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Mercury Distribution in Liver, Kidney, Muscle and Feathers of Caspian Sea Common Cormorant (*Phalacrocorax carbo*)

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Abstract: We conducted a study to screen mercury (Hg) level in the Caspian Sea common cormorant (*Phalacrocorax carbo*) to determine the biological behavior of this element and to assess the exposure of wild fish-eating birds, which are a bioindicator to this pollutant. Mercury concentration was measured in liver, kidney, muscle and feathers. The mean concentration of mercury was 8.32±1.32, 9.25±1.71, 2.064±0.22 and 4.44±0.3 ppm in liver, kidney, muscles and feathers respectively. Hg concentration was highest in the kidney and liver ($p<0.01$). The amount of mercury accumulation obtained was as follows: Liver ≈ Kidneys > Feathers > Muscles. Hg concentration in the liver and muscle increased significantly with growth from juvenile to adult ($p<0.05$). Comparison of Hg concentration between males and females indicated that Hg concentration in the muscle ($p<0.05$) and kidney ($p<0.01$) was significantly different.

Key words: Common cormorant, mercury, liver, kidney, muscle, feathers, Caspian Sea

INTRODUCTION

The increase of global mercury levels in the last decades is of concern because mercury is a persistent toxic heavy metal that both bioaccumulates and biomagnifies in wild life. Heavy metals are potentially toxic substances; their stability causes certain problems in the environment (Spalding *et al.*, 1994). One of the outcomes is their vast biological existence in the food chain. Because of this process, the higher members of the food chain may contain higher amounts of metals several times more than the amount found in water or air. It will consequently endanger the plants and the animals that consume the food (Caldwell *et al.*, 1999). Mercury is one of the most toxic elements in the environment, considered as the most significant among other heavy metal pollutants. Its terrible damages to humans' health and that of other creatures have already been investigated in detail. Mercury has the potential to cause many diseases and side effects in human beings directly or indirectly. It can also have toxic effects and damage on the wild life and may cause miscellaneous side effects (Boening, 2000). It has obviously been revealed that birds are quite sensitive to all pollutants and other damaging changes in the environment. The position of the carnivorous birds at the top of the food chain and their long lifespan indicate that they are more affected by the pollutants and by the changes in the various parts of the ecosystem through time (Furness and Greenwood, 1993). Among birds, fish eating birds will suffer more damages due to Hg pollution, since the toxic Hg compounds specially methyl mercury are solved in the water and taken to their food chain by planktons. Sundlof *et al.* (1994) revealed that the concentration of Hg in the liver of some wading birds collected from south Florida was so much that it caused some apparent nervous symptoms and some damages

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to their reproduction system and concluded that the reduction of some Ciconiformes in Florida might be partially due to the Hg pollution of their food resources. In another study it was noted that some of the great white herons infected by chronic liver and kidney diseases as a result of Hg pollution were dead and it was concluded that the Hg pollution is harmful for the wading birds' health and reproduction (Spalding *et al*., 1994).

Common cormorant (*Phalacrocorax carbo*) is a species dependent on the aquatic ecosystems, which has been taken into consideration by the researchers due to its high population, its special fish-eating habits and its damage to fisheries resources. The common cormorant belongs to the order Pelecaniformes, family Phalacrocoracidae and seabirds in taxonomy. Their predating position at the top of the aquatic ecosystem chain has made them sensitive to the environmental changes. The pollution and changes in climate in aquatic ecosystems, which make the habitats inappropriate to inhabit, have lead to a decrease in their population (Barati, 2003). Common cormorants live all over the world including Europe, Africa, Asia, Oceania and Northern America so that these species could be a potential global environmental monitor for toxic contaminants, such as mercury (Saeki *et al*., 2000). The mercury pollution has deteriorating effects on birds' breeding and survival and since these polluted birds may transfer the mercury pollution to other animals and human beings (Caldwell *et al*., 1999), the current study has been conducted on the amount of the mercury accumulation in common cormorants (*Phalacrocorax carbo*). The amount of the mercury accumulation in their various organs, including liver, kidneys, muscles and feathers, was estimated and compared.

MATERIALS AND METHODS

The Fereidoonkenar region was chosen for sampling after a study on the common cormorant's biological habits and migrations. The Fereidoonkenar region is located in 52° 25′ to 52° 35′ E and 36° 35′ to 36° 45′ N, in the south of the Caspian Sea in Iran. The sampling was done randomly in the fall of 2004. Fourteen common cormorants were captured by net. The average weight and length of captured birds were 2.02 kg (1.25-2.45 kg) and 82.5 cm (71-88 cm), respectively. After collecting the samples (Table 1), they were transported to the laboratory and their biometrical measures were gathered. The growth stage of the birds was assigned based on their external characteristics such as their feather color. All the body feathers of an adult common cormorant were black, whereas a juvenile has some brown feathers among the black ones. The juvenile may also be distinguished from adults by the size of the Fabricius bile (Saeki *et al*., 2000). The samples were divided into two groups of the adults and the juveniles based on their physical characteristics. The birds were then stored in polyethylene bags and frozen. After being frozen, the birds were dissected and their gender was determined based on their genitals. The liver, kidneys, muscles and feathers, were dismantled and dried in the oven at 60°C for 48 h. The samples were powdered and prepared for mercury analysis. Mercury was measured by the Mercury Analyzer Leco AMA254 at the laboratory of the Tarbiat Modares Natural Resources University. For the statistical analysis of the data, the SPSS program was applied performing Kruskal-Wallis, Mann-Whitney U, T-test and the Pearson Correlation.

