

Unit 3 Ecosystem

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Ecosystem

Definition-

A.G. Tansley in 1935 defined ecosystem as 'the system resulting from the interaction of all the living and non-living factors of the environment.'

Structure of an ecosystem:

An ecosystem comprises of following components:

I) Abiotic (non-living) component: It includes-

- 1) Amount of inorganic substances- P,S,C,N,H,O etc. involved in material cycles.
- 2) Distribution of inorganic substances in the ecosystem.
- 3) Climate of given region- temperature, pressure, rainfall, light conditions, etc

II) Biotic (living) component:

A) Autotrophic component-

- 1) Fixation of light energy, use of simple inorganic substances to build complex substances are the characteristics of autotrophic organisms.
- 2) These are plants and photosynthetic bacteria which are capable of synthesizing their own food.
- 3) Organisms are known as producers.

B) Heterotrophic component-

- 1) Utilization, rearrangement and decomposition of complex materials are the characteristics of heterotrophic organisms.
- 2) Organisms are known as consumers. They are dependent on other organisms for food.

They are distinguished into two type-

a) Macroconsumers-

- i) **Herbivores/primary consumers-** they feed on plants.

Carnivores-

- ii) **Secondary consumers** - feed on herbivores.
- iii) **Tertiary consumers-** feed on secondary consumers.

b) Microconsumers:

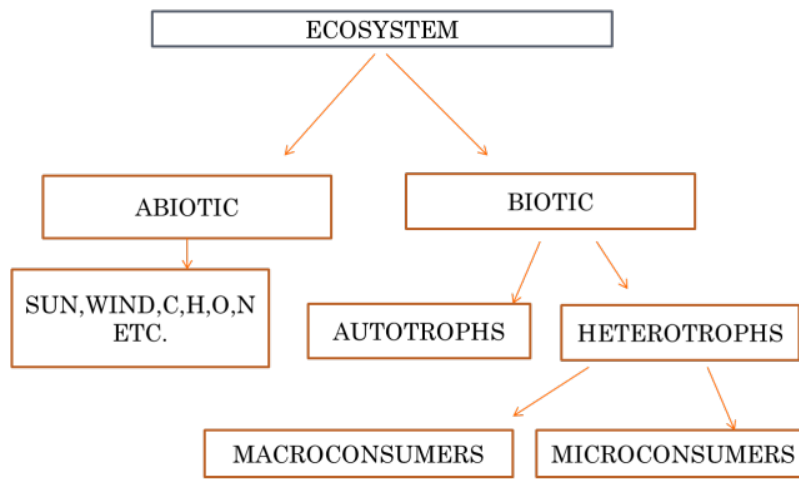
They break down complex organic substances into simple inorganic elements.

They are responsible for decomposition of dead organic matter in an ecosystem. Thus, liberate nutrients in free form into soil.

Also known as decomposers

Examples-

Fungi, Bacteria and earthworm.



Flowchart showing structure of an ecosystem.

Types of ecosystems

Natural- operate on their own without major interference by man. They are of following types-

a) **Terrestrial-** natural ecosystems that operate on land are called terrestrial ecosystem. E.g- forest, grasslands, desert.

b) **Aquatic-** natural ecosystems that operate in water are known as aquatic ecosystems. **Freshwater ecosystems** – streams, rivers, running springs (**lotic**-flowing water body) and ponds, swamps, puddle (**lentic**-standing or non flowing water body)

marine ecosystems - oceans, seas

Artificial- these are maintained by man by addition of energy and planned manipulations. e.g croplands

Terrestrial ecosystems:

A) Forest ecosystem – Forest is an ecosystem dominated by trees. Producers are mainly trees.

Different forests exist in different climatic regions of the earth. At 0° i.e. at equator and upto 10°N&S, equatorial forests are found. Between 10° to 30°N&S of equator, tropical and sub-tropical regions exist. Temperate forests exist between 30° to 60° N&S of equator. Between 60° to 90°N&S of equator, boreal forest are present and finally at poles occurs tundra vegetation.

