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Bioaccumulation Of Selected Heavy Metals In *Scylla Serrata* (Forskal, 1775) And *Mugil Cephalus* (Linnaeus,1758) Of Punnakayal Mangrove Ecosystem

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ABSTRACT
The aim of the work is to analyse the selected heavy metal concentration in *Scylla serata* (Forskal, 1775) and *Mugil cephalus* (Linnaeus ,1758) of punnakayal mangrove ecosystem. The heavy metal concentration in sediment, water were also studied. Heavy metal concentrations in water(µg/l) Cu (3.86)> Cd (1.29)> Pb(0.980); sediment (µg/g)Cu (19.16)>Pb(14.43)>, Cd (13.4); crab(µg/g)Cu (1.31) > Pb (0.38)> Cd (0.262) and fish (µg/g)Cu (0.36)> Cd (0.18)> Pd (0.15) were documented. The maximum concentration of heavy metals were found in sediment and minimum concentration was found in fish tissue. Metal concentrations were within the safe limit in the organisms studied and there is every possibility of increase in metal concentration in the near future due to continuing anthropogenic activity. In the selected area the physico chemical parameters of water were also analysed and recorded as temperature, 26˚c; salinity, 28.56 ‰; Dissolved Oxygen, 3.100 mg/l; Turbidity, NT units 1.6; total dissolved solids, 48423 mg /l; electrical conductivity, 72274; pH, 7.61; total salkalinity, 112mg/l; total hardness, 6200 mg/l; calcium, 1520 mg/l ; magnesium, 576 mg/l; sodium, 14200g/l; potassium, 1400 mg/l; iron, 0.24 mg/l; free ammonia, 0.13mg/l; nitrite, 0.10 mg/l; chloride, 22500; fluoride, 23 mg/l; sulphate, 2588mg/l and phosphate, 0.10 mg/l. Biochemical composition in muscle of the crab and fish revealed the presence of high amount of protein 24.67 and 29.05 mg/g wet weight respectively. Total heterotrophic bacterial load was highest in the sediment (173 x 10^{-3} CFU g^{-1}) and lowest in the fish (88 x10^{-3} CFU g^{-1}).

INTRODUCTION
Urbanaization and industrialization senerely affected mangrove ecosystems, that they have lost their important functions as a fishing ground, preventing coastal erosion and retaining pollution (Ostano and Villate, 2006). Industrial agricultural and concentration in coastal water (Sanker *et al.,* 2006). Bioaccumulation of toxic heavy metals become an environmental problem. These metals enter the food chain and get accumulated to dangerous levels and affected human health (Manahan, 2000). World Health Organization (WHO, 1995) insisted the control of heavy metals in the food source. Higher concentration of heavy metals in food when consumed results in diseases such as cardiovascular, renal, neurological and bone diseases (Chalia Pakul *et al.,*2008) .
Since heavy metal contamination occurs worldwide several researches are carried out and their presence in water, sediment, plants and animals proved the existence of natural or manmade sources and the need to find their impact on living organisms (Harikamal and Jista, 2010).
Finfish and shellfish are rich sources of high quality protein and fetches worldwide importance as food.
Heavy metal analysis was made sediments (Sthevan *et al.,* 2011), molluscs and fish (Laxmi *et al.,*2011) and crab (Muhammed *et al.,*2016) collected from mangrove , estuarine and coastal water. Kannan *et al.,*(2016) estimated heavy metal concentration in water, sediment, mangrove and associated mangrove species of Ennore mangrove ecosystem of India.

MATERIALS AND METHODS
Water, sediment and animal sample for the present study were collected from punnaikayal mangrove ecosystem. Punnaikayal mangrove area located at lat. 08˚ 39’ 491’’ N, long. 78˚ 07’ 234’’E.
Water sample in duplicate for the measurement of inorganic and organic constituent were collected in pre – cleaned, polyethylene bottles and stored in an ice box and brought to the laboratory. To estimate dissolved oxygen, samples were collected in 300 ml acid washed reagent bottles and fixed immediately. Physico chemical parameter were analysed by the standard methods (APHA). Biochemical analysis of crab and fish muscle were made following the methods of Lowery *et al.,*(1951), Bragdon (1951) and aim modified methods of Sheifter *et al.,*(1950) for protein , lipid and carbohydrate respectively. Total heterotrophic bacterial load was estimated (APHA, 1992). Heavy metal analysis for heavy metals analysis tissus were dried in hot air oven at 80˚c ± 1˚c for 24 hours and ground. 1 g of powder was digested with 9ml of concentrated nitric acid and 1 ml of perchloric acid .Sample was heated for evaporation on a hot plate. Digested sample was filtered and made to 25 ml using double distilled water. Pb , Cu and Cd were analysed using Atomic Absorption Spectrophotometer(AA SELI CO SD 194). Metals also analysed for sediment and water.

