

Short Communication

Mercury Levels in Liver, Kidney and Muscle of Common Teal *Anas crecca* from Shadegan Marshes, Southwest Iran

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Introduction

Bioaccumulation of heavy metals in tissues of animals has received considerable attention because of the lethal and sublethal effects of their accumulation. Heavy metals come from industrial sources, storm water runoff, and agricultural runoff, as well as from natural erosion, biogeochemical cycles, and volcanism. They enter the food chain via air, water, soil and biota, accumulating disproportionately at higher levels of the food chain. Mercury is considered one of the most potentially serious pollutants since it has no known biological function in the body of aquatic animals, is highly toxic and, unlike other heavy metals, tends to be accumulated through the food chain. Furthermore, inputs of mercury to the environment include a large anthropogenic component (Ek *et al.* 2004).

Birds are particularly useful as bioindicators of pollution because they are often high in the food chain (Burger *et al.* 1994). Several physiological and biological processes, such as feeding habits, growth, age, reproduction, moulting, and migration may influence metal concentration and distribution in birds (Kim *et al.* 2007). The avian mercury concentration gradient is usually at its highest levels in feathers, followed by liver, kidney, heart, and muscle tissues (Burger 1993).

Numerous waterfowl species are regarded as convenient bioindicators of environmental heavy metal pollution. They are readily recognizable, show distinct sexual dimorphism, are long-lived,

abundant, and have wide geographical ranges: in other words, they meet the requirements of good biomonitors (Kalisinska *et al.* 2004). Such species include the Common Teal *Anas crecca*. Several authors have investigated mercury levels in piscivorous birds such as Great Cormorants *Phalacrocorax carbo* (Houserova *et al.* 2007), Australasian Gannet *Morus serrator* (Burger *et al.* 1994), Black-Headed Gull *Larus ridibundus* (Lewis & Furness 1991) and tropical terns (Burger & Gochfeld 1991). However, Rothschild & Duffy (2005) reported mercury concentrations in muscle, brain and bone tissues of Common Teal *Anas crecca* and other Alaskan waterfowl. The mean values for mercury in Alaskan waterfowl were unlikely to cause adverse reproductive or behavioural effects in the birds. The objective of our study was to determine the levels of mercury in liver and kidney of Common Teal taken from Shadegan Marshes, in southwest Iran.

Study Area

Shadegan Marshes are situated in a currently sensitive military zone close to the border with Iraq. The area is adjoined by the Tigris-Euphrates alluvial salt marshes of Iraq (Fig. 1). The harvest of reeds is of considerable importance in the local economy. Shadegan Marshes and the tidal mudflats of Khor-al Amaya and Khor Musa are outstanding examples of floodplain wetlands and coastal mudflat ecosystems of the Persian Gulf, playing a significant hydrological and ecological

role in the natural functioning of the northern Gulf. They support an extremely diverse wetland fauna and flora, and thus play an important role in maintaining the genetic and ecological diversity of the region (Scott 1995). Several studies have pinpointed major sources of contamination in this area, including agricultural use of fertilizers, herbicides and pesticides, and also hazardous substance spills from various refineries and Bandar Imam Khomeini Petrochemical Factory (Zolfaghari *et al.* 2007).



Figure 1. Map of Iran and location of study area, Shadegan.

Materials and Methods

Six Common Teal were collected from Shadegan Wetland: these had been shot by hunters in October 2007. The specimens were dissected to separate liver, kidney and pectoral muscle from their bodies. Samples were freeze-dried and homogenized (Houserova *et al.* 2007) then were ground in a mortar. Advanced Mercury Analyser AMA 254, controlled by WinAMA software, was used to determine total mercury concentrations by direct analysis of solid (with ASS 254 auto-sampler) and liquid samples (with ALS 254 auto-sampler). Homogenized solid samples were directly weighed ($50\text{--}100\pm 0.1$ mg) into the pre-cleaned combustion boats. In order to assess the analytical capability of the proposed methodology, accuracy of total Hg analysis was checked by running three samples of Standard Reference Materials (SRM), National Institute of Standards and Technology (NIST), SRM 1633b, SRM 2709, and SRM 2711 in seven replicates

(Al-Majed & Preston 2000). Recovery varied between 94.8 % and 105%. The detection limit of the instrument used was $0.001\mu\text{g/g}$ of dry weight. Mercury concentrations are expressed as $\mu\text{g/g}$ on a dry weight basis. Values are reported as mean \pm standard errors (SE) and a probability level of $p\leq 0.05$ was accepted as significant.

Results and Discussion

Mean mercury concentrations in liver, kidney and muscle preparations were 4.34 ± 1.35 $\mu\text{g/g}$ (ranging from 0.67 to 8.76), 3.41 ± 0.99 $\mu\text{g/g}$ (ranging from 1.05 to 5.20) and 1.44 ± 0.49 $\mu\text{g/g}$ (ranging from 0.36 to 3), respectively (Fig. 2). Mercury concentrations in liver of 49 to 125 $\mu\text{g/g}$ have been reported for free-living birds found dead or dying (Thompson 1996). While maximum observed mercury concentration in the liver of Teal (8.76 $\mu\text{g/g}$) 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 $\mu\text{g/g}$ (Nicholson & Osborn 1983). Mercury levels in the kidneys of three Common Teal reached the threshold level for nephrotoxicity. Mercury concentrations in livers were strongly, positively and linearly correlated with those in kidneys of the Common Teal ($p<0.05$, $r=0.88$, Fig. 3).

