Ecological Pyramids and Decomposers: Nature's Hierarchy

Dr. Krishnappa Venkatesharaju
Assistant Professor, Department of Environmental Science And Engineering, Presidency University, Bangalore, India
Email Id- venkateshraju.k@presidencyuniversity.in

ABSTRACT:
Decomposers and ecological pyramids are key ideas in ecology that help us understand how energy and nutrients move through ecosystems. This summary gives a general review of ecological pyramids and decomposers, emphasizing their importance and major research discoveries. The trophic levels of an ecosystem are represented by ecological pyramids, which also show the movement of biomass and energy from producers to consumers. Pyramids of numbers, pyramids of biomass, and pyramids of energy make up their three main categories. These pyramids show how energy and biomass decrease as we climb the trophic ladder, demonstrating the dependency and effectiveness of energy transmission throughout ecosystems. Decomposers, sometimes known as nature's recyclers, are crucial to the movement of nutrients across ecosystems. They transform dead plants and animals into simpler forms that may be ingested by other creatures. Decomposers are microorganisms such as bacteria, fungus, and others that perform the decomposition process, returning nutrients to the environment and preserving the nutrient cycle.

KEYWORDS:

Ecosystem, Energy, Food, Plants, Producers, Pyramids, Trophic.

I. INTRODUCTION

The interaction of the food chain and the size metabolic connection between the linearly organised diverse biotic components of an ecosystem, which is the primary feature of each kind of ecosystem in the Trophic structure. The trophic structure and operation may be seen at the following trophic levels [1]–[3]. Producers Herbivores Carnivores It may be understood using ecological pyramids. The base of this pyramid is the first level, often known as the producer level. The three levels combine to form the peak. There are three main categories of ecological pyramids, as follows. Pyramid of numbers: It displays how many distinct creatures are present at each level, The energy pyramid. This graphic displays the production and/or flow rates of energy at various trophic levels. The energy pyramid displays the production and/or flow rates of energy at various trophic levels. Two of the earliest pyramids. That is, the biomass pyramid may be either upright or inverted. The structure of the food chain in a given ecosystem will determine this, but the energy pyramids will always be upright. The following is a quick summary of these pyramids:

1. Number Pyramids

The connection between producers, herbivores, and predators at different trophic levels is shown by number pyramids.

- **a)** In a grassland, there are always the most producers, which are mostly grasses.
- **b)** This indicates a decline towards the apex, which is understandable given that there are less grasses there.
- **c)** Compared to rabbits and mice, snakes and lizards are secondary consumers that are scarcer.
- **d)** Hawks and other birds are least prevalent among the top (tertiary) consumers.

The pyramid stands up in this fashion. In an environment with ponds, the pyramid is also upright as seen below:

- **a)** The producers, which are mostly phyto-planktons such as bacteria, algae, etc., are most numerous.
- **b)** The secondary consumers, such as small fish that eat each other, water beetles, etc., are less numerous than the herbivores.
- **c)** The herbivores, which are smaller fish; rotifers, etc.
- **d)** The secondary consumers (carnivores), which are the bigger fish, are least numerous.

The situation is different in a forest eco-system, however. There, the form of the pyramid of numbers is considerably different:

- **a)** Producer in this case, the producers are mostly large-sized trees, few in number, and make up the pyramid's foundation.
- **b)** There are more herbivores than there are producers, including fruit-eating birds, elephants, deer, and others.
- **c)** After then, the number of succeeding carnivores gradually declines.

The pyramid is set upright once again in this fashion. The pyramids are reversed in a parasite food chain, however. This is due to the fact that several herbivores may flourish on a single plant. Each herbivore has the potential to feed numerous parasites, which in turn sustain a large number of hyperparasites. Consequently, there is a reversal stance from the producer to the consumers. In other words, when the number of creatures steadily rises, the pyramid becomes inverted [4], [5].

2. Biomass Pyramids

Because they display the quantitative correlations of the standing crops rather than geometric relationships, biomass pyramids are, in comparison, more fundamentalist. The biomass pyramids in several ecosystem types may be compared as follows: In both grasslands and forests, the biomass of organisms normally declines with time as they move up the food chain from producers to top predators. The pyramids are erect in this fashion. The producers in a pond, on the other hand, are tiny creatures, therefore their biomass is little. This value steadily rises towards the pyramid's peak, and the pyramids are shaped upside down [6]–[9].

