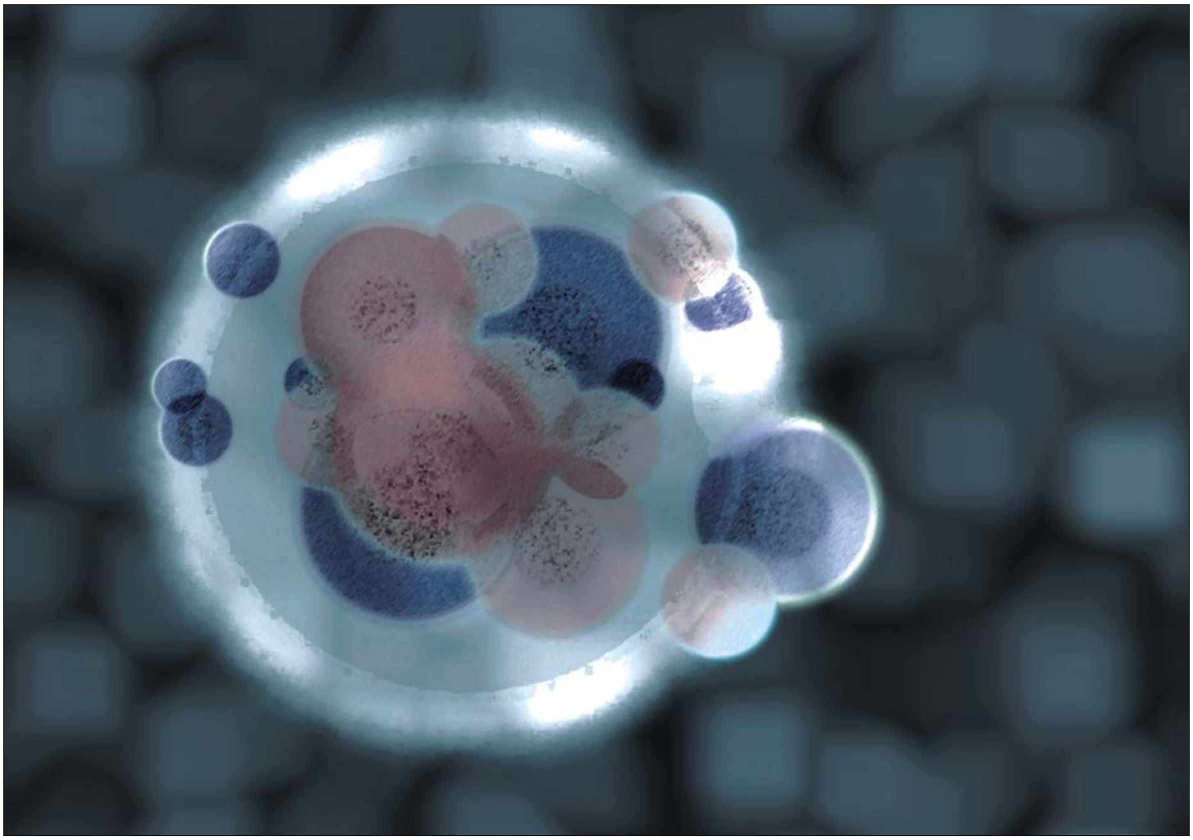

Journal of Biological Sciences

ISSN 1727-3048

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Biological Sciences 9 (3): 272-275, 2009
ISSN 1727-3048

Bioaccumulation of Heavy Metals in *Euryglossa orientalis* from the Hendijan Seaport (Coastal of Persian Gulf), Iran

[1]M.T. Ronagh, [1]A. Savari, [2]F. Papahn and [1]M.A. Hesni
[1]Department of Marine Biology, Faculty of Marine Science,
Khoramshahr Marine Science and Technology University, Khoramshahr, Iran
[2]Department of Biology, Faculty of Science, Shahid Chamran University of Ahvaz, Ahvaz, Iran