Forest cover in India is about 24.62%.

Evergreen forests- trees in these forests retain their leaves for longer duration. They show stratified arrangement of trees.

Deciduous forests- trees in these forests shed their leaves during a particular season. Trees have broad leaf.

Coniferous forests- trees in these forests are needle like leaves. They have cones instead of flowers for reproduction.

Abiotic component-

1) Organic and inorganic substances present in soil and atmosphere.

2) Dead organic debris- plant litter accumulation in temperate climates.

Biotic component:

Producers-

1) Mostly trees- species differ in different forests.

2) Ground vegetation and shrubs can also be found.

Examples of dominant producers-

a) **Tropical moist deciduous forests-**

Tectona grandis,
Butea frondosa,
Shorea robusta, etc .

b) **Temperate coniferous forests-** *Pinus, Juniperus, Cedrus,* etc.

Consumers:

Primary consumers:

- 1) Animals feeding on tree leaves – insects
- 2) Grazing animals – fruit bats, squirrels

Secondary consumers- snakes, lizards that feed on herbivores.

Tertiary consumers – Top carnivores-Lion, Tiger, Eagle

Decomposers –

- 1) Fungi – *Aspergillus*, *Polyporous*
- 2) Bacteria – *Clostridium*, *Pseudomonas*, *Bacillus*

Rate of decomposition is rapid in tropical and subtropical forests.

B) GRASSLAND ECOSYSTEM

It is dominated by grasses. Rainfall in grasslands is not sufficient to support growth of diverse tree species but is more than desert. Several species of grasses and few shrubs can be found in grassland.

India has some of the vast grasslands in states of Gujarat, Maharashtra, Madhya Pradesh, etc.

Also montane grasslands/ mountain grasslands are found in Himalayas and shola grasslands of nilgiri hills.

Abiotic component-

- 1) Elements like C,H,O,N,P,S, etc present in soil.
- 2) Carbondioxide, nitrates, phosphates and sulphates, etc present in soil.
- 3) Trace elements or micronutrients

Biotic components-

- 1) Mainly grasses like *Cynodon*, *Setaria*, *Digitaria*, etc.
- 2) Few shrubs

Consumers:

Primary consumers-

- 1) Grazing animals like cows, deers, sheep, rabbit, etc.
- 2) Insects feeding on leaves.

Secondary consumers-

Snakes, frogs, lizards, fox, jackals, etc feeding on herbivores

Tertiary consumers-

Hawks

Decomposers-

Fungi like *Aspergillus*, *Rhizopus*, *Fusarium*, *Mucor*, etc.

Bacteria

C) Desert ecosystem:

Regions where annual rainfall is less than 25cm form desert. It is a habitat with extreme temperatures and water scarcity. Deserts can be hot deserts and cold deserts. In hot desert, climate is hot and dry while in cold deserts, winters are chilling with abundant rain and snow. In India, Thar desert is a hot desert and Ladakh is a cold desert.

Producers-

- 1) Shrubs, grasses and few trees.
- 2) Plants show various modifications-
 - a) Leaves reduced to thorns
 - b) Succulent stems
 - c) Extensive branched root system
- 3) Examples- *Cactus*, *Acacia*

Consumers :

Animals show adaptations like-

- a) They are nocturnal in habit
- b) They conserve water by excreting concentrated urine.

Examples-

- 1) Common are reptiles (mostly insectivorous) and insects.
- 2) Rodents and birds
- 3) Camels

Decomposers :

- 1) Poor organic matter
- 2) Fungi and bacteria

Aquatic ecosystems

A) Pond ecosystem:

A pond is a shallow ecosystem. It is capable of regulating itself and support a diverse group of organisms.

Abiotic component-

- 1) Inorganic and organic substances such as nitrogen, phosphorous, calcium, humic acid, amino acids, etc.
- 2) Physical conditions like temperature, light, pH, etc.

Biotic component-

Producers-

Macrophytes- these are large plants found in pond.

