- The food chains also help in maintaining and regulating the population size of different animals and thus, help maintain the ***ecological balance*.**
- Food chains show a unique property of **biological magnification** of some chemicals. There are several pesticides, heavy metals and other chemicals which are non-biodegradable in nature. Such chemicals are not decomposed by microorganisms and they keep on passing from one trophic level to another. And, at each successive trophic level, they keep on increasing in concentration. This phenomenon is known as biomagnification or biological magnification.

**CASE STUDY**

A **build-up of DDT concentration :** A striking case of biomagnification of DDT (a broad range insecticide) was observed when some birds like Osprey were found to suffer a sharp decline in their population. The young ones of these birds were found to hatch out in premature condition leading to their death. This was later found to be due to bio-magnification of DDT through the food chain. DDT sprayed for pest control was in very low concentration, but its concentration increased along the food chain through phytoplanktons to zooplanktons and then to fish which was eaten by the birds. The concentration of DDT was magnified several thousand times in the birds which caused thinning of shells in the birds' eggs, causing death of the young ones.

It becomes very clear from the above instance that the animals occupying the higher trophic levels are at a greater risk of biomagnification of toxic chemicals. Human beings consuming milk, eggs and meat are at a higher trophic level. So, we have to stop indiscriminate use of pesticides and heavy metals if we wish to save ourselves from their biologically magnified toxic levels.

## ■ ECOLOGICAL PYRAMIDS

**Graphic representation of trophic structure and function of an ecosystem, starting with producers at the base and successive trophic levels forming the apex is knows as an ecological pyramid.** Ecological pyramids are of three types:

**Pyramid of numbers:** It represents the number of individual organisms at each trophic level. We may have *upright* or *inverted* pyramid

of numbers, depending upon the type of ecosystem and food chain as shown in Fig. 3.5. A grassland ecosystem (Fig. 3.5*a*) and a pond ecosystem show an upright pyramid of numbers. The producers in the grasslands are grasses and that in a pond are phytoplanktons (algae etc.), which are small in size and very large in number. So the producers form a broad base. The herbivores in a grassland are insects while tertiary carnivores are hawks or other birds which are gradually less and less in number and hence the pyramid apex becomes gradually narrower forming an upright pyramid. Similar is the case with the herbivores, carnivores and top carnivores in pond which decrease in number at higher trophic levels.

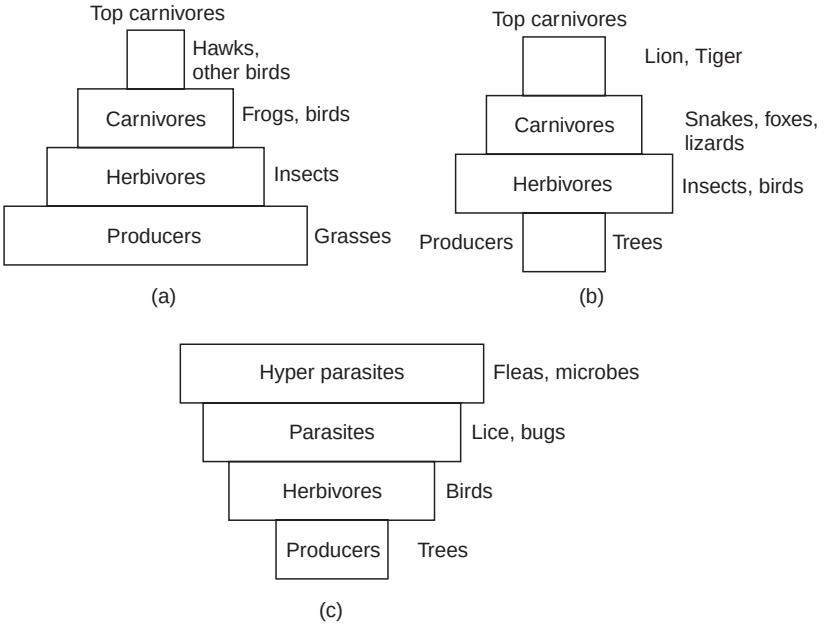


Fig. 3.5. Pyramid of numbers (*a*) grassland (*b*) forest (*c*) Parasitic food chain.

In a forest ecosystem, big trees are the producers, which are less in number and hence form a narrow base. A larger number of herbivores including birds, insects and several species of animals feed upon the trees (on leaves, fruits, flowers, bark etc.) and form a much broader middle level. The secondary consumers like fox, snakes, lizards etc. are less in number than herbivores while top carnivores like lion, tiger etc. are still smaller in number. So the pyramid is narrow on both sides and broader in the middle (Fig. 3.5 *b*).

