The Potential of some snails as bioindicator of Trace metals level in East Hammar marsh, south of Iraq.

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Abstract:

East Hammar marsh in south of Iraq has enormous environmental importance. It represents habitats for biodiversity of different organism as mollusca (snails). Determination of concentration and distribution of cadmium(Cd), copper(Cu), lead(Pb) and zinc(Zn) in water (as dissolved and particulate matter), sediments and three species of freshwater snails *Bellamya bengalensis*, *Lymnaea auricularia* and *Melanoides tuberculata* were carried out during September 2007 to September 2008 in four selected stations of East Hammar marsh. Some environmental parameters of the marsh were measurements included water temperature, pH, dissolved oxygen, salinity, as well as total organic carbon in sediments. Flame atomic absorption spectrophotometers in addition to other suitable tools were used throughout this study.

Total concentrations in the snail were higher than water and sediment whereas *B. bengalensis* recorded the highest values in contrast with *L. auricularia* and *M. tuberculata*. Seasonal variations were observed in the mean concentrations of the studied metals in both phases of water due to the differences of water levels and suspended particulate matter in the study area during seasons as well as the differences in the added pollutants to the environment of E. Hammar during the study period.

1-Introduction :

The value of the environment is a matter of serious anxiety, due to the consequences of human intervention are already obvious. Although environment is extremely important for people and other living organisms, it is also endangered due to human activities that are continuously ruining it (Davis, 2006). East Hammar marsh is one of the important water bodies in the province of Basra that expose to continuous of many serious pollutants like trace metals, which is one of the natural ingredients in the earth's crust and may enter water bodies through nonpoint source pollution. Contamination by this type of pollutants may increases the risk of these contaminants when they reach the aquatic environment in large quantities (Hutton and Symon, 1988; Blanco, 2005). Wetlands (marshes) are of the most important ecosystems used to get rid of trace metals in the water due to the presence of aquatic plants that accumulate of these metals in its biomass (Karpiscak *et al*., 2001; Mah *et al*., 2007).

Trace metals are found in water both in soluble and particulate also found in sediments and are accumulated in the bodies of living organisms, including invertebrate.

Many studies have addressed the global impact of trace metals on *Pneumoniae* snails, these studies proved that *Lymnaea* sp. sensitized to the very high component of chronic exposure to lead and been classified by Grosell *et al*. (2006) as the most sensitive aquatic organisms to pollutants because it has highly susceptible to acute and chronic exposure to trace metals without any deaths.

In Basra, metal analysis in water, sediment and different aquatic biota have seen a continuously increased interest over the last decade by research groups. Many studies concerning metal pollution in the environmental compartments have been recorded before and after 2003 (reflooding of the desiccated marshes). Most of These studies of Abaychi& DouAbul (1985); Abaychi& Al-Saad(1988); Al-Mudaffar *et al*.,(1992); Abaychi & Mustafa (1988);Al-Imarah (2000) were restricted on Shatt Al-Arab River, while Al-Saad *et al*., (2009) explained that East Hammar marsh have low levels of some pollutants such as hydrocarbons and trace elements in the water and sediments. Aziz *et al*.,(2006) were studied levels of some trace metals in Shatt Al-Basra canal and the ability of some aquatic plants as bioindicator on these metals.

Thus, this present study focused on the environmental pollution of trace metals in East Hammar marsh and the importance of snails as bioindicators to the pollution of trace metals, aiming at recording the metal pollution problem in the southern marshes of Iraq.

Description of the study stations:

Four stations were selected to study the trace metal pollution in East Hammar marsh (table 1). The stations are: Burgah (1), Saddah (2), Abu Sukhayr (3) and Qarmat Ali Bridge (4) were identified by using GPS (geographical positioning system). The first three stations were characterized by the density of aquatic plants, and scarcity in the fourth one.

