TOPIC: ECOSYSTEM

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B.SC PART 1
ZOOLOGY(HONS.)-PAPER I-GROUP B
CHAPTER 2
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ECOLOGICAL PYRAMIDS

The trophic structure of an ecosystem can be indicated by means of ecological pyramid. At each step in the food chain a considerable fraction of the potential energy is lost as heat. As a result, organisms in each trophic level pass on lesser energy to the next trophic level than they actually receive. This limits the number of steps in any food chain to 4 or 5. Longer the food chain the lesser energy is available for final members. Because of this tapering off of available energy in the food chain a pyramid is formed that is known as ecological pyramid. The higher the steps in the ecological pyramid the lower will be the number of individuals and the larger their size.

The idea of ecological pyramids was advanced by C.E. Elton (1927). There are different types of ecological pyramids. In each ecological pyramid, producer level forms the base and successive levels make up the apex. Three types of pyramidal

relations may be found among the organisms at different levels in the ecosystem. These pyramids are three types

1. Pyramid of numbers
2. Pyramid of biomass (biomass is the weight of living organisms), and
3. Pyramid of energy

1. Pyramid of numbers:

It depicts the numbers of individuals in producers and in different orders of consumers in an ecosystem. The base of pyramid is represented by producers which are the most abundant. In the successive levels of consumers, the number of organisms goes on decreasing rapidly until there are a few carnivores. The pyramid of numbers of an ecosystem indicates that the producers are ingested in large numbers by smaller numbers of primary consumers. These primary consumers are eaten by relatively smaller number of se condary consumers and these secondary consumers, in turn, are consumed by only a few tertiary consumers (Fig. 3.8, 3.9,).

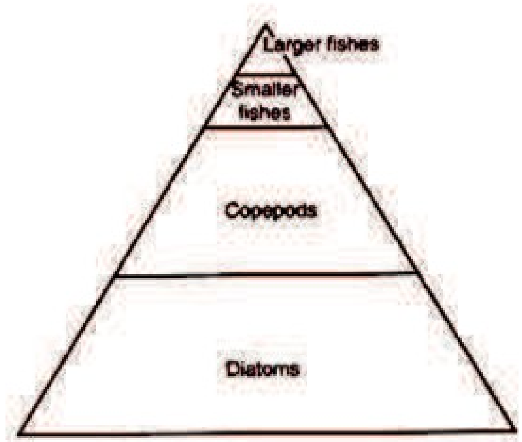
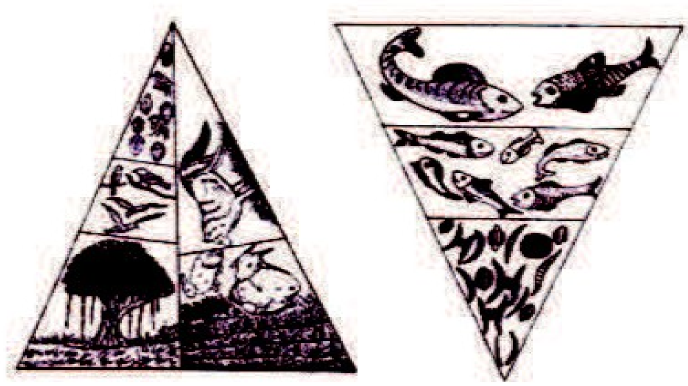


Fig .3.8 Pyramid of numbers of a lake ecosystem

This type of pyramid is best presented by taking an example of Lake Ecosystem . In this type of pyramid the base trophic level is occupied by producer elements—algae, diat oms and other hydrophytes which are most abundant. At the second trophic level come the herbivores or zooplanktons which are lesser in number than producers.

The third trophic level is occupied by carnivores which are still smaller in nu mber than the herbivores and the top is occupie d by a few top carnivores. Thus, in the ecological pyramid of numbers there is a relative reduction in number of organisms and an increase in the size of body from base to apex of the py ramid. In parasitic food chain starting from tree , the pyramid of numbers will be inverted (Fig. 3.9).



