MERCURY ACCUMULATION IN LIVER, KIDNEY, PECTORAL MUSCLE AND BREAST FEATHERS OF ZARIVAR WETLAND COMMON COOT (*FULICAATRA*)

Borhan **M**ansouri[1], **F**arshid **M**ajnoni[2], **H**azhir **K**arimi[3]

[1]Young Researchers Club, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran.

[2]Department of Environmental Sciences, Faculty of Environment, Birjand University, Birjand, Iran.

[3]Department of Environmental Sciences, Faculty of Natural Resources, Isfahan University of Technology, Isfahan, Iran.

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Abstract

In this survey, the mercury concentration of kidney, liver, breast feathers and pectoral muscle was assayed in water bird, the Coot *Fulicaatra*. Bird samples were collected from November 2011 to January 2012 throughout the Zarivar wetland in western of Iran, and mercury was assayed by using a Varian 220 atomic absorption spectrophotometer; the results were given as µg/g. Results showed that the mercury concentration in the Coot were decreased in sequence of liver >feather > kidney> pectoral muscle. Also, the results indicated that the levels of the mercury concentration in the Coot were higher in females than in males. Mercury concentrations were different between the tissues of Coot, but there was no difference between sex (male vs. female; except mercury in muscle).

Keywords*:Biological Monitoring, Contamination Organs, WaterBird, Zarivar Wetland*

Introduction

Metal contamination of the natural environment is a persistent and worldwide problem, especially close to point-sources, such as wastewater discharge from Marivancity and places of tourists. Once metals are accumulated by an aquatic organism they can be transferred through the upper classes of the food-chain (Mansouri *et al.* 2012a).One of the most significantproperties of a toxic contaminant is its ability to accumulate in the tissues of organisms. Among the metals, mercury (Hg) have the ability to bioaccumulate in food chains, and most of the long-lived predatory species exhibit high concentrations of this toxic element. Mercury has long been considered as an environmental contaminant because of its high toxicity at low concentrations and bioavailability (Khangarot, 2003; Ebrahimpour *et al.* 2010). The toxicity of mercury depends greatly on the forms of the mercury compounds (organic and inorganic). Both inorganic and organic mercury in water pose considerable risk to aquatic biota since mercury in both forms is cumulatively toxic (Skubal & Meshkov, 2002).

Birds are exposed to uptake of contaminants mainly through the feeding of contaminated food. These species can give interesting data to assessment the quality of the environment. Many studies have suggested water birds as bioindicators for mercury in aquatic systems and local pollution around breeding sites (Frederick *et al.* 2002;Zamani-Ahmadmahmoodi et al. 2010; Aazami *et al*., 2011).They are at the top of their food we band can give data over a large area around each sampling site, they supply data not only on bioavailability of contaminants but also on how, where, and when they are transferred within the food web (Rumbold 2005; Mansouri *et al.* 2012b; Hoshyari *et al.* 2012). In the Zarivar Wetland region, Coot commonly breed in between plants, frequently forming dense multispecific colonies surrounded by diverse foraging habitats. Therefore, they suffer from contamination by wastewater discharges, as detected in various studies using water birds as indicators.

Many biomonitoring studies in the literature have evaluated levels of mercury in bird tissues (Kim *et al.* 1996; Houserová *et al.* 2007; Abdennadher *et al.* 2011; Misztal-Szkudlinska *et al.* 2011).Also, there are several reports that document mercury contaminated birds living in the south and southwest of Iran (Zamani-Ahmadmahmoodi *et al.*2009a, b; Zolfaghari *et al.* 2009).No research has been performed on the concentration of mercury in different tissues of the *Fulicaatra* in western of Iran. Therefore, this species can be considered as bioindicators of environmental pollution such as mercury. Our study aimed to further investigate of mercury in gender related variation in trace metal accumulation and determine the significance between mercury concentration in kidney, liver, pectoral muscle and feather.