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RESULT

Fish and shellfish serves as good source of protein to feed the exploding population. The present investigation evaluate the nutritional quality of *Scylla serrata* and *Mugil cephalus* and analysed the potential risk of heavy metals associated with their consumption.

WATER QUALITY PARAMETERS

In the selected area the water temperature was recorded as 26°C and the salinity found by using refractometer was 28.56 ‰. The water sample was taken immediately to the laboratory without allowing any change for further analysis. The pH and the electrical conductivity were measured by the pH meter and found to be alkaline that is 7.61 and 72274 micro mho/cm respectively. Spectrophotometer readings showed that the turbidity of the water was 1.6 NT unit. Total dissolved solids weighed after evaporating the known volume of water in the oven was 48423 mg/l. Iron analyzed using AAS were 0.24µg/l.

Other water quality parameter studied were 0.13 mg/l of ammonia, 3.100 ml/l of dissolved oxygen, 112 mg/l of total alkalinity and 6200 mg/l of total hardness, 1520 mg/l Calcium, 576 mg/l Magnesium, 14200 mg/l Sodium and 1400 mg/l Pottasium. Nitrite and nitrate were found total 0.10 mg/l and 23 mg/l, Chloride 22500 mg/l, Fluoride 1.8 mg/l, Sulphate 2588 mg/l, Phosphate 0.10 mg/l were also determined result were show in Table .1 and Fig 1, 2 and 3

BIOCHEMICAL COMPOSITION:

Protein, carbohydrate and lipid were estimated in the muscle of the mud crab *Scylla serrata* and fish *Mugil cephalus* by using biochemical methods. Among the three components studied, Protein content was in large quality 24.67 mg/g wet wt as in many of the marine organisms. Carbohydrate was estimated as 3.9 mg/g wet wt and Lipid content was at the lowest concentration of 0.7 mg/g wet wt in the mud crab (Fig.4).

Biochemical composition of fish *Mugil cephalus* as shown in the (Fig.5). Among the components studied, protein content was in large quantity 29.05 mg/g wet wt as in many of the marine or estuarine organisms. Carbohydrate was estimated as 4.07 mg/g wet wt and the lipid content was at the lowest concentration of 2.62 mg/g wet wt in the fish *Mugil cephalus.*

TOTAL HETEROTROPHIC BACTERIA:

Water sample, sediment, mud crab and fish collected from the mangrove area were analysed for the heterotrophic bacterial load, by using serial dilution and pour plate technique, in order to understand the pollution load of the area and the condition of the mud crab and fish for safe consumption and the result were tabulated (Table-2). Fig.6 explains the highest level of THB in the sediment (173×10^{-3} CFU g^{-1}) and lowest level of THB in mud crab (96×10^{-3} CFU g^{-1}) and fish (88×10^{-3} CFU g^{-1}). Total heterotrophic bacteria in the water was 154×10^{-3} CFU g^{-1}.

Table. 1 Water Quality parameter in Mangrove Water of Punnakayal, Mangrove Ecosystem

S.NO	CHEMICAL PARAMETERS	VALUES
1.	Temperature(^{0}C)	26
2.	Salinity ‰	28.56
3.	Dissolved Oxygen(mg/l)	3.100
4.	Turbidity NT Units	1.6
5.	Total Dissolved Solids mg/l	48423
6.	Electrical Conductivity Micro mho/cm	72274
7.	Ph	7.61
8.	Total Alkalinity mg/l	112
9.	Total Hardness mg/l	6200
10.	Calcium mg/l	1520
11.	Magnesium mg/l	576
12.	Sodium mg/l	14200
13.	Potassium mg/l	1400
14.	Iron mg/l	0.24
15.	Free Ammonia mg/l	0.13
16.	Nitrite mg/l	0.10
17.	Nitrate mg/l	23
18.	Chloride mg/l	22500
19.	Fluoride mg/l	1.8
20.	Sulphate mg/l	2588
21.	Phosphate mg/l	0.10
22.	Faecal Coliforms per 100 ml	Nil