Table 1: Gender and age of common cormorants hunted from Fereidoonkenar region

	Gender	
Age	Male	Female
Adults	4	1
Juveniles	5	4

RESULTS AND DISCUSSION

The mean concentration of mercury in the liver, kidney, muscles and feathers were 8.32, 9.25, 2.064 and 4.44 ppm, respectively (Table 2). There is a significant difference for concentration in the four organs (Fig. 1) and between sexes (Fig. 2). Mercury concentration in the common cormorants' tissues was as follows: Liver ≈ Kidneys > Feathers > Muscles. Mercury is a heavy metal that is present in the earth's crust and it is methylated by bacteria in aquatic environments to methyl mercury (MeHg) in anaerobic conditions (Boening, 2000). It is then concentrated by the food chain so predatory fish and other seafood animals may have the highest level (Hall *et al*., 1997). Today, the main source of exposure to chemical contaminants such as mercury is from methylation of inorganic mercury in bodies of fresh and ocean water (Khaniki *et al*., 2005). To evaluate mercury accumulation, birds are often used as a bioindicator of mercury level in both the marine and freshwater environments

Table 2: Mercury concentration (ppm) in studied tissues of common cormorants

	Hg concentration		
Tissue	Mean	Min.	Max.
Muscle	2.06	1.04	3.39
Liver	8.32	3.30	20.84
Kidney	9.25	3.30	23.99
Feather	4.44	2.63	6.76

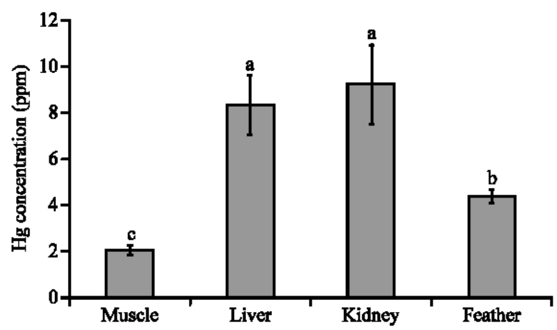

Fig. 1: The comparison of mercury concentration in muscle, liver, kidney and feather of common cormorants (The different alphabet indicates significant differences at 99%)

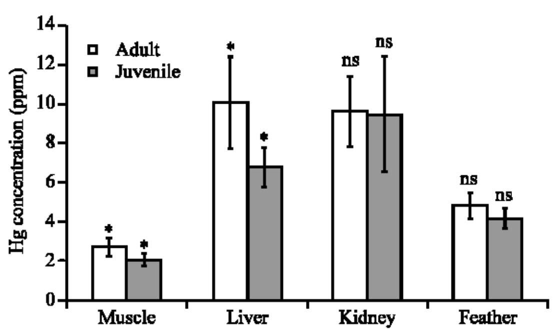

Fig. 2: The comparison of mercury concentration in muscle, liver, kidney and feather between male adult and male juvenile cormorants, *Significant difference of 95%, **Significant difference of 99%, ns: No significant difference of 95%

(Evers *et al*., 2003; Cohen *et al*., 2000; Rumbold *et al*., 2001; Henny *et al*., 2002; Evers *et al*., 2005). Based on the findings in this study, the maximum mercury concentration in the common cormorants' organs was found in the liver and the kidneys. In a similar study estimation of the mercury and cadmium concentration in the common cormorants (*Phalacrocorax carbo*) gathered from the Biwa and the Tokyo lakes in Japan (Saeki *et al*., 2000), revealed the maximum mercury concentration in the liver and the kidneys. Another researcher also showed that the highest concentration of methyl mercury is in the liver of sea bird species (Kim *et al*., 1996). In the present study, the mercury concentration in the males' muscles ($p<0.05$) and kidneys ($p<0.01$) was significantly higher than that of the females. This might be due to some defensive mechanism in the female such as laying eggs. Mercury concentration in the liver and muscles of the adult cormorants is significantly higher than that of the juvenile cormorants ($p<0.05$) that indicated more exposure of adult birds to mercury.