- 1) Rooted plants, submerged, floating and emergent plants.
- 2) *Typha*, *Vallisneria*, *Hydrilla*, etc.
- 3) Free floating plants like *Lemna*, *Eichhornia*, *Azolla*, etc

Phytoplanktons : these are minute organisms which are transported to other place by water action.

Spirogyra, *Volvox*, *Chlamydomas*, etc.

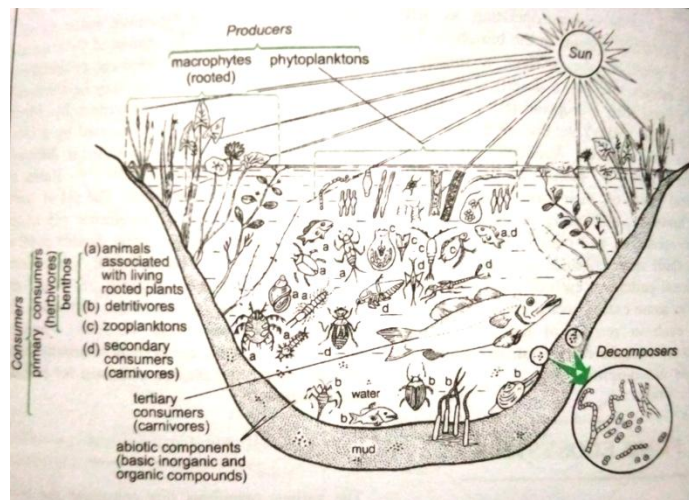


Figure- Pond ecosystem copyright@P.D.Sharma

B) Marine ecosystem- oceans

Oceans are salt water ecosystems. Major oceans of the world are Pacific Ocean, Indian Ocean, Atlantic Ocean, Arctic Ocean and Antarctic Ocean.

Producers-

- 1) Planktons- diatoms, dinoflagellate
- 2) Sea weeds like brown and red algae
- 3) Chemosynthetic bacteria.

Consumers-

Primary consumers- Crustaceans, molluscs, fish, etc.

Secondary consumers- Carnivorous fish like Mackerel, Herring

Tertiary consumers- fish like Haddock, Halibut, Cod

Decomposers- microbes –bacteria

Fungi

FOOD CHAIN

Definition- the transfer of food energy from producers to herbivores to carnivores and then to decomposers in an ecosystem is known as food chain.

GRASS---> GRASSHOPPER---->FROG---->SNAKE

Feeding habits of organisms form trophic levels or nutrition levels. Producers form the first trophic level, herbivores form second trophic level and primary consumers form third trophic level and so on.

GRAZING FOOD CHAIN-

1) It begins with living green plants and ends in consumers.

2) It is dependent on influx of solar radiation.

Examples- In pond, grazing food chain begins with phytoplankton which are producers, these are then eaten by zooplanktons which form primary consumers which in turn are eaten by fish.

Phytoplankton → Zooplankton → Fish

In grassland ecosystem, grazing food chain begins with green plants i.e grasses as producers then primary consumer which is rabbit and then carnivores like fox.

Grass → Rabbit → Fox

Detritus food chain-

1) It begins with organisms feeding on dead organic matter i.e detritivores and then to their predators.

2) It is less dependent on influx of solar radiation and mostly dependent of influx of organic matter.

Example- In mangrove ecosystem,

The leaves fall off the mangrove trees into water, the leaf fragments are acted upon by saprotrophs like fungi, bacteria, protozoa, etc. these are in turn eaten by crabs, mysids, molluscs, etc i.e detritus consumers. These are then eaten by small carnivores like minnows and game fish, further eaten by top carnivores like larger fish and birds.

