

**Mercury Levels in Selected Tissues of Blue Swimming Crab,  
*Portunus pelagicus* (Linnaeus, 1758) and Sediments from  
Boushehr Coasts (Northern Persian Gulf), Iran**

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**Abstract:** Persian Gulf supports diverse ecosystems and biota in need of remediation and protection and metal data from this region is needed. The levels of mercury in tissues of blue swimming crab, *Portunus pelagicus* and sediments in the Boushehr coasts, south Iran were investigated. Mercury analysis was performed by Atomic Absorption Spectrophotometer. The distribution pattern of mercury in the tissues of crab and sediments was as follows: sediments > hepatopancreas > muscle > exoskeleton. Total mercury levels in the tissues of *P. pelagicus* from the other five sampling stations ranged between ( $5.32 \pm 0.33 \mu\text{g/g}$ ) and ( $0.17 \pm 0.18 \mu\text{g/g}$ ). In present study recorded that there was negligible differences in Hg levels between sexes. We found that mercury levels were larger in tissues of female of the species than the males. There were no significant differences in mercury levels between sexes of *P. pelagicus*. In present study maximum concentration of total mercury in sediments and all tissues of *P. pelagicus* absorbed in Airforce station ( $p < 0.05$ ). Differences in Hg among could have resulted from diverse pollution source, ecological particularity, industries and human activities.

**Key words:** Mercury • Blue Swimming Crab • *Portunus pelagicus* • Contamination • Persian Gulf

## INTRODUCTION

The Persian Gulf is a body of water in the Middle East between the Arabian peninsula and Iran. This inland sea is connected to the Gulf of Oman by the Strait of Hormuz [1]. Persian Gulf is a semi-enclosed formation and heavy discharges of the surrounding industries have been ongoing for many decades. Other sources of Persian Gulf pollution include invasions and bombardments that have been staggering in the recent years and are yet to be fully investigated. Although heavy metals in general and Hg in particular are very toxic to both humans and the wildlife, limited research is available on Hg pollution in the Persian Gulf area. Aquatic environments, such as Persian Gulf, are especially at high risk for Hg contamination since much of the atmospheric deposition and all of the industrial water-

runoffs culminate in these ecosystems. Large areas of agricultural lands, local fisheries, oil export facilities and a petrochemical plant operate in the general area. Moreover, an overall reduction in Gulf water quality and quantity has ensued, leading to changes in plant community composition which can be expected to have affected aquatic and terrestrial organisms of the area. Effects of recently introduced war-pollution on these wetlands and their inhabitants, while still not fully known, may be severe and irreversible. Known sources of damage to these Gulfs include degradation due to acid rain falls after 1991 Persian Gulf invasion (Evans 1994) and agricultural runoff from use of fertilizers, herbicides, pesticides and spills of hazardous substance from various refineries and Petrochemical Factory.

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Mercury naturally occurs in the environment as a result of the volcanic degassing of the Earth's crust and weathering of mercury rich geology. While water from areas rich in mercury ores may exhibit high local mercury concentrations, industrial processes, agriculture and the combustion of fossil fuel are the most significant sources of aquatic contamination. Common sources include caustic soda, pulp and paper and paint manufacturing. Mercury is also used in batteries, dental amalgam and in bactericides [2-4]. Mercury has as far as we know, no necessary function in any living organism and is considered as a nonessential metal. On the contrary, mercury is among the most toxic elements to man and many higher animals [5, 6]. In addition to that the concentrations of total mercury in crabs tissues are generally low, aquatic invertebrates, also, accumulate mercury to high concentrations. As for most metals, factors known to influence mercury concentrations and accumulation in the marine organisms include metal bioavailability, season of sampling, hydrodynamics of the environment, size, sex and changes in tissue composition and reproductive cycle [7]. Accumulation of these metals only begins after the organisms are faced with high concentration in the surrounding medium [8], but body levels of nonessential metals such as mercury were not found to be regulated by crustacean [9]. Heavy metals concentrations in aquatic ecosystems are usually monitored by measuring its concentration in water, sediments and biota [10]. Sediments are important sinks for various pollutants such as heavy metals [11, 12] and also play a useful role in the assessment of heavy metal contamination [13].

