

Lecture: 2

ABIOTIC FACTORS:

These factors are also known as *physical factors*, *non-living factors* and *density independent factors*.

Various *physical* factors are: Temperature, Moisture & Humidity, Rainfall Light, Atmospheric Pressure, Air currents, Water and Place to live (niche).

TEMPERATURE:

Temperature affects **directly** on the dispersal, distribution, movement, development, metabolism, fecundity, reproduction and longevity of insect by keeping other parameters constant.

Also **indirectly** through influence on food availability (crops) and other environmental factors such as moisture, air movement etc.

Animals are generally divided into two types, Based on the maintenance of body temperatures

- ***Warm blooded (Endothermic)***: Animals maintain the body temperatures constant irrespective of atmospheric temperatures. Ex: Mammals, Birds.
- ***Cold blooded (Ectothermic)***: Animals change their body temperature when the atmospheric temperature changes. Ex: Insects *Sociohomeothermic* animals such as *honey bees* can be able to maintain their body temperatures slightly above the atmospheric temperatures, they maintain their own temperatures inside their colony irrespective of the temperature outside.

Temperature and Insect Development:

- The *optimum temperature for the normal development of insects is 10-35°C* and is known as Zone of Optimum or Normal Development.

The different temperature zones from low to high are:

Zone of Fatal Low Temperature (-14°C to -5°C).

Zone of Inactivity due to low Temperature (-5°C-10°C).

Zone of effective temperature (10°C-35°C)

Zone of Inactivity due to high Temperature (35°C-50°C)

Zone of fatal high Temperature (50-60°C)

Certain insects do not get freezes even the surrounding temperatures go below the freezing point (*cold hardiness/super cooling*). These insects have *Cryoprotective compounds* like **glycerol**, **sorbitol** and **erythritol** which help insects not forming ice crystals in haemolymph by depressing the freezing point. The freezing point of most insects is between (-10°C to -2°C).

Insects suspend their activities, and these are two types.

- **Hybernation** is the period of suspended activity in individuals occurring during seasonal low temperatures, while **Aestivation** is a period of suspended activity in individuals occurring during seasonal high temperatures or in dry season. This *reversible inactivity* can last for number of weeks during winter and summer, respectively. As soon as the temperature becomes moderate, these insects resume activity.

Temperature and Fecundity:

In insects, fecundity (egg laying ability) is maximum at moderately high temperatures and decline at both upper and lower limits of favorable temperature. *Aphids remain parthenogenetic under high temperatures* and many hours of sunshine, while the opposite condition gives rise to **oviparous** forms.

Temperature and Insect Distribution:

Tropical and sub-tropical conditions like in India are favorable for distribution and establishment of insects.

Mediterranean fruit fly *Ceratitis capitata* (Tephritidae-Diptera) could not establish in England and North Europe, because it cannot withstand temperature below 10°C.

Mosquitoes (Culicidae-Diptera) are abundant at 70-80°F (=10°C) but are rare at 100-113°F (30°C).

Temperature and Dispersal:

Insects tend to move away from unfavorable temperatures.

The rice weevil *Sitophilus oryzae* (Curculionidae: Coleoptera) found in the upper layers of storage bins, because the inner layers are warm and it cannot tolerate beyond 32°C and hence adults migrate to upper layers of the bins.

Desert locust *Schistocerca gregaria* (Acrididae: Orthoptera) start gathering in basking groups to gain warmth and they take flight only when the temperature near the ground is between 17-22°C and stop migrate when the temperature goes down to 14-16°C.

Adaptations to Temperatures (Acclimatization):

The effect of temperature on growth can be quite complicated. The reaction to a certain changed temperature depends on whether that change has been brought gradually or suddenly. By a gradual change, the insects become conditioned and that conditioning is called **acclimatization** or **acclimation**.

Various scientists suggests that the *rate of acclimatization is dependent on the duration for which they are conditioned*, and also depends upon whether the change in temperature is brought about suddenly or gradually. At high temperatures, locusts expose minimum body surface to sun rays by lying parallel to them (changes body angle) while they expose maximum body surface to sun rays at low temperatures laying at right angles to them.

Thermal Constant:

• *The total heat energy required to complete a certain stage of development in the life history of a species or in the completion of the physiological process is constant, and is termed as thermal constant and will be expressed in day/hour degrees.*

MOISTURE

In nature, insects are found under a wide range of moisture conditions from fresh water to the driest sun-dunes in deserts.

In aquatic animals, the dryness is expressed in terms of osmotic pressure of the water.

The truly terrestrial insects can live in dry places under varying conditions of moisture, *Collembola* live in very humid places where air is always saturated with moisture.

At the other extreme, the desert insects, which can survive in air containing less than 10% moisture.

Since food is the source practically for all insects, their feeding habits reflects adaptations to cope with conditions of excessive moisture or shortage of water, for example, aphids and bugs, ingest large quantities of plant sap and get rid of excessive water through excretion and also special arrangement in digestive system (filter chamber).

On the other hand, those living on dry foods such as grains do not get sufficient water. For example, *Ephestia* larvae could live in flour dried at 30°C. This led to discovery that these insects could retain body water through metabolism. Of various forms of water, the vapor form plays important role in life of terrestrial organisms.

A certain amount of atmospheric humidity is essential for controlling the loss of water from body. If the humidity is low, the animals die from desiccation at high temperature, and if the humidity is too high, it may harm in many ways, including the development of fungi and bacteria epizootics.

Water is essential constituent of protoplasm, i.e. life, though the actual quantities vary in different insects. For example in *Tribolium*, *Sitophilus*, *Trogoderma* and *Callosobruchus*, which are pests of stored grains; water constitutes 50% of their body weight. However, bodies of most of insects contain 80-90% water and larvae of certain dipteran that live in moist surroundings contain up to 98% water. The phytophagous insects live on food that has plenty of water and it is taken up by the insect as such adaptations to conserve water in body.

Adaptations to conserve water in body

- Morphological adaptations include:
 - 1- Body pigmentation
 - 2- Integument
 - 3- Pilosity / hairiness
 - 4- Winglessness
 - 5- Form of the body
 - 6- Other characters
- Biological adaptations
- Physiological adaptations