Ecosystems

Introduction

Biology is the science of life. **Ecology** is basically a branch of biology dealing with the relationships of organisms with their environment and with each other, OR the study of the interactions that take place between the organisms and their environment

The word "**ecology**" ("Ökologie") was coined in 1866 by the German scientist **Ernst Haeckel**. It is derived from the Greek words Oikos= home + logos= study OR logy.

Environment is the complete range of external conditions under which an organism lives, including physical, chemical, and biological factors, such as temperature, light, the availability of food and water, and the effects of other organisms.

Difference Between Environment and Ecology	
Environment	Ecology
The environment indicates the interaction between physical, chemical and biological components.	It is the study of the relations between living things, the environment, and their interaction.
It includes issues like deforestation, pollution, global warming, and other major issues	Ecological issues include population size, diversity, biological distribution, and competition between them.
It is the study of internal and external factors that affect the environment.	It aims to understand the processes of life, distribution, adaptation, and biodiversity.

Ecology deals with specific levels, sometimes discretely and sometimes with overlap. These levels are **organisms, populations, communities, ecosystems and the biosphere.** The place of living is the organism's environment. Hence, ecology is sometimes, called as environmental biology.

Organisms: It is every single or multi-celled living organism independently that performs all its vital activities such as nutrition, respiration, movement, growth ... etc. The ecology of the individual is concerned with studying the behavior of the individual, his physiological state and his outward appearance, and the individual represents the building unit that forms the population group.

Population: It is a group of individuals that belong to one type of living organisms that are similar in structure and characteristics, they live in a specific place at the same time, and able to produce new individuals belonging to the same species. ,they are usually those who constitute the community life.

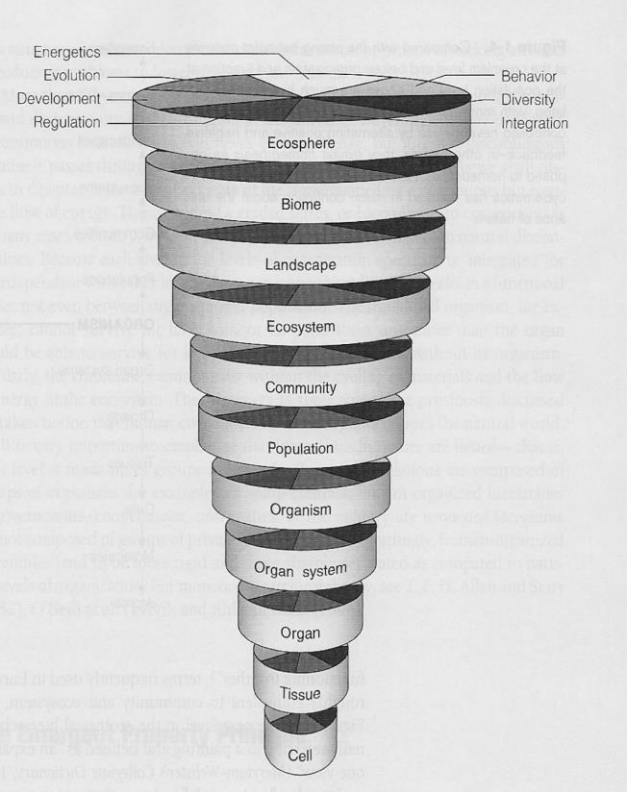
Community: A life formation that includes "a number of different population groups that belong to different types and live in a specific place and at a specific time, and the existence of some of them depends on each other."

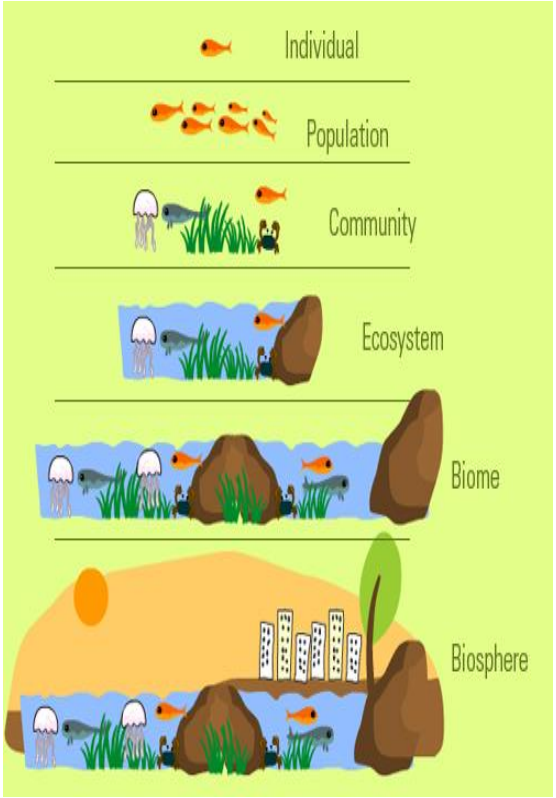
Ecosystem: It is an organizational or spatial unit that includes living organisms and non-living components interacting with each other to lead to the exchange of materials and energy between the living parts.

