ECOLOGICAL PYRAMIDS

The concept of ecological pyramids was first proposed by **Charles Elton (1927).** He observed that animals at the base of a food chain are relatively abundant, while those at the end are relatively few in numbers. The concept of Eltonian pyramids (pyramid of numbers) is not restricted to a pyramidal pattern in the distribution of numerical abundance however, but can also imply a pyramidal pattern in the distribution of biomass abundance (i.e. a pyramid of biomass).

Definition

Ecological pyramid is a graphical representation of the trophic structure of an ecosystem, in which relative energy values at each trophic level in a food chain or food web in an ecosystem are represented graphically, where producers form the base and successive trophic levels form the successive tiers of the pyramid. Ecological pyramids are also called **Eltonian Pyramids** (after the name of the an English Ecologist, Charles Elton, who first gave this concept), and **Trophic Pyramids** (as they represent interrelationship between successive trophic levels). Depending upon the method of measurement of energy at each trophic level, there are three types of ecological pyramids:

PYRAMID OF NUMBER:

Shows the number of organisms at each trophic level in a given ecosystem, with greater numbers shown by larger area for that section of the pyramid. For this, number of individuals at each trophic level is counted per unit area in terrestrial ecosystems (unit = no./m^2) or volume in aquatic ecosystems (no./m^3). In most pyramids of numbers, the organisms at the base of the food chain are the most abundant, and fewer organisms occupy each successive trophic level. For example in a grassland ecosystem, number of grass individuals (producers) is far greater than number of mice (primary consumer), and likewise, number of snakes (secondary consumer) is lesser than number of mice, and finally, number of hawks is the lowest in the given unit area (Fig. 1A). However, frequently the number pyramids are inverted (i.e. base smaller than one or more upper tiers) when individual producer organisms are much larger than average consumers e.g. in temperate deciduous forest, where large number of birds or insects (primary consumers) feed on one big tree (Fig. 1C, D).

PYRAMID OF BIOMASS:

Shows the total biomass at each trophic level of a food chain or food web in a given ecosystem, with greater biomass shown by larger area for that section of the pyramid. Biomass is a quantitative estimate of the total mass, or amount, of living material; it indicates the amount of fixed energy at a particular time. Biomass is represented as dry weight, or as live weight per unit area (g/m^2) or volume (g/m^3). Typically, pyramids of biomass illustrate a progressive reduction of biomass in succeeding trophic levels (Fig. 2A,B). However, biomass pyramids tend to be inverted when individual producers are much smaller than the average consumers, as in aquatic ecosystems dominated by planktonic algae (Fig. 2C).

PYRAMID OF ENERGY

Shows the energy content of the total biomass at each trophic level of a food chain or food web in a given ecosystem, with greater energy shown by larger area for that section of the pyramid. Energy content is expressed as $kcal/m^2/year$. These pyramids always have large energy bases and get progressively smaller through succeeding trophic levels (Fig. 3). Energy pyramids show that most energy dissipates into the environment when going from one trophic level to the next (according to second law of thermodynamics, no biological process is ever 100% efficient). Therefore, energy pyramids are always upright. Energy flow provides better basis than numbers and biomass for comparison of ecosystems. Numbers overemphasize the importance of small organisms (e.g. parasitic food chain, Fig. 1D) and biomass overemphasizes the importance of large organisms (e.g. aquatic ecosystem, Fig. 2C). Hence, neither are reliable criterion for comparing the functional role of populations that differ widely in size-metabolism relationship, although of the two, biomass is generally more reliable than numbers.

