Sediments are the largest repository and potential source of metallic contaminations in the marine environment. Since metals from natural fluvial process and human development activities accumulate together. It is difficult to determine what proportion of sedimentary metal load is natural and what proportion is anthropogenic. This is generally because of variable anthropogenic input and natural sedimentary metal loads that can vary by several orders of magnitude. This depends on grain size distribution, mineralogy of sediments and environmental conditions. It is essential therefore, to understand the dynamics of any trace metal, such as lead, the information is necessary. In this study lead on sediments were classified as total lead (Detrital-acid insoluble) and loose lead (non-detrital-acid soluble).

All heavy metals become toxic at some concentration (Bryan, 1971). This paved way for this research. In aquatic ecosystems, the heavy metals have received considerable attention due to their toxicity and accumulation in biota (Javed and Hayat, 1999). In fish, the toxic effects of heavy metals may influence physiological functions, individual growth rates, reproduction and mortality (Woodward et al., 1994). In Pakistan, the water pollution has become a serious problem due to discharge of un-treated industrial effluents and domestic sewage, containing bulk quantities of toxic heavy metals, into the rivers (Javed, 2005). Trace
metals are essential for normal physiological processes abnormally high concentration, however can be toxic to aquatic organisms (Javed, 2003). Nussey et al. (2000) found that bio-accumulation of chromium, nickel and manganese varied significantly in different species of fish depending on size, gender and season.

Three kinds of analytical method were used for metals determination and quantification: flame spectrophotometer atomic absorption, UV spectrophotometer, and voltammeter method. The flame spectrophotometer atomic absorption gives the best result by testing with certified reference material (Herve et al., 2010) as per said above reference AAS (Thermo jerral ash). Used for total and loosely bounded lead analysis from sediments.

The discharges of industrial wastes have resulted in high metal concentrations in the local marine environment, especially in the coastal sediments (Saad et al., 1981; Mance, 1987; Ni et al., 2005).

Higher concentrations of the pollutants were recorded in the dry season than rainy season except for phosphate and nitrate, which showed the reverse trend. Nickel, lead, copper, chromium and cyanide were neither detected in the effluent nor impacted water body (Otokunefor and Obiukwu, 2005). Similar observations recorded in all the seven spots, a peak hike is lead concentration observed in summer season of April, May and June.
For some metals, natural and anthropogenic inputs are of the same order (for sample Hg and Cd), whereas for others (for example Pb) inputs due to human activities dwarf natural inputs (Clark, 2001). As said in the above reference a high concentration of total and loosely bounded lead concentration observed in places like, Velankanni and Nagapattinam. A hike in lead concentration observed in the month of August, September and January due to heavy tourist vehicle rush and movements for attending flag hoisting festival, Christian festival, year celebrations at Velankanni and in the month of December Kandhuri festival at Nagapattinam. As a renewed Bird Wild Life Sanctuary, Kodikarai received extensive tourist vehicle population that leads to elevation in lead level.

Similarly the results of this present study indicated that relatively higher concentration of total lead is encountered in the Tourist area, estuaries / backwaters than the nearshore waters, this might suggest that the source for trace metals in the nearshore waters may be the discharge through rivers. The water quality is poor in tourist areas like Nagai, Velankanni, Kodikarai and Kodikarai experienced very high lead concentrations because of boat construction industry tourism and fishing industry. In these study areas we have seen higher concentrations of lead in both Velanganni and Nagai which are nearby areas. A hike in concentration was noticed in the month of August and September. Because of the Velankanni flag hoisting festival. The flag hoisting festival falls in the month of August last due to the arrival of very high tourist
population. Monsoon records a high concentration at the estuarine and back water region like Muthupet. Nagai recorded a high concentration of Pb during Kandhoori festival time i.e. in the month of December. Kodiakarai recorded a very high concentration in all seasons because its one of the important tourist attractive site and Boat industry and fishing area. As the same case of all coastal towns, waste water and industrial sewage come directly to the sea (Rasoanandrasana, 2006). Metal concentration in column water (Nirilalaina, 2007) at the same station point allow us to establish metals distribution in sea water-sediment system. These values show the metals affinity to be fixed in sedimentary particles.