Table 1: Position of the study station in E. Hammar

No.	**Station**	**Altitude**	**latitude**
1	Burgah	30' 40.074	047'38.574
2	Saddah	30' 36.655	047'40.218
3	Abu Sukhayr	30'34.406	047'41.823
4	Qarmat Ali Bridge	30'35.410	047'44.794

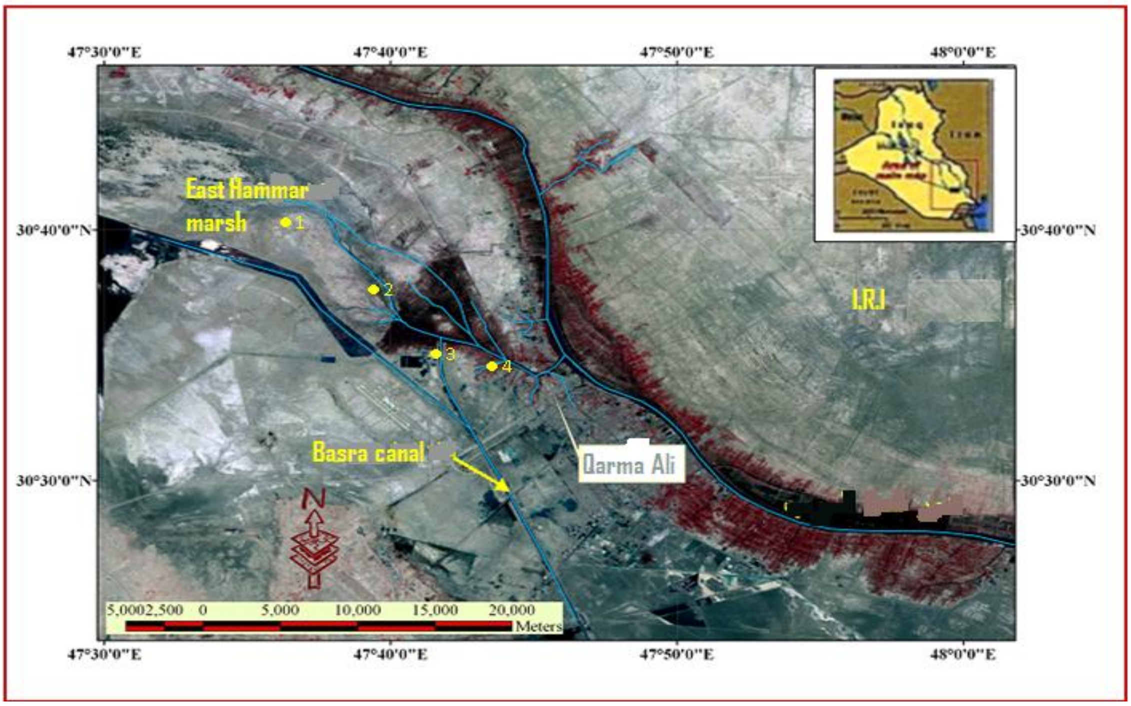

Figure1: Study stations of E. Hammar marsh

Materials and methods

Samples of water, sediments and snails were collected monthly from the study stations between September 2007 and September 2008. Water samples were collected using plastic containers capacity of 10 liters. Grab sampler was used to collect sediment samples then kept in plastic bags in a cool box. Samples of snails were collected from the sediments in the intertidal zone depending on method of IMRP (2006) and snails attached on aquatic plants were collected. Measurement of some physiochemical characteristics of water, including water temperature, Dissolved Oxygen, salinity and pH were done using the portable equipment for these measurements (Horiba Multimeter instrument) .

Extraction of trace metals from the dissolved phase of water was done by ion exchange method (Riley and Taylor, 1968), while particulate phase of water and sediment by the method of ROPME (1987) using concentrated nitric and Hydrochloric acids. and Soft parts were removed from the snails shell and extracted by the method of ROPME (1983). Concentrations of trace metals in the samples were measured using a Flame atomic absorption spectroscopy and the results tested by SPSS (statistical analysis program). Bioconcentration factor (BCF) for each species of snail was calculated depending on the equation described by Evans and Engel (1994): B.C.F. = MC in organism / MC in water, where MC=metal concentration.

Results:

The results of physical and chemical factors of water in different stations of E. Hammar showed clear spatial and seasonal variations, as shown in the table 2.

Table 2: Mean of Physical and chemical factors in water samples of different study stations in E.Hammar marsh.

