Ecology

Ecology (from Greek: οἶκος, "house", or "environment"; -λογία, "study of")[A] is a branch of biology[1] concerning interactions among organisms and their biophysical environment, which includes both biotic and abiotic components.
E. P. Odum (1963) defined Ecology as structure and function of nature

Autecology

A subfield of ecology concerned with the individual organism or species in relation to its environment

Synecology

A branch of ecology that deals with the structure, development, and distribution of ecological communities.

Other branches: Habitat ecology, population ecology, production ecology, paleology, space ecology, human ecology etc.

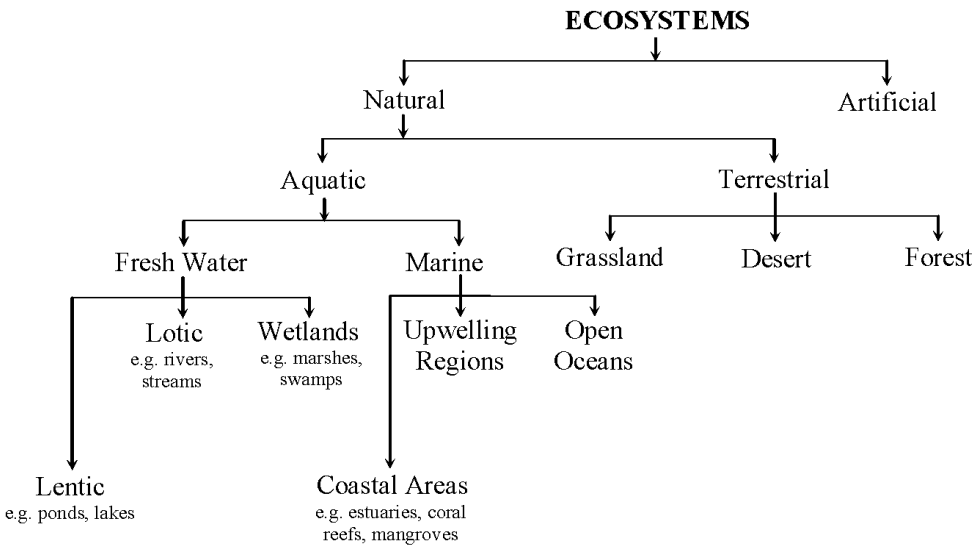
The Ecosystem

The term ecosystem was proposed by A.G. Tansley in 1935.

An **ecosystem** is a community of living organisms in conjunction with the nonliving components of their environment, interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.

Kinds Of Ecosystem

An ecosystem can be natural or artificial, temporary or permanent and large or tiny. Thus, various constituent ecosystems of the biosphere fall into the following categories :



1. Natural ecosystems. These types of ecosystems operate by themselves without any major interference by man. Based upon the particular kind of habitat, these are further classified as :

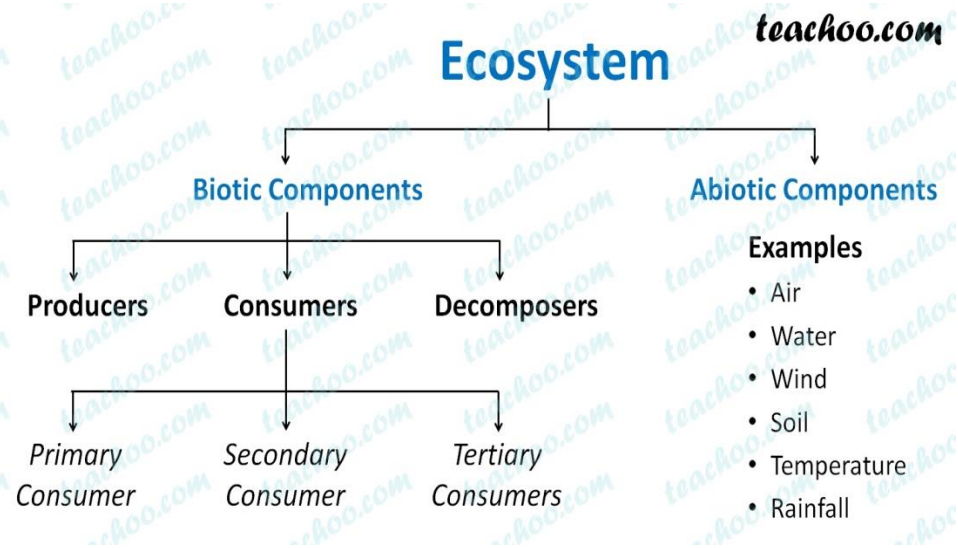
(i) **Terrestrial** ecosystems such as forests, grasslands, deserts, a single log, etc.

(ii) **Aquatic** ecosystems which may be further distinguished as follows : (a) Fresh water ecosystems. These may be **lotic** (running water as spring, brook, stream or river) or **lentic** (standing water as lake, pond, pool, puddle, ditch, swamp, etc.). (b) Marine ecosystems. These include salt water bodies which may be deep bodies as an ocean or shallow ones as a sea or estuary.

