Terrestrial ecosystem

- A terrestrial ecosystem is the type of ecosystem that is located on land.

- Examples of terrestrial ecosystem are taiga, tundra, deciduous forest, savanna, tropical rain forests, and deserts.

Factors that govern terrestrial ecosystem

(a) Temperature

- Organisms need optimum temperature for germination, growth and reproduction.

- Outside the optimum temperature, the germination, growth and reproduction of some species can be impaired.

(b) Water (moisture)

- Water is important for photosynthesis and transport of nutrients within plants.

- Thus, it is essential in germination, growth and reproduction of plant species.

(c) Soil

- Soil is the medium for plant growth. The type of soil determines the vegetation types in a terrestrial ecosystem.

- E.g. loamy soil supports more diverse vegetation than sandy soil.

(d) Topography

- Topographic variables such as altitude, slope angle and slope aspect affect life in terrestrial ecosystems.

- Thus, it is essential in germination, growth and reproduction plant species.

Producers in terrestrial ecosystem

- Flowering plants (angiosperms) constitute the major group of terrestrial plants.

- Other groups of plant include gymnosperms, mosses, and ferns.

- The principal role of terrestrial plants is the provision of food for animals but they also serve as habitats for some animals.

- Terrestrial plants play a major role in nutrient recycling.

Consumers in terrestrial ecosystem

- Many different kinds of animals feed on plants of terrestrial ecosystem, and therefore constitute consumers of this ecosystem. E.g. insects, snails, mammals, birds etc.

- There are also some animals that feed on other animals in terrestrial ecosytem. E.g. lion, preying mantis, man etc.

Decomposers in terrestrial ecosystem

- These are mostly fungi and bacteria. They decay dead organic matter and release nutrients into the soil.

- That is, terrestrial decomposers help in nutrient cycling.

Dynamic interrelationships of organisms with one another and with their environments

- The various interrelationships in ecosystems take the form of energy flow and nutrient cycling.

- Energy flow within an ecosystem can be expressed in food chains.

- A food chain is a feeding relationship in which a preceding organism is fed upon by a succeeding organism, which in turn is fed upon by another organism and so on.

- By so doing, energy is transferred from one organism to another.

Types of food chains

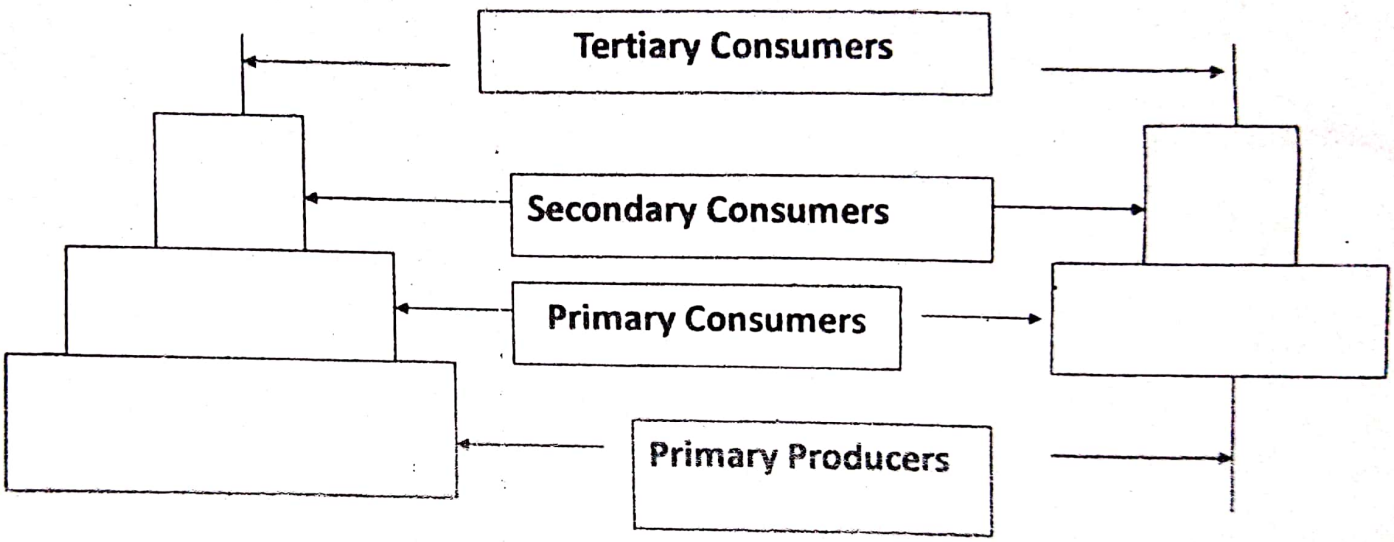
(a) Grazing (predator) food chain

- Plants form the base of the predator or grazing food chain. The plants are consumed by primary consumers, which in turn are fed on by secondary consumers and so on.

- Grazing food chain thus depends on sunlight energy captured by plants, and then the movement of the captured energy from plants to herbivores, and so on.