Anthropogenic activities like mining, ultimate disposal of treated and untreated waste effluents containing toxic metals as well as metal chelates (Amman et al., 2002) from different industries, e.g., tannery, steel plants, battery industries, thermal power plants etc. and also the indiscriminate use of heavy metal containing fertilizers and pesticides in agriculture resulted in deterioration of water quality rendering serious environmental problems posing threat on human beings (Lantzy and Mackenzie, 1979; Nriagu, 1979; Ross, 1994) and sustaining aquatic biodiversity (Das et al., 1997; Ghosh and Vass, 1997). Though some of the metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for life processes in plants and microorganisms, while many other metals like Cd, Cr and Pb have no known physiological activity, but they are proved detrimental beyond a certain limit (Bruins et al., 2000), which is very much narrow for some elements like Cd (0.01 mg/l), Pb (0.10 mg/l) (ISI,
1982) and Cu (0.050 mg/l). The deadlier diseases like edema of eyelids, tumor, congestion of nasal mucous membranes and pharynx, stuffiness of the head and gastrointestinal, muscular, reproductive, neurological and genetic malfunctions caused by some of these heavy metals have been documented (Abbasi et al., 1998; Johnson, 1998; Tsuji and Karagatzides, 2001). Therefore, monitoring these metals is important for safety assessment of the environment and human health in particular. Although conductivity increased towards the downstream of the river attributable to the tidal effect of Bay of Bengal (Gupta and Gupta, 1999) the change was not significant. The lowest conductivity in monsoon may be due to the dilution effect of rain water.

Similar observations were notice in this study except tourist places like Velankanni, Nagai and Kodikarai, the lead level decreased due to dilution effect of rain water and another similarity observed during post-tsunami studies i.e., during January 2005.

**Tsunamic wave effects**

In the year 2004 on December 26th the tsunami waves struck the Peninsular India and resulted to tremendous destruction of properties and loss of human life. In this study the effect of tsunami has reduced the concentration of lead to zero in all the coastal study areas, resulting the concentration of lead came down to below detectable limits value except Kodiakarai. During tsunami Kodiakarai faced less destruction by the natural calamity tsunami wave because of the mangrove forest presence.
Due to this Kodiakarai shows a minimal concentration of lead concentration even in the tsunamic wave devastation. Both total and loose lead concentrations went to below detectable limits (Not traceable) in all the six sites except Kodikarai.

The relative dominance of the heavy metals in water was observed in the following sequence: Fe > Mn > Ni > Cr > Pb > Zn > Cu > Cd. The highest concentrations of most of the heavy metals (Fe, Zn and Cu) at Palta may be due to the discharge of heavy metal loaded industrial waste water (Shah et al., 2005).

The seasonal variations of metals differ according to the station, in relation to the physicochemical conditions, the hydrodynamism and the nature of the contributions, which prevail in the area. The enrichment degrees calculated by means of the metal contamination index reveal that the sediments receiving the urban and industrial wastes are moderately to significantly contaminated, while those which are far from the rejections are less contaminated. The follow-up of metal pollution in bays of the Ebri lagoon has become a necessity (Yao Koffi et al., 2009).

The seasonal variation in lead concentration could be seen especially low values during premonsoon months while higher values are recorded during summer and monsoon months (Palanikumar, 1995). The range of concentration of total lead varied upto 1.2 ppm. The industrial activities in coastal areas are suggested responsible for the higher
concentration found in the nearshore waters. In Vam Sadhar river and coastal zone, Deva Varma et al. (1993) reported the lead content varied upto 63 ppm in the clay fraction and 51 ppm in the bulk sediments of east coast of India. They suggest that variation of clay minerals at weathering site may have induced the downstream variations. In their studies trace metals such as zinc and copper showed an increase in concentration from river line locations to coastal locations where lead showed a decrease in concentration. These reduction could be due to co-precipitation of lead along with hydroxides of iron and manganese in the estuaries.

The concentration of total lead was high in the following three regions 1) Kodiakarai 2) Velankanni 3) Nagapattinam and 4) Manora. A hike in total lead concentration was recorded during tourist seasons i.e., in the month of May and June at Kodiakarai, Velankanni, Nagai and Manora. Next to tourist time a hike has been recorded during festival time i.e., Velankanni festival time (flag festival) in the month of August fourth week end and Nagapattinam Kandhoori festival time i.e., in the month of December every year.

The possible causes for the decrease and increase in lead during monsoon found in both these studies and from the present study area may be due to the monsoon flow lead level has shown a increase in tourist and fishing areas this is because lead have been washed toward the sea due to anthropogenic action. An increase in lead level in two seasons one during summer that is tourist season and another is during monsoon time. But a
very high concentration of lead has been recorded in tourist areas during tourist seasons. The consequential changes in redox potential may cause the release of loosely held forms of the trace metals including lead into the water column (Forstner and Wittmann, 1983). It is possible therefore the coastal sediments act as sinks for trace metals during summer and release lead to the overlaying water during monsoon and transports them to the offshore waters.

