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# EVALUATION OF TRACE METALS IN KOTTAPURAM - CHETTUVA *Kayal* AT THRISSUR DISTRICT IN KERALA

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## ABSTRACT

**The concentration of trace metals such as copper, zinc, lead and cadmium in water, sediment and different animal tissues was examined in the Kottapuram- Chettuva *Kayal* during a period from August 2009 to July 2010. Among the four trace metals studied copper seems to be the most abundant and cadmium the least, in all compartments. No station wise variation is observed for all trace metals in water. The order of metals in the system is Cu > Zn >Pb> Cd. There is no correlation between the concentration in water and soft tissues. This study revealed the presence of trace metals in various aquatic animals along with water and sediment.**

**KEYWORDS:** Kottapuram- Chettuva *Kayal,* Trace Metals, Water, Sediment, Animal

All phases of industrial developments and human intervention generate hazardous wastes in the aquatic ecosystem. The significant percentage of heavy metals in the hydrosphere cause toxic affect in the aquatic organisms. The toxicity of heavy metal leads to the gradual environmental destruction and abnormal changes in the species composition in the system. The bioconcentration undergoes biomagnification in organisms through various trophic levels. As it travels through the food chain it poses serious impact on human health. The potential threats of these heavy metals in humans have to be controlled by biomonitoring of the aquatic system. The present study is focused on the appraisal of trace metals in water, sediment and aquatic organisms in Kottapuram-Chettuva *Kayal.*

## MATERIALS AND METHODS

The present investigation was carried on the heavy metal contamination in water, sediment and various aquatic animals of Kottapuram-Chettuava *Kayal* at Thrissur district in Kerala. The expanse of water has an approximate length of 50km. Four major rivers of Kerala such as Keecheri, Karuvannur, Chalakudy and Periyar join into this *Kayal*. Monthly samples of water, sediment and animals were collected from three stations for a period of twelve months from August 2009 to July 2010. Northern branch of Periyar River and also Chalakudy river drains at station I, station II is located where the Karuvannur River opens and station III is 15km away from the Chettuva barmouth. The samples were digested as per the methods of APHA (1998).The concentrations of metals were estimated by the method described by Danielsson *et al.* (1978 and 1982). Extracts were analyzed by Atomic Absorption Spectrophotometer. Analysis of variance and correlation coefficient were carried out for all the variables.

## RESULTS AND DISCUSSION

The seasonal mean concentration of copper, zinc and lead in water, sediment and tissues is depicted in Table 1. Analysis of variance of copper, zinc and lead is presented in Table 2. The copper content in water is almost similar in all stations (Fig.1). The copper concentration in water showed that the monthly and seasonal variations are significant. The maximum seasonal mean concentration (2.57 $\mu g.l^{-1}$) was measured during premonsoon at station III and minimum (0.74 $\mu g.l^{-1}$) during monsoon at station II. Copper content in sediment collected from Kottapuram-Chettuva *Kayal* is depicted in Fig.2. Sediment copper concentration did not vary significantly in all three sampling sites. However, this was not the case with different seasons and months when the copper occurrence was highly significant at $p<0.01$ level. Maximum seasonal mean concentration determined is 88.9$\mu g.g^{-1}$ during premonsoon (Station I) and minimum 24.43 $\mu g.g^{-1}$ during postmonsoon at station III. The gradual decrease in copper concentration both in water and sediment may be due to the intrusion of water from Karuvannur river and Chettuva barmouth and the eventual dilution of water in the system. The highest concentration (573.88$\mu g.g^{-1}$) was recorded in crab *Scylla serrata* and the lowest (17.68$\mu g.g^{-1}$) in the fish named *Ambassis thomassi.* Among fishes *Etroplus suratensis* recorded the maximum seasonal mean concentration (55.98$\mu g.g^{-1}$) and minimum in *Ambassis thomassi* (17.68 $\mu g.g^{-1}$) during monsoon and premonsoon respectively. Statistical analysis showed that there is no significant variation between seasons or months in the case of copper content in various tissues. No positive correlation was denoted between animal groups. Distribution of copper in water, sediment and tissue revealed that water exhibited the minimum values followed by sediment and maximum in the tissues of

