ECOLOGY AND ECOSYSTEM

DEFINITION OF ECOLOGY:

Ecology is the branch of biology that deals with the relations of organisms to one another and to their physical surroundings.

ECOLOGICAL FACTORS:

The ecological factors can be classified into i) Climatic factors, ii) Topographic factors, iii) Edaphic factors, iv) Biotic factors, v) Limiting factors.

i) Climatic Factors---

- Light – Sunlight is the source of energy for the biological world. In plants light is essential for photosynthesis, transpiration, growth, development and the metabolic processes. In animals light influences metabolism, growth, development and reproduction.
- Heat – Generally the optimum range of temperature for living organisms is 4^0C to 45^oC. All metabolic and physiological activities are influenced by heat. Growth, development, distribution, migration, reproduction and other activities are dependent on heat.
- Water – It is the most important factor. All physiological functions are controlled by water. In plants photosynthesis, circulation, growth and development are most influenced by water. In animals, circulation, digestion, excretion, growth, reproduction and other activities are controlled by water.
- Rainfall – Rainfall directly influences the type of vegetation of a region, which in turn influences the distribution of animals.
- Wind – Wind primarily controls the process of transpiration in plants. Some morphological and physiological structures of organisms are also influenced by wind.
- Humidity – Some physiological functions like transpiration, absorption are mostly influenced by humidity.
- Atmospheric gases – Gases like oxygen, carbon-dioxide, nitrogen and water vapour are very important for all living organisms.
- pH – It is a controlling factor for organisms living in soil and water. For every species there is an optimum range of pH level.

ii) Topographic factors---

These are the physical geographical factors. Altitude, slope and direction of mountain chains and valleys are the three main types of topographic factors.

- With increase in altitude there is decrease in temperature, atmospheric pressure and amount of oxygen, which have effect on physiology and distribution of living organisms.
- Slope and direction of mountain ranges influence the amount of solar radiation, rainfall, wind speed and other climatic factors, which in turn affect plant and animal world.

iii) Edaphic factors ---

Edaphic factors deal with the structure, formation and characteristics of soils. Soil water, soil air, soil temperature, soil pH and soil organisms are the important parts of edaphic factors.

iv) Biotic factors---

The living components i.e. plants, animals and microbes are the parts of biotic factors. The interactions among the organisms are very essential for their survival. The interactions can be intraspecific (between population of same species) or interspecific (between population of different species). These interactions can be classified into some types ---

- Symbiosis – in this type of interrelationship two different species depend upon each other and are mutually benefitted. The species are known as symbionts. Eg. The interrelationship between the bacteria *Rhizobium* and leguminous plants. Root nodules of leguminous plants are the habitat of the bacteria and the plant utilizes the nitrogen fixed by the bacteria to form protein.
- Commensalism – It is a type of relationship between two organisms in which one gets benefit from other without harming it. Eg. Remora fish has a disk on its head that helps to attach itself to larger animals like sharks, mantas and whales. When the larger animal feeds, the remora fish detaches itself to eat the extra food.
- Parasitism – It is a close relationship between two species, where one organism, the parasite, lives on or inside another organism, the host, causing it some harm. Eg. *Plasmodium vivax,* a protozoan parasite causes malaria disease in human is an endoparasite. Bed bug, lice are ectoparasite on human and some other animals.
- Epiphytism – In this relationship a plant (such as some mosses and some orchids) grows attached to another plant and uses it solely for support, causing no harm to it. Epiphytes obtain water from rain and atmospheric moisture by special hanging roots. Nutrients are generally absorbed from the debris that collects on the supporting plant. Eg. *Dendrobium* –epiphytic orchid
- Competition – It is an interaction between species in which both require same resource that is in limited supply. There are three major mechanisms of competition – interference, exploitation and apparent competition.

v) Limiting factors ---

Limiting factor refers to any of the factors (variables) in an environment capable of limiting a process, such as growth, abundance or distribution of a population of organisms in an ecosystem.

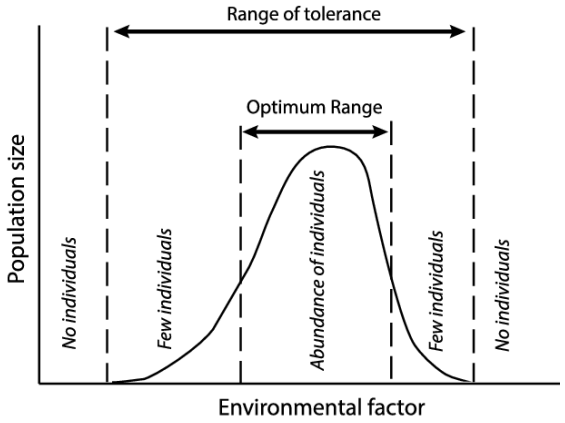
Laws of limiting factors:

Liebig's law of minimum: It states that growth is not dictated by total resources available, but by the scarcest resource. For example, if one of the essential plant nutrients is deficient, plant growth will be poor even when all other essential nutrients are abundant.