Materials and methods

Zarivar wetland is located in the western of Iran, in 1278 m above sea level. Its latitude and longitude coordinates are 35°31′ to 35° 37′ N and 46°03′ to 46°10′ E, respectively (Fig. 1). The main water sources are precipitation (800 mm/year) and from springs on the wetland floor. The water surface area of this wetland varies seasonally from 1300 to 2300 ha. The average total area and water depth are 720 ha and 4-5 meters, respectively. It provides a suitable habitat for birds, fish, shrimp and other aquatic organisms. The unique habitats of the Zarivar Wetland are believed to be in danger of serious degradation and collapse due to metal pollution. This Wetland is situated closed to the Marivan City, places of tourists and agricultural sources. Therefore, the wastewater discharge from adjacent populated areas (mainly Marivan City), chemical fertilizers and pesticides from farmlands, improper solid waste management and the pressure caused by increasing number of tourists are devastating its ecological and environmental quality (Asarab Consultant Inc., 2007).

Bird samples were collected from November 2011 to January 2012 throughout the Zarivar Wetland. A total of 20 birds belong to Coot *Fulicaatra* were analyzed for mercury concentration in the kidney, liver, pectoral muscle and breast feather samples. The specimens were killed, weighed, stored in plastic bags, and kept at -20 °C until dissection and analysis. Liver, kidney, and pectoral muscle samples were dissected from the bodies of the specimens and weighed separately. The collections included with average weight (±SE) of 630 (±60)gand length body (±SE) of 39 (±2) cm. Liver, kidney, pectoral muscles and feather were separately dissected from the bodies of the specimens. Liver, kidney, and pectoral muscle samples were freeze-dried and homogenized. Finally they were changed into the powder. We chose breast feather because it is believed that exposure to metals is better represented by this type of feather and are less affected by molt compared to flight feathers. Feathers were washed vigorously in deionized water alternated with acetone to remove loosely adherent external contamination and were air dried overnight. The tissues samples were digested in a mixture of nitric acid and perchloric acid. Tissues were then accurately weighed into 150 mL Erlenmeyer flasks; 10 mL nitric acid (65 %) added to each sample; and samples left overnight to be slowly digested (Mansouri *et al.,* 2012b); thereafter, 5 mL perchloric acid (70 %) was added to each sample. Afterward, the digested samples were diluted with 25 ml deionized water. The concentration of mercury was estimated using a Varian 220atomic absorption spectrophotometer. The detection limit and recovery were 0.04 µg/g and 98%, respectively.

Data analyses were performed using the statistical package SPSS (version 16; SPSS, Chicago, IL). Data were tested for normality using a Kolmogorov–Smirnov test. Data were normally distributed; therefore, a parametric test was used for analysis. Mercury concentration in tissues was tested for mean differences between species using Student's *t* test. Also, concentrations of mercury were compared among kidney, liver and pectoral muscle samples in Coot using one- way analysis of variance (analysis of variance [ANOVA]). The concentration of mercury in tissues was expressed as microgram per gram dry weight (dw). Values are given in means ± standard errors (SE) and we considered a *p* value of <0.05 ($P < 0.05$) to be statistically significant.

Results and discussion

The results showed that the liver accumulated the highest level of mercury in *Fulicaatra* followed by the feather (Tables 1). Results also showed that mercury concentration in the *Fulicaatra* was decreased in sequence of liver >feather > kidney> pectoral muscle. Mean levels of mercury in liver, kidney, pectoral muscle and feather of *Fulicaatra* were 0.22, 0.13, 0.09 and 0.20 µg/g, respectively. Mercury concentration differed significantly in kidneys, livers, pectoral muscles and feather among organs in *Fulicaatra* (one-way ANOVA, F=6.60, p<0.001). The results indicated that the levels of the mercury concentration in the *Fulicaatra* were higher in females than in males. Also, the results indicated that with the exception of mercury in muscle (*t* test, p< 0.05), there were no significant differences between males and females in water bird species, *Fulicaatra*. Pearson correlation coefficients of mercury in the tissues are shown in Table 2. There was no significant correlation between tissues and weight.

