

TROPHIC STRUCTURE OF ECOSYSTEMS

All organisms with similar feeding habits are grouped together and known as **TROPHIC LEVEL**.

Food Chains- The transfer of food energy from the source in the plants through a series of organisms with repeated stages of eating and being eaten is known as the FOOD CHAIN. Food chain can be a simple form as in:

Plants herbivores carnivores decomposers. e.g. in a marine ecosystem a food chain could be :

Phytoplankton zooplankton whales bacteria.

Often there are more than four steps in a food chain. For example, an ecosystem could contain a sequence of three types of carnivores feeding on each other.

Plants herbivores carnivores carnivores carnivores decomposers.

However, it is rare to find more than six steps in a food chain.

There are two basic types of food chains:

- 1) Grazing food chain; and
- 2) Detritus food chain.

GRAZING FOOD CHAIN- In grazing food chain; the **plants** are **eaten live** by the herbivores. This involves a fairly rapid and direct transfer of food energy from the living plants to grazing animals and carnivores.

DETRITUS FOOD CHAIN – In detritus food chain; **dead plants materials** (detritus), such as dead leaves, **is eaten** by a group of animals known as DETRITIVORES.

In terrestrial ecosystems; detritivores include soil mites, earthworms and millipedes, and in the aquatic ecosystems they include various worms and mollusks. The detritus food chain transmit energy to other ecosystem components more slowly than the grazing food chain chain does. Dead plant material (detritus) may remain in the system for a long time before it is consumed, although the action of the detritivores is often aided by the decomposers. Detritus food chains are generally more complicated than then grazing food chains. The two types of food chain may exist separately or they may operate in conjunction with each other.

FOOD WEB – Although simple linear food chains can be found in many types of ecosystems, feeding relationships are frequently more complicated than this because the majority of animals consume a wide variety of food. Most herbivores eat many types of plant, while most carnivores eat several types of herbivores and other carnivores.

Consequently, the linear food chains interconnect to form FOOD WEBS.

The grazing and detritus food chains often link up in food webs at the carnivore level.

The patterns of feeding relationships in food chains and webs can be determined by several techniques such as:

- 1) by analyzing the gut contents of animals
- 2) by introducing radioactive tracers to plants and monitoring their progress through the system.

ECOLOGICAL PYRAMIDS

In a grazing food chain the trophic structure can be

Green plants ----- Herbivore----Carnivore--- Top carnivore----- Decomposers

T_1 T_2 T_3 T_4 T_5

Elton, a biologist, observed that the number of organisms at T_1 is always higher than that of T_2 and at T_4 ; it is least.

Trophic structure of an ecosystem could be indicated by means of ecological pyramids in which T_1 (green plants) form the base and successive levels (consumers- T_2 , T_3 and T_4) form the tiers which make up the apex.

These pyramids are three types:

1. Pyramid of numbers;
2. Pyramid of biomass;
3. Pyramid of energy.

The first TWO types of pyramids give us information about standing crop (i.e. the amount of biomass at any time) of the ecosystem; while the third type (i.e. pyramid of energy) is indicative of the productivity of the system; and each bar represents the total amount of energy utilized at each trophic level.

1. PYRAMID OF NUMBER

In Africa, it has been estimated that the support of a single lion necessitates the slaughter of around 50 Zebras or their equivalent a year. The need to quantify the relationship between predators and their prey led Elton to coin the phrase, pyramid of numbers. In an ecosystem; if we count the number of individuals belonging to each of the trophic levels and represent them in successive levels in tiers, we shall get the following types of pyramids A and B.

A – When the primary producers are small as in grassland or aquatic habita

B – When the primary producers are large as tree.

The pyramid of numbers enables us to ascertain the numerical relationships between producers and consumers within a particular ecosystem. Its principal limitation is that it provides no basis for a comparison of different ecosystems.e.g. a pond and a stream, where the situations are quite different. The problem can be overcome to some extent if we use as our parameter the dry mass (biomass) of organisms rather than their numbers.

BIOMASS – is the weight of an organism after all the water has been removed.

2. PYRAMID OF BIOMASS

This is also useful for visualizing an ecosystem. In such a pyramid, the biomass of all the individuals of a trophic level are added together. The pyramid of biomass shows how, in general, biomass tends to decrease along with energy transfer.

Pyramid of biomass differ for terrestrial and aquatic ecosystems. In terrestrial ecosystems the biomass of all the primary producers is always maximum at any time and the top carnivores have minimum biomass. In ocean (aquatic) system, however, the situation is different and the biomass of the consumers is always higher than that of the primary producers which are diatoms etc; and have a shorter life-span. Pyramid of Biomass could be represented as shown below:

Terrestrial Ecosystem

Aquatic Ecosystem

The pyramid is upright in the case of terrestrial ecosystem and inverted in that of aquatic ecosystem.

3. PYRAMID OF ENERGY

The pyramids of number and biomass do not give an estimate of production rate of the ecosystem and in order to know the ecological efficiency (the efficiency of energy transfer from one trophic level to the next) or productivity of the ecosystem, we base the pyramid on energy accumulation pattern at different trophic levels.

The energy available for use by organisms at each trophic level averages only approximately 10% of the preceding level. This means that as much as 90% of the energy is used up or lost during metabolism. In a pond ecosystem, for example, for every 1,000 kilocalories of energy taken in as light by the algae, which are the producers, almost 900 Kcal. are available to the minnows that eat the algae.

Bass, the secondary consumers that eat minnows, receive only 10% Kcal. or only 0.01 of the original energy input. If a human catches and eat the bass, the energy he/she receives is only 1 kilocalorie, or 0.001 of the energy initially stored by the algae.

To visualize this decrease in available energy in an ecosystem, ecologists create diagrams called Ecological pyramids and an energy pyramid shows the amount of energy, measured in calories, contained in the bodies of organisms at each trophic level. Notice that at each level. Less energy is available .i.e. such a pyramid for all ecosystems is always an upright one.