Trace metal analysis in zooplankton from Dandi creek - west coast of India

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Abstract- Zooplankton was sampled from Dandi creek -west coast of India (19^0, 48.041'N and 72^0, 41.255'E) on monthly basis from September 2009 to September 2010.Three stations were selected for collection of zooplankton, station 1 was in the open sea, station 2 was in the mouth of the creek and station 3 was in the creek. These stations covered an area of 12 km long and the depth varied from 2.7 to 25.5 meters (average 13.22 m). Five metals including Cadmium (Cd), Chromium (Cr), Lead (Pb), Mercury (Hg) and Arsenic (As) were analyzed in the zooplankton using Plasma Emission Spectrometer. Out of these five metals Arsenic (As) and Mercury (Hg) were not detected in zooplankton sample throughout the study period. The concentration of heavy metals shows variation in open sea, mouth of the creek and inner creek area .The concentration of Cadmium (Cd) in open sea ranged from 0.6376 to 2.958 ppm (average 1.3404 ppm), at the mouth of the creek 0.4486 to 1.932 ppm (average 1.1186) and 0.3750 to 2.954 ppm (average 1.6593 ppm) in inner creek. The concentration of Chromium (Cr) ranged from 9.471 to 67.56 ppm (average 25.369 ppm) in open sea, 8.326 to 56.19 ppm (average 20.403 ppm) at mouth of the creek and 13.88 to 54.69 ppm (average 31.776) in inner creek . The concentration of Lead (Pb) ranged from 9.584 to 49.97 ppm (average 20.90 ppm) in open sea, 3.799 to 47.28 ppm (average 25.95 ppm) at mouth of the creek and 4.410 to 62.63 ppm (average 36.68 ppm) in the inner creek area.

Index Terms- Heavy metals, Zooplankton, Dandi creek, West coast, Thane.

I. INTRODUCTION

India, with long coastline of over 8000 km has an area of about 2.015 x 10^6 km^2 as its exclusive economic zone (Ibrahim, *et al*., 1995). Western coastline has a wide continental shelf having an area of 0.31 million km^2 which is marked by backwaters and mudflats. Presently, Indian coastline is facing increasing human pressure viz, overexploitation of marine resources, dumping of industrial and toxic wastes, oil spills and leakages which have resulted in damage to marine ecosystem. Mumbai, the financial capital of India is generating about 3000 MLD of sewage from seven service areas and discharging into adjoining West Coast, Malad, Mahim, Marve and Thane Creeks (Kamble, *et al*.,2010). Thane district is blessed with vast natural water resources in the form of perennial rivers which are major source of drinking water supply to Mumbai. Further, it also has a long coastline and a wide network of small creek-lets. The important occupations in the region are fisheries and agriculture, which are highly dependent on these important water resources. The heavy industrialization and the increasing urbanization are responsible for the rapidly increasing stress on the water environment of the area. It is therefore necessary to protect these water resources of the region. Ecologically sensitive area of Dahanu Taluka and critical polluted area of Tarapur industrial estate are under the jurisdiction of Thane Region. The region is also marked with the long coast line and rapidly growing residential areas of Thane, Mira- Bhayander, Vasai, Virar etc. (MPCB Report May 2005). In order to control the marine pollution it is necessary to generate data base on the pollutant status in a region for comparison and for other studies. Planktons are sensitive to the presence of a wide spectrum of pollutants and hence their species diversity and or abundance can be used as an indicator of water quality (Ibrahim and Joseph 1995). Zooplankton may contribute to the transfer of trace metals to higher trophic level and have been chosen as one of the recommended groups for the baseline studies of metals in the marine environment (Rejomon *et al*., 2008). The presence of very minute quantities of pollutants may become harmful either due to their direct effect on zooplankton or indirectly due to the transfer of the pollutants to other trophic levels through zooplankton (Rezai *et al*.,2003). Among the heavy metals cadmium (Cd) and mercury (Hg) have the ability to accumulate in food webs, and most of the long- lived predatory species exhibits high concentration of these toxic metals (Bocher *et al*.,2003).