(a) (b)

Fig .3. 9 Pyramid of numbers grassland and cultivated field (up-right) Pyramid of

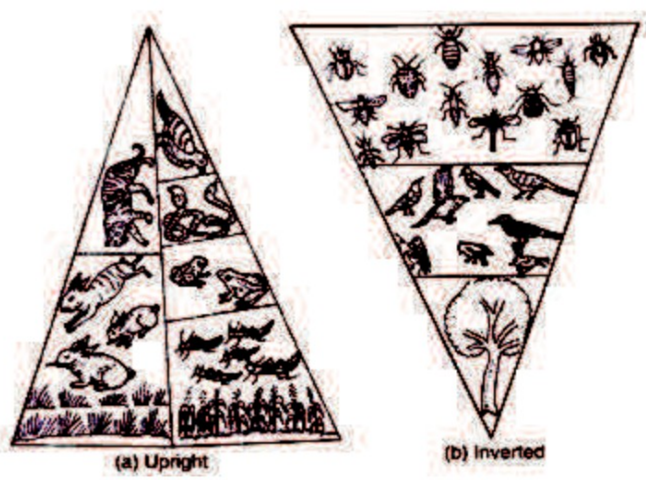
numbers of (Parasitic ecosystem)

2. Pyramid of biomass of organisms:

The living weights or biomass of the members of the food chain present at any one time form the pyramid of biomass of organ isms. This indicates, by weight or other means of measuring materials, the total bulk of organisms or fixed energy present at one time. Pyramid of biomass indicates the decrease of biomass in each tropic level from base to apex, e.g., to tal biomass of producers is more than the total biomass of the herbivores.

Likewise, the total biomass of se condary consumers will be lesser than that of herbivores and so on (Fig. 3.11 a, 3.11 b). Since some energy and material are lost in each successive link, the total mass supported at each level is limited by the rate at which the energy is being stored below. This usually gives sloping pyramid for most of the communities in terrestrial and shallow water ecosystems. The pyramid of biomass in a pond ecosystem will be inverted as shown in Fig. 3.10.

Fig. 3.10 Pyramid of biomass



(a) Grass land Ecosystem (b) Aquatic Ecosystem

Fig.3.11 Pyramid of biomass

3. Pyramid of energy:

This depicts not only the amount of total energy utilized by the organisms at each trophic level of food chain but more im portant, the actual role of various organisms in transfer of energy. At the producer level t he total energy will be much greater than the energy at the successive higher trophic level.

Some producer organisms may have small biomass but the total energy they a ssimilate and pass on to consumers may be greater than that of organisms with much larger biomass. Higher trophic levels are more e fficient in energy utilization but much heat is lost in energy transfer. Energy loss by respiration also progressively increases from lower to higher trophic states (Fig.3.12).

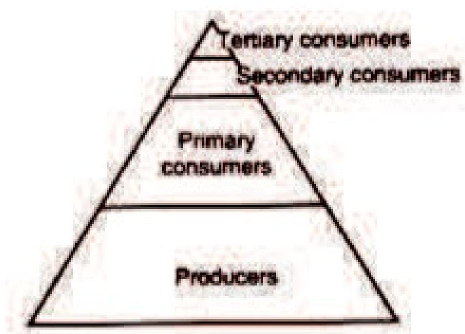


Fig .3.12 Pyramid of energy

In the energy flow process, two things become obvious. Firstly there is one wa y along which energy moves i.e. unidirectional flow of energy. Energy comes in the ecosystem from outside source i.e. sun. The energy captured by autotrophs does not go back to the sun, the energy that passes from autotrophs to herbivores does not revert back and as it moves progressively through the various trophic levels, it is no longer available to the previous levels.

Thus due to unidirectional flow of energy, the system would collapse if the supply from primary source, the sun is cut o ff. Secondly, there occurs a progressive decrease in energy level at each trophic level whi ch is accounted largely by the energy dissipated as heat in metabolic activities.