Biosphere: It is "the area of the earth's surface in which life exists. It extends from the deepest depth in which living organisms are found in the seas and parts of the earth's crust to the highest elevation on which life is found in the mountains, and its thickness is approximately 14 km.

Ecosphere: It includes the biosphere in addition to other non-biospheres, such as hydrosphere, lithosphere and atmosphere.

Biome: is defined as a community of various plants and animals, that inhabit a particular type of geographic region of Earth. They can be found over a range of continents.





COMPONENTS OF ECOSYSTEMS

All ecosystems consist of two components, **Abiotic** and **Biotic** components

1. ABIOTIC COMPONENTS

The abiotic components are the non-living components of the ecosystem. They are of three categories

1. Climatic and physical factors -air, water, soil and sunlight; rainfall, temperature, humidity, soil texture and geomorphic conditions.

2. Inorganic substances- There are various nutrient elements and compounds, such as carbon, nitrogen, sulfur, phosphorous, carbon-di-oxide, water, etc. These are involved in the cycling of materials in the ecosystems.

3. Organic compounds- These are proteins, carbohydrates, lipids, humic substances, etc. They largely form the living body and link the abiotic compounds with the biotic factors.

The abiotic factors determine the type of organisms that can successfully live in a particular area.

Some of the major non-living factors of an ecosystem are: Sunlight, Water, Temperature, Oxygen, Soil, Air.

2. BIOTIC COMPONENTS

Biotic components - include all living organisms and their products.

This group includes all animals, plants, bacteria, fungi and their waste products like fallen leaves or branches or excreta.

Based on their activity, biotic components are classified into four categories as

a) **Producers**: They vary in size from microscopic phytoplankton found in aquatic ecosystems such as algae to higher plants that differ in their sizes and shapes. It also contains some types of bacteria and they are called autotrophs, as they use sunlight as energy to convert inorganic compounds into organic compounds that are used to build their bodies. All plants and algae are producers because they are they do photosynthesis, while some bacteria are producers because they build up photosynthesis and chemical construction process.

b) **Consumers**: They are organisms that consume organic materials, manufactured by productive organisms, directly or indirectly, and they are called heterotrophic organisms (also called non-autotrophic or dependent nutrition). There are different types of consumers,

1-PRIMARY CONSUMERS: called **Herbivores** they are eat plants.

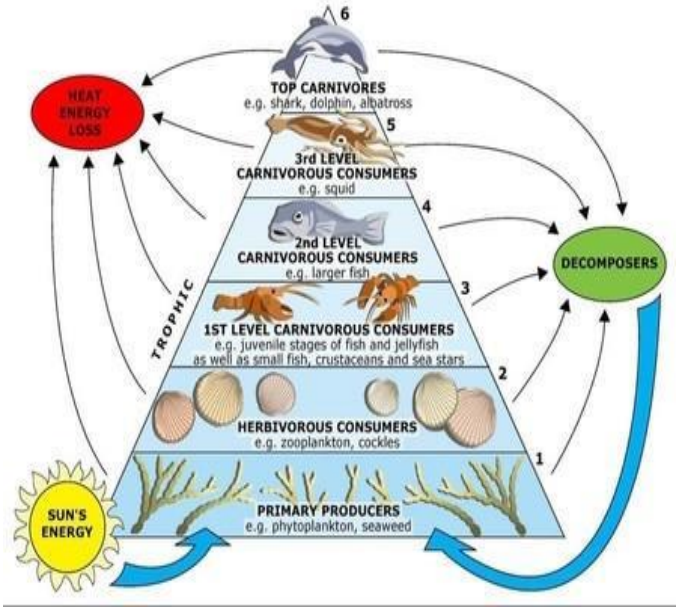
2-SECONDARY CONSUMERS: Secondary consumers are those which predate on primary consumers, including
-Carnivores they are eat animals.
-Omnivores eat both plants and animals.
- Scavengers It feeds on dead, rotten animals and plants.