Mercury pollution problems can be linked to specific sources of contamination and this is of great concern when such sources are adjacent to marine eco system supporting fisheries (Ninomiya *et al*., 1995). The built up of metal concentration in coastal areas receiving industrial effluents and sewage may affect the growth and development of plankton leading to decrease in the productivity of the region. The uptake of metals by plankton provides an entry in to the marine food chain. Heavy metals are one of the constituents that affect marine ecosystem. Their toxicity in aquatic ecosystem determined their chemical forms. Changes in oxidation state of the heavy metal can have profound effect on their toxicity and bioavailability (Donart & Bruland, 1995).The 8 most common pollutant heavy metals listed by Environmental Protection Agency (EPA) are Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead and Zinc. They are released in water bodies through effluent discharge from industries, metal processing, paints and pigment production, biocides production units and through domestic sewage. Marine pollution due to metals is less visible and direct as compared to other types of marine pollution but its effects on marine ecosystems and humans are very extensive. The concentration of metals varies among the fishes based on the fish species; age, developmental stage and other physiological factors. Fish accumulate substantial concentrations of mercury in their tissues and thus can represent a major dietary source of this element for humans. Fish are the single largest sources of mercury and arsenic for man (Khayatzadeh & Abbasi, 2010). Among the heavy metals cadmium and mercury have the ability to accumulate in food webs, and most of the long- lived predatory species exhibit high concentration of these toxic metals due to biomagninification (Bocher *et al*., 2003). **Lead** is highly toxic substance, exposure to which can produce a wide range of adverse health effect. There are many ways in which human beings are exposed to lead, through household dust, bare soil, food, drinking water, ceramics, deteriorating paints, home remedies, and other cosmetics. Lead is microscopic and invisible to the naked eye. At high level of exposure, a child may become mentally retarded, fall into a coma even results in death from lead poisoning. Lead can increase blood pressure in adult and also responsible for muscle and joint pain, fertility problems, nerve disorders etc. **Cadmium** is distributed in earth's crust and it is principally used as the pigments in plastics and electroplating. It is also used in different industrial processes. Water with very high cadmium level is harmful to the stomach, leading to the vomiting and diarrhea. Based on the limited data on human, the United States Department of Human Health and Human Services (DHHS) has determined that cadmium and calcium compound are carcinogenic. Cadmium is toxic to plants, animals and microorganisms.

It accumulates mainly in the kidney and liver of vertebrates and in aquatic invertebrates and algae. It can affect marine plants resulting in decreased growth rate and even death. **Chromium** is naturally occurring compound found in rock, soil, and aquatic plants. The major sources of chromium emission in to the marine environment are the chemical manufacturing industries, cement producing plants, combustion of fossil fuel, textile industries, paper and paint industries etc. Chromium can cause asthma, kidney failure, inflammation of the skin , abdominal pain and teeth discoloration . **Mercury** is thick and only metal that is liquid at room temperature. It is an element exists in several forms and various compounds. All are toxic and some are lethal in very small quantities. Mercury effortlessly penetrates cell membrane and gets deep into living tissues including brain and placenta of mammals. It can cause neurological damage, immune system suppression and can cause fatal abnormalities in mammals .In humans it has been associated with various neurological effects, abnormal development and heart damage, visual field constriction, behavioral changes, memory loss, headaches, tremor, loss of fine motor control, spasticity, hair loss. mental retardation in children, Seizures, Cerebral palsy ,Blindness and deafness , Disturbances of swallowing, sucking, and speech , hypertonia, a muscle rigidity etc.The main source of this mercury is contaminated seafood. Mercury levels over 0.5 to 1.0 ppm are considered unsafe for human consumption. **Arsenic** is a metal and is found throughout the earth crust, most often as arsenic sulphide or as metal arsenates and arsenides. In fact arsenic is found in trace amounts in all living matter. In commercial and industrial use, arsenic is used in manufacture of transistors, lasers and semiconductors, as well as processing of glass, pigments, textiles, paper, metal adhesives, ceramics, wood preservatives, ammunition and explosives. Arsenic is also used to limited extent in pesticides, food preservatives and pharmaceuticals including veterinary drugs. Depending upon the amount arsenic can be toxic to marine fishes, invertebrates, zooplankton plankton and aquatic plants. Arsenic in large quantity is also harmful for human and responsible for many diseases such as irritation of stomach and intestine, decreased production of erythrocytes and leukocytes, skin cancer, lymphatic cancer, skin changes, lung irritation and DNA damage. Information of heavy metals from coastal waters around Mumbai and Thane region are limited. Zooplankton being the main constituents of food of most of the fishes of the coastal waters, play an important role in transfer of heavy metals among the fishes through food chain. Dandi creek and adjacent sea receive large quantity of industrial effluents from the surrounding the Boisar – Tarapur industrial belt.