The urbanization, industrialization and fishing activities are the sources of lead contamination of sediments in these coastal region. The automobile exhaust is also suggested as a significant source of lead in the present study area. In a study in Minnesota, USA, Mark et al. (1988) have observed a staggering 20136 \( \mu g/g \) of lead in the soil sample collected from the private foundations residence area. They suggest that lead based house paints used in these area and high automobile exhaust as the possible cause for the high lead concentration in soils and water courses draining these urban areas.

The automobiles as the source of lead contaminant of soil and sediments in urban areas has also been suggested by Albasel and Cottenie (1985) in Belgium. They found that the accumulation of lead was particularly pronounced along highways and the contamination decreased rapidly with increasing distance from Highway.

Maryvonne et al. (1990) have reported an increase in lead during summer and decrease during monsoon. In this study has found a similarity
in the distribution of metals in the fine sediments of Loire estuary, France. They suggest that the increased flow rate in winter reduces the potential fixation of metals in sediment, diluting the pollution load, reduces setting, dispersing and expelling the recently deposited sediments into the offshore waters. In addition, in the present study area due to organic pollution of the estuaries generally anoxic conditions prevail in summer (Ramanibai, 1986) and with monsoon flow the oxidizing conditions return. This could be a potential reason for the resuspension of loosely bound non-detrital fraction of lead into the overlying waters.

The current study indicates a slight increase in the total lead concentration in the coastal and estuarine sediments from 2004 to 2010 thus suggest the existence of an increasing trend of trace metal pollution threat along the deltaic coastal area of Tamilnadu.

Sediments effectively sequester hydrophobic chemical pollutants entering water bodies such as lakes. Lake sediments provide a useful archive of information on changing lacustrine and watershed ecology (Cohen, 2003). Sediments can be sensitive indicators for monitoring contaminants in aquatic environments. The sediments were polluted with various kinds of hazardous and toxic substances, including heavy metals. These accumulate in sediments via several pathways, including disposal of liquid effluents, terrestrial runoff and leachate carrying chemicals originating from numerous urban, industrial and agricultural activities, as
well as atmospheric deposition. Core sediments provide useful information on the changes in the quality of the lake from a past period.

Many researchers had studied the pollution history of aquatic ecosystems by core sediments (Lopez and Lluch, 2000; Karbassi et al., 2005; Mohamed, 2005). Sediment core contain information about the events that occurred in pre-cultural time in the lakes and its catchments area. The sediment history broadly reflects the contamination history of an area. Currently, environmental pollution because of urbanization and industrial development is a major concern (Sadiq, 1992; Heyvaert et al., 2000; Alemdaroglu et al., 2003). Concentration of trace metals in coastal estuaries can be elevated due to high inputs from natural, as well as anthropogenic sources. Thus, understanding the transport and distribution of trace metals in estuaries is a goal of environmental chemists (Unnikrishnan and Nair, 2004). One of the most distinguishing features of metals from other toxic pollutants is that, they are not biodegradable. Sediments can incorporate and accumulate many metals added to a body of natural water. The favourable physico-chemical conditions of the sediment can remobilize and release the metals to the water column. It has been stated that specific local sources such as discharge from smelters (Cu, Pb, Ni), metal based industries (e.g., Zn, Cr and Cd for electroplating), paint and dye formulators (Cd, Cr, Cu, Pb, Hg, Se and Zn), petroleum refineries (AS, Pb), as well as effluents from chemical manufacturing plants may lead to metal accumulation in sediments (Al-Masri et al., 2002; Bonnevie et al., 1994). In fact, there is a need of
controlling both point and non-point discharges and especially pollution prevention by controlling at source discharges of heavy metals from industries (Bakan and Ozkoc, 2007).

The heavy metal accumulation in the tissues, water and sediment increased as the exposure time increased. If this continues, heavy metal will reach the tissues of human beings through the food chain. Therefore, this should be noted by industrialists and they should take steps to minimize the aquatic pollution (Soundarapandian et al., 2009).

In this study, sediment analysis performed from the coastal marine sediments because sediments are major repositories for metals and besides providing the environmental status; they are also used to estimate the level of pollution in a region (Burton and Scott, 1992; Caccia et al., 2003).

Anthropogenic impacts have resulted in an accumulation of heavy metals in the estuarine sediments during winter monsoon (post monsoon), whereas the coastal environment has remained essentially unaltered during the same season (Balachandran et al., 2003). This is interesting because under different environments, there could be shifts in preferences of metals onto adsorption sites before sedimentation. The distribution of these metals in this environment is already discussed by Balachandran et al. (2005).

