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FACTORS OF ECOLOGY

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Some of the major ecological factors that constitute the environment of an organism are as follows:

1. Climatic Factors
2. Edaphic Factors
3. Topographic Factors
4. Biotic Factors
5. Limiting Factors.

In any eco-system, a living organism is influenced by a number of factors and forces. These environmental factors are known as **eco-**

factors or ecological factors, which include light, temperature, soil, water etc.

These factors may be biotic (living) and abiotic (non-living). The sum total of all these factors constitutes the environ-ment of an organism.

All these ecological factors can be broadly classified into the following divisions:

(i) Climatic or Aerial factors:

(a) Light;

(b) Temperature;

(c) Water

(d) Rainfall,

(e) Humidity,

(f) Atmospheric gases (wind).

(ii) Topographic or Physiographic factors:

(a) Altitude;

(b) Direction of mountain chains and valleys,

(c) Steepness and exposure of slopes.

(iii) Edaphic factors:

These deal with formation of soil, its physical and chemical properties and details of related aspects.

(iv) Biotic factors:

These are all kinds of interactions be-tween different forms of life. These are plants, animals, micro-organisms etc.

(v) Limiting Factors:

1. Climatic Factors:

A. Light:

Light plays an important role in the species composition and development of vegetation. Light is abundantly received on the surface of the earth. And, on an average approximately only 2-3 per cent of this solar energy is used in Primary Productivity.

Light intensity shows special variations due to the factors like atmos-pheric water layer, particles dispersed in the air, etc. Further,

the vegetation of an area may also affect the light intensity. In deep shade under trees, or under water, light becomes limiting below which photo-synthesis is not sufficient for effective growth.

(a) Effect of Light on Plants:

Light plays a vital role directly or indirectly in regulating the growth (structure, form, size), metabolism, development and dis-tribution of plants.

The plants are influenced by light in the following ways:

1. Effect on Chlorophyll synthesis:

The synthesis of chloro-phyll in green plants can take place only in the presence of light. It is seen that if a coprophilous plant is kept in pro-longed darkness, the chlorophyll amount practically disap-pears.

2. Effect on number and Position of Chloroplasts:

Light has marked effect on the number and position of chloroplasts, the chlorophyll bearing organell. The upper surface of leaves which receive maximum sunlight has the largest number of chloroplasts

arranged in line with the direction of light. On the other hand, the leaves of the plants which shade chloroplasts are very few in number and arranged at right angles to the light rays, thus increasing the surface of absorption.

3. Effect on Photosynthesis:

Photosynthesis is a process of conversion of solar energy (light) into chemical energy (in presence of chlorophyll) which is subsequently used for the preparation of carbohydrate from carbon dioxide and water.

Photosynthesis Process:

From the above statement, it is clear that light is highly es-sential for photosynthesis. The rate of photosynthesis is slower at lower intensity and it increases linearly with in-creasing light intensity upto a particular point, known as “Saturation point,” and after attaining this point, it remains constant. The intensity of light at which the plants no longer carry on photosynthesis or when the photosynthesis bal-ances respiration is called compensation intensity.

4. Effect on Respiration:

In plants, respiration is a process of the oxidation of carbohydrate (produced in the photosyn-thesis) into carbondioxide and water. According to Calvin (1958), the rate of respiration increases at higher light intensity and it decreases at lower light intensity.

5. Effect on Transpiration:

The rise in atmospheric tempera-ture which may be due to the conversion of solar radiation into heat increases the rate of transpiration. The process of opening of stomata (which depends

upon light) leading to loss of water from the aerial surface of plants is known as transpiration.

6. Effect on Production of Hormone:

Light inhibits the synthe-sis of auxins or growth hormones in plants as a result of which the shape and size of the plants gets modified.

7. Effect on development of Flowers, Fruits and Vegetative parts:

The intensity of light largely influences the growth and de-velopment of flowers, fruits and vegetative parts of plants. Light

of higher intensity favours development of flowers, fruits and seeds but light of lower intensity promotes the development of vegetative parts and causes delicacy.

8. Effect on Formation of Anthocyanin Pigment:

Intense light helps in the formation of anthocyanin pigments in plants. The plants in Alpine regions have beautiful flowers contain-ing this pigment.

9. Effect on Movement:

The effect on sunlight in modulating the movement of plants is called phototropism or heliotropism. The elongation on stem towards light is known as posi-tive photo-tropism and the movement of roots away from light is known as negative photo-tropism. The leaves grow transversely to light.

10. Effect on Photoperiodism:

The response of plants to the relative length of the day (known as photo-period) is known as photoperiodism. According to the

response of the plants to the length of the photo-period, the plants have been clas-sified into three groups:

(i) Long Day Plants (L.D.P.): The plants which bloom when the light duration is more than 12 hours per day e.g. radish, potato, spinach, etc.

