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The physical factors as limiting factors

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The broad concept of limiting factors is not restricted to physical factors, because of biological interrelations are also important in controlling the actual distribution and abundance of organisms in nature .

Temperature

Temperature is one of the essential environmental factors. Compared with the range of the thousands of degrees known to occur in our universe ,life , as we known it, can exist only within a tiny range of about 300 degrees centigrade-from about – 200 to 100oC . Actually, most species and most activity are restricted to an even narrower band of

temperature. Some organisms, especially in resting stage, can exist at a very low temperatures at least for brief periods, whereas a few microorganisms, chiefly bacteria and algae are able to live and reproduce in hot springs where the temperature is close to the boiling point.

In general the upper limits are more quickly critical than the lower limits and the range of temperature variation tends to be less in water than on land, and aquatic organisms generally have narrower limit of tolerance to temperature than equivalent land animals.

Temperature, therefore is universal important and is very often a limiting factor. Temperature , light and water are largely on control the seasonal and daily activates of plants and animals .

Temperature is often responsible for the zonation and stratification which occur in both land and water environments.

Animals fall into three groups relative to temperature regulation

To regulate temperature, some groups of animals generate heat metabolically. This internal heat production is **endothermy,** meaning “heat from within.” The result is **homeothermy** (from the Greek *homeo,* “the same”), or maintenance of a fairly constant temperature independent of external temperatures. Another group of animals acquires heat

primarily from the external environment. Gaining heat from the environment is **ectothermy,** meaning “heat from without.” Unlike endothermy, ectothermy results in a variable body temperature. This means of maintaining body temperature is **poikilothermy** (from the Greek *poikilos*).

Birds and mammals are notable **hoameotherms,** usually called warm blooded. Fish, amphibians, reptiles, insects, and other invertebrates are **poikilotherms,** often called cold blooded because they can be cool to the touch. A third group regulates body temperature by endothermy at some times and ectothermy at other times. These animals are **heterotherms** (from *hetero,* “different”). Heterotherms employ aboth endothermy and ectothermy, depending on environmental situations and metabolic needs. Bats, bees, and humming birds belong to this group.

Environmental sources of heat control the rates of metabolism and activity among most poikilotherms. Rising temperatures increase the rate of enzymatic activity, which controls
metabolism and respiration . For every 10°C rise in temperature, the rate of metabolism in poikilotherms approximately doubles.

Most terrestrial poikilotherms can maintain a relatively constant daytime body temperature by behavioral means, such as seeking sunlight or shade.

Homeothermic birds and mammals meet the thermal constraints of the environment by being endothermic. They maintain body temperature by oxidizing glucose and other energy-rich molecules in the process of respiration. The process of oxidation is not 100 percent efficient, and in addition to the production of chemical energy in the form of ATP, some energy is converted to heat energy.

Homeotherms use some form of insulation— a covering of fur, feathers, or body fat . For mammals, fur is a major barrier to heat flow. Mammals change the thickness of their fur with the season, a form of acclimation.

Arctic and Antarctic birds such as penguins have a heavy layer of fat beneath the skin. Birds reduce heat loss by fluffing the feathers, making the feathered ball.

However, some animals use unique physiological means for thermal balance. The camel, for example, stores body heat by day and dissipates it by night, especially when water is limited.

Many ectothermic animals of temperate and Arctic regions withstand long periods of below-freezing temperatures in winter through supercooling and developing a resistance to freezing.

Supercooling of body fluids takes place when the body temperature falls below the freezing point without actually freezing. The presence of certain solutes in the body that function to lower the freezing point of water influences the amount of supercooling that can take place . Some Arctic marine fish, certain insects of temperate and cold climates, and reptiles employ supercooling by increasing solutes, notably glycerol, in body fluids. Glycerol protects against freezing damage, increasing the degree of supercooling. In some species, more than 90 percent of the body fluids may freeze, and the remaining fluids contain highly concentrated solutes, muscles and organs are distorted. After thawing, they quickly regain normal shape.

The ecological rules

There is some rules that correlates organism especially (endothermic animals) with latitudes such as:

- **Bergmann's rule:** It is a biological rule formulated by Christian Bergmann. This rule that correlates temperature with body mass in animals. Generally, animals living in cold areas are larger than their counterparts in warmer areas The rule is often applied only to mammals and birds (endothermic).
- **Allen's rule:** it is an ecological rule posited by Joel Allen. It states that animals from colder climates usually have shorter appendages (such as tail, ear, nose, leg etc) than the equivalent animals from warmer climates. In cold climates, the increase of exposed surface area lead to increasing loss of heat. Animals in cold climates need to conserve as much energy as possible. A low surface area to volume ratio helps to conserve heat. In warm climates, the

opposite is true. Therefore, animals in warm climates will have high surface area to volume ratios so as to help them lose heat.

Light

Light is the ultimate source of energy ,without which life could not exist. Light energy varies with different media, the transparency of air and water is an important in regulating the amount and quality of light that may be available in particular habitat . Light therefore , is not only a vital factor but also a limiting , both at the maximum and minimum levels. Therefore is not other factor of greater interest to ecologist!.

