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## UNIT II

### Ecosystems

#### Ecology

- Ecology comes from the Greek words oikos (house or place where one lives) and logos (study of). It can be surmised as the Study of the “House” in which We Live.
- This term was introduced by Ernst Haeckl in 1869. Ecology can be defined more specifically as the study of the interactions between organisms and the nonliving components of their environment.
- Ecology involves collecting information about organisms and their environment, looking for patterns, and seeking to explain these patterns

#### Ecosystem

- Ecosystem is the structural and functional unit of ecology where living organisms interact with each other and also with the surrounding physical environment.
- In other words, it is the whole community in which plants and animals live together. In an ecosystem, biotic and abiotic components are inseparably inter-related.
- These components interact with each other. As ecosystem is an open system, the energy and the components can easily flow throughout the boundaries.

#### Types of Ecosystem

Mainly there are two types of ecosystems. Namely terrestrial ecosystem and aquatic ecosystem

**1. Terrestrial ecosystem:** This is the ecosystem which exists on land. It can be further divided into the following types,

- Forest ecosystem
- Grassland ecosystem
- Desert ecosystem

**2. Aquatic ecosystem:** This is the ecosystem which exists in water. It can be further divided into,

- Fresh water ecosystem (Pong or lake or river ecosystem)
- Marine ecosystem (Ocean ecosystem)

#### Structure of Ecosystem

##### Abiotic components:

- It is the nonliving component of the ecosystem.
- The abiotic components of the ecosystem include basic inorganic elements and compounds like soil, water, oxygen and a variety of organic compounds.
- Also some physical factors like humidity, wind and water currents, solar energy etc. are also abiotic components.

##### Biotic components:

- It is the living component of the ecosystem. In terms of nutrition, biotic components can be grouped as autotrophs and heterotrophs.

- Autotrophs include green plants which make their own food with the help of sunlight and other inorganic matter.
- Heterotrophs include non-green plants and all animals which depend on autotrophs for their food needs.
- On a broader scale biotic components includes producers, consumers and decomposers

### **Producers:**

- Producers are the autotrophic elements of the ecosystem.
- They use radiant energy of the sun during the process of photosynthesis whereby carbon dioxide is assimilated and the light energy is converted into chemical energy.

### **Consumers:**

- These are the members of the ecosystem which consume the food prepared by the producers and hence are called as consumers.
- The following are different classes included in consumers,
  - **Primary consumers:** These are herbivorous animals which are dependent on the green plants for their food. For example, insects, cow, deer, buffalo, goat etc.
  - **Secondary consumers:** These are carnivorous and omnivorous animals which feed on primary consumers and producers or both. For example, sparrows, fox, crow, snake etc.
  - **Tertiary consumers:** These are the top carnivorous animals which feed on other carnivorous, herbivorous and omnivorous animals. For example, lion, tiger, vulture, hawks etc.

### **Scavengers and parasites:**

- These are the parasitic plants and animals which make use of the living tissues of different plants and animals. The scavengers use dead remains of animals and plants as their feed.

### **Decomposers and transformers:**

- These are living components of the ecosystem. Decomposers and transformers help to maintain the dynamic structure of ecosystems.
- The decomposers attack dead remains of producers and consumers. Decomposers degrade the complex organic substances into simpler compounds.
- Whereas the transformers change the organic compounds into inorganic forms that are suitable for reuse by the producers or green plants. For example, Fungi and Bacteria.

### **Function of an ecosystem**

- The function of an ecosystem is a broad, vast and often confused topic.
- The function of an ecosystem can be best studied by understanding the history of ecological studies. The function of an ecosystem can be studied under the three heads

**1. Trophic Level Interaction** - Trophic Level Interaction deals with how the members of an ecosystem are connected based on nutritional needs.

**2. Ecological Succession** - Ecological Succession deals with the changes in features / members of an ecosystem over a period of time.

**3. Biogeochemistry:** Biogeochemistry is focussed upon the cycling of essential materials in anecosystem.

As we would be discussing about ecological succession and bio geochemistry in the future chapters, we shall confine to trophic level interaction alone in this chapter.