Parameter	season	1	2	3	4	Mean
Water temperature (C°)	Autumn	14	21.2	21.4	21.8	19.6
	Winter	8	8.2	8.4	9.3	8.5
	Spring	21	23	23	20	21.8
	Summer	27	28	30	30	28.8
	Mean	**17.5**	**20.1**	**20.7**	**20.3**	**19.6**
Dissolved Oxygen (mg/l)	Autumn	12	12.6	11	8.8	11.1
	Winter	11.6	12.2	12	9.3	11.27
	Spring	11	11.3	10.2	10	10.62
	Summer	11	11.5	9	9	10.12
	Mean	**11.4**	**11.9**	**10.55**	**9.27**	**10.78**
pH	Autumn	6.6	7.8	8	7.7	7.5
	Winter	7.9	8	8.1	8	8
	Spring	8.2	8.1	8.2	8.2	8.2
	Summer	7.7	7.8	7.5	7.6	7.6
	Mean	**7.6**	**7.9**	**8**	**7.9**	**7.8**
Salinity (‰)	Autumn	3	2.2	1.9	3	2.5
	Winter	3.8	3.8	2.8	2.2	3.2
	Spring	5.3	4.1	4	4.7	4.8
	Summer	3.5	3.3	3.3	3.1	3.3
	Mean	**4.2**	**3.4**	**3**	**3.2**	**3.4**

Analysis of sediment samples showed that the highest values of TOC were recorded in station 3 during winter, while the lowest values were in station 1 during summer. Significant spatial variation ($p<0.05$) among the different stations of E.Hammar (Fig. 2).

Different concentrations of trace metals, Cadmium, Copper, Lead and Zinc in two phases of water (dissolved and particulate), sediment and three species of snails included *Bellamyea bengalensis* , *Lymneae auricularia* and *Melanoides tuberculata* were recorded in present study. The results showed that the snails had contained higher concentrations of Copper, Lead and Zinc than found in sediments and water (Tables 3and 4), but concentrations of Cadmium in the particulate of water were higher than in the snails.

The annual concentrations of trace metals (Fig. 3) cadmium, copper, lead and zinc in the dissolved water during the study period were 0.22, 1.55, 6.05 and 4.50 µg / l respectively, while in the particulate were 15.52, 28.73, 19.31 and 38.73 µg / g dry weight respectively. The concentrations of metals in sediment were 0.37, 16.13, 13.54 and 26.7 µg / g dry weight, respectively.

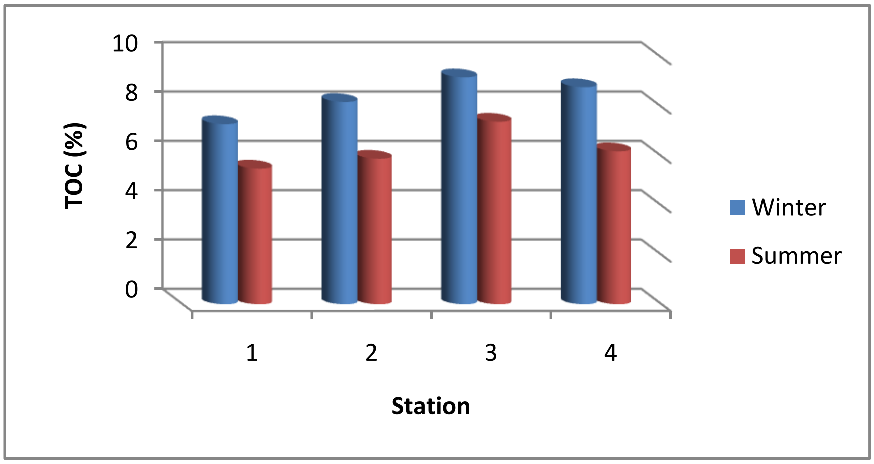

Fig.2: Spatial variation of TOC (%) during study period in E. Hammar marsh

Table (3): Mean concentrations of trace metal in water and sediment of different study stations in E.Hammar marsh during Sep2007 to Sep.2008.

Part	Metal	Station							
		1		2		3		4	
		Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.
Dissolved (µg/l)	**Cd**	**0.15**	0.06	**0.18**	0.05	**0.24**	0.08	**0.33**	0.06
	Cu	**0.86**	0.11	**1.2**	0.09	**1.5**	0.71	**2.68**	0.25
	Pb	**4.39**	0.54	**5.04**	1.02	**6.9**	0.51	**7.87**	1.46
	Zn	**3.67**	1.74	**4.13**	0.61	**5.5**	0.07	**5.49**	1.74
Particulate (µg/g d.w.)	**Cd**	**7.43**	2.1	**6.71**	1.53	**19.68**	2.67	**27.32**	4.19
	Cu	**19.8**	4.61	**29.75**	4.47	**27.56**	5.14	**37.86**	7.28
	Pb	**14.19**	2.54	**15.19**	1.98	**19.31**	1.79	**28.58**	4.69
	Zn	**33.63**	8.86	**34.64**	1.72	**38.93**	14.19	**48.09**	4.79
Sediment (µg/g d.w.)	**Cd**	**0.34**	0.04	**0.39**	0.05	**0.37**	0.09	**0.41**	0.11
	Cu	**9.83**	0.74	**12.26**	0.86	**17.65**	2.06	**21.32**	1.97
	Pb	**10.63**	0.58	**10.18**	1.23	**13.53**	1.12	**18.83**	2.28
	Zn	**19.34**	6.09	**24.1**	1.46	**28.6**	2.12	**34.82**	5.09