The effect of sublethal concentration of Portland cement powder in solution on some haematological parameters in Nile tilapia (Oreochromis
*nilotica* (L.)) mean weight 8.20 ± 0.25 g was investigated using static bioassay system for 70 days. The sublethal concentrations used were 19.60, 9.80, 4.90, 2.45, 1.23 and 0.00 (control) mg/l, there were significant differences (P < 0.05) in the water quality parameters monitored. However, temperature did not show any significant variation (P < 0.05) in both test tanks and the control. Haematological parameters examined include Pack cell volume (PCV), Haemoglobin (Hgb), Total erythrocyte count (TEC), total leucocyte count (TLC) and Erythrocyte Sedimentation Ratio (ESR) which all decreased significant (P < 0.05), the decrease being proportional to the increase in Portland cement powder in solution (Mohamed and Sambo, 2008).

Heavy metals are serious pollutants of the aquatic environment of their environmental persistence and ability to be accumulated by aquatic environment. *Clarias batrachus* was exposed to 0.02, 0.04, 0.06, 0.08 and 0.10 ppm of HgCl₂ for 35 days. After 35 days of exposure red blood cells (RBC) count (1.66, 1.59, 1.54, 1.42 and 1.23, $10^6$ mm³) and Hb content (67.2, 50.8, 42.6, 31.6 and 29.2 g/dl) decreased when compared to the control (RBC – 1.77, $10^6$ mm³ and Hb – 75.0 g/dl) (Maheshwaran *et al.*, 2008).

The sublethal effect of lead on haematological profile of *Clarias batrachus* were studied. Lead nitrate was used to prepare stock solution from which different standard concentration were prepared. A total of 64 specimens of *Clarias batrachus* (weight 80-100 g and 18-20 cm
respectively) were used in the study. They were divided into four groups and each group has 16 fishes. They were then exposed to various concentrations of 10, 50 and 100 mg/l of lead nitrate for acute and chronic studies. In exposed fishes various haematological changes were noticed. The RBC counts, haemoglobin percentage and serum protein levels were decreased significantly in comparison to control groups (Mastan et al., 2009). The above similarities observed in the present study a decrease in TEL, TLC, Hb, differential count and thrombocytes are observed in both male and female fish *M. gulio*.

A decreasing trend of protein, carbohydrate and lipid observed in the present study as the toxicity of fluoride (F) to 16 cm long freshwater male catfish (*Clarias batrachus* Linn.) was evaluated after their exposure to two sublethal concentrations of NaF (35 mg F ion/L and 70 mgF ion/L) for 90 days. Changes in biochemical parameters in muscle, liver and testis tissues were recorded. Significant depletion of total protein and lipids in these tissues occurred at both the lower and higher F concentrations. A significant reduction of glycogen content was found in muscle and testis at the lower concentration, but it increased in all three tissues at the higher concentration. Moreover, an increase in the level of cholesterol in muscle, liver, and testis occurred at both concentrations, but it was significantly higher (P < 0.05) only at the higher concentration (Anand Kumar et al., 2007).

The PL were exposed to a sublethal concentration of lead (1.44 ppm) for 30 days. The major biochemical constituents, including total
carbohydrates, proteins, lipids and ninhydrin-positive substances (TNPS) were estimated using standard methods. Lead exposure resulted in retardation of growth with a significant decrease in length and weight occurring at day 10 and onwards. Of all the biochemical constituents, total protein showed the maximum decrease (79.3%) followed by total lipids (68.1%) and then by total carbohydrates (51.4%) in lead-exposed PL. The data suggest lead exposure causes reduced growth and the depletion of biochemical constituents. This may be due to metal interactions and inhibition of metabolic pathways responsible for synthesis of biochemical constituents or to greater utilization of these constituents under metal stress conditions (Chinni and Yallapragada, 2000). Similar observations were observed in the present study on estuarine fish *Mystus gulio* and in shrimp *Penaeus monodon*. The protein, carbohydrate and lipid level in the body tissues of these animals treated with lead nitrate show a decreasing trend comparing to the control animals (fish and prawn).

The fish, as a bioindicator species, plays an increasingly important role in the monitoring of water pollution because it responds with great sensitivity to changes in the aquatic environment. The sudden death of fish indicates heavy pollution; the effects of exposure to sublethal levels of pollutants can be measured in terms of biochemical, physiological or histological responses of the fish organism (Mondon *et al.*, 2001).