Blackman's law of limiting factor: The Blackman's Law of limiting factor states, "When a process is conditioned as to its rapidity by several separate factors, the rate of the process is limited by the pace of the 'slowest' factor." It means that several factors control the rate of the process. In the case of photosynthesis, there is always a minimum, optimum, and maximum for each factor. No photosynthesis will happen when there is a minimum value for a factor.

Shelford's law of tolerance: It is a law stating that a certain organism's survival and existence depend upon the multifaceted set of conditions wherein each individual has definite minimum, maximum and optimum ecological factors to establish success.

Each individual or a population is subject to an ecological change that crop up the minimum and maximum capacity to any complex environmental factors. The range wherein it carried out from the minimum to maximum signifies the limit of tolerance of an organism.



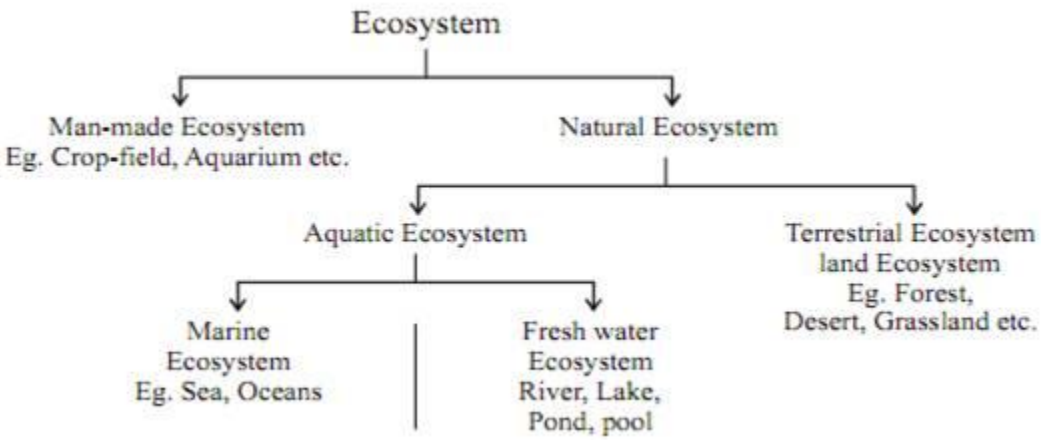
For every environmental factor there are two zones-----i)zone of tolerance and ii) zone of intolerance.

In the zone of tolerance there are optimum zone (most favorable for growth and development of the organism), critical minimum zone and critical maximum zone (growth and development of the organism decreases and ultimately stops).

Definition of ecosystem;

The ecosystem is the structural and functional unit of ecology where the living organisms interact with each other and the surrounding environment. In other words, an ecosystem is a chain of interactions between organisms and their environment. The term "Ecosystem" was first coined by A.G.Tansley, an English botanist, in 1935. Ecosystems are dynamic entities—they are subject to periodic disturbances and are always in the process of recovering from some past disturbance. The tendency of an ecosystem to remain close to its equilibrium state, despite that disturbance, is termed its resistance. The capacity of a system to absorb disturbance and reorganize while undergoing change so as to retain essentially the same function, structure, identity, and feedbacks is termed its ecological resilience.

Types of ecosystems;



Components of ecosystem;

The structure of an ecosystem is characterized by the organization of both biotic and abiotic components. This includes the distribution of energy in our environment. It also includes the climatic conditions prevailing in that particular environment.

The structure of an ecosystem can be split into two main components, namely:

- Biotic Components
- Abiotic component

The biotic and abiotic components are interrelated in an ecosystem. It is an open system where the energy and components can flow throughout the boundaries.

Biotic components;

They are the living components of ecosystem. They are classified into autotrophs and heterotrophs.

Autotrophs are the producers of the ecosystem. They are of two types ----photoautotrophs and chemoautotrophs. Photoautotrophs are the green plants containing chlorophyll, which convert solar energy to chemical energy (glucose), with the help of water and carbon-dioxide. The process is known as photosynthesis. Chemoautotrophs are some bacteria, like sulphur bacteria, iron bacteria. They obtain their energy from a chemical reaction and use inorganic energy sources (such as ferrous iron, hydrogen sulphide, carbon-dioxide).

