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# Trace metals in Penaeid shrimp and Spiny lobster from the Bay of Bengal

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**ABSTRACT** Seasonal variation of trace metal (Cu, Pb, Zn, Ni, Cd, Mn, Fe and Cr) concentrations in abdominal tissue and cephalothorax of Penaeid shrimp (*Penaeus monodon*) and Spiny lobster (*Panulirus polyphagus*) from the offshore fishing grounds of the Bay of Bengal, Bangladesh coast were analyzed from January to December 1996 by atomic absorption spectrophotometry. Metal concentrations ($\mu g.g^{-1}$ dry weight) ranged from 12.2 to 75.6 for Cu, 0.8 to 3.8 for Pb, 17.5 to 105.1 for Zn, 2.8 to 8.9 for Ni, 0.2 to 0.6 for Cd, 3.1 to 15.2 for Mn, 9.0 to 110.0 for Fe and 1.7 to 4.9 for Cr. Concentrations of metals in the muscle tissue (abdomen) were found to be lower than in the cephalothorax and the levels do not pose a health hazard for consumers. This is the first report of these elements in Penaeid shrimp and Spiny lobster from the Bay of Bengal.

KEYWORDS: trace metals, shrimp, lobster, accumulation, bay of bengal.

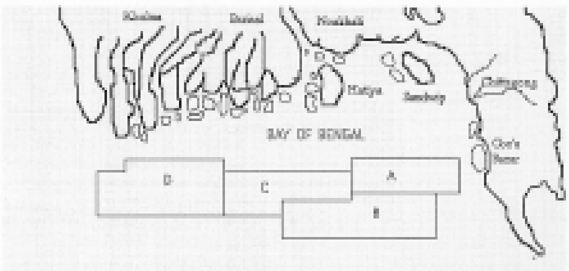
## INTRODUCTION

Metalloids are serious pollutants because they are stable compounds not readily removed by oxidation, precipitation or any other natural processes. Lower concentrations of metalloids may also kill aquatic organisms and may hinder or prevent the self-purification process of a water body. The problems associated with trace metal contamination were first highlighted in industrially advanced countries because of their larger industrial discharges, and especially because of incidents of mercury and cadmium pollution in Sweden and Japan.[16,19,11] In Japan, Minamata disease caused the death of many people from intake of fish, contaminated with toxic levels of mercury. Similarly, the toxicity and devastating effects of cadmium on animals were amply proved by itai-itai disease in humans. Several studies have revealed that cadmium is dangerous to aquatic organisms[4] and that it can be bioaccumulated in the food chain.[3,5,10]

Fish are known to concentrate metals in body tissues in varying proportions depending upon species, environmental conditions and inhibitory processes. Since, they constitute an important human food, they are potentially an indirect source of metals entering the body but they may also suffer from a wide range of metabolic, physiological, behavioral and ecological effects.[9] These include disturbances in osmoregulation and respiration, tissue damage, reduced energetic resources and poor performance.[17,14,13] The extent of such effects depends on the inherent toxicity of the metal, its concentration, its chemical form and the species affected. Cumulative effects of metals or chronic poisoning may occur as a result of long-term exposure even to low concentrations.

## MATERIALS AND METHODS

Penaeid shrimp (*Penaeus monodon*) and Spiny lobster (*Panulirus polyphagus*) were collected seasonally (ie, pre-monsoon, monsoon and post-monsoon) from commercial fishing trawlers in the Bay of Bengal (Fig 1). For each species 10 samples of approximately the same size were collected at each sampling. Collected samples were then stored at $-18^{o}C$.[25] After rinsing the samples with distilled




A = South Patches, B = South-West of South Patches
C = East of Swatch of No Ground, D = Swatch of No Ground

Fig 1. Coastal and marine environment of Bangladesh with commercial fishing grounds.

water, shells and legs were removed and the abdomens were separated from cephalothorax and tail. Then the cephalothorax and abdominal muscle of each shrimp and lobster were minced separately after external water had been absorbed with tissue paper. Then, the samples of each species and tissue type at each collection time were pooled and homogenized to obtain 12 composite samples.[25] The composite samples were then dried in an oven at 105°C and digested in a mixture (0.5:5:1) of sulphuric acid, nitric acid and perchloric acid[1] so that metal concentrations could be determined by atomic absorption spectrophotometry using a Hitachi A-1800 spectrophotometer.

