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Autecology and Synecology

Ecological studies are based on **three basic principles: Habitat, Taxonomic group and levels of organizations.** Depending upon the consideration of ecological unit as either individual or group of organisms, the levels of organization is divided into **autecology**and **synecology**.

Autecology

The study of interaction between individuals and its environment is known as "**autecology**" or "**ecology of individual**".

In autecology, at a given time, we study the influence of individual's reactions to its natural environment and requirements together and affects of its interacting environment. In simple words how an organism or single species interacts (what it required and after interaction how it reacts) with its natural environment (i.e. under the present conditions prevailed by the organism). Individual species contribute as the unit of autecology study.

In autecology, we study in details the morphology of individual effected by its prevailing environment, its geographical distribution based on the surrounding, influence of environment on the life cycle and growth of organism, its taxonomical position and several factors including those which effects different developmental stages of individual's life cycle.

Examples of Autecology

For instance, the influence of the change in temperature of the surrounding can highly influence the life cycle and developmental stages of individual. In brief, lizards, crocodiles and several other reptiles can hatch their eggs and sex of the baby is determined by the temperature at the time of hatching.

Best and classical example is provided by the Darwin's finches of Galapagos Island. Darwin, Zoologist, who went on a voyage, very finely observed the Galapagos Island and revealed that the birds habituating that Island, called Finches, differ in the shape and size of their beaks clearly indicating that different finches habituating different area and feeding on different vegetations evolved to survive and developed beaks of different size and shape.

Another example includes the adaptation of organism to higher altitudes. At higher altitudes, due to higher pressure, there is less availability of oxygen to body tissues, so the individual adapt to it by developing higher number of RBCs which can effectively and with high affinity bind to the

oxygen molecules through hemoglobin. While the individual living in plain areas are susceptible to these sudden changes in oxygen levels and pressure and can be attacked by hypoxia condition.

Synecology

In 1896, Schrocter and Kirchner coined the term Synecology. Organisms of different species living in a group can affect each other's life in any possible way under their natural conditions. It's a more complex condition. Unlike autecology, where single organism is the unit of study, in synecology "group of organisms" are considered as the unit of study. Therefore, an ecological approach "group of organisms" as the unit of study is termed as synecology.
Synecology can be divided into population, community ecology, and biome and ecosystem ecology.
An example of synecology is side effects of acid rain to a pond ecosystem. As the acid rain falls in a pond, rich in flora and fauna (mainly with fish diversity), it directly and indirectly affects the health of population or community or total biome or pond ecosystem. Acid rain creates an unfavorable environment in the pond ecosystem by stimulating various chemical reactions attributed to the characteristic feature of acid rain.