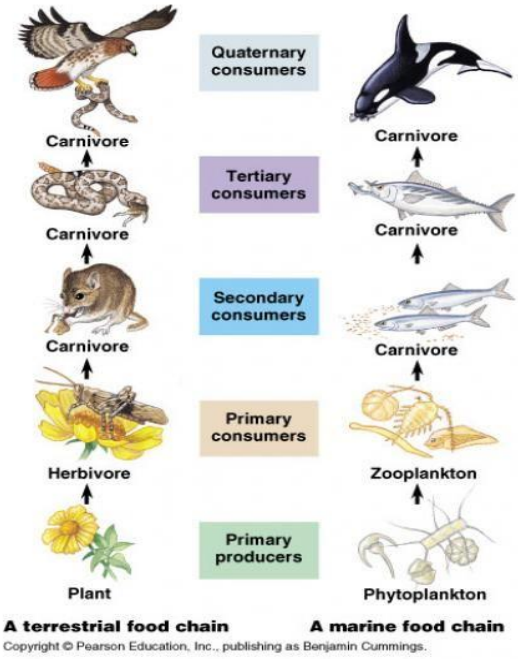
3- TERTIARY CONSUMERS are the predators of predators. They are mostly larger animals.

c) **Transformers** are certain types of bacteria . They attack on materials excreted by other living organisms (even dead plants and animals). They transform the above into either organic or inorganic substances. These substances are suitable for the nutrition of green plants.

Transformers help in recycling the nutrients which came as waste already.

d) **Decomposers** They are also called as microconsumers. They are heterotrophs that break down the dead tissue and complex organic matter found in plant and animal bodies, and release simple substances . These substances will be used by autotrophs once again. They play a very important role in the ecosystem because they recycle the nutrients. Bacteria and fungi are the main decomposers.





Types of ecosystems

Ecosystems are classified into **terrestrial ecosystems** and **aquatic ecosystems**.

1-Aquatic ecosystems

Global waters cover about three quarters (two-thirds) of the earth's surface either as fresh water where salt content is less than 0.5 per cent or as saline water where the salt content is more than 3.5 per cent or as brackish water where salt content is intermediate between fresh water and saline water. On the basis of their salt content aquatic ecosystems can be divided in saline water bodies and fresh water bodies. The salt content of fresh bodies is very low, always less than 5 ppt (parts per thousand). As against this the water bodies containing salt concentration equal to or above that of sea water (i.e., 35 ppt or above) are called as saline water bodies or marine water bodies. Seas and oceans of the world come under this category. Estuaries and brackish water bodies have salt content somewhere in between 5 to 35 ppt.

Aquatic ecosystem is any watery environment, from small to large (i.e. from ponds to oceans), running or still (rivers or lakes) that contain a group of interacting organisms (plants, animals, microbes) that are dependent on one another and their water environment for energy and food (carbon), nutrients (e.g. N, P) and shelter.

Ecosystems consisting of water as the main habitat are known as **aquatic ecosystems**. There are three kinds of aquatic ecosystems : Fresh water, saline and brackish water ecosystems. Freshwaters are again of two types, the static water ecosystems are called lentic systems and flowing water ecosystems are called as lotic systems.

1.2.Ecological classification of aquatic organisms

The aquatic organisms of all the three types of ecosystem i.e. marine. Freshwater or brackish, are classified on the basis of their zone of occurrence in the aquatic system and their ability to cross these zones. The organisms in the aquatic ecosystem are unevenly distributed but can be classified on the basis of their life form or location into five groups:

i) Neuston : These are unattached organisms which live at the air-water interface such as floating algae and plants and several types of animals. Some spend most of their lives on top of the air-water interface. such as water striders, while other spend most 'of their time just beneath the air-water interface and obtain most of their food within the water, -e.g., beetles.

ii) Periphyton : These are organisms which remain attached or clinging to stems and leaves of rooted plants or substances emerging above the bottom mud. Usually sessile algae and their associated group of animals fall in this group.

iii) Plankton : This group includes both microscopic plants (phytoplankton) and animals (zooplankton) found in all aquatic ecosystems, except certain swift moving waters. The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems. Planktons are divisible into :