Plants ⟶ Herbivores ⟶ Primary carnivores ⟶ Secondary carnivores

Pyramid of numbers of grazing (predator) food chain



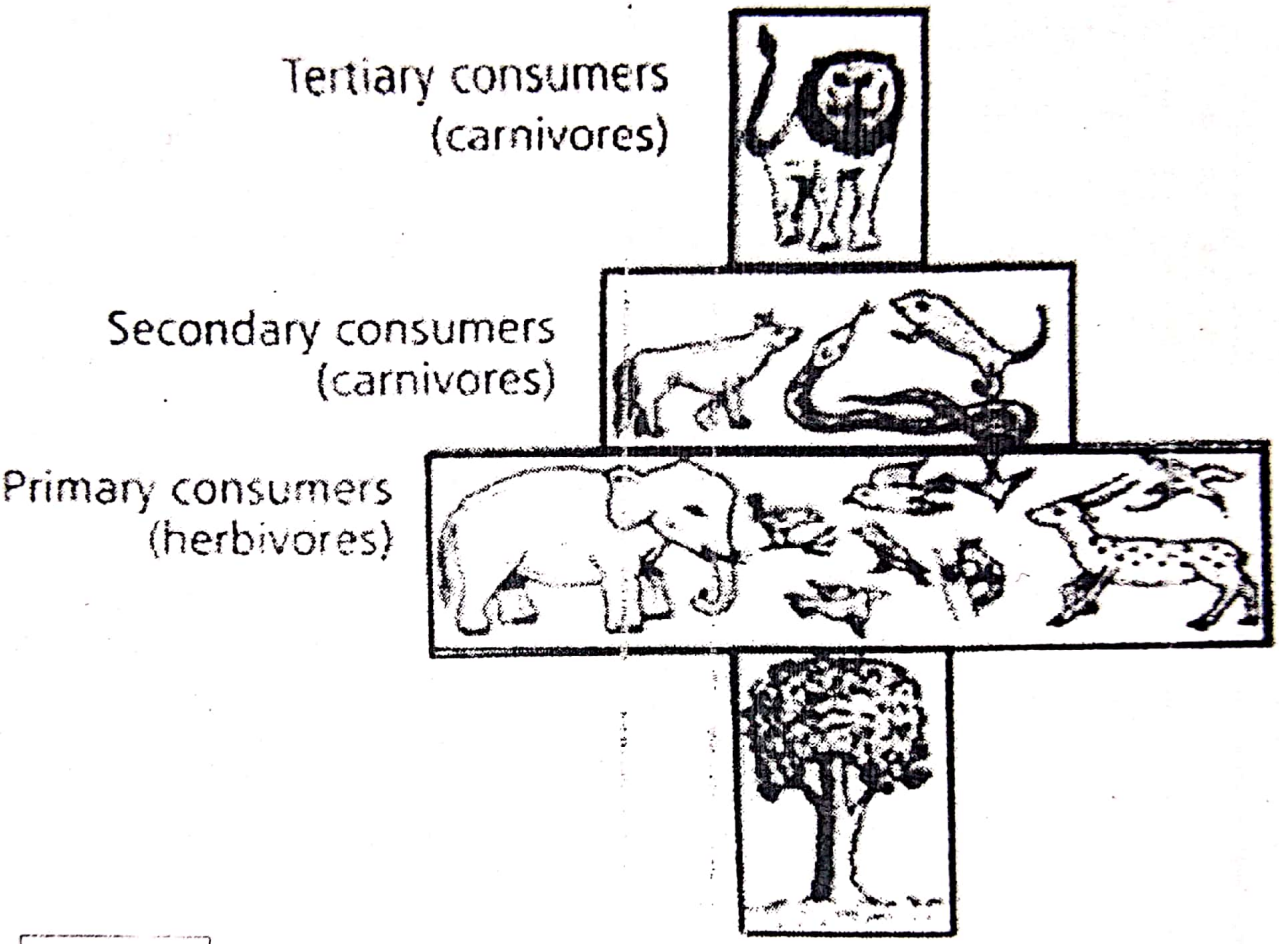


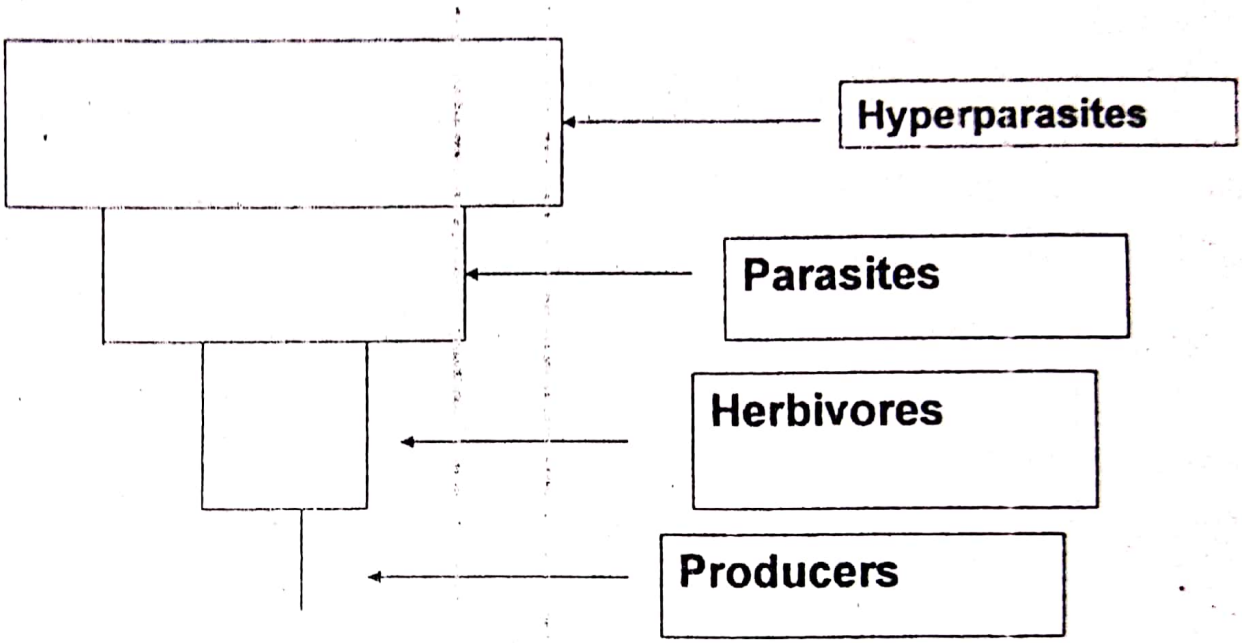
Fig.: Pyramid of numbers in forest ecosystem