Crabs belong to a group of animals known as decapods crustaceans. Most of the marine crabs occurring along the Persian Gulf coasts belong to the family Portunidae. The blue swimming crab, *P. pelagicus* is widely distributed throughout the coastal and estuarine areas of the tropical western Pacific and Indian oceans [14]. *P. pelagicus* is one of the important representatives of decapod crustacean and a species commonly found in Persian Gulf coasts, Iran. Crabs are infrequently reported on in the toxicology literature and metal toxicity data is needed for crustacean from Persian Gulf area. Crabs have the capability of accumulating heavy metals [9] and is thus a suitable bioindicator for environmental contamination with these agents. Hepatopancreas, the key site of heavy metal accumulation in Crustacean [15], is one of the most important organs that play important roles

in metal detoxification [16]. Therefore, it is of great interest to investigate the toxicity of heavy metal on hepatopancreas in blue swimming crabs. Crabs are an excellent bioindicator of metal contamination and can be used to effectively and accurately monitor metal level for several reasons. Anthropogenic pollutants such as industrial, municipal and agricultural wastes finally end up in wetlands; exposing waterfowl to a variety of environmental pollutants. We examined Hg levels in the sediments and hepatopancreas, muscle and exoskeleton of species *Portunus pelagicus* from Boushehr coasts located in Southwestern Iran.

## MATERIAL AND METHODS

**Study Area:** The study was carried out in Boushehr coasts, which is one of the several adjoining coasts in the Persian Gulf (Figure 1). The Persian Gulf lies on the Southeastern Iran, between longitudes 48°25' and 56°25' East and latitudes 24°30' and 30°30' North. It has an estimated area of 260 Km<sup>2</sup> and extends 909 Km long to a depth average of about 30-40 meter [1]. Specifically, the Boushehr coast lies between Longitudes 50°6' and 52°58' East and Latitudes 27°14' and 30°16' North and it is about 60 kilometers long.

**Sampling Stations:** Samples of species of blue swimming crabs were collected between July and September 2011 from 5 coastal localities in Boushehr coasts a distance of about 60 kilometers. Sampling covered areas of the direct or indirect influence of urban and industrial releases, those located near the mouth of the tributary rivers which carry industrial discharges of pollutants to the offshore waters and a locality not under the influence of industrial or urban releases. The sampling stations were selected to reflect progression of pollution, ecological particularity, vegetation and human activities in the area. The pollution source in sampling stations include degradation due to acid rain falls and agricultural runoff from use of fertilizers, herbicides, pesticides and spills of hazardous substance from various refineries, badges and boat building, Petrochemical Factory and high amount of wastewater.

**Station 1:** This station is located at Heyleh area. Mainly fishers occupy the area. The human activities here include boat traffic and fishing with living houses on the shoreline. Vegetation is sparse with mainly mangrove *Avicennia* sp.