(ii) Short Day Plants (S.D.P.): The plants which bloom when the light duration is lesser than 12 hours per day e.g. cereals, tobacco, cosmos, dahlia etc.

(iii) Day neutral Plants (D.KP.): The plants which show little response to the length of the day light e.g. cotton, bal-sam, tomato, etc.

11. Effect on Seed Germination:

The germination of seeds is largely influenced by light. In most of the plants, the red light induces seed germination and in some plants blue light promotes the process. In some cases, far-red light is seen to inhibit seed germination.

12. Effect on Distribution of Plants:

The duration and intensity of light plays an important role in determining the distribu-tion of plants. Hence the vegetation of different geographi-cal regions are different from one another (Kebs 1972).

13. Effect on Photo-morphogenesis:

The development of plants in seedling stage is controlled by light. The seedlings present in dark condition are non-green and highly elongated with poorly developed root system and no-foliage.

However, an exposure of the dark grown seedling to light makes it normal.

(b) Effect of Light on Animals:

Besides the multifarious influence of light over plants, it has far reaching effects on the various biological activities of animals such as growth, development, reproduction, locomotion, pigmen-tation, metabolism etc. Some major effects of light on animals are described below:

1. Effect on Metabolism:

The rate of metabolism in animals is largely influenced by light intensity through enzyme activity. Higher the intensity of light higher will be enzyme activity and higher will be the general metabolic rate. However, the cave-dwelling animals are not influenced much by light in-tensity.

2. Effect on Reproduction:

In case of some animals and birds, the breeding activities are induced by light through its inoculating action over the gonads. In

addition, there ex-ists a definite relationship between the length of the day (i.e. the amount of light) and egg lying by the birds.

3. Effect on Development:

Light has differential action over development. In case of some animals, light accelerates the development and in some other cases, it retards the same. For example, Salmon larvae grows larger in darkness.

4. Effect on Pigmentation:

Light induces the formation of pig-ments in animals. It is seen that higher the intensity of light, higher will be pigmentation. For example, the human inhab-itants of tropical region have higher concentration of mela-nin in their skin. Hence comparatively darker than their coun-terparts in temperate regions.

5. Effect on Locomotion:

In some lower animals, light con-trols the speed of locomotion and such a process is known as photo kinesis. They are of two types:

(a) Phototaxis:

It is a process of the movement of animals in response to the light stimulus. When an animal moves towards the light source, it is said to be positively photoactic and when moves away from the light source, it is said to be negatively photoactic.

(b) Phototropism:

When only a part of organism shows re-sponsive movement to light stimulus, it is called as pho-totropism. It is seen in case of sessile animals.

6. Photoperiodism:

The response of animals to the length of the day or the rhythms of light and darkness is called photophase. And, portion of darkness is called scatophase.

7. Effect on Eyes:

The degree of development of eyes depend on the intensity of light available in the environment. For example, in case of the cave dwelling animals and deep sea fishes, the eyes are absent or rudimentary as these animals live in total darkness.

Thus, from the above discussion, it is clear that light is most important environmental abiotic factor which produces diverse ecological effects. Besides, the preparation of food by photo-syn-thesis, it has direct effects on morphology, growth,

development, metabolism, reproductive behaviour, and survival of most of the plants and animals.

(B) Temperature:

Temperature is a measurement of the degree of heat. Like light, heat is a form of energy. The radiant energy received from the sum is converted into heat energy. Heat is measured in calo-ries. The temperature at which physiological processes are at their maximum efficiency is called optimum temperature.

The mini-mum, optimum and maximum temperatures are called cardinal temperatures. The cardinal temperature varies from species to species, and in the same individual from part to part. The distributions of plants, animals are also influenced by tem-perature.

(a) Effects of Temperature on Plants and Animals: In affecting the structure physiology, growth and distribution of plants and animals, temperature plays an important role.

The effects of temperature on plants and animals are briefly listed below:

(i) Effect on cell and Protoplasm: In the extremely low temperature, the protoplasm may be frozen to ice. On the other hand, in the extremely high temperature, the protein may coagulate.

(ii) Effect on Metabolism: In the presence on different enzymes, various metabolic activities in the living organ-isms are carried out. With a slight increase in tempera-ture, the metabolic activities may increase. However, the metabolic rate may decrease when there is

higher in-crease in temperature. Finally, there will be no such ac-tivities when enzymes become defunct.

(iii) Effect on Respiration: The rate of respiration usually doubles as per the Van't Hoff's law with increase in tem-perature by 10 °C in case of poikilothermic animals.

(iv) Effect on Development: The development of plants and poikilothermic animals is influenced by tempera-ture. The

development of eggs and larvae is higher in the hot climates compared to cold climates in case of poikilotherm animals.