(b) Parasitic food chain

- This is where many herbivores feed on a single plant, and each herbivore is fed on by several parasites. The parasites may be consumed by many higher parasites (hyperparasites).

- The number of organisms at each trophic level increases progressively. Thus, pyramid of numbers in parasitic food chain is always inverted.

Pyramid of numbers for parasitic food chain



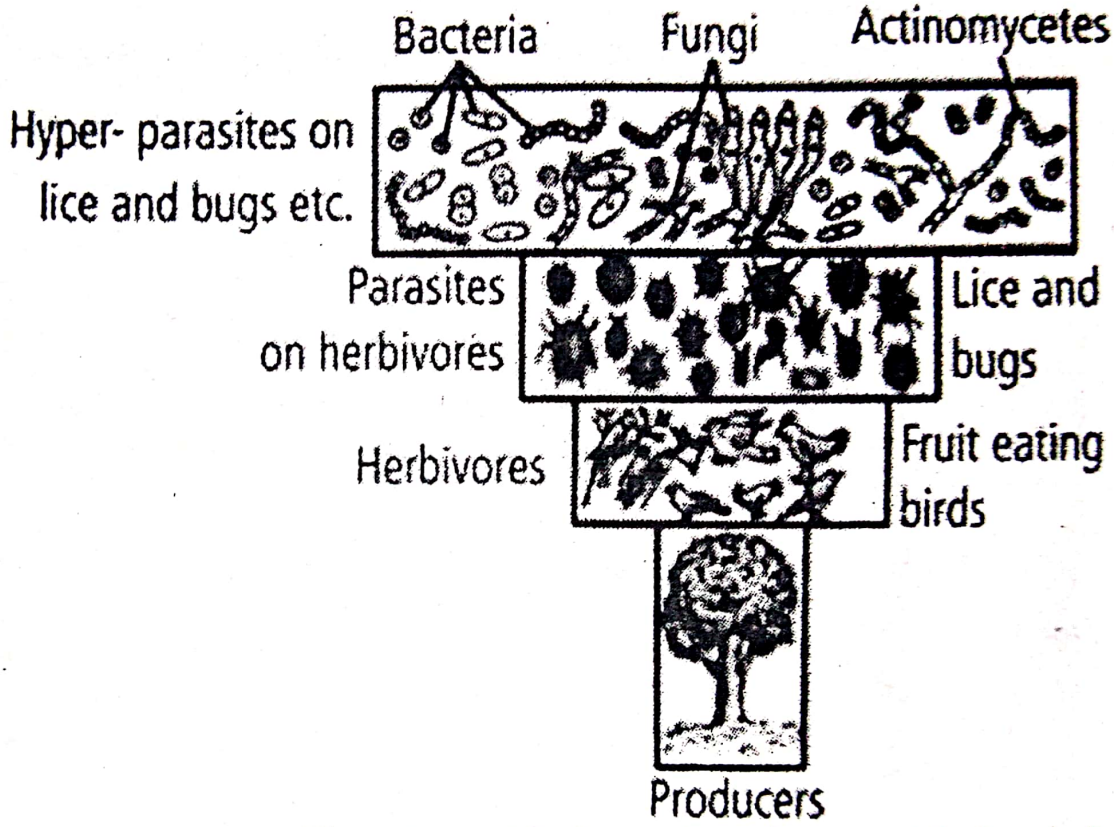


Fig.: Pyramid of numbers in parasitic food chain

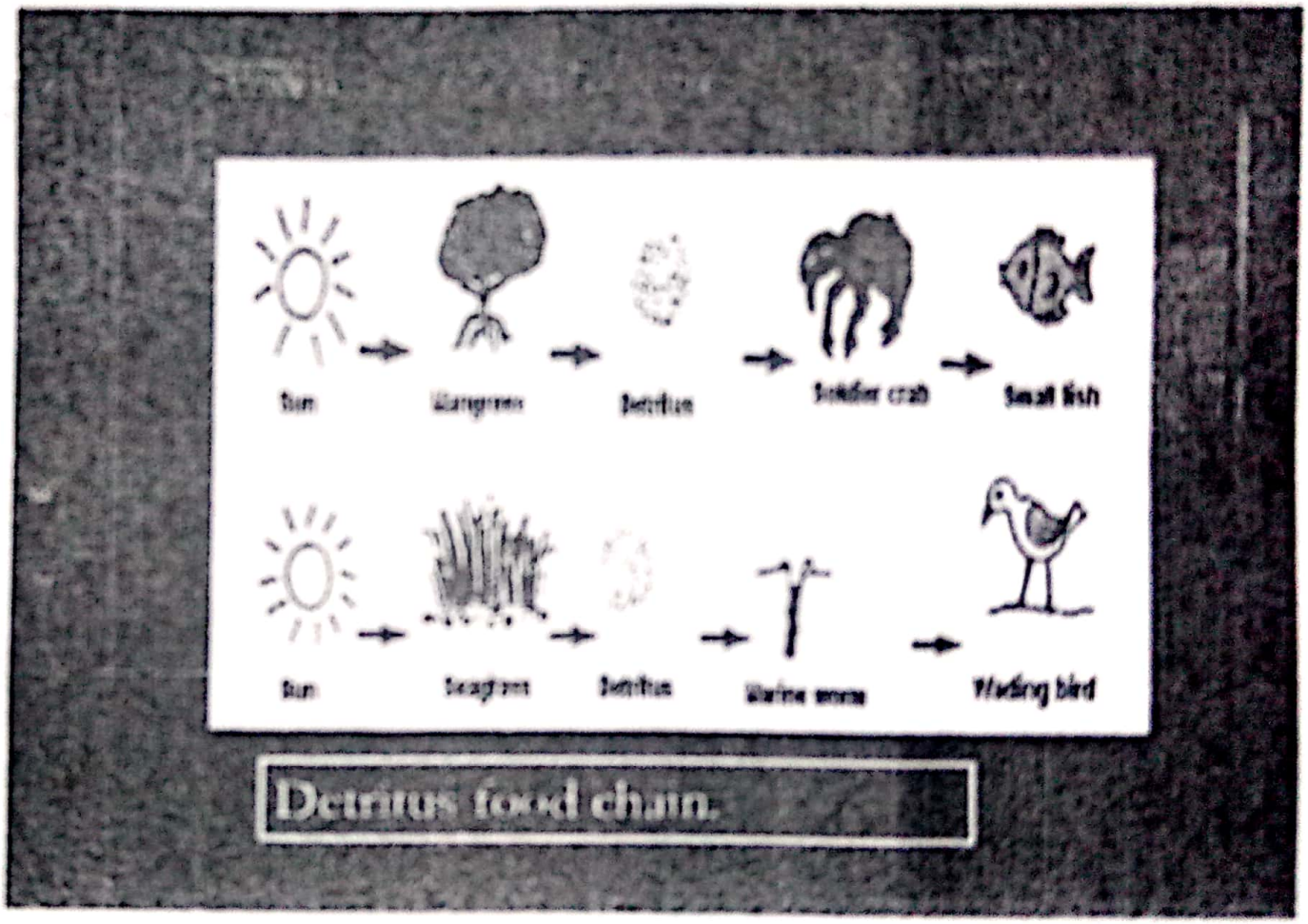
(c) Detritus/decomposer/saprophytic food chain

- Dead plants and animals form the base of detritus food chain.