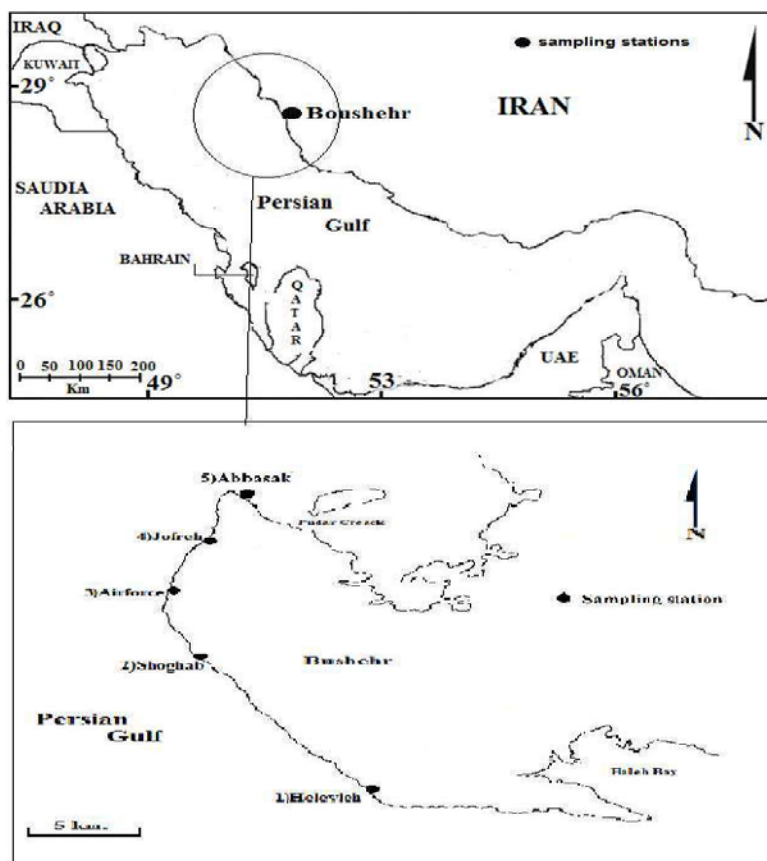


Fig. 1: Map of Boushehr coasts showing Sampling stations and the Study Site

**Station 2:** This station is located at Shoghab area. It is located downstream of Station 3. Human activities here include fishing, badges and boat building.

**Station 3:** This station is located at Airforce area. It is about 15 kilometer away from Station 2. There are industrial and human activities. The major activities here included jetty operations, oil, petrochemical industries and high amount of wastewater.

**Station 4:** This station is located at Jofreh area. There are no industrial activities here. The shoreline fringes have mainly *Avicenia* sp. The main activity is fishing and boat ferrying. The area is shallow and at low tide, the greater part of the bottom sandy coast is exposed.

**Station 5:** This station is located at Abbasak area. The human activities here include agricultural lands, local

fisheries, oil export facilities and a petrochemical plant operate in the general area.

**Sample Collection:** Sediment Sampling was performed with Van Veen grab from the bottom at all stations. After sampling, the samples were packed in plastic bags, preserved and transferred to laboratory for analysis. Samples of biological material and sediment were immediately transferred to new polyethylene bags. All samples were frozen or stored at about 5°C until further processing. Each aliquot of sediment was digested for 4 h in a water bath at 60 °C, after adding 3 ml each of concentrated HNO<sub>3</sub>, H<sub>2</sub>S O<sub>4</sub> and HF. H<sub>2</sub>S O<sub>4</sub> was used because the sediment from most of the sampling sites contains 8 to 10% of organic matter [17]. The digestion of each sample of sediment was made in duplicate. Each sample of crabs was homogenized in an acid-cleaned

mortar and 2 g were digested in triplicate in a water bath at 60 °C for 6 h after adding 2.5 ml each of concentrated HNO<sub>3</sub> and H<sub>2</sub>S O<sub>4</sub>.

Crabs sampling was performed with shrimp trawl. After sampling, samples were transferred to the laboratory in a cooler and stored in a deep freezer for further analysis. Each crab was properly cleaned by rinsing with distilled water to remove debris, planktons and other external adherent and then they were dissected for collect tissues hepatopancreas, muscle and exoskeleton. It was then drained under folds of filter, weighed, wrapped in aluminum foil and then frozen at 10°C prior to analysis. The tissues were placed in clean watch glasses and were oven dried at 105°C for 1 hour and later cooled in the desiccators.

The analysis of total mercury were done by the cold vapor method [18] using a Perkin-Elmer Atomic Absorption System AA-2380 with automatic background correction and a Perkin-Elmer Mercury Analysis System 303-0830. Replicate (3 to 5) measurements were made on each sample. All glassware used was cleaned by the procedure described by Ober *et al.*, (1987) [19]. All the reagents used were of spectroscopic grade and ultra-high purity (99.9 %). In all experiences several blanks were performed with the reagents used, in order to check for possible contamination. The data obtained were statistically analyzed for confirmation of the results. Metal toxicity from different tissues and sediments was calculated by using regression equation and results were expressed in µg /gm dry weight.