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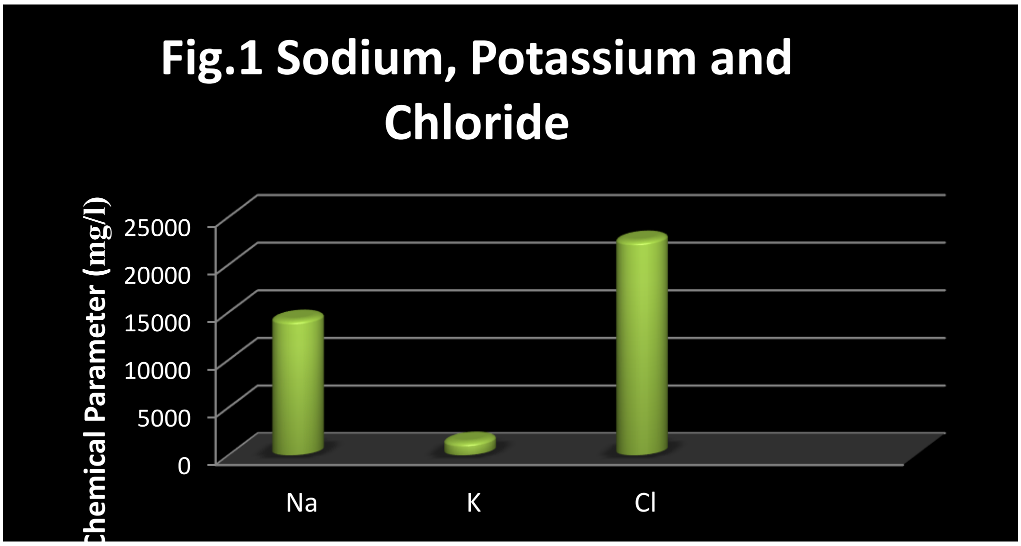