±SD: standard deviation

Annual concentrations of metals Cadmium, Copper, Lead and Zinc in snail species during the study period were 11.25, 54.62, 26.47 and 84.27 µg / g dry weight respectively for snail *B. bengalensis* that recorded the highest values, while 10.3, 40.45 , 21.78 and 60.79 µg / g dry wt. respectively for *L. auricularia*, and the lowest values were 6.97 , 35.13 , 18.26 and 48.07 µg / g dry wt. respectively of *M. tuberculata*. Different values of bioconcentration factor were calculated (Fig. 4) and indicated on the variability of species ability to accumulate the metal.

Seasonal variations were observed in this study (Figures 5 &6), in general the highest values were recorded in summer, while it decreased during spring. Station 1 had the lowest concentration in comparison with other stations.

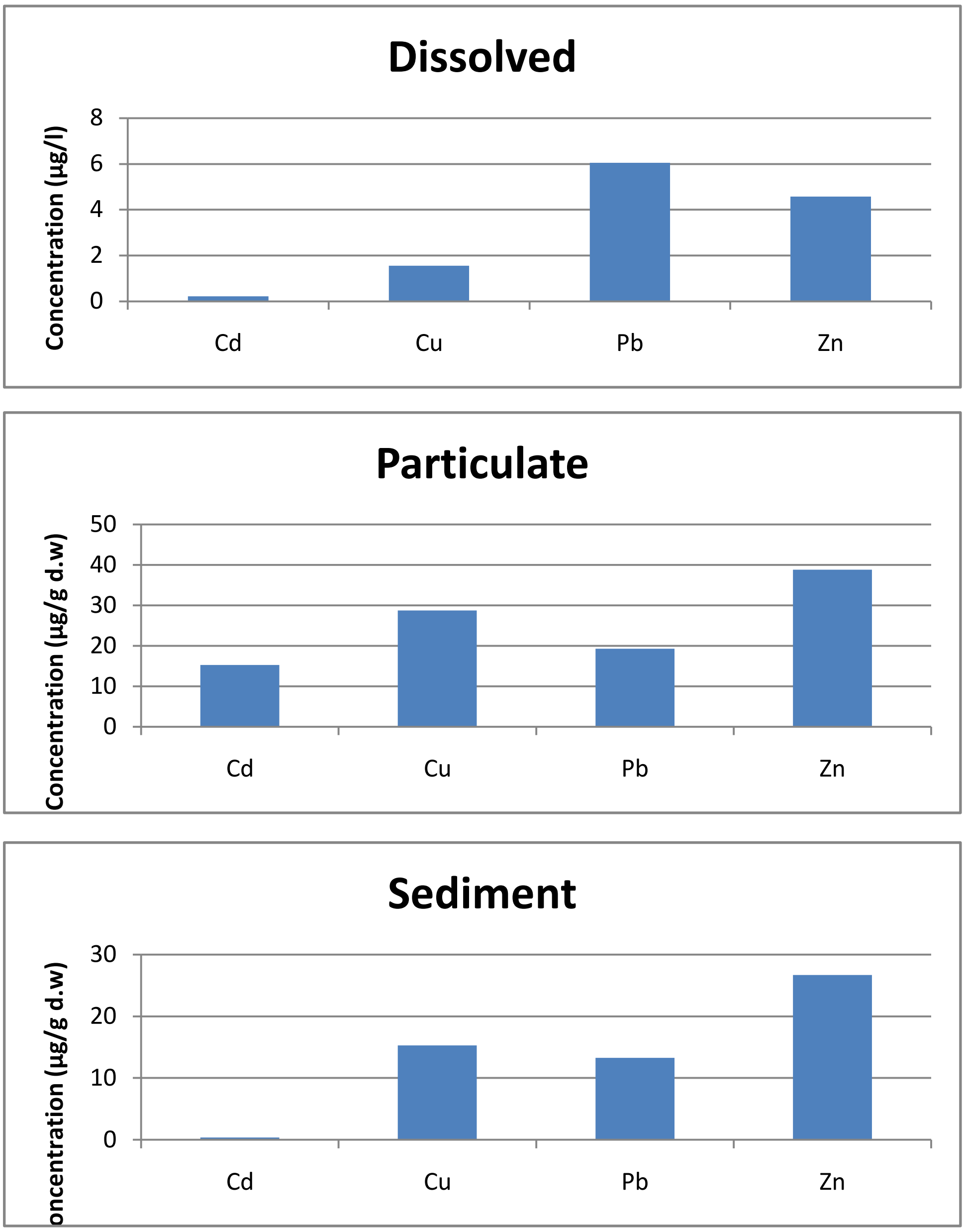

Fig. 3: Mean of annual concentration of trace metal in water(dissolved and Particulate) and sediment among different study stations of E.Hammar during Sep.2007- Sep.2008.

