**ECOLOGY AND ENVIRONMENT**

The term ecology was first of all used by zoologist, Reiter in 1868. Ecology has been derived from the greek words Oikosmeaning house or living place and logos meaning science or discourse or study.

According to Ernst Haeckel (1869)“Ecology is the study of relationship between organisms and their environment”. According to Odum(1963)“Ecology is the study of structure and function of nature”. According to professor R. Mishra (1967)“Ecology is the interaction of form, function and factors”.Professor R. Mishra is known as **father of Indian ecology.**

**Branches of ecology**

Kirchner and Schroeter(1869) have divided ecology into two main branches:

**Autecology**autecology deals with the ecology of individual organism. Here, we study the relation of individual species to its environment.

**Synecology** under natural conditions, organisms do not live in isolation, rather they live in groups such as population, community etc. In synecology, the units of study are such groups- population, community etc.Based upon the types of groups,synecology has been divided into the following subdivisions:

**Population ecology**: population is a group of organisms belonging to a single species. Population ecology deals with the various factors of environment affecting population.

**Community ecology**: community is a group of organisms belonging to different species. Community ecology deals with the study of environmental factors affecting community.

**Ecosystem ecology:** when the community existing in a particular area is taken along with its physical environment- air, water, soil etc., then it is called an ecosystem. Ecosystem ecology deals with the interrelationships between the biotic and abiotic factors of the ecosystem.

**Environment**

The word ‘environment’ commonly means surroundings. Every organism lives amongst the various living and non-living objects, events and effects, which together constitute the environment for their sustenance. Interaction between the organism and the environment is essential for the continuity of life on earth. The environment is an all-inclusive term. Environment is the product of all the forces, conditions and objects which affect the life of organisms.

**Types of environment** there are two main types of environment:

Natural environment and manmade environment.

**Natural environment** natural environment includes the following:

1. **Lithosphere** it includes Earth's crust, which comprises rocks and soil.
2. **Hydrosphere** it includes surface and groundwater resources of earth.
3. **Atmosphere** it is the gaseous part of the earth which reaches up to 500 km above the earth's surface.
4. **Biosphere** it is the part of the earth where life exists.

**Man-made environment** man-made environment comprises

1. **Human groups**
2. **Material infrastructure**: infrastructure built by man (human settlements in urban and rural areas) railway tracks, roads etc.
3. **Production relationship:** it includes the factors of production (Primary, secondary and tertiary activities).
4. **Institutional systems:** educational, commercial etc.

The external environment has three main components:

**Physical environment**: this includes water, soil, sound, heat, light, river, mountain, mineral substances, radiation etc.

**Biological environment**: plants, animals and microorganisms form the biological environment.

**Psycho-sociological environment**: psycho-sociological environment is expressed by the social relationships of human beings. In this we study the social, economic, cultural, political and philosophical environment, in which human beings develop and evolve.

**Organisms and environment**

All the factors both living and non-living, which directly or indirectly affect an organism or a community together form its environment. The living biotic factors include plants, animals and microorganisms whereas, the non-living or abiotic factors include soil, water, air, light, temperature etc.Each such factor is called environmental factor or ecological factor. Although, different factors of the environment act in conjunction with each other but for the convenience of study they have been divided into the following types:

**Physical or abiotic factors** these have been classified into three types:

Climatic factors

Topographic factors

Edaphic factors

**Climatic factors**

All the factors which form the climate of a given region are studied under the branch of science called climatology. The main factors which affect and determine the climate of a region are as follows-

**Light**

Light is an essential factor for most of the activities of plants.The energy required by organisms are directly or indirectly obtained from environment. Light affects plants through quality, intensity and duration.Light also affects the distribution of plants and animals.

**Quality of light** the light which is visible to human being is called the visible light and it ranges from 390 to 700 nm. This visible light is composed of seven different wavelengths starting from violet to Red. Out of these red and blue are the most effective in photosynthesis.

