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Effect of Factor of Aquatic Environment on Aquatic Organisms

The aquatic environment is subject to water movements ranging from small vertical circulations to strong currents. The streams have a unidirectional movement and in seas the movement is reversible. Many aquatic animals have accordingly taken to sedentary or sessile lives depending on water movements. Radial symmetry is a characteristic of such animals.

Transformation from a sessile to a locomotive existence favors a bilateral symmetry. The currents of water often abrade (= rub off) the inhabiting flora and fauna and varied modifications are encountered to withstand this abrasive action. Thick scales, strong shells and many attachment devices such as the holdfasts and suckers all are the results of this environmental stress. The ability to breathe air dissolved in water, at times even resorting to anaerobic existence, the modification of various senses to respond to stimuli characteristic of aquatic environments, the phenomenon of osmoregulation, and above all the phenomenon of external fertilization are other remarkable physiological adaptations to live in an exclusively aquatic medium.

Water and Ecological Adaptations

Water makes up a large proportion of the bodies of plants and animals, whether they live on land or in water. Active cytoplasm holds about 70-90 per cent of water. It has several important physiological properties. There exists a strong relationship between the water status of soil, plant and atmosphere. The rooting zone of the soil (zone of soil in which the water absorbing organs, roots, root hairs are present), the plant body and the lower layer of atmosphere behave as a continuum, called **SPAC** or **soil plant atmosphere continuum** in relation to water transfer. Solar radiation is the primary energy source for the water transport process in the SPAC. On the other hand, animals obtain water: i. By drinking, ii. By absorbing it through their skin from contact with some damp ground, iii. Directly from their food or iv. From water produced by metabolism.

The scarcity or abundance of water brings about adaptations in living organisms. Plants which grow in areas where Water is available in plenty, are classified as mesophytes and terrestrial animals living under such conditions are called mesocoles. Plants growing in water are called hydrophytes, while animals that live in the aquatic environment are called aquatic animals or hydrocoles. Some plants can grow in ecosystems where water is scarce and where the day temperature is very high. These plants are called xerophytes and the animals living in such xeric conditions are called desert animals or xerocoles. Xerophytes living in physiologically dry soils, i.e. saline soils with high concentrations of salts such as NaCl, MgCl and $MgSO_4$ are called halophytes. Helophilous helophytes include mangroves of sea shores of *Bombay such as Rhizophora mucronata and Sonneratia*.

I. Hydrophytes and hydrocoles and their adaptations. Hydrophytes include:

(a) Free floating hydrophytes (e.g., *Wolffia, Lemna, Spirodella, Azolla, Eichhornia crassipes, Salvinia and Pistia).*

(b) Rooted hydrophytes with floating leaves (e.g. *Trapa, Nelumbo, Nymphaea).*

(c) Submerged floating hydrophytes (e.g., *Ceratophyllm, Utricularia,* Najas.

(d) Rooted submerged hydrophytes (e.g., *Hydrilla, Chara,* Vallisneria, etc.),

(e) Rooted emergent hydrophytes or amphibious plants *(e.g., Sagittaria, Ranunculus,* etc.). Tenagophytes are amphibious plants—they grow in water bodies as well as in water logged soil.

The hydrophytes grow in hydric conditions and show the following general adaptive features. They possess poor mechanical, absorbing, conductive and protective tissues. They also contain an extensive development of air spaces (aerenchyma) in the tissues. Roots are either absent (e.g., *Wolffia*) or poorly developed (e.g., *Hydrilla*). Roots may not have root hairs, root cap (instead of root cap *Eichhornia* has root pockets) and vascular tissue. Roots of hydrophytes are generally fibrous and adventitious, when present. The stem of hydrophytes is weak, slender and spongy. In some it is like a horizontal rhizome covered with mucilage, while it may be hard, as in *Nelumbo*. The aerial, leaves may be broad but the submerged leaves are thin long or ribbon shaped. Stomata are completely absent in submerged leaves (e.g., *Anacharis*), but in floating forms, stomata are confined only to the upper surfaces of leaves as in *Nymphaea*.

