

Ecology

Part I (H)

Zoology. P.G. IInd semester
VIIth Paper

Limiting Factor in Terrestrial Ecosystem

Includes:

- Liebig's Law of minimum and Shelford's Law of Tolerance
- Various interspecific & Intraspecific relationship

All Living Organisms, Plants or animals have a range of tolerance for every environmental factor such as temperature, humidity or salt contents of the aquatic environment. If ~~the~~ an environmental factor exceeds the maximum tolerable level or it comes down to the minimum tolerance in any given area it becomes a limiting factor. It prevents the distribution of particular animals or animal groups in that area.

For Example, in aquatic medium the concentration of salts is often a limiting factor.

Justus Liebig and V.E. Shelford have propounded two different laws governing the distribution of animals and growth of organisms.

Liebig Blackman's Law of Minimum

Justus Liebig, 1840 while studying the relationship between the available amounts of essential elements and plant growth, discovered that the crop yield was

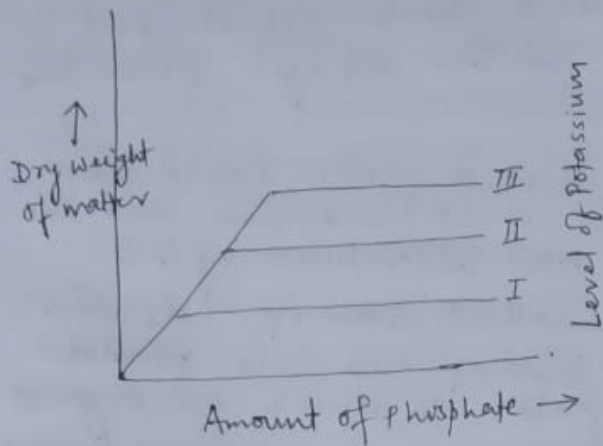
was frequently limited by such elements which are utilized in low concentration. This concept is described as Liebig's law of minimum. It holds that the growth is dependent on the amount of foodstuff that is present in minimum quantity.

The hypothesis of Liebig was originally concerned with the chemical material required by plants in their natural environment.

Later workers have expanded to include animals and all of the abiotic environmental factors. ~~A~~ A number of environmental factors like temperature, atmospheric gases, humidity, amount of light and many other similar biotic factors are able to act as limiting factors with respect to the organism. Therefore, F. F. Blackmann, a British Physiologist incorporated the law of minimum with the law of limiting factors.

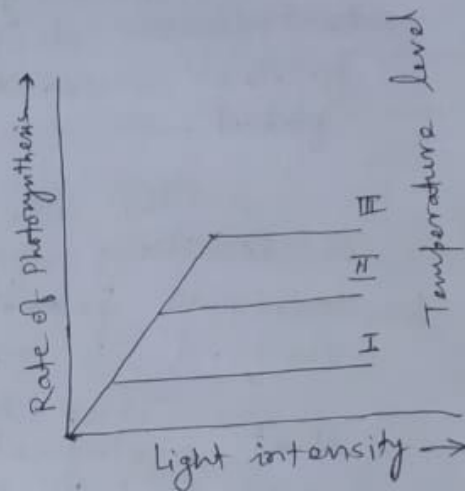
Blackman, while studying the factors affecting the rate of photosynthesis discovered that the rate of photosynthesis is governed by the level of the factor that is operating at a limiting intensity.

Further work on limiting factors and substance has shown that a high level of one factor will modify the limiting effect of second. The phenomenon has been described as "factor interaction."



A. Liebig's Law of minimum

" The amount of phosphate plotted against the dry weight of matter produced at three different levels of the supply of potassium which becomes a limiting factors.



B. Blackman's Law of limiting factor.

" The rate of photosynthesis plotted against the light intensity at three different temperatures, each of which limits the rate of photosynthesis

Shelford's Law of Tolerance

It is observed that organisms are limited in their growth and their occurrence both by too little of an element or too low an intensity of the factors, but also by too much of the element or too high an intensity of the factor i.e. the amount of a substance below or above certain limits proves to be harmful to the organisms.

For example, CO_2 increases the rate of plant growth, because small increase in its concentration increases the rate of photosynthesis in green plants. But, when it is increased considerably it becomes toxic.

Similarly, small addition of arsenic to human diet has a tonic effect, but further increase in the dosages proves to be fatal.

The idea that a factor could have a limiting effect at its ^{maximum} and the minimum quantity was introduced by V.E. Shelford in 1913 & called "Law of Tolerance".

Thus the law of tolerance postulates that ecological factors to which an organism responds has maximum and minimum limiting effects and a value below a critical minimum or quality above the critical exclusion.

The range between the critical minimum and critical maximum is known as limits of tolerance. Any value lying between these critical limits will naturally fall in the limits of tolerance for an organism. If the limits of tolerance are exceeded for a particular species, it will lead to the disappearance of the species from that area as long as such condition exists.

The concept of optimum is that point within the limits of tolerance at which a given factor is acting at a level best suited to the requirements of a given organism.

Certain additional information has been incorporated with the law of tolerance. A plant or animal may have a wide range of tolerance for one factor in the environment but relatively low range of tolerance for ~~one~~

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another factor. In such a case, if conditions are not suited to one condition, the limit of tolerance may be reduced with regards to the other also.

For example, some species of freshwater fishes are eurythermal (having a wide range of tolerance for temperature), but are stenohaline (having a narrow range of tolerance for salt). Lowering of temperature of brackish water resulted in the reduction of tolerance of estuarine species to low salinity.

Not only this, the range of tolerance and the optimum condition vary for geographical ranges of the same species. Therefore, the law of tolerance and limits of tolerance help in understanding the biological distribution under natural conditions and also in the appearance of variations within species populations.

