Estimation of Heavy Metals in Water, Sediment and Bioaccumulation in *Sphaeroma annandalei annandalei* in Shatt Al Arab River, Iraq

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***Abstract*— The present study investigates the concentration of six heavy metals Fe, Co, pb, Cd, Cu and Ni in water and sediment for five stations in Shatt Al Arab River from winter 2008 to winter 2009. It is also investigates the ability of *Sphaeroma annandalei annandalei* to accumulation these metals. Bioaccumulation average of heavy metals was 2936.210, 46.663, 23.939, 23.312, 58.818, 144.647 µg/g dry wet for Fe, Co, pb, Cd, Cu and Ni respectively. Heavy metals in water and sediment followed the order Fe > Ni > Pb > Co > Cd > Cu and Fe > Ni > Pb > Co > Cu > Cd respectively. Present study indicates an increase in average concentration of heavy metals in biomass due to increase heavy metals pollution in water and sediment of Shatt Al Arab River.**

Keywords- Pollution, Heavy metals, Sphaeroma annandalei, Bioaccumulation, Isopod (key words)

I. INTRODUCTION

Iraqi environment exposed to different pollutants due to wars during last years [1], increase in industrial and commercial activity along with people increase, waste, sewage and oil production. All these provided aquatic environment with many pollutants like heavy metals that enter food chin and bioaccumulation inside aquatic creature bodies reaching to human [2, 3]. After aquatic creatures die, heavy metals reside in sediment and recycle again in water [4, 5].

The bioaccumulation of heavy metals in living organisms and biomagnification in them means or describes the processes and pathways of these pollutants transfer from one trophic level to another, thus exhibiting the higher bioaccumulation ability in organisms related to the higher living status [6]. Factors known to influence metal concentrations and accumulation in these organisms include metal bioavailability and concentration, season of sampling, hydrodynamics of the environment, size, sex, type of organs, type of living state, exposure period, changes in tissue composition and reproductive cycle [7, 8, 9]. Metal body loads of aquatic biota were often measured and used to evaluate ecological risks and potential sublethal effects [10]. Invertebrates are generally more sensitive to pollutants than fish or algae. Among them, amphipods, isopods and decapods are important components of the marine intertidal and subtidal fauna [11]. Isopods live among algal turfs, crevices, or under the stones, are omnivorous, that are feeding on bacterial biofilms, algae or/and organic detritus [11]. *Sphaeroma annandalei* is free-living isopod lived in brackish water and boring in soil and sediment [12]. Reference [13] showed that increased salinity had a positive effect on the survival of these animals.

Numerous studies have quantified heavy metals concentrations in different crustacean species in different aquatic habitats for example [14, 15, 16, 17]. Little studies were conducted to measure the concentrations of heavy metals in crustacean from Shatt Al Arab river as in [18, 19]. Thus the present study was take an interest in determination the concentration of 6 heavy metals in 5 stations in Shatt Al Arab river and the ability of *S. ananndalei ananndalei* for bioaccumulation these metals in soft tissue.

II. MATERIAL AND METHODS

Five stations along the Shatt Al Arab river from Qarmat Ali river to Fao were chosen for the assessment of heavy metals concentrations from winter 2008 to winter 2009 “Fig. 1”. Surface water samples were taken from each station by using polyethylene bottles. Bottles were kept in 1% nitric acid [20] at 4°C before their use. Sediment samples were also randomly collected for analysis from the river bank at the same stations as the isopod samples. Isopods were collected with hands washed with D. W. and saved in cooler box. After collection, the samples were transported to the laboratory in a cooler box.

A. Sample Preparation

The sediment samples were laboratory dried after that oven-dried for 24 h. at 60° and the dried samples were pulverize into fine powders using laboratory mortar and pestle, afterwards sieved out by 2 mm sieve. The isopod samples were washed with Deionized water again and dried on filter paper, then oven dried for 24 h. at 70° and later cooled in a desiccators. The dried samples were pulverize into fine powders using laboratory mortar and pestle.

Stations	coordinate	
St 1 Qarmat Ali river	30°34 13 83 N	47°45 05 94 E
St 2 Qrnaland	30°31 47 90 N	47°50 27 92 E
St 3 Abo Al Kasib	30°28 31 13 N	47°53 49 73 E
St 4 Am Al Rasas	30°27 00 50 N	48°06 06 18 E
St 5 Fao	29°58 21 79 N	48°29 04 51 E