Light affects plants in following ways:

1. Chlorophyll is produced in the presence of sunlight in plants. Plants manufacture carbohydrates in the presence of sunlight in the process of photosynthesis.
2. For germination of some seeds light is essential.Such seeds are called photoblastic seeds. Example *Rumex*. On the other hand, in negative photoblastic seeds example *Vanillafragrans,*  germination is inhibited by light.
3. Stomatal opening and closing is also affected by light.
4. Growth of plants, enzyme synthesis, differentiation of tissues, flowering transport of plant hormones etc. are also affected by light.
5. Several types of Movement in plants such as phototacticmovement in *Chlamydomonas* cells,photonasticmovement in Sunflower and phototrophic response of plant shoot are all examples of effect of light on plants.
6. Photoperiodism- the effect of relative duration of exposure of light and dark on flowering in plants is called photoperiodism. According to photoperiodic response plants have been classified into following types:

**Short day plants** these plants require light exposure less than the critical photoperiod for flowering example *Datura*, soybean etc.

**Long day plants** these plants require light exposure more than the critical photoperiod for their flowering example Spinach, radish etc.

**Day neutral plants** flowering in these plants is not affected by light exposure for example cotton, tomato, cucumber etc.

**Stratification** in evergreen forest, plants form 3-6 strata or horizontal zones such as trees of great height, trees of moderate height,low height trees, shrubs and herbs.In such forest, small plants do not get sufficient sunlight.

**Effect of light on animals** animals also are affected by the intensity and duration of light in the following manner:

**Reproduction** light duration affects reproduction in animals-

**Short day animals** some animals such as deer, sheep, goat etc. reproduce undershort day conditions.

**Long dayanimals** reproduction in these animals occurs under long day conditions such as Turkey, Sterling etc.

**Day neutral animals** reproduction in these animals is not affected by duration of light exposure for example rabbit, guinea pig, etc.

**Migration** Birds migrate towards north during Spring and returned to their homes in autumn.

**Pigmentation**In many animals change in pigmentation takes place according to season.In frog and wall lizard, colour of skin is light in bright light and skin is dark colour when the animal is present in dim light or darkness.

**Period of activity** Some animals are active only at night, these are called nocturnal animals.Animals which are active during day are called diurnal animals.

**Eye size**As compared to diurnal animals, nocturnal animals have large eyes example owl.

**Effect of light on aquatic habitat**In the water bodies such as lakes and oceans, light zones are found which have been divided into the following types:

**Littoral zone** this is the shallow water zone near the shore of water bodies like lakes and oceans.

**Open Water zone or limnetic zone** this is the open Water zone away from the shore water.Light is not able to reach the bottom. This zone is divided into the following layers-

**Photic zone** this is the uppermost zone having a depth of 20-40 m in non- polluted, clear water bodies.Its depth may reach up to 200 metres.

**Profundal zone** the intermediate zone between the photic and the benthic zone is called the profundal zone.

**Benthic zone** this is the completely dark bottom of lake. Some consumers, decomposers, snails and fishes with bulging eyes are found in this zone

**Temperature**

Temperature is a very important climatic factor. In plants it affect seed germination, growth, flowering, seed and fruit formation, photosynthesis and respiration etc.Every organism requires an optimum temperature. Besides this, it has a tolerance limit of maximum and minimum temperature. Based on these plants have been classified into the following four categories:

**Megatherms** these plants require continuous high temperature for their growth and development for example Tropical rainforest.

**Mesotherms**the plants living at high temperature of summer alternating with low temperature of winter.Example-Subtropical deciduous forest.

**Microtherms** these regions always maintain lower temperature.Such plants cannot tolerate high temperature.Example-mixed coniferous forest.

**Hekistotherms**these include plants growing in arctic and alpine regions. These plants can tolerate very low temperature.

