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Mercury Levels in Mole Crabs *Hippa cubensis, Emerita brasiliensis, E. portoricensis,* and *Lepidopa richmondi* (Crustacea: Decapoda: Hippidae) from a Sandy Beach at Venezuela

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Mercury pollution in Venezuela's coastal area has been demonstrated for several years, especially at the Golfo Triste region (10° N, 68° W), which was subjected for several years to the discharges of mercury from a chlorine-alkali plant that used an electrolytic process involving mercury electrodes. From 1987 to 1989 a base line study along the entire coast of Golfo Triste was carried out (Pérez, 1989) showing the great extent of mercury pollution in the region, although this metal was found in relatively moderate levels compared to other world coastal zones subjected to mercury discharges. Reports on this subject indicated significant levels of mercury found in sea stars (Iglesias and Penchaszadeh, 1983), several fish species (Ishizaki and Urich, 1985) and the angiosperm *Thalassia testudinum* (Pérez, 1995).

The levels of heavy metals accumulated in some marine organisms may be many orders of magnitude above background concentrations, thus demonstrating the potential of certain species as bioindicators of heavy metal pollution (Chan, 1989). Accumulation of mercury in marine organisms has been reported by several workers (e.g. Pastor et al., 1994; Bhattacharya and Sarkar, 1996; Bianchini and Gilles, 1996; Berge and Brevik, 1997). Their results have indicated that some crustaceans may be appropriate bioindicators for mercury pollution, due to their high accumulation of this element.

Four species of mole crabs, *Hippa cubensis, Emerita brasiliensis, E. portoricensis,* and *Lepidopa richmondi* (Crustacea:Decapoda:Hippidae) inhabit the open sandy beaches of Golfo Triste (Rodríguez, 1980). Mole crabs dig with the uropods and fourth pair of legs. In the surf zone, mole crabs are usually washed out with each wave; while the wave is receding they rapidly burrow backward in the soft sand until only the antennae are visible. The mole crabs are filter feeders. In species that inhabit open beaches, their second antennae filter plankton and detritus from the receding wave current (Barnes, 1980). In this study the concentrations of total mercury in four species of mole crabs from Golfo Triste were compared to mercury levels found in water and sediment of the same sampling localities, in order to discern their potential as bioindicators of mercury pollution.

MATERIALS AND METHODS

Golfo Triste (10° N, 68° W) is a large bay with a relatively wide continental platform, very few topographic irregularities and usually sandy or muddy bottoms up to 90 m deep. Most of the coastal fringes are sandy beaches; however rocky substrates, coral keys and mangrove forest occur at the east and west sides.

Samples of water, surficial sediments and available species of mole crabs were collected twice between September and November 1990 from 8 coastal localities in Golfo Triste (Fig. 1). Regular, low and sandy beaches characterize these localities. Sampling covered areas of the direct or indirect influence of urban and industrial releases (Quizandal, Goigoaza, El Palito, Palma Sola), those located near the mouth of the tributary rivers which carry industrial discharges of pollutants to the offshore waters (Alpargaton, Boca de Yaracuy and Boca de Aroa) and a locality not under the influence of industrial or urban releases (Patanemo).

Water samples (100 ml) were collected in triplicate, in pre-cleaned polyethylene bottles and they were preserved with concentrated HNO_3. Three superficial sediment samples were collected with a grab. A 1-g aliquot from each sediment sample was taken in duplicate from the surface in the central portion of the grab to avoid contamination, with an acid-cleaned plastic spatula. Samples of mole crabs were collected by hand, selecting whole adult and not reproductively mature specimens. 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_3, H_2SO_4 and HF. H_2SO_4 was used because the sediment from most of the sampling sites contains 8 to 10% of organic matter (Pérez, 1989). The digestion of each sample of sediment was made in duplicate. Whole soft tissue of crustaceans was prepared for analysis. Each sample of five specimens was homogenized in a 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_3 and H_2SO_4.

The analysis of total mercury were done by the cold vapor method (Beaty, 1978) 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 glass-ware used was cleaned by the procedure described by Ober et al. (1987). 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.