2. Artificial ecosystems. These are also called man-made or man-engineered ecosystems. These are maintained artificially by man where, by addition of energy and planned manipulations, natural balance is disturbed regularly, e.g., croplands such as sugarcane, maize, wheat, rice-fields ; orchards, gardens, villages, cities, dams, aquarium and manned spaceship.

Structure Of Ecosystem

The structure of an ecosystem is basically a description of the species of organisms that are present, including information on their life histories, populations and distribution in space. It is a guide to who's who in the ecosystem. It also includes descriptive information on the non-living (physical) features of environment, including the amount and distribution of nutrients. An ecosystem typically has two major components :



A. Abiotic or Non-living Components

Abiotic component of the ecosystem comprises three sort of components :

(1) Climatic condition and physical factors of the given region such as air, water, soil, temperature, light (i.e., its duration and intensity), moisture (relative humidity), pH, etc.

(2). Inorganic substances such as water, carbon (C), nitrogen (N), sulphur (S), phosphorus (P) and so on, all of which are involved in cycling of materials in the ecosystem (i.e., biogeochemical cycles). The amount of these inorganic substances, present at any given time in an ecosystem, is designated as the standing state or standing quality.

(3). Organic substances such as proteins, carbohydrates, lipids, humic substances, etc., present either in the biomass or in the environment, i.e., biochemical structure that link the biotic and abiotic components of the ecosystem.

B. Biotic or Living Components

In the trophic structure of any ecosystem, living organisms are distinguished on the basis of their nutritional relationships, which are discussed as follows :

1. Autotrophic component. Autotrophic (auto = self ; trough = nourishing) component of ecosystem includes the producers or energy transducers which convert solar energy into chemical energy (that becomes locked in complex organic substances such as carbohydrate, lipid, protein, etc.) with the help of simple inorganic substances such as water and carbon dioxide and organic substances such as enzymes.

2. Heterotrophic component. In the heterotrophic (hetero = other; trophic = nourishing) organisms predominate the activities of utilization, rearrangement and decomposition of complex organic materials. Heterotrophic organisms are also called consumers, as they consume the matter built up by the producers (autotrophs).

It includes various organisms which are classified into the following types :

(a) Producers.

These are photoautotrophic green plants and photosynthetic bacteria. The producers fix radiant energy of sun and with the help of minerals derived from water and mud, they manufacture complex organic substances as carbohydrates, proteins and lipids.

(b) Consumer

(i) Herbivores (Primary consumers).

These animals feed directly on living plants (producers) or plant remains. They may be large or minute in size and are of following two types : 1. Benthos which are the bottom dwelling forms such as fish, insect larvae, beetles, mites, molluscs (e.g., Pila Planorbis, Unio, Lamellidens, etc.), crustaceans, etc. 2. Zooplanktons which feed chiefly on phytoplanktons and are chiefly the rotifers as Brachionus, Asplanchna, Lecane, etc., although some protozoans as Euglena, Coleps, Dileptus, etc., and crustaceans such as Cyclops, Stenocypris, etc., are also present in the pond. Besides these small-sized herbivores, some mammals such as cow, buffaloes, etc., also visit the pond casually and feed on marginal rooted macrophytes. Some birds also regularly visit the pond to feed on some hydrophytes.

(ii) Carnivore order-1 (Secondary consumers).

These carnivores feed on the herbivores and include chiefly insects, fish and amphibians (frog). Most insects are water beetles which feed on zooplanktons; some insects are the nymphs of dragonflies which feed upon aquatic insects.

(iii) Carnivore order-2 (Tertiary consumers).

These are some large fish as game fish that feed on the smaller fish and, thus, become the tertiary (top) consumers.

(c) Decomposers.

They are also called microconsumers, since they absorb only a fraction of the decomposed organic matter. They bring about the decomposition of dead organic matter of both producers (plants) as well as macroconsumers (animals) to simple forms. Decomposers help in returning of mineral elements again to the medium of the pond and in running biogeochemical cycles. Decomposers of pond ecosystem include chiefly bacteria, actinomycetes and fungi. Among fungi, species of Aspergillus, Cephalosporium, Cladosporium, Pythium, Rhizopus, Penicillium,

Thielavia, Alternaria, Trichoderms, Circinella, Fusarium, Curvularis, Paecilomyces, Saprolegnia, etc., are most common decomposers in water and mud of the pond.

Function Of An Ecosystem

When we consider the function of an ecosystem, we must describe the flow of energy and the cycling of nutrients. That is, we are interested in things like how much sunlight is trapped by plants in a year, how much plant material is eaten by herbivores, and how many herbivores are eaten by carnivores. Thus, the producers, the green plants, fix radiant energy and with the help of minerals (such as C, H, O, N, P, Ca, Mg, Zn, Fe, etc.) taken from their edaphic (soil) or aerial environment (the nutrient pool) they build up complex organic matter (carbohydrates, fats, proteins, nucleic acids, etc.). Some ecologists prefer to refer to the green plants as converters or transducers, since in their view, the most popular and prevalent term 'producer' from energy view point is somewhat misleading. Their view point is that green plants produce carbohydrates and not energy and since they convert or transduce radiant energy into chemical form, they must be better called converters or transducers.