(v) Effect on Growth: When the temperature is slightly in-creased, the poikilothermic invertebrates indicate an increase in temperature the seedlings of several plants exhibit the elongation of the hypocotyle.

(vi) Effect on Transpiration in Plants: Transpiration is the process of loss of water from the aerial surface of plants. The rate of

transpiration increases with increase in atmospheric temperature and vice versa.

(vii) Effect on Reproduction: Maturation of gonad and gametogenesis need specific temperature which varies from species to species. The animals have different breeding periods and the maturation of gonads occur at different times. All these are due to the effect of tem-perature.

(viii) Effect on Sex-ratio: The Sex-ratio in the poikilothermic animal population is determined by temperature. There is considerable increase in the number of male individu-als in the copepad macrocyclops (an arthoropod) with the increase in the temperature.

(ix) Effect on Morphology: As per Jordan's Rule, the fishes living in low temperature water regions tend to have more number of vestibule than their counterparts living in the high temperature water regions.

As per the principle of Bergman's rule, the homoiothermic animals of colder climates are longer in size than their counterparts found in the hot regions of the globe. As per the Allen's Rule, the tail, snout and legs are com-paratively smaller in the mammals of cold climates than those in the hot climatic regions.

(x) Effect of Colouration: As per the principle of Gloggei's Rule, the body colour of animals is influenced by tem-perature. In the hot and humid climates the birds and mammals have darker pigmentation than their counter-parts in the dry and cold climate.

(C) Water:

Water is an indispensable part of land and soil productivity. The misuse of water leads to soil degradation and erosion. Proper management of water is highly necessary for better production. Water is also indispensable for human beings.

Thus, it goes without saying that water is the most important substance necessary for life. All the physiological processes take place in the medium of water. Protoplasm, the very basis of life, is

made up mostly of water. Plants and animals show considerable variation in their re-quirements of water.

On the basis of nature of soil, the water requirement of different plants and animals are as follows:

(a) Hydrophytes: Plants living in water require large quanti-ties of water.

(b) Xerophytes: Terrestrial plants which cannot tolerate ex-tremely dry conditions and pass through long periods without-water.

(c) Mesophytes: Terrestrial plants require moderate quan-tity of water.

Similarly, animals also belong to three important ecological groups depending on the requirement of water:

(a) Hydrocoles: Aquatic animals which live in water and require large quantity of water.

(b) Xerocoles: Terrestrial animals which can tolerate ex-tremely dry conditions and pass long periods without water.

(c) Mesocoles: Terrestrial animals requiring moderate quan-tity of water.

(D) Rainfall:

The main source of soil water is precipitation. The rainfall pro-vides water to plants and animals. Rainfall occurs due to inter-change of

water between earth's surface and the atmosphere. This is known as the hydrologic cycle. In this cycle two important things are precipitation and evapo-transpiration.

Annual rainfall determines the types of vegetation in any re-gion. We find evergreen forests in tropical regions due to heavy rainfall throughout the year. Grasslands are found in such regions where there is heavy rainfall during summer and low rainfall dur-ing winter.

In our country there are differences in the quantity of annual rainfall. Also, the distribution of rainfall in different seasons of the year is different. Therefore, we find that vegetation types in different parts of the country are much different from each other. We also notice different types of animals and birds in different geographical regions due to changes in vegetation and in turn, vegetation causes changes in the types of forests, animals and birds.

Different regions of the earth receive, different quantity of rain-fall depending upon the geographical features and the availability of

moisture laden winds. The quantity, duration and intensity of rainfall regulate plant life.

Only a part of the rain water is used by the plants, the rest is lost in many ways like evaporation and run-off. Thus, there is a difference between the actual rainfall and the effective rainfall.

The evaporation is governed by the moisture content and the temperature of the atmosphere, and hence, in effective rainfall the total rainfall in relation to temperature is taken into account.

The quantity of water that a soil holds or that infiltrates into the soil depends upon the properties of soil and type and den-sity of vegetation covering it. In a bare area, the rain drops beat the compact surface of the soil and loosen the soil particles which are washed away.

In a clay soil, the clay particles are densely packed and these stick to each other. For space is reduced and water percolation is checked. This results in horizontal movement of water in the form of run-off, resulting in the loss of effective rainfall. Inverse is the case with a

sandy soil, where in water infiltrates into the soil. The vegetation intercepts the beating effect of rainfall and thus, water is gradually soaked in soil from where plants use it over a long period.

The degree of slope is another factor for water loss. There-fore, on hill slopes, terrace cropping is practised.

Though most of the plants cannot make use of atmospheric humidity, several lichens, filmy ferns and epiphytic orchids can absorb humidity from the air.