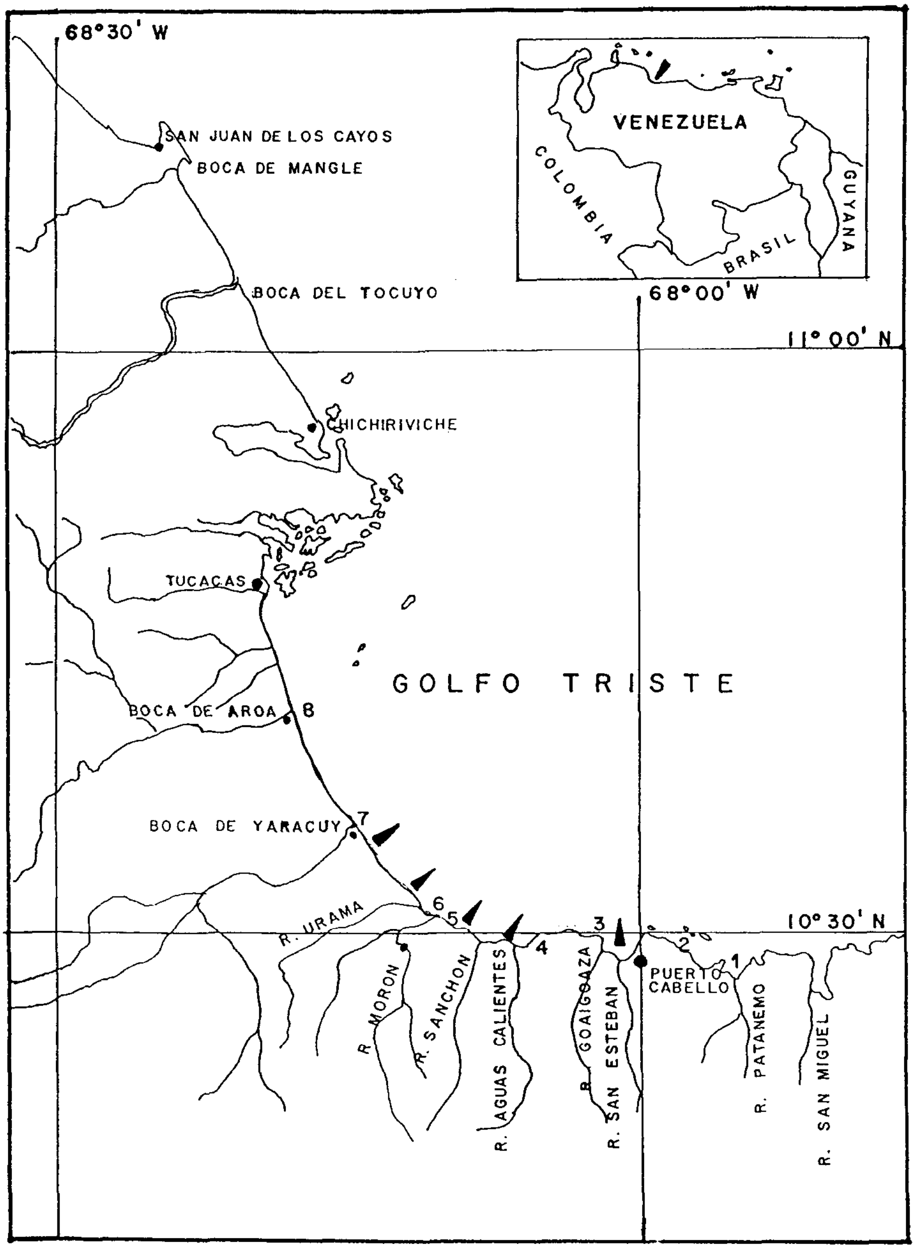

Figure 1. Sampling stations: 1. Patanemo, 2. Quizandal, 3. Cumboto, 4. El Palito, 5. Palma Sola, 6. Alpargatón, 7. Boca de Yaracuy, 8. Boca de Aroa. Arrows indicate the localization of the urban and industrial discharges.

The concentrations of total mercury found in each sample of sediment and organisms were averaged over the total number of samples from each station (Mean ± S.D.). The results are given in ppb (ng Hg/g WW or ng Hg/L).

Table 1. Total mercury levels (ppb) and ranges found in sediment samples and in four species of mole crabs from eight localities at Golfo Triste, Venezuela. SD: standard deviation.