Discharge from the industries is linked to arsenic in the surrounding water bodies including Dandi creek which may find its way in to the zooplankton and then in to the fishes and humans through aquatic food chain. This paper briefly evaluates the presence of some heavy metals in zooplankton of the Dandi creek and examines the possible implications on the fish production in Dandi coastal area.

II. Materials and Methods

Zooplankton samples were collected from 3 different locations (Fig.1), using H.T.Net with TSK flow meter attached to the mouth of the net with the help of mechanized boat. During sampling, guidelines suggested by Bernhard (1976) were strictly followed to avoid the contamination.

Collected samples were kept in ice box and immediately brought in the laboratory for metal analysis. On reaching the laboratory the samples were washed with distilled water, dried at 70 ^{0}C, powdered and stored. The dried samples were digested in conc. HNO_3 (15-25ml) followed by perchloric acid until a clear solution was obtained. The volume of the solution was made 10 ml with glass distilled water. The metals were analyzed by PES, AAS and ICP methods (Fishman & Friedman, 1984., APHA, 1992 &1998). Total 5 metals, Cd, Cr, Pb, Hg, and As were analyzed from three different stations i.e. station 1,2 and 3. Station 1 representing open sea where as stations 2 mouth of the creek and station 3 representing the inner zone of the creek

III. Results and Discussion

The concentration of different heavy metals observed in Zooplankton at different stations of Dandi creek are given in the table1-3 & fig.1.1-1.3.Among the five metals arsenic and mercury were not detected in any of the zooplankton sample. The concentration of cadmium at station 1 was in the range of 0.6376 to 2.958 ppm (av. 1.351 ppm).The maximum value was observed in the month of August and minimum in the month of November. The concentration of lead ranged between 9.576 and 49.97 ppm with an average of 20.8596 ppm. The maximum value recorded in the month of August and minimum in the month of September. The chromium concentration was in the range of 9.471 and 67.56 ppm (av.25.3601ppm). The maximum value was observed in the month of September and the minimum in April.

At station 2 the concentration of cadmium ranged between 0.4486 and 11.659 ppm with an average of 1.88031ppm. The maximum value was observed in the month of May and the minimum in the month of September. The concentration of lead ranged from 3.799 to 47.28 ppm (av.25.9513ppm). The maximum value recorded in the month of May and minimum in September. Chromium concentration was in the range of 8.326 to 56.19 ppm giving an average of 20.40ppm. The maximum value was observed in the month of October and the minimum in March. Cadmium concentration at station 3 was in the range of 0.375 and 2.954 ppm (av.1.659ppm). The maximum value was recorded in the month of July and the minimum in the month of December. The concentration of lead was in the range of 4.094 to 62.63 ppm with an average of 36.06 ppm. The maximum value was recorded in the month of March and the minimum in the month of November. Concentration of chromium ranged between 13.88 and 54.69 ppm giving an average of 31.77pm. The maximum value was observed in the month of August and the minimum in the month of March. In general there was quite significant variation at all three stations in premonsoon monsoon and postmonsoon seasons.

In the present investigation five metals were analysed in zooplankton samples, in which cadmium chromium and lead were present in the zooplankton samples throughout the study period. It may occur due to the bioaccumulation and biomagnifications process. Asha *et al* .(2010) observed concentration of lead in zooplankton in the range of 0.5 to 1.21 from Tuticorin Bay. Chinnaraja *et al* .(2011) recorded the lead concentration from 1.25 to 16.43 ppm in zooplankton from Coromandal coast. Gajbhiye & Nair (1985) reported cadmium concentration form 6.85 to 14.57 ppm in zooplankton from nearshore waters of Mumbai. In zooplankton chromium concentration was slightly higher (8.32 to 67. 56 ppm). High chromium concentration (0.98 to 60.30 ppm) in zooplankton was reported by Tisan & Chandy (2011) from Ropmes Sea. Zauke and Schmalenbach(2010) observed heavy metal in zooplankton and decapod crustaceans from the Barents Sea. The presence of heavy metals in water and zooplankton indicative of deterioration of aquatic system and increased concentration may adversely affect the marine life.