Metals levels in tissues can serve as an indication of the bioavailable fraction of the element in the environment (Johansen *et al.,* 2006), can be used to monitor exposure to metals in birds and their ecosystem, and can be used to assess the variable capacity in metal accumulation (Naccari *et al.* 2009), thus alerting managers and the public to future ecological problems (Tsipoura *et al.,* 2008). The concentration of metals in liver, kidney, and muscle can be considered indicative of chronic exposure to metals based on the diet and the amount of pollution in the habitat (Naccari*et al*., 2009). Muscle was the tissue with least mercury in all birds. Freadman (1979) suggests that oxidation of mercury compounds and their rapid excretion can rid the muscle tissue from mercury, while in other tissues, where oxidation is low, mercury levels are higher. The results in this survey indicated that the muscle accumulated the lowest level of mercury in *Fulicaatra*. Studying on the mercury concentration on the tissues of *Phalacrocorax carbo,* Mollazadeh et al., (2011) showed that mercury concentration was higher in liver than in the kidney and muscle. Also, Zamani-Ahmadmahmoodi *et al*.(2009a) showed that the level of mercury in liver of *Bubulcus ibis* and *Egrettagarzetta* was higher than in kidney, muscle and feather. Mercury concentrations in liver of 49 to 125 µg/g have been reported for free-living birds found dead or dying (Thompson,1990). While maximum observed mercury concentration in the liver of *Fulicaatra*(0.22 µg/g)was lower than concentrations associated with mortality. Furthermore, nephrotoxicity and kidney lesions have been documented in birds with a kidney mercury concentration range of 5 to 13 µg/g (Nicholson & Osborn, 1983). In the current study, mean mercury concentrations in *Fulicaatra* kidney (0.13 µg/g) were lower than nephrotoxicity thresholds. Mercury concentrations in theliver, kidney and pectoral muscle of *Fulicaatra* in the present study were lower than those in *Bubulcus ibis* and *Egrettagarzetta*from Iran (Zamani-Ahmadmahmoodi *et al.,* 2009a)and *Phalacrocoraxcarbo* and *Anasplatyrhynchos* (Aazami et al 2011). In contrast, mercury concentrations in the liver (0.22 µg/g), kidney (0.13 µg/g) and pectoral muscle (0.09 µg/g) of *Fulicaatra* in the present study was higher than those in *Fulicaatra* (0.09, 0.08 and 0.03 µg/g in the liver, kidney and muscle, respectively) from the wetlands of the Caspian Sea (Aazami et al 2011).

Feathers can be used to evaluate metal contamination, especially for organic bound metals such as mercury, which accumulate in the plumage, and for which feathers are the main elimination routes (Lewis & Furness 1991; Lewis *et al.* 1993; Guruge *et al.,* 1996). Mercury in feathers reflects mainly the amount derived from the diet at the time when feather are developing. Mercury concentrations of 5 µg/g dry weight in feathers are often associated with impaired reproduction (Burger & Gochfeld 2000). In this study, mercury concentrations in feathers of *Fulicaatra* (0.20 µg/g) was lower than 5 µg/g. The high values of mercury in the specimens point to that the environment is highly stressed with regards to the mercury.

12Generally, human activities like the wastewater discharge from adjacent populated areas (mainly Marivan City), chemical fertilizers and pesticides from farmlands and improper solid waste management may be noted as the prime pollution sources and the main factor in increasing this metal. Mercury concentrations in the *Fulicaatra* feathers from the present study was lower than those in *Fulicaatra* from the wetlands of the Caspian Sea (Aazami et al 2011)and *Egrettagra zetta* and *Bubulcusibis* from southwestern of Iran (Zamani-Ahmadmahmoodi*et al.* 2009a). During the growth of feathers, most of the mercury load not eliminated in excrement and eggs seem to accumulate in the plumage. Thus, feathers contain higher concentrations of mercury than generally found in the tissues of a bird (Solonen& Lodenius 1990).

Respecting gender-dependent mercury body burden in birds, there are conflicting data. Studies in the literature have indicated a difference in mercury concentrations between male and female birds (Hutton 1981; Gochfeld& Burger 1987), whereas other studies have reported no differences in mercury concentrations between genders (Zamani-Ahmadmahmoodi *et al.,* 2010; Aazami *et al.,* 2001). In the present study, except mercury in muscle(*t* test, $p< 0.05$), there was no evidence of significant differential accumulation between male and female birds. As well as, the mercury concentration in the tissues of *Fulicaatra* was higher in the females than in the males. Gender related variation in trace metal accumulation could be related to ecological or physiological factors. Braune& Gaskin (1987) reported that female Bonaparte's gull (*Larusphiladelphia*) could excrete a higher percentage of the body burden of mercury than males. In contrast, studying the metals of the liver of three duck species, Gochfeld& Burger (1987) showed that the level of mercury was higher in males than in females. Evers *et al.* (2005) argues that this difference in mercury levels between sexes can be attributed to depuration in eggs, sexual dimorphism, and niche partitioning of the forage base.