Abstract: In this study, we quantified bioaccumulation of lead and copper in gill, liver and muscle of three length groups (A, B and C) of *Euryglossa orientalis* and sediments from the Hendijan Seaport at South coastal of Iran from October 2006 to July 2007, seasonally. The concentrations of heavy metals were determined by using flame atomic absorption spectrophotometry (FLAAS) after wet digestion method. The average sediment concentration was taken into account for metal exposure: 25.63 mg Pb kg^{-1} and 12.79 mg Cu kg^{-1}. No significant differences were found between different seasons ($p>0.05$). Concentrations of Pb and Cu in the liver, gills and muscle were significantly different ($p<0.05$). Muscle, generally, accumulated the lowest levels of metals in every season and also the highest metal concentrations were observed in the liver (386.72±11.72 mg Cu kg^{-1}) and gills (14.97±0.22 mg Pb kg^{-1}) in summer. The results showed that the metal accumulation in summer season was higher than in the other seasons and also in a group was higher than other groups in all seasons. Generally, there were significant seasonal changes for Pb and Cu concentrations in all tissues ($p<0.05$) and concentrations of Pb and Cu in three groups were significantly different ($p<0.05$). These results suggest that Cu-liver and Pb gill accumulation can be good environmental indicators of metal stress in *Euryglossa orientalis*.

Key words: Bioaccumulation, heavy metal, *Euryglossa orientalis*, Persian Gulf

INTRODUCTION

Anthropogenic activities may generate metal pollution in air, soil and water. The ecosystem seems to offer an effective filter, retaining contaminants in soil profiles, transferring them into aquatic and/or terrestrial systems and thereby increasing the bioavailability and poisoning risk both to humans and the environment (Sánchez-Chardi *et al*., 2007).

Heavy metal pollution of the marine environment has long been recognized as a serious environmental concern. The presence of some heavy metals in aquatic environments and their accumulations in fish and in the other organisms has been investigated during recent years (Fernandes *et al*., 2007; Dural *et al*., 2007; Barbosa *et al*., 2000; Bassi and Sharma, 1993). Heavy metals are present in the aquatic environment where they bio accumulate along the food chain. Accumulation occurs in the tissues of aquatic animals and may become toxic for fish and also for people when it reaches a substantially high level. An early example of an environmental problem due to heavy metal occurred, starting in 1952, in the vicinity of the Japanese fishing harbor of Minimata. A hitherto unknown disease (Minimata disease) arose and grew rapidly into a real epidemic and was shown to be due to organomercury compounds (Dural *et al*., 2007; Vandecasteele and Block, 1991). Especially, since well-known instances where fishermen from Minimata.

Bay and villagers from Jintsu River died or became paralyzed from mercury and cadmium poisoning, respectively. For this reason, determination of chemical quality of aquatic organisms, particularly the contents of heavy metals is extremely important for human health (Dural *et al*., 2007; Cid *et al*., 2001). This research was conducted for the first time for Hendijan Seaport which is located in the North western Persian Gulf Coast of Iran (N 30° 15' 34"). Along the coast of Hendijan Seaport, there are agricultural lands and industrial plants (petrochemical plants, LPG plants, oil transfer docks and cargo ship's ballasts water). The most of pollutants intern to bay by Zohreh River. Due to heavy industrial and agricultural activities in the region, the bay has the polluted coastal waters of Khuzestan Province. Therefore, mainly untreated agricultural municipal and industrial wastes affect the Zohreh River and Hendijan Seaport direct or

Corresponding Author: M.T. Ronagh, Department of Marine Biology, Faculty of Marine Science,
Khoramshahr Marine Science and Technology University, Khoramshahr, Iran Tel/Fax: 986324233322

indirectly. This bay has a great importance for the local fisheries activities in Khuzestan Province. According to the report of the Iranian Fisheries Organization, 15 t of aquatic organisms were supplied from the Hendijan Seaport, in 2005. Besides being an important area for local fisheries. This research, on determination of heavy metal pollution, was carried out for the first time for Hendijan Seaport. Present specific objectives were to determine the distribution of heavy metals in *Euryglossa orientalis*. This species is a benthic economical fish in Persian Gulf.

MATERIALS AND METHODS

The samples were caught by fishermen's nets seasonally from October 2006 to July 2007 from the Hendijan Seaport and transported daily to the laboratory. The total length (cm) and weight (g) of fishes were measured (Table 1). Samples were divided in three length groups, A: 15 to 19.9 cm TL, B: 19.9 to 24.9 cm TL and C: ≥25 cm TL. All fishes were stored in plastic bags at -20°C until dissection. Each sample collected from the Hendijan Seaport seasonally was dissected for its muscle, gill and liver tissues (N = 50).

Sediments were extruded and sectioned in 2-4 cm thick slices, which were dried for 24 h at 105°C and digested with a hydrochloric-nitric acid mixture.

The tissues digested with concentrated nitric acid and perchloric acid (2:1 v/v) (Merck) at 60°C for 3 days and all samples were diluted with double distilled water. Metal concentrations in sediments, liver, muscle and gill were measured by flame atomic absorption spectrometry.