The biochemical components such as protein, lipid and carbohydrate of the liver of two important penaeid prawns were
significantly reduced, following six days of exposure to 0.005 ppm and 0.01 ppm of mercuric chloride during various reproductive stages i.e., preparatory, prespawning, spawning and postspawning. Liver protein recorded highest in contrast to lipid and carbohydrate irrespective of the species, sex and medium depletion was at 0.01 ppm Hg medium. The effect of mercury was more in *Penaeus indicus* than that of *Penaeus monodon*, the female species and prespawning stage. Liver-lipid deleteriously affected the female *Penaeus indicus* during spawning while carbohydrate affected it prominently during preparatory stage. Hg concentration of 0.01 ppm had much damaging effect on liver. The change caused due to test solutions in the biochemical constituents of the liver of the prawns indicate that female had more affected than male. The protein content indicated decline with the increase of time period, the depletion of percentage also raised with the increase of time exposure for carbohydrates and lipids (Snehalata Das *et al.*, 2001). As in the above statement the present study enumerates the same, there was a decrease in protein, carbohydrate and lipid content in the tissues of liver, muscle and gonads of *M. gulio*.

Endosulfan, a broad-spectrum non-systemic organochlorine (OC) pesticide is extensively used to control a wide variety of pests in agriculture, horticulture and public health programmes. Biochemical changes occurring in the metabolically active tissues of gills (GL), hepatopancreas (HP) and muscle (MU) of the penaeid shrimp, *Metapenaeus monoceros* (Fabricius) on exposure to two sublethal doses
(40 and 60 ng/l) of endosulfan were studied for 23 days of exposure (DoE). The results of the study revealed that sublethal doses of endosulfan significantly alters the proximate composition of major tissues, particularly the TP levels in the MU tissues thereby reducing the nutritive value of this economically important panaeid shrimp. Since *M. monoceros* exhibits significant biochemical changes on exposure to endosulfan, this species could possibly be used as biosensor of coastal marine and estuarine pollution (Suryavanish *et al.*, 2009).

Test results indicated that the brackish water juvenile shrimp, *Palaemonetes africanus* were sensitive to the cadmium solution especially at concentration above 4.0 mg/l (Joel and Amajuoyi, 2009). Evaluation of toxic effect of lead on the edible lobster, *Thenus orientalis* for the LC$_{50}$ value and effect of heavy metal lead on the nutritional status viz., protein, carbohydrate and lipid in ovary, spermatheca, hepatopancreas, muscle and haemolymph was made. The results assume greater interest as most water bodies are increasingly subjected to environmental pressure due to pollution (Kalyanaraman and Senthilkumar, 2009). Similar observations are found in the present biochemical study of the shrimp *Penaeus monodon*’s muscle and hepatopancreas tissues and the same exhibits similar kind of results in decreasing order in protein, carbohydrate and lipid depletion from the control animal.

The present bioaccumulation studies show similar result of heavy metal accumulation comparing from the control fish *M. gulio* and control
shrimp *P. monodon*. The lead nitrate accumulation in the estuarine fish *M. gulio* is of following order Gill > Liver > Kidney > Skin. The shrimp *P. monodon* shows higher state of lead nitrate accumulation in the organ hepatopancreas.

Acute toxicity tests were performed in *Echinogammars olivii* (Amphipoda), *Sphaeroma serratum* (Isopoda) and *Palaemon elegans* (Decapoda) from the Sinop Peninsula in the Black Sea. 96 h LC$_{50}$ values were estimated for copper, zinc and lead in these species using the static bioassay method. The results indicated that Cu was more toxic to the species followed by Pb and Zn. *E. olivii* was more sensitive to the metals than *S. serratum* and *P. elegans* (Bat *et al.*, 1999).

Knowledge of accumulation trend of a particular trace metal is a prerequisite for knowing the importance of a known metal concentration in the aquatic organism. They accumulate the trace metals in their soft tissues to concentrations several fold higher than those of required level (Wright, 1977; Bryan, 1979; Rainbow and While, 1990).

The main routes of accumulation of metals by fish are through the gills, skin and food (Ni *et al.*, 2005). Trace metals such as copper (Cu), zinc (Zn), cadmium (Cd) and iron (Fe) were found to bioaccumulate in liver followed by gills and muscles in fish (Taylor *et al.*, 1985; Chan, 1995; Wong *et al.*, 1999; Ni *et al.*, 2005).
The present study shows similar observation in the estuarine fish *Mystus gulio* in the bioaccumulation studies and the rate of accumulation is high in gills comparing the organ tissues next in liver, kidney and muscles.