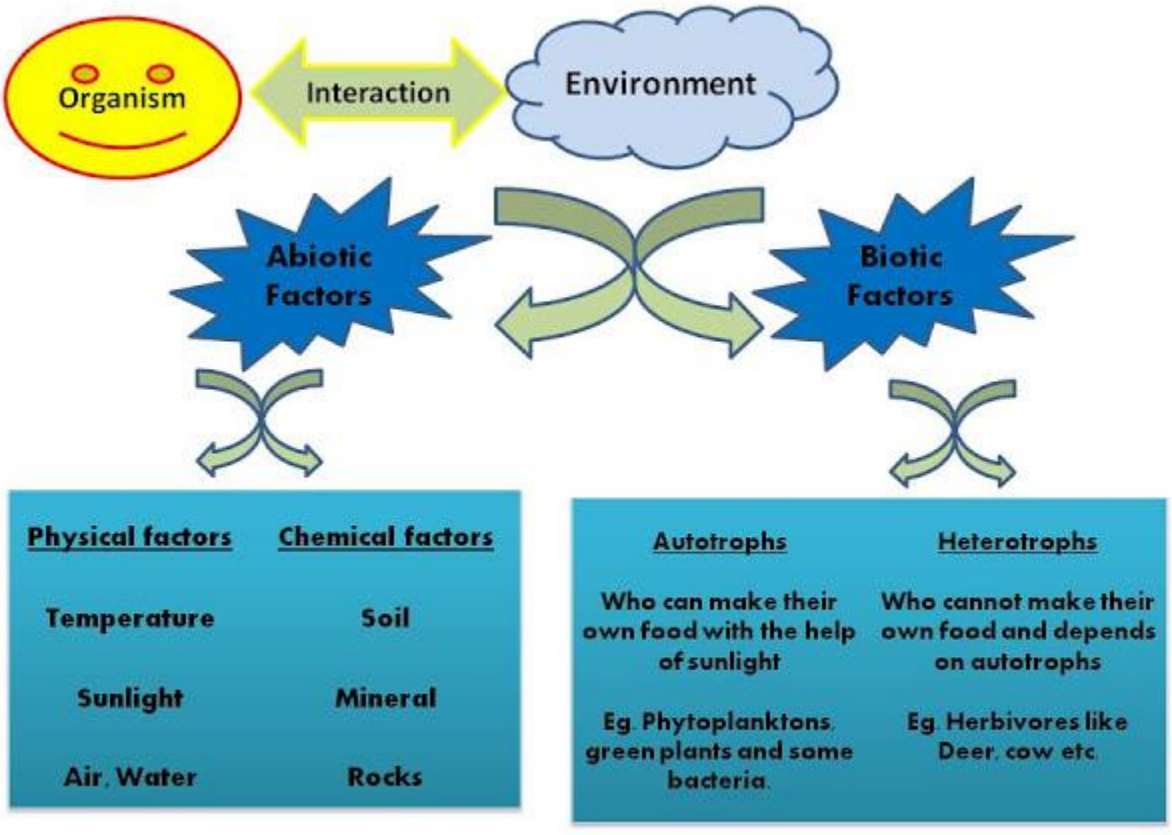
A classical example includes, Gause's principle derived concept of Resource Partitioning where organism of different species compete for the same resources eg. Food, space etc. thereby, leading to partitioning of resources or habitat.

Autecology	Synecology
It is the study of individual organism or individual species or a population in relation to their environment	It is the study of group of organisms or many species or communities in relation to their environment
It is also called as population ecology	It is also called as community ecology
The study is at the level of an individual, a population or an entire species	Synecology is concerned with study of the highest level of biological organization; many populations in an area (called as community) interacting with each other and also with the environment. It can even be the study of an ecosystem
Autecology is comparatively simple experimental and inductive.	Synecology is complex, philosophical and deductive. (Refer: Inductive vs Deductive)
Autecology studies can be accommodated in a laboratory setup and data is interpreted using conventional mathematical tools**	Synecology studies refers to the interaction of a whole system and that cannot be accommodated in a laboratory setup as the system is naturally formed after interactions of hundreds of years such as a forest ecosystem
Example: Study of Zebra population in relation to its environment (may be factors like rainfall, hunting, lion population etc in a grassland ecosystem) see the figure (in dotted black lines)	Example: Study of entire grassland ecosystem (including all the species or communities) see the figure (in green thick border)

Ecology and levels of organization

The branch of science (biology) dealing with the relations and interactions between organisms and their environment, including other organisms is termed as ecology. It's also defined as the study of relationships between living organisms and their environment or the set of relationships of a particular organism with its environment. The word "ecology" was first coined by a germen zoologist, Ernst Haeckel (1834-1919).

The sum total of all surroundings includes abiotic and biotic factors is called **environment**.



Levels of Organization of Ecology

The levels of organizations are divided into following headings:

1. **Living organism**: single, may be any type of living organism
2. **Population**: total of all living organisms of same species living and interacting in a particular area or habitat and reproduce to give offspring.

3. **Community**: different type of population interacting at particular geological area.
4. **Ecosystem**: living organism interacts with their physical environment interconnected with different populations transfer energy and material between them.

Law of Limiting Factor

Limiting factors (nutrients, light, water, space etc) are the factors present in limited supply.
The three laws explaining the effect of different factors on organism:

1. Law of minimum- Liebig's law

Carl Sprengel developed a law, later popularized by Liebig, called as law of minimum.