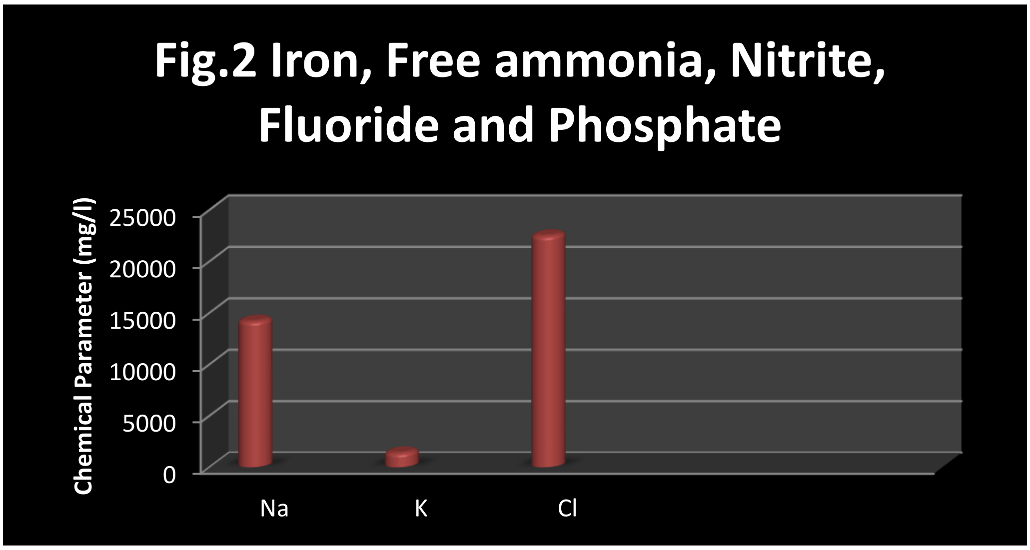

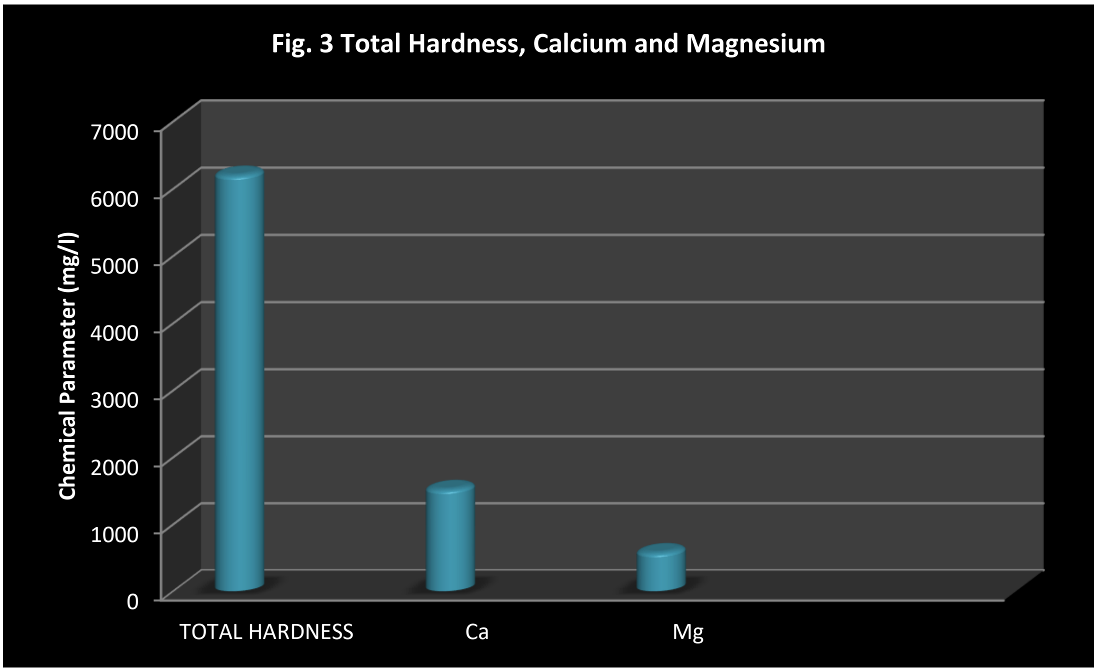

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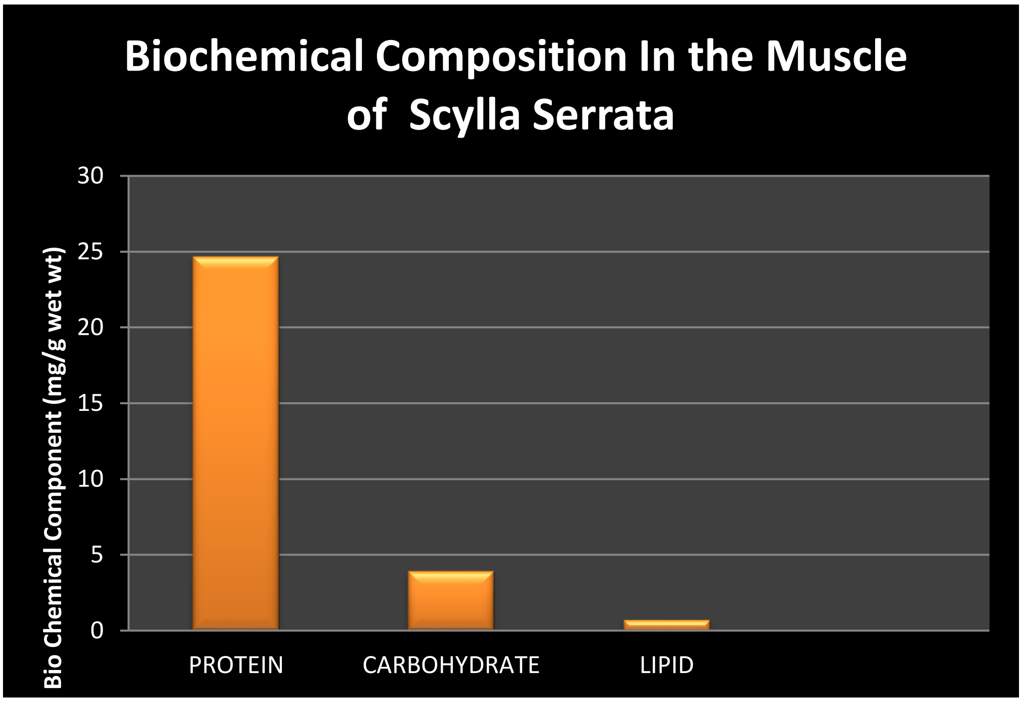