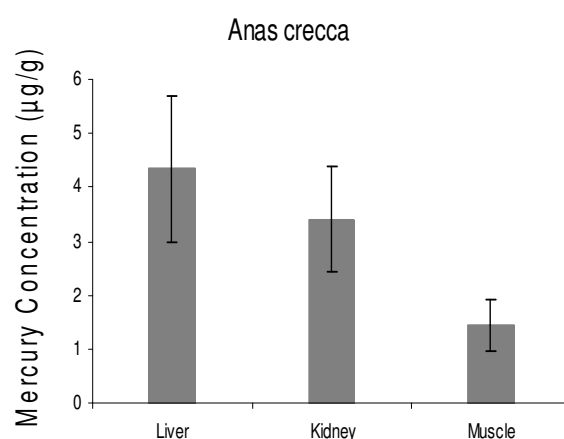


Figure 2. Mercury concentrations (Mean \pm SE) in tissues of Common Teals.

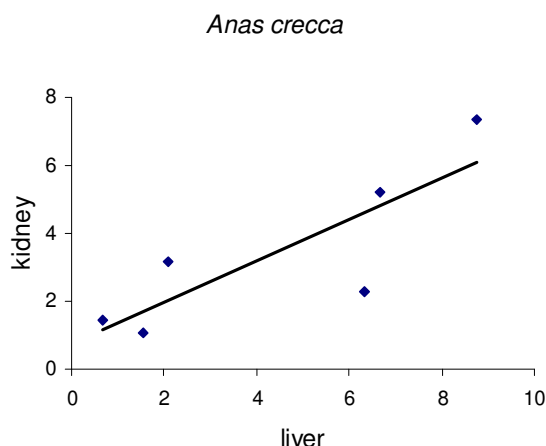


Figure 3. Relationship of mercury concentrations between liver and kidney of the Common Teals ($p < 0.05$, $r = 0.88$).

In birds, mercury is associated with several effects, such as reduced food intake leading to weight loss, progressive weakness in wing and disordered legs and difficulty in flying, walking, and standing; paralysis, convulsion, and death. Mercury can also affect populations of free-ranging birds through an increase in mortality and/or a decrease in fecundity and hatching and fledging rates (Ochoa-Acuna *et al.* 2002). Once metals enter a bird, they can be stored in internal tissues such as the kidneys and the liver (Ek *et al.* 2004). The birds demethylate mercury in the liver and kidney to inorganic forms, which then accumulate in the tissues (Houserova *et al.* 2005).

One important aspect of a comparison among species is to consider whether any species exhibit metal levels that are above those levels known to cause sublethal, behavioural or reproductive effects. Concentrations of mercury in the different tissues of analysed species were comparable to those of other aquatic birds. Levels of mercury in the livers of Common Teal were higher than those in Cinnamon Teal *A. cyanoptera* from the southeast Gulf of California (Ruelas-Inzunza *et al.* 2007). Comparison of mercury levels between some Anatidae species, with Common (Green-winged) Teal *A. crecca carolinensis*, Northern Pintail *A. acuta*, and White-winged (Velvet) Scoter *Melanitta [fusca] deglandi*, showed that it did not vary much in particular, generally having quite low levels ($< 0.5 \mu\text{g/g ww}$) (Braune & Malone 2006).

In the Shadegan area, Common Teal is hunted for its meat. World Health Organization (WHO 1972) reported that the weekly amount of tolerable mercury intake is $5 \mu\text{g/kg}$ body-weight. Therefore a person with 70 kg body weight can ingest $350 \mu\text{g/kg-week}$ of mercury. According to the results of this study, the mean concentration of mercury in muscles of Common Teal was $1.44 \mu\text{g/g}$ or $1440 \mu\text{g/kg}$. Therefore, 314 g is the total weekly maximum amount of Common Teal meat that could be consumed by a 70 kg individual without exceeding a body concentration of $5 \mu\text{g/kg-week}$; for a child (body weight of 15 kg) this amount would be only 67 g. As mentioned above, mercury concentrations in the liver and kidney of Common Teals were higher than those in muscles, therefore it seems that consumption of liver and kidney of these birds may be harmful.

Common Teals are migratory waterbirds to Shadegan Wetland (Nabavi *et al.* 2006). Kunisue *et al.* (2003) reported that migratory birds did not necessarily reflect only the pollution in the sampling area, even though that was known to be high. Even though pollution in their breeding grounds might be low, exposure to mercury in their wintering grounds or in stopover sites may adversely affect their subsequent reproductive activities. This means that measures to protect migratory birds will necessitate making improvements to the environment not only in breeding grounds, but also in stopover sites and wintering grounds.

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