1.

**GENERAL INTRODUCTION**

To-day the cry of pollution is heard from all the nooks and corners of the globe and pollution has become a major threat to the very existence of mankind on this earth. It is now becoming an intellectually challenging problem of mankind on this earth. The pollution of various resources has gone to such an extent that human beings are unable to breath fresh air and drink clean water. It is not far off that a drop of water will be much costlier than a drop of oil. Water, like air is one of the most important natural resources of man without which life cannot exist. In India inspite of fairly good rainfall in many parts of the country, the stream flow in many areas are inadequate for continuous use throughout the year. Besides, domestic, agricultural and industrial uses, water sources have been used for fishing, navigation etc. (Trivedi, 1984).

Pollution of aquatic environment originates from atmospheric input, land run off and seepage through land as in the case of ground water. A wide variety of pollutants namely, physical, chemical, biological and radiological have been identified as detrimental to human health and they can affect other living organisms in the ecosystems. Pollutants like radionuclides, pesticides, heavy metals, hydro-carbons are generated exclusively by man and so they are called
anthropogenic substances. These substances when present in high concentration become toxic to the ecosystems (Pillai, 1985).

Industrial processes involving the use of water are invariably, the essential source of pollution of metals. Fossil fuel combustion and cement production contributes to significant mobilization of metals. Electroplating processes and thermal power station also generate large volumes of liquid waste containing metals. Domestic sewage is yet another source in the urban regions of riverine system. The use of metal containing pesticides in agriculture and leaded petrol in motor vehicles results in atmospheric pollution by mercury and lead, respectively. The fertilizers, fungicides and sludges release copper, zinc and cadmium. Oil and coal particularly from some localities contain significant quantities of heavy metal. Oil is rich in vanadium, nickel, molybdenum and mercury (Nair, 1984).

The elements with atomic number greater than 20 are termed heavy metals excluding alkali metals, alkaline earth elements, lanthanides and actinides (Kopp and Kroner, 1972, Wolfe and Rice, 1972). Of all the elements present on the earth’s crust H, C, N, O, Na, Mg, P, S, Cl and K constitute 99.9% of all living matter. In addition 14 elements viz B, F, Si, V, Cr, Mn, Zn, Fe, Co, Cu, Se, Mo, Sn and I are the
essential trace elements including many heavy metals. Rest of the elements including heavy metals such as Hg, Pb, Cd, As, Cr not essential for the growth and development of organism or their function in biological systems have not been established (Brooks, 1978).

The essential heavy metals have a specific role to play in living systems. For example cobalt is a constituent of vitamin B12 and selenium is a substitute for vitamin E. Boron is known to be essential to green algae and angiosperm (Brooks, 1978). Essential elements generally exist in combination with organic molecules either as metalloproteins or as metaprotein complexes. Common examples of metalloprotein are Fe containing haemoglobin and Cu containing haemocyanin. Zinc is a constituent of many metalloprotein enzymes like carbonic anhydrase and carboxy peptidase. Enzyme xanthine oxidase contains Fe and Cu (Vallee and Wacker, 1970). Some of the metals such as Hg, Pb, Cd, As, Cr, Zn, Cu, Mn and Fe, when present in aquatic environment above certain levels may constitute contamination.

The seriousness of this heavy metal contamination was felt for the first time during the out break of "Minamata disease" (Irukayama, 1967), a direct result of eating mercury contaminated shell fish. Following this, several
diseases caused by the excess accumulation of heavy metals were reported. The excessive accumulation of Pb in human system produces nephritis, a stage of severe contamination of kidney. Cadmium leads to a disease known as Itai - Itai (Kobayashi, 1970) and arsenic causes hyperkeratosis, a disease related with cancer (Chen and Wu, 1962).

Enhanced levels of heavy metals in the medium cause concern because of the following reasons (Pillai, 1985).

1. Possibility of accumulation of these metals in the human food and building up with time to toxic levels.
2. Bioconcentration / accumulation and magnification by aquatic organism.
3. Chronic and sublethal effects to organisms at low concentrations.
4. Persistence in the environment with possibilities for environment transformation into more toxic compounds.
5. Possible intake through drinking water and aquatic food.
7. Carcinogenic and teratogenic possibilities of some of the heavy metals and their compounds.
8. Phytotoxicity of heavy metals.
9. Synergistic effect of heavy metals to organisms.