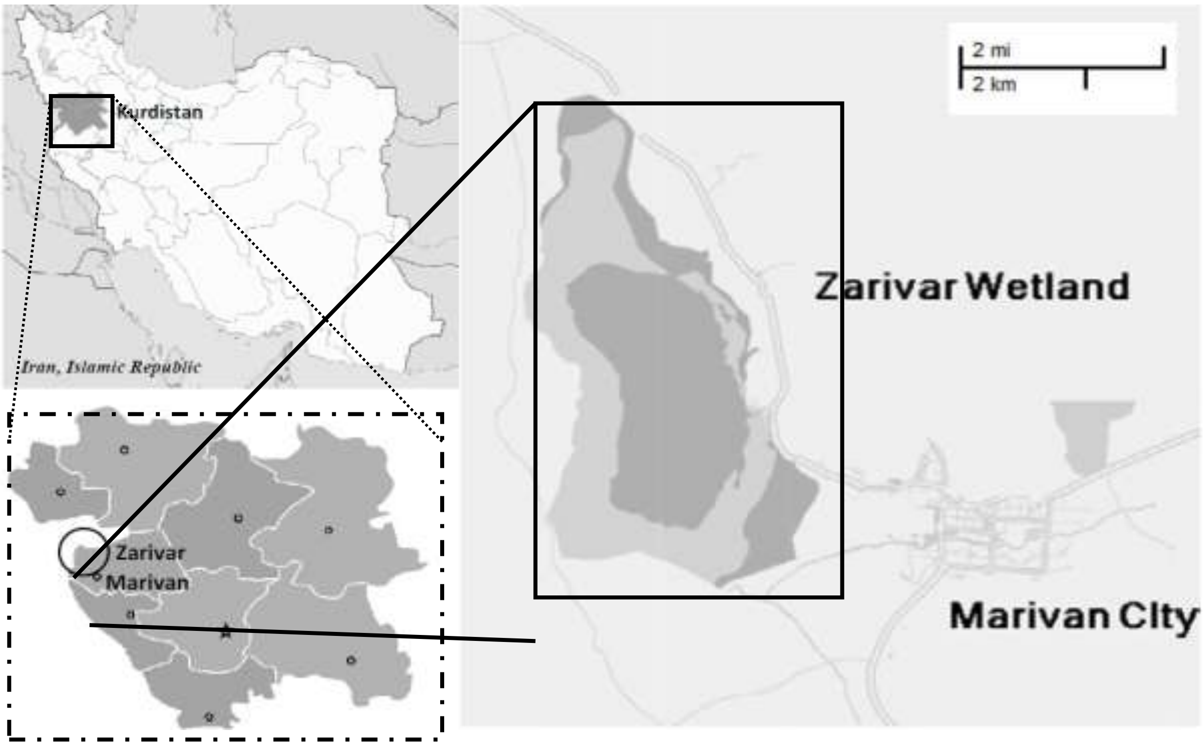
Table (1): Means (±SE) of mercury concentration (µg/g dry weight) in tissues of Coot from Zarivar wetland in western of Iran

Species Sex	No.	Tissues				*F*	[a]*p*
		Kidney	Liver	Pectoral muscle	Feather		
Coot							
Male	10	0.10±0.01	0.19±0.03	0.06±0.01	0.17±0.02		
Female	10	0.16±0.04	0.27±0.04	0.14±0.04	0.24±0.03		
Min-Max		0.01-0.44	0.01-0.45	0.01-0.34	0.03-0.45		
Overall mean		0.13±0.02	0.22±0.03	0.09±0.02	0.20±0.02	6.60	0.001
[b]*p*-value		NS	NS	0.05	NS		

[a]*p* value for Analysis of variance (ANOVA) of mercury concentration in the tissues of Coot
[b]*p* value for Student's *t* test to compare between males and females; NS not significant

Table (2): Correlation coefficient (r) between the mercury concentrations in tissues of Coot from Zarivar wetland in western of Iran

	Kidney	Liver	Muscle	Feather	Weight
Kidney	**1**				
Liver	0.25	1			
Muscle	0.04	0.00	1		
Feather	0.07	0.39	0.41	1	
Weight	-0.08	0.32	-0.24	-0.03	1



Fig(1): The map of Zarivar Wetland

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