Statistical analysis were carried out using the SPSS statistical package program. The Kolmogorov-Smirnov method was used to test normal variable distribution and two-way ANOVA was used to compare differences in metal concentrations in the sediments along different seasons. Metal tissues concentrations were also compared by one-way ANOVA with Tukey test. The significance level (α) was set at 0.05.

Table 1: Minimum, mean, maximum length and weight of fish specimens used in this research

Variables	Season Autumn	Winter	Spring	Summer
Total length (cm)				
Min.	15.3	15.7	16	16
Max.	28.8	24.8	31	30
Mean	20.6±4	20.2±2.7	22.3±4.4	21.7±4.6
Total weight (g)				
Min.	55	59	63.5	63.5
Max.	388	293	521	505
Mean	157.1±100.6	155.2±67.2	191.2±108.7	197±142.9

N = 50 in each season

RESULTS

Total metal concentrations in the sediments are shown in Fig. 1. No significant differences were found between different seasons ($p>0.05$).

Spring and winter seasons showed significantly lower levels of Pb whereas winter and autumn were contaminated by Cu. The average sediment concentration was taken into account for metal exposure: 25.63 mg Pb kg^{-1} and 12.79 mg Cu kg^{-1}.

Concentrations of Pb and Cu in the liver, gills and muscle were significantly different ($p<0.05$) from each other. Gill contained Pb levels significantly higher ($p<0.05$) than the liver and muscle (Table 2).

The mean concentration of Pb in the gill was higher in A group with a range of 7.77-14.97 mg kg^{-1}, than other groups and the highest concentration observed in A group in summer, while in the muscle and liver it was always below 5.20 and 7.03 mg kg^{-1} in all group and seasons, respectively (Table 2).

The level of Cu was significantly higher in the liver than in gill and muscle tissues ($p<0.05$). The mean concentration of Cu in the liver was higher in A group with a range of 227.92-386.72 mg kg^{-1}, than other groups and the highest concentration observed in A group in summer, while in the muscle and gill it was always below

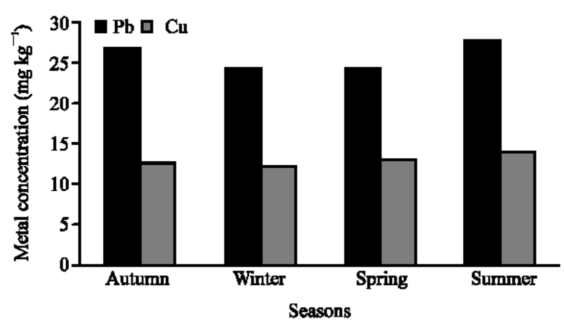

Fig. 1: Seasonal variation of Pb and Cu concentrations in the sediments of Hendijan Seaport

Table 2: Pb concentrations (mg kg^{-1} dry wt.; Mean±SD, N = 50) in the gill, muscle and liver tissues in the three groups of the studied specimens

Tissues	Length group	Season Autumn	Winter	Spring	Summer
Gill	A	13.41±0.73	7.77±0.68	14.84±0.79	14.97±0.22
	B	12.24±0.73	5.13±0.69	12.50±0.78	13.83±1.54
	C	10.71±0.26	Not caught	9.38±0.79	10.72±0.71
Muscle	A	3.35±0.36	2.73±0.23	3.73±1.31	5.12±0.52
	B	3.29±0.28	2.05±0.23	3.24±0.69	5.18±0.85
	C	3.19±0.27	Not caught	2.98±1.06	5.20±1.05
Liver	A	5.54±0.50	2.73±0.35	3.86±0.51	7.03±0.78
	B	4.13±0.59	1.71±0.34	3.22±0.31	6.68±0.70
	C	3.65±1.07	Not caught	2.95±0.29	6.15±0.77

Table 3: Cu concentrations (mg kg^{-1} dry wt.; Mean±SD, N = 50) in the gill, muscle and liver tissues in the three groups of the studied specimens