Radiation consists of electromagnetic waves of a wide range in length. The solar radiation reach the earth surface consist of electromagnetic waves ranging in length from about 0.3 to 10 microns. To the human eye , visible light lies in the range of 390 to 760 nm.

Ecologically , the quality of light (wave length), the intensity , and the duration (length of day) are known to be important. Both animals and plants are known to respond to different wave lengths of light. The growth ,migration, reproduction and diapause are affected by light in different insects , fish, birds , and mammals.

The relationship of intensity to photosynthesis in both land and aquatic plants follows the same general pattern of linear increase up to an optimum or light saturation level, followed in many instances by a decrease at very high intensities.

Light and animal navigation

Animal navigation is the ability of many animals to find their way accurately without maps or instruments. Birds such as the Arctic tern, insects such as the monarch butterfly and fish such as the salmon regularly migrate thousands of miles to and from their breeding grounds, and many other species navigate effectively over shorter distances.

In the 20th century, Karl von Frisch showed that honey bees can navigate by the sun, by the polarization pattern of the blue sky, and by the earth's magnetic field; of these, they rely on the sun when possible. William Tinsley Keeton showed that homing pigeons could similarly make use of a range of navigational cues, including the sun, earth's magnetic field, olfaction and vision.

Insects and birds are able to combine learned landmarks with sensed direction. Internal 'maps' are often formed using vision, but other senses including olfaction and echolocation may also be used.

The ability of wild animals to navigate may be adversely affected by products of human activity. For example, there is evidence that pesticides may interfere with bee navigation, and that lights may harm some species navigation.

Biological clocks

The major influence of light on animals is its role in timing daily and seasonal activities including feeding, food storage, reproduction, and migratory movements.

The internal mechanisms in organisms used to control the periodicity of various functions or activities are **biological clocks.**

An internal biological clock is fundamental to all living organisms,

influencing hormones that play a role in the sleep cycle, metabolic rate, and body temperature.

Biological processes fluctuate in cycles, or rhythms, that range from minutes or even to months. Biological processes that cycle in 24-hour intervals are called **daily rhythms**.

When a daily rhythm results from a physiological response to the diurnal environmental cycle, it is called a **circadian rhythm** (Latin *circa,* "about," and *dia,* "day"). Many autonomic processes of individual organisms exhibit a circadian rhythm, including the control of body temperature, melatonin (hormone related to the sleep–wake cycle) secretion, cortisol (primary stress hormone) secretion, and metabolism.

Circadian rhythms are believed to include at least three elements:

(1) *input pathway* that transmits environmental signals (light) to the clock,

(2) *pacemaker* (clock), and

(3) *output pathway* through which the pacemaker regulates the rhythms.

The input pathway to the pacemaker in mammals begins with photoreceptors in the eye. The retina of the eyes contains "classical" photoreceptors called photo-responsive cells. These cells, which contain a photosensitive pigment, follow a pathway leading to the pineal gland, a small organ shaped like a pine cone (hence its name) and located in the epithalamus region of the brain. The pineal gland provides the output pathway through the secretion of melatonin. Melatonin is a structurally simple hormone that communicates information about the light environment to

various parts of the body. Secretion of melatonin peaks at night and declines during the day. Ultimately, melatonin has the ability to entrain biological rhythms. The eye is the only photosensitive organ in mammals. In other vertebrates, such as birds and some lizards, the pineal gland is on the surface of the brain, directly under the skull.

Bioluminescence

Bioluminescence is the production and emission of light by a living organism. Bioluminescence occurs widely in marine vertebrates and invertebrates, as well as in some fungi, microorganisms including some bioluminescent bacteria and terrestrial invertebrates such as fireflies.

Bioluminescence is a form of chem-iluminescence where light energy is released by a chemical reaction. The light-emitting pigment luciferin and the enzyme luciferase. Luciferin reacts with oxygen to create light.

Biofluorescence, on the other hand, is not a chemical reaction. Biofluorescent organisms absorb light, transform it, and eject – or “re-emit” – it as a different color. When specialized fluorescent molecules are “excited” by high-energy light (like blue light), they lose a fragment of the light energy and release the rest at a lower-energy wavelength (like green). Most marine light-emission is in the blue and green light spectrum.

The most frequently encountered Bioluminescence organisms may be the dinoflagellates present in the surface layers of the sea, which are responsible for the sparkling phosphorescence sometimes seen at night in disturbed water.

A different effect is the thousands of square miles of the ocean which shine with the light produced by Bio-fluorescence bacteria, known as mareel or the milky seas effect.

Non-marine bioluminescence is less widely distributed, the two best-known cases being in fireflies and glow worms. Other invertebrates including insect larvae and annelids possess Bio-fluorescence abilities.

Bioluminescence used for defense against predators such as Dinoflagellates. They shine when they detect a predator. Also, Bioluminescence is used by a variety of animals to mimic other species. Many species of deep sea fish such as the anglerfish and dragon fish make use of mimicry to attract prey.