(E) Wind:

Air in motion is called wind. It is a vital environmental factor. It affects plants, and other organisms. It modifies the water rela-tion and light conditions of a particular region. Wind brings about a number of physical, anatomical and physiological changes of plants. Such changes are breakage and uprooting of plants, de-formation, erosion and deposition,, salt spray etc.

The wind accelerates transpiration, removes solid moisture and at high velocities causes soil erosion. Erosion is the removal of the surface soil, rich in organic matter and fine mineral parti-cles.

Excessive transpiration leads to desiccation and death of apical meristems. Thus, the plants tend to become dwarf, pro-fusely branched and usually have small leaves. The sand parti-cles blown with the wind deposit on leaf surface and reduce photo-synthesis, cause rise in temperature and lead to rapid des-iccation.

On the exposed mountain tops, plants frequently live in dan-ger of being uprooted and blown away by strong winds. In these situations, the vegetation is largely composed of species with a prostrate habit of growth and a tenacious underground root or rhizome system.

(F) Humidity:

Atmospheric moisture in the form of invisible vapour is known as humidity. Humidity is greatly influenced by intensity of solar radiation, temperature, altitude, wind, water status of soil etc. Low

temperature causes higher relative humidity by decreasing the capacity of air for moisture. Processes as transpiration, ab-sorption of water etc. are influenced by atmospheric humidity. Humidity, thus, plays an important part in the life of plants and animals.

(G) Atmospheric Gases:

Some principal gases like nitrogen, oxygen, carbon-dioxide, helium, hydrogen, methane, ozone etc. are found in atmosphere. In addition to these gases, there are water vapours. Industrial gases, dust, smoke particles, micro-organisms etc. are present in the

atmosphere. These gases have important influence on the environment.

2. Edaphic Factors:

Edaphic factors deals with different aspects of soil, such as the structure and composition of soil, its physical and chemical fea-tures. A galaxy of complex factor constitutes the soil.

(A) Definition:

Soil is usually defined as “any part of earth’s crust in which plants root”. The soil is constituted as a result of long-term proc-ess of complex interaction leading to the production of a mineral matrix in close contact with interstitial organic matter both living and dead.

After a long time, the parent mineral matter takes the modified shape which forms soil. The interactions among climatic, topographic and biological factors pave the process of transfor-mation and modification of mineral matter into soil.

Thus, soil has mainly the following components:

(i) Mineral matter.

(ii) Soil organic matter or humus.

(iii) Soil water/soil solution.

(iv) Soil Atmosphere.

(v) Biological system (fauna of bacteria, fungi, algae, proto-zoa, ratifies, arthropods, etc.).

(B) Formation of Soil:

The soil development may be classified into two major phases:

1. Weathering of parent rock.
2. Maturation and profile development.

1. Weathering:

The weathering is the process by which large rocks are broken down to small pieces and converted to a fine powder. This is a long-

term process occurring mostly under the influence of the climatic conditions of the area, and hence called weathering.

The mechanical or physical weathering takes places by the movement of rocks with running water or ice (as in rivers and glaciers) and by action of gravitational forces as landslide in moun-tainous regions. The freezing of water in small crevices in the rocks may also exert enough pressure to breakdown rocks into pieces.

In hot desert, large diurnal fluctuations in temperature also cause breaking down of rocks, especially exfoliation of sedimen-tary rocks. The chemical weathering includes hydrolysis, oxidation and carbonation of mineral compounds in the rocks by the action of weak acids like carbonic acid. Traces of sulphuric acid and nitric acid also occur in certain regions and influence weathering.

Biological weathering includes the action of various organisms, particularly lower plants (lichens and mosses) which secrete

vari-ous organic acids, and produce humic acids after death and de-cay. These acids help in the weathering process.

2. Maturation:

The maturation process determines the struc-ture of the soil profile and the type of the soil. It is largely influ-enced by the prevalent climatic conditions, and indirectly by the type of vegetation found in that area.

There are four major maturation processes:

(a) Melanization:

The humus derived from the dead organic matter gets mixed in the upper layers of the soil which become dark coloured. It occurs mostly in the regions of low humidity.

(b) Podzolization:

In regions with high rainfall or high hu-midity and low temperature, the minerals in the humus get leached from the upper horizon and

get precipitated in middle of B horizon (alluvial) forming a hard pan. This leaves an ash-coloured surface layer of the soil from which the soil derives its name Podzol.

(c) Gleization:

In very cold climates the underground water lying above the rock layer continuously reacts with the partly weathered mineral matter. The hydrolysis and re-duction of the minerals result in the formation of a hard gley horizon.

