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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.

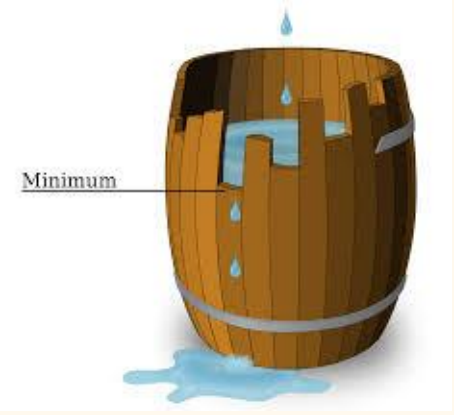

Figure 1: Liebig's Barrel

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.

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).

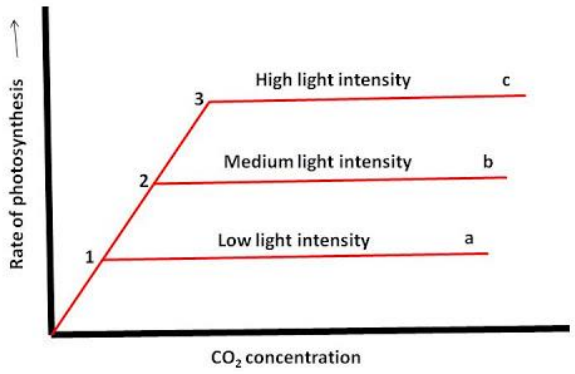

Figure 2: Graph illustrating Blackman's law of limiting factor

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.