- This type of food chain begins with fungi and bacteria feeding on dead plants and animals to release nutrients into the soil.

- Detritivores such as earthworms, termites, beetles etc. feed on the detritus formed as a result of fungi and bacteria actions to speed up the decay process. The detritivores may be fed upon by larger animals like moles.

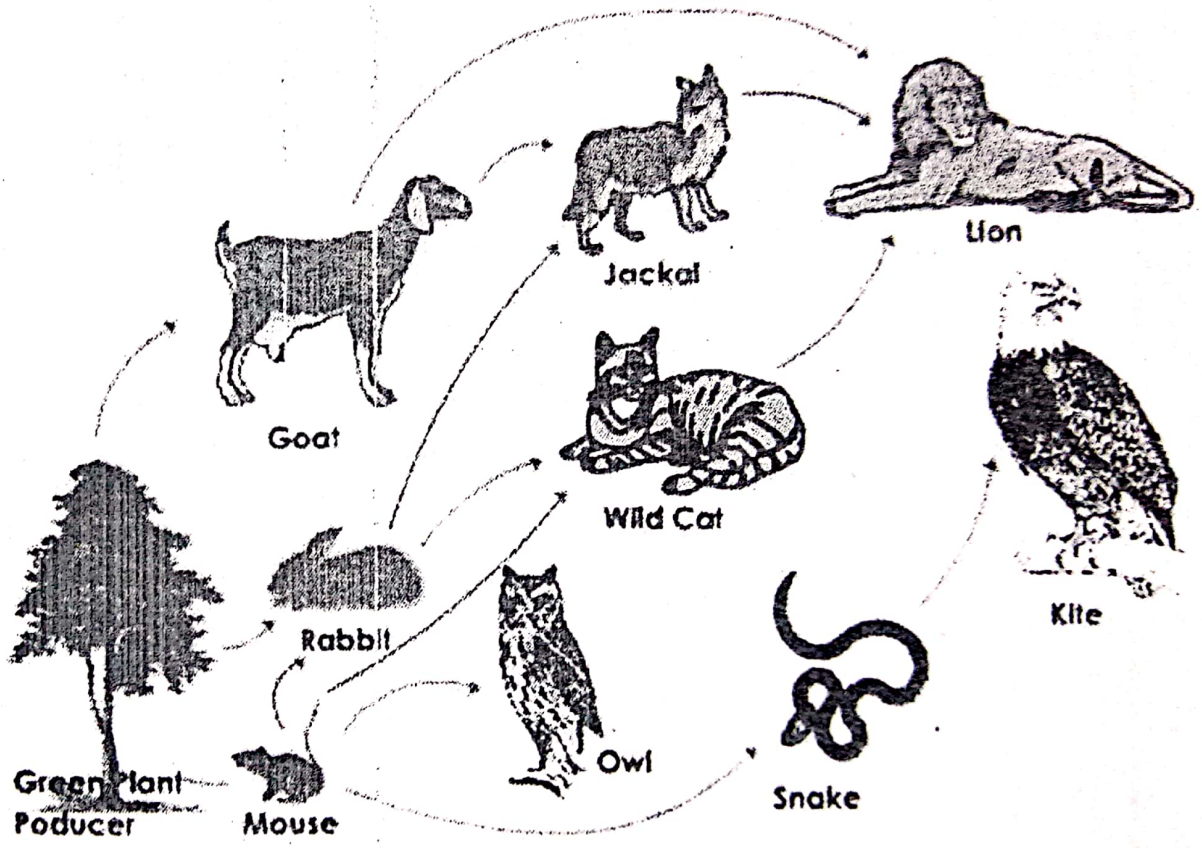
- The fungi and bacteria can also be acted upon by several small animals like protozoans, which in turn, may have small carnivores feeding on them. Larger carnivores can still feed on the small carnivores.