Table (4): Mean of trace metal concentrations(µg/g d.w.) in different species of snails of different study stations in E.Hammar marsh during Sep2007 to Sep.2008.

Species	Metal	Station							
		1		2		3		4	
		Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
B. bengalensis	Cd	**7.1**	3.47	**6.1**	0.98	**18.2**	4.16	**21.1**	4.5
	Cu	**32.88**	6.2	**46.88**	6.57	**65.08**	5.07	**100.41**	7.54
	Pb	**16.86**	6.34	**23.74**	8.45	**38.38**	4.07	**30.05**	3.87
	Zn	**87.64**	38.99	**66.93**	15.97	**96.52**	1.5	**105.05**	8.92
L. auricularia	Cd	**5.8**	3.56	**9.27**	4.15	**14.26**	7.84	-	-
	Cu	**20.79**	1.59	**41.44**	6.96	**54.46**	28.12	-	-
	Pb	**14.07**	5.7	**19.69**	7.77	**29.14**	3.33	-	-
	Zn	**63.13**	36.14	**63.88**	15.37	**56.72**	44.32	-	-
M. tuberculata	Cd	**3.83**	2.78	**3.02**	-	**12.48**	1.29	-	-
	Cu	**25.13**	4.33	**37.4**	-	**46.72**	9.73	-	-
	Pb	**13.44**	2.87	**20.82**	-	**23.83**	4.91	-	-
	Zn	**45.33**	26.4	**57.65**	-	**48.54**	34.69	-	-