Tissues	Length group	Season: Autumn	Winter	Spring	Summer
Gill	A	9.42±0.45	8.43±0.61	8.92±0.360	17.32±0.810
	B	8.76±0.38	7.76±1.04	7.84±0.720	16.71±0.500
	C	7.87±0.40	Not caught	6.47±0.540	15.37±1.100
Muscle	A	-	2.07±0.35	2.41±0.240	5.61±0.760
	B	-	2.24±0.18	2.65±0.200	5.21±1.040
	C	-	Not caught	2.85±0.240	5.08± 0.27
Liver	A	354.61±25.15	244.59±11.65	302.27±16.39	386.72±11.72
	B	311.27±7.500	227.92±10.15	328.61±27.82	376.72±9.260
	C	280.09±24.07	Not caught	342.27±2.860	366.41±15.63

5.61 and 17.32 mg kg^{-1} in all group and seasons, respectively (Table 3). Muscle, generally, accumulated the lowest levels of metals in every season and also the highest concentration Pb and Cu observed in gill and liver, respectively. The results showed that the metal accumulation in summer season was higher than in the other seasons and also in A group was higher than other groups in all seasons (Table 2, 3). Generally, there were significant seasonal changes for Pb and Cu concentrations in all tissues ($p<0.05$) and concentrations of Pb and Cu in three groups were significantly different ($p<0.05$).

DISCUSSION

The present study shows that metal concentrations in the sediments tended to vary among seasons and summer displayed particularly high levels. This variation may be due to the differences in the sources of metal pollution and physical-chemical conditions favoring sediment contamination in different seasons.

Therefore, average concentrations of 25.63 mg Pb kg^{-1} and 12.79 mg Cu kg^{-1} assuming random fish in coastal area can be used to assess the fish-sediment accumulation factors.

Bioaccumulation is species-dependent and therefore feeding habits and life style can be strongly related to the sediment exposure (Chen and Chen, 1999).

The uptake of sediment-associated contaminants by fish may occur by respiratory and digestive tract, whereas the dermal route is usually a minimal contributor of exposure, due to the often effective barrier provided by the external epithelium. Present data show that mean concentrations of metals in the gills, liver and muscle are very variable (Table 2, 3).

Many studies also indicated that different fish species from the other area contained different metal levels in their tissues (Canli and Atli, 2003; Kalay *et al*., 1999; Marcovecchio, 2004; Fernandes *et al*., 2007). The metal accumulation in different fish organs depends on their physiological role, behavior and feeding habits, as well as regulatory ability, as reported by Chattopadhyay *et al*. (2002) and Clearwater (2002). Other factors, such as sex and size, may also influence metal bioaccumulation (Al-Yousuf *et al*., 2000; Canli and Atli, 2003). The concentrations of essential metals, such as Cu in organisms, tend to be highly regulated compared to nonessential. Fish can use different strategies of metal homeostasis to achieve a steady-state balance. The mechanisms of reducing metal accumulation and toxicity include uptake inhibition, increased elimination and detoxification and storage. This study showed that the highest concentration Cu was in liver and for Pb was in the gill.

The lowest concentration, for both metals, was found in muscle. Similar findings were obtained in the muscle of *Liza macrolepis*, *L. saliens*, *Oreochromis mossambicus* (Chen and Chen, 1999; Kotze *et al*., 1999; Fernandes *et al*., 2007) and other fish.

Gills are the first organs to be exposed to resuspended sediment particles, so they can be significant sites of interaction with metal ions. On the other hand, the liver has a key role in basic metabolism (Moon *et al*., 1985) and is the major site of accumulation, biotransformation and excretion of contaminants in fish (Triebskorn *et al*., 1994, 1997). It is well known that a large amount of metallothionein induction, caused by contamination, occurs in liver tissues of fish (Olsvik *et al*., 2001). In contrast, the muscle tissues are not considered an active site for metal accumulation (Romeo *et al*., 1999).

Liver and gills are known to be target organs for Cu in fish (Arellano *et al*., 1999). Results of the present study showed a positive correlation between the Cu-liver and Cu-gill and the highest concentration, found in liver, revealed that this organ is involved in the metabolism of copper.

Prolonged exposure may result in impairment of the normal detoxification response for copper, leading to liver bioaccumulation.

REFERENCES

Al-Yousuf, M.H., M.S. El-Shahawi and S.M. Al-Ghais, 2000. Trace metals in liver, skin and muscle of *Lethrinus lentjan* fish species in relation to body length and sex. Sci. Total Environ., 256: 87-96.

Arellano, J.M., V. Storch and C. Sarasquete, 1999. Histological changes and copper accumulation in liver and gills of the Senegales sole, *Solea senegalensis*. Ecotoxicol. Environ. Saf., 44: 62-72.