In another study, determination of the mercury concentration in the liver of seven species of the wading birds in Southern Florida revealed that mercury concentration in the adults' livers was three times more than that of the chicks (Sundlof *et al*., 1994). The mercury concentration significantly increased as the birds grew up (from a chick into an adult) in all tissues except for the brain (Saeki *et al*., 2000). It obviously indicates that the mercury is accumulated in the body as the birds grow up and feed. In marine mammals, it has been revealed that the amount of the mercury in their body increases as they grow older (Denton *et al*., 1980; Honda *et al*., 1986). Similarly, some other researchers have also reported that the mercury concentration in adult birds is higher than juvenile birds. In fact, nutritionally, mercury is a non-essential element in the body and has such a long biological half-life that it accumulates in the body with age and with increasing levels of exposure to the environment (Saeki *et al*., 2000). Mercury in the food eaten during feather growth considerably affects the mercury levels of the feathers, from the result of this study, feathers as indicators of environmental mercury pollution should preferably be from nestlings. total feathers should be analysed rather than only parts of them (Solonen and Lodenius, 1990). Although we must note that birds are equipped with a molting system for mercury removal (Saeki *et al*., 2000).

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REFERENCES

Barati, A., 2003. The phenology of reproduction and successful breeding of common cormorant in Ramsar. M.Sc. Thesis. Tarbiat Modares University, Tehran.

Boening, D.W., 2000. Ecological effects, transport and fate of mercury: A general review. Chemosphere, 40: 1335-1351.

Caldwell, C.A., M.A. Arnold and W.R. Gould, 1999. Mercury distribution in blood, tissues and feathers of double-crested cormorant nestling from arid-lands reservoirs in south central New Mexico. Arch. Environ. Contam. Toxicol., 36: 456-461.

Cohen, J.B., A.R. Barclay, A.R. Major and J.P. Fisher, 2000. Wintering greater scaup as biomonitors of metal contamination in federal wildlife refuges in the Long Island region. Arch. Environ. Contam. Toxicol., 38: 83-92.

Denton, G.R.W., H. Marsh and G.E. Heinsohn, 1980. The unusual metal status of the dugong Duging dugon. Mar. Biol., 57: 201-219.

Evers, D.C., K.M. Taylor, A.R. Major, R.J. Taylor, R.H. Poppenga and A.M. Scheuhammer, 2003. Common loon eggs as indicators of methylmercury availability in North America. Ecotoxicology, 12: 69-81.

Evers, D.C., N.M. Burgess, L. Champoux, B. Hoskins, A.R. Major, W. Goodale, R.J. Taylor, R. Poppenga and T. Daigle, 2005. Patterns and interpretation of mercury exposure in fresh water avian communities in northeastern North America. Ecotoxicology, 14: 193-221.

Furness, R.W. and J.J.D. Greenwood, 1993. Birds as Monitors of Environmental Changes British Trust for Ornithology. 1st Edn. Thetford Norfolk, UK, pp: 342.

Hall, B.D., R.A. Bodaly, R.J.P. Fudge, J.W.M. Rudd and D.M. Rosenberg, 1997. Food as the dominant pathway of methyl mercury uptake by fish. Water Air. Soil. Pollut., 100: 13-24.

Henny, C.J., E.F. Hill, D.J. Hoffman, M.G. Spalding and R.A. Grove, 2002. Nineteenth Century Mercury: Hazard to wading birds and cormorants in Carson River, Nevada. Ecotoxicology, 11: 213-231.

Honda, K., Y.R. Fujise, K. Tatsukawa, N. Itano and Miyazaki, 1986. Age-related accumulation of heavy metals in bone of the striped dolphin. Mar. Environ. Res., 20: 143-160.

Khaniki, G.R.J., A. Inteaz, E. Nowroozi and R. Nabizadeh, 2005. Mercury contamination in fish and public health aspects: A review. Pak. J. Nutr., 4: 276-281.

Kim, E.Y., T. Murakami, K. Saeki and R. Tatsukawa, 1996. Mercury levels and its chemical form in tissues and organs of seabirds. Environ. Contam. Toxicol., 30: 256-266.

Rumbold, D.G., S.L. Niemczyk, L.E. Fink, T. Chandraesekhar, B. Harkanson and K.A. Lane, 2001. Mercury in eggs and feathers of great egrets (*Ardea albus*) from Florida Everglades. Arch. Environ. Contam. Toxicol., 41: 501-507.

Saeki, K., Y. Okabe, E.Y. Kim, S. Tanabe, M. Fukuda and R. Tatsukawa, 2000. Mercury and cadmium in common cormorants (*Phalacrocorax carbo*). Environ. Pollut., 108: 249-255.

Solonen, T. and M. Lodenius, 1990. Feathers of birds of prey as indicators of mercury contamination in southern Finland. Holarctic. Ecol., 13: 229-237.

Spalding, M.G., R.D. Bjork, G.V.N. Powell and S.F. Sundlof, 1994. Mercury and cause of death in great white herons (*Ardea herodias occidentalis*). J. Wildlife Manage., 58: 735-739.

Sundlof, S.F., M.G. Spalding, J.D. Wentworth and C.K. Steible, 1994. Mercury in livers of wading birds (*Ciconiiformes*) in southern Florida. Environ. Contam. Toxicol., 27: 299-305.