II. Xerophytes and xerocoles and their adaptations. Xerophytes grow in conditions of water scarcity, high temperature, strong winds, high transpiration rate and evaporation higher than precipitation. The soil is very dry and porous. The essential adaptations of Xerophytes involve increased water absorption by roots, storing of water and retardation of transpiration. Thus, in search of water, roots of xerophytic trees may go very deep in the soil and have extensive root hairs to absorb it. The roots of plants such as *Calotropis procera*, *Ficus*, and *Acacia nilotica* may go as deep as 10 to 16 meters and may reach the water table. As a consequence, these plants survive in deserts or arid conditions even if their rate of transpiration is higher. The storage of water is facilitated either by modifications of leaves, as in Mesembryanthemum and in the malacophyllous xerophytes (in which leaves contain turgescent parenchymatous cells) as *Aloe, Begonia, Bryophyllum, Agave, Yucca*, etc., or modification of stems, as in cacti such as *Opuntia* (phylloclade) and Euphorbia. In some xerophytes the water is stored in their roots as in Asparagus and Ceiba parvifolia. All these xerophytes are called succulents because they possess thick; fleshy, water storage organs such as stems, leaves and roots. Non-succulent xerophytes such as *Calotropis*, *Prosopis, Acacia, Zizyphus, Casuarina, Nerium, Saccharum and Pinus* possess other sort of xerophytic adaptations, viz., extensive root system, high osmotic pressure and other modifications in the leaves. Reduced transpiration is achieved by decreasing the leaf surface, as in *Casurina, Acacia* and *Asparagus* or by modifying the leaves into spines and barbed bristles, as in cacti, or by having thick, leathery, thick cuticle or wax-coat bearing leaves with well-developed hypoderma and sunken stomata to reduce transpiration, as in *Calotropis* and *Nerium.* Halophytes (e.g., mangroves) resemble xerophytes and have high osmotic pressure; succulent organs; thin, evergreen, small leathery leaves with water storing tissues and thick cuticles and special air-breathing roots called pneumatophores.

Different animals have evolved the following adaptive features to live in arid environment:

1. Nocturnal life style. Most desert animals are nocturnal and seek shade or burrow deep n the soil in the daytime to avoid excessive heat and dryness. Some xerocole rodents passively use heat through conduction by pressing their bodies against the burrow walls.

2. Deceptive coloration. Desert animals are usually grey, brown or red matching with the color of the sand or rock.

3. Suspended animation. Certain animals, usually with simpler organization, such as rotifers, nematodes, desert snails, etc., retain their vitality in long dry environment. Other forms (frogs, toads, etc.) aestivate during droughts and are active during moist season of the year.

4. Fast movement. Desert animals move much faster than other land animals, since they have to travel long distances in search of food and water.

5. Migration. Many birds and mammals of arid zones migrate when water becomes scarce or as a result of drought or for other reasons, the food supply is less.

6. Heat loss by radiation. Animals such as jack-rabbits (*Lepus*) and fox (*Vulpes velox*) have large ears that reduce the need of water evaporation to regulate the body temperature. Their ears function as efficient radiators to the cooler desert sky, which on clear days may have a radiation temperature 25°C below than that of the animal body. By seeking shade and sitting in depressions, Lepus could radiate 5 kcal/ day through its two large ears (400 cm^2).

7. Impervious skin. The drier habitats (deserts, etc., are invaded by only those animals high contain a thick impermeable body covering. Such integuments occur in many insects, birds and mammals. Some mammals such as human beings, apes and horses lose much water (and salt) through sweat glands in heat regulation. Most rodents and some ruminants such as antelope nearly or completely lack sweat glands. Moist skinned forms (most amphibians and earthworms), certain mites and soft-bodied insects are restricted to swamps, stream margins, moist soils and other similarly damp places.

8. Upturned nostrils. Desert animals have nostrils directed upwards; this may provide a protection from clogging by wind blown sand.

9. Water from food and from metabolism. Most herbivores and carnivores (frog, toad, lizards and snakes) live on the moisture obtained with food. Many insects utilize the high water contents of plants to meet their water requirements. In fact, most animals make use of water released during metabolism when fats and carbohydrates are broken.

10. Internal lungs or tracheal system. Mode of respiration has some correlation with water. Crustaceans, with their gills covered by a water-retaining carapace, carry with them a liquid environment for their gills. The scaly body covering of a fish may be practically impermeable to water and exchange of gases may be limited to gills and gut. Internal lungs, whether in pulmonate snails, land isopods, spiders or higher vertebrates (amphibians, reptiles, birds and mammals) together with the internal tracheal system of insects are water saving. Much water is lost in breathing even in animals having internal lungs.

11. Dry excretion. A further water-saving device is the excretion of concentrated, relatively dry nitrogenous and faecal waste materials (e.g., cow, donkey). Water saving insects, reptiles and birds excrete nitrogenous waste as solid uric acid.

B. TEMPERATURE

Temperature is one of the essential and changeable environmental factors. It penetrates into every region of the biosphere and greatly influences all forms of life by exerting its action through increasing or decreasing some of the vital activities of organism, such as behaviour, metabolism, reproduction, ontogenetic development (viz., embryogenesis and blastogenesis) and death. Temperature is a universal influence and is frequently a limiting factor for the growth is distribution of animals and plants. Normal life activities go on smoothly at a specific temperature or at a specific range of temperatures. This is called the optimum temperature or the optimum range of temperature. Organisms react to any rise or fall of the optimum temperature angel and biotic communities more often encounter alterations only due to extremes of temperature (*viz*., minimum or maximum temperatures). The interaction of temperature with certain other abiotic environmental factors such as humidity, etc., cause into many other climatic changes which influence the living organisms in one way or another.

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