**Statistical Analyses:** Data were analyzed using the one-way analysis of variance (ANOVA) and group means were compared using Duncans multiple range test. P values < 0.05 were considered significant.

## RESULT

Total mercury levels in the tissues of *P.palagicus* from the other six sampling stations ranged between (4.70±0.80 µg/g) and (0.29±0.22 µg/g). The results of the levels of concentration of Hg in the tissues of the female crab *P.palagicus* are presented in Tables 1. In present study, results showed that Hg concentration was highest in hepatopancreas, followed by muscle and exoskeleton. The highest concentration of Hg in the tissues of female crab was found in hepatopancreas (5.32 ± 0.33 µg/g) and least concentration found in exoskeleton (0.57 ± 0.18µg/g). Results indicated that Hg concentration in hepatopancreas tissue was higher than muscle and exoskeleton. Tables 2 showed the Hg concentration in the tissues of the male crab *P.palagicus*. The highest concentration of Hg in the tissues of male crab was found in hepatopancreas (4.05 ± 0.39 µg/g) and least concentration found in exoskeleton (0.17± 0.18 µg/g). In present study recorded that there was negligible differences in Hg levels between sexes. We found that mercury levels were larger in tissues of female of the species than the males. There were no significant differences in mercury levels between sexes of *P.pelagicus*. There was significant difference (p<0.05) between the level of Mercury in the different stations.

Table 1: Concentration of Hg (µ g/g dry weight) in tissues the female of *Portunus pelagicus* from different stations along Persian Gulf coasts

Sexes	Tissue	Sampling stations				
		Heyleh	Shoghab	Airforce	Jofreh	Abbasak
Female	hepatopancreas	0.95 ± 0.55	1.10 ± 0.20	5.32 ± 0.33	1.61 ± 0.05	1.92± 0.44
	muscle	0.70 ± 0.21	0.88 ± 0.49	1.13 ± 0.31	1.21 ± 0.11	1.35 ± 0.52
	exoskeleton	0.57 ± 0.18	0.56 ± 0.19	1.01 ± 0.43	0.84 ± 0.33	0.84 ± 0.12

Table 2: Concentration of Hg (µ g/g dry weight) in tissues the male of *Portunus pelagicus* from different stations along Persian Gulf coasts

Sexes	Tissue	Sampling stations				
		Heyleh	Shoghab	Airforce	Jofreh	Abbasak
male	hepatopancreas	0.69 ± 0.55	0.83 ± 0.12	4.05 ± 0.39	1.10 ± 0.59	1.63 ± 0.72
	muscle	0.43 ± 0.21	0.58 ± 0.40	1.90 ± 0.55	0.92 ± 0.44	1.09 ± 0.52
	exoskeleton	0.17± 0.18	0.40 ± 0.19	1.41 ± 0.70	0.68 ± 0.20	0.66 ± 0.31

Table 3: Concentration of Hg ( $\mu$  g/g dry weight) in sediments from different stations along Persian Gulf coasts

Sampling stations				
Heyleh	Shoghab	Airforce	Jofreh	Abbasak
$0.88 \pm 0.05$	$0.93 \pm 0.05$	$6.40 \pm 0.01$	$1.70 \pm 0.02$	$2.77 \pm 0.12$

The maximum concentration of Hg ( $6.40 \pm 0.01 \mu\text{g/g}$ ) was noted in Airforce station and minimum concentration ( $0.88 \pm 0.05 \mu\text{g/g}$ ) was in Heyleh station. In the present study, results showed that concentrations of Mercury in the sediments and tissues of crabs in Airforce station were significantly higher ( $P < 0.05$ ) than the other stations. There is a growing concern about the physiological and behavioral effects of environmental trace metals in human population and probably due to nearby to petrochemical industries and a high amount wastewaters containing Hg always dumped at this station.