Detritus food chain.

Food webs

- Reading assignment



Food Web In a Forest

Methods of assessing food chains

- Gut contents analysis
- Faecal analysis
- Direct observation in the field and/or laboratory
- Radiotracer

Ecological pyramids

- Ecological pyramids are quantitative ways of representing feeding relationships and energy transfer between organisms in an ecosystem.

- They usually take the form of bars stacked on each another.

- Ecological pyramids enable us to easily assess energy flow and losses within ecosystems.

- Construction of ecological pyramids makes it possible to compare different ecosystems or seasons within the same ecosystem.

Types of ecological pyramids

Pyramid of numbers

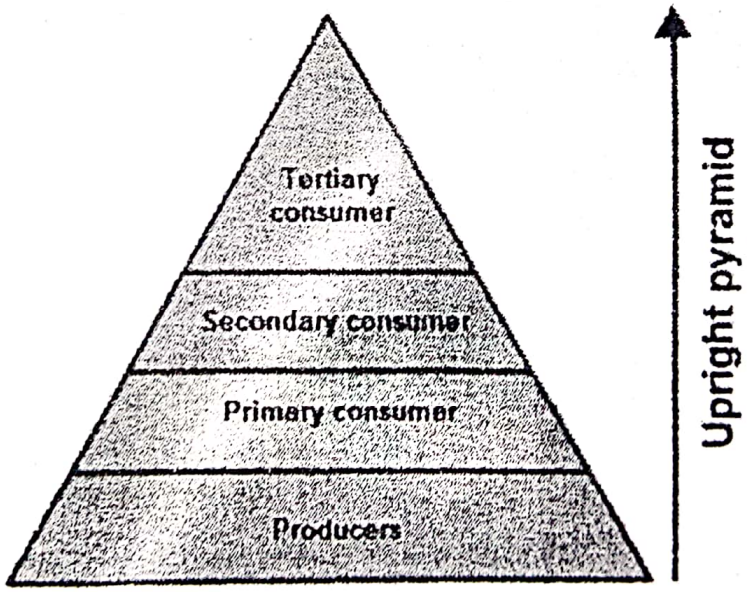
- Pyramid of numbers shows the relationship in terms of number of organisms (producers, herbivores and carnivores) at their successive trophic levels.

- There is a decrease in the number of individuals from lower to higher trophic levels. Pyramid of numbers varies from one ecosystem to another.

- Three types of pyramid of numbers exists: upright, partially upright and inverted.

Upright pyramid of numbers

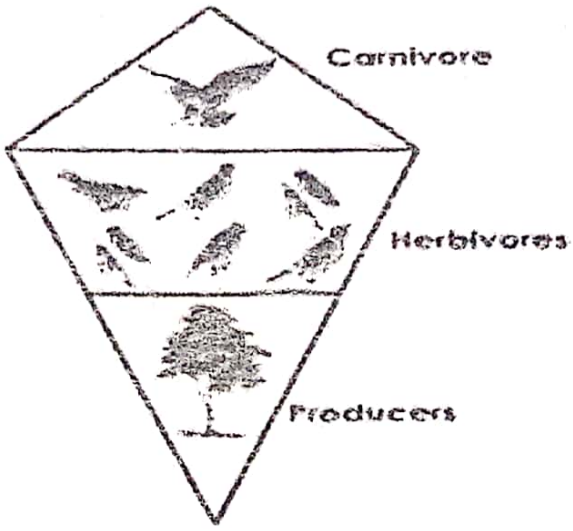
- **The body size of the producers are so small that many of them are needed to support lesser number of primary consumers, which in turn support smaller number of secondary consumers, etc.**