Fallen leaves--->Fungi, Bacteria, Protozoa --->Insect Larvae, Shrimps, Molluscs --->Game fish---> Birds

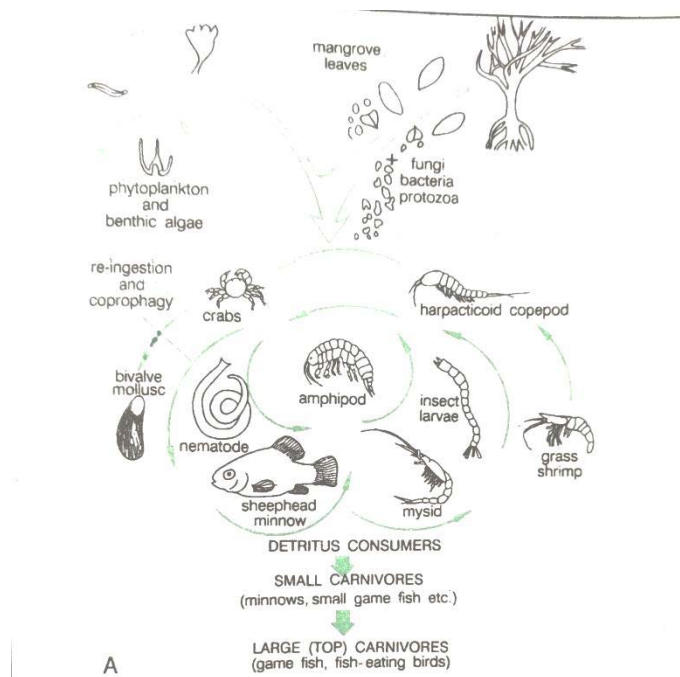


Fig. Detritus food chain in mangrove ecosystem copyright@P.D.Sharma

FOOD WEB

Definition- an interlocking pattern formed by several food chains connected together is known as a food web.

- 1) In nature, several organisms at every trophic level are interconnected forming a food web.
- 2) In grassland ecosystem, grass can be eaten by mouse, rabbit or a grasshopper. So, there are alternative herbivores in grassland. Grasshopper may be eaten by a lizard and then by a hawk or grasshopper may be eaten directly by a hawk. In first case, lizard will be secondary consumer while in second case, hawk will be secondary consumer. Hawk can also feed on rabbit (herbivore) and on snake (secondary consumer). Thus, food habits of different organisms create a web of trophic levels known as food web.

Importance of food web-

- 1) They maintain stability of an ecosystem
- 2) Increase / decrease in population of herbivores affect the consumer that prefers that herbivores.
- 3) In the absence of herbivores, producers would have increased in number and perished due to increased competition.

Complexity of food web depends on-

- 1) Length of food chain- if organisms are more diverse in their food habits, food chain will be longer.
- 2) Alternative consumers present in an ecosystem.

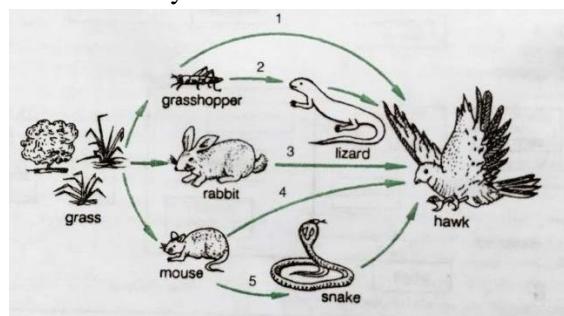


Fig. Food web in grassland ecosystem copyright@P.D.Sharma

Ecological succession

Definition- Occurrence of relatively definite sequence of communities over period of time in same area is known as ecological succession.

Group of organisms belonging to different species living together in an area is known as a community.

Types of ecological succession: Basic types of ecological succession are as follows:

Primary succession:

- 1) It begins on a primitive substratum which is devoid of any living matter.
- 2) First group of organisms to establish an area are known as pioneers or primary community or primary colonizers.

Secondary succession:

- 1) It begins on previously built substrata where living matter is already present.
- 2) In such an area, existing community might have disappeared due to climatic factors, invasion by exotic species, human activities, etc.
- 3) Succession over such an area is rapid.