Trophic Level Interaction was developed by zoologist Charles Elton. It deals with who eats who and is eaten by whom in an ecosystem. The study of trophic level interaction in an ecosystem gives us an idea about the energy flow through the ecosystem. The trophic level interaction involves three concepts namely

1. Food Chain
2. Food Web
3. Ecological Pyramids

### **Food Chain**

Plants are eaten by insects, which are eaten by frogs; these frogs are eaten by fish, which are eaten by human beings. This sequence is known as Food chain.

Plant → insect → frog → fish → human

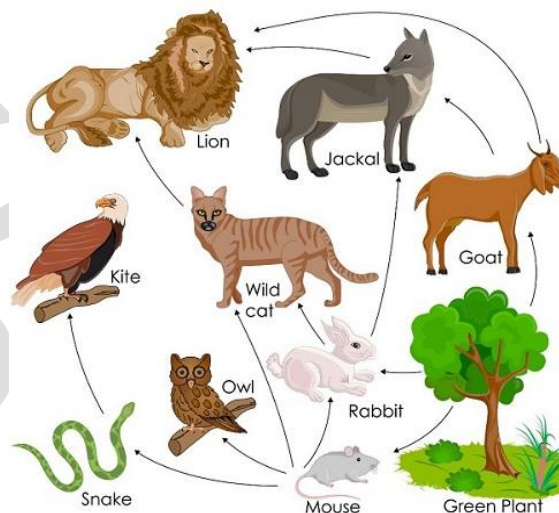
Each step in the food chain is called a “Trophic level” as in above food chain – 5 trophic levels

Type of food Chain

- **Grazing :** Starts with green plants  
e.g. Grass → Grasshoppers → Birds → Snakes →Hawks
- **Parasitic:** Also starts with green plants but here smaller organisms depending on larger organism  
e.g. Grass → cow → lice
- **Detritus/saprophytic:** Starts with dead plant/animal/ waste material → decomposers

### **Food Web**

Food chain assumes the isolated linear line. But in real life, frog could be eating other insects apart from grasshopper. Fish could be eating smaller fishes apart from frog. So there exists an interconnected network of food chains. This interconnected network of food chains is known as food web.

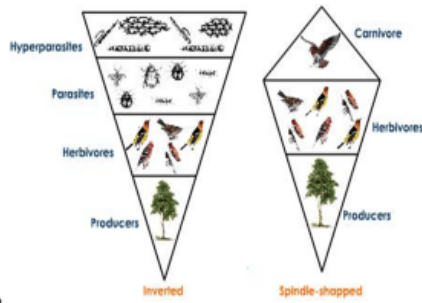


### **Ecological pyramids**

Ecological pyramids represent the trophic structure or trophic function of the ecosystem and and is mainly of 3 types:

#### **Pyramid of Number**

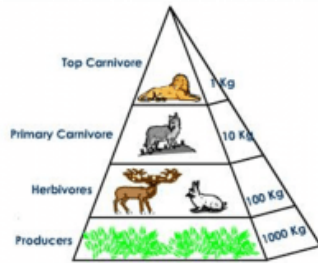
- Depicts the number of individual organisms at different trophic levels of food chain
- May be inverted or upright or spindle shape



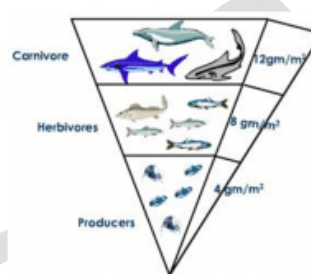
## Pyramid of Biomass

- Depicts total dry weight of all organisms at each trophic level at a particular time, measured in  $g/m^2$
- May be upright or inverted