Total mercury levels in sediment from the other five sampling stations ranged between ( $6.40 \pm 0.01 \mu\text{g/g}$ ) and ( $0.88 \pm 0.05 \mu\text{g/g}$ ) (Table 3). Higher levels of total mercury in sediment were seen at Airforce station. This station is located near the mouth of rivers which carry petrochemical industrial discharge to offshore waters. Results showed that mercury levels in sediment from the other six sampling stations were higher than tissues of crab samples. However, total mercury concentration in sediments were always higher than the mercury levels found in tissues of *P. pelagicus* samples at the same locality (Table 3) In our samples, we found significant correlations between mercury in sediments and tissues of crab ( $p < 0.05$ ), but there were no significant differences in mercury levels between tissues of *P. pelagicus*. The magnification order of mercury in the sediments and tissues of crab was as follow: sediments > tissues. It can be concluded from the present study that the tissues of crabs studied contain mercury less than the sediments.

## DISCUSSION

Hg concentrations in tissues the female of *P. pelagicus* are shown in Table 1. In present study, results showed that Hg concentration was highest in hepatopancreas, followed by muscle and exoskeleton. According to field and experimental studies, tissue distribution and accumulation of Hg in crabs varies widely depending on size, sex, growth stage, molting, migration, season of sampling, metal bioavailability, hydrodynamics of the environment, changes in tissue composition and reproductive cycle [7]. Hg concentrations in tissues the male of *P. pelagicus* are shown in Table 2. In our samples, we found significant correlations between mercury in sediments and tissues of crab ( $p < 0.05$ ). Crabs in this

study have very similar diets; they are all intermediate consumers which feed mainly on invertebrates for example: shrimp, bivalve and vegetation. Foraging grounds of these crabs are also somewhat different which leads to differences in prey size and ultimately Hg intake. Crabs also, spends more time in shallow waters and coastal and in terrestrial areas where anthropogenic mercury is less widely present. We therefore expected to see dissimilar levels of mercury in tissues of this specie. Despite the fact that there were no significant differences in mercury levels between tissues of *P. pelagicus*.

In present study recorded that there was negligible differences in Hg levels between sexes. We found that mercury levels were larger in tissues of female of the species than the males. There were no significant differences in mercury levels between sexes of *P. pelagicus*. Therefore the small difference that has been reported in Hg body burdens in male and female is consistent with our current data. Therefore the negligible difference in mercury levels between sexes can be attributed to depuration in eggs, sexual dimorphism and niche partitioning of the forage base. To our knowledge, this is the report on Hg levels in blue swimming crab, *P. pelagicus*. Here we present Hg levels in multiple tissues of *P. pelagicus* from Persian Gulf in Southwest Iran. Scarcity of data on these crabs makes this information an invaluable regional data. Differences in mercury concentrations among the species is likely to have resulted from metal bioavailability, hydrodynamics of the environment, changes in tissue composition, reproductive cycle different feeding mechanism, temperature, salinity, stations of collection and sources of pollution within Persian Gulf.

Hg accumulation strategies vary between crustacean taxa and the regulation of body levels of Hg as an accumulation strategy would seem to be present only in decapods [8]. The result of the analysis has shown that crab *portunus pelagicus* can be used as bio-indicator as it contains variable levels of the metals analyzed with high enrichment of Hg observed. As far as the crabs consume organic substances present in the bottom of sediments of aquatic systems, they are good biomonitor for pollutants presents in the ecosystems. It is also important the fact that this species represents both source of income and nourishment for the marginal populations effects. The high concentrations of heavy metals in commercially

important crustaceans sampled from Persian Gulf (Airforce station) is a cause of concern and requires regular monitoring of water quality around the point sources present opposite to the Northwestern part of the Persian Gulf, in combination with the fact that crab consumption is the main source of heavy metal intake in people not occupationally exposed, amplifies the need for preventive measures to safeguard public health. The heavy metal accumulation in the different tissues and sediments increased as the exposure time increased. So, heavy metal will reach the tissues of human beings through the food chain. Therefore, it should be mentioned by industrialists and they should take steps to reduce the aquatic pollution. The magnification order of mercury in the sediments and tissues of crab was as follow: sediments > tissues. It can be concluded from the present study that the tissues of crabs studied contain mercury less than the sediments and is safe for human consumption according to WHO criteria statistical.