Pyramid of Number

Partially upright pyramid of numbers

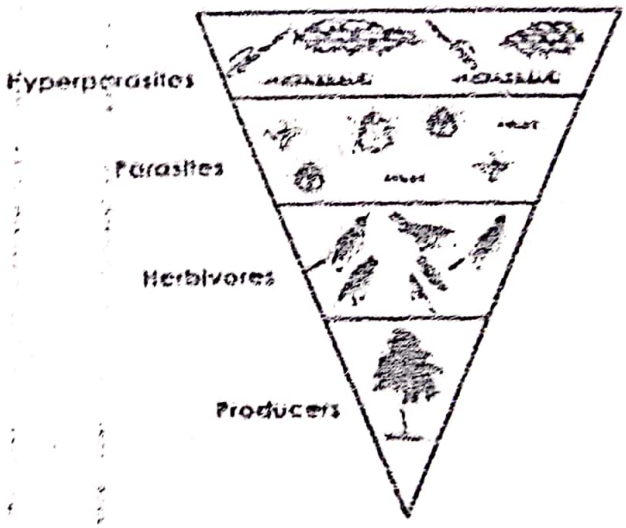
- Due to large body size of producers, a smaller number of them is needed to feed a higher number of primary consumers, which in turn support a smaller number of secondary consumers, etc.



Partly Upright
Pyramid of Number

Inverted pyramid of numbers

- This occurs where one primary producer supports numerous herbivores and the herbivores support more number of parasites, which in turn support more hyperparasites.



Inverted pyramid of number

Advantage of pyramid of numbers

- It is easy to collect data for the construction of pyramid of numbers.

Disadvantages of pyramid of numbers

- In some cases, it is not easy to decide which trophic level an organism belongs to.

- All organisms are included regardless of their sizes, and as a result organisms of different sizes are given the same status. This could lead to different shapes of pyramid of numbers.

- Numbers of organisms can be too great to represent accurately.

Pyramid of biomass

- This is the representation of the total mass of organisms at each trophic level.

- Pyramid of biomass gives a better diagram than pyramid of numbers because it shows the loss of mass from producers to consumers, and among consumers in a food chain.

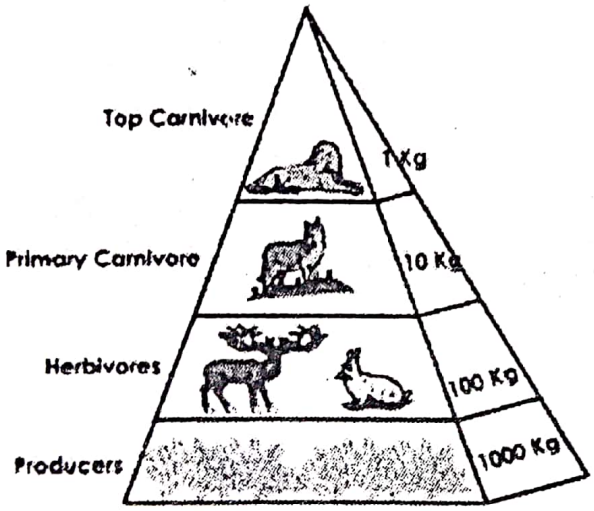
- That is, there is a gradual decrease in mass with increasing trophic level.

- The biomass of trophic levels is obtained by collecting, drying and taking the final weight of organisms.

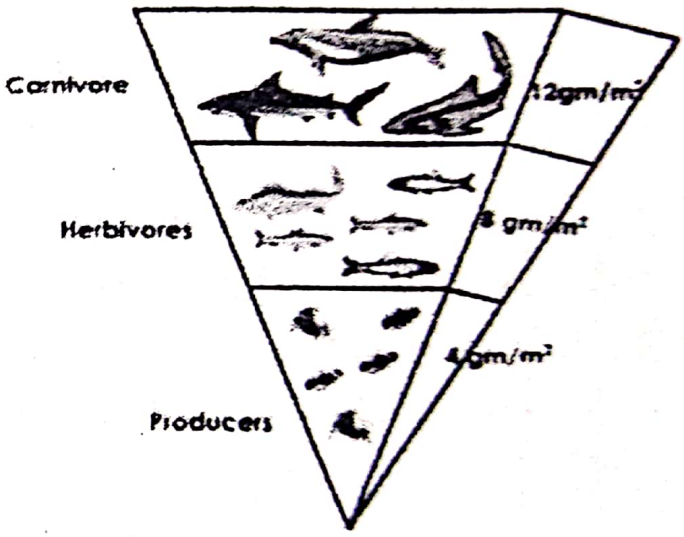
- The biomass of trophic levels at a given time is known as standing crop biomass or standing biomass.

- This dry weight which represents biomass, gives the amount of energy available in the form of living organic matter of the organisms.

- There are two types of pyramid of biomass namely, upright and inverted pyramids of biomass.



Upright Pyramid of biomass in a Terrestrial Ecosystem



Inverted Pyramid in an Aquatic Ecosystem

Advantages of pyramid of biomass

- It produces more accurate data.
- It eliminates the misleading problem of size differences associated with pyramid of numbers.

Disadvantages of pyramid of numbers

- It is more laborious and expensive than pyramid of numbers.
- It destroys biodiversity because organisms must be killed before their biomass can be measured.
- There is a difficulty in assigning organisms to specific trophic levels.

- Biomass of organisms is affected by seasons. That is, the time of the year in which biomass is measured could influence the values obtained.