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animals. The order of incidence of copper in various test animals, indicated that *Scylla serrata* > *Meretrix casta* > *Etroplus suratensis* > *Gerrus filamentosus* > *Ambassis thomassi* (Fig.3). Among animals, *Scylla* (Crab) and *Meretrix* (Clam) recorded highest values for copper than fishes probably on account of the copper containing pigment haemocyanin. The concentration of copper in *Meretrix* showed no positive relation with that of water. This lack of correlation might be due to the metal levels in bivalves may be responding largely to fluctuations in metals associated with suspended particles rather than soluble component. This seems to be in view of the high particle retention efficiencies shown by many bivalves.

Analysis of variance shows that the concentration of zinc in water was almost similar in all stations (Fig.4). The seasonal mean concentration ($0.87\mu g.l^{-1}$) was high during post monsoon at station II and minimum ($0.330\ \mu g.l^{-1}$) during premonsoon at station I. There is highly significant variation in concentration of zinc in sediment in all stations during various seasons. Maximum seasonal mean concentration ($59.96\ \mu g.g^{-1}$) was registered during postmonsoon at station II and minimum during monsoon at station III. The sediment concentration of zinc was seemed to be positively correlated with different stations (Fig.5). Pragatheeswaran *et al* .(1988) also reported high values of zinc during postmonsoon in water samples and sediments of Kodiyakkari coastal environment. The zinc concentration varied among animals at $p<0.05$ level. However seasonal variation is insignificant. Among fishes, the highest concentration was monitored in *Ambassis thomassi* during monsoon ($118.99\ \mu g.g^{-1}$) and lowest during premonsoon ($70.79\ \mu g.g^{-1}$). In comparison, the incidence of zinc in water and sediment was maximum in postmonsoon at station II and minimum in premonsoon. Among the test animals, fishes showed the maximum deposition of zinc in most cases followed by the bivalve and the crab (Fig.6). The zinc content in tissues seems to be high during monsoon. This indicate that the zinc content in the animal is related to either its feeding habits or to an increase in the water. The zinc in the animals is comparable to the zinc discharged from the industrial belt at Eloor to the Periyar River part of which reaches into this *Kayal* through its northern branch. The order of zinc in the system was tissue > sediment > water. The zinc concentration determined in sediment was almost 100 times higher than noted in water, where as in the case of tissues the concentration was almost doubled in comparison with the sediment values.

The concentration of lead in water seems to be similar in all the three stations (Fig.7) and not significant during different seasons and months. Both maximum ($1.45\mu g.l^{-1}$) and minimum ($0.1\mu g.l^{-1}$) seasonal mean concentration of lead was observed at station III during monsoon and premonsoon respectively. The lead content in water seems to be positively correlated with that of *Scylla serrata* ($r = 0.589$). The concentration of lead in sediment showed fluctuation during different seasons (Fig.8). Highest mean concentration ($35.14\ \mu g.g^{-1}$) in sediment was recorded during postmonsoon at station III and lowest ($3.77\ \mu g.g^{-1}$) during monsoon at station III. Lead concentration in sediment and tissues showed wide fluctuation during different seasons but its concentration in water was similar during all seasons. Among test animals *Meretrix casta* showed the maximum concentration of lead followed by *Scylla serrata.* In fishes the lead content seems to be below the detection limit during August, September and October (Fig.9). According to Eisler (1981) the apparent selectivity of lead among bivalve is reported to depend to a considerable extent upon its availability in the environment, its physical and chemical properties, the kind and number of ligands available for chelation, its transport and storage and the stability of the complex formed.