Heavy metals which are brought into the pond and estuary become increased or decreased due to the fluctuations
in the physico-chemical parameters and seasonal variations. The fluctuations in temperature (Senthilnathan, 1990; Saisastry and Chandramohan, 1990; Lyla, 1991; Gouda and Panigrahy, 1993) in hydrogen ion concentration (Kannan, 1980; Sivakumar, 1982) in dissolved oxygen content (Dwivedi et al., 1973; Dehadrai, 1970 a,b; Chandran, 1982; Saraladevi et al., 1983; Murugan and Ayyakkannu, 1991) and in salinity (Shanthi et al., 1990; Sastry and Malik, 1992) were reported. Seasonal variations of metal concentrations in water and bivalves were also reported by Zingdae et al. (1976), Matkar et al. (1981), Kureishy et al. (1981), Lakshmanan and Nambisan (1983), Israel (1992) and Mitra and Choudhury (1993). No such information is available in the present study areas and so the present investigation is proposed.

Aquatic organisms possess the ability to accumulate heavy metals from water. This accumulations can be an active metabolic process in which ions are transported across the cell membrane with metabolically produced organic molecules or it can be a passive process of adsorption on the surface. Monitoring the level of heavy metals in natural waters at an early stages of contamination is rather difficult due to low concentrations involved. However, some of the molluscan species are very good integrators of heavy metals especially Cr, Mn, Co, Ni, Cu, Zn, Cd and Pb and permit a more reliable
analyses, (Lakshmanan and Nambisan, 1986). Heavy metal accumulation by bivalve molluscs has been reported by various workers (Pringle et al., 1968; Segar et al., 1971; Eisler et al., 1972; Bryan, 1973; Martin et al., 1975; Ayyappan Nair et al., 1977; D’Silva and Kureishy, 1978; Thompson, 1979; Wesley and Sanjeevaraj, 1983; Manoharan, 1991; Tariq and D’Silva 1993). Most of them have used marine mussels, oysters and cockles in biomonitoring of heavy metals in marine environment. A very few in India have used Meretrix casta, an estuarine clam for this type of study (Kumaraguru, 1980; Lakshmanan and Nambisan, 1983; Nair and Nair, 1986). Since plenty of clams are available and no mussel is present in Agniar estuary, the clam M. casta is selected as a biomonitor.

Monitoring of heavy metals in fresh water system, using freshwater bivalves was carried out by many authors (Merlini, 1966; Mathis and Cummings, 1973; Price and Knight, 1978; Forester, 1980; Heit et al., 1980; Adams et al., 1981; Salanki et al., 1982; Schmitt and Finger, 1982; Czarnezki, 1983). In India work on biomonitoring of heavy metals in freshwater system remains inadequate and limited to that of Hameed and Mohanraj (1989) who employed Lamellidens marginalis to monitor metal levels in Kaveri river system.

Metal accumulation ability was found to be variable in different body components of the bivalves viz shell, whole
body, digestive glands, gill, viscera, mantle and foot-adductor muscle (Owen, 1974; Boyden and Romeril, 1974; Anderlini, 1974; Brayan and Hummerstone, 1978; Wesley and Sanjeevaraj, 1983; Nair and Nair, 1986; Krishnakumari and Vijayalakshmi, 1992; Mitra and Choudhury, 1993). Among the body components, the digestive glands accumulated more heavy metals (Brooks and Rumbsy, 1965; Bryan, 1979; Kumaraguru, 1980; Hameed and Mohanraj, 1990).

High level of metal accumulation in the gills of bivalves was reported by Pringle et al. (1968) Rajendran et al. (1988); Martincic et al. (1984) and Chidambaram (1992). Other body components accumulated lesser amount of heavy metals. A higher accumulation rate of lead in the shell of bivalves was reported by Merlini (1965), Wesley and Sanjeevaraj (1983), Pillai (1985) and Hameed and Mohanraj (1990). Therefore the study of metal content in the body components is very much useful to assess the ability of bioaccumulation.