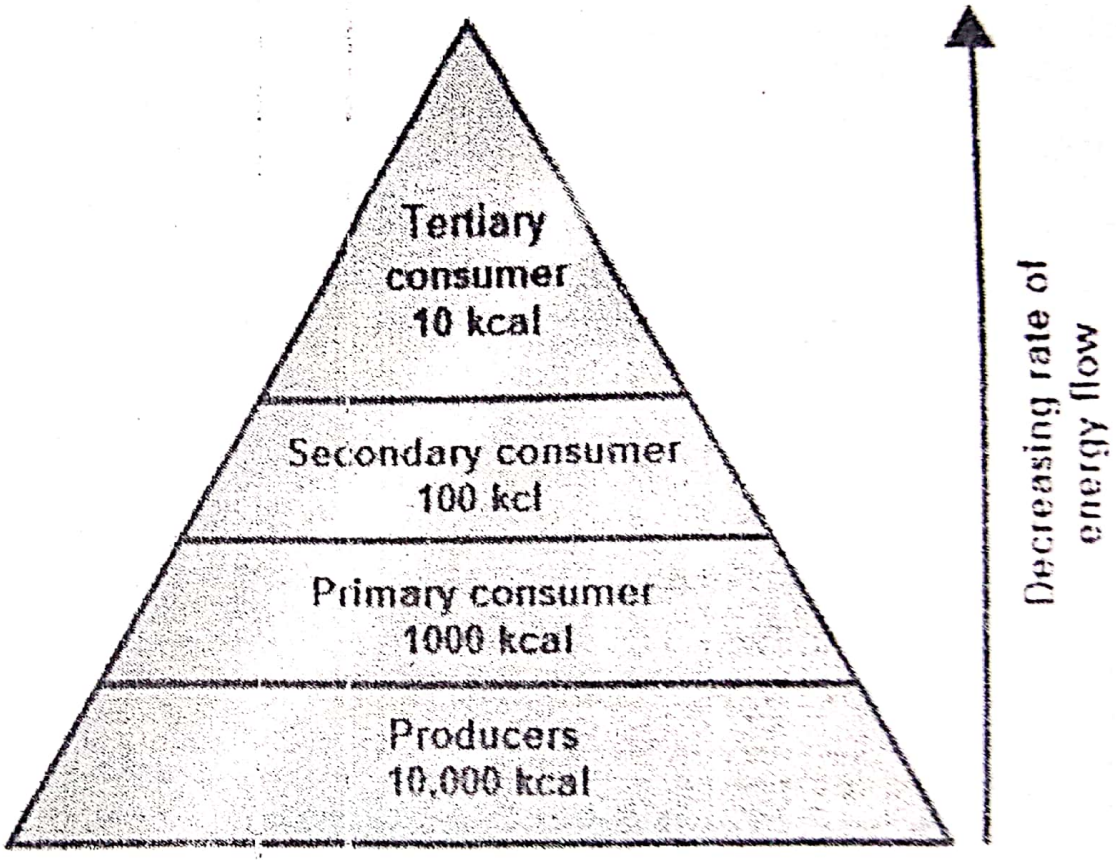
- Pyramid of biomass only measures standing crop biomass but not rate of production (productivity).

Pyramid of energy

- Pyramid of energy is a representation of the amount of energy trapped per unit time and area in different trophic levels of a food chain.

- It is the most accurate way of representing feeding relationships of organisms at different trophic levels. This is because it takes into account energy gains and losses over time.

- Thus, it truly measures energy flow at different trophic levels. Each bar represents the amount of energy per unit area/volume flowing through a trophic level in a given time period.