Other terminologies used for the law are: Liebig law or Liebig's law of minimum. According to this law, the growth is regulated by the limited factors i.e. resources in scarcity and not by the resources in abundance.
This law was originated after studying and observing the crop and plant growth. The studies reveal that if we increase the supply of nutrients already present in enough amounts, it does not affect the growth of plants i.e. no further growth happens.
But when we provide the nutrients which are present in scarcity or in limited supply, growth improvements are detectable. Hence, it is the limiting factor that affects the growth of plants. Liebig law was explained by Dobeneck in his own

thoughts by an example called "**Liebig's barrel"**(figure 1)**,** in this barrel the capacity to sustain water is limited by the shortest staves similar to the growth regulation by most limiting nutrients.

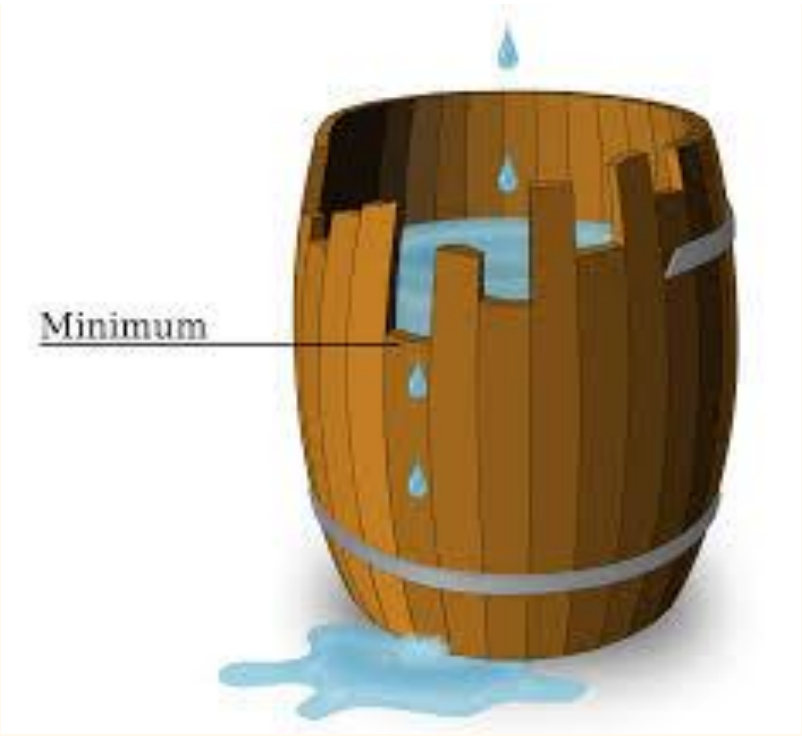


Figure 1: Liebig's Barrel

The principles of Liebig's law conclude as a concept, where "The availability of nutrient in scarcity is the limiting factor which is equally important for plant growth as the nutrient in abundance".

The scientific applications of "law of minimum" are extended to ecosystem models or population. The organism or plant growth depends on many factors (organic or inorganic/ biotic or abiotic factors). At any given time, these factors are available in different levels and one among all different factors, are present in minimum levels, thus limiting than other factors. Liebig's law of minimum explains that it is this limiting factor whose rate of availability affects the growth.

Recently, this law is applicable on natural resources management. For example, Phosphorous or other resources recycling is required for the non-renewable resources, limited in supply without any other alternative or substitutes. Biotechnological innovations including genetic modifications extend the limits by altering the dependency on biological limiting factors.

2. Blackman's law of limiting factor:

Blackman's was a plant physiologist with his most study on limiting factor on plant's photosynthesis system.

He stated that a number of factors regulate the biological processes but the factors in different amount affect the process on the whole.

For example, photosynthesis requires basic components like water, sunlight in proper intensity, chloroplast temperature, carbon dioxide, chlorophyll present in certain required amount. Any of these factors if present in scarcity will affect the rate of photosynthesis. In the graph (figure 2) the rate of photosynthesis is depicted on Y axis while CO_2 concentration in X-axis. At first when the concentration of CO_2 increases, the rate of photosynthesis is directly proportional to the amount of CO_2 supplied and the graph (slope 1) shows increase in rate of photosynthesis but after a limit any further increase in CO_2 concentration has no effect on the rate and the rate become constant (Line 1 to a). Now at this time when the increase in CO_2 has no effect on rate of photosynthesis, the intensity of light became the limiting factor. And now as we increase the intensity of light further increase in the rate of photosynthesis is achieved (slope 2). After a point any further increase at this intensity will not affect the rate and it became constant again (line 2 to b). The rate reaches its highest limits (slope 3) at high intensity of light and CO_2 concentration and again became constant (line 3 to c).