## Results and Discussion

The concentrations of trace metals found in abdominal muscle and cephalothorax of shrimp and lobsters are given in Table 1. Seasonal fluctuations in concentration were irregular and those for Cd, Pb, Cr, Mn, and Ni were smaller than those for Fe, Zn and Cu. These fluctuations probably depended on accumulation efficiency, molting frequency and environmental availability of the metals.

Higher levels of metals were found in the cephalothorax than in abdominal muscle, as was previously observed by Peerzada et al.[20] These higher values might be due to the different composition of organs in cephalothorax and abdomen and their efficiency in accumulating metal during intake of food and then subsequent digestion.

Heavy metals in epibenthic macroinvertebrates from the coastal zone and continental slope of Kenya were studied by Everaarts and Nieuwenhuize.[7] In crustaceans, concentrations (μg.g$^{-1}$ dry weight) of Cu, Cd, Zn and Pb ranged from 45 to 90, 1.0 to 8.5, 49 to 102 and 0.1 to 0.6 respectively. Khan and Alam [15] studied crustaceans of the Karnafully estuary and found concentrations (μg.g$^{-1}$ dry weight) of Cu, Pb, Cd, Zn and Fe in the muscle of *Metapenaeus monoceros* at 33.1, 3.6, 0.7, 40.8 and 43.0, respectively. In our investigation metal concentrations, except for Pb, were lower than these.

Biney and Ameyibor[2] studied accumulation of Fe, Cu, Zn, Pb, Cd and Hg in pink shrimp (*Penaeus notialis*) and reported levels of accumulation lower than ours. This suggests exposure to higher levels of metals in the Bay of Bengal environment than in the earlier study, possibly as the result of industrial discharge, river input during low tide, atmospheric input, etc.

Simkiss and Taylor[24] discussed the pathways of metal accumulation by aquatic organisms, and identified six possible types (Fig 2). It is generally accepted that trace elements are taken up by aquatic biota in a passive process, down a concentration gradient into tissues. This can occur despite the presence of much higher concentrations of the elements in the tissues than in the external medium, as the metals in the tissues are bound to a wide range of biochemical sites.[18] In a few instances, uptake may also occur through ion pumps, and in these cases, an energy dependence exists.[23,26]

A comparison of the data on penaeid shrimp from the literature and the data of the present study (Table 2) shows that the concentrations of trace metals we

**Table 1.** Trace metal concentrations (μg.g$^{-1}$) in muscle (abdominal tissue) and cephalothorax (head) of *Penaeus monodon* and *Panulirus polyphagus.*

| Species | Representative organ | Season | Metal Concentration (mg/g dry weight) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Pb | Zn | Ni | Cd | Mn | Fe | Cr |
| *Penaeus monodon* | Muscle | Pre-monsoon | 21.3 | 1.3 | 35.7 | 5.9 | 0.3 | 6.5 | 14.5 | 2.9 |
| | | Monsoon | 16.7 | 0.9 | 24.2 | 2.9 | 0.2 | 4.1 | 9.1 | 1.8 |
| | | Post-monsoon | 12.2 | 0.8 | 30.1 | 4.0 | 0.2 | 3.1 | 15.7 | 1.7 |
| | Cephalothorax | Pre-monsoon | 71.3 | 3.1 | 92.1 | 3.4 | 0.5 | 7.3 | 53.1 | 3.7 |
| | | Monsoon | 62.8 | 2.1 | 108.2 | 5.2 | 0.3 | 11.8 | 50.1 | 2.6 |
| | | Post-monsoon | 68.8 | 2.2 | 76.2 | 8.9 | 0.6 | 8.8 | 48.0 | 4.1 |
| *Panulirus polyphagus* | Muscle | Pre-monsoon | 25.8 | 1.9 | 64.5 | 7.0 | 0.4 | 10.1 | 35.6 | 3.1 |
| | | Monsoon | 26.0 | 1.0 | 17.6 | 4.4 | 0.3 | 4.1 | 21.4 | 2.5 |
| | | Post-monsoon | 35.7 | 1.1 | 46.6 | 3.1 | 0.3 | 5.8 | 32.0 | 2.5 |
| | Cephalothorax | Pre-monsoon | 70.5 | 3.8 | 77.1 | 3.1 | 0.4 | 3.2 | 79.0 | 4.1 |
| | | Monsoon | 75.6 | 3.5 | 92.4 | 2.8 | 0.5 | 15.2 | 110.0 | 4.4 |
| | | Post-monsoon | 72.0 | 2.8 | 105.1 | 4.7 | 0.4 | 13.4 | 54.4 | 4.9 |

