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Bioaccumulation and ecological risk assessment of heavy metals in the sediments and mullet *Liza klunzingeri* in the northern part of the Persian Gulf

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ABSTRACT

The concentrations of some heavy metals (Cu, Zn, Pb and Cd) were investigated in the sediments and in the mullet *Liza klunzingeri* from the northern part of the Persian Gulf. The levels of Cu, Zn and Pb in the sediment varied significantly among the sampling sites ($P < 0.05$). Sediments from the northern part of the Persian Gulf had serious ecological risk when considering PER. The ranges of the average concentrations of Cu, Zn, Pb, and Cd in the tissue of *L. klunzingeri* were 10.00–16.66 mg/kg, 18.75–32.50 mg/kg, 3.25–14.16 mg/kg and 0.37–3.33 mg/kg, respectively. The health risk analysis of individual heavy metals in the fish tissue indicated dangerous levels of Pb and Cd for the general population at some sampling sites.

Persistent pollution induced by heavy metals in marine ecosystems is a major problem, particularly in shallow coastal water. Rivers, inlets and estuaries filled with run-off from adjacent grounds continuously discharge more heavy metal loadings in ecosystems that are surrounded by industrialized communities (Bloom and Ayling, 1977; Unnikrishnan and Nair, 2004).

The origination of heavy metal elements in coastal sediment may be from the physical and chemical weathering of parent rocks, wastewater discharge and atmospheric deposition (Callender, 2005).

In the aquatic environment, sediments serve as the largest pool of metals. More than 90% of the heavy metal loadings are associated with the suspended particulate matter and sediments in aquatic ecosystems (Amin et al., 2009; Zhang and Shan, 2008).

Metals in the form of suspended particulates settle down and pool up in sediments (Kucuksezgin et al., 2008), while those of dissolved metals adsorb onto fine particles, which then carry them to the bottom sediments (Singh et al., 2005). Several factors, including the mineralogical and chemical compositions of suspended material, anthropogenic influences, deposition, sorption, enrichment in organism (Jain et al., 2007), and various physico-chemical characteristics (Singh et al., 2005) can influence the distribution of heavy metals.

Most metals that are essential for physiological function processes in fish (Taylor et al., 1985) are considered as normal constituents of the marine environment (Nieboer and Richardson, 1980). However, above tolerable limits, these metals are a major factor that can affect fish mortality, and behavioral, biochemical and histological changes in fish are observed under sub-lethal doses of metals (Bu-Olayan and Thomas, 2004).

Metals can be taken up by fish from water, food, sediments, and suspended particulate material (Hardersen and Wratten, 1998). However, the presence of a given metal at high concentrations in water or sediments does not involve direct toxicological risk to fish, especially in the absence of significant bioaccumulation. By far, bioaccumulation is mediated by both abiotic and biotic factors affecting metal uptake (Rajotte et al., 2003).