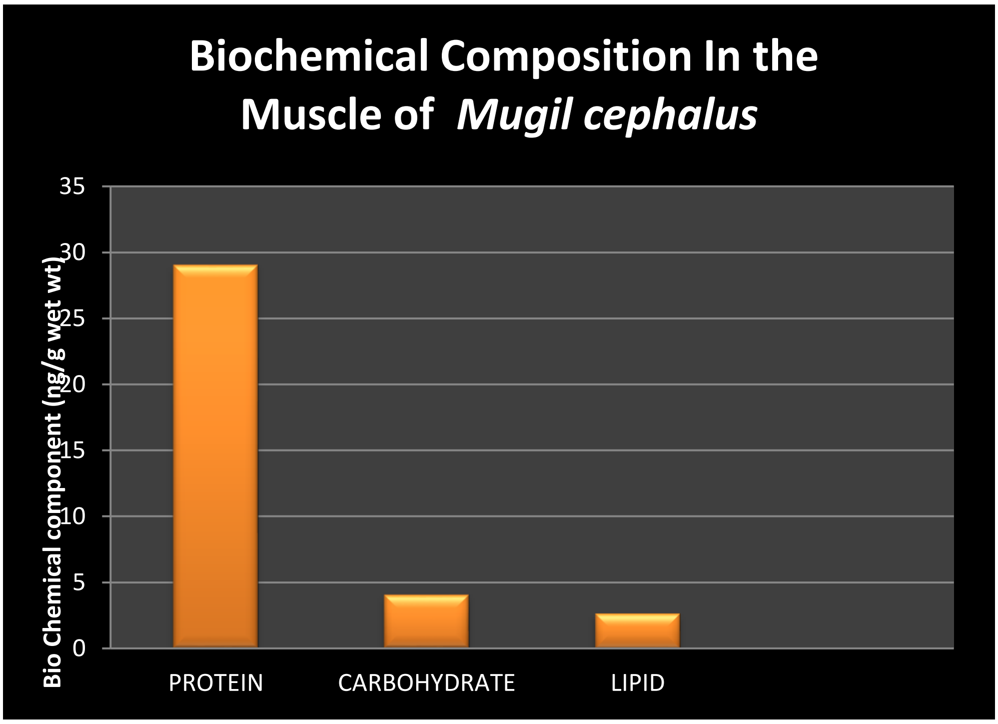

TABLE-2 TOTAL HETEROTROPHIC BACTERIAL LOAD IN DIFFERENT SAMPLES

S.NO	SAMPLE	THB
1	WATER	154×10^{-3} CFU l^{-1}
2	SEDIMENT	173×10^{-3} CFU g^{-1}
3	CRAB	96×10^{-3} CFU g^{-1}
4	FISH	88×10^{-3} CFU g^{-1}

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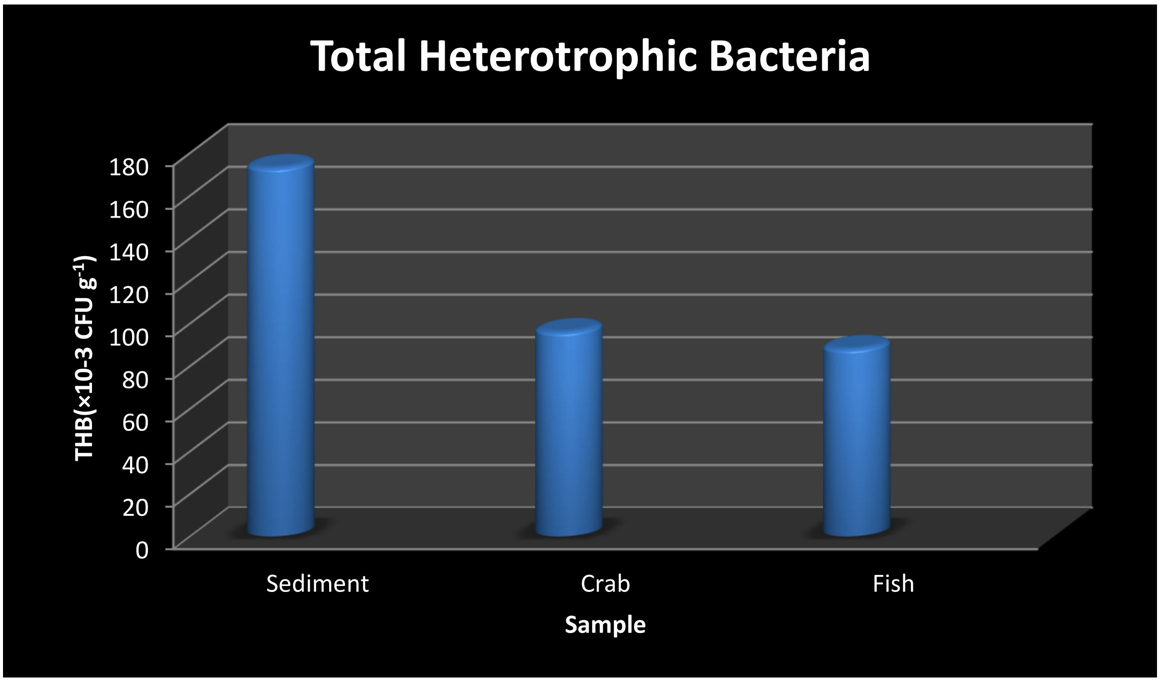
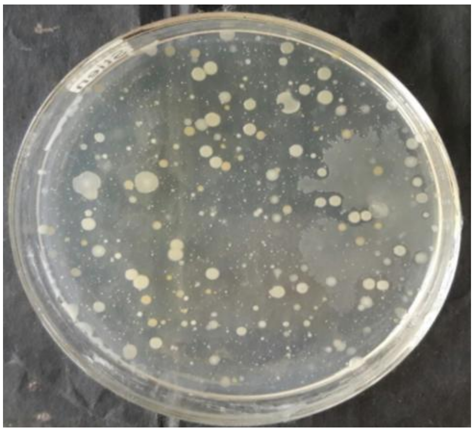