Pyramid of Energy

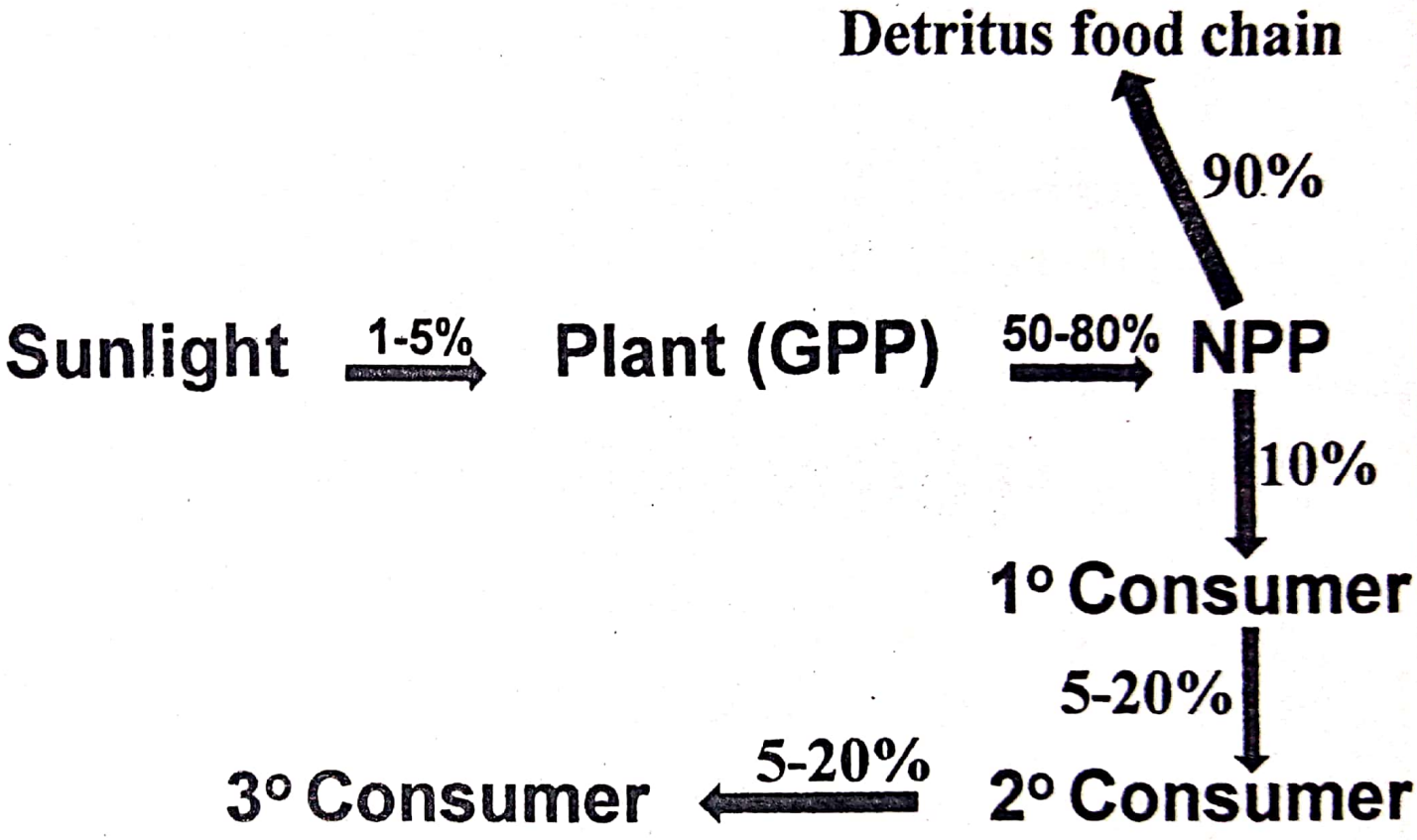
Advantages of pyramid of energy

- **It takes into account the rate of production.**
- **The energy content of organisms with different weight can be directly compared using pyramid of energy.**
- **Beside making it possible to compare different ecosystems, pyramid of energy also enables the relative energy flow of populations within an ecosystem to be compared.**

Disadvantages of pyramid of energy

- It is most laborious and expensive.
- It is difficult and complex to collect energy data; it requires combustion of organisms.
- It destroys biodiversity.
- There is still the difficulty of assigning organisms to specific trophic levels.
- About 80% of energy fixed by producers may be passed on to detritivores and decomposers and yet pyramid of energy does not include dead organic mater.

ENERGY TRANSFER AND EFFICIENCY IN ECOSYSTEMS



Energy transfer efficiency

- Ecological efficiency describes the efficiency with which energy is transferred from one trophic level to another.

- Only about 1-5 % of sunlight energy that reaches plants is used in photosynthesis. The remaining percentage is lost from the plant through reflection, radiation and heat evaporation.

- Through photosynthesis, light energy is converted to chemical energy and stored in plants. The total amount of chemical energy stored by plants is referred to as gross primary productivity (GPP).

- Part of the GPP (usually 20-50 %) is used by the plants themselves through respiration and photorespiration. The remaining percentage stored in the plant is referred to as net primary productivity (NPP).

- Consequently, NPP forms about 50-80 % of GPP. This amount is usually about 1-2 % of sunlight energy absorbed by plants.

- When animals feed on producers, they obtain part of the NPP in the plants. Thus, the NPP in plants is what is potentially available to animals.

- About 10 % of the NPP in plants become available to primary consumers for production (i.e. growth, repair, reproduction). This is referred to as secondary production.

- The remaining percentage of NPP (90 %) is lost via detritus food chain to detritivores and decomposers through litter fall and death.

- In turn, about 80-95 % of the secondary production in the primary consumers are lost through respiration, excretion and defaecation, leaving only 5-20 % available for use by secondary consumers.

- Tertiary consumers also obtain only up to 20 % of the secondary production in secondary consumers as least 80 % of this energy is lost in the secondary consumers in the form of respiration, excretion and defaecation.

Ecological tithe (The 10 % law)

- This law shows the general level of energy transfer efficiency in ecosystems.

- It states that only about 10 % (1/10) of the amount of energy in a trophic level is passed on to another trophic level. That is, energy available at a trophic level is about 10 % (1/10) of the energy present at a previous trophic level.

- Per this law, the number of trophic levels in food chains of ecosystems is limited by the amount of energy available for transfer.

Factors that limit primary production

Aquatic ecosystems

- Light limits primary production greatly in aquatic ecosystem because sunlight energy can only penetrate to a certain depth, beyond which there is no plant life.

- Nutrient availability can also limit production in aquatic ecosystem.

- E.g. in oceans, nitrogen and phosphorus deficiency may limit phytoplankton growth.

- However, in fresh water ecosystem, high levels of these nutrients may cause eutrophication, which changes lakes from phytoplankton communities dominated by diatoms and green algae to communities dominated by cyanobacteria.

Terrestrial ecosystems

- Terrestrial ecosystems' productivity is limited by temperature and moisture.

- Terrestrial ecosystems that possess warm and moist conditions are the most productive. E.g. Tropical rain forests.

- On the contrary, terrestrial ecosystems that are either dry or dry and cold have low productivity. E.g.s desert (dry condition), tundra (dry and cold).