**Table 2.** The concentration of trace metals ($\mu g.g^{-1}$ dry weight) in Penaeid prawn (Crustacea, Natantia, Penaeidae) from marine environment of different climatological latitudes.

| Geographical area (Ref.) | Cu | Pb | Zn | Ni | Cd | Mn | Fe | Cr |
|---|---|---|---|---|---|---|---|---|
| Bay of Bengal (Present study) | 12.1-21.2 | 0.8-1.2 | 24.1-35.7 | 2.8-5.8 | 0.2-0.4 | 3.1-6.5 | 9.1-15.7 | 1.7-2.9 |
| Java Sea [6] | 5-120 | - | 26-109 | - | 0.6-13.9 | - | - | - |
| Coast Malay Peninsula [8] | 60-130 | 0.7-3.4 | 60-85 | - | 0.2-0.9 | - | - | - |
| Hong Kong Coastal water [22] | 31-84 | ND | 39-146 | - | ND | 26-90 | 32-781 | - |
| Coastal zone, Kenya [7] | 45-90 | 0.1-0.6 | 49-102 | - | 1.1-8.5 | 6.0-29.0 | 190-1160 | - |
| E Atlantic Ocean [22] | 17-99 | 1.5 | 51-83 | - | 1.9-7.1 | 0.9-2.8 | 11.0-34.0 | - |
| NE Atlantic Ocean [21] | 10.0-61.0 | - | 40-70 | - | 1.8-6.6 | 1.3-8.1 | 17-61 | - |
| Coastal zone NE Pacific [12] | 14-20 | 0.7-1.3 | 48-53 | - | 0.1 | - | - | - |

found were, in general, significantly lower. In conclusion, the penaeid shrimp and spiny lobster of the offshore fishing grounds of the Bay of Bengal were found to have safe levels of metal concentrations for human health.

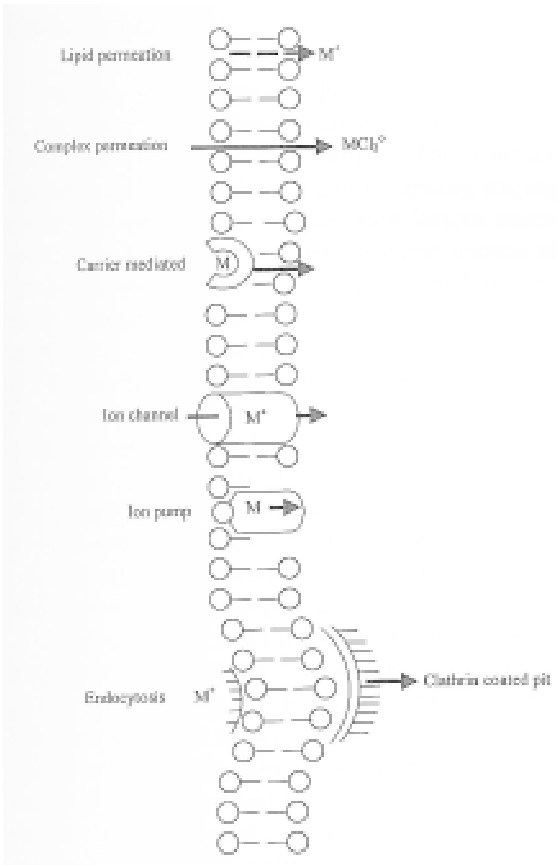



Fig 2. Mechanisms porposed for the fluxes of metal ions into cells [24].

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