergy

SAQ 2

Fill in the blanks, selecting the right word from the list given below :

i) ..... is a blanket around the earth, that protects it from scorching during the day and freezing during the night.

ii) A layer of ..... present about 25 km from earth's surface absorbs a great deal of incoming..... rays of the sunlight.

iii) ..... also known as the breath of life, is essential for the chemical processes that sustain life.

iv) The life found in the atmosphere includes several kinds of ....., ..., ... and ..... .

v) At a height of about 4000 metres, it is a difficult for people to survive without the supply of additional ..... .

(pollen grains, oxygen, atmosphere, seeds, ozone, microbes, ultraviolet, spores, oxygen.)

15.4 THE FORESTS

Forests represent a well-organised, dominant and highly evolved community of living organisms on this planet. Over one third of the total land area of the world is covered by one or an other kind of forest. Forests represent nature's major processors of solar energy and about 90% of the total global biomass. These are located in all the geographic regions of the world, except in the polar areas.

15.4.1 Some Features of the Forests

Forests are the most widespread stretches of vegetation, harbouring diverse kinds of life forms. They are dominated by trees. Besides trees, forest ecosystem includes various types of small plants, mosses, ferns, fungi, several kinds of micro-organisms, insects, reptiles,

birds, mammals and animals of diverse kinds. All these live under the soil or on it, and in the water and air of the forest. Each organism is a part of the forest ecosystem, and each reacts with all the other organisms. But all require the energy to survive, which is provided by the sun and trapped by the foliage. Forests possess multi-layered structure termed as stratification (Fig. 15.4). This makes available space for living for a wide variety of plant and animal species. For example, there are small, tender plants, that form the lower most layer. Then there are small shrubs which form the second layer. A third layer may consist of small trees. And the tall trees that form roof or canopy of the entire vegetation may constitute the fourth layer. Various kinds of animal life, depending on their living habits, occur in different layers of vegetation.

15.4.2 Life in Forests

Trees are the pillars of the forest upon which much of the other forest life is shaped. Associated with them, there may be more than a thousand kinds of shrubs, vines, herbs, ferns, mosses, and toadstools, even in a small area of a forest. Using trees as support, the smaller plants grow in their shade, and depend on the high humidity that the canopy of leaves maintains. As we have said above, all these constitute different layers of vegetation. In addition, the forest consists of all sorts of animals such as, birds, amphibians, reptiles and mammals. Forests are also the house of a variety of insects, mites etc. Some seek nectar from the flowers, others feed on green leaves and tender parts of plants, some bore deep holes in the wood, some form mines in the plant tissue and so on. Ants and termites are everywhere. It is a very rare forest that does not harbour a dazzling collection of beetles, butterflies, grasshoppers, spiders, scorpions and other insects. The abundant insects constitute the prime food for birds. Man too is a member of the forest community – and probably is the most destructive of all! Men are mostly intruders, who go into the forest for collecting wood or even for cutting down trees to prepare land for cultivation. There are, however, small segments of human population known as tribes, who live in the forests. They have perfect adaptation to the environmental conditions of forest life.

Let us have a closer look at the forest and its life. First we shall see what is there on the forest floor. The dead leaves, twigs and fallen branches lie in heaps on the forest floor. At a casual glance, they appear as a lifeless rotting mass. But actually they form the cover of a hidden world of forest soil. These heaps enclose and shelter more life than can be found in any other layer of the forest. Under these, the inhabitants live, in numbers that stagger one's imagination. There are very tiny organisms such as bacteria, protozoa, algae, fungi, mites, and bigger ones like millipedes, beetles, many forms of insects and earthworms. By the activity of the micro-organisms, the dead organic matter is broken down to simple forms that mix with soil and thus become available for the plants. The occasional fires in forests due to lightning or other reasons, also help in the recovery of nutrients from the dead organic matter. Fire burns dead matter, and the resultant ash containing minerals, eventually mixes with the soil.