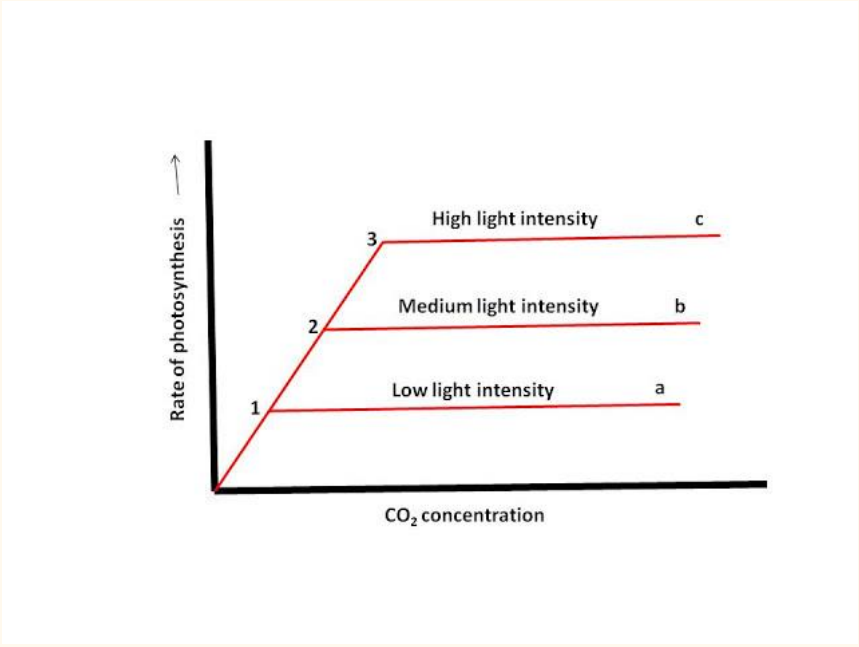


Figure 2: Graph illustrating Blackman's law of limiting factor

3. Law of tolerance- Shelford's Law

Till now we are concentrating on the minimal limiting factors affecting the growth or rate of biological process.

But Shelford's law states that it's not only the factor present in limits/scarcity but also the excess/ abundance of that same factor can affect the growth, development of organism or rate of biological process.

For instance all nutrients required for the growth and development of organism/plant are equally important but any nutrient in abundance may limit other nutrients absorption, thus indirectly restricting or limiting the growth of organism/plant.

Thus the law of tolerance by Shelford's revealed that the growth and development of organism depends on the maximum and minimum limits of factors involved in the biological process.

Thus every factor has its own maximum and minimal limits in every organism and the "Zone of tolerance" is the range between these two limits.

Based on this, the environmental factors have two zones: (a) Zone of Intolerance and (b) Zone of Tolerance. Further the Zone of tolerance is sub divided into three zones; (i) Optimal zone, (ii) Critical minimum zone and (iii) Critical maximum zone.

(a) Zone of Intolerance

The Zone unfavourable for the growth and development of organism is termed as Zone of Intolerance. The limit of tolerance varies from species to species with respect to different factors.

Organism survives best if have a wide range of tolerance and broad distribution range.