General process of ecological succession : It includes following steps-

1) Nudation –

- i) Development of a bare area without life is known as nudation
- ii) Climatic factors like drought, glaciers, frost, lightening, etc. may develop a bare area.
- iii) Soil erosion by water, wind and deposition by landslides, volcanic activity form a barren land.
- iv) Human activities like deforestation and epidemic diseases destroy the entire population.

2) Invasion-

- i) Successful establishment of a species in the bare area is known as invasion.
- ii) Seeds, spores and other propagules of a species migrate to new area by air, wind, water, etc. Subsequently, they adjust to prevailing conditions and establish by reproducing.
- iii) **Ecesis**- The process of successful establishment of a species as a result of adjustment with the conditions prevailing there is known as ecesis.
- iv) **Aggregation** – Individuals of a species come close to each other by increasing their number via reproduction. This is called aggregation.

3) Competition and Coaction-

- i) Limited space and nutrition creates a competition between (inter-specific) and within (intra-specific) species.
- ii) The species that are unable to compete with other species are discarded in the area.
- iii) **Co-action**- In a given habitat, individuals of species affect each other's life in various ways and this is known as coaction.

4) Reaction –

- i) The mechanism of modification of environment through influence of living organisms on it is known as reaction.
- ii) Changes occur in soil, water, light conditions, temperature, etc.

iii) Environment is modified which becomes unsuitable for existing community which is replaced by another community over time.

iv) **Sere** - the whole sequence of communities that replace one another is known as a sere.

Various communities constituting a sere are known as **seral communities**.

5) Stabilization-

i) Over period of time, terminal community maintains itself in equilibrium with the surrounding climate, it is not replaced by any other community. This is known as stabilization.

ii) The stage is known as climax and the community is known as climax community.

HYDROSERE- Ecological succession that occurs in water habitats.

In pond ecosystem, hydrosere begins with colonization by phytoplanktons (pioneer community) and terminates into forest(climax community)

1) Phytoplankton stage- blue green alga, diatoms are first to colonize the pond (pioneer community).

Protozoans like *Paramoecium*, *Amoeba* can also be found. Soil pH is less than 5. These organisms multiply and grow for some period.

2) Rooted submerged stage- a soft mud is formed at the bottom of the pond due to mixing of organic matter formed after death of phytoplanktons and silt brought by rain water. Pond becomes shallower and light can penetrate easily making it suitable for growth of rooted submerged plants like *Hydrilla*, *Vallisneria*. Animals found- *Daphnia*, *Cyclops*, dragon flies, mayflies, etc.

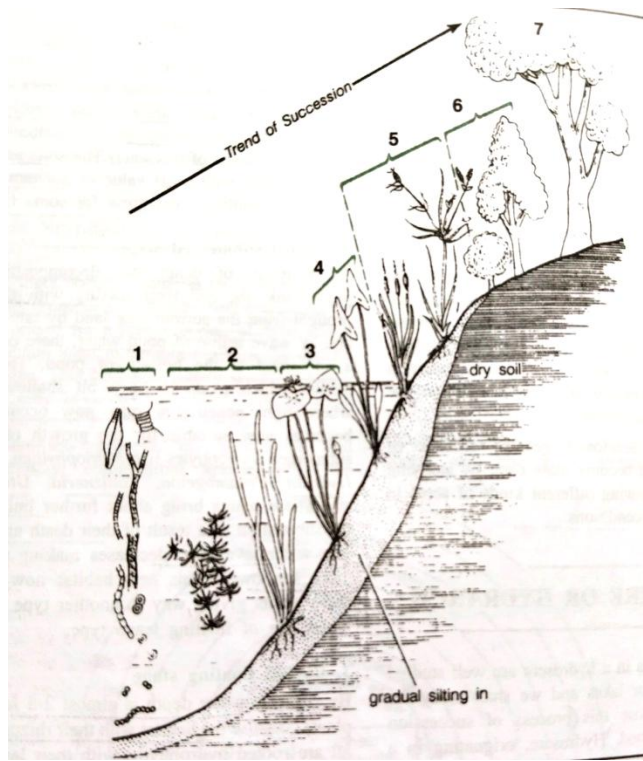
3) Rooted floating stage- water depth becomes 2-5 feet. Rooted plants with leaves floating on the surface- *Nelumbo* are found at this stage. Free floating plants- *Azolla* also can be found due availability of minerals. Animals found- snails, beetles, turtles, snakes, etc.