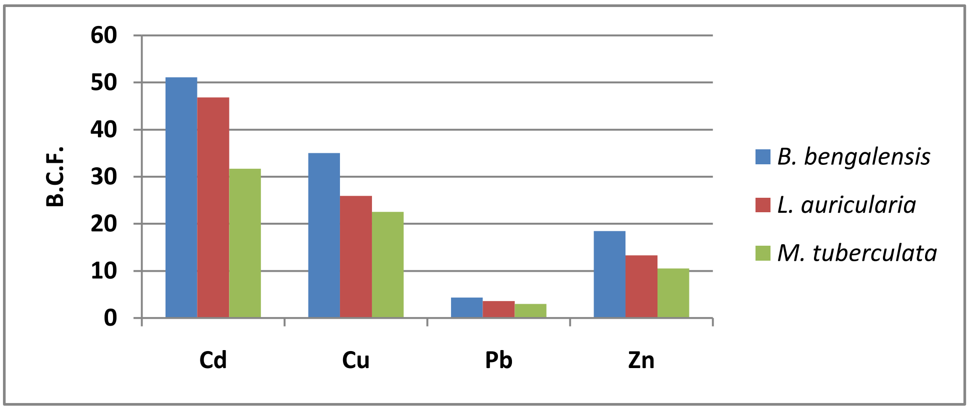

Fig 4: Bioconcentration factor of different trace metals of different species

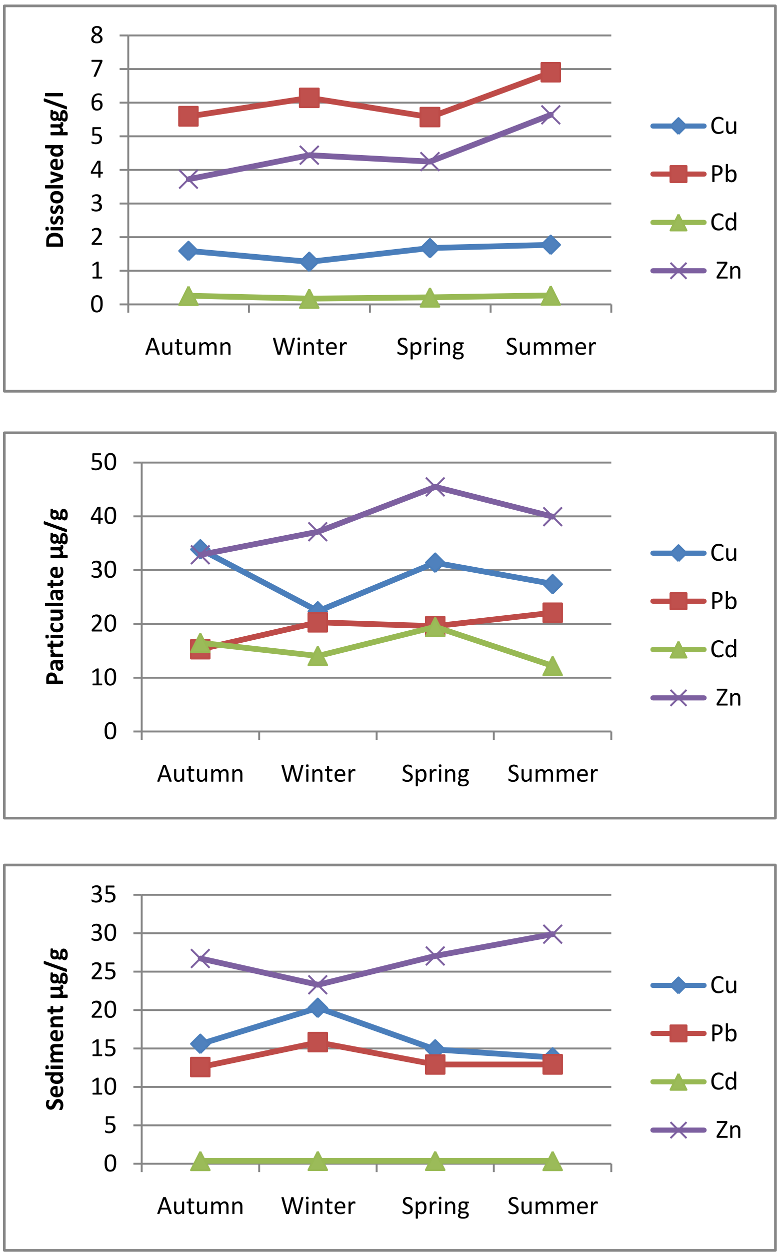

Fig. 5: Seasonal variations of trace metals in water (dissolved&particulate) and sediment samples of different stations of E.Hammar.