(d) Patternisation:

In very hot and humid climate, the rapid decay of organic matter and release of base from organic combination result in the solubility of silica and forma-tion of oxides of iron, aluminium and manganese, etc. This results in a red coloured soil, usually rich in iron, and deficient in bases and organic matter.

However, on the basis of the nature of transporting agents, the transported soil may be classified as follows:

(i) Coiluvial (by gravity)

(ii) Alluvial (by running waters)

(iii) Qlacial (by glaciers—large masses of snow, ice)

(iv) Eolian (by wind)

Thus, the classification of soil has been made on the basis of a combination of climatic/vegetation and soil morphology.

(C) Soil Erosion:

The nutrients required by plants are present in the top layer of the soil. This top layer is known as feeding zone of plants. The top soil is made out of the most valuable natural resources. It is very fertile and usually lies at a depth of 15-20 cm. over the face of land.

But we found an acute problem of soil erosion. It is natural process. For formation of an inch of soil it takes 500 to 1,000 years. But the fertile soil is wasted or lost because of several rea-sons. Scientists

express soil erosion as a part of the soil pollu-tion. Soil-erosion is called the creeping death of soil.

In the regions with high density of population there is maxi-mum soil erosion. Repeated cultivation of land with same type of crop leads to soil erosion. Because of the problems by deforesta-tion, the multipurpose dams have been endangered.

Soil erosion is the result of deforestation, flood, over grazing etc.

Kinds of soil erosion: Soil erosion is of many types. These are mainly:

(i) Normal or Geological erosion:

This type of soil ero-sion is caused by normal or natural conditions without any interference of man.

(ii) Accelerated soil erosion:

There is no equilibrium be-tween the formation and loss of soil. The rate of soil loss is very rapid due to interference of man and ani-mals.

Agents of soil erosion: Soil erosion is caused by a number of agents. These are:

Water erosion:

Rain drops remove the soil. The thin covering form large area are lost by rain water and known as sheet erosion. When sheet erosion takes place with full momentum, it leads to cutting of soil surface as thin channels or streams. It is known as rill erosion. Several rills form the steep slope on wide channels of water leading to gully erosion.

Wind erosion:

In dry (arid) regions the soil is mainly sandy and the vegetation is grossly inadequate. Wind in Rajasthan and other arid regions causes loss of soil. Loss of natural vegetation, cover of land due to deforestation and over grazing, mining activities etc. lead to dry and dust soil. Heavy wind causes loss of soil when soil parti-cles are blown off.

With low rainfall, poor drainage system and high temperature, water evaporates quickly, leaving behind the salts. In lands around

the oceans, generally salt accumulates. Such salts are comprised of chlorides, sulphates, carbonates, nitrates potassium, sodium, magnesium etc. In the form of small heaps, the considerable por-tion of such salty soil is carried by wind.

While the heavy wind throws away the smallest soil particles into air, the heavier particles of soil are pushed or spread over the surface by wind. The former process is known as suspension whereas the latter process is termed as surface creep.

Pressure of heavy rains, gravitational force and other factors leads to land slides or slip erosion. During floods in rivers the river bank erodes due to heavy speed of water flow. This is known as stream bank erosion.

Loss of forest due to deforestation, rapid growth of popula-tion, industrial activities, mining, etc. cause heavy flow of rain water from the top hills. These cause loss of soil as the fertile soil is washed away by the speedy flow of water.

(D) Soil Conservation:

The loss of soil should be checked in view of its vital impor-tance to humanity. The soil erosion should be controlled through adoption of various methods and conservation procedures.

The soil erosion is mainly due to wind and water, thus, the soil conservation methods should be through:

(i) Protection of soil from the severity of rain drops (through afforestation).

(ii) To prevent water from concentrating and passing through the slopes.

(iii) To slow down the momentum of water flow through vari-ous scientific techniques.

(iv) To plan out methods by which water can adequately enter into soil.

(v) Growing vegetarian cover and thereby to minimise the wind velocity.

(vi) Soil binders like growth of grasses can prevent soil ero-sion etc.

3. Topographic Factors:

The factors concerned with physical geography of the earth are known as topographic factors. These factors influence vegetation which causes variation in climate of a geographic region, ultimately give rise to a characteristic microclimate.

The different topographic factors are:

(1) Altitude of the place

(2) Steepness and exposure of the slope, and

(3) Direction of the mountain chains.

1. Altitude of the place:

As the altitude above the sea level increases, there happens a decrease of temperature. Besides, the values of pressure, humidity, wind velocity etc. also changes. All these factors together give a definite pattern of vegetational zone.

2. Steepness and Exposure of the slope:

The slope of mountain affects the nature of vegetation. In northern hemisphere, south facing slopes receives more solar radiation than the north facing slope. This may be due to the fact that the steep

southern slope receives the solar radiation almost at right angles during the mid-day whereas the northern slopes receive only oblique rays during morning and evening hours. This difference in solar radiation brings about a change in vegetation in the two sides of the slope.