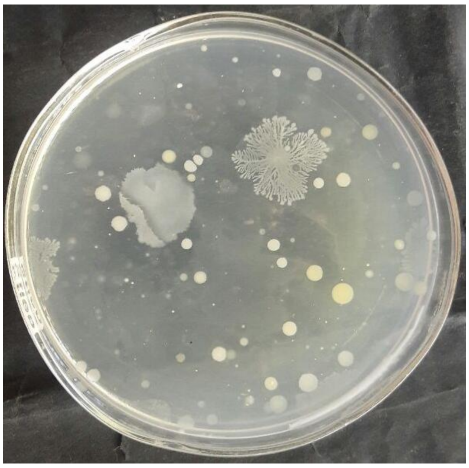
Plate – 3 Total Heterotrophic Bacterial (THB) Load

Sediment

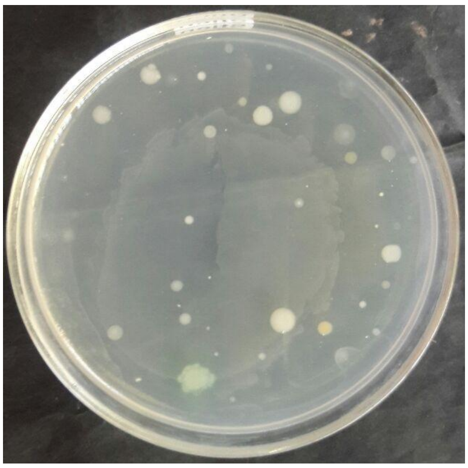
Water



Fish



Crab



HEAVY METAL ANALYSIS:

Heavy metal content in the water sample, sediment and the muscle of the *Scylla serrata* and *Mugil cephalus* was analysed by using Atomic Absorption spectrophotometer (AAS) and the result were tabulated (Table 3).