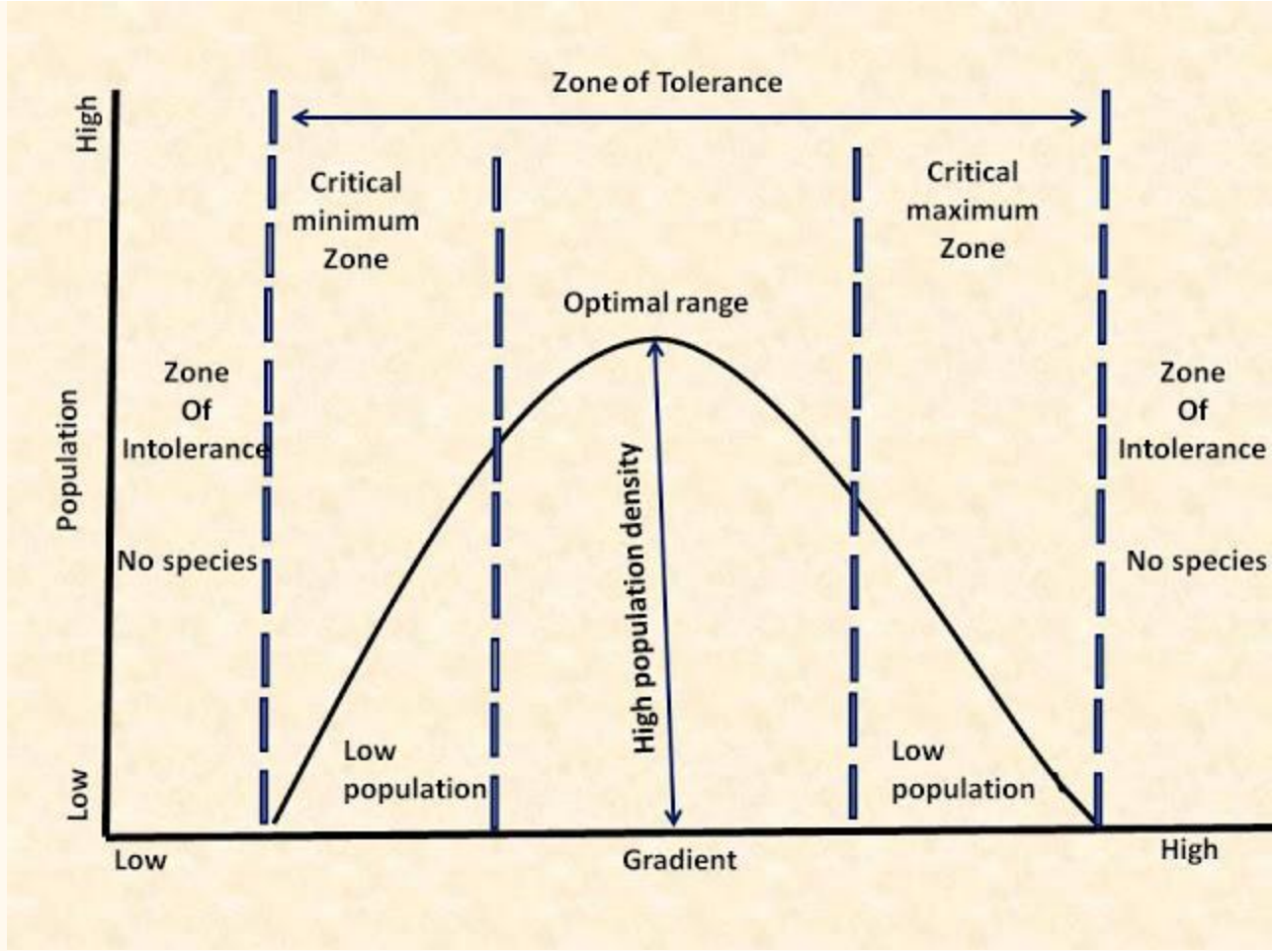
(b) Zone of Tolerance

An organism grows best in the Zone of Tolerance, which is favourable for its development. This zone is sub divided into three zones:

i. **Optimum zones:** optimum zone is the most favourable zone in the range between two extreme limits thus supports maximum for the growth and development of organism.

ii. **Critical minimum Zone:** it's the lowest limit of minimum below which the organism growth is inhibited.

iii. **Critical maximum zone**: it's the maximum limit of tolerance zone above which organism growth ceases.


Zone of Tolerance
High
Critical minimum Zone
Critical maximum Zone
Optimal range
Zone Of Intolerance
Zone Of Intolerance
Population
No species
No species
High population density
Low population
Low population
Low
Low
Gradient
High