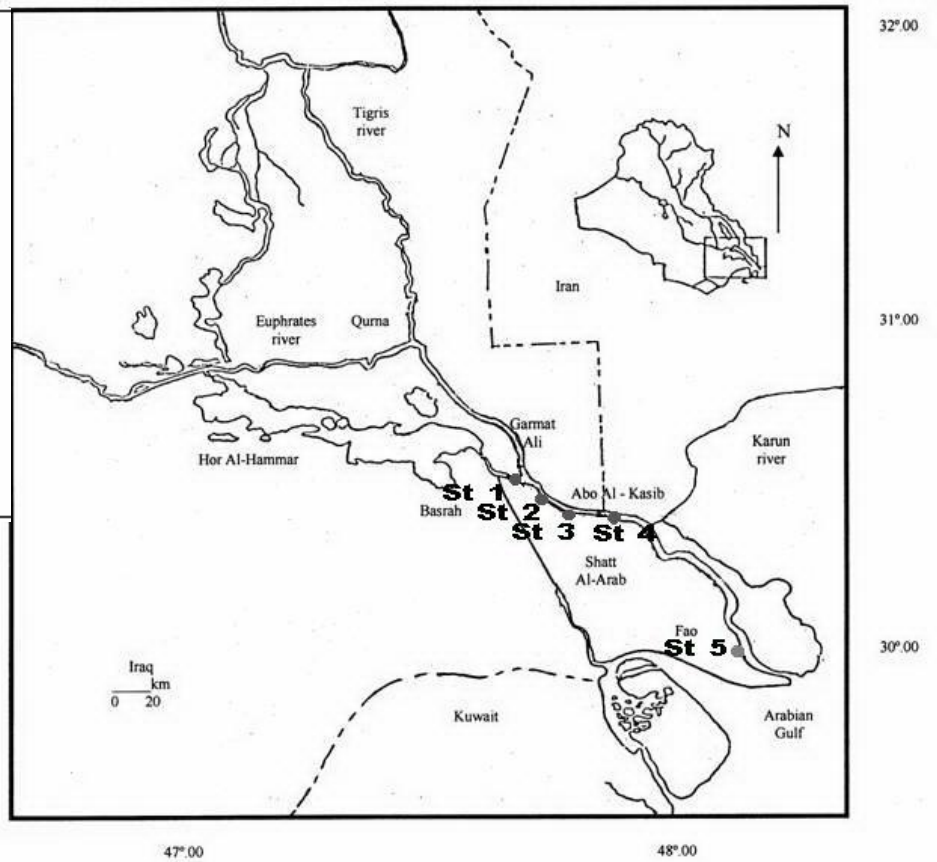

Figure 1. Map of Shatt Al Arab river Basrah / Iraq showing locations of study area with coordinate.

B. Chemical Analysis of Samples

Water samples were digested according to [21]. Sediment samples were digested according to [22]. 1g of a dried isopod powder was digestive according to [23] with addition 1 ml of hydrogen peroxide to further oxidize any recalcitrant lipid materials in the sample. All samples solution were filtered through Whatman No.1 filter paper, transferred into 50-ml standard bottles and then diluted with Deionized water.

All samples were analyzed for Fe, Co, pb, Cu, Cd and Ni were carried out by using a Flame Atomic Absorption Spectrophotometer (pye-unicam). Heavy metals concentration in water was expressed as microgram per liter (µg/1), whereas those in the sediment and the isopod tissue as microgram per gram (µg/1).

Bioconcentration factors (BCFo-s) of the heavy metals in the isopod samples were obtained using the equation according to [10].

$$BCF\ o\text{-}s = C\ organism / C\ sediment \quad (1)$$

where
C organism: represent heavy metals concentration in organism
C sediment: represent heavy metals concentration in sediment.

C. Statistics

Statistical comparison among means of more than two groups was performed by one way ANOVA. Differences were considered significant at $P \leq 0.05$. Correlation between metals was done. SPSS software version 16.0 was used for statistical analysis.

III. RESULT

A. Heavy Metals in Water

The data in Table 1 show heavy metals concentrations in water In generally, the heavy metal concentrations obtained from water samples were relatively high in most stations and seasons except some data was not detected, while the Fe data was highest compared with other heavy metals. The order of mean metal concentrations in the water samples was Fe >Ni > pb > Co > Cd > Cu.

B. Heavy Metals in Sediment

The results obtained for the sediment samples were high except Cd relatively low. The data was presented in Table 2 and followed this order Fe > Ni > Pb > Co > Cu > Cd.

C. Bioaccumulation of Heavy Metals

1) Fe: Highest bioaccumulation in this species was 5737.50 µg / g dry wet during winter 2008 in fourth station while the lowest bioaccumulation was 103.99 µg / g dry wet in first station during spring as showed in Table 3. Highest seasonal average for bioaccumulation was 4978.048 during winter 2008 while the lowest average was 1757.377 µg / g dry wet during autumn. Significant different ($P < 0.05$) was between winter 2008 and all season as well as between summer and winter 2009.