The trace metal cadmium was below the detection level in most of the months (Fig.10). Maximum concentration was registered during June at station I. No detectable concentration was obtained at station II throughout the sampling period. Concentration of cadmium in sediment was high (1.016µg.g-1) during February at station II (Fig.11). Except *Meretrix casta* all other animals registered nil value from August to March (Fig.12). In *Meretrix sp.*, the highest value ($2.95\ \mu g.g^{-1}$) was obtained during February. Cadmium levels showed order of abundance as tissues > sediment > water. Cadmium uptake by various organisms is correlated with cadmium concentration in water.

The mean tissue concentration of zinc, lead and cadmium were found to be low during premonsoon may be due to the low levels of these metals or the form in which they occur may not be readily available for an easy uptake by the animals.

Among fishes, *Etroplus* recorded higher values for all the trace metals compared to *Gerrus* and *Ambassis*. This may be due to the feeding behavior of these fishes where, *Etroplus* is a bottom feeder and others, column feeders. It is a known fact that the bottom feeders spending more time on bottom tend to forage and feed in an environment usually containing higher concentration of trace metal than the water column (1986).

**Table 1: Mean ± SE values of trace metals (µg.l-1 air dry wt.) in water, sediment and tissues collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

| | Stations | | | | | | Animals | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Water | | | Sediment | | | | | | | |
| | Station I | Station II | Station III | Station I | Station II | Station III | *Meretrix* | *Scylla* | *Ambassis* | *Etroplus* | *Gerrus* |
| Copper | | | | | | | | | | | |
| Monsoon | 1.40±0.29 | 0.74±0.08 | 1.00±0.07 | 35.78±3.22 | 34.45±3.13 | 30.05±5.81 | 223.55±46.39 | 254.63±110.6 | 40.13±7.40 | 55.98±4.98 | 27.58±3.72 |
| Post-Monsoon | 2.27±0.49 | 2.26±0.49 | 2.45±0.47 | 37.68±2.47 | 33.58±0.85 | 24.43±2.76 | 358.40±136.46 | 573.88±60.92 | 50.71±20.21 | 52.75±4.97 | 48.33±8.3 |
| Pre-Monsoon | 1.20±0.23 | 1.81±0,81 | 2.57±1.13 | 88.91±33.25 | 76.6±24.71 | 66.81±17.41 | 389.20±160.43 | 207.69±126.75 | 17.68±4.25 | 37.19±8.02 | 36.50±7.93 |
| | | | | | | | | | | | |
| Zinc | | | | | | | | | | | |
| Monsoon | 0.48±0.07 | 0.52±0.06 | 0.60±0.10 | 37.86±0.82 | 42.52±2.21 | 31.99±0.65 | 75.22±7.56 | 61.85±12.39 | 118.99±17.89 | 17.14±18.1 | 85.15±20.60 |
| Post-Monsoon | 0.65±0.12 | 0.87±0.35 | 0.39±0.05 | 46.40±4.08 | 59.96±5.06 | 44.03±3.68 | 77.73±4.40 | 62.70±4.18 | 110.74±25.86 | 73.45±16.25 | 85.98±13.56 |
| Pre-Monsoon | 0.33±0.11 | 0.41±0.13 | 0.41±0.18 | 55.39±12.29 | 55.29±7.29 | 53.47±10.54 | 78.61±3.78 | 79.41±5.13 | 70.79±10.11 | 89.70±24.98 | 75.88±18.84 |
| | | | | | | | | | | | |
| Lead | | | | | | | | | | | |
| Monsoon | 0.07±0,04 | 0.07±0.04 | 1.14±0.69 | 3.77±0.47 | 3.94±0.35 | 11.61±1.36 | 137.59±7.37 | 47.88±10.59 | 2.91±0.60 | 4.67±2.89 | 7.10±3.10 |
| Post-Monsoon | 0.40±0.23 | 1.30±0.29 | 1.45±0.61 | 20.40±5.19 | 18.42±2.91 | 35.14±4.92 | 129.69±21.57 | 77.28±28.31 | 4.59±1.73 | 3.49±1.47 | 6.08±4.35 |
| Pre-Monsoon | 0.17±0.12 | 0.89±0.33 | 0.01±0.01 | 6.99±2.48 | 7.27±0.52 | 19.25±2.12 | 109.86±32.35 | 37.79±14.58 | 1.32±0.56 | 13.41±3.92 | 11.56±3.96 |