Accumulation and elimination pattern of both metals were also depending on metal concentration and exposure time. Many studies have shown similar results either with prawn (Vijayaram and Geraldine, 1996; Reddy *et al.*, 2006) or other organisms such as freshwater amphipod.

The current study shows some interesting points, the gills show as an important site for acute exposure of the fish *M. gulio*. As we see gills are the main point of entry and it has constant and direct contact with the aquatic environment a greater uptake of trace metals are common. Increased accumulation of metals in gills of the body to soluble species of metals (Jackim *et al.*, 1973).

Marine organisms, in general, accumulate contaminants from the environment and therefore have been extensively used in marine pollution monitoring programmes (Linde *et al.*, 1998; de Mora *et al.*, 2004).

Length and weight, physical and chemical status of water (Al-Yousuf *et al.*, 1999) can play a role in the tissue accumulation of metals. The high level accumulation of metals in some fish species could be due to heavy rainfall during monsoon season which increase the metal content of water by washing down the agricultural waste. Bioaccumulation is
species-dependent and therefore feeding habits and life style can be strongly related to the sediment exposure (Chen and Chen, 1999). Other factors, such as sex and size may also influence metal bioaccumulation (Canli and Atli, 2003).

These metals could find their way and remain for a very long time in seafoods, animals and plants and then passed on through food chain to man. Pollution by heavy metals occur largely from industrial processes of electroplating, metallurgy, minning, petroleum processing, large scale use of coal, batteries, fertilizers, dyes and pigments (Egereonu et al., 2000).

Fish also have been popular targets of heavy metal monitoring programs in marine environments because sampling, sample preparation and chemical analysis are usually simpler, more rapid and less expensive than alternative choices such as water and sediment (Rayment and Barry, 2000). According to Teodorovic et al. (2000) and Abdullah (2008) heavy metals studies in aquatic biota give an idea that heavy metals in aquatic organisms could be more reliable water quality indicator than chemical analysis of water column and sediment. Heavy metals content in aquatic organisms has also been successfully used in evaluation in heavy metals input into European and American rivers. Heavy metals including lead are found in various tissues of fish and shrimps (Vazquez et al., 2001).

The high accumulation of lead in the liver which also noted in their findings, is related to the fact that liver plays a key role in accumulation and detoxification (Gbem et al., 2001).
In general, studies on heavy metals can be important in two main aspects, public health point of view and the aquatic environment viewpoint. Heavy metals are present in the aquatic environment where it can accumulate along the food chain. Moreover, small amounts of absorbed heavy metals are either stored in a metabolically available form for essential biochemical processes or detoxified into metabolically inert forms and held in the body either temporarily or permanently (Hashmi et al., 2002). Besides, the high production of seafood through aquaculture provides a good source of high-quality protein. As 56 per cent of the world’s population obtains at least 20 per cent of their animal protein, the increasing trend of aquaculture production is a welcome sign considering to the global burden of diseases (Ezzati, 2002).

Tiger prawn and tilapia fish until now have been the most important aquaculture, tolerance with the salinity ranges and meets the market needs. Aquaculture projects are often located on or near estuaries and coastal area because these water often provide ideal conditions for salt water aquaculture (Hashmi et al., 2002). Toxicity occurs when the rate of metal uptake into the body exceeds the combined rate of excretion and detoxification of metabolically available metal (Rainbow, 2002). This study shows that the lowest concentration of Cd and Pb were in the crayfish muscles in comparison to the exoskeleton, gills and digestive gland. Also, these results indicate that the analysis of Cd and Pb in different organs of *P. clarkia* might be a useful as a bioindicator for trace metals pollution in the freshwater system, due to their ability to rapidly
accumulate and retain them in their tissues for long periods of time (El-Shaikh et al., 2005). However, the presence heavy metal at high concentrations in water or sediment does not involved direct toxicological risk to fish, especially in the absence of significant bioaccumulation. It is known that bioaccumulation is to a large extent mediated by abiotic and biotic factors that influence metal uptake. Due to the deleterious effects of metals on aquatic ecosystems, it is necessary to monitor their bioaccumulation in key species, because this will give an indication of the temporal and spatial extent of the process, as well as an assessment of the potential impact on organism health (Fernandes et al., 2006).

Seasonal variations in the concentrations of four trace heavy metals (cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn)) were determined in Donax trunculus (Mollusca, Bivalvia) at two contaminated sites in the gulf of Annaba (East of Algeria): El Battah and Sidi Salem. The average concentrations of the metals exhibited the following order: Zn > Cu > Pb > Cd for the two sites. The statistical analysis revealed a significant effect of seasons for all metals measured, the highest values being recorded in winter for Zn and in summer for the other metals (Beldi et al., 2006).