Besides the small creatures in the forests, there are other life forms that are much bigger in size and can be easily seen. All these have remarkably ingenious specialisations for life in forests. For example, various types of birds live on tree tops and feed on fruits or tiny insects living on plants. For this purpose, they have highly specialized beaks and claws, some of which are shown in Fig.15.5. Woodpeckers climb on tree trunks and extract insects hidden under the bark with their strong and pointed beak(Fig.15.5b). For this purpose, they also have sharp and curved claws to hold firmly to the tree trunk (Fig.15.5h). In addition different animals have adapted to noctural or diurnal habits depending on when they can easily feed and also remain protected. The owls, for example, hunt at night because that is when the rodents (rats etc.) they eat, roam about in open in search of food. The mesh of branches in the forest makes rapid movement difficult for many animals especially the large ones, like the elephant, buffalo, leopard and several others. Each of them possesses one or more adaptations for moving through the undergrowth. Some of these are: strength, weight of body, stout limbs and wedge-shaped head. Creatures like the owl, that hunt at night have large, sensitive eyes and acute hearing power. Bats, which also fly at night, locate their prey with the help of high pitched sound which they produce. This sound on reflection from even small animals, discloses their position to the bats.

Fig.15.4: A segment of a forest showing several layers of vegetation. There are tall trees, small shrubs, tender plants near the surface, and climbers that go around the tree trunks.

Forests in Different Regions of the World

Since forests occur in different parts of the world and in varying climatic conditions, we shall now see as to what kind of life occurs in the forests situated in different regions and climatic conditions of the world.

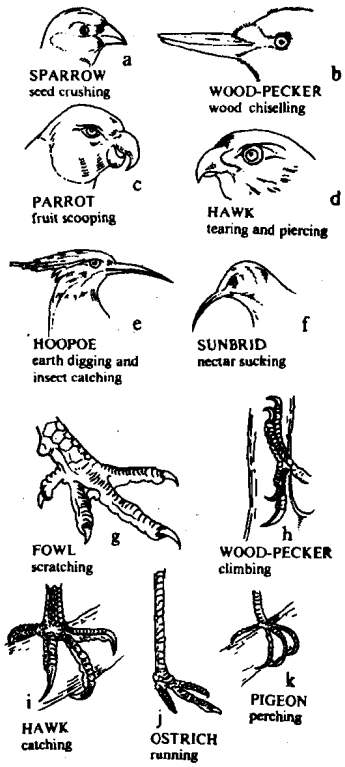

Fig.15.5 (a)–(f): A variety of beaks suited to particular modes of feeding of birds. (g)–(k): Some adaptive variations in the feet of birds.

(After Salim Ali)

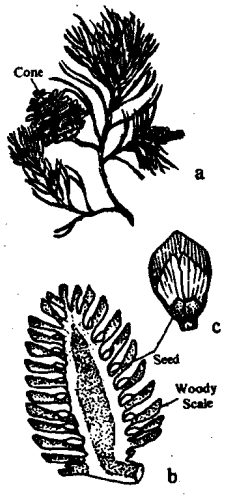

Fig.15.6(a): A pine twig with a cone, and needle-like leaves. (b) A cone cut longitudinally, shows woody scales enclosing seeds. (c) A scale with seeds has been taken out and placed in a way that it faces us.

i) Forests where the temperature drops to –40°C, have little diversity of life. The extreme cold not only threatens the tissues of trees, but denies them one of the essential supplies of life, that is water, as it gets frozen into ice. So how do these plants cope with the cold? In these regions, plants such as pines etc. are found. They have long, needle-like leaves, (Fig.15.6a), that are coated with wax. This is an adaptation to avoid snow settling on the leaves, and weighing them down. The thick wax-coating prevents loss of water, which is hard to replace in these conditions These plants also have dark leaves, that absorb maximum amount of heat from even the feeble sunshine. Depending on the plants present in the area, diversity of animal life too varies. As the leaves are hard, resinous, not easily bitten, so many insects do not touch them. But several birds extract seeds from the cones (Fig.15.6) of such trees and enjoy eating them.