4) Reed swamp stage- also known as amphibious stage. Plants are rooted but shoots exposed to air e.g.- *Typha*. Animals found– snails, water scorpion, kingfisher.

5) Sedge- meadow stage- water level is much reduced at this stage. ammonia, sulphides become oxidised to nitrates and sulphates. Plants like- *Carex*, *Juncus* form a mat like vegetation in the centre. Animals found- snails like *Anodonta*.

6) Woodland stage- dry soil is present for most period. Terrestrial plants are found growing; shrubs like *Salix* and trees like *Populus*. There is accumulation of humus.

7) Forest stage- climax community. In tropical climate, tropical rain forests are formed. In temperate climate, trees like *Quercus* are found. In moderate rainfall, tropical deciduous forest or monsoon forests are formed.



1- phytoplankton stage, 2- rooted submerged stage, 3- rooted floating stage, 4- reed swamped stage

5- sedge-meadow stage, 6- woodland stage, 7- forest stage

Fig. Hydrosere in pond copyright@P.D.Sharma.

LITHOSERE- Ecological succession that occurs on bare rock surfaces. The original surface is water deficient and poor in organic matter. It has minerals only.

It includes following stages-

1) Crustose lichen stage- these lichens are first to colonize substratum poor in organic matter and moisture e.g *Rhizocarpon*. They cause weathering of rocks by producing acids. After their death, organic matter is added to soil. This is a slow process. Animals like ants and spiders living in cracks and crevices are found at this stage.

2) Foliose lichen stage- these have large leaf like thalli (body) e.g *Parmelia*. They absorb and retain more moisture. Humus is accumulated and a fine soil develops.

3) Moss stage- thin soil that is formed favours the growth of xerophytic mosses e.g- *Polytrichum*. Thickness of soil increases further by addition of organic matter after the death of organisms.

4) Herbs stage – accumulation of soil and minerals favours growth of herbs. Xeric condition decrease. Grasses like *Poa* are found.

5) Shrub stage- herbs are replaced by shrubs like *Rhus*.

6) Forest stage- shrubs are replaced by xerophytic trees followed by mesophytic trees. Animals like Snails, slugs, centipedes, mouse, birds, etc. are found at this stage.

Causes of ecological succession-

- 1) Erosion, deposition, wind, fire, lightening, volcanic activity, etc destroy existing population creating a bare area.
- 2) Human activities like large scale deforestation, mining can create a barren land.
- 3) Migration of foreign species to an area, aggregation, competition, reaction, etc. change the existing community.
- 4) Climatic changes responsible for stabilizing one community than other.

Energy flow in an ecosystem:

Energy in an ecosystem flows from producers to consumers to decomposers. It is unidirectional.

Solar energy is fixed by green plants (producers) during photosynthesis and complex carbohydrates are synthesized. A small percentage i.e 1% to 5% of the total energy received by earth is used by green plants in photosynthesis.

Models proposed to study energy flow in an ecosystem are-

1) Single-channel energy flow model:

- i) This model assumes that the flow of energy occurs from producers to consumers to decomposers.
- ii) Boxes represent the trophic levels and pipes represent the energy flow.
- iii) The total light (I) that falls on green plants is around 3000 Kcal, out of this 1500 Kcal is the light absorbed (L_A). This 1500 kcal is used for gross primary production (P_G) which is rate at which solar energy is captured in carbohydrates during photosynthesis.
- iv) A part of gross primary production is used in respiration and lost as heat. This is unavailable at successive trophic levels. Thus, the net primary production (P_N) which is at producer level is 15 Kcal.
- v) Out of this energy that enters herbivores, some is not utilized (NU) which is stored or exported and not assimilated (NA) which is egested.
- vi) The secondary production at herbivores (P_2) is 1.5 Kcal and at carnivores (P_3) is 0.3 Kcal or less. Thus, at every trophic level the energy is reduced.
- vii) If the food chain is long then less energy is available to carnivores, but if the food chain is shorter, greater energy is available to carnivores.