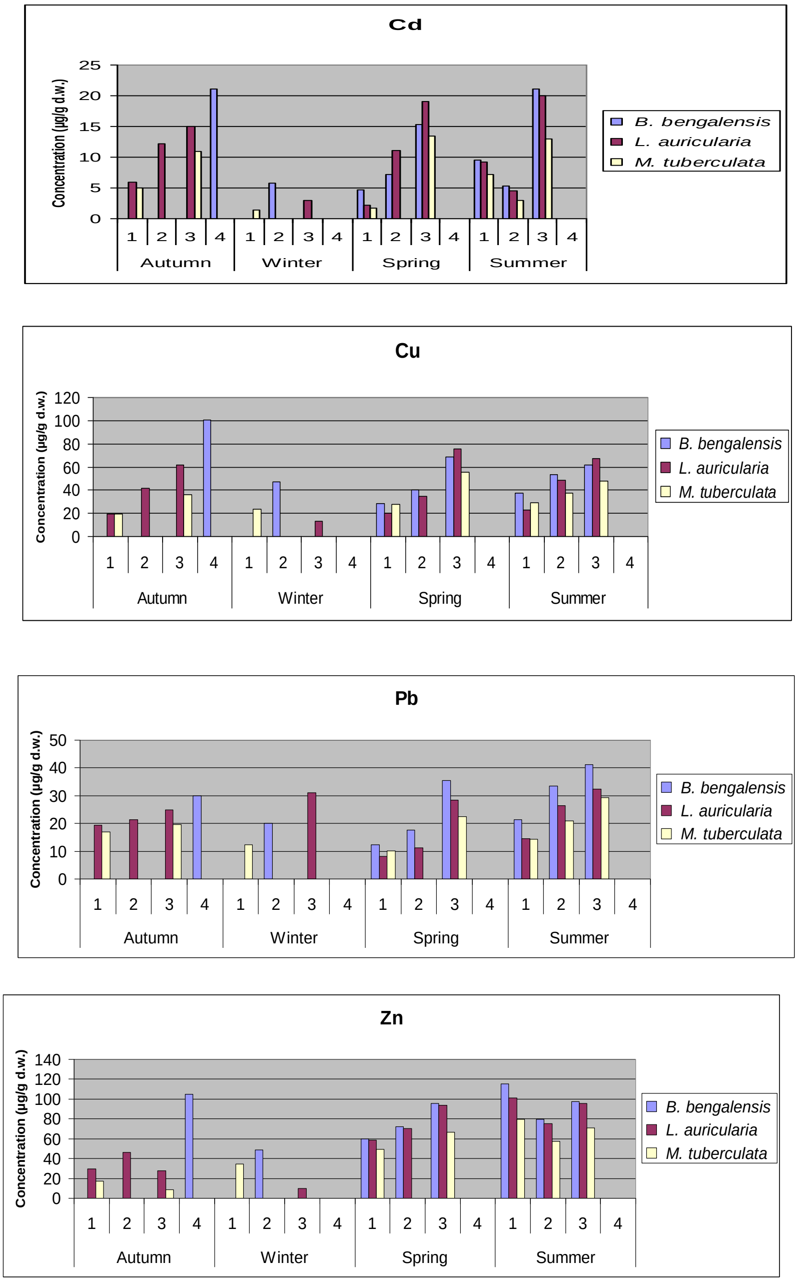

Fig. 6: Seasonal variations of trace metals (μg/g d.w.)**in different species of snails in different stations during study period.**

Discussion:

Many environmental factors such as temperature, salinity and pH of water affecting the concentration of trace metals in the aquatic environment (such as marshes) and also affect the process of bioaccumulation in the tissues of aquatic organisms through their influence on the interface between metals and cellular membranes and rates of metabolic as well as the effects on the presence and distribution of fauna in the aquatic environment (Khani *et al.,* 2006; Mah *et al.,* 2007). A slight decrease in pH value Observed at summer and autumn in all stations as a result of decomposition of organic material, which increases with temperature (Wetzel and Likens, 2000). High values of salinity recorded may be due to the lack of water levels during the study period.

Significant seasonal and spatial changes ($p < 0.05$) in concentrations of trace metals cadmium, copper, lead and zinc in the dissolved phase of different study stations were observed. Concentrations of trace metals in the aquatic environment are changing over time; the main factor affecting this change is due to received water from agricultural and different human activity discharges. The highest concentrations of trace metals were in summer, while the lowest were in winter and spring because of differences in water levels among the different stations (Gbaruko and Friday, 2007), high levels of water in winter and early spring, causing dilution and dispersion of the metals in the water, this was agreed with that found by Shenone *et al.* (2007) on some wetlands of Argentina. Frequent dust in summer also plays an important role in increasing concentrations of trace metals in the aquatic environment, and during this study there were many of dust especially in March, May and July in 2008.The highest concentrations of particulate phase of metal in spring and summer and this might be due to the high dense of plankton in this period, as showed by Hussein *et al.* (2002) that there is a direct correlation between the density of plankton, and temperature that leads to increasing the particles and thus increasing its content of trace metals. It has been proved by many researchers the ability of these plankton to remove trace metals from the water bodies (Montgomery, 1997; Teitzel & Parsek, 2003) and this may explain the high concentrations of metals in the particulate phase of water compared with dissolved phase, as well as adsorption on surfaces of plankton.

The results showed presence of significant seasonal and spatial variations ($P < 0.05$) in concentrations of trace metals in sediment. The differences dependent on the type and quantity of substances in the environment , water temperature , salinity, and size and type of sediment as well as vital activities of the organism in those areas, and rates of sedimentation (Cao *et al*., 2006). Difference in metal concentration in sediment may due to the high ability of sediment to adsorp of positive and negative ions. Concentration of trace metals increased directly with increasing of total organic carbon (Mach,2004). The low content in organic matter in the sediment of stations 1 and 2 reflected the picture of desiccation and burning process occurred in East Hammar marsh before 2003.

The current study found that the concentration of metals in the sediment was higher than in the dissolved phase of water because of the high adsorption ability of the metals in the sediment, and the appropriate concentration of metals in the sediment increases with the concentration in the water, (Salvado *et al*., 2006).

