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Effect of Size upon Metal Content of Lobster (*Thenus orientalis*) from the Kuwait Marine Environment

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Trace elements are found in natural water bodies at varying concentrations. The most potentially dangerous of these elements are heavy metals, viz., Pb, Cd, Hg and the metalloids, viz., As, Se, Sb. Heavy metals have a great affinity for sulfur and attack sulfur bonds in enzymes of aquatic organisms thus immobilizing the latter. Other vulnerable sites are protein carboxylic acid (-CO_2H) and amino (-NH_2) groups. Heavy metals bind to cell membranes affecting transport processes through the cell wall of the organisms. They also tend to precipitate phosphate biocompounds or catalyze their decomposition. Body levels of essential metals such as copper and zinc can be regulated by some crustacea at concentrations below a threshold level.Accumulation of these metals only begins after the regulation mechanisms break down at metal concentrations above the threshold levels (Rainbow, 1985 ; Rainbow and White, 1989). In contrast, body levels of non-essential metals such as mercury, cadmium and lead were not found to be regulated by crustacea (Krishnaja et al . , 1987 ; Pastor et al., 1988). Studies influencing sex and size on metal accumulation and tissue distributions in Norway lobster *Nephrops norvegicus* was carried out to determine the toxicity of heavy metals (Canli and Furness , 1993) .

In Kuwait, trace metal input may be derived from a number of anthropogenic and natural sources. Metals, viz., arsenic, selenium and mercury have been found to enter coastal waters by sewage and other waste-water effluents, power plant cooling water discharges, auto emissions, petroleum and petrochemical industrial wastes, storm drain outfalls and solid waste landfills (UNEP 1980). In addition to these anthropogenic sources, trace metals have also been found to be introduced into local marine waters adsorbed on airborne and waterborne particulate material (Anderlini et al. 1982).

This study was undertaken to determine (a) the concentration of arsenic, selenium and mercury in lobster, *Thenus orientalis* L., (b) to investigate the correlation co-efficient between each metal,viz.,arsenic, selenium and mercury,

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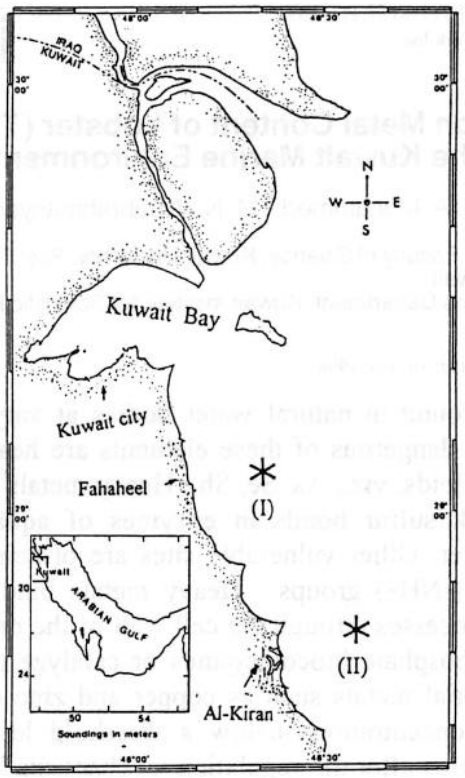

Figure 1. Lobster sampling stations in Kuwait coastal waters.

(c) to examine the correlation between metal concentration and the size (length and weight) of lobsters and (d) significant difference in metal concentration (if any) between male and female lobsters.

MATERIALS AND METHODS

Thenus orientalis, locally named "Umm Al-rubyan" or "mother of the shrimp", were collected by otter trawl during routine pre-season surveys by the research vessel *Mutaheda-5* from July to August 1996 and from January to February 1997 at two different stations in the Arabian Gulf (Fig. 1). These two stations were chosen for the study mainly due to the (a) availability of lobsters, (b) unrestricted sites for conducting research activities and also compare the degree of metal concentrations (if any) in lobsters in each station. Out of fifty two lobsters examined, half were males and half were females.The lobsters were washed with double distilled deionized water and their total length, carapace width and total weight was measured. The muscles surrounding the abdominal segments were removed and stored in disinfected sterile polyethylene containers at -20°C prior to analysis. Precautionary measures to

prevent contamination during collection, dissection and analysis were taken care by (a) cleaning all glasswares and equipments in Arister grade diluted nitric acid (10% v/v), (b) using disposable plastic containers for collection of lobsters and plastic tubes for preservation and analytical purposes and (c) Auto-programming 'system care' in the computer involving acid wash, cleaning sample loops and filters *insitu* Microwave digester (spectro-prep-CEM) during digestion.

Samples were thawed at room temperature and dried to constant weight at 65°C. Coarse homogenization of each sample was done by crushing in a PVC pestle and mortar (particle size 450 pm). Dried samples of 0.12 g, each was weighed into Fisher brand disposable sterile centrifuge tubes of 50 ml capacity and wet ashed in nitric acid (10%, v/v), and hydrochloric acid (1% v/v) for 48 hours for the analysis of mercury and selenium. Potassium iodide (5% v/v) and ascorbic acid (5% v/v) were added for the analysis of arsenic. The samples were then diluted to 50 ml with double distilled deionized water, and digested in an automatic microwave digestion system (Spectra Prep CEM). The digested sample solution was analyzed with a Perkin Elmer 5100 Atomic Absorption Spectrophotometer (AAS), using the hydride technique (MS-200). This technique, involves the reaction of acidified aqueous samples with a reducing agent, to determine the level of As, Se and Hg. This reaction generates a volatile hydride which is transported to a quartz cell by means of an argon carrier gas. In the quartz cell, the hydrides are converted to gaseous metal atoms. Blanks were treated similarly.