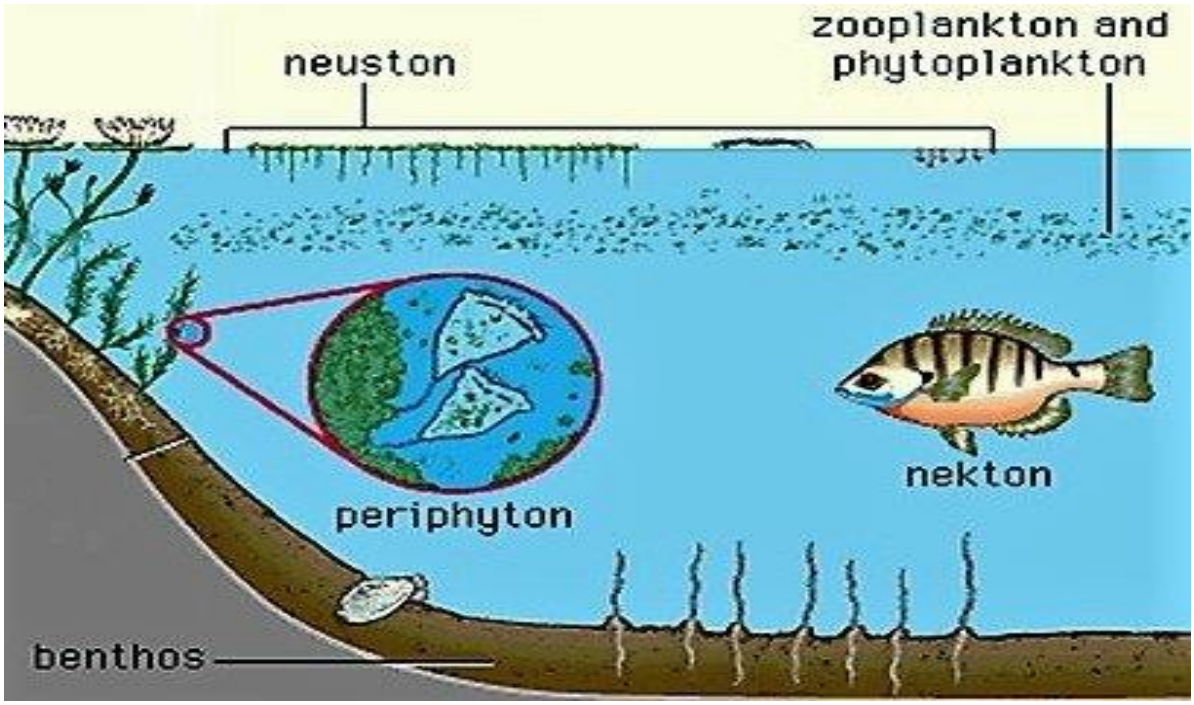
1) Plants (chiefly algae) known as phytoplankton ; and

2) Animals (primarily crustaceans and protozoans) known as zooplankton.

Most phytoplanktons and zooplanktons are capable, however, of at least some movement. Certain zooplanktons are extremely active and move relatively large distances, considering their small size, but they are so small that their range is still largely controlled by currents.

iv) Nekton :This group contains animals which are swimmers. The nektons are relatively large and powerful as they have to overcome the water currents . The animals range in size from the swimming insects, which may be only about 2 mm long, to the largest animals that have lived on earth namely the blue whale.

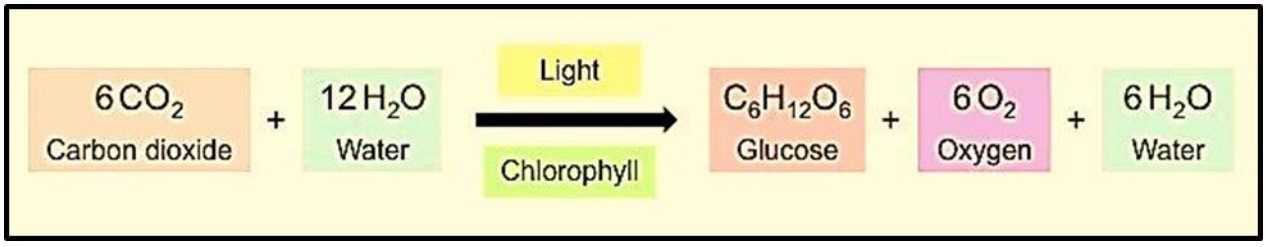
v) Benthos :The benthos or the benthic organisms are those found living in or on the bottom or benthic region of the water mass. They exhibit a variety of adaptations to the environment. The reason for this is that the bottom is a more heterogeneous habitat than either the open water or the surface and this diversity is reflected in the organisms. Practically every aquatic ecosystem contains well developed benthos. The adaptations of the organisms in the benthic community reflect the composition of the bottom, its stability or tendency to shift, and its depth.