Parasitic food chain shows an inverted pyramid of number. The producers like a few big trees harbour fruit eating birds acting like

herbivores which are larger in number. A much higher number of lice, bugs etc. grow as parasites on these birds while a still greater number of hyperparasites like bugs, fleas and microbes feed upon them, thus making an inverted pyramid (Fig. 3.5 *c*).

**Pyramid of biomass:** It is based upon the total biomass (dry matter) at each trophic level in a food chain. The pyramid of biomass can also be *upright* or *inverted.* Fig. 3.6 (*a, b*) show pyramids of biomass in a forest and an aquatic ecosystem. The pyramid of biomass in a forest is upright in contrast to its pyramid of numbers. This is because the producers (trees) accumulate a huge biomass while the consumers' total biomass feeding on them declines at higher trophic levels, resulting in broad base and narrowing top.

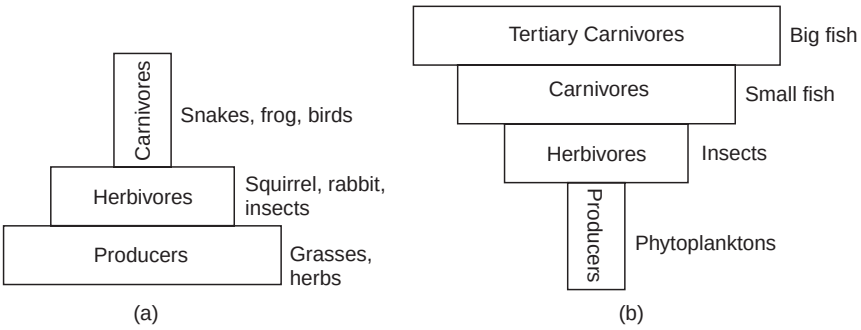


Fig. 3.6. Pyramid of biomass (*a*) Grassland (*b*) Pond.

The pond ecosystem shows an inverted pyramid of biomass (Fig. 3.6 *b*). The total biomass of producers (phytoplanktons) is much less as compared to herbivores (zooplanktons, insects), Carnivores (Small fish) and tertiary carnivores (big fish). Thus the pyramid takes an inverted shape with narrow base and broad apex.

**Pyramid of Energy:** The amount of energy present at each trophic level is considered for this type of pyramid. Pyramid of energy gives the best representation of the trophic relationships and it is always *upright*.

At every successive trophic level, there is a huge loss of energy (about 90%) in the form of heat, respiration etc. Thus, at each next higher level only 10% of the energy passes on. Hence, there is a sharp decline in energy level of each successive trophic level as we move from producers to top carnivores. Therefore, the pyramid of energy is always upright as shown in Fig. 3.7.

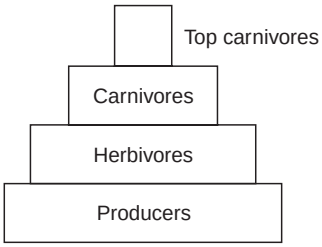


Fig. 3.7. Pyramid of energy.

## ■ ENERGY FLOW IN AN ECOSYSTEM

Flow of energy in an ecosystem takes place through the food chain and it is this energy flow which keeps the ecosystem going. The most important feature of this energy flow is that it is **unidirectional** or **one-way flow.** Unlike the nutrients (like carbon, nitrogen, phosphorus etc.) which move in a cyclic manner and are reused by the producers after flowing through the food chain, energy is not reused in the food chain. Also, the flow of energy follows the two laws of Thermodynamics:

**Ist law of Thermodynamics** states that energy can neither be created nor be destroyed but it can be transformed from one form to another. The solar energy captured by the green plants (producers) gets converted into biochemical energy of plants and later into that of consumers.

**IInd law of Thermodynamics** states that energy dissipates as it is used or in other words, its gets converted from a more concentrated to dispersed form. As energy flows through the food chain, there occurs dissipation of energy at every trophic level. The loss of energy takes place through respiration, loss of energy in locomotion, running, hunting and other activities. At every level there is about 90% loss of energy and the energy transferred from one trophic level to the other is only about 10%.

**Energy flow models:** The flow of energy through various trophic levels in an ecosystem can be explained with the help of various energy flow models.

(*a*) **Universal energy flow model:** Energy flow through an ecosystem was explained by E.P. Odum as the universal energy flow model (Fig. 3.8). As the flow of energy takes place, there is a gradual loss of energy at every level, thereby resulting in less energy available at next trophic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy not utilized (NU). This is the energy lost in locomotion,