ii) Now, let us see the type of life forms occurring in the areas having long winters. Most of the water tends to freeze in such conditions, and thus is not available to plants. This situation is the same as that of a drought. So what do the plants do in such a situation? Most of them simply shut down. They do this by shedding off their leaves, thereby preserving the moisture contained in the cells of their roots, trunks and branches. Plants having developed such life saving mechanisms are termed as deciduous,—a Latin word that means 'to fall off'. In such forests, during the autumn season heaps of fallen leaves may be seen everywhere in the forest. During this period, plants do not produce any new leaves, flowers or fruits.

The animals in such forests, have developed equally remarkable ways to survive the harshness of winter and long periods of food shortage. Some birds migrate thousands of miles, to areas where food is not a problem and temperature is to their liking. Some birds do not migrate, but remain inactive, lower their heart beat and breathing rates considerably. Thus they conserve a lot of energy. Some animals do not migrate but go to sleep or hibernate, for example bears curl up and sleep. The duration of sleep varies from animal to animal. During hibernation, the sleep is so deep that some of the animals will not wake up even if they are prodded and shaken.

iii) Thick forests occur in areas that receive plenty of rain and have high temperatures throughout the year, as these are the ideal conditions for abundant growth. Such forests have the richest and the most varied types of plants and animals found anywhere on the earth. In one hectare of such a forest, it is common to find over a hundred different kinds of tall trees and several kinds of small plants. The richness is not restricted to plants only. Over 1600 species of birds live in these forests, and the number of insects is uncountable. The canopy of such forests is a deep continuous layer of greenery that is, about 6 to 7 metres deep. Each leaf is so angled that it will collect the maximum amount of sunlight. As a result only little direct sunlight reaches the forest floor and so it is much darker there. Similarly because of the intense vegetation, strong winds are reduced to a gentle breeze inside the forest. Much of the rain is intercepted by the canopy. Only when the leaves are thoroughly wetted, does water drip gently to the forest floor. There are no well defined seasons, so that all the trees do not shed their leaves simultaneously. Each species has its own season for shedding leaves. Some shed leaves after every 6 months, some after more than 12 months and so on. Similarly flowering period also varies. Some plants bear flowers after 10 months, others after 12 months and so on. Therefore one finds flowers of different kinds all the year round.

The aerial plants, such as orchids and bromeliads (Fig.15.7), and intertwining vines are interesting plant types found in such warm and humid forests. These plants reach for light by climbing on taller trees, whereas intertwining vines, reach the place where sunlight is available, by supporting their trailing branches along the long tree trunks. Tiny plants also grow near the forest floor. Such plants have large and dark leaves, to trap whatever little light is available.

Because of the relative scarcity of edible plant material close to the ground, much of the animal life in such forests lives high above the ground, in the green world of the canopy. This includes numerous birds, monkeys, insects and other animals. In fact, the tree tops are alive with noise and colour of countless birds. The animals have developed certain adaptations for tree life. They have slender shapes, necessary for agile movement. These animals hunt, thieve and scavenge food materials; breed and die within the forest, without ever leaving them. The insect population flourishes in these forests, despite the intense competition for food and constant threat of being eaten by sharp-eyed birds. They have evolved several mechanisms in the form of a protective strategy known as camouflage. Whereby they assume the colour of their surroundings, and shape their bodies like leaves etc. So that they cannot be recognised easily.

iv) Forests in areas where temperature is very high in summers, have the danger of losing too much moisture. The leaves of plants growing in such areas have a waxy, water-tight surface and relatively few pores, often mainly on the underside. Many leaves hang downwards from the branches during the hotter part of the day so that they do not catch too much of sun's heat. Such trees give little shade, because of the position of their leaves and thereby most of the light reaches the ground.

In brief, we have seen that plants and animals have acquired characteristics to fit them for the different conditions in different types of forests.