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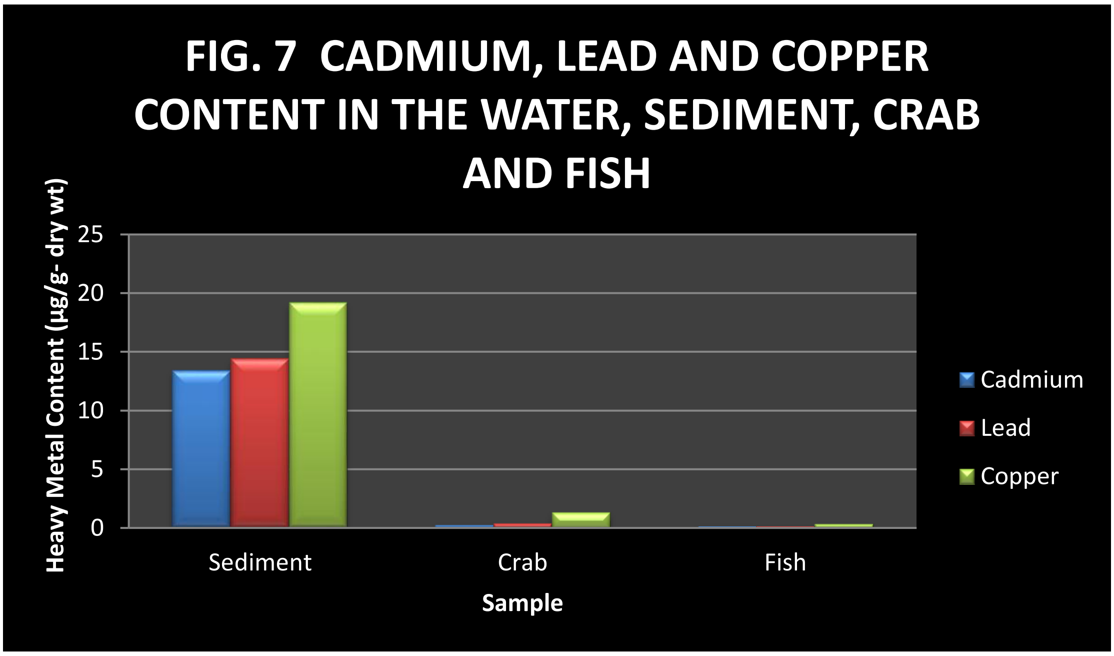
Cadmium content of the water sediment, mud crab and fish were 1.29µg/l, 13.4 µg/g dry wt, 0.262 µg/g dry wt, 0.18 µg/g dry wt, lead content of the water, sediment, mud crab, and fish were 0.980µg/l dry wt, 14.43 µg/g dry wt, 0.38 µg/g dry wt, 0.15 µg/g dry wt, the sample analyzed showed copper in the concentration of 3.86 µg/l, 19.10 µg/g, 1.31 µg/g, 0.36 µg/g, in water, sediment, mud crab and fish respectively (Fig.7).
Heavy metals in water, sediment, crab and fish were in the sequential order of Cu> Cd> Pb; Cu> Pb> Cd; Cu> Pb> Cd and Cu> Cd> Pb respectively.

TABLE: 3 HEAVY METALS IN THE WATER, SEDIMENT *SCYLLA SERRATA* AND *MUGIL CEPHALUS*

Heavy Metals	Water (µg/l)	Sediment (µg/g dry weight)	Crab (µg/l dry weight)	Fish (µg/g dry weight)
Cadmium	1.29	13.4	0.262	0.18
Lead	0.980	14.43	0.38	0.15
Copper	3.86	19.16	1.31	0.36
Permissible Limits set by different athorities	Cd	Pb	Cu	
FDA (2001)	4	1.4	-	
WHO (1987)	0.05- 5.5	0.05- 6.0	10-100	
NHMRC (1987)	10	-	350	



DISCUSSION

The protein, carbohydrate and lipid content analysed in *Mugil cephalus* was 29.0 mg/g wet wt, 4.07 mg/g wet wt and 2.62 mg/g wet wt respectively. Similar results were reported by Suganthi *et al*.,(2015) in the *Mugil cephalus* collected from Muthupet mangroves
Kumaran *et al*.,(2012) reported lipid content of 2.42 % in *Mugil cephalus*.
Generaley fish have very low levels of carbohydrate. The value could be due to the fact that glycogen is not a major reserve in the fish Das and Sabu, 2001, and Jayasree *et al*., (1994). Variation of biochemical composition which occur within the same species depends upon the fishing ground, season, age and sex of the individuals and its reproductive status (Suganthi *et al*., 2015).
Determination of harmful and toxic substance in water, sediment, and living organisms presents direct information on pollution hazards in the aquatic environment (Hugget *et al*., 1973). In the present study Cadmium content of the water sediment, mud crab and fish were 1.29µg/l, 13.4 µg/g, 0.262 µg/g, 0.18 µg/g, respectively (Fig.7). lead content of the water, sediment, mud crab, and fish were 0.980µg/l, 14.43 µg/g, 0.38 µg/g, 0.15 µg/g. The sample analyzed showed copper in the concentration of 3.86 µg/l, 19.10 µg/g, 1.31 µg/g, 0.36 µg/g, in water, sediment, mud crab and fish. Heavy metals in water, sediment, crab and fish were in the sequential order of Cu> Pb> Cd; Cu> Cd> Pb; Cu> Cd> Pb and Cu> Pb> Cd.