IV. Conclusion

The present investigation on the heavy metal analysis in zooplankton shows an increase of certain metals in the creek regions and this may suggest the decline of fish production in this area. If control measures are not followed then the fishery potential of Dandi coastal area may decline and or may cause various diseases in human beings who consume them. The present investigation suggests that the health of Dandi creek is affected due to various developmental changes including the growth of chemical industries in Tarapur MIDC area, due to the growing chemical industries discharging effluents from industries and domestic sewage from nearby villages.

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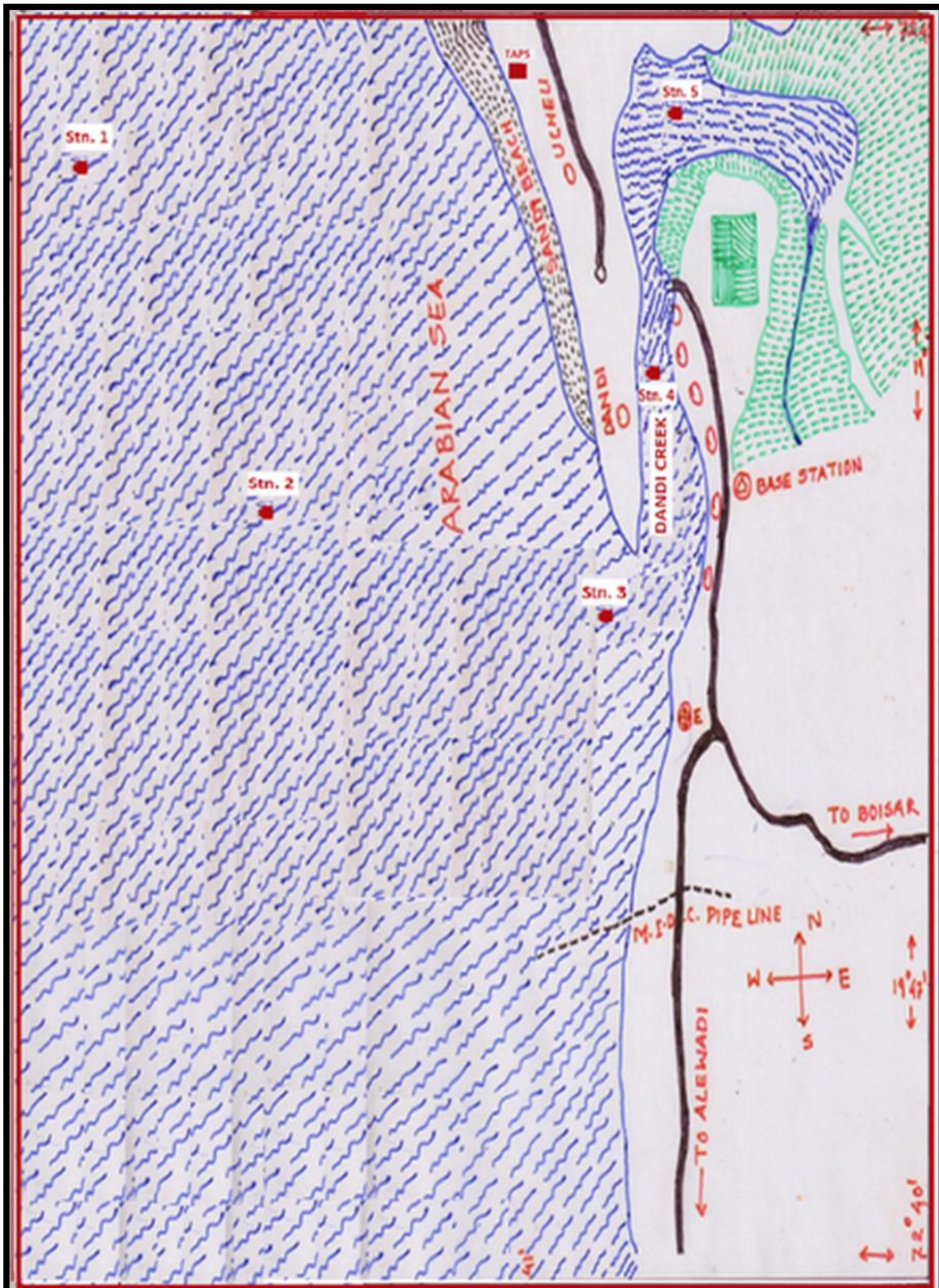


