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Short Communication

Organic and total mercury in muscle tissue of five aquatic birds with different feeding habits from the SE Gulf of California, Mexico

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ABSTRACT

We measured organic and total Hg in muscle tissue of five species of aquatic birds from the south-eastern gulf of California region, Mexico. Concentrations of total and organic Hg measured in *Pelecanus occidentalis* were the highest (2.85 and 2.68 $\mu g\, g^{-1}$); lowest values of organic Hg (0.20 $\mu g\, g^{-1}$) and total Hg (0.47 $\mu g\, g^{-1}$) were detected in *Anas discors* and *Anas clypeata*, respectively. Differences of Hg levels were related to feeding habits, being concentrations in birds of piscivorous habits more elevated than corresponding values in non-piscivorous species.

1. Introduction

Though mercury (Hg) occurs naturally in the environment, anthropogenic activities have affected its global cycle by mobilizing increasing amounts of this metal in the environment; currently, such mobilization of Hg is larger than from natural processes (Fitzgerald and Lamborg, 2005). The different chemical forms of Hg have varying toxicities, organic species of Hg, specially methylmercury (MeHg), are more toxic because of their ability to pass the blood-brain barrier (Honda et al., 2006). Considering environmental compartments through which Hg is transferred, aquatic ecosystems are very susceptible to MeHg contamination, as they host active populations of Hg methylating bacteria (Fitzgerald et al., 2007). Organic Hg produced by this biomethylation mechanism in aquatic sediments is able to enter the aquatic food chain (Clarkson and Magos, 2006), where a biomagnification process takes place and Hg reaches highest concentration in muscle tissue of predatory fish and other top consumers as marine mammals and birds.

In the Gulf of California region, studies concerning the accumulation of Hg in muscle tissue of vertebrates like fish (Gutiérrez-Galindo et al., 1988; Ruelas-Inzunza and Páez-Osuna, 2005; García-Hernández et al., 2007) and birds (Ruelas-Inzunza et al., 2007) are scarce; in relation to studies on the presence of organic Hg in aquatic biota, there is one study related to the occurrence of total Hg–MeHg in stranded marine mammals (Ruelas-Inzunza et al., 2003). Considering the lack of information related to the levels of organic Hg in muscle tissue of aquatic birds (Fournier et al., 2002; Henny et al., 2002; Heinz and Hoffmann, 2004), the aim of the present study is to measure mercury concentrations in muscle tissue of selected birds from Sinaloa coasts in order to determine the ratio of total Hg-organic mercury in avifauna of different feeding habits. Additionally, Hg concentrations in muscle tissue of studied species were compared with reported information in birds from other sites.

2. Materials and methods

Birds were collected from different sites along the south-eastern gulf of California region (Fig. 1); information related to dates and sites of collection, weight of specimens and feeding habits are provided in Table 1. Birds were caught by authorized hunters during February 2002; the number of specimens for each species were three for *Anas clypeata* and five for the others. Identification of specimens was made according to field guides (Peterson and Chalif, 1989). Dissection of organisms was made in order to separate pectoral muscle. Samples were freeze-dried for 72 h (−49 °C and 133×10^{-3} mBar) then ground in an automatic agate mortar (Retsch) for 10 min.

For total Hg analysis, powdered samples (0.25 g) were pre-digested with acid (5 ml of quartz distilled concentrated nitric acid)

