

Mercury Depuration in *Pomatoschistus microps* during Acclimatation

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Abstract—Mercury (Hg) is a persistent contaminant in the environment and highly toxic for living organisms. In impacted areas such as drainage lagoons after receiving tonnes of Hg from chlor-alkali effluents, organisms are exposed to high concentrations of mercury and fish become the main route for Hg accumulation in humans. In this work *Pomatoschistus microps* specimens were captured in a contaminated area and subsequently maintained in laboratory conditions for depuration during five weeks. Four tissues (muscle, liver, gills and skin) were analysed for mercury content in order to evaluate the depuration trends of the selected tissues. Mercury was quantified by pyrolyse atomic absorption spectrometry in fish the tissues and in the water compartment. Certified reference materials (CRM-277, DORM-3, TORT-2, DOLT-3) were also used for quality control. Mercury kinetics were higher in the liver tissue showing higher depuration rates in the first two weeks. In spite of presenting starting lower depuration rates, muscle depurations kinetics were the highest in the last three weeks of the depuration period. Skin and gills presented the lowest depuration rates along the experiment. After the five week of the depuration process the mostly eatable part of the fish (muscle) reduced its Hg burden to one third of the initial levels (from 0.3 to 0.1 $\mu\text{g g}^{-1}$).

Keywords: mercury, depuration, tissues, *Pomatoschistus microps*

INTRODUCTION

Mercury (Hg) is a priority pollutant due to its persistence, bioaccumulation and toxicity in the environment. Hg uptake occurs mainly via ingestion of contaminated food and Hg accumulation processes might occur during fish life cycle depending on the diet. Therefore, fish show different rates of accumulation reflecting the prevalent exposure of the contaminant and the environment contamination level. Fish and aquatic organisms generally accumulate mercury in their bodies directly from water, through the sediment and food (Mason *et al.*, 2006; Raldua *et al.*, 2007). The highest trophic level of fish, such as carnivorous fish, accumulate high levels of substances by biomagnification (Evans *et al.*, 2000; Kehrig *et al.*, 2002; Ikingura and Akagi, 2003). The properties of mercury leads to a global large dispersion resulting in high environmental exposure/incorporation in organisms

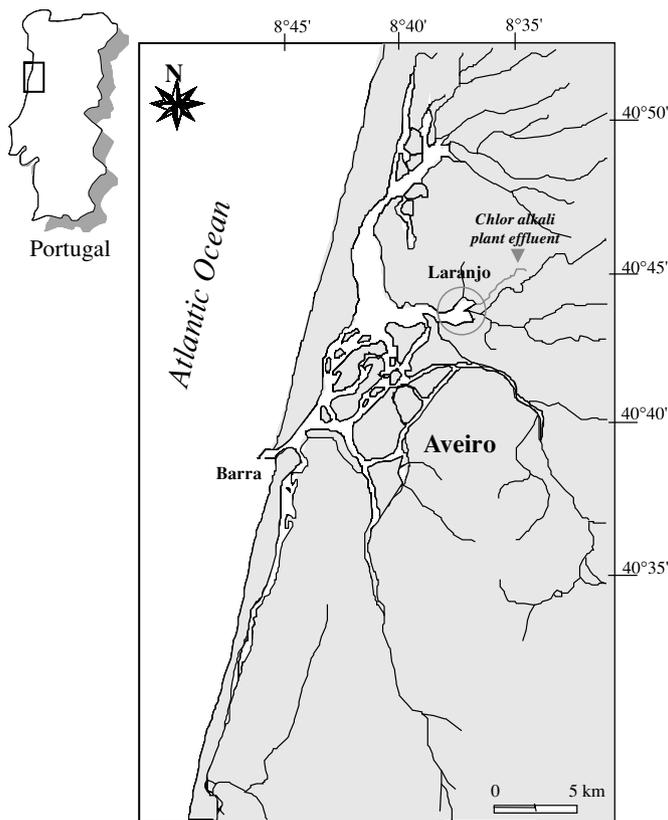


Fig. 1. Schematic representation of Ria de Aveiro (Portugal) highlighting sampling site Laranjo in the contaminated area.

of a high trophic level in the food chains, and in human populations (Metian *et al.*, 2008). The half-life in the human blood is from 1 to 3 weeks for inorganic and elemental mercury and 50 days for methylmercury (Esteban and Castaño, 2009).