TABLE I. CONCENTRATIONS OF HEAVY METALS IN WATER (µg / l) IN ALL STUDY STATIONS

seasons	winter 2008	spring	summer	autumn	winter 2009	winter 2008	spring	summer	autumn	winter 2009
	Fe					Co				
St 1	1623.31	987.91	2161.15	1996.29	17248.8	550.9	72.53	Nd	418.57	354.45
St 2	9321.90	17796.8	8917.06	10089.1	7729.91	0.8619	547.05	119.42	285.11	122.30
St 3	1244.32	4006.85	19559.3	25038.8	11130.1	Nd	92.45	362.15	920.8	Nd
St 4	2500.00	---	12262.5	18920.1	4891.41	Nd	---	601.35	Nd	0.9983
St 5	8134.73	6746.60	18500.0	34207.7	44221.2	1.52	504.70	1032.5	Nd	876.37
	pb					Cd				
St 1	323.80	110.61	138.91	418.56	652.55	Nd	60.49	175.75	323.81	500.88
St 2	435.55	620.45	443.51	290.45	122.37	790.87	492.1	384.21	527.25	544.82
St 3	371.35	180.20	299.4	637.15	335.14	Nd	544.82	395.43	88.39	103.62
St 4	232.65	---	844.04	146.16	98.31	365.03	---	500.88	218.09	128.18
St 5	192.85	566.48	602.85	174.84	166.78	158.17	878.75	483.32	1258.6	891.21
	Cu					Ni				
St 1	134.75	100.37	183.44	67.76	Nd	55.92	44.99	27.56	89.48	103.45
St 2	102.49	79.21	122.94	35.39	11.14	92.26	Nd	39.49	106.24	72.71
St 3	472.35	141.72	55.5	258.45	561.30	111.84	53.75	30.75	103.45	81.08
St 4	Nd	---	132.01	257.09	120.41	55.92	---	39.14	64.30	55.98
St 5	302.85	0.882	0.897	1.766	56.89	134.18	97.86	89.472	88.483	41.49

St= study stations Nd = Not detected --- = no sampling

TABLE II. CONCENTRATIONS OF HEAVY METALS IN SEDIMENT (µg / g) DRY WET IN ALL STUDY STATIONS

seasons	winter 2008	spring	summer	autumn	winter 2009	winter 2008	spring	summer	autumn	winter 2009
	Fe					Co				
St 1	4301.96	4300.31	4750.32	4265.42	4261.21	31.55	55.28	59.38	12.67	18.87
St 2	4138.30	5362.53	5766.34	3095.22	4216.94	50.16	43.14	42.99	12.90	16.71
St 3	4236.75	2214.12	5301.12	3081.96	4229.08	62.83	13.44	30.41	45.26	79.28
St 4	4167.71	---	3361.33	2266.14	3916.98	43.41	---	29.43	30.43	20.11
St 5	5213.14	4272.55	3398.13	4181.78	4192.01	30.01	28.04	12.89	44.76	58.25
	pb					Cd				
St 1	39.93	41.00	43.96	27.43	25.09	10.61	4.57	8.32	9.43	5.54
St 2	66.44	83.53	86.58	53.17	57.90	18.18	15.22	12.89	0.88	2.33
St 3	30.30	43.10	50.31	49.25	33.36	2.04	0.0456	0.9781	1.5275	0.9731
St 4	24.55	---	24.75	32.11	36.66	0.0943	---	10.35	1.25	3.91
St 5	18.32	23.47	30.44	40.10	31.22	0.369	0.098	4.52	12.93	2.62
	Cu					Ni				
St 1	27.40	33.27	27.78	22.44	27.49	51.12	105.73	29.41	0.843	114.54
St 2	35.21	33.54	30.52	22.36	64.58	49.34	40.42	62.66	75.52	104.98
St 3	31.31	20.81	45.88	43.33	37.18	74.89	30.96	18.24	113.28	0.9872
St 4	29.53	---	33.55	22.36	45.82	48.46	---	12.57	75.52	14.25
St 5	22.71	46.77	44.921	21.52	29.35	44.31	79.3	38.21	0.6932	105.73

St= study stations Nd = Not detected --- = no sampling

2) Co: The variation of Co bioaccumulation was between 2.89 – 254.07 µg / g dry wet in fifth and second stations during winter 2009 and summer respectively. Some not detected concentration was in first station during winter 2008, 2009 and third, fifth stations during winter 2008, summer respectively as showed in Table 3. Highest bioaccumulation seasonal average was 87.500 during spring while the lowest average was 19.897 µg / g dry wet during winter 2008.

3) Pb: During winter 2009 in fourth station, the concentration was not detected while other concentrations were high 56.52 µg /g dry wet in second station during summer but lowest concentration was 3.69 µg / g dry wet during same season as showed in Table 3. Seasonal average was between 10.430 – 38.178 µg / g dry wet during winter 2008, 2009 respectively. Found statistically significant different ($P<0.05$) between winter 2008 and spring, winter 2009.