Mainly in Grasslands Ecosystem



Mainly in Aquatic Ecosystem

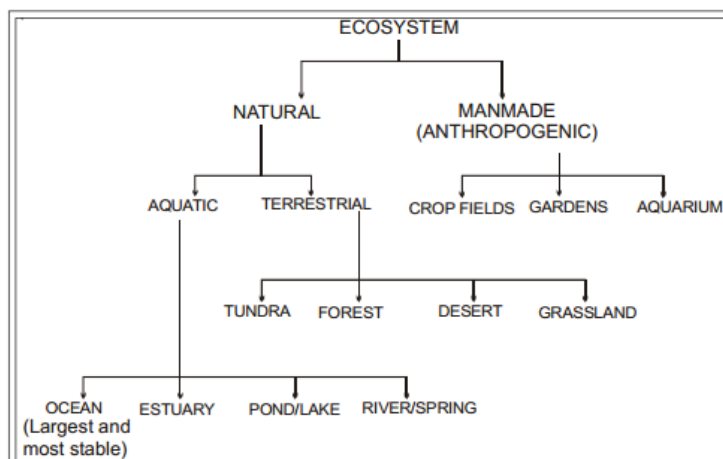


## Pyramid of Energy

- A graphic representation of the amount of energy trapped per unit time and area in different trophic level of a food chain with producers forming the base and the top carnivores at the tip
- Always upright



## Types of Ecosystems



These ecosystems are capable of operating and maintaining themselves without any major interference by man. A classification based on their habitat:

- Terrestrial ecosystems
- Aquatic ecosystems

**Terrestrial Ecosystem** - Terrestrial ecosystems are many because there are so many different sorts of places on Earth. Some of the most common terrestrial ecosystems that are found are the following:

- Forest ecosystem
- Grassland ecosystem
- Desert ecosystem

**Forest Ecosystem** - Forests occupy roughly 40 percent of the land. In India these occupy roughly one-tenth of the total land area. The different components of forest ecosystem include:

- A biotic component: Include inorganic and organic substances present in soil and atmosphere. Dead organic debris is also present in forests.
  - Biotic components: These include producers like trees, shrubs and ground vegetation.
- Among the primary consumers are the herbivores which include animals feeding on tree leaves as ants, flies, beetles, spiders etc. and larger animals like elephants, deer etc.
- Secondary consumers are the carnivores like snakes, birds and fox etc.
- Tertiary consumers are the top carnivores like lion, tiger etc.
- Decomposers include microorganisms like fungi, bacteria and actinomycetes.

**Grassland Ecosystem** - These occupy a comparatively fewer area, roughly 19 percent of the earth's surface. The various components of grassland ecosystem are:

- Abiotic components: These include the nutrients present in soil and the aerial environment. C, H, O, N, P, S are supplied by Carbon dioxide, water, nitrates, phosphates and sulphates.
  - Biotic components: These may be categorized as:
- Producers: These are mainly grasses e.g. Cynodont species, Dicanthium species etc. Shrubs may also be present.
- Consumers: These occur in the following sequence:
- Primary consumers are the herbivores feeding on grasses are mainly grazing animals as cows, deer's and rabbit etc. Besides them there are insects, termites and millipedes that feed on leaves.
- Secondary consumers: Carnivores feeding on herbivores e.g. Fox, Snakes, frogs, Lizards etc.
- Decomposers: Microbes including fungi like Mucor, Aspergillus, Rhizopus etc and some bacteria and actinomycetes.

**Desert Ecosystem** - Desert occupy about 17 percent of land, occurring in the regions with an annual rainfall of about 25 centimetres. The species composition of such an ecosystem is varied and typical due to the extremes of temperature and water factors.

The biotic components include:

- **Producers** are shrubs, especially bushes, some grasses and a few trees.
- **Consumers** include animals like reptiles and insects which are able to live under xeric conditions. In addition, there are some nocturnal rodents and birds. The camel feeds on tender shoots of the plants.
- **Decomposers** are very few, as due to poor vegetation the amount of dead organic matter is correspondingly less. They are some fungi and bacteria.

**Aquatic ecosystem** - An aquatic ecosystem is an ecosystem that exists in water. Within an aquatic ecosystem, the environment is a water one. Aquatic ecosystems can be divided into fresh water

ecosystems (such as fresh rivers or freshwater lakes) and marine ecosystems such as the sea and rock pools.