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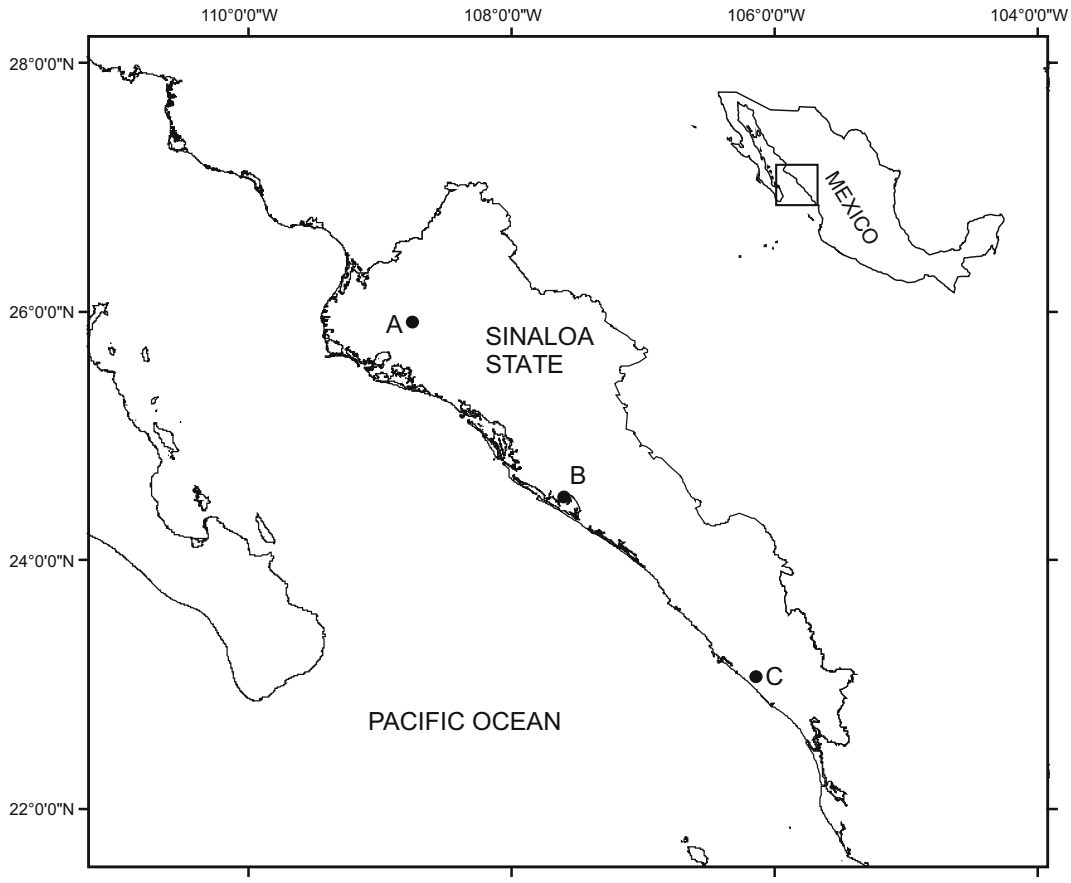

Fig. 1. Location of sampling sites for collection of birds in the coasts of Sinaloa (SE Gulf of California).

Table 1
Specific sites and weight of collected birds from Sinaloa coasts during February 2002.

Species	Common name	Food items	Fresh weight (g)	Site/residence
Birds				
Phalacrocorax brasilianus	Neotropic cormorant	Fish, crustaceans	803 ± 39	B/R
Pelecanus occidentalis	Brown pelican	Fish, crustaceans, molluscs	3750 ± 282	B/R
Anas clypeata	Shoveler	Seeds, invertebrates	427 ± 81	C/M
Anas discors	Blue-winged teal	Seeds, invertebrates	378 ± 25	A/M
Aythya affinis	Lesser scaup	Invertebrates, aquatic vegetation	734 ± 54	C/M

M, migratory and R, resident.

overnight using teflon vessels (Savillex). Digestion was made by using a hot plate at 120 °C for 3 h. Digested samples were stored in polyethylene containers for further analysis. Analyses were carried out by reducing mercury compounds in solution samples using $SnCl_2$ (Loring and Rantala, 1995); measurements were made by cold vapour atomic absorption spectrophotometry (CV-AAS) with a Varian SpectrAA220 equipment. For organic mercury determinations, four steps were followed (May et al., 1987; Horvat, 1991; Barregard et al., 1993): (a) acid extraction with HCl 6 M; (b) separation of inorganic Hg by ionic exchange in glass columns filled with a Dowex resin (100–200 mesh size); (c) conversion of organic Hg to Hg^{2+} by ultraviolet radiation (100 w lamp) during 48 h; and (d) detection by CV-AAS. From previous studies (Quevauviller and Morabito, 2000; Sanz-Landaluze et al., 2004), matrix interferences with organic Hg determinations have been reported; considering the above situation, the standard addition method (Hintelmann, 1999; Syr-song et al., 2004) was used. Mercury concentrations are expressed as $\mu g\, g^{-1}$ on a dry weight basis; precision and accuracy of the analytical method were assessed by using certified reference material (NIST-2977); calculated organic Hg ($0.0359\ \mu g\, g^{-1}$) fell within certified value (0.0362 ± 0.0017). The precision (expressed as variation coefficients) fluctuated from 4.5% to 9.1% for total Hg and from 6.3 to 9.6% for organic Hg. Multiple comparisons of total Hg and organic Hg between piscivorous and non-piscivorous species were made by a one-way ANOVA using GraphPadPrism 4.0 Package.

3. Results and discussion

Levels of total and organic Hg in avifauna from Sinaloa coasts are presented in Fig. 2. Concentrations of total Hg and organic Hg were significantly ($p < 0.05$) higher in species that feed mainly on fish, in comparison to species that feed on seeds and invertebrates. Total Hg and organic Hg in muscle tissue of *Pelecanus occidentalis* were significantly higher ($p < 0.05$) than corresponding concentrations in *Anas discors* and *Aythya affinis*. In the case of the other piscivorous species (*Phalacrocorax brasilianus*), total Hg and organic Hg levels were significantly ($p < 0.05$) more elevated than in *A.*