Despite imposed legislation preventing large discharges of mercury to the environment, tonnes of mercury are still trapped and stored in impacted areas such as Ria de Aveiro (Portugal) (Fig. 1), heavily contaminated by chlor-alkali plant discharges in the last five decades of the XX century (Pereira *et al.*, 1998; Abreu *et al.*, 2000; Monterroso *et al.*, 2003; Pereira *et al.*, 2006; Abreu *et al.*, 2008).

Considering mercury behaviour in fish tissues, liver has the ability to accumulate large quantities of Hg from the environment, acting in the storage, redistribution and detoxification, and being the main target for Hg accumulation in fish from heavily contaminated environment. The muscle appears to act as a reservoir for accumulation of Hg protecting other organs (Ribeiro *et al.*, 2008).

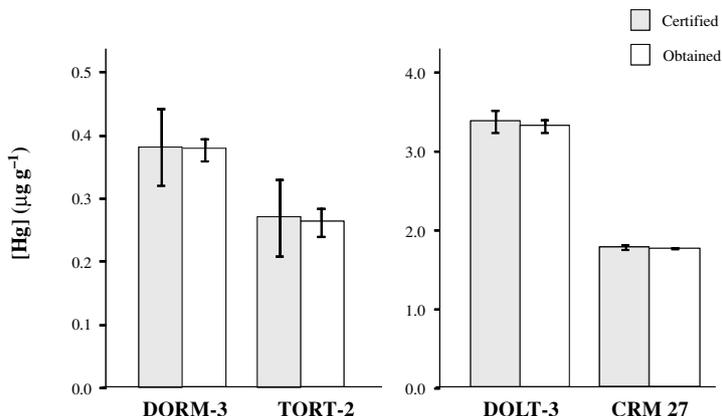
Fig. 2. *Pomatoschistus microps*.

Fig. 3. Certified values (CRMs), obtained values and respective standard deviations.

Skin and gills are directly exposed to the level of Hg in the water compartment and playing an important role in the bioconcentration and also in the depuration processes.

The epibenthic euryhaline fish *Pomatoschistus microps* (Fig. 2) is a widespread organism in estuaries of the Atlantic coast of northwestern Europe. These small fish are intermediate predators in the food web, connecting microbenthos with larger predator fish being ecologically important in estuarine ecosystems.

METHODS

Fish specimens were collected in a inner lagoon (Laranjo) of Ria de Aveiro using a small trawl net. In the lab, fish were maintained in a circulated flow system for depuration during five weeks (salinity = 30 ± 2 , pH = 7.5 ± 0.5 , T = $20 \pm 1^\circ\text{C}$) with a photoperiod of 14h light/10h dark. Fish specimens were fed twice a day on available commercial food (ZM 400). The daily amount of food was estimated to correspond to approximately 2% of the fish weight.

Hg was quantified by pyrolyse atomic absorption spectrometry (Mercury Analyser, Leco AMA 254) in fish tissues and in the water compartment. Certified reference materials (CRMs) estuarine sediment CRM-277, fish protein DORM-

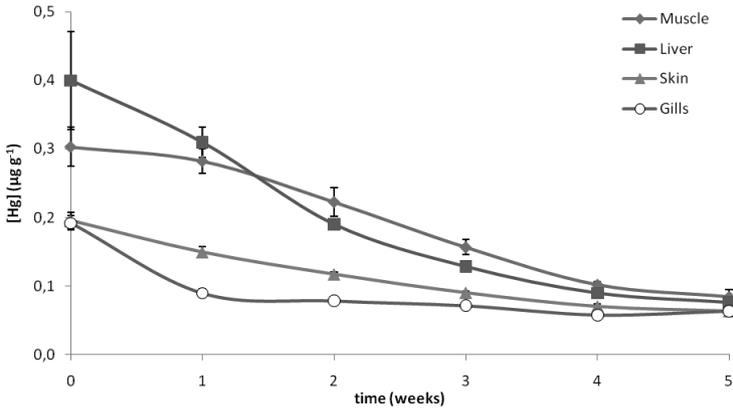


Fig. 4. Evolution of [Hg] ($\mu\text{g Hg g}^{-1}$) in liver, muscle, skin and gills during depuration period (5 weeks).