Fig.1 Map showing location the stations

Table-1-3: Variation of heavy metals in zooplankton at different stations during 2009-10 (Values in ppm dry weight)

Station 1

Months	Cd	As	Pb	Hg	Cr
Sep,09	**1.518**	**ND**	**9.576**	**ND**	**67.56**
Oct	**0.6735**	**ND**	**27.07**	**ND**	**37.08**
Nov	**0.6376**	**ND**	**10.17**	**ND**	**35.82**
Dec	**0.9209**	**ND**	**20.2**	**ND**	**19.7**
Jan,10	**0.8226**	**ND**	**13.79**	**ND**	**26.42**
Feb	**0.9612**	**ND**	**9.589**	**ND**	**14.89**
Mar	**0.8974**	**ND**	**10.89**	**ND**	**18.35**
Apr	**1.392**	**ND**	**19.28**	**ND**	**9.471**
May	**1.965**	**ND**	**30.39**	**ND**	**17.98**
Jun	**1.8896**	**ND**	**20.69**	**ND**	**18.32**
Jul	**1.265**	**ND**	**39.24**	**ND**	**13.69**
Aug	**2.958**	**ND**	**49.97**	**ND**	**23.98**
Sep	**1.456**	**ND**	**10.32**	**ND**	**26.42**

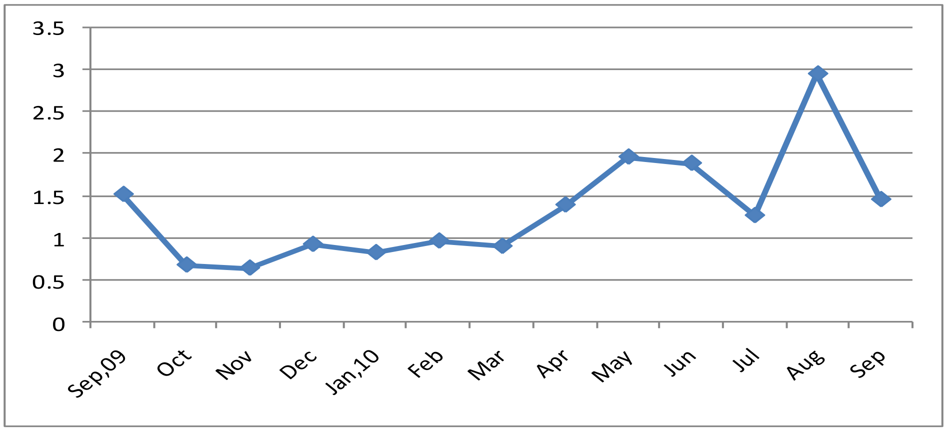
Station 2

Months	Cd	As	Pb	Hg	Cr
Sep,09	0.4486	ND	21.89	ND	14.44
Oct	1.111	ND	5.793	ND	56.19
Nov	0.9882	ND	3.799	ND	32.53
Dec	0.7576	ND	9.115	ND	18.33
Jan,10	0.79984	ND	33.21	ND	10.69
Feb	1.465	ND	29.28	ND	29.48
Mar	1.547	ND	32.18	ND	8.654
Apr	0.9834	ND	28.81	ND	13.88
May	1.932	ND	47.28	ND	26.13
Jun	0.6984	ND	41.65	ND	9.365