Heterotrophs are not able not synthesize food by photosynthesis, are dependent on autotrophs for food energy. They are the consumers of an ecosystem. On the basis of the food dependency consumers can be classified as primary consumers, secondary consumers and tertiary consumers.

Herbivorous animals which feed directly on green plants are primary consumers. Carnivores that feed on primary consumers are secondary consumers and top carnivores that feed on secondary consumers are tertiary consumers.

Decomposers or transformers are heterotrophic organisms that depend on dead organisms as their source of food. Microorganisms like bacteria, fungi, protozoa and worms are the decomposers of ecosystem. They degrade complex organic matter to form simpler substances, which can be again utilized by producers to produce food. They are very important for maintaining the equilibrium of the ecosystem.

Abiotic components;

These are the nonliving components of the ecosystem, essential to the biotic components for their survival. These are classified as -----

Physical components: the environmental factors like light, air, temperature, humidity etc.

Inorganic components: the inorganic substances like water, O_2, N_2, S, Ca, K, P, C etc.

Organic components: various organic compounds like carbohydrate, protein, lipid.

Food chain:

It is the transfer of food energy from one trophic level to next through repeated eating and being eaten .Food chain length is important because the amount of energy transferred decreases as trophic level increases; generally only ten percent of the total energy at one trophic level is passed to the next, as the remainder is used in the metabolic process. There are usually no more than five tropic levels in a food chain.

The efficiency of a food chain depends on the energy first consumed by the primary producers. The primary consumer gets its energy from the producer. The tertiary consumer is the 3rd consumer, it is placed at number four in the food chain.

Producer → Primary Consumer → Secondary Consumer → Tertiary Consumer.

Food chains are very important for the survival of most species. When only one element is removed from the food chain it can result in extinction of a species in some cases.

Types of food chain:

Predator or grazing food chain ----This type of food chain is exhibited when living green plants are fed on by grazing herbivores, which are, in turn, fed on by carnivores. Ecosystems with this type of food chain are highly dependent on an influx of solar radiation.
This type of chain thus depends on autotrophic energy capture and the transfer of this captured energy to herbivores. Most of the ecosystems in nature exhibit this type of food chain. Examples of food chains in this category include:

- Phytoplankton -> zooplanktons -> Small fish -> Larger fish -> Birds
- Grasses → Rabbit → Fox

Detritus food chain-----This type of food chain starts from dead organic matter, which is fed on by microorganisms to organisms feeding on detritus and their predators. Such ecosystems are, therefore, less dependent on direct solar energy. These depend chiefly on the influx of organic matter produced in another system. Example:
Humus → Earthworm → Domestic fowl → Human being
Parasitic food chain -----
It is a type of food chain that starts from herbivore, but the food energy transfers from larger organisms to smaller organisms. Example:
Cow----------→ Worm (parasite) ----------→ Protozoa
Fruit-eating bird ----------→ Lice, Bugs (parasites)
Importance of food chain:
1) The study of food chain improves our understanding of the problems of bio-magnifications (That is, the increasing concentration of a toxic substance in tissues of tolerant organisms, which build up at successively higher levels in a food chain).
2) The studies of food chain help us to understand the feeding relationships and the interactions between organisms in an ecosystem.
3) Having knowledge of the food chain in an ecosystem enables us to appreciate the energy flow mechanism and circulation of matter in an ecosystem.
4) It improves our knowledge about the movement of toxic substances in an ecosystem.

Food web:

A food web is the natural interconnection of food chain and a graphical representation of what-eats-what in an ecological community. Another name for food web is consumer-resource system**.** The linkages in a food web illustrate the feeding pathways, such as where heterotrophs obtain organic matter by feeding on autotrophs and other heterotrophs. The food web is a simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange.
Charles Elton pioneered the concept of food cycles, food chains, and food size in his classical 1927 book "Animal Ecology"; Elton's 'food cycle' was replaced by 'food web' in a subsequent ecological text. Food webs are limited representations of real ecosystems as they necessarily aggregate many species into trophic species, which are functional groups of species that have the same predators .and prey in a food web.