3. The Energy Pyramid

The energy pyramid provides the clearest representation of the ecosystem's general makeup. Here, the pace of food production affects the quantity and weight of organisms at every stage. The energy pyramid depicts the speeds at which food mass moves through the food chain as compared to the biomass and number pyramids, which are images of standing situations organisms existing at any one time. It is usually shaped upright.

Function of an Eco-system

It is crucial to comprehend ecosystems' activities in addition to their structural components if we are to understand them fully. The method that an eco-system uses to function or run normally is included in the function of ecosystems. The operational perspective of the ecosystem is that nature is made up of both living and non-living elements. Therefore, it is practically extremely impossible for them to remain apart from one another. The producers, or green plants, capture radiant energy and, with the aid of minerals (C, O, N, P, L, calcium, magnesium, zinc, and iron, among others), taken from their soil and surrounding air nutrient pool, they build up complex. Some people prefer to refer to the producers as converters or transducers because they feel that the term producer implies an energy viewpoint that is somewhat misleading. They assert that since green plants transform or transduce radiant energy into chemical form rather than producing energy, they should be referred to as converters or transducers rather than producing carbohydrates. The word producer, however, is so often used that it is desirable to keep it that way [10]. We talk about the movement of energy and the cycling of nutrients while thinking about how an ecosystem works. In other words, we are interested in factors like the amount of sunlight that plants absorb annually, the amount of plant material that herbivores consume, and the number of herbivores that predators consume.

1. Using Solar Energy to Produce Food Energy

The main energy source in the environment is solar radiation. It is the fundamental source of energy for the biosphere. It is given to the green plants. , which is transformed into heat energy. Through plant communities, it is lost from the environment to the atmosphere. Only a tiny percentage of the radiant solar energy is used by plants during the process of photosynthesis to produce food. Green plants convert some solar energy into chemical or food energy. These energies are used by green plants to grow their tissues. It is kept in the primary producers at the base of the food chain. At trophic level two of the food chain, the herbivorous animals use the chemical energy that is stored at fast level one as a source of energy. Through respiration, some energy from trophic level one is lost, and some is transferred to animals that consume plants at trophic level two.

2. The Circulation of Elements Through Energy Flow

It is clear that the primary driver of nutrient circulation in the many biotic components of the ecosystem is energy flow. The biosphere, atmosphere, hydrosphere, and lithosphere are only a few of the closed systems of cycles through which biological and inorganic materials are reversibly transported. This activity is carried out in a manner that keeps the overall mass of these materials almost constant and ensures that biotic organisms always have access to them.

3. The Conversion of Elements into Inorganic Flow

The following are the methods that plants and animals release their organic components:

- **a)** The breakdown of leaf litter left behind by deceased animals and plants by decomposers and their transformation into soluble inorganic form.
- **b)** Lighting-induced burning of plants, unintentional forest fires, or purposeful human activity.
- **c)** When organic material is burned, parts of it are liberated into the sky and again fall to the earth when it rains. After becoming soluble inorganic form of elements, they are added to soil storage, where certain parts in the form of ashes are broken down by microorganisms.
- **d)** Bacteria break down the waste products that mammals emit. They end up in soil storage in soluble inorganic form.

4. The Growth and Development of Plants

The absorption of nutrients from inorganic elements by plants via their roots is a part of the biogeochemical cycles. The soil, which is where these inorganic components are kept, provides the nutrients. Plant growth and development are aided by the breakdown of leaves, plants, and animals into soluble inorganic compounds that are stored in soil. Some elements are formed by decompositions. These elements are readily incorporated into the growth and development of plant tissues via biochemical processes, primarily photosynthesis.

5. Ecosystem Productivity

The quantity of organic matter that is produced at a certain pace, or in a given length of time, is referred to as an ecosystem's productivity. The following categories of productivity exist:

Initially, Productivity: It is related to autotrophic producers, the majority of which are photosynthetic; thus, they are, to a much lesser degree, chemosynthetic microorganisms. These include green plants, higher and lower saprophytes, phytoplankton, and a few photosynthetic microorganisms. Primary productivity may be defined as the rate at which radiant energy is stored by producers' photosynthetic and chemosynthetic activity. In addition, primary productivity may be identified as:

(1) Primary productivity: Gross Primary Productivity is the rate at which organic matter is stored in plant tissues at a rate greater than that at which it is used by plants for respiration during the measuring period. Thus, this is the pace at which biomass is increasing. Net primary production therefore refers to the equilibrium between gross photosynthesis, respiration, and other plant losses like mortality, etc.