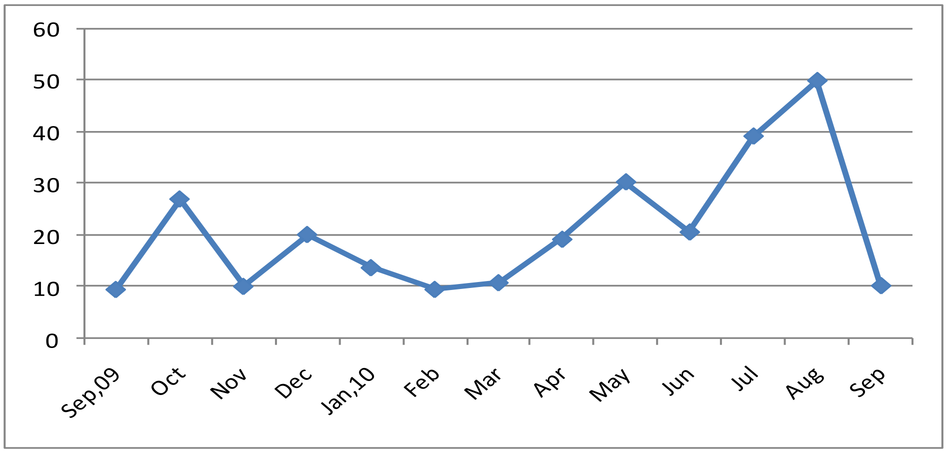
Jul	1.069	ND	26.49	ND	26.54
Aug	11.659	ND	38.46	ND	8.326
Sep	0.985	ND	19.41	ND	10.69

Station 3

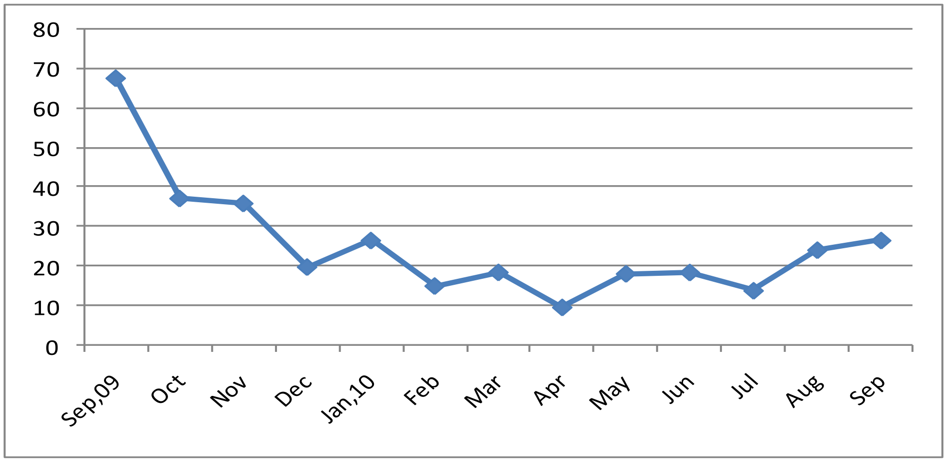
Months	**Cd**	**As**	**Pb**	**Hg**	**Cr**
Sep,09	1.093	ND	4.094	ND	24.97
Oct	0.6586	ND	10.96	ND	47.94
Nov	0.6827	ND	4.41	ND	42.27
Dec	0.375	ND	9.366	ND	19.99
Jan,10	1.098	ND	42.36	ND	21.54
Feb	2.161	ND	39.93	ND	21.88
Mar	1.669	ND	62.63	ND	13.88
Apr	1.398	ND	40.36	ND	24.69
May	2.698	ND	57.72	ND	32.86
Jun	2.168	ND	28.97	ND	39.26
Jul	2.954	ND	59.58	ND	47.59
Aug	2.632	ND	51.25	ND	54.69
Sep	1.984	ND	57.26	ND	21.54