Barbosa, A.M., E.A.Gutierrez-Galindo and G. Flores-Munoz, 2000. *Mytilus californianus* as an indicator of heavy metals on the northwest coast of Baja California, Mexico. Mar. Environ. Res., 49: 123-144.

Bassi, R. and S.S. Sharma, 1993. Changes in proline content accompanying the uptake of zinc and copper by Lemna minor. Ann. Bot., 72: 151-154.

Canli, M. and G. Atli, 2003. The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. Environ. Pollut., 121: 129-136.

Chattopadhyay, B., A. Chatterjee and S.K. Mukhopadhyay, 2002. Bioaccumulation of metals in the East Calcutta wetland ecosystem. Aquati. Ecosyst. Health Manage., 5: 191-203.

Chen, M.H. and C.Y. Chen, 1999. Bioaccumulation of sediment-bound heavy metals in grey mullet, *Liza macrolepis*. Mar. Pollut. Bull., 39: 239-244.

Cid, B.P., C. Boia, L. Pombo and E. Rebelo, 2001. Determination of trace metals in fish species of the Ria de Aveiro (Portugal) by electro thermal atomic absorption spectrometry. Analytical Lett., 33: 3333-3341.

Clearwater, S., 2002. Metals in the aquatic food web: Bioavailability and toxicity to fish. Fact sheet on environmental risk assessment. Int. Council Mining Met., 6: 1-7.

Dural, M., M.Z.L. Göksu and A.A. Özak, 2007. Investigation of heavy metal levels in economically important fish species captured from the tuzla lagoon. Food Chem., 102: 415-421.

Fernandes, C., A.F. Nhas-Fernandes, F. Peixotoc and M.A. Salgado, 2007. Bioaccumulation of heavy metals in Liza saliens from the Esmoriz-Paramos coastal Lagoon. Portugal. Ecotoxi. Environ. Safty, 66: 426-431.

Kalay, M., O. Ay and M. Canli, 1999. Heavy metal concentrations in fish tissues from the Northeast Mediterranean Sea. Bull. Environ. Contam. Toxicol., 63: 673-681.

Kotze, P., H.H. Preez and J.H.J. Van-Vuren, 1999. Bioaccumulation of copper and zinc in *Oreochromis mossambicus* and *Clarias gariepinus*, from the Olifants river, Mpumalanga, South Africa. Water SA, 25: 99-110.

Marcovecchio, J.E., 2004. The use of *Micropogonias furnieri* and *Mugil liza* as bioindicators of heavy metals pollution in La Plata river estuary, Argentina. Sci. Total Environ., 323: 219-226.

Moon, T.W., P.J. Walsh and T.P. Mommsen, 1985. Fish hepatocytes: A model metabolic system. Can. J. Fish Aquat. Sci., 42: 1772-1782.

Olsvik, P.A., P. Gundersen, R.A. Andersen and K.E. Zachariassen, 2001. Metal accumulation and metallothionein in brown trout, *Salmo trutta*, from two Norwegian rivers differently contaminated with Cd, Cu and Zn. Comp. Biochem. Physiol. Part C, 128: 189-201.

Romeo, M., Y. Siau, Z. Sidoumou and M. Gnassia-Barellia, 1999. Heavy metal distribution in different fish species from the Mauritania coast. Sci. Total Environ., 232: 169-175.

Sánchez-Chardi, A., M.J. López-Fuster and J. Nadal, 2007. Bioaccumulation of lead, mercury and cadmium in the greater white-toothed shrew, Crocidura russula, from the Ebro Delta (NE Spain): Sex-and age-dependent variation. Environ. Pollut., 145: 7-14.

Triebskorn, R., H.R. Köhler, J. Flemming, T. Braunbeck, R.D. Negele and H. Rahmann, 1994. Evaluation of bis (tri-n-butyltin) oxide (TBTO) neurotoxicity in rainbow trout (*Oncorhynchus mykiss*). I. Behaviour, weight increase and tin contents. Aquat. Toxicol., 30: 189-197.

Triebskorn, R., H.R. Köhler, W. Honnen, M. Schramm S.M. Adams and E.F. Müller, 1997. Induction of heat shock proteins, changes in liver ultra-structure, and alterations of fish behavior: Are these biomarkers related and are they useful to reflect the state of pollution in the field? J. Aquat. Ecosyst. Stress Recov. 6: 57-73.

Vandecasteele, C. and C.B. Block, 1991. Modern Methods for Trace Element Determination. John Wiley and Sons Inc., New York, ISBN: 0471940399, pp: 259.