Having discussed the life in forests, we shall now see what makes forests an important constituent of earth's environment. Forests not only add to the beauty of the landscape, but make the climate salubrious and provide suitable habitat for the wildlife. They are also described as environmental buffers. Forests consume large quantities of water through the roots of plants and lose it through respiration by the leaves. Extensive forests, to some extent also increase precipitation. They intercept heavy rainfall and release the water steadily and slowly to the soil beneath to prevent the soil running away with the rushing water. The roots of innumerable small plants and trees hold the soil in place.

Forests are also important, because they are the source of wood used for building purposes and for industry, that manufactures newsprint paper and plywood etc. The wood of about one hundred or more species of trees are clipped, to produce pulp for paper. Forests also supply food, fodder, fibres etc., which are the indispensable needs of people residing in or near them. They yield a wide variety of products of commercial value, such as lac, resin and essential oils. They are also the storehouse of medicinal plants many of which are yet to be explored and fully utilized.

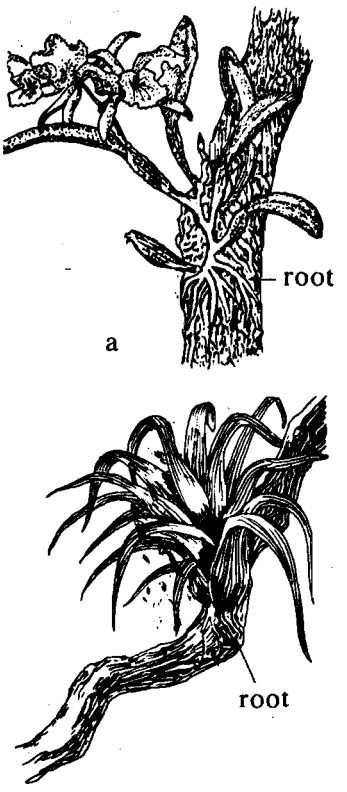

Fig.15.7: Aerial plants. An orchid (a), and a bromeliad (b) on the trunks of trees. These plants fulfil their water requirements from rain and nutrients from particles borne by the wind. The surface of trees, that support them, also offer an additional supply of nutrients.

15.4.3 Ecological Crises

Forests have been over-exploited and are shrinking throughout the world. It is estimated, that during the ten years, from 1963 to 1973, forest area has declined by 15 per cent, affecting all regions of the world. India is losing forests at an extremely rapid rate. According to the satellite data, India lost 1.3 million hectares of forest every year between 1972 and 1982. Arunachal Pradesh, Manipur and Andaman & Nicobar islands are the only areas which fulfil the stipulation of forest cover in hill regions laid down by the National Forest Policy in 1952. The maximum deforestation has occurred in Madhya Pradesh, which lost nearly 2 million hectares, Maharashtra lost one million hectares, Orissa, Andhra Pradesh and Jammu & Kashmir lost nearly a million hectares of forest land each during the above said period.

Now let us see, what has led to the destruction of forests in our country?

i) Shifting cultivation, i.e., the process of slashing and clearing of the forest, burning much of the fallen vegetation and cultivating a mixture of crops for two or three years, until the soil loses its productivity. Then this process is repeated elsewhere. Shifting cultivation is practiced in many hilly areas of India.

ii) The conversion of forests to pastures for cattle.

iii) Overgrazing - Grazing intensity is high in most of the forest areas of India. This has depleted vast forest areas. In addition to depletion of vegetation cover, trampling by cattle, hardens the soil, preventing forest regeneration. When there are no plants, the soil becomes loose, and is lost by winds or is washed off by heavy rains.

iv) Commercial exploitation of timber is one of the main causes of forest destruction. Wood (for building, for making boxes to transport fruits, for making paper, and just for burning) is in great demand, and this represents a major threat to our lush green forests. The restrictions, which the government puts on cutting trees are circumvented by greedy contractors and those who share the profit. At this rate, forests will perish one day. New plantations will help, but they cannot replace the present forests for a very long time. It will take at least a hundred years for a plantation to become a forest. It must be remembered, that reducing forests to barren land not only disrupts animal life and its balance but also the lives of tribal people who have been existing for centuries in harmony with the forests.

v) Developmental activities such as irrigation projects, building of roads etc. have led to the destruction of forests. This amounts to acquiring a good thing, like roads, by losing something which is even better.