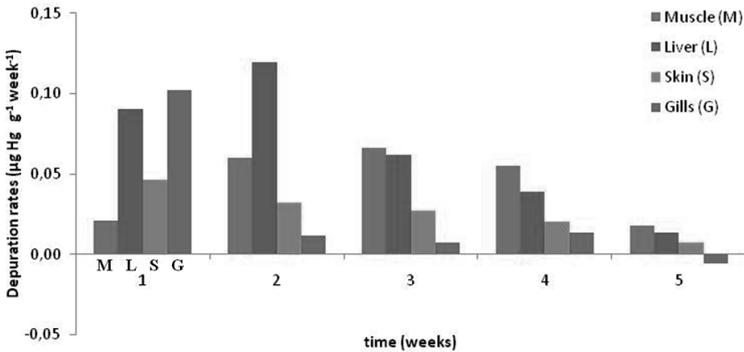


Fig. 5. Mercury depuration rates ($\mu\text{g Hg g}^{-1}\text{week}^{-1}$) in liver, muscle, skin and gills during the experiment period (5 weeks).

3, lobster hepatopancreas TORT-2, and dogfish liver DOLT-3 were also used for quality control. CRMs were processed as samples and quantified in triplicates along the Hg quantification process.

RESULTS AND DISCUSSION

Mercury concentration obtained in CRMs and certified values (Fig. 3) are not statistically different.

Liver and muscle tissues showed the highest levels of mercury along the depuration experiment (Fig. 4), respectively from $0.400 \pm 0.072 \mu\text{g g}^{-1}$ (average \pm standard deviation, $n = 7$) to $0.076 \pm 0.003 \mu\text{g g}^{-1}$ and from 0.303 ± 0.028

$\mu\text{g g}^{-1}$ to $0.084 \pm 0.011 \mu\text{g g}^{-1}$, always below the legislation level ($0.5 \mu\text{g g}^{-1}$). Results indicate that the main uptake of mercury in fish occurs by the ingested food (Gonzalez *et al.*, 2005; Piraino and Taylor, 2009) and the ingestion of non contaminated food might have promoted the inverse process.

Skin and gills showed comparatively lower starting values (Fig. 4), respectively $0.195 \pm 0.012 \mu\text{g g}^{-1}$ and $0.192 \pm 0.011 \mu\text{g g}^{-1}$; decreasing to $0.063 \pm 0.006 \mu\text{g g}^{-1}$ and $0.064 \pm 0.005 \mu\text{g g}^{-1}$ at the end of the depuration period.

The starting of the depuration period is enhanced by the transition from a state where $[\text{Hg}]_{\text{liver}}/[\text{Hg}]_{\text{muscle}} > 1$ to a state where $[\text{Hg}]_{\text{liver}}/[\text{Hg}]_{\text{muscle}} < 1$, due the internal redistribution of Hg following the protein degradation and muscle tissue catabolism for energy (Cizdziel *et al.*, 2003), reflecting the uptake and lower assimilation of mercury after ingestion of non contaminated food in the Lab environment, explaining the higher decrease in liver mercury burden and being responsible for the higher depuration rates in muscle and liver along the experiment, except in the first week where gills reflect the transition from the contaminated environment to the Lab system showing the highest depuration rate (Fig. 5). During the last week, the slight increase of Hg accumulation in the gills (and the resulting negative depuration rate) is possibly due to the increase of mercury in the water column (mainly dissolved fraction and contamination from faeces) along the depuration period from 0.005 to $0.010 \mu\text{g L}^{-1}$. The skin tissue shows an almost steady decrease in the Hg depuration rates illustrating the progressive evolution from the contaminated environment to final depuration state.

CONCLUSIONS

Mercury kinetics were higher in liver and muscle tissue, however, the liver showed higher rates in the first two weeks. Gills were the tissue that first reflects the transition from the contaminated environment. Skin presented a progressive decrease of both mercury concentration and depuration rates reflecting the evolution of Hg burden in the fish along the depuration process.

During the five weeks period the mostly eatable fraction of the fish (muscle) reduced its mercury burden to one third of the initial level.

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