ECOLOGICAL PYRAMIDS

The concept of ecological pyramids was developed by Charles Elton (1927), the pioneer British Ecologist. There is some sort of relationship between the number, biomass and energy content of the primary producers, consumers of the first and second orders and so on to top carnivores in the ecosystem. This relationship may be represented graphically by means of pyramids which is referred to as ecological pyramids, where the first or producer level forms the base of the pyramid and the successive levels (the tiers) making the apex. Ecological pyramids are of three general types: (i) Pyramid of numbers, showing the number of organisms at each trophic level (number m-2), (ii) Pyramid of biomass, showing the total dry weight or any other suitable measure of the total amount of living matter (g m-2), and (iii) Pyramid of energy, showing the amount of energy flow and/or productivity at successive trophic levels (calories m-2 year-1).

1 Pyramid of Numbers

The relationship between the number of producers, consumers of primary, secondary and tertiary orders constitutes the pyramid of numbers. The form of the pyramid of numbers will vary widely with different communities, depending on whether producers are small (phytoplankton, grass) or large (oak trees). Sometimes, number of individuals varies so widely that it is difficult to represent the entire ecosystem on the same numerical scale. Such data could best be presented in a tabular form. In a grassland, the producers which are mainly grasses, are always maximum in number. This number then shows a successive decrease towards apex, as the primary consumers (herbivores), which are rabbits, mice, etc., are lesser in number than the grasses; the secondary consumers, the snakes and lizards are lesser in number than the rabbits and mice. Finally, the top (tertiary) consumers, the hawks and birds, are least in number. Thus, the pyramid becomes upright. Similarly, in pond ecosystem, the pyramid is upright. Here the producers, which are mainly phytoplanktons as algae, bacteria, etc. are maximum in number; the herbivores which are very small fish, rotifers, etc., are lesser in number than the producers; and the secondary consumers (carnivores), such as water beetles and small fish, etc., are lesser in number than the herbivores. Finally, the top (tertiary, consumers), the bigger fish and birds are least in number.

In a forest ecosystem, however, the pyramid of numbers is somewhat different in shape the producers which are mainly large-sized trees are lesser in number, and form base of the pyramid. The herbivores, which are the fruit eating birds, deers, etc., are more in number than the producers. Then, there is a gradual decrease in the number of successive carnivores, thus making the pyramid again upright one.

However, in a parasitic food chain, the pyramids are always inverted. This is due to the fact that a single plant may support the growth of many herbivore birds and each one of these, in turn, may provide nutrition to several hyperparasites like bugs and lice. Thus from the producers towards consumers, the number of organisms successively shows an increase, making the pyramid inverted one. In crop ecosystem, the pyramid is upright one where primary

consumers, viz., grasshoppers are lesser in number than the crops; frogs, snakes, and eagle- the primary, the secondary and the top consumers respectively are present in decreasing number.

2 Pyramids of Biomass

In this type of pyramid, the relationship between different trophic levels is presented in terms of weight of organisms (biomass). In grassland and forest, there is generally a gradual decrease in mass of organisms at successive levels from the producers to the top consumers. Thus, pyramids are upright. In an aquatic ecosystem (like pond), however, the biomass of producers is least. This value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted one. In this case the biomass of diatoms and phytoplanktons (primary consumers) that feed on them. The biomass of large carnivore fishes (secondary consumers) which feed on smaller fishes is the highest of all the trophic levels. In English Channel the biomass of primary producers is only 4 g m-2 whereas that of the consumers is 21 g m-2. Infact, this is the case in most aquatic bodies . In lakes and sea, on the other hand, the phytoplanktons usually outweigh their grazers (zooplanktons) during periods of high primary productivity, as during the spring "bloom", but at other times, as in winter the reverse may be true. This difference in biomass trend can be explained if the time is also taken into account.

3 Pyramid of Energy

The pyramid of energy represents the total quantity of energy utilized by different trophic level organisms of an ecosystem per unit area over a set period of time (usually, per square metre per year). The primary producers of an ecosystem trap the radiant energy of the sun and covert it into potential chemical energy. This trapped energy flows in the food chain from the producers to the top carnivores, decreasing at successive trophic levels. If the relationship of total quantity of energy utilized in unit area over a particular period of time by different trophic levels is diagrammatically represented, an upright pyramid is invariably formed. As against the pyramid of numbers and biomass, the shape of the pyramid of energy is always upright because in this the time factor is taken into account. In a grassland the green plants (primary producers) trap the maximum light energy in a particular area over a fixed period of time. Similarly, in a pond ecosystem, the phytoplanktons, in a particular area, trap and accumulate much more energy than the herbivore fishes in the course of year because of their large numbers and quicker rate of multiplication. Comparatively, the amount of energy utilized in a year by the top carnivores is much less than that of herbivore fishes.

Of the three types of pyramids as discussed above, the energy pyramid gives by far the best overall picture of the functional role of communities in an ecosystem. This is because of the fact that energy pyramid is a picture of rate of passage of food mass through the food chain, whereas number and biomass pyramids are pictures of standing states, i.e. organisms present at any moment. Its shape is invariably an upright one, and not affected by variation in the size and metabolic state of individuals, if all the sources of energy in the ecosystem are considered. The number and biomass pyramids on the other hand, may be upright or inverted depending upon the size and biomass of the producer organisms as compared to consumers.