the marine environment

IN recent years, pollution of marine environment by heavy metals has become a national and international problem. The current alarm about metal pollution in the sea however started with the tragedy of 'Minimata' disease caused by the consumption of mercury-contaminated shellfish and fin fish taken from Minimata Bay in Japan. Then there was 'Itai itai' disease caused by the consumption of foods contaminated by cadmium from Niigata in Japan.

The term heavy metal is a loose one. It includes transition metals like chromium, cobalt, nickel, copper, zinc, cadmium, mercury, lead, arsenic, antimony and bismuth. Of these, the most toxic metallic pollutants are mercury, lead, zinc and copper. Heavy metals occur naturally in the marine environment. In addition, these heavy metals enter the aquatic systems by direct discharges via industrial and urban effluents, surface run off and indirectly from aerial fallout.

In India, use of heavy metal fungicides in agriculture is increasing as seed-dressing agents. Antifouling properties of mercury compounds are yet used in pulp mills, industrial and domestic sewage wastes from various sources are now a threat to the survival of fishes and other organisms. The common feature of these metals is that they are all relatively toxic even at fairly low concentrations and are readily concentrated by aquatic organisms and plants. The seriousness of heavy metal contamination is further compounded by the fact that they are generally water-soluble, non-degradable, vigorous oxidizing agents and are strongly bonded to many biochemicals inhibiting their functions.

Certain metals are essential to normal growth and development of organisms, but some are toxic. An element can be regarded as essential only (i) if the organism can neither grow nor complete its life cycle in the absence of the element, (ii) if the element cannot be replaced by any other element, and (iii) if the element exerts a direct influence on organism and its metabolism. Similarly, an element can be regarded as toxic if that element injures growth or metabolism of an organism when supplied above a certain concentration. In fact, all metals are toxic at high concentrations but some are highly toxic even at lower concentrations. Elements like copper, mercury, lead, cadmium, zinc and chromium are very toxic. Except copper and zinc, others are non-essential and toxic. Because certain metals are required in life processes, most organisms have a capability of concentrating them. Capability is enhanced by some feeding and metabolic processes which can lead to enormously high concentrations. Invertebrates appear to have a particularly high capability for concentrating metals

along with other foreign materials found in their environment when they filter plankton during feeding. Fishes apparently can accumulate metals either directly from sea water or indirectly through food chain. Because of the ability of many metals to form complexes with organic substances, they have a tendency to be fixed in the tissue and not to be excreted. In other words, they have a large biological half-time. This is perhaps one of the major problems that metals pose with respect to their effects on aquatic organisms.

It has been known for many years that concentration of heavy metals is significantly higher in marine biosphere. Today, additional quantities of heavy metals are being added to estuarine and coastal regions from agricultural and industrial waters, hospitals, domestic sewage and from the polluted atmosphere. At sufficiently high concentrations, heavy metals are toxic to marine and estuarine organisms and to their consumers at higher trophic levels including man. Recently Qasim and Gupta (1980), while reviewing the existing knowledge on the incidence and implication of heavy metal toxicants in fishes of the Indian ocean, have emphasized the importance of carrying out studies on bioaccumulation of heavy metals in various tissues of fishes inhabiting the open sea, coastal areas and estuaries.

Many marine fishes and shell fish have got the capacity to concentrate trace metals in their tissues to much higher levels than they are in other organisms and also they concentrate them several hundred times more than the concentration of metals in sea water. Bioassay studies are also required on food organisms of commercially valuable species. If concentrations of metals are not high enough to kill the fish, but are high enough to destroy the organisms on which the fish feeds, there will be substantial damage to fishery. Hence, toxicity of a metal and its effects on organisms will depend upon (a) the chemical form of metal, (b) presence of other metals, (c) physiological status of organisms, and, (d) environmental physico-chemical parameters like salinity, temperature, dissolved oxygen and the pH of water. Entry of heavy metals into organisms depends upon the rate of absorption of a metal by animals which is affected by factors like salinity, pH , presence of other metals, complexing agents, temperature, size difference, maturity and starvation of the animal. The environmental parameters of waters effect toxicity of the metal either by influencing physiology of organisms or by altering chemical form of the metal in water. In general, metals are less toxic at lower temperatures and high salinity than at high temperatures and lower salinity. Toxicity of a metal is also dependent upon residence time of metals concerned. Generally, most metals have a long residence time and hence exert their toxic effect over a long time.

Most metallic elements occur naturally in estuarine environments, and are classified as pollutants only when added by man in quantities sufficient to produce deleterious effects. In the natural environment, organisms are exposed chronically to sublethal concentrations of several contaminants simultaneously, and concentrations of metals present within the organisms result from the relative rates of metal accumulation and turnover. These rates vary among species and also with the concentration and physicochemical form of the metal. Assessment of potential effects of metal contaminants on estuarine organisms must consider organismic response not only to levels of metals in the environment, but also the contained metals. Furthermore, both the cycling of a particular metal and its toxicity characteristics may depend upon the physicochemical form of the metal introduced into the system. An understanding of the potential physiological effects resulting from contaminative metal additions to estuarine environments therefore requires knowledge of the complex physical and biological processes that control distribution and turn over of metals in the component organisms and in the entire ecosystem.

With the growing interest in pollution of marine environment, many countries are conducting monitoring studies on metals in both seawater and marine organisms. Invertebrates are considered excellent indicator organisms because of their ability in concentrating metals, among other pollutants. Besides measuring concentrations of these metals in aquatic organisms, there is a need to study effects of concentrated metals on organisms and on ecosystem. This will require careful evaluation of effects of metals on various trophic levels in marine ecosystem and movement of metals through food web.

The effects of heavy metals on aquatic organisms can be divided into (a) direct effects and (b) indirect effects. The latter is effected through the effect on food chain organisms and ecological stress. The direct effects are seen in behaviour, migration, physiology, metabolism, reproduction, development and growth of aquatic animals.

Conclusion

The real problem today is not whether heavy metals are toxic or not, since we know that they are : but what concentrations are permissible/safe levels in our waters which do not produce harmful effects on users of water and fish from the waters. Although much work has been done on heavy metal pollutants, there is still a great need for information on normal responses and functions of organisms, to assess influences of metals and their toxicities fully. It is impossible to prevent pollution of environment totally

but metal pollution and toxicity could be minimized by certain precautionary measures like development of adequate environmental control and management. Continuous monitoring of our environment and food products from these waters must be built up.

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