## REFERENCES

1. Ampf, J.K. and M. Sadrasab, 2006. The circulation of the Persian Gulf. Journal ocean science, 2: 27-41.
2. FAO., 1992. Committee for inland fisheries of Africa: Report of the third session of the working party on pollution and fisheries. FAO Fish. Rep., 471: 43.
3. Munthe, J., 1993. Mercury in the atmosphere, emissions, transformations, depositions and effects. Swedish environmental research institute (IVL), B 1110, pp: 28.
4. OECD., 1994. Mercury. Risk reduction monograph No 4. Vol. II, OECD Working papers No 92, Paris, pp: 159.
5. Steinnes, E., 1995. 'Mercury', 245-259. In Alloway. B.J. (ed.), Heavy metals in soil. Blackie Academic and Professional, London, pp: 368.
6. Landner, L. and L. Lindestrom, 1998. Zinc in society and in the environment. Miljöforskargruppen, Stockholm, pp: 160.
7. Boyden, C.R. and D.J.H. Phillips, 1981. Seasonal variation and inherent variability of trace elements in oysters and their implications for indicator studies. Marine Ecology Progress Series, 5: 29-40.
8. Rainbow, P.S. and S.L. White, 1989. Comparative strategies of heavy metal accumulation by crustaceans: Zinc, copper and cadmium in a decapod, an amphipod and a barnacle. Hydrobiologia, 174: 245-262.
9. Pastor, A., J. Medina, J. Del Ramo, A. Torreblanca, J. Diaz-Mayans and F. Hernandez, 1988. Determination in different tissues. Bulletin of Environment Contamination and Toxicology, 41: 412-8.
10. Camusso, M., L. Vigano and R. Baitstrini, 1995. Bioaccumulation of trace metals in rainbow trout. Ecotoxicology and Environmental Safety, 31: 133-141.
11. Ikem, A., N.O. Egiebor and K. Nyavor, 2003. Trace elements in water, fish and sediment from Tuskegee Lake, Southeastern USA. Water, Air and Soil Pollution, 149: 51-75.
12. Eimers, M.C., R.D. Evans and P.M. Welbourn, 2001. Cadmium accumulation in the freshwater isopod *Asellus racovitzai*: The relative importance of solute and particulate sources at trace concentrations. Environmental Pollution, 111: 247-253.
13. Ho, S.T., L.J. Tsai and K.C. Yu, 2003. Correlations among aqua-regia extractable heavy metals in vertical river sediments. Diffuse Pollution Conference, Dublin, 1: 12-18.
14. Kumar, M., G. Ferguson, Y. Xiao, G. Hooper and S. Venema, 2000. Studies on reproductive biology and distribution of blue swimmer crab (*Portunus pelagicus*) in South Australian Waters. Research report series, 47: 1324-2083.
15. Reinecke, A.J., R.G. Snyman, J.A.J. Nel, 2003. Uptake and distribution of lead (Pb) and cadmium (Cd) in the freshwater crab, *Potamonautes perlatus* (Crustacea) in the Eerste River, South Africa. Water Air Soil Pollution, 145: 395-408.
16. Wang, L., X.Q. Yang, Q. Wang and D.X. Wang, 2001. The accumulation of Cd and the effect of EST in five tissues and organs of *Eriocheir sinensis*. Acta Zoologica Sinica, 47(Suppl.): 96-100.
17. Pérez, D., 1989. Baseline of biological reference in the marine coastal environment from Golfo Triste, Venezuela. Research Report Institute of Marine Sciences and Technology, Universidad Simón Bolívar, Caracas, Venezuela, pp: 385.
18. Beatty, R., 1978. Concepts, instrumentation and techniques in atomic absorption spectrophotometry Perkin Elmer Corp., U.S.A., pp: 49.
19. Ober, A.G., M. González and I. Santa María, 1987. Heavy metals in molluscan, crustacean and other commercially important Chilean marine coastal water species. Bulletin of Environment Contamination and Toxicology, 38: 534-539.
20. Johannesson, M., et al., 2002. The Market Implication of Integrated Management for Heavy Metals Flows for Bioenergy use in the European Union. Kalmar University, Department of Biology and Environmental Science, Kalmar, Sweden, pp: 115.