The accumulation of heavy metals by bivalves influenced by the physico-chemical parameters and seasonal changes, were reported by several workers (Frazier, 1975; Bryan and Uysal, 1978; Subramanian, 1981; Luoma et al., 1985; Brethret et al., 1986). During monsoonal period, higher metal concentrations were present due to freshwater input along with heavy metal-containing industrial wastes, agricultural wastes and sewage sludges (GESAMP, 1985; Pillai, 1985). The metal concentration
has been at a minimum when maximum pH was recorded and conversely a higher metal concentration was recorded at low pH (Sanchez and Lee, 1978; Metzner, 1977; Israeli and Kurshid, 1991, ’93; Israeli, 1992). During monsoon, higher dissolved oxygen cause the chemical speciation of heavy metals and thereby bioavailability increased (Lakshmanan and Nambisan, 1983; Ajmal and Razi-ud-din, 1988). During lower salinity higher metal concentrations were reported by Kumaraguru, 1980 and Bargaoenkar and Gokhale, 1992.

The uptake of heavy metals by bivalves was tested in laboratory exposing the bivalves to different sublethal concentrations. Laboratory experiments on bioaccumulation were carried out on estuarine and fresh water bivalves by many investigators (Zingdae et al., 1976; Pauley and Nakatani, 1968; Mellinger and Willis, 1973; Foulquier et al., 1973; Salanki and Varanka, 1976; Akberali and Earnshaw, 1982a; Cassini et al., 1986; Tallandini et al., 1986; Herwig et al., 1989). This kind of laboratory studies are very few in India and limited to the work of D’Silva and Kureishy (1978), Wesley and Sanjeevaraj (1983), Saraladevi and Everaarts (1990) and Krishnakumari and Vijayalakshmi (1992) in estuarine bivalves and of Hameed and Mohanraj (1990) in freshwater mussel. More information is essential to draw general conclusion on the behaviour of the animal to the presence of metal in the medium. The bioaccumulation of
metals in bivalves have borne a linear relationship to metal concentration of the medium. The situation was also found to be true in field studies as reported by Sundararaj and Krishnamoorthy (1972), Zirino and Yamamoto (1972), Van der weijden et al. (1977), Bryan and Uysal (1978), Subramanian et al. (1979) and Lakshmanan and Nambisan (1983). Similar linear relationship was proved in laboratory experimental studies on bivalves (Schulz-Baldes, 1974; George and Coombs, 1972; Saraladevi and Everaarts, 1990), is to be studied.

Toxicity bioassays constitute one of the commonly used biological methods in aquatic environmental studies. Toxicity tests using single species microcosm and communities are the foundation for laboratory evaluation of fresh water and estuarine pollution effects. Laboratory determination of toxicity may be divided into short term or acute bioassay and long term or chronic bioassay (Negilski, 1975). Acute tests (Sprague, 1973) provide a valuable information on the concentration and time course producing a lethal response in a test organism and they are much concerned with the determination of median lethal response (LC50). Chronic tests permit the day to day mechanisms to proceed until they become affected by blockage or disruption of some slower metabolic processes.

Sublethal studies were emphasised by Perkins (1979) and Watdichuk (1979). Such studies on the effect of pollutants
are very much essential to know the physiological
consequences. The effect of heavy metals on oxygen
consumption (Capuzzo and Sanser, 1977; Baby and Menon, 1986;
Krishnakumar et al., 1990; Mohanraj and Hameed, 1991) on
Heart rate (Scott and Major, 1972; Dietz and Tomkins, 1980;
Akberali and Trueman, 1985) on dissolution and reformation of
crystalline style (Hameed and Mohanraj, 1989) and growth
condition index (Sastry and Miller, 1985; Augenfeld et al.,
1980-81) were studied. The effects on the physiological
responses are used as an index to assess the heavy metals
stress on the test animal and these results in general are
useful to predict the toxicity of the metals on living
resources of any aquatic system.

Therefore, it is proposed to undertake biomonitoring of
heavy metal in a fresh water Chediyan pond and in Agniar
estuary and to study the bioaccumulation ability of a
freshwater mussel Lamellidens marginalis and an estuarine
clam Meretrix casta collected from Chediyan pond and Agniar
estuary respectively and to evaluate the impact of heavy
metal toxicity on respiration, heart beat, growth condition
index and dissolution and reformation of crystalline style.