1.3. Factors Limiting the Productivity of Aquatic Habitats

In general, productivity refers to the rate of generation of biomass in an ecosystem usually expressed in units of mass per volume (unit surface) per unit of time, such as grams per square meter per day (g m−2 d−1). The unit of mass can relate to dry matter or to the mass of generated carbon. The productivity of autotrophs, such as plants and algae, is called **primary productivity**, while the productivity of heterotrophs, such as animals, is called **secondary productivity**.

The primary productivity Primary production is the synthesis of new organic material from inorganic molecules such as H_2O and CO_2. It is dominated by the process of photosynthesis which uses sunlight to synthesize organic molecules such as sugar.



Secondary production is the generation of biomass of heterotrophic (consumer) organisms in a system. This is driven by the transfer of organic material between trophic levels, and represents the quantity of new tissue created through the use of assimilated food. Secondary production is sometimes defined to only include consumption of primary

producers by herbivorous consumers (with tertiary production referring to carnivorous consumers), but is more commonly defined to include all biomass generation by heterotrophs. Organisms responsible for secondary production include animals, protists, fungi and many bacteria.

Sunlight and oxygen are the two most important limiting factors of the aquatic ecosystems. This distinguishes them from the terrestrial ecosystems where moisture and temperature are the main limiting factors. We will now consider some of the important limiting factors which exert controlling influence on productivity of aquatic ecosystems, namely sunlight, transparency, temperature and oxygen.

1- Sunlight : Sunlight is a major limiting factor for water bodies, since light rapidly diminishes as it passes down the column of water. The upper layers of the aquatic ecosystems, up to which light penetrates and within which photosynthetic activity is confined forms the photic zone. The depth of this zone depends on the transparency of water.

2- Transparency : Transparency affects the extent of light penetration. It is indirectly related to turbidity. Suspended particulate matters such as clay, silt and phytoplankton make the water turbid. consequently limiting the extent of light penetration and this photosynthetic activity in a significant way.

3- Temperature : The water temperature changes less rapidly than the temperature of air because water has a considerably higher specific heat than air, that is larger amounts of heat energy must be added to or taken away from water to raise or lower its temperature. Since water temperatures are less subject to change, it follows that aquatic organisms have narrow temperature tolerance. As a result, even small changes in water temperatures are a great threat to the survival of aquatic organisms than comparable changes in air temperatures are in terrestrial organisms.

4- Dissolved oxygen : Oxygen in the terrestrial ecosystems occurs in the atmosphere along with other gases in a certain fixed concentration however, in aquatic ecosystems it is dissolved in water, where its concentration varies constantly depending on factors that influence the input and output of oxygen in water. Oxygen is found in waters in dissolved form. It enters the aquatic ecosystem through the air water interface and by the photosynthetic activities of aquatic plants.
Therefore, the quantity of dissolved oxygen present in an ecosystem depends on the rate at which these two processes occur. For example, the turbulence that occurs in waterfalls as well as wave activity that occurs in open water, increase the rate of oxygen transfer from air to water (unless the water is already saturated with oxygen).

The transfer of oxygen is also affected by the surface area of the waterway. A wide shallow section of a river has a larger surface area of oxygen transfer than a narrow deep segment. Further, the quantity of oxygen that is produced per unit area due to photosynthesis is related directly to the density of aquatic plants that are present in water.

Dissolved oxygen escapes the water body through air-water interface and through respiration of organisms (fish, decomposers, zooplanktons, etc). The amount of dissolved oxygen retained in water is also influenced by temperature as oxygen is less soluble in warm water. Warm water also enhances decomposer activity. Therefore, increasing the temperature of a water body increases the rite at which oxygen is depleted from water.

Aquatic ecosystems are features in the landscape that participate in the processing and transport of materials from continents to oceans. Aquatic ecosystems are sources of biodiversity, and they sustain livelihood and economic activities around the world.

It is on the saline basis, that aquatic ecosystems are categorized into:

I) Fresh water ecosystems- lakes. ponds, swamps, pools, springs, streams, and rivers.

2) Marine ecosystems - shallow seas and open ocean. And,

3) Brackish water ecosystems-estuaries, salt marshes, mangrove swamps and forests.