Lead accumulation was dose and tissue-dependent, with highest uptake by the gills. Gill concentrations of aquarium D fish averaged about 4-fold higher than in skeleton or skin and muscle. In vitro, lead (2.5 – 25 ppm) caused dose-dependent reductions in the ratio of reduced glutathione/oxidized glutathione (GSH-GSSG) in gills incubated in
physiological buffer. These findings demonstrate that fathead minnow gills bind and accumulate waterborne lead rapidly and preferentially and raise the possibility that gill lipid peroxidation contributes to lead toxicity at low water hardness (Spokas et al., 2006).

Comparative acute toxicity tests were carried out with three heavy metals viz., cadmium, copper and lead on giant prawn (Macrobrachium rosenbergii) and tiger prawn (Penaeus monodon) post larvae. The metals showed toxicities in order Cu > Cd > Pb. The LC$_{50}$ values recorded for M. rosenbergii were higher than the values recorded for P. monodon, hence the specific metals were more toxic to P. monodon than M. rosenbergii (Fafioye and Ogunsanwo, 2007).

Cray fish exposed to lead nitrate (500 $\mu$gL$^{-1}$) 3 days, the bioaccumulation shows higher lead concentration on gills and lowest in muscles in a following descending order gill > exoskeleton. hepatopancreas > digestive tract.green gland>testis and ovary>muscles (Naghshbandi et al., 2007). Accumulated metals were also stored in different tissues in prawn body. Among tissues most studies found that hepatopancreas accumulated maximum levels of metals followed by gill and muscle (Vijayaram and Geraldine, 1996; Reddy et al., 2006). The above mentioned observations are observed in this present work. Hepatopancreas shows a high level of lead nitrate accumulation 2335 $\mu$g/g for 48 hrs and 3280 $\mu$g/g for 96 hrs.
Heavy metals may be accumulated by shrimps either through food or water. The more important route of heavy metal concentration in the marine biota is through water (Maddock and Taylor, 1977). The low concentrations of metal in gills have shown that gills may also be an important route for metal efflux in addition to kidney (Everall et al., 1989). The gills function as the major route for uptake of heavy metals. Uptake of heavy metals from the medium by the gills surface by mucous layer and probably on the properties of a saturable carrier in the cell wall (Vijayaraman, 1993).

The accumulation of the heavy metals in the shrimps will reach the human beings and will result in ‘biomagnifications’ (Soundarapandian et al., 2010). Among the various organs, bioaccumulation was higher in hepatopancreas and lower in gills. The higher accumulation of the heavy metal, mercury in the hepatopancreas may be due to uptake of nutrients and it is the storage organ of inorganic reserves. Large amount of accumulation of heavy metal in the tissues of shrimp in the industrially polluted area clearly revealed the effect of heavy metal, mercury which impacts the inhabitants, especially shrimps (Soundarapandian et al., 2010).

The accumulation of heavy metal, mercury in water and sediment increased every month and it was higher at station-II which was located nearer to the industrial belt area. The accumulation of heavy metal, mercury in the gills, hepatopancreas, testis and vas deferens also increased
every month and it was found to be higher at station-II. Among the various organs, bioaccumulation was higher in hepatopancreas and lower in gills. The higher accumulation of the heavy metal, mercury in the hepatopancreas may be due to uptake of nutrients and it is the storage organ of inorganic reserves. Large amount of accumulation of heavy metal in the tissues of shrimp in the industrially polluted area clearly revealed the effect of heavy metal, mercury which impacts the inhabitants, especially shrimps, in the Uppanar estuary. The accumulation of the heavy metals in the shrimps will reach the human beings and will result in biomagnifications. This hazardous situation may be prevented by treating the effluents properly before being let off into the Uppanar estuary (Soundarapandian et al., 2010). As mentioned in the above statements the present study shows a similar result of accumulation of lead nitrate high in hepatopancreas comparing to muscle tissue in *P. monodon*.

The metal elimination study shows similar results in the present study in both *M. gulio* and *P. monodon*. The state of metal elimination is high in kidneys next is gills for *M. gulio* and in shrimp *P. monodon* the level of accumulation and elimination are high in hepatopancreas.

According to Short and Meyers (2001), histology is an important field regarding fish health that can often detect subtle conditions or early signs of disease not easily recognized on gross examination. Results from a histological assessment, can provide better insight into the
environmental and/or physiological demands presented to fish in their natural environment.