**Table 2: Data showing the Analysis of variance of trace metals in water, sediment and tissues collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

| | | COPPER | | | ZINC | | | LEAD | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SOURCE | df | SS | MSS | F VALUE | SS | MSS | F VALUE | SS | MSS | F VALUE |
| WATER | | | | | | | | | | |
| TOTAL | 35 | 48.18 | | | 3.49 | | | 24.19 | | |
| STATIONS | 2 | 1.22 | 0.61 | 1.03 | 0.12 | 0.06 | 0.86 | 2.9 | 1.45 | 2.46 |
| SEASONS | 2 | 10.06 | 5.03 | 8.45** | 0.39 | 0.2 | 2.8 | 3.48 | 1.74 | 2.95 |
| PERIODS WITHIN SEASONS | 9 | 23.8 | 2.64 | 4.44** | 1.45 | 0.16 | 2.31 | 4.83 | 0.54 | 0.91 |
| ERROR | 22 | 13.1 | 0.56 | | 1.54 | 0.07 | | 12.97 | 0.59 | |
| SEDIMENT | | | | | | | | | | |
| TOTAL | 35 | 42524.79 | | | 7267.13 | | | 4234.79 | | |
| STATIONS | 2 | 1131.74 | 565.87 | 3.17 | 547.47 | 273.73 | 7.48** | 1127.99 | 563.99 | 68.04** |
| SEASONS | 2 | 16055.76 | 8027.88 | 44.99** | 1918 | 959 | 26.22** | 2142.77 | 1071.39 | 129.25** |
| PERIODS WITHIN SEASONS | 9 | 21412.07 | 2379.12 | 13.33** | 3966.94 | 444.1 | 12.14** | 781.65 | 86.85 | 10.48** |
| ERROR | 22 | 3925.22 | 178.42 | | 804.71 | 36.58 | | 182.37 | 8.29 | |
| ANIMALS | | | | | | | | | | |
| TOTAL | 59 | 25816932 | | | 60849.59 | | | 170628.6 | | |
| STATIONS | 4 | 1246913 | | 14.62** | 7868.44 | 1967.11 | 2.83* | 132115.2 | 33028.79 | 55.33** |
| SEASONS | 2 | 105776.3 | 52888.13 | 2.48 | 1769.06 | 884.53 | 1.27 | 895.08 | 447.54 | 0.75 |
| PERIODS WITHIN SEASONS | 9 | 291120.1 | 32346.68 | 1.52 | 20646.41 | 2294.05 | 3.3** | 11353.98 | 1261.55 | 2.11* |
| ERROR | 44 | 937881.8 | 21315.49 | | 30565.69 | 694.67 | | 26264.39 | 596.92 | |
| FISHES | | | | | | | | | | |
| TOTAL | 35 | 13966.8 | | | 50661.59 | | | 1398.18 | | |
| STATIONS | 2 | 1127.44 | 563.72 | 2.04 | 1946.91 | 973.45 | 1.23 | 189.43 | 94.71 | 3.03 |
| SEASONS | 2 | 2437.82 | 1218.91 | 4.41* | 4873.03 | 2436.52 | 3.07 | 125.21 | 62.6 | 2 |
| PERIODS WITHIN SEASONS | 9 | 4316.37 | 479.6 | 1.73 | 26385.44 | 2931.72 | 3.69** | 396.37 | 44.04 | 1.41 |
| ERROR | 22 | 6085.17 | 276.6 | | 17456.22 | 793.46 | | 687.18 | 31.24 | |
| *(p< 0.05) | **(p< 0.01) | | | | | | | | | |