**Effect of temperature on plants**

Temperature affect plants in the following ways:

1. The effect of temperature on plants is observed in their morphology, metabolism and geographical distribution. The metabolic activities increase with increasing temperature up to a certain level but excessive increase leads to decrease rate of metabolism and can cause death.
2. Temperature affect photosynthesis and respiration in plants.
3. Temperature stimulates seedling growth.
4. High temperature results into increased transpiration rates, which may cause death of plants.
5. Some seeds required chilling treatment before sowing in order to accelerate flowering when planted.The process is called vernalization.

**Water, rainfall or precipitation**

73% of earth’s surface is water. Water is an important constituent of protoplasm. Rainfall, snowfall and humidity of air directly affects the vegetation of an area. In between the earth’s surface and the atmosphere two processes which continuously occur are precipitation and transpiration. The interchange of water between these two layers is called the **water cycle**. The minerals present in soil, form a solution in water which is available to the plants.The main source of water are precipitation, rainfall, snowfall etc. Dew and frost are formed by the condensation of moisture in air.Rainwater is the most important source of surface water found in rivers,ponds,soil as well as groundwater.In India, rainfall occurs during monsoons. 40 to 45% of rainfall enters into the rivers and ponds. Almost 20% of this water percolates through soil and reaches the water table. 35% of water, evaporates back into the atmosphere.

**Effect of water on plants** water affect plants in the following manner:

1. Water is a medium for different biological reactions.
2. Water is universal solvent.
3. Water affects the distribution and habit of plants.
4. Different soils have different water holding capacity.Soils can be **physically dry**(deficiency of water in soil) or **physiologically dry** (excess of salt in soil). In both these cases water is not available to the plants.On the basis of availability of water,terrestrial plants have been divided into three types:
5. **Hydrophytes** plants growing in humid and water saturated areas.
6. **Mesophytes**plants growing in moderately humid areas.
7. **Xerophytes** plants growing in dry areas.
8. Along with other factors,water affects morphology and distribution of plants and their communities.
9. Water makes available minerals present in the soil,in soluble form to the plants.

**Atmospheric moisture or humidity**

The water present in the form of vapour in air is called humidity or atmospheric moisture.Mostly, it is represented as relative humidity (RH).Relative humidity is the total amount of moisture present in unit volume of air at a certain temperaturedivided by the total amount of moisture required by that volume of air for complete saturation at that temperature. It is measured by thermo-hydrograph,psychrometer for dry and wet bulb thermometer.

**Effects of atmospheric humidity on plants** atmospheric humidity affect plants in the following manner:

1. Humidity affects the vaporization, vapour condensation and precipitation.
2. Plants growing in humid atmosphere are relatively long, thin and pale. Leaves of such plants have less developed palisade parenchyma.
3. Some plants like orchids, mosses and lichens directly use atmospheric moisture.
4. Spore germination of fungi and other microorganisms is directly affected by moisture.
5. The climate of any place is mainly decided by temperature, light and atmospheric humidity.

**Atmospheric gases**

Atmosphere which is 15 to 18 km from earth surface affects weather and organisms on earth. Oxygen(O**2**), carbon dioxide(CO**2**), nitrogen(N**2**), microorganisms, pollen grains, carbon particles and numerous gases released from factories for example Sulphur dioxide (SO**2**), ammonia (NH**3**), carbon dioxide (CO**2**), nitrogen oxide (NO**2**), Sulphur dioxide (SO**2**) etc. get mixed with atmospheric gases.

**Wind**

Air in motion is called wind.Wind always moves from high pressure to low pressure area.

**Effects of wind on plant:** Wind affects plant in the following ways:

1. wind results in uprooting of plants and breaking of branches.
2. Increase in wind velocity increases the rate of transpiration and vice versa.
3. High wind velocity leads to loss of soil moisture.
4. Wind helps in pollination and dispersal of fruits and seeds.
5. Wind causes soil erosion.
6. Spores of bacteria, fungi, algae and other microorganisms are also dispersed through wind.