The accuracy of the method was verified using standard reference materials viz., oyster tissue (SRM-1566a) from the National Bureau of Standards and lobster hepatopancreas (TORT-2) from National Research Councel of Canada. Recoveries were above 90 % for all the trace metals measured (Table 1.).

Table 1. Recovery values of heavy metal concentrations measured Certified Reference materials µg/g dry weight.

Metal	Certified values (µg/g)		Present study (µg/g)		Recovery (%)	
	SRM-1566a	TORT-2	SRM-1566a	TORT-2	SRM-1566a	TORT-2
As	14.0	21.6	13.9	19.81	99.3	91.7
Hg	0.0642	0.27	0.059	0.25	91.9	92.6
Se	2.21	5.63	2.12	5.41	94.9	96.1

RESULTS AND DISCUSSION

The data on Kuwait lobster *Thenus orientalis* from the two stations are presented in Table 2 . All lobster data were found to be above detection limits. Logarithmic values were used to derive a presentable linear regression model and condense the data to express linearity. Factors influencing the concentration of trace metals in marine organisms include species differences and size (NAS 1977). The length and total weight of *Thenus orientalis* ranged from 7.0 to 25.2 cm and 11.0 to 293.4 g with a mean of 15.5 cm and 111.8 g respectively. Out of 52 lobsters collected from station I and II, 26 were males and 26 were females. When the mean concentrations of individual metal from station I was compared with their counterpart in station II, (e.g. mean concentration of As from station I as against As in station II) no significant correlation was observed. Thus, it proved that the mean concentration level of each metal was seldom different between the two sampled stations. However, when the total mean concentrations of all the trace metals from station I, was compared with the total mean concentrations of trace metals in station II, significant correlation was observed.. This further probed to determine the significant differences between male and female lobsters. It is interesting to note that significant difference exists between the mean concentration of each metal in male and female lobsters irrespective of stations I and II and hence, the study was also focussed to determine the correlation between the sex of lobsters (Table 2).

Table 2. Mean concentrations and standard deviations of As, Hg and Se in lobster muscle (µg/g dry weight) from the coast of Kuwait.

Station	Number	Arsenic	Mercury	Selenium
I	26	12.56 ± 1.47	0.12 ± 0.04	1.71 ± 0.64
II	26	13.27 ± 1.28	0.11 ± 0.01	1.68 ± 0.19
Male	26	12.27 ± 2.17	0.09 ± 0.04	1.47 ± 0.68
Female	26	11.07 ± 2.22	0.12 ± 0.07	1.18 ± 0.36

Significant linear relationships observed between total body weight (g) , total length (cm) and carapace width (cm) in both male and female species are represented in Table 3. These relationships were found to be similar to that of the calculated slope for opposum shrimp, *Mysis relicta* by Lasenby and Van Duyn (1992) and similarly for jing shrimp *Metapenaeus affinis* and grooved

Table 3. The fitted linear regression model for *Thenus orientalis* in Kuwait waters.

	Y X	Total length (cm) Total weight (g)	Carapace width (cm) Total weight (g)	Mercury (µg) Total weight (g)	Arsenic (µg) Total weight (g)	Selenium (µg) Total weight (g)
Male	*a*	0.5872	0.6505	-1.4974	1.3692	0.8128
	se	0.0704	0.1038	0.1968	0.0556	0.1233
	b	0.3001	0.1660	0.2189	-0.1574	-0.3749
	se	0.0376	0.0554	0.1052	0.0297	0.0659
	σ	0.0763	0.1124	0.2133	0.0602	0.1336
	P	> 0.001	0.006	0.048	> 0.001	> 0.001
	R^2	0.7261	0.2718	0.1530	0.5391	0.5742
Female	*a*	-0.3831	0.6203	-2.2198	0.8319	1.0580
	se	0.1115	0.0991	0.5949	0.1621	0.2948
	b	0.3966	0.1814	0.5382	0.0984	-0.4450
	se	0.0492	0.0438	0.2627	0.0716	0.1301
	σ	0.0465	0.0413	0.2481	0.0676	0.1230
	P	> 0.001	> 0.001	0.052	0.182	0.002
	R^2	0.7302	0.4173	0.1489	0.0730	0.3274

Linear regression equation : $y = a + bx$, se = standard error (r) = $1- r^2 / \sqrt{n}$, σ = standard deviation
R^2 = co-efficient determination , P = significant for t value .

tiger prawn *Penaeus semisulcatus* (Bou-Olayan et al. 1995). However , differences in these relationship was observed from the results of other investigators.

Significant correlation were found to exist between Hg and Se in lobster muscle content. A surge in Hg metal content in lobster muscle was found to be inversely proportional to that of Se metal content irrespective of the sex of lobsters. This was supported by the studies conducted by Mackay et al. (1975) within the livers of marine mammals. They also suggested that Se may protect these animals from the effects of accumulated Hg . Halstead (1970) and Monier -Williams (1949) stated Se is itself a toxic element. In the present study, As content in the muscles of lobster was found to vary with sex and thus showed no correlation with other metals, viz., Se and Hg.

The concentration of arsenic found in lobster muscle in this study was found to be higher than standard accepted for sea foods in Saudi Arabia (0.5 µg/g) and HongKong (10µg/g) (Attar et *al.* 1992) and shrimp species (*Metapenaeus affinis* and *Penaeus semisulcatus*) from several stations in the Arabian Gulf region (Bou-Olayan et al. 1995).

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