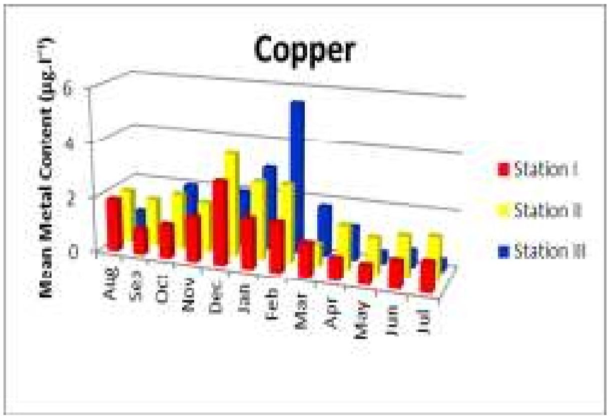


**Figure 1: Copper content in water collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

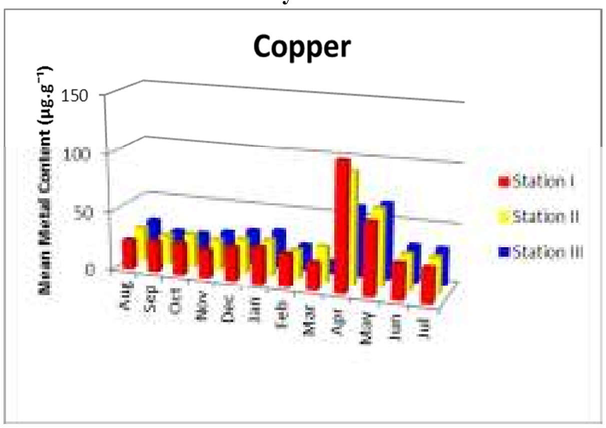


**Figure 2: Copper content in sediment collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

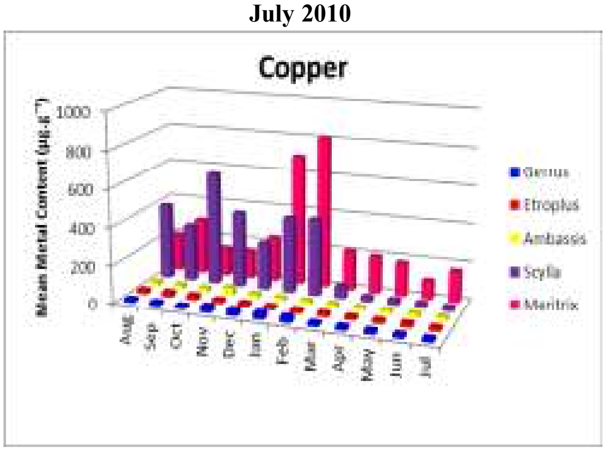


**Figure 3: Copper content in animals collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

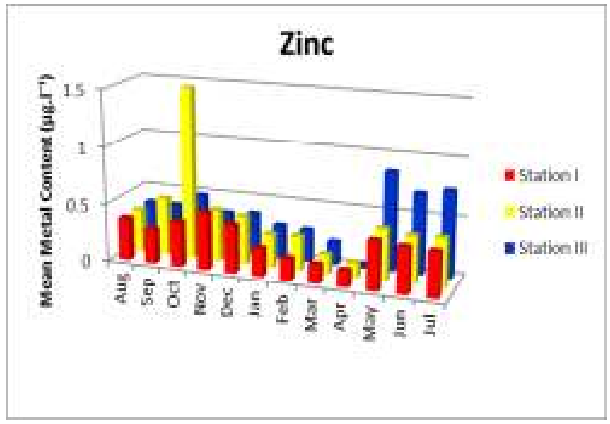


**Figure 4: Zinc content in water collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

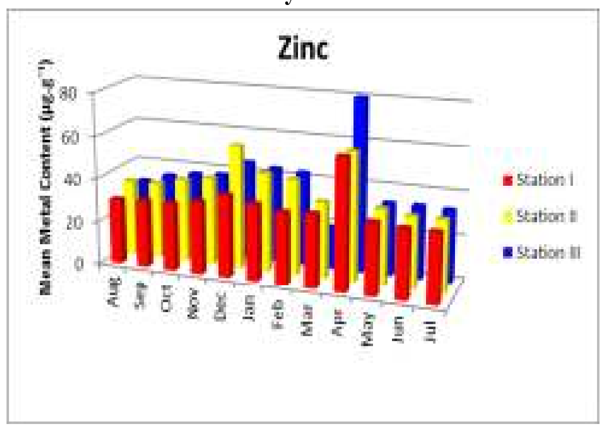


**Figure 5: Zinc content in sediment collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

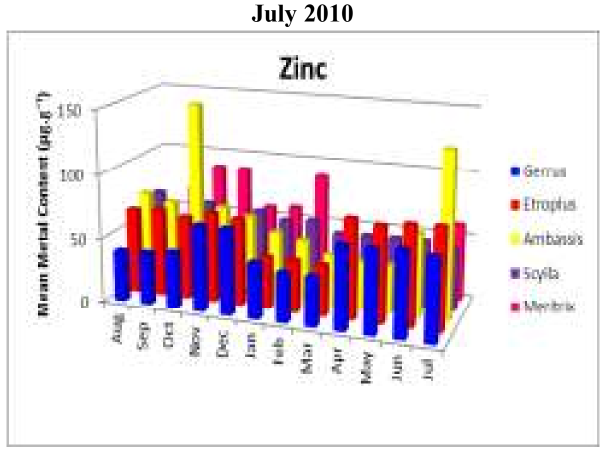