Concentration of Cadmium

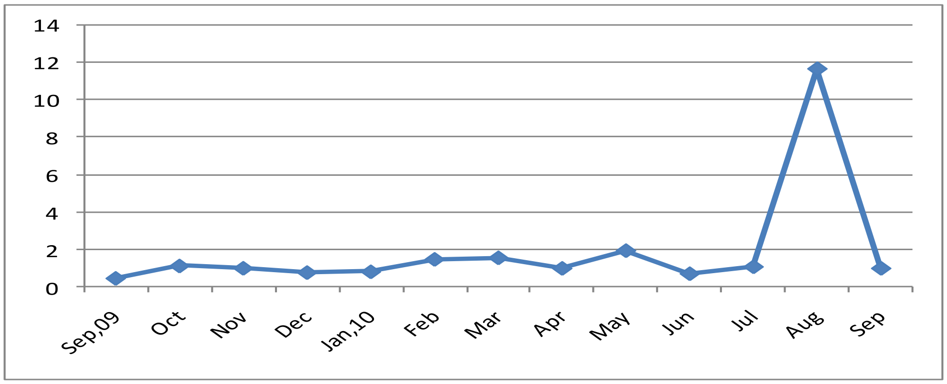


Concentration of Lead

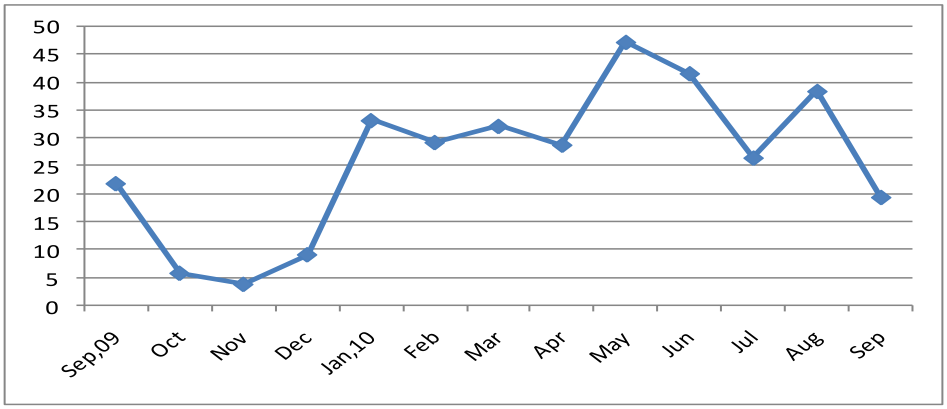


Concentration of Chromium

Fig-1.1 Variation of heavy metal in Zooplankton at Station 1 during 2009-10



Concentration of Cadmium



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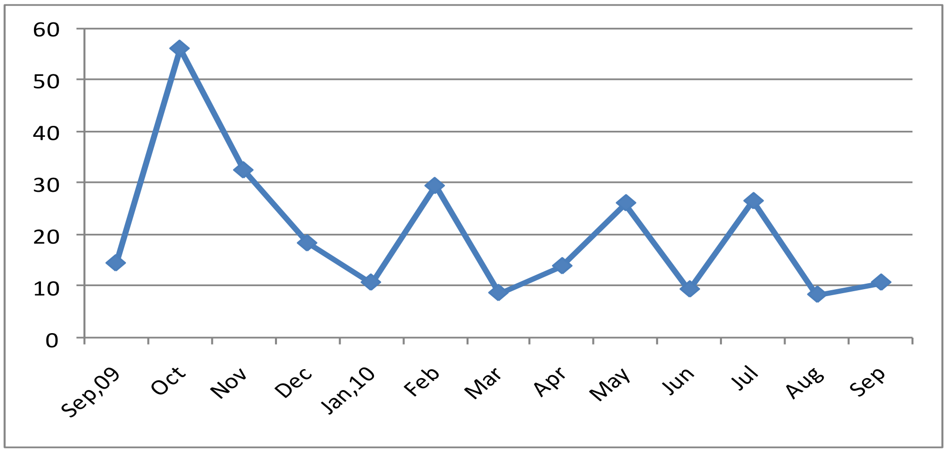
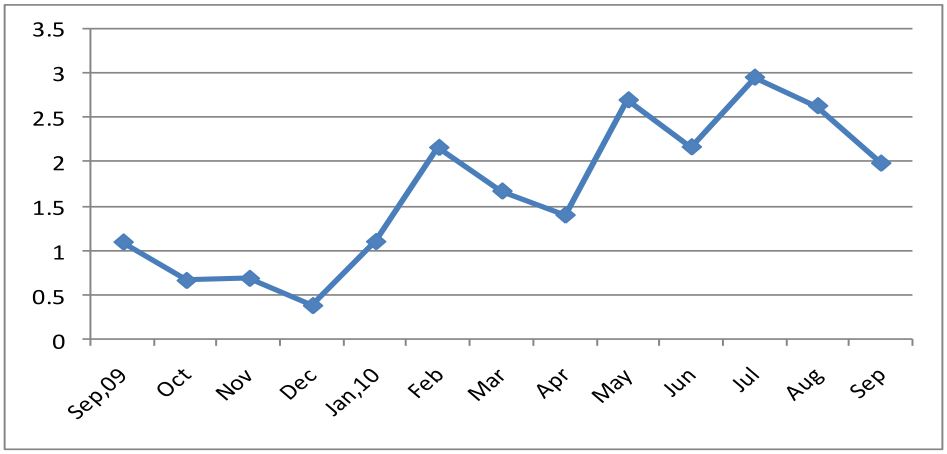