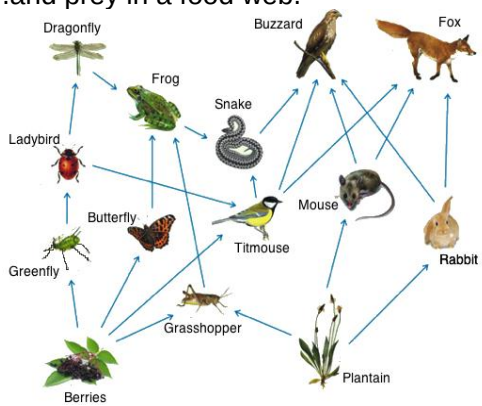


Fig: A food web

Ecological pyramid:

Ecological Pyramid is a graphical depiction which is meant to illustrate the relationship between different living organisms at different trophic levels in an ecosystem.

There are three types of ecological pyramids---

Pyramid of numbers: represent the total numbers of individuals (population) present in each trophic level. The term “pyramid of numbers” was first coined by Elton in 1972. This pyramid is quite convenient especially when it comes to counting the number of organisms. Counting is a simple task and it can be done over the years to determine the changes in a specific ecosystem. Nevertheless, some organisms are hard to count, particularly when it comes to young forms.

It is divided into two different forms, upright and inverted.

In the Upright pyramid of numbers, the numbers of organisms mostly reduce from bottom to top. It usually occurs in pond and grassland ecosystems where plants occupy the base of the pyramid. The next levels of the pyramid include the consumers.

An inverted pyramid is actually the opposite of the upright pyramid. It can closely be observed in tree ecosystem, where trees are the producers and insects are the consumers.

Amongst the three ecosystem pyramids, the pyramid of number is the most incorrect, as it does not take into consideration the exact population. Hence, it cannot completely elaborate on the trophic structure in a system.

This pyramid ignores the biomass of species and it doesn’t show the energy transferred between individual groups.

.Pyramid of Biomass: This pyramid indicates the total mass of organisms in a particular trophic level. A pyramid of biomass shows the relationship between the amount of food available and how much energy is being passed at each trophic. Biomass consumed by animals mostly is either converted to living tissue, converted to energy or remain as undigested products. The pyramid is usually larger at the bottom but as it goes up it reduces in size and becomes smaller. There is always a reduction of biomass with an increase in trophic level. Approximately 10% to 20% of the biomass is passed from one trophic level to the other.

The pyramid of biomass has two forms inverted an upright pyramids. The aquatic ecosystem is characterized by an inverted pyramid because phytoplankton producers are located at the base of the pyramid, while consumers have larger biomass and they are located at the top. An example of an upright pyramid is the terrestrial ecosystem. It has a large base mainly consists of primary consumers, the smaller trophic levels are located at the top. When there is a reduction of biomass with a rise in trophic levels, signifies wastage and consumption of biomass at every transfer level

Pyramid of energy: This upright pyramid illustrates the flow of energy from producers to consumers. Furthermore, it indicates the actual role played by various organisms in energy transfer. Energy pyramids indicate how much energy is required in the next trophic level as it flows upwards. The pattern of energy flow in this pyramid can be described based on the law of thermodynamics which states that energy is neither created nor destroyed it is only transformed from one form into another. The rate at which food material passes (in form of energy) through the food chain determines how energy pyramids are constructed. Some of the organisms have smaller biomass, but the total energy they take in and pass on is considerably greater than that of organisms with larger biomass. Energy pyramids are usually slopping because there is less energy being transferred from each trophic level than what was placed into it. If we consider cases such as in open water communities, producers have less bulk biomass than the consumers. But energy stored and passed on should be greater than the next level.

Fig: Pyramid of energy

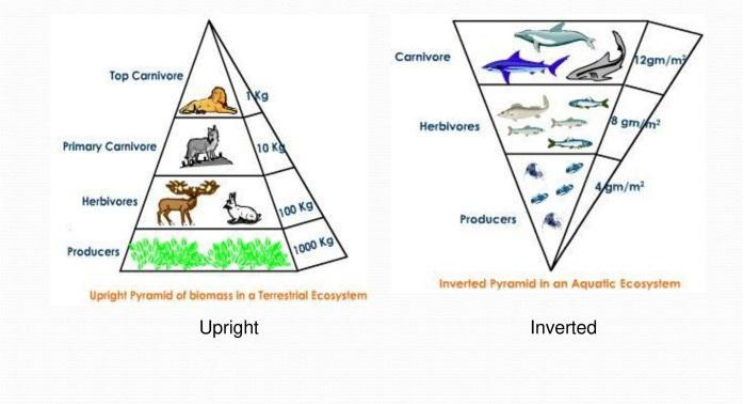


Fig: pyramid of biomass