Now that we know the causes of deforestation, let us discuss its consequences. Removal of

forests causes soil erosion, silting of lakes and rivers, resulting in devastating floods and loss of thousands of species of plants and animals forever. Some of these effects have been depicted in Fig.15.8. If one plant species becomes extinct, it takes with it many dependent organisms, sometimes as many as 30.

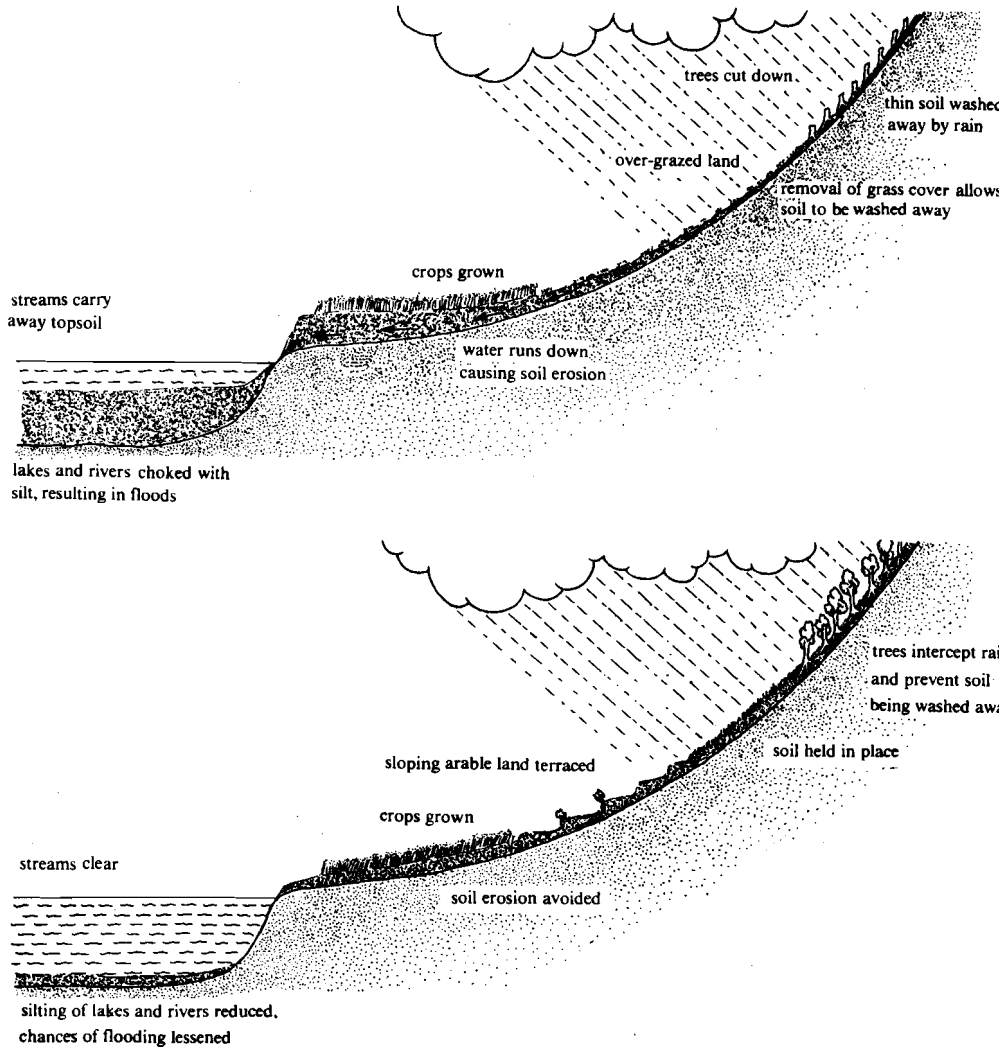

Fig.15.8: (a) Consequences of deforestation, (b) Conservation

Trees can grow on hillsides, even when the soil layer is quite thin. When the trees are cut down to clear them for cultivation and the soil is ploughed, there is less protection from the wind and rain. Heavy rainfall washes the soil off the hillsides into the rivers. The hillsides, thus, are left bare and useless, and on the other hand, the rivers become choked up with mud and silt resulting in floods. The disastrous floods in our country have been attributed largely to deforestation. According to the National Commission of Floods (1980), the annual economic loss due to floods during 1977-78, was more than 1000 crores. The total areas affected by floods has doubled during the last decade.

Degradation of forests leads to the destruction of habitat for many wildlife species. Presently, over one hundred species of wild animals need immediate protection as their population has dwindled to dangerously low levels. Similarly, many plants, too, have suffered from the onslaught of human activities. In a recent list prepared by the Botanical Survey of India, 135 species of Indian plants have been listed, which need immediate protection for their survival. Similarly, over 200 species of animals all over the world have become extinct. Atleast one species has ceased to exist each year of this century. Presently, eight hundred species of animals distributed in various regions of the world, are in great danger of extinction. The list includes orang-utan, the pygmy chimpanzee, the mountain gorilla, the leopard, eight species of whales, five species of rhinoceros, the polar and grizzly bears and many species of birds.

Don't you think, that the situation is grave! Many people have realised that concrete steps should be taken towards conservation, to slow down the destruction of the environment. It is