INTRODUCTION OF LAW OF LIMITING FACTORS

All living organism, plants and animals have a range of tolerance for every environmental factor such as temperature, humidity, or salt contents of the aquatic environment. If an environment factor exceeds the maximum tolerable level or it comes down to the minimum tolerance in any given area, it becomes a limiting factor preventing the distribution of particular animals or animal groups in that area. For example, in aquatic medium the concentration of salts is often a limiting factor. Just us Liebig and V.E. Shelford have propounded two different laws governing the distribution of animals and growth of organisms.

The effect of limiting factors was studied by Blackman in 1905. He formulated the principle of limiting factors which states that when a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of the slowest factor. In other words the rate of a physiological process is limited at a given time by one and only one factor which is deficient.

Blackman (1905) studied the effect of CO_2 concentration, light intensity and temperature on rate of photosynthesis. All other factors were maintained in optimum concentration. Initially the photosynthetic material was kept at 20°C in an environment having 0.01% CO_2.

When no light was provided to photosynthetic material, it did not perform photosynthesis. Instead, it evolved CO_2 and absorbed $O_2$from its environment. Blackman provided light of low intensity (say 150 foot candles) and found photosynthesis to occur.

When light intensity was increased (say 800 foot candles), the rate of photosynthesis increased initially but soon it levelled off. The rate of photosynthesis could be further enhanced only on the increase in availability of CO_2. Thus, initially light intensity was limiting the rate of photosynthesis.When the same was available in sufficiency, CO_2 became, Limiting.

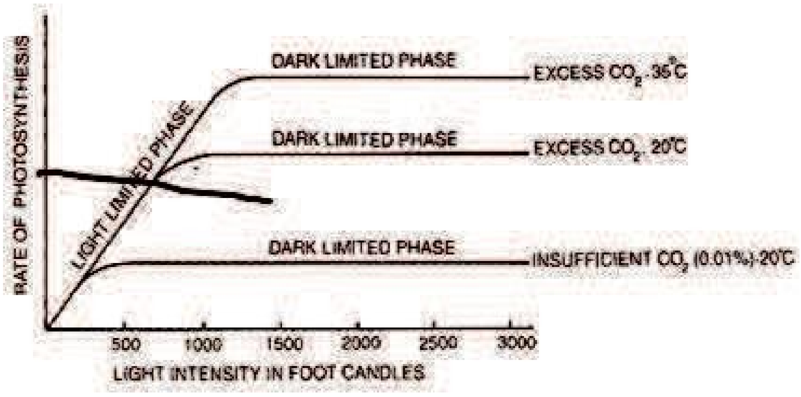


Fig.3.13 Blackman's law of limiting factors

When both were provided in sufficient quantity, the rate of photosynthesis rose initially but again reached a peak. It could not be increased further.

At this time, it was found that increase in temperature could raise the rate of photosynthesis up to 35°C. Further increase was not possible. At this stage, some other factor became limiting. Therefore, at one time only one factor limits the rate of a physiological process.

3.6 PRODUCTIVITY

In ecosystem the rate of energy trapping by green plant is related to the rate of production of organic material from inorganic substance (in a given area over a given period of time).This rate of production of biomass is called primary productivity. Primary productivity is affected by respiratory metabolism of animals & plant. Productivity is responsible for increases in weight in all parts i.e.: leaves, stem, fruits & roots, as against the agricultural productivity which refers to useful part of grain fooder part. The functional efficiency of ecosystem depends upon the production rate of primary producers. The productivity depends upon the climatic region of an ecosystem. For examples on sea shore productivity may be 2 to 4 grams/square meter/day and in deep sea only .5 to 1 gm. In Lake Ecosystem the productivity value varies from 6 to 10 gm/m^2/day and even up to 50gm in highly productive lake. The net production rate of crop plant ranges from .30 to 1 kg /square meter/year. Sugar cane and bamboo poles are efficient converter of solar energy, its net primary productivity range from 2 to 4 kg/m^2/year.

3.7 SUMMARY

Ecosystems are self-maintaining and self-regulating bodies, even then the role of cybernetic in ecology ecosystem is not ruled out. Man for his benefit must control and run the various
natural and artificial ecosystems.The various habitats, such as the forest, pond and sea the desert, grass, land and Lake Etc. have their own environmental characteristic and flora and fauna.