

EFFECTS OF TEMPERATURE

(i) Effect of Temperature on Metabolism

Chemical reactions inside the body of an organism are directly or indirectly influenced by enzymes, which are in turn influenced by temperature. The normal enzymes of an organism are adjusted to operate best at temperatures in the range from 28°C to just over 30°C and they are most effective and last for a long time. The enzymes are highly sensitive to temperature changes. Increase in metabolism beyond 48°C brings about retardation in the activity of the enzymes. Therefore there is reduction in the rate of metabolism dependent upon this enzyme. Thus metabolic processes are influenced by temperature and increase with it up to a maximum and suddenly decline at the upper lethal temperature. Low temperature gradually slow down chemical reactions or finally bringing them to a halt. The halting of any chemical reactions is sufficient to cause death.

(11) Effect of Temperature on Growth

Temperature affects the growth rate in various animals and plants. Birds and ~~and~~ mammals of the same species attain a greater body size in colder regions. Cold blooded amphibians and reptiles are smaller in colder climates than among closely related species which inhabit the warmer regions. This is known as Bergmann's principle. The related observations that extremities such as tail, ears and legs of mammals are shorter in colder climates has been delineated as Allen's rule. This rule is ~~is~~ very clearly taken from the difference in the size of ears of arctic fox, red fox and desert fox. The races of birds inhabiting colder region develop relatively narrower and more acuminate wings than those in warmer climates (Rensch's rule).

Fishes inhabiting water of low temperature tend to have more vertebrae than those of warmer water. It has been observed that cold forms of many species are frequently larger than the individuals of warmer water. This is the Jordan's rule.

Extremely low and high temperature both have adverse effect on the

growth of plants. Low temperatures bring about cold injuries such as freezing injury or chilling injury. Extreme high temperatures cause stunting and death of plants. This is called heat injury.

(iii) Effect of Temperature on Colouration

The colouration of animals is subject to the influence of temperature. Insects, birds and mammals bear darker pigmentation in warm humid climates. This phenomenon is called the Gloger's rule. The walking stick Carausius turns black at 15°C and brown at 25°C . Some crustaceans like prawn turn light coloured with increasing temperature. In horned toad the Phrynosoma and tree frog Hyla at low temperatures have been known to induce dark pigmentation.

(iv) Effect of Temperature on Size of Population.

Even very slight temperature differences can have very large effects. Species of which most individuals cannot reach maturity during a normal year, and their number decreases from year to year, until eventually one of the rare

Page |

very warm summer makes it possible for all the individuals to complete development. Now the size of the population leaps suddenly from very small to very large, so that the species can persist during the following normal years.

(vi) Effect of Temperature on Sex Ratio

In many cases the environmental temperature determines the sex ratio of the species. In the case of Macrocyclops edulis a copepod, the sex ratio is found to be temperature dependent: The number of male organisms significantly increases with the rise of temperature. Similarly at the mean temperature of about $21-25^{\circ}\text{C}$ the males of plague flea the Xenopsylla cheopis increases. The position may be reversed on more cooler days. Anastatus colemani which parasitises the eggs of the pentatomid bug Placosternum dama could develop inside the host eggs at 33°C and at temperature of $29-31^{\circ}\text{C}$ male predominated. Under normal conditions of temperature the daphnids produce parthenogenetic eggs that develop into females whereas with increase in temperature they produce sexual eggs which after fertilization develop either into males or females.

(vi) Effect of Temperature on Reproduction

The temperature has a very significant role in the maturation of gonads and in formation of male and female gametes and their liberation. Reproduction ability is maximum in the tropical areas, and less in the colder areas. Most of the species breed during summer (April to June), some in winter and few breed uniformly throughout the year. Fecundity is the reproductive capacity of animals, is also affected. In Calliphora vicina the blow fly, the number of eggs laid increases with increase in temperature upto 32.5°C . In Plutella maculipennis the number of eggs laid by a moth during its life time is influenced by the temperature at which the caterpillar was reared and the temperature at which the moth was reared. At 15°C more eggs were produced than at 22°C . In Chrotogonus trachypterus, the females become sexually mature at $30^{\circ}\text{C} - 35^{\circ}\text{C}$ and lay highest number of eggs at 30°C . The number of eggs decreases when the temperature rises from 30°C to 35°C . In Melanoplus sanguinipes and Comnula pellucida the production of eggs at 32°C is 20 to 30 times more than those produced at 22°C .

(vii) Effect of Temperature on Development.

For development the time required at various temperature is also an important feature in animals and plants. The dragon fly Tetragoneuria is so regulated by the temperature that at one ~~time~~ time it takes 2 yrs to complete the development and at the another only one year. The entire development of forest ground beetle Plerostichus oblongopunctatus from egg to mature beetle at 15°C takes about 82 days but it takes only 46 days at 25°C . In P angustatus the period is reduced from 96 to 36 days at the same temperature. The development of larvae in Chilo ~~donnellus~~ donnellus the sorghum borer takes 16 hrs at 15°C and 8 hrs at 30°C . In sugar cane borer Chilo infuscatellus the larval period extends over 16-24 days in summer and 147-171 days in water. In blow fly Calliphora sericata, the incubation period decreases with increase in temperature.