(2) Secondary Productivity: These are the consumer-level rates of energy storage. Simply spreading the food matters to various tissues by a general method since customers only use food materials (that have already been made) in their respiration. There is no distinction between the secondary productivity's gross and net value.

(3) Net Productivity: Net productivity is the rate of organic matter storage that is not utilised by heterotrophs, which is equal to net primary production less consumption by heterotrophs over the course of a unit time. Thus, it is the rate of growth of primary producers' biomass that has been left over after consumption.

(4) Ecosystem Stability: The equilibrium between the production and consumption of each element within an ecosystem is referred to as the stability of that ecosystem. In other words, stability of equilibrium and balance between energy intake and output, as well as the regular operation of several biogeochemical cycles-

(i) The Equilibrium Model. According to the equilibrium model, an ecosystem always tends to be stable. When an ecosystem's community is disrupted by an external environmental change, it swiftly recovers to its initial condition, in contrast.

(Ii) The Non-Equilibrium Model: According to the non-equilibrium model, ecological stability is unusual because disruptions brought on by frequent external environmental change prevent species assemblages in an ecosystem from developing in an ordered state.

Decomposers

All living things in our world need a steady supply of nutrients to grow. A crucial link in the maintenance of nutrient cycles is the death and decomposition of plants and animals, which releases nutrients. An early phase of fast leaching and populations of macromolecules occur when an organism dies. The deceased creature has completely decomposed. The crumbling components of the litter are broken down by enzymatic activity. Microorganisms quickly recolonize the area after invasion by animals, which also reduces the biomass of the litter. Structure and chemical make-up become simpler.

The Decomposition Process

Leaching, catabolism, and comminution are the three interconnected parts of the breakdown process.

1. Leaching

Physically, leaching occurs shortly after litter is dropped. Detritus is separated from soluble material by the action of water. Occasionally, more than 20% of the nitrogen content of the litter may be leached out.

2. Catabolization

The method used by plants or animals to convert live tissue into waste.

3. Comminution.

Comminution is the process of reducing anything to very small or tiny particles. Comminution is the process of reducing the size of debris. The communal debris is physically disposed of by the decomposer animals while they are eating. same using the nutrients and energy for their own development (secondary production). The decomposers eventually perish and become part of the debris.

Function of Decomposition

Following are the two main purposes of breakdown in ecosystems:

- **i.** Mineralization of necessary elements.
- **ii.** Transformation of organic soil stuff into inorganic form.

In nature, the development of organic matter in soil takes time. Any bit of plant debris may take hundreds of years to completely decompose. However, certain breakdown remnants from this time period do help to produce soil organic matter.

Biological Community of Decomposers

Numerous bacteria, fungus, protests, and invertebrates make up the community of decomposer organisms. The many species in this community work together cohesively. For instance, a fungus breaks down plant waste and is consumed by an animal. Bacteria breakdown the animal when it dies, and protozoa may consume the bacteria. The two main organisms that decompose organic materials are fungi and bacteria. Due to their sensory activity, several protozoa, nematodes, annelids, and arthropods significantly affect how fungus and bacteria operate. Most woodland, grassland, and desert ecosystems are rich in microarthropod fauna, which mostly consists of oribatid mites along with other mites and collembolans.

Decomposer with Varying Relations

There are several decomposer organisms that cannot be given a rigid or set place in the food chain. Their trophic relationships may sometimes change.

1.Nectroph: Nectrophs are several types of decomposers. They quickly kill the food supply since they only utilise live things for a brief period of time. Nectrophs are creatures that consume live bacteria and fungus, such as certain plant parasitic microorganisms, as well as some herbivores, predators, and microtrophs.

2. Biotrophs: In contrast, biotopes use their live food supply over an extended period of time. For instance, obligatory plant parasites such as mycorhizae and root nodules, as well as root-feeding nematodes and aphids.

3. Saprotophs: Most decomposers and the apostrophes that use dead food fall under this group.

Decomposers occupying different trophic levels

There are certain species that may occupy different trophic levels depending on the situation and cause decompositions. For example, necrotrophs like Fusarium and Thizoctonia, which often have a saprotrophic inclination, are root parasites. In a similar manner, predators like foxes and kites sometimes exhibit saprotrophic behaviour. Sometimes, biotrophs take on the roles of necrotrophs or saprotrophs.