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Anthropogenic activities disposed heavy metals which find their way into the sea through rivers or through direct discharge of industrial effluents. These heavy metals enter, resuspended back into the water column and accumulated in the marine organisms (Arun and Hema, 2007). Though copper serves as a cofactor in a number of enzyme system for organisms it is the most toxic metal after mercury and silver, to marine forms (Khaled, 2004). Cu is an essential metal for normal growth and development of crustaceans where as Cd and Pb are non-essential metals. Non- essential metals are detoxified and stored in an inert form, or may accumulate and cause toxic effects (Rainbow,1990).
were within WHO acceptable limits. Mohammed *et al*., (2016) showed that *Scylla serrata* from the estuary of east coast of South Kalimantan, accumulated Cu, Pb, Zn and Cr below threshold level.
Ogundiran and Fasakin, (2015) document detectable level of Pb and Cd in crabs which may be attributed to the contamination of estuaries.
In the mud crabs found in the mangrove region, heavy metals are absorbed from the food in the digestive tract. They also are taken through permiable gill membrane (Dallinger, 1993).
Since the fish and crabs are carnivores, which feed on zooplankton and small fish, the present concentration of heavy metals in their muscle tissue might be due to the process of biomagnifications.
The environmental parameters affected the uptake of metals in organisms in mangrove water. Kock *et al*., (1996) reported that cadmium and lead showed higher uptake rates, in summer when water temperature was high due to increased metabolic rate. pH affected rate of metal accumulation directly. Cogun *et al*., 2004, documented increased accumulation of Cu at lower pH. Concentration of Cd and Pb are higher in fish from acidified lakes. Acidity of water affected bioaccumulation directly by changing the solubility of metal components or indirectly by causing damage of gills epithelia. Water hardness decreased the accumulation of Cu in the gill of aquatic organisms (Raja *et al*., 2007).
Salinity can reduce uptake and accumulation of metals by the fish (Bladisserotto *et al*., 2004).
In the present study concentration of Cd, Cu and Pb in the muscle of crab and fish were below the permissible limit in the food set by WHO,(1988); MFR,(1985) and ABIA,(1991).

SUMMARY AND SUGGESTION

Aquatic environment, the source of rich wealth is being used as a dumping ground of waste materials, industrial discharge, untreated sewage disposal, land run off and fertilizers. The increasing industrialization is the major source of heavy metals pollutants in the aquatic ecosystem. The level of heavy metals above the essential concentration would result in toxicity.
• Physico- chemical parameters of water analysed were temperature (26° C), pH (7.61), Total alkalinity (112 mg/l), Total hardness (6200 mg/l), Calcium (1520 mg/l), Magnesium (576 mg/l), Sodium (14200 mg/l), Potassium (1400 mg/l), Iron(0.24 mg/l), Free ammonia (0.13 mg/l), Nitrate (23 mg/l), Nitrite (0.10 mg/l), Chloride (22500 mg/l), Fluoride (1.8 mg/l). Sulphate (2588 mg/l), and Phosphate (0.10 mg/l).
• Biochemical content in the muscle of mud crab *Scylla serrata* and fish *Mugil cephalus* were as follows :
Protein, carbohydrate and lipid estimated in *Scylla serrata* were 24.67 mg/g wet wt, 3.9 mg/g wet wt, and 0.7 mg/g wet wt respectively and those of *Mugil cephalus* were 29.05 mg/g dry wt, 4.07 mg/g dry wt, 2.62 mg/g dry wt, respectively. The results revealed the presence of high amount of protein than carbohydrate and lipid in the organisms studied.
Biochemical composition was not altered much in the mud crab and mullet of the mangrove region in Punnakayal.
• Total heterotrophic bacterial load of water, sediment, crab and fish were observed and recorded. THB was highest in the sediment and lowest in the fish.
• Heavy metal (Cd, Pb, and Cu) analysis was made in *Scylla serrata* and fish *Mugil cephalus,* water and sediment in Punnakayal mangrove ecosystem. Heavy metal concentration was less in the organisms than in the water and sediment. Heavy metals in water, sediment, crab and fish were in the sequencial order of Cu> Pb> Cd; Cu >Cd >Pb; Cu> Pb> Cd; Cu> Pb> Cd respectively.
The result of this study provided valuable information about the metal content in water, sediment, crab and fish muscle of the Punnakayal mangrove region
C Monitoring program is essential for managing the mangrove area in ecologically sound and sustainable manner. Restoration activities are being taken up by the Tamil Nadu Forest Department in order to conserve and manage the ecosystem. Public interest and support is also needed in restoration of Punnakayal Mangrove ecosystem.

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