**Figure 6: Zinc content in animals collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

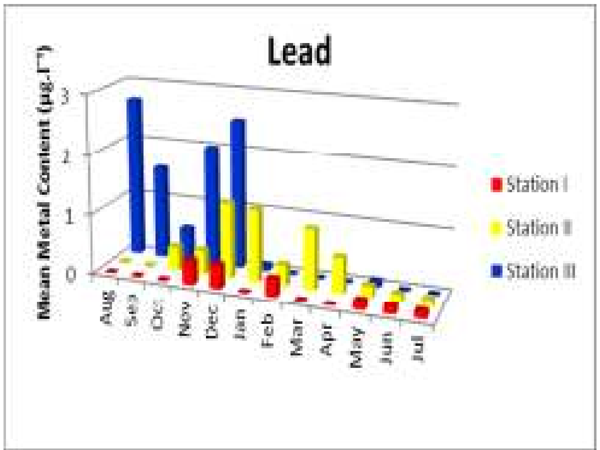


**Figure 7: Lead content in water collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

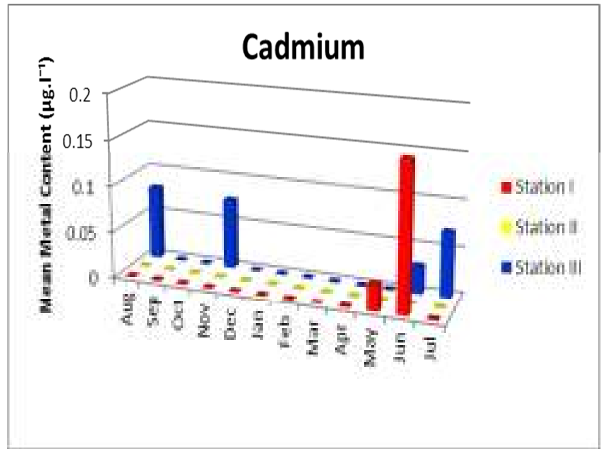


**Figure 10: Cadmium content in water collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

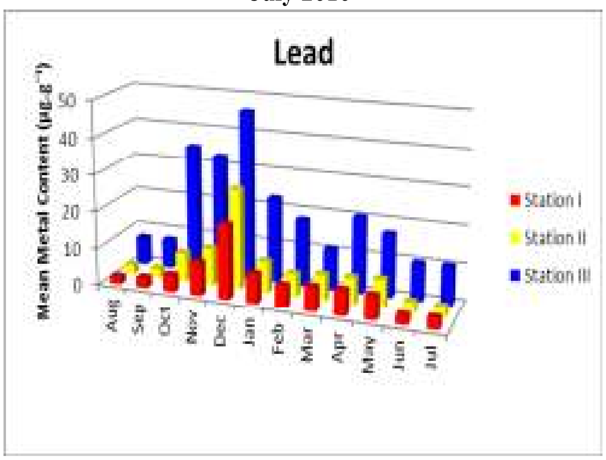


**Figure 8: Lead content in sediment collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

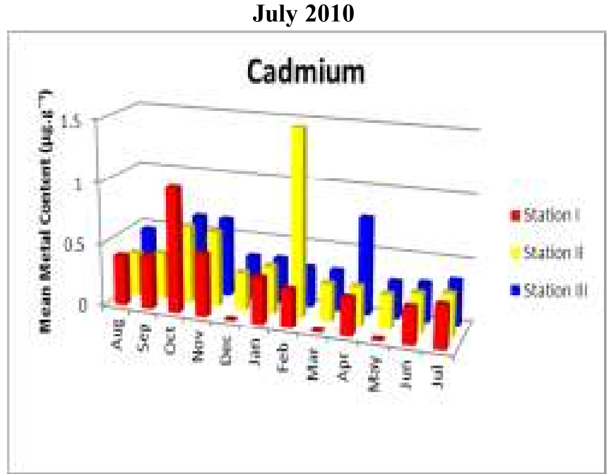


**Figure 11: Cadmium content in sediment collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

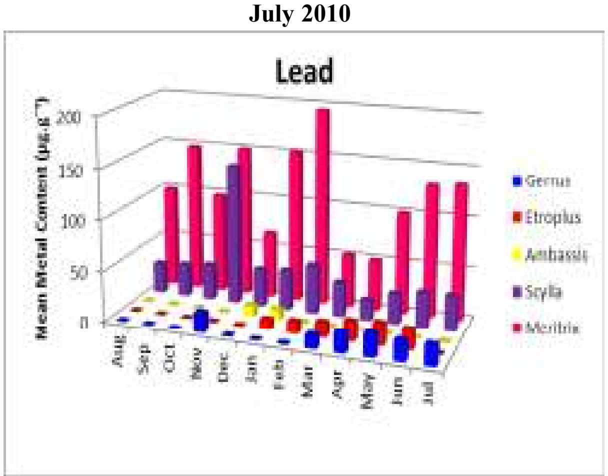


**Figure 9: Lead content in animals collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

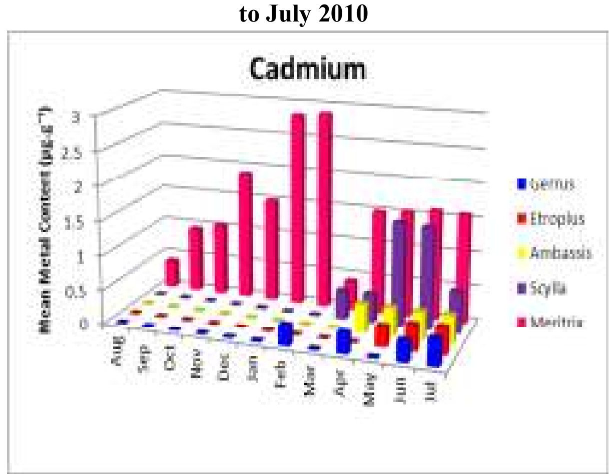


**Figure 12: Cadmium content in animals collected from Kottapuram-Chettuva *Kayal* during August 2009 to July 2010**

## CONCLUSION

The study indicates that the trace metals entering into this water body through some sources. The present investigation revealed that copper content was high and cadmium was low trace metal at all the three compartments. Copper concentration is high in animals followed by sediment and water. A systematic monitoring of all water quality parameters including all trace metals are required in order to get a clear picture on the pollution prevailing in this water body. Further studies and close vigil is needed in order to keep this system clean, healthy and free from pollution.

## ACKNOWLEDGEMENT

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