Sampling	Sediment		Hippa cubensis		Emerita brasiliensis		E. portoricensis		Lepidopa richmondi	
sites	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Patanemo	10.2 (0.9)	9-11			3.0 (0.7)	2-4				
Quizandal	31.6 (8.2)	20-42	17.1 (6.5)	10-30	106.8 (31.1)	54-143			33.1 (17.2)	12-60
Cumboto	24.1 (3.5)	20-30	14.3 (3.2)	11-20	102.5 (18.7)	60-123	35.6 (6.2)	26-46	40.9 (60.6)	22-130
El Palito	29.1 (0.8)	28-30					44.8 (5.4)	38-53		
Palma Sola	35.8 (0.7)	23-47	12.3 (3.7)	8-20	1062 (299.4)	623-1439	43.2 (6.3)	34-50		
Alpargatón	34 (8.6)	20-48			398.2 (146.1)	161-540	196.1 (102.2)	57-313	14.3 (2.7)	11-17
Boca de Yaracuy	25.6 (9.9)	20-31					45.5 (17.6)	24-69	18.5 (3.7)	10-30
Boca de Aroa	27.9 (5.2)	20-35			49.3 (11.8)	32-66	33.7 (5.8)	26-42		
All sites, pooled	28.8 (10.6)	9-48	14.6 (5.1)	8-30	200.9 (320.5)	2-1439	66.3 (71.1)	26-313	32.9 (29.3)	10-130
7 polluted sites, pooled	30.3 (9.7)	15-48	14.6 (5.1)	8-30	243.4 (338.4)	2-1439	66.3 (71.1)	26-313	32.9 (29.3)	10-130

RESULTS AND DISCUSSION

In areas slightly or moderately contaminated by heavy metals, water does not generally contain noticeable quantities of mercury, given that this metal, once it is present in the water in its ionic form, can constitute a wide variety of complexes and chelates with organic compounds or attaches to the sediment particles (Grant, 1973; Aubert et al., 1973), Besides, microorganisms make inorganic mercury available for incorporation into trophic webs, by conversion to monomethyl and dimethyl mercury. Since monomethyl mercury is not only the most toxic form, but is also somewhat soluble and volatile, it can be rapidly assimilated by living organisms, given its affinity to proteins and other molecules that contain -SH groups (Barlett et al., 1978). Thus, total mercury in the marine environment is mostly distributed between sediments and biota (Forstner and Wittmann, 1979). In this study the levels of total mercury found in the water, in the eight sampling stations, were between 1 and 2 ppb.

Table 1 shows summary data for total mercury levels found in sediment samples and in the mole crabs species. Sampling made in Patanemo, a location supposedly free of mercury pollution, allowed us to reference total mercury content in sediment and *Emerita brasiliensis.* At Patanemo, total mercury levels found in *E. brasiliensis* ranged from 2 to 4 ppb. Total mercury levels in sediment were between 9 and 11 ppb. These values were similar or lower than the 10 ppb reported for sediment samples from unpolluted areas (Knauer, 1976; Lebel et al., 1996).

Total mercury levels in sediment from the other seven sampling stations ranged between 20 and 47 ppb (Table 1), comparable to the values reported for sediment samples from the Gulf of Nicoya in Costa Rica (Dean et al., 1986), the west coast of India (Zingdee and Desay, 1981; Sasamal et al., 1987), and some zones of the Mediterranean Sea (Renzoni et al., 1973; Baldi et al., 1979). All these sites, as Golfo Triste, are affected by effluents from industries of caustic soda, caustic potassium, chloride, plastics, paints, paper pulp, fungicides and other chemicals. Higher levels of total mercury in sediment were seen at Palma Sola and Alpargaton. These stations are located near the mouth of rivers (Fig. 1), which carry petrochemical industrial discharge to offshore waters.

Total mercury concentrations in *Hippa cubensis* and *Lepidopa richmondi* were generally lower than the levels found in sediment samples of the same locality. However, total mercury concentration in *Emerita brasiliensis* and *E. portoricensis* were always higher than the mercury levels found in sediment samples at the same locality (Table 1). Moreover, comparing the species studied, the highest mean levels of mercury were found in *Emerita brasiliensis.* Heavy metal accumulation strategies vary between crustacean taxa and the regulation of body levels of a heavy metal as an accumulation strategy would seem to be present only in decapods (Rainbow and White, 1989). Despite this fact, at present there is no information in the literature about the biology of the *Emerita* species that might account for their much higher accumulation of mercury than *Hippa* and *Lepidopa* species.

Golfo Triste appears to be an area slightly to moderately contaminated by mercury. Species of mole crabs *Emerita brasiliensis* and *E. portoricensis* may be appropriate bioindicators for mercury pollution due to their high accumulation of this metal.

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