**topographic factors**

Topographic factor is related to the study of the shape and feature of the surface of the earth. These factors act in conjunction with climatic and edaphic factors.Topographic factors are of following types:

1. **Altitude** with rise in altitude, the temperature and atmospheric pressure of an area decreases but wind velocity and relative humidity increases.
2. **Direction of mountains and valleys** direction of mountain affects rainfall, wind and exposure to sunlight. When wind clash with mountains, it turns towards different direction.
3. **Steepness of slope** steepness of slope affects the amount of solar radiations obtained and also the flow of water and resultant soil properties.
4. **Exposure of slope** the side of the slope which is exposed to sun and wind has altogether different vegetation than the wind and sun shadow side.

**Edaphic factors**

All terrestrial plants obtain minerals and water from soil.The microorganisms present in soil also affect plants. The upper fertile layer of earth crust in which plants grow is called soil. Soil has the following components:

1. Mineral matter
2. Organic matter
3. Soil water
4. Soil air
5. Soil organisms

The branch dealing with the study of soil is called pedalogy.Based upon the soil type, plants have been divided into the following categories:

1. **Oxylophytes** these plants grow in acidic soil.
2. **Halophytes** these plants grow in saline soil.
3. **Psammophytes** plants growing in sandy soil.
4. **Lithophytes** plants going on rock surfaces.
5. **Chasmophytes** plants growing in rock crevices.

**Formation of soil**

The process of soil formation has been divided into two main steps:

**a-Weathering** in the process of weathering rock surface breaks up into small particles. This involves physical, chemical and biological processes.

**b-Pedogenesis** it is also called soil development. As against weathering pedogenesis is a purely biological process.Many organisms such bacteria, lichen,fungi, algae, micro-arthropods, molluscs etc. are added to the weathered rock material.

**Soil profile** the formation and development of soil results into formation of the soil profile. The sequence of layers present one on top of the other and exposed through pit section of the soil is called the soil profile.

**Classification of soil**soil is mainly of two types:

**a)Residual soil** when the process of weathering and pedogenesis occur at the same place i.e., on the parent rock itself, then the soil formed is called residual soil.

**b) Transported soil**when the weathered material is transferred through some agency to another site, where pedogenesis occurs, then the soil formed is called transported soil.

Based on the agency of transfer, transported soils are following types:

**Alluvial soil-** here the agency of transfer of weathered material is running water.**Colluvial soil-**The agency of transfer is gravity.

**Eolian soil-**The agency of transfer is wind.

**Glacial soil-** When the agency of transfer is ice or snow.

**Soil texture**

1. **Minerals**The minerals in soil are present in the form of particles like sand, silt, clay etc.Sand and gravel provide physical support to the plant whereas silt and clay provide nutrient and water holding capacity to the soil.All the three types of particles mix together to form the Loam.
2. **Soil air** Amount and distribution of air in soil depends upon the size of the soil particle. Soil with large particles contain more air and soil with small particle size has less space and therefore less amount of hair.
3. **Soil water** the amount of water present in the soil is an essential factor for plant growth. Soil in which water is not retained due to large particle size is called **physically dry soil** and plants growing in soil with high salt concentration are not able to absorb water. Such soils are called **physiological dry soil.**

**Types of soil water**Rainfall is the main source of water. After rains, most of the water collects in rivers, lakes and ponds. This water is called the runoff water. The remaining water can be found in the following forms:

**i)Hygroscopic water**This water is present forming a thin layer or microfilm on the surface of soil particle.

**ii)Capillary water**This water is held in the capillaries found between the soil particles.This is only water available to plants.

**iii)Gravitational water**Due to gravitational pull, some amount of water percolates deep in the soil to reach the groundwater table.

**iv)Chemically bound water**This water is found chemically bound to elements like Iron, copper, Silicon, aluminium etc.

**Chemical nature of soil**The acids,alkali and minerals ofsoil directly affect plant growth and development. *Rhododendron* requires acidic soil whereas grasses require natural or alkaline soil.