In addition to this, the steepness of slope accelerates the downward movement of surface water. The downward movement of water over the slope causes soil erosion and as a result, the vegetation disappears from that area.

3. Direction of mountain chains:

The direction of mountain chains considerably influences the rainfall in an area. If the moun-tain chains lie in the path of wind full of water vapour, then there is heavy rainfall on the wind striking side on the mountain chain.

4. Biotic Factors:

Under natural situations, organisms live together with their inter-actions directly and indirectly. The biotic factors constitute the living organisms of the environment and definitely they have

their interactions. The population occurring together in an area interacts with each other in several ways. In the study of environmental reactions of a particular kind of organisms, these interactions are generally referred to as the biotic factors.

We can elaborate in detail the relationship found in biotic factor, influencing the environment. Ecologists use the term symbiosis which means living together. All types of interactions including parasitism have been included under “symbiosis.” Symbiosis means interaction of living organ-isms which are naturally beneficial.

M. C. Dougall (1918) listed all beneficial as well as harmful effects or association of organisms under the single concept “sym-biosis”.

He categorized the effects of interactions of biotic factors (living organisms) into:

(i) Disjunctive symbiosis, and

(ii) Conjunctive symbiosis.

Where the associated organisms are not constantly in contact, are known as disjunctive symbiosis. Dissimilar organism living is contact with each other is termed as conjunctive symbio-sis. Co-actions between species have been elaborated by Burkholder (1952).

Burkholder on the basis of several combina-tions of 0, + & — have developed nine types of interactions in which '0' indicates no significant interaction,'+' stands for growth, survival or beneficial to other population. — 'stands for popula-tion growth inhibition.

Analysis through Problem Combination of 0, + and - Resulting In Diversified Interactions

Odum has analysed the aforesaid interaction into two main groups. These are:

1. Positive interactions:

(Populations help one another) commensalism, proto-co-operation and mutualism are grouped under positive interactions.

2. Negative interactions:

(Members of one population may eat members of the other population.) They compete for food and interfere with other population. Predation, parasitism and antibiosis are grouped under negative interactions.

1. Positive Interactions:

When the populations help one another and either one or both the species are benefited, the interactions are known as positive interactions. The benefits may be in respect of shelter, food,

substratum or transport and the association may be con-tinuous or transitory, obligate or facultative and the two partners may be in close contact or one of them may live within a specific area of the other or attached to its surface.

The beneficial interac-tions are:

(a) Mutualism:

Mutually beneficial inter-specific interactions with permanent and obligatory contact indispensable for their survival is termed as

mutualism. Generally, two species (population) enter into some contact beneficial to each other.

Some examples of mutualism are as follows:

(i) Pollination by Animals: Bees, moths, butterflies etc. de-rive their food from plants and bring about pollination.

(ii) Dispersal of fruits and seeds: Generally, the animals dis-perse the fruits and seeds. The birds eat the fruits and the seeds contained in fruits are left through excrement at different places.

(iii) Symbiotic nitrogen fixers: The bacterium Rhizobium forms nodules in the roots of leguminous plants and lives symbiotically with the host. Bacteria derive food from the higher plants and in return fix gaseous nitro-gen which is necessary for the plants.

(b) Commensalism:

Commensalism represents two or more populations living to-gether without entering into any kind of physiological exchange. In this process, one is benefited without any effect on the other. A commensal which lives upon the hosts is called as ectocommensals.

A variety of micro-organisms, saprophytic bacteria and fungi, and protozoans live within tissues or cavities of higher plants and animals. There are many commensals which make temporary contact with other organisms. Squirrels, monkeys, tree frogs, birds and snakes belong to this category.

From the living root as well as leaves of higher plants, there is a continuous diffusion of their metabolic products like sugar and amino acid. These are the sources of nutrient for micro-organ- isms. These micro-organisms supply protection to roots and leaves

against attack by pathogens. Some metabolic products are pro-duced by micro-organisms. These are specified as auxins. These microbes play a vital role in controlling the growth and develop-ment of the higher plants.

(c) Proto-Co-Operation:

The positive relationship between populations, mutually ben-efiting each other has been termed as proto-co-operation. Such association of populations is non-obligatory mutualism. Exam-ple of proto-co-operation is sea anemone. Adamsia palliate is at-tached to the shells

or hermit crab. The sea anemone is carried by the crab to fresh feeding sites. The crab is also protected from its enemies by sea anemone.

2. Antagonism or Negative Interactions:

The relationship between members of different species in which one or both are harmed is termed as antagonism. This has been referred to as negative interactions.

The relationships of an-tagonism include:

(a) Antibiosis.