Concentration of Chromium

Fig-1.2 Variation of heavy metal in Zooplankton at Station 2 during 2009-10



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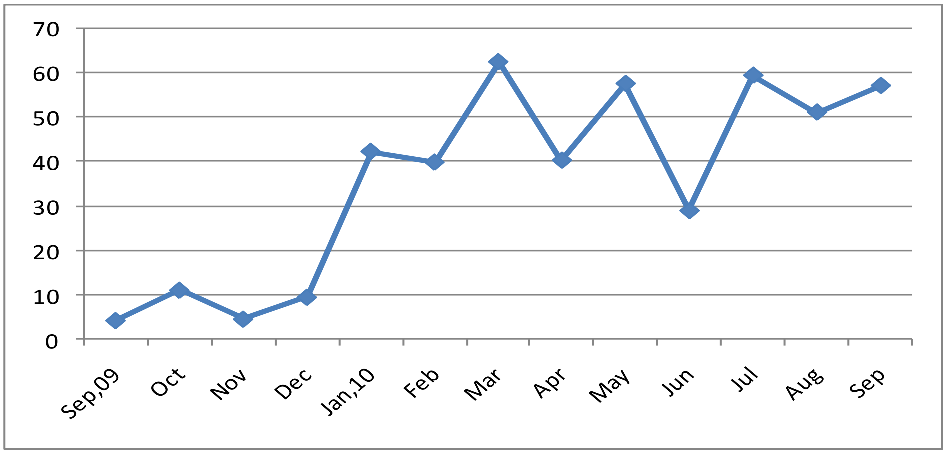

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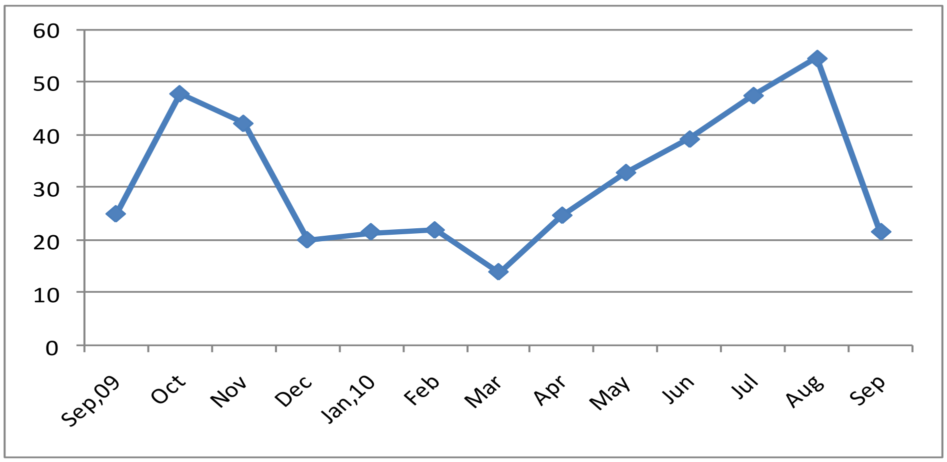

Concentration of Chromium

Fig-1.3 Variation of heavy metal in Zooplankton at Station 3 during 2009-10