There were significant differences (P <0.05) in concentrations of trace metals in snails seasonally and spatially; that may be due to differences in the amount of water coming to the region, as well as differences in the environmental factors (Gavrilovic et al., 2007). EPA (1980) has shown that uptake of the trace elements from water by aquatic organism increases with temperature. Different organism differ in their ability to concentrate trace metals in its tissues and this is what was revealed in this study, since the variation in concentrations of different species of snails may not be due to spatial changes only, but it was due to the difference in the species ability to concentrate these metals (BCF for the organism) and its mechanism, This may be also due to differences in environmental requirements, behavior , food habits and metabolism of the species, or may be caused by a sudden contamination ,This is confirmed by a study of Dural *et al.* (2006). Concentration of trace metals in the snails were higher from their levels in sediments and this is consistent with the results of Heng *et al.*(2004) which determined the concentration of copper and zinc in the snail *Turritella* sp. and found double of their concentration in the sediments. The levels of trace metals in the snail tissues are highly dependent on the levels of these metals in the surrounding environment of the organism, and this is what was observed in the current study. The concentration of metals in the snail *B. bengalensis* were higher than the others, as it was noted the adoption of bio-accumulation of trace metals with the size of the species and this is consistent with what found by Swaileh *et al*. (2001).

Qarmat Ali Bridge station (station 4) was Characterized by high concentrations of copper, lead and zinc compared with other stations that may be due to the vulnerability to persistent discharge by the electric power station in Najibiyah and its proximity to the bridge which is characterized by the activity of vehicles and boats movement in the other hand, as well as discharging water pollutants resulting from the activities of the car washing near the station. As concentrations of metals in other stations and were lower, this is may due to the ability of marshes to get rid of pollutants, acting as natural candidates to remove of pollutants and that enter the environment because of the richness and biodiversity of these areas. East Hammar marsh is characterized by high productivity and density of the aquatic plants; these plants operate on the accumulation of pollutants in their tissues and thus reduce the concentration of metal pollution in the water, which is confirmed by the results of a study of Mahmoud (2008).

Snail’s ability for concentrating trace metals in their bodies were differs significantly among the species dependent on station and season. *B. bengalensis* had the highest ability for that, followed by the two species *L. auricularia* and *M. tuberculata*. The results indicated that studied snails would be suitable organisms for detecting increased levels of trace metals by measuring the bioconcentration factor that showed their ability to concentrate these metals and for their wide occurrence

The combination of high temperature and uptake by snails seemed to offer the best environmental conditions to reduce the highest rates of metal. During the warmer months, metal uptake is rapid while during the colder month the uptake process is less efficient. Hence, uptake was the most effective in the spring and summer months in E.Hammar marsh.

Conclusion

It can be conclude from present study that East Hammar marsh is exposed to different levels of trace metals pollutants that can be detected using species of snails in the area as follows *Bellamya bengalensis,Lymnaea auricularia* and *Melanoides tuberculata.*

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إمكانية استعمال بعض القواقع كدلائل حية لمستويات لمعادن النزرة في هور شرق الحمار، جنوب العراق

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الخلاصة

يعد هور الحمار في جنوب العراق ذو أهمية بيئية كبيرة، إذ يمثل موطنا لتنوع مختلف الأحياء مثل النواعم (القواقع). أجري عمل تحديد لتراكيز وتوزيع كل من عنصر الكادميوم والنحاس والرصاص والخارصين في كل من الماء (بطوريه الذائب والعالق) والرواسب وثلاثة أنواع من القواقع *Bellamya bengalensis* و *Lymnaea auricularia* و *Melanoides tuberculata* خلال المدة من أيلول 2007 إلى أيلول 2008 في أربع محطات مختارة من هور الحمار. تم قياس بعض المعايير البيئية في الهور شملت درجة حرارة الماء و الأس الهيدروجيني والأوكسجين المذاب والملوحة فضلاً عن كمية المادة العضوية في الرواسب. كان التركيز الكلي للعناصر النزرة في القواقع أعلى منه في الماء و الرواسب، وقد سجل *B. bengalensi* أعلى القيم مقارنة مع النوعين الآخرين. لوحظ تباين فصلي في معدلات التراكيز للمعادن المدروسة في كلا طوري الماء بفعل الاختلاف في مستويات الماء والمواد العالقة خلال الفصول، فضلا عن الملوثات المضافة في بيئة هور الحمار.