(b) Parasitism.

(c) Predation.

(d) Competition.

(a) Antibiosis:

Through the production of some substances or environmen-tal conditions due to metabolic pathways, there is death of one organism by another. This is termed as antibiosis. Productions of

chemicals which are antagonistic to microbes have been referred as antibiotics.

Bacteria, actinomycetes and fungi produce a good deal of anti-microbial substances. In marine wastes, population of some microbes has known as red tide, cause devastating loss of fish and other water animals. Interactions between micro-organ-isms and pathogens create hypersensitive reactions which are harm-ful, to one or both.

(b) Parasitism:

A parasite is the organism living on or in the body of another organism and deriving its food from its tissues. A galaxy of plants and animals are parasites in their mode of existence. Species of cuscuta grow on other plants on which they depend for nourish-ment. Orabanche conopholis and Epifagus are found on roots of higher plants. Most of the parasites are micro-organisms. Fungi, bacteria, mycoplasms, rickettsias etc. are the examples of plants and animals of this category.

(c) Predation:

Predator is free living organism which kills and devours individuals of other species. The parasite which lives on or in its host derives nourishments without killing it, whereas the preda-tor kills and devours its prey. Carnivore's animals are predatory.

There are some plants (carnivores) like fungi which feed upon other animals. Species like Dectylella, Dactylaria, Arhtrobotrys, Zoophagus, etc. capture insects and other worm like animals. Plants, especially aquatic plants are eaten by animals like duck, fish, etc.

Carnivorous plants like nepenthes, Darligtona, Dionaea etc consume insects and other small species for their food. They adopt various methods to attract and catch their victims.

(d) Competition:

When two organisms survive for something which is inadequate leads to competition. Darwin (1859) in his famous work, "On the Origin of Species Through natural Selection" has highlighted the concept of struggle between species. Plants compete for light, nutrients in a forest and animals for food and shelter.

Competition may be:

(i) Intra-specific.

(ii) Inter-specific.

Intra-specific competition occurs between the members of same population. Inter-specific competition occurs between the populations of different species. It is known as interference com-petition. The intra-specific competition is the basis for the develop-ment of theory of natural selection and evolution of species. In-ter-specific competition between plants may be found

itself by chemical aggression or allelopathr. A population cannot tolerate a certain range of temperature, humidity, etc. Thus, any popula-tion can only survive and reproduce within certain environment limits.

5. Limiting Factors:

A limiting factor is that substance of quality in the environment, j the supply of which is least abundant or over abundant in rela-tion to the need of the living organism concerned.

Limiting factors are of two types on the basis of their correlation with population density:

(i) The density dependent limiting factor.

(ii) The density independent limiting factor.

(A) The Density Dependent Limiting Factor:

The effect of such type of limiting factor has direct correlation with population density. The influence of limiting factor increases j with the increase in population density. For example, food sup-ply is

density dependent. Higher the population density lower food will be available to eat and higher will be food scarcity.

(B) The Density Independent Limiting Factor:

The effect of such type of limiting factor is limited to many or few individuals without reference to the population level. For example, flood is density independent. It may wipe out entire population of a species whether these are few or many.

Besides, the other limiting factors which influence living organisms are the various environmental factors. The environmen-tal factors may be abiotic or biotic. The abiotic factors are either physical factors (light, temperature, water, soil, wind, etc.) and chemical factors (nutrients). The nutrients may be divided into macro-nutrients (required in large quantities) and micro-nutrients (required in traces).

The essential macro-nutrients for plants are carbon, oxygen, nitrogen, phosphorous, sulphur, potassium, cal-cium and

magnesium. The essential micro-nutrients are boron, chlorine, sodium, copper, iron, manganese, Zinc vanadium, and molybdenum.

The effects of some important limiting factors on living organ-isms are discussed below:

(i) Climatic and Atmospheric Factors:

Each living organ-ism has limits of tolerance and some optimum range of tolerance for the environmental factors like sunlight,

tem-perature, humidity, rainfall or wind. If the climate nor-mally exceeds the limits of tolerance of a living organ-ism, it will not exist in that region. If it exceeds the opti-mum limits, the living organism will not thrive there.

If the local climate sometimes exceeds the limits of toler-ance, then the living organism may temporarily occur in that area but it will be eliminated during the period when the climate becomes extreme. Low temperature acts as a limiting factor in the higher latitude and

altitudes in winter. Similarly, oxygen is a limiting factor in high alti-tudes (in mountains).

(ii) Soils:

In this case, the limiting factor influences indi-rectly the animal population through the plants. A good growth of vegetation does not mean that there will be an abundant supply of nutritional foods to the animals. Sometimes, the plants prepare higher amount of carbo-hydrate during the short supply of nutrients by soil, but these

produce relatively lower amount of proteins and vitamins needed to support the abundance of animal life.