According to Nussey et al. (2000), bioaccumulation of chromium, lead and manganese varied in different tissues of cyprinid fish (*L. ambratus*) depending on size, gender and season. The histopathology showed that lead caused some alterations of the liver parenchyma, like blood congestion in sinusoids, vacuolation of hepatocytes and necrosis. Several studies had shown a variety of changes in the liver of *O. niloticus*, resulting from exposure to different toxic chemicals (Fernandes et al., 2007; Jiraungkoorskul et al., 2002, 2008). A common morphologic response of the fish liver to toxicity is an accumulation of hepatic glycogen and/or lipid (Wolf and Wolfe, 2005). Lipid or glycogen vacuolization can cause an increase in the size of hepatocytes; however, Hinton et al. (2001) identified three additional potential causes of hepatocellular enlargement: organelle proliferation (hypertrophy); the failure of sublethally-injured hepatocytes to mitotically divide (megalocytosis) and vacuolar swelling of the endoplasmic reticulum cisternae (hydropic degeneration). Moreover, a clearly pathologic response of the fish liver to anxious substance is hepatocyte necrosis.

Following exposure the gills exhibited rapid alterations that include detachment and lifting of the epithelial linings from the surface of the gill filament (primary, PL) and respiratory (secondary, SL) lamellae. This led to extensive haemorrhage from the gills. Thus the quantity of blood
flowing across the gills decreased substantially. Simultaneously, uncontrolled regeneration of the PL and SL occurred, leading to extensive hyperplasia of the epithelial cells lining the PL, and SL. Consequently, the gill filaments appeared as a cylindrical solid mass of cells with very little or almost no free surface left on the SL for gaseous exchange. The goblet mucous cells also exhibited periodic fluctuations in their density and staining behaviour. The chloride cells showed periodic fluctuation in their number at different stages of exposure. The density of the chloride cells is inversely proportional to the thickness of the epithelial lining of the PL and SL. Due to prolonged exposure, the neighbouring SL fused together and the entire gills appeared as a solid mass of undifferentiated cells. Subsequently, the ladder-like arrangement of the pillar cells-blooc capillaries of the gills also collapsed, causing asphyxiation and the death of the fish (Parashar and Banerjee, 2002).

It was found that the metals were accumulated in different tissues of both fish by various levels, where, the non-edible parts accumulated more metals than the edible muscles. Zn, Cu, Pb and Cd concentrations in the fish muscles were blow the maximum permissible limit, however, Fe in the muscles exceeded the permissible limit. Several histopathological alterations, including vacuolar degeneration with focal areas of necrosis in liver, proliferation in the epithelium of gill filaments and fusion of secondary lamellae, severe degenerative and necrotic changes in the intestinal mucosa and seminiferous tubules, degeneration and atrophy in cardiac muscle fibers and degeneration in muscle bundles were observed.
in the studied tissues of both fish as a result of the accumulated metals (Mohamed, 2008).

Histological alterations were observed in the muscles of both fish, including degeneration in muscles bundles with focal areas of necrosis, atrophy of muscle bundles and edema between muscle bundles. The liver showed vacuolar degeneration in the hepatocytes, focal areas of necrosis and fibrosis, aggregations of inflammatory cells between the hepatocytes, dilation and congestion in blood sinusoids and thrombosis formation in the central veins. In the gills, the pathological alterations included proliferative, degenerative and necrotic changes in the epithelium of gill filaments and secondary lamellae, edema in secondary lamellae, dilation and congestion in blood vessels of gills filaments and mucous cells proliferation. The kidney showed vacuolar degeneration in the epithelium of renal tubules, focal areas of necrosis, haemorrhage and haemosiderin between the renal tubules and edema in Bowman’s capsules with atrophy in the glomeruli (Mohamed, 2009).

In this present study, the above mentioned observations coincide with the present study the histological work shows damage in muscle tissues with necrosis, atrophy, vacuolation in liver, necrosis in hepatocytes, gill lamellae damage, blood vessels damage, kidney with vacuolation, necrosis, damage in Bouman’s capsule in M. gulio.

It may be concluded that the river water as such is not suitable for drinking purpose due to the excess concentration of Fe, Mn, Pb and Ni
and it may not be suitable for irrigation due to the excess concentration of Mn. The excess heavy metal load of river water can be attributed to the discharge of industrial effluents and municipal wastes, geology of river bed and catchment area. Though some of the detected heavy metals are beneficial for human and plants up to a certain limit, it may be harmful beyond that. Adoption of adequate measures to remove the heavy metal load from the industrial waste water and renovation of sewage treatment plants are suggested to avoid further deterioration of the river water quality.