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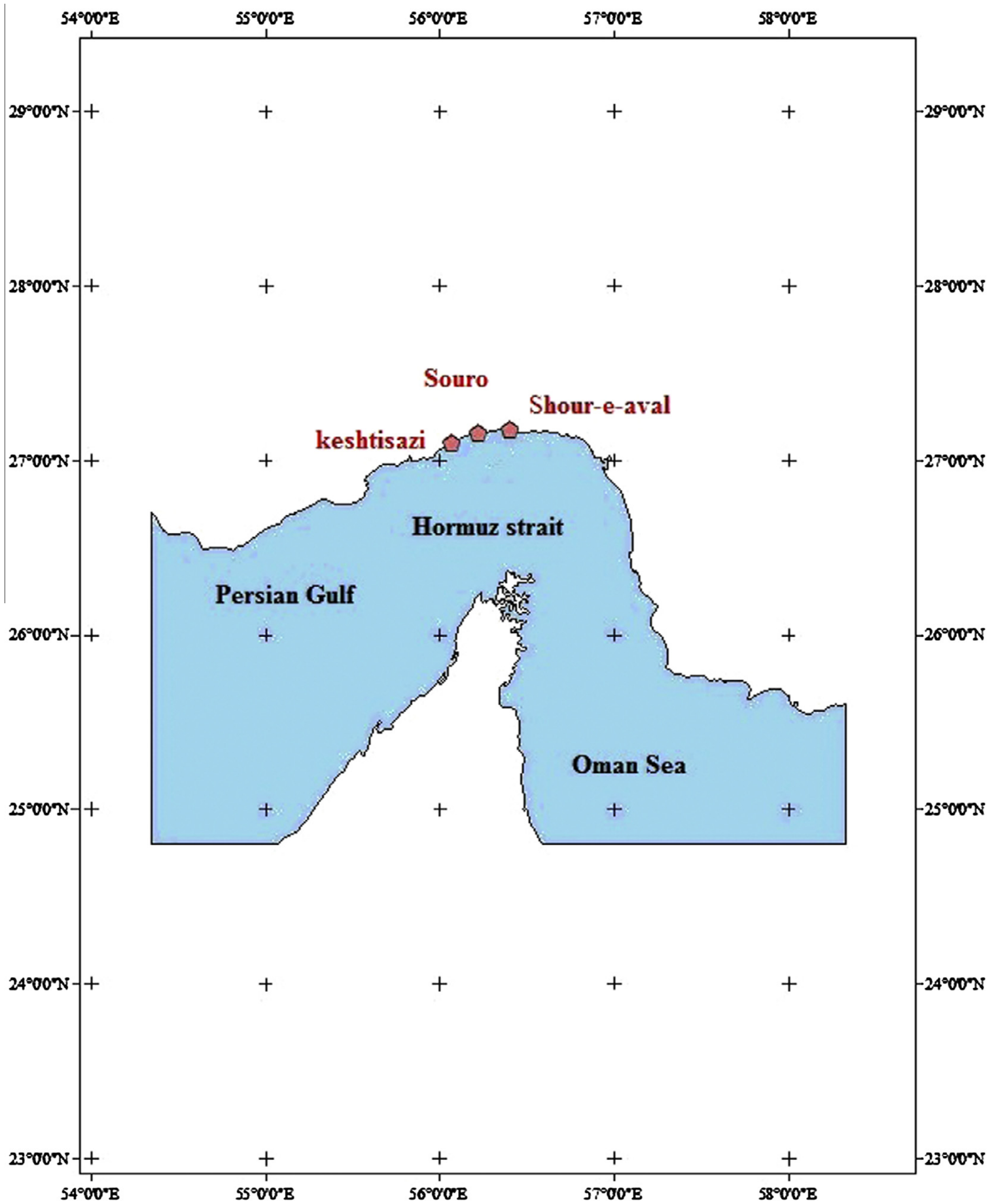

Fig. 1. The locations of the sampling sites in the northern part of the Persian Gulf.

The family Mugilidae plays an important role in commercial fisheries and aquaculture worldwide. *Liza klunzingeri* is one of the most important fisheries species in the Persian Gulf. It is dispersed within the Indian Ocean, Arabian Sea and the Gulf of Oman (Randall, 1995) and caught by beach seines, set nets, and gill nets (Ismail et al., 1998). This species is oviparous, and the eggs are pelagic and non-adhesive. As a filter and detritus-mud feeder fish, it is exposed to a wide range of contamination in sediments and water (Minos et al., 1995). Therefore, this species may be a good candidate for monitoring programs.

The objectives of the present study were to assess the extent and ecological risk assessment of heavy metals (Cu, Zn, Pb and Cd) in the surface sediments and *L. klunzingeri* from the northern part of Hormuz Strait in the Persian Gulf.

A total of 30 individuals of *L. klunzingeri* were collected from three sampling sites in the northern part of Hormuz Strait in March 2013. The sampling sites were Souro (St1, length 122 ± 14.76 cm; weight 22.90 ± 8.56 g); Shour-e-aval (St2, length 128.33 ± 5.38 cm; weight 25.11 ± 3.25 g); and Keshtisazi (St3, length 117.66 ± 8.50 cm; weight 20.92 ± 4.25 g) (Fig. 1). Most of the locations were near the mouths of commercial waste and domestic discharges. Then, samples were created from tissue dissected from each individual.

The fish samples were collected in sterile polythene bags and kept in the laboratory deep freezer (−20 °C) to prevent deterioration until further analysis. An acid mixture (10 mL, 70% high purity HNO3 and 65% HClO4, 4:1 v/v) was added to the beaker containing 1 g of the dry sample, according to AOAC (1995). The mixture was then digested at 80 °C until the transparent solution was achieved. After cooling, the digested samples were filtered using Whatman no. 42 filter paper, and the filtrate was diluted to 50 mL with distilled water.

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