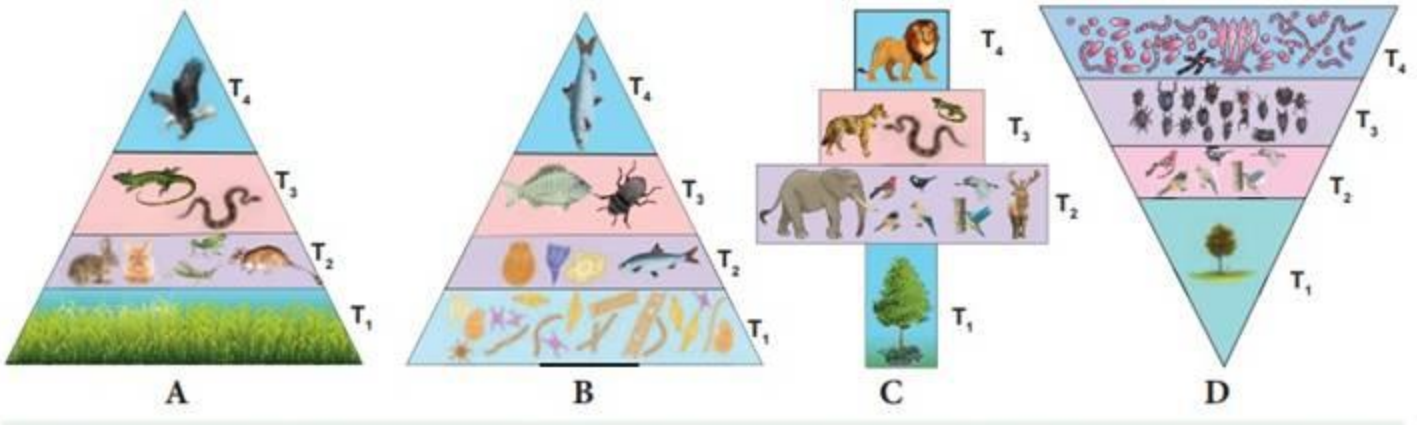

Figure 1 Pyramids of numbers (individuals per unit area) in different types of ecosystems. **Upright**-A) Grassland ecosystem B) Pond ecosystem , **Spindle shaped** -C) Forest ecosystem, **Inverted**-D) Parasite ecosystem

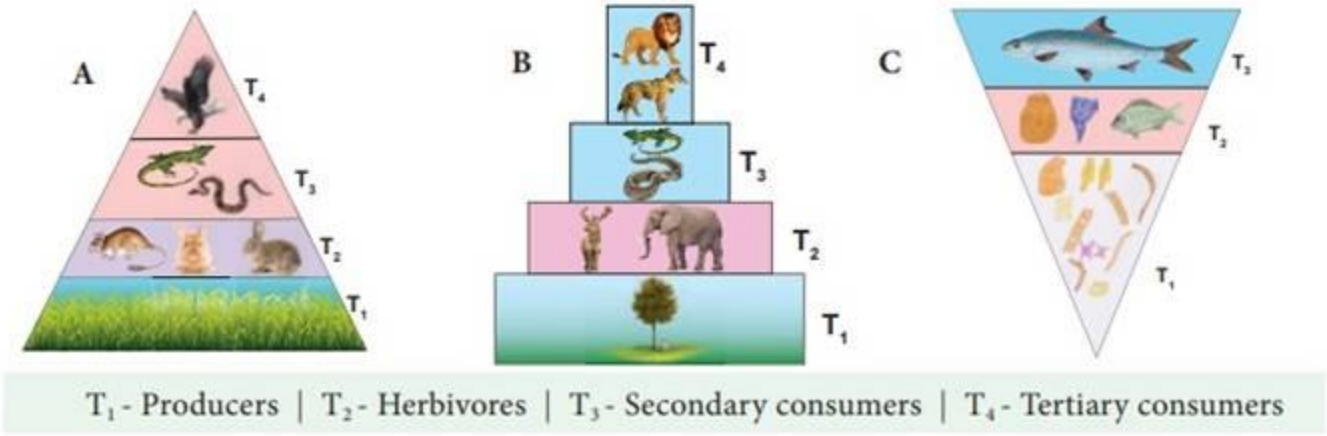

Figure 2 Pyramids of biomass (dry weight per unit area)in different types of ecosystems. **Upright**-A) Grassland ecosystem B) Forest ecosystem, **Inverted**- C)Pond ecosystem

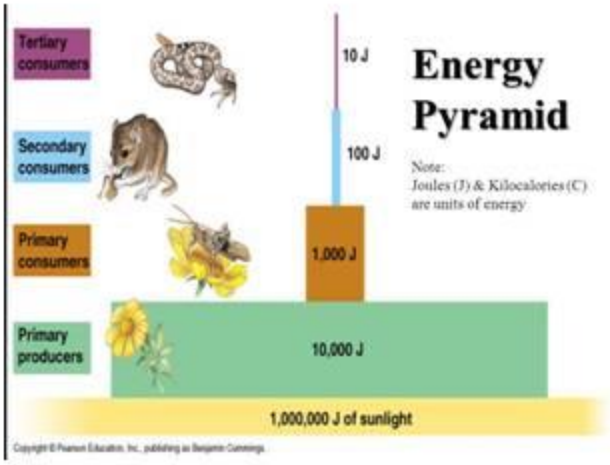

Figure 3. Pyramid of energy (kcal/m^2/year or kJ/m^2/year or J/m^2/day)

Answer the following:

- What does the set-up illustrate? What are its different types?
- Name the scientist who proposed this concept.
- What does figure 1 illustrate?
- What are the differences between representations of figure 1, 2, and 3?
- Mention merits and demerits of each of the three types of representations.
- What are the intrinsic limitations of ecological pyramids?
- What do T1, T2, T3, and T4 mean in the given set-up?
- What is the importance of undertaking such a study?
- What will happen to figure 1D, if it is constructed using biomass? Explain.
- What are the other names for ecological pyramids?
- Give the units used for the representation of the following ecological pyramids:
  - a)Pyramid of number
  - b)Pyramid of energy
  - c)Pyramid of biomass
- Why among the types of ecological pyramids, representation of Pyramid of Energy is considered more appropriate?