(viii) Effect of Temperature on Crossing Over

In Drosophila the temperature may affect the crossing and somatic expression of gene characters. Mutations also occur under certain temperature. The development

of wings, eyes and other characters may be influenced by keeping Drosophila larvae or pupae at high or low temperatures.

(1a) Effect of Temperature on Animal Behaviour

Temperature generally influences the behavioural pattern of animals. Certain animals show positive response to one stimulus at a given temperature and negative to the same stimulus at a different temperature. In the tropics, much wider changes in temperature are not encountered, different wood ~~bore~~ borers have been known to react differently to different environment. In Bankia courpocrenulate the intensity of attack is maximum during the winter months. The advantage gained through the motaxis towards a source of heat bestows the rattle snake with an un-nerving accuracy for striking at its prey, even in complete darkness. The arrival of cold weather in temperate zones causes the snakes to coil up and huddle together.

(X) Effect of Temperature on Cyclomorphosis

In some plankters the body form changes with the season of the year. This phenomenon known as cyclomorphosis is exhibited by the increased size of the 'helmet' and length of spines in certain cladocera like Daphnia during warm months. These changes produce increase in body surface and were originally believed to be an adaptation aiding floatation since the buoyancy of water becomes reduced as the temperature increases.

(XII) Effect of Temperature on Plants

Both extremely low and high temperature have adverse effect on the growth of plants. Low temperatures being about such cold injuries as desiccation, chilling injury and freezing injury. In ~~desiccation~~ desiccation, tissues are dehydrated and injured due to rapid transpiration and slow absorption during winter. Chilling injury is the killing or injury of plants of hot climate when exposed to low temperatures for some time. In some plants of temperate climates, if exposed to low temperatures water is frozen into ice crystals

in the intercellular spaces causing injury to cells. This is known as freezing injury. Some perennials can tolerate extremely low temperatures and this ability is called cold resistance. Extremely high temperatures cause stunting and final death of plants, which is due to adverse effects on a number of physiological processes as ~~res~~ respiration, transpiration, protein metabolism etc. This is called heat injury.

(xii) Effect of Temperature in Distribution

Temperature acts as a limiting factor in the distribution of animals. As each species has a definite range of temperature tolerance beyond which the activities will not be normal. Thus the favourable temperature range for any particular species is determined by the prevailing temperature at which normal physiological activities of the organism take place. Coral reefs require a minimum temperature of 21°C for their existence. They flourish in the ~~warm~~ warm waters of the tropics and subtropics. They are completely absent in colder regions. Pecten greenlandicus found in a Greenland

is never found above 0°C . Rotifers appear or in the ponds when the temperature is below 24°C and disappear when it rises above 24°C . Spotted Salvelinus fontinalis prefers 14°C to 19°C , and thus cannot tolerate a temperature above 25°C . The desert animals on the other hand are able to withstand very high temperature.

The effect of temperature in distribution of plants has been widely studied. On the basis of temperature conditions the world's vegetation can be divided into four classes.

1. Megatherms: Where high temperatures prevail throughout the year and dominant vegetation is tropical rain forest.
2. Mesotherms: With high temperature alternating with low temperature, and dominant vegetation is tropical deciduous forest.
3. Microtherms: Where low temperatures prevail and vegetation is of mixed coniferous forests type.
4. Heterotherms: With very low

temperature and alpine vegetation being dominant.

There are probably a few places on the surface of the earth that are either too hot or too cold for some plants to grow. Temperature is the most important factor in determining the general distribution of vegetation but its effect is much greater upon the flora than upon the kind of vegetation. Grassland, forest and desert are not related to the forest temperature but the flora of a region is determined by it. This is Schimper's 1st law with reference to the forest zones of the Western Himalayas which are covered successively with deciduous coniferous ~~of~~ elfin scrub, herbs, lichens and mosses as one ascends the mountain. Temperature is also the most important factor in determining the distribution of crop plants.

Hibernation and Aestivation

Some animals pass winter in dormant state and this phenomenon is known as hibernation. It is a characteristic feature of poikilothermic animals e.g. plants, fishes, amphibians and reptiles as well as some homiothermic animals.

e.g. Myotis chinophilus, Plectus macratus hedge-hog, and ground squirrels etc. It is an special adaptation for some of the animals to tide over the unfavourable cool conditions. During this phase, the body temperature is low, and metabolic rate is reduced. On return of favourable conditions, these animals come out of sleep and return to their normal active life.

Dormancy of animals in summer, when the temperature is high is called aestivation. During summer the temperature rises, the days increase and there is shortage of food. This phenomenon is very common among insects, some invertebrates, lung-fishes, amphibians, mammals and plants. In insects aestivation occurs in the form of diapause and in lung fishes, Protopterus burrows in mud and secretes cocoon around itself during summers. During this period, the animals cease the growth development, feeding and the usual metabolic rate decreases.

Questions.

1. Write the effects of temperature on various organisms.
2. Short notes of effects of temp on plants.