Influence of Environmental factors on Marine Habitat

The sea covers about 70% of the earth's surface and is a great reservoir of life. Among the three major habitats of the biosphere, marine realm provides the largest inhabitable space for living organisms. The study of organisms in relation to oceanic environment is known as marine ecology. The factors affecting the marine habitat are enlisted as follows:-

Temperature

Ocean is the largest store house of the sun's heat and it occupies much space. This stored heat of the ocean is able to regulate the temperature of the world. The extremes of temperature range from – 3 to 40º C, while in the Indian seas the temperature ranges between 18 to 25º C at the surface. Seasonal variations of temperature in tropical waters are not much. There is always a direct stratification in sea and the temperature of the bottom water of the deep sea may be about – 1º C. The density of the sea water increases with decrease in temperature. Similarly the solubility of oxygen also increases generally with a lowering of temperature.

Seawater temperature affects marine organisms by changing the reaction rates within their cell(s). Although each species has a specific range of temperature at which it can live, the warmer the water gets the faster the reactions and the cooler the water the slower the reactions. An organism's response to water temperature is considered to be cold blooded (or poikilothermic) or warm blooded (homiothermic) depending on their ability to control their internal body temperature. If any species is moved out of its temperature tolerance range, it may die in a short time although temperatures on the cool side of the range are easier for organisms to tolerate than temperatures on the warm side because cell reactions just slow down in the cold but may speed up over six times the normal levels for each 10º C of heat.

Cold blooded (poikilothermic) marine organisms lack any body temperature regulatory controls. These include marine plants, invertebrates, most fish and marine reptiles. These species each have their specific temperature tolerance range within which they must live (some are adapted to polar temperatures, some to tropical temperatures). Some have a narrow range (and are thus very restricted) and some have a wide range (and are thus less restricted).

Warm blooded (homiothermic) marine organisms have some type of internal temperature controls to maintain a constant body temperature. These organisms include a few fish, all sea birds and mammals. This ability allows these warm blooded marine species to migrate over vast distances through various temperatures without problems and include some of the animals on Earth with the longest migrations.

Marine animals show a varied response to temperature. The stenothermal animals like reef corals, salps and heteropods are always found around 20º C. Eurythermal animals like Cardium and Arenicola are able to withstand wide ranges of temperature. Temperature difference in the sea though not very conspicuous yet acts as effective barrier for the distribution of animals.

Marine animals present certain structural variations in relation to temperature. The number of vertebrae in fishes of colder regions is more. The fish species of flounders have 35 vertebrae in the warmer regions while in the colder regions they may have up to 50. The cold water forms also show an increase in size. This is because it takes a longer time for the cold water forms to attain sexual maturity and thus they get a chance to grow till then. There are however a few exceptions to this rule. The sea urchin, Echinus esculentus, and the gastropod Urofolpinx cinerea, show a larger maximum size in warmer waters.

There is also an increase in respiratory rates in many marine organisms. In Mytilus edulis , the respiratory rate increases with temperature up to the optimum limit and then it slowly decreases. A similar behaviour is found in Calanus finmarchicus and Emerita sp.

Salinity

The salinity of the open ocean at about 300 metres depth is about 3.5%. There is a slight variation in salinity in some seas, as in the Mediterranean where it is 3.9% while in the red sea it is 4.6%. The salinity of the sea is due to the two elements sodium and chlorine which account for 80% of the salts of the sea. The composition of chemicals contributing to seawater salinity is given in the following table.

In the sea water, cations and anions are not balanced against each other. As a result, sea water is weakly alkaline (pH 8 to 8.3) and strongly buffered. This factor possesses much biological importance. The various salts of the sea are indispensable to the marine life. Animals absorb and utilize many substances like Ca, Na, K, Mg, S, C l etc. They also use many inorganic materials like Na, Mg, Ca, and silicic acid to build their bodies. A few animals even use and store rare elements. Strontium sulphate is utilized by some radiolarians. Bromine and iodine is stored by horny corals and vanadium is used by ascidians.

An increase or decrease of salinity brings about changes in the specific gravity of the sea water. All marine animals are affected by changes in specific gravity. Only some animals like the teleostean fishes have the swim bladders which are used for hydrostatic control. Animals with hard skeletal materials of calcium and silicon face the problem of sinking. These animals however have various adaptations developed to keep themselves afloat, which include reduction of calcium contents by having perforations in the shell of foramnifers and thin shell in radiolarians. Some pelagic molluscs have thin and uncalcified shells, which aids in floatation.

Osmotic properties of the seawater present another problem to some of the marine animals. Most of the marine animals are isotonic with seawater and when they come across any change in salinity, they are put to much difficulty. The stenohaline animals have a restricted distribution. These animals are usually found in the open oceans far away from estuaries and below the level of tidal variation and only a few metres below the surface.

Euryhaline animals include the coastal forms found between tide levels. Arenicola, Mytilus, Sagitta and Oikopleura are some good examples. Some animals like the shore crab, Carcinus, can tolerate lower salinity at higher temperature. The younger organisms have lesser tolerance for lower salinity than their adults.

Salinity has a profound effect on the respiratory activities of marine animals. The respiratory rates increase with a reduction in salinity. The animals spend much of their energy in osmoregulation, when salinity falls and this leads to a higher rate of oxygen consumption and higher respiratory rates. The highest respiratory rates are found in estuarine forms like Hydrobia, Carophium and Pygospio.

More calcium carbonate is deposited in the skeleton of molluscs, crustaceans and other animals living in the water with a high salinity content. The molluscs found living in lower salinity have thinner shells. Animals can tolerate lower salinity when the temperature is high.

Nutirents

The concentration of phosphates and nitrates, which are the two major plant nutrients, has been recogised as one of the major factors limiting primary production in aquatic systems. It is known that during photosynthesis phytoplankton absorb these nutrients for the formation of particulate organic matter. Due to this absorption, the concentration of the nutrients in the euphotic zone decreases and this naturally limits further organic production. A certain amount of nutrients utilized by phytoplankton are however, regenerated by bacterial activity within the euphotic zone itself. But a good amount is lost from the euphotic zone as a result of the sinking of phytoplankton as well as through consumption by zooplankton inhabiting deeper levels during day time. Thus, much of the nutrients absorb from the euphotic layer are transferred to the deeper zones of the aquatic systems (marine or lakes), where they are regenerated. The nutrients that accumulate in the deeper levels, particularly in the oceans, are mostly returned to the surface waters by vertical mixing process such as upwelling, eddy diffusion, vertical convection and wind mixing. In addition to this, land drainage and river influx also contribute to the replenishment of nutrients of the surface waters, at least of the coastal areas.

Seasonal and regional variations of primary production are often attributed to the influence of these plant nutrients. The cycle of phytoplankton in temperate latitudes, with marked peak in spring and decrease in production during summer, has been correlated with the changes in nutrient levels. During winter, owing to vertical mixing, the euphotic zone is enriched with nutrients which result in high productivity during spring. On the other hand, in summer, owing to the increase in temperature and the consequent formation of the thermocline, the nutrient replenishment in the euphotic zone by vertical mixing is prevented and this results in the decrease of production.

In the tropical waters, a permanent thermocline is present throughout the year and consequently, replenishment of nutrients by normal mixing process does not take place. Thus, short supply of nutrients in the tropical waters seems to impose a restriction on the rate of primary production. The high productivity recorded in the waters of the south-west coast of India, especially during the south-west monsoon period, has been correlated with the upwellings in this region, which bring about high nutrient concentration in the surface waters. However, the individual species requirements for phosphates and nitrates are not fully known.