(iii) Water:

All the plants require water to support their ac-tive growth and metabolism. Some plants cannot toler-ate moisture deficiency even for a brief period and will droop and die when the soil dries out. Xerophytes sur-vive under prolonged drought.

(iv) Biotic Factors:

Biotic factors are the most important lim-iting factors influencing the growth and distribution of plants and animals. Out of all the biotic factors, food supply for animals is the most common factor limiting the growth of animal population either directly through being short of requirements or indirectly through behav-ioural responses to food shortage.

The number of plant eating animals in any area is limited by the abundance of the plants on which the animals feed. The growth of the plant may be limited by competition from other se-cret substances which inhibit the growth or establish-ment of other plants. The number of carnivorous in any area is limited to the availability of the prey upon which they feed. Also there must be enough prey animals to enable the prey species to exist and produce the predator.

Laws of Limiting Factors:

To explain the effect of different limiting factors on living organisms, a number of laws and principles are proposed by dif-ferent scientists which may be described as follows:

1. Liebig's Law of Minimum:

The law was suggested by Jestusvon Liebig in 1840. After doing a series of experiments on the effect of inorganic nutrients on growth

of crop plants, he sug-gested that the growth of a plant is limited whenever the essen-tial nutrients were in short supply, in comparison to the mini-mum need of the plants. This observation was proposed in the form of the law of minimum.

This law states that an organism requires minimum quantity of a particular nutrient for its proper growth. For example, plants will either not grow at all or exhibit poor growth if any nutritive component of the soil or air is deficient.

The nutrient deficiency makes the other nutrients metabolically inactive. Subsequently, the law has been used in a broader sense to include limitations imposed by other factors of environment and it was modified as follows:

"If the factor is depleted below the critical minimum level the organism will fail to grow or will grow abnormally".

2. Blackman's Law of Limiting Factor:

The law was pro-posed by F.F Blackman in 1905. Blackman extrapolated the law of minimum including both deficient and controlling factors. He studied the process of photo-synthesis in detail and suggested that the process is controlled by five important factors.

These are—the availability of the quantity of water, the quantity of carbon-dioxide, the intensity of solar radiation, the quantity of

chlo-rophyll and the temperature of chloroplast. A deficiency of any of these factors will affect the rate of photo-synthesis.

From the above experimental observations, he suggested the law of limiting factors which states that a biological process is controlled by a number of factors and deficiency of any of these factors, will affect the process.

3. Shelford's Law of Torerance:

It Shelford in 1913 ex-tended the concept of limiting factor so as to include the limiting effects of maximum as well as minimum quantity of a factor on organisms. This concept of Shelford is known as Shelford's Law of Tolerance.

According to him, not only less amount of a factor can be limiting but also the excess amount of the same factor can be limiting to the growth and development of an organism. For example, carbon

dioxide is necessary for photo-synthesis, but if concentration of the gas becomes considerably higher it would be toxic for the plant.

Thus, every organism has an ecological minimum and maxi-mum for every factor and the range between these two limits is known as limits of tolerance or zone of tolerance. In other words, any factor which is below or above the zone of tolerance, for an organism or community may be taken as the limiting factor for the same. The zone beyond or prior to the range of tolerance is known as zone of intolerance.

According to this law, every environmental factor has two zones:

(a) Zone of tolerance

(b) Zone of intolerance

(a) Zone of Tolerance:

This zone is favourable for the growth and development of the organism which may be further subdi-vided into three sub-zones:

(i) Optimum Zone:

It is the most favourable zone for the growth and development of organism. The temperature of this zone is called optimum temperature of organism.

(ii) Critical Minimum Zone:

It is the lowest minimum limit of temperature below which the growth and develop-ment of the organism ceases and organism becomes non-functional.

(iii) Critical Maximum Zone:

It is the highest maximum limit of temperature above which the growth and develop-ment of the organism ceases.

(b) Zone of Intolerance:

It is the zone below the critical mini-mum and above critical maximum. This zone is unfavourable for the survival of the organism for a longer period of time.

Range of Temperature Tolerance:

There is a variation of tolerance from species to species with respect to a particular factor. An organism may have narrow range of tolerance for one factor but wide range of tolerance for other factor.

Organisms having wide range of tolerance for all factors have better chances for survival and are widely distributed. By combining the

idea of the minimum and the concept of limits of tolerance, a more general and useful concept of limiting factors can be obtained.

Thus, in the environment, the organisms are controlled by:

(i) The quantity variability of materials for which there is a minimum requirement.

(ii) The physical factors which are critical.

(iii) The limits of tolerance of the organisms themselves to these and other components of environment.

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THANK YOU