The two ecological processes of energy flow and mineral cycling involving interaction between the physico-chemical environment and the biotic communities, may be considered the 'heart' of ecosystem dynamics. In an ecosystem, energy flows in non-cyclic manner (unidirectional) from sun to the decomposers via producers and macroconsumers (herbivores and carnivores), whereas the minerals keep on moving in a cyclic manner

Food Chains in Ecosystems

- A **food chain** is a linear sequence of organisms through which nutrients and energy pass as one organism eats another.
- In a food chain, each organism occupies a different **trophic level**, defined by how many energy transfers separate it from the basic input of the chain.
- At the base of the food chain lie the **primary producers**. The primary producers are autotrophs and are most often photosynthetic organisms such as plants, algae, or cyanobacteria.
- The organisms that eat the primary producers are called **primary consumers**. Primary consumers are usually **herbivores**, plant-eaters, though they may be algae eaters or bacteria eaters.
- The organisms that eat the primary consumers are called **secondary consumers**. Secondary consumers are generally meat-eaters—**carnivores**.
- The organisms that eat the secondary consumers are called **tertiary consumers**. These are carnivore-eating carnivores, like eagles or big fish.
- Some food chains have additional levels, such as **quaternary consumers**—carnivores that eat tertiary consumers. Organisms at the very top of a food chain are called **apex consumers.**

- In nature, basically two types of food chains are recognized—grazing food chain and detritus food chain.

1. Grazing food chain.

This type of food chain starts from the living green plants goes to grazing herbivores, and on to carnivores. Ecosystems with such type of food chain are directly dependent on an influx of solar radiation.

This type of chain thus depends on autotrophic energy capture and the movement of this captured energy to herbivores. Most of the ecosystems in nature follow this type of food chain. The phytoplanktons →zooplanktons →Fish sequence or the grasses →rabbit →Fox sequences are the examples, of grazing food chain.

2. Detritus food chain.

This type of food chain goes from dead organic matter into microorganisms and then to organisms feeding on detritus (detrivores) and their predators. Such ecosystems are thus less dependent on direct solar energy. These depend chiefly on the influx of organic matter produced in another system. For example, such type of food chain operates in the decomposing accumulated litter in a temperate forest.

Significance of food chain:

1. The studies of food chain help understand the feeding relationship and the interaction between organisms in any ecosystem.

2. They also help us to appreciate the energy flow mechanism and matter circulation in ecosystem and understand the movement of toxic substances in the ecosystem.

3. The study of food chain helps us to understand the problems of bio-magnifications.

Food Web

A food web is a detailed interconnecting diagram that shows the overall food relationships between organisms in a particular environment. Many interconnected food chains make up a food web.

Sometimes, a single organism gets eaten by many predators or it eats many other organisms. This is when a food chain doesn't represent the energy flow in a proper manner because there are many trophic levels that interconnect. This is where a food web comes into place. It shows the interactions between different organisms in an ecosystem.

Ecological Pyramids

An ecological pyramid is a graphical representation of the relationship between different organisms in an *ecosystem*. Each of the bars that make up the pyramid represents a different *trophic level*, and their order, which is based on who eats whom, represents the flow of energy

Types of Ecological Pyramids

Pyramid of numbers

This shows the number of organisms in each trophic level without any consideration for their size. This type of pyramid can be convenient, as counting is often a simple task and can be done over the years to observe the changes in a particular ecosystem. However, some types of organisms are difficult to count, especially when it comes to some juvenile forms. Unit: number of organisms.

Pyramid of biomass

This indicates the total mass of organisms at each trophic level. Usually, this type of pyramid is largest at the bottom and gets smaller going up, but exceptions do exist. The biomass of one trophic level is calculated by multiplying the number of individuals in the trophic level by the average mass of one individual in a particular area. This type of ecological pyramid solves some problems of the pyramid of numbers, as it shows a more accurate representation of the amount of energy contained in each trophic level, but it has its own limitations. For example, the time of year when the data are gathered is very important, since different species have different breeding seasons. Also, since it's usually impossible to measure the mass of every single organism, only a sample is taken, possibly leading to inaccuracies. Unit: g m^{-2} or Kg m^{-2}.

Pyramid of productivity

The pyramid of productivity looks at the total amount of energy present at each trophic level, as well as the loss of energy between trophic levels. Since this type of representation takes into account the fact that the majority of the energy present at one trophic level will not be available for the next one, it is more accurate than the other two pyramids.

The pyramid of productivity is the most widely used type of ecological pyramid, and, unlike the two other types, can never be largest at the apex and smallest at the bottom. It's an important type of ecological pyramid because it examines the flow of energy in an ecosystem over time. Unit: J m^{-2} yr^{-1}, where Joule is the unit for energy, which can be interchanged by other units of energy such as Kilojoule, Kilocalorie, and calorie.