**Organic matter and humus**After death of organisms, the organic matter undergoes decomposition. Fresh fallen organic matter is called **litter**. Under this, is present the layer of partially decomposed organic matter called**duff**. Microorganisms convert it into dark, amorphous form called **humus.**

Humus undergoes mineralization, a process in which microorganisms form minerals. Presence of humus has the following advantages:

1. It makes the soil more fertile.
2. It increases the water holding capacity of soil.
3. It helps in increasing porosity and aeration.

**Soil temperature**Temperature of soil affects plants in various ways:

1. It affects the activity of microorganisms.
2. Activity of spores of disease causing organisms.
3. Temperature helps in seed germination.
4. It affects the water absorption by root and also the growth and development of underground stem.

**Soil organisms**Soil contains algae, fungi, bacteria, nematodes, termites, earthworms,molluscs, arthropods like organisms and different types of spores also. The microorganisms present in soil decompose organic matter which increases soil fertility. Some free- living, nitrogen fixing organisms, fix atmospheric nitrogen. These include many blue green algae (cyanobacteria) and bacteria. These organisms along with earthworms secrete mucus,which helps in binding together soil particles.

**Biotic factors**

Organisms do not leave alone. They live in a community. The individuals of a community interact with each other in various ways. These interactions may be intraspecific or interspecific. Biotic factors are studied under the following heads:**1) Interrelationship between plants and animals**Many herbivorous animals do selective grazing due to which, the population of that species in the community is reduced.Many animals feed on leaves and stem of plants (goat, camel etc.), whereas many other animals such as rat, squirrel feed on fruits and seeds. Pollination in many plants, occurs through the agency of insects, butterflies,birds etc.The attractive colour of flowers,fragrance and nectar helps in this process. Pollination help in increasing the population of plants. Human beings perform artificial pollination for many food crops. Many animals also help in the dispersal of fruits and seeds of plants. Fruits and seeds of many plants get attached with the body of animals and get transported from one place to another for example*Xanthium.*

Insectivorous plants such as *Drosera*,*Dionaea, Utricularia,Nepenthes* etc. are found in soil deficient in nitrogen. These plants capture insects and feed on them, in order to satisfy their nitrogen demands. Human beings are also big consumer of plants.Plants provide food, fibre, fuel, medicines, materials for house making etc.

Carnivorous animals feed on herbivorous animals for their food requirements. Thuscarniavorous animals have an indirect effect on the population of plants in a community.

**2. Interrelationships between plants of an area** Severaltypes of mutual relationships exist between plants found in area.Some of them are as follows:

**Lianas**They are also called woody climber, an important example is commensalism.

**Epiphytes**These plants include members of family orchidaceae.These plants grow on other plants but do not obtain water and food from them.

**Parasitic plants**These plants absorb nourishment from other host plants.They are mainly of two types:

**1**. **Total or obligate parasites**These plantsentirely depend on host plant for their food requirement.They are following types:

1. **Total stem parasite**Here the haustoria arising from stem of parasite enters into the xylem and phloem of stem of host and absorb nourishment. Example*Cuscuta*.
2. **Total root parasite**Such parasite, absorb nourishment from roots of host plants for example *Orobanche*,*Balanophora,Rafflesia.*

**2. Partial parasite**These plants, synthesise their own food but at the same time, absorb certain essential nutrients from the host plant.

a)**Partial stem parasite**These plants, obtain nourishment from the stem of other plants for example *Viscum album.*

b)**Partial root parasite**They draw nourishment from the root of host plant for example *Santalum.*

**Symbiotic plants**Mutually beneficial relationship between two plants is called symbiosis.Example lichen (symbiosis between algae and fungi).

**Saprophytic plants**Thisinclude, plants which obtain nourishment from dead organic matter, for example *Monotropa*(Indian pipe plant),*Neottia*.

**Interrelationships between plants and soil living microorganisms**Many types of Bacteria,protozoa, algae, fungi, worms, nematodes and viruses live in soil and affect plant growing there. Many nitrogen fixing organisms (diazotrophs) live in certain plants.Example: Cycas, legumes etc.