### **Pond Ecosystem**

Pond serves as an example of freshwater ecosystem. It exhibits a self-sufficient and self-regulating system. The components of the pond ecosystem are as follows:

- Abiotic components: The chief substances are heat, light, pH value of water and the basic inorganic and organic compounds .
- Biotic components: These include;
  - **Producers** are autotrophic, green plants and some photosynthetic bacteria. These are of following types:
    - Macrophytes are mainly rooted larger plants e.g Trapa, Typha, Nymphae etc. Some free floating forms like Azolla, Wolffia, Lemna etc also occur in the pond.
    - Phytoplanktons are minute floating or suspended lowerplants e.g Zygnema, Spirogyra etc
  - **Consumers** are heterotrophs. Most of the consumers are herbivore, a few are insects and large fishes are carnivorous feeding on herbivores. The herbivores are further differentiated as Benthos and zooplanktons. Secondary consumers are carnivores which include insects and fish. Tertiary consumers are also carnivores and include some large fish feeding on smaller ones.
  - **Decomposers** include variety of microbes chiefly bacteria, actinomycetes & fungi.

### **Ocean Ecosystem**

The oceans cover about 70 percent of the earth's surface. Each ocean represents a stable ecosystem. The biotic components of an ecosystem are as follows:

- **Producers** are autotrophs which include the phytoplankton's such as diatoms and dinoflagellates. In addition, brown and red algae also contribute.
- **Consumers** include herbivores e.g. crustaceans, molluscs, carnivores (Herring, shad) feeding on herbivores. Tertiary consumers include carnivorous fishes like Cods, Haddock etc. that feed on secondary consumers.
- **Decomposers** are the microbes that feed on dead organic matter of producers and macro consumers e.g. Bacteria and fungi.

### **Cropland Ecosystem**

In nature we find another kind of ecosystems, where man is very much involved in their operation. These are called as cropland ecosystems that are artificial or man engineered. In order to obtain more food, timber etc. Man becomes responsible for the replacement of natural ecosystems. Thus, a Cropland ecosystem is an artificial ecosystem aimed primarily to grow a single species of one's choice e.g. Wheat, maize, paddy etc.

### **Ecological Succession**

Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature as all the biotic components have to keep up with the changes in our environment.

The ultimate aim of this process is to reach equilibrium in the ecosystem. The community that achieves this aim is called a climax community. In an attempt to reach this equilibrium, some species increase in number while some other decreases.

In an area, the sequence of communities that undergo changes is called sere. Thus, each community that changes is called a seral stage or seral community.

All the communities that we observe today around us have undergone succession over a period of time since their existence. Thus, we can say that evolution is a process that has taken place simultaneously along with that of ecological succession. Also, the initiation of life on earth can be considered to be a result of this succession process.

If we consider an area where life starts from scratch by the process of succession, it is known as primary succession. However, if life starts at a place after the area has lost all the life forms existing there, the process is called secondary succession.

It is obvious that primary succession is a rather slow process as life has to start from nothing whereas secondary succession is faster because it starts at a place which had already supported life before. Moreover, the first species that comes into existence during primary succession is known as pioneer species.

### **Types of Ecological Succession**

These are the following types of ecological succession:

- **Primary Succession**

- Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.
- When the planet was first formed there was no soil on earth. The earth was only made up of rocks. These rocks were broken down by microorganisms and eroded to form soil.
- The soil then becomes the foundation of plant life.
- These plants help in the survival of different animals and progress from primary succession to the climax community. If this primary ecosystem is destroyed, secondary succession takes place.

- **Secondary Succession**

- Secondary succession occurs when the primary ecosystem gets destroyed. For eg., a climax community gets destroyed by fire.
- It gets recolonized after the destruction. This is known as secondary ecological succession. Small plants emerge first, followed by larger plants.
- The tall trees block the sunlight and change the structure of the organisms below the canopy. Finally, the climax community arrives.

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