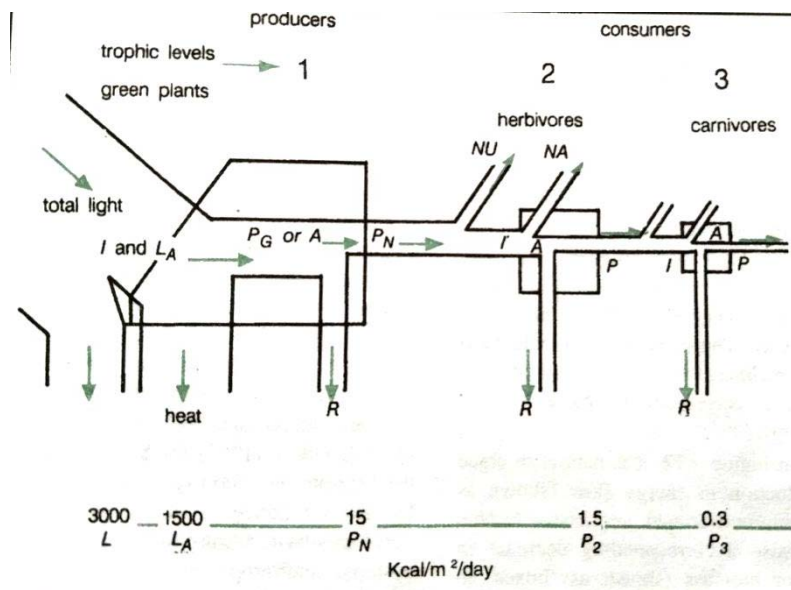


Fig. single channel energy flow model copyright@P.D.Sharma

Y-shaped energy flow model or 2 channel energy flow model :

- i) Two types of food chain are found in nature grazing food chain and detritus food chain.
- ii) Grazing food chain begins with living plants and ends in consumers whereas detritus food chain begins with organisms feeding on organic matter i.e. decomposers and ends in consumers.
- iii) Y-shaped energy model assumes that the two food chains cannot be separated in nature. Under natural conditions, waste material from the grazing food chain is acted upon by decomposers.
- iv) Y- shaped energy model also depicts the detritus food chain. A common boundary is shown for both the food chains. It places decomposers in a separate box. Import, export and storage of organic matter are included in this model. One arm represents the grazing food chain while other represents detritus food chain.

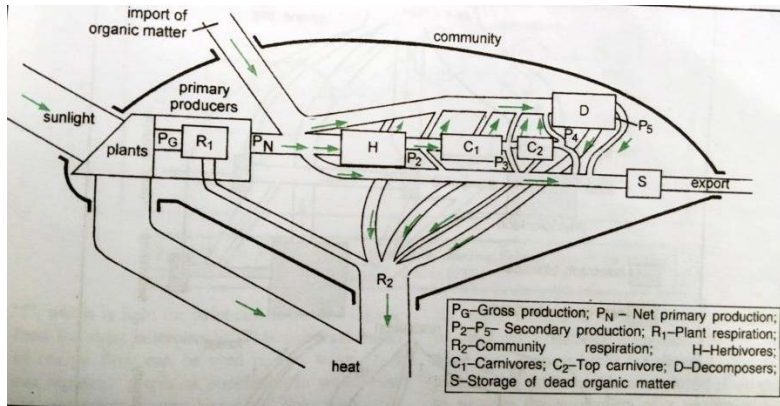


Fig. Y-shaped energy flow model copyright @P.D.Sharma