Soul Invertebrates and Termites

Some soil invertebrates, such as earthworms and collembolans, disperse organic materials throughout the soil, while termites and ants concentrate it at specific locations, such as mounds or the area surrounding the royal chamber. The estimated activities of the main groups of soil animals are shown in the following table.

Energy- Its Flow in Ecosystem

Energy-Defined

Energy is the ability to accomplish work, whether that labour is on a large scale like moving air masses across continents and building mountains or a little one like sending a nerve impulse from one cell to another.

Kinds of Energy

Potential and kinetic energy are the two types. They may be described as follows:

1. Potential Energy

Energy at rest is called potential energy. It can do the job and is ready to do so.

2. Kinetic Energy

Work is produced by kinetic energy, which derives from motion. Energy may be stored as work in one of two ways:

- **i.** As potential energy or as actual work.
- **ii.** Without storing energy, it can organize matter.

3. Laws of Thermodynamics

Two principles of thermodynamics define how energy is used and stored. The principle of energy conservation Energy is neither generated nor destroyed, according to the rule of conservation of energy. It may take on several shapes, move from one location to another, or interact with matter in a variety of ways. There is no gain or loss of overall energy throughout this procedure. Simply said, energy is moved from one location or form to another.

II. CONCLUSION

Ecosystems comprise both biotic and abiotic components. Plants, animals, and other species are examples of biotic factors. Rocks, temperature, and humidity are examples of abiotic variables. Fundamental elements of ecosystem dynamics include decomposers and ecological pyramids. Ecological pyramids show the interdependence of species within trophic levels by illuminating the movement of energy and biomass. Decomposers play a vital role in the sustainability of ecosystems and the recycling of nutrients in nature. Understanding these ideas and their ramifications may help with ecosystem management, conservation efforts, and the creation of sustainable practises that maintain ecosystem balance and health.

REFERENCES

[1] B. D. Fath and M. C. Killian, 'The relevance of ecological pyramids in community assemblages', Ecol. Modell., 2007, doi: 10.1016/j.ecolmodel.2007.06.001.

[2] R. Trebilco, J. K. Baum, A. K. Salomon, and N. K. Dulvy, 'Ecosystem ecology: Size-based constraints on the pyramids of life', Trends in Ecology and Evolution. 2013. doi: 10.1016/j.tree.2013.03.008.

[3] E. N. Latushkina, E. V. Stanis, and T. K. Bicheldey, 'Responses of the human body to the effectfrom exposure to anthropogenic increase of ambient air pollution', Biomed. Pharmacol. J., 2019, doi: 10.13005/bpj/1638.

[4] V. M. Waghulkar, 'Dark side of PPCP: An unconscious infiltration into environment', Int. J. ChemTech Res., 2010.

[5] T. Ertekin and Ç. Yüksel, 'The Role of Ecological Literacy Education with Academic Support in Raising Environmental Awareness for High School Students: Enka Ecological Literacy Summer Camp Project Case Study', Procedia - Soc. Behav. Sci., 2014, doi: 10.1016/j.sbspro.2014.02.089.

[6] J. C. Bendul, E. Rosca, and D. Pivovarova, 'Sustainable supply chain models for base of the pyramid', J. Clean.

Prod., 2017, doi: 10.1016/j.jclepro.2016.11.001.

[7] L. A. K. Singh, 'Supplement to Khan 2012 - Technological enhancements needed in photo-trap approach for forthright use by tiger population managers', J. Threat. Taxa, 2012, doi: 10.11609/jott.o3103.2551-2.

[8] S. C. Walpole, D. Prieto-Merino, P. Edwards, J. Cleland, G. Stevens, and I. Roberts, 'The weight of nations: An estimation of adult human biomass', BMC Public Health, 2012, doi: 10.1186/1471-2458-12-439.

[9] M. Abbaspour and A. Nazaridoust, 'Determination of environmental water requirements of Lake Urmia, Iran: An ecological approach', Int. J. Environ. Stud., 2007, doi: 10.1080/00207230701238416.

[10] C. Brix-Asala, R. Hahn, and S. Seuring, 'Reverse logistics and informal valorisation at the Base of the Pyramid: A case study on sustainability synergies and trade-offs', Eur. Manag. J., 2016, doi: 10.1016/j.emj.2016.01.004.