hoped that, if these steps are taken even now, it will go a long way to bring a halt to the extermination of species and to preserve the beautiful areas of the world. In our country, too, a number of people have become aware of the situation, and several steps have been taken in this direction. Quite a few forest protection movements have been started by the people residing in or near the disturbed areas.

The Chipko Andolan - the movement to hug trees, is a well known movement for conservation. The story about how this movement started is this. In the year 1970, Gopeshwar in the Garhwal area of Uttar Pradesh and nearly 20 nearby villages were devastated by a flash flood in the Alaknanda river. There was clear evidence, that these floods had been caused by man-made erosions. The people of this area realised that if these destructive activities of man continued, it would ultimately wipe off the hill people. The people of Gopeshwar and their leader Shri Chandi Prasad Bhatt organised a movement and pledged that no more tree felling would be allowed in the area. So, whenever, the contractors approached forests for felling trees, these local people used to go and hug the trees. They said that if the contractors have to cut a tree, their axe will have to fall on them first. So the contractors had to give up, and the local people were successful in saving a lot of trees and plants.

Like a migratory bird, the Chipko Andolan flew from the Himalayas to various corners of the country, such as the hilly districts of Karnataka, the hills of central India, and to Aravalli hills in Rajasthan. This movement is also spreading to other areas of the Western Ghats.

SAQ 3

Given below are some words. Place them appropriately in the blank spaces of the statements given below:

i) ..... are the major processors of solar energy.

ii) ..... are the dominant life forms of forests.

iii) Forests occur throughout the world except the ..... areas.

iv) In a forest, plants of different kinds and heights are arranged naturally in such a way that they form distinct layers. Such a situation is referred to as ..... .

v) ..... and ..... are the plants found typically in warm and humid forests.

(polar, stratification, forests, orchids, trees, bromeliads)

15.5 SUMMARY

In this unit you have learnt that:

- Oceans, atmosphere and forests are three significant components of earth's environment.
- Oceans, contain an immense amount of salty water and form a continuous water body over the earth's surface. One can find living beings all along the oceanic depth. Phytoplankton, however, occur in the water layers near the surface, where sunlight is available. Life forms occurring in various depths of oceanic water have special adaptive features that enable them to withstand the harsh conditions, such as poor light, higher pressure due to the water above, low temperature etc. The life forms become less and less in number, as one moves away from the sea shore.
- Today we find that the ocean ecosystem is very much disturbed. This is because of the pouring of untreated wastes by various industries directly into the ocean or into the rivers; sedimentation due to erosion of coasts; destruction of mangroves; quarrying of rocks etc.
- Atmosphere provides a protective covering to the earth, and generates conditions that enable life to prosper on the earth. A variety of life exists in the atmosphere – from microscopic organisms to birds of various kinds.
- The quality of atmospheric air is deteriorating by activities like the addition of smoke and dust by the industries and automobiles, sprays used to kill agricultural pests etc.
- Forests, cover over one third of the total land area of the world. These are located in all the geographic regions except the polar areas. Depending on the availability of food, sunlight and water, different living beings live in different layers of the forest. Forests perform important ecological role. They have been found to regulate precipitation. During rainfall, a large quantity of water is absorbed by forests, and then is slowly released to the soil beneath, and to the streams and rivers that flow through the forest.
- Recent surveys have shown that all over the world, the area under forest cover is decreasing day by day due to thoughtless commercial activities of man, and various other

reasons. The consequences of deforestation, in the long run, are deleterious for the life on earth. Quite a few forest conservation movements have been started. But all this is just like a small drop in the ocean. We must do our best to conserve earth's environmental components.

15.6 TERMINAL QUESTIONS

1) Although all organisms require essentially the same resources from their physical environment to survive, certain resources are more plentiful in some ecosystems than in others. Give examples of two ecosystems in which each of the following is plentiful : light, water, oxygen, nutrients, and space.

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2) Answer the following in four or five lines.

i) Where is life in the oceans more abundant and why?

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ii) Describe what happens to solar energy reaching the earth's atmosphere.

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iii) What is the major reason of stratification in forest ecosystem?

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3) Given below are some aspects of the ecological crises, in oceans, atmosphere and forest, that you have just studied. What you have to do in this exercise is to match the statements of the first column with those of the second column. Write the number of the appropriate match in the given box .

I Column		II Column
1 Erosion of coasts	☐	1 By rivers and from surface runoff
2 Depletion of vegetation cover, trampling and consequent hardening of soil, preventing regeneration of plants	☐	2 Shifting cultivation
3 Enormous amount of dust and smoke pumped in the air	☐	3 Spilling during drilling operations, and from tankers
4 Silt gathering near coasts	☐	4 Automobiles, industries and excessive use of fossil fuels
5 Slashing and clearing the vegetation in an area, burning the fallen plants,		5 Deforestation

	and cultivating crops for a couple of years. Then after repeating the same process elsewhere	☐	
6	A film of oil spreading over large area of sea water	☐	6 Overgrazing
7	Soil erosion, silting of lakes and rivers, and consequent floods	☐	7 Destruction of plants growing in the coastal regions for fuel, fodder etc.

15.7 ANSWER

Self Assessment Questions

1) i) oceans
   ii) tides, waves, currents
   iii) energy, nutrients
   iv) upwellings
   v) greenish

2) i) atmosphere
   ii) ozone, ultraviolet
   iii) oxygen
   iv) pollen grains, seeds, spores, microbes
   v) oxygen

3) i) forests
   ii) trees
   iii) polar
   iv) stratification
   v) orchids, bromeliads

Terminal Questions

1) i) Light—atmosphere, grassland
   ii) Water—lake, oceans
   iii) Oxygen—atmosphere, forest
   iv) Nutrients—forests, estuary
   v) Space—atmosphere, desert

2) i) Life in the oceans is abundant around the margin of the continents and islands, because here plenty of nutrients are available. This enables the luxuriant growth of producers, and of other organisms dependent on them.
   ii) When sunlight, reaches the upper atmospheric layers consisting of ozone, many of the sun's harmful rays, such as the ultraviolet rays are absorbed, thus making it safe for the life.
   iii) Stratification enables the various kinds of organisms occurring in a small area of the forest, to obtain the basic necessities of life such as light, temperature etc., according to their requirements.

3) 1 7
   2 6
   3 4
   4 1
   5 2
   6 3
   7 5