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# DISTRIBUTION OF MACRO AND MICRO-ELEMENTS IN MARINE INVERTEBRATES FROM KARACHI

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This study includes three species of crab (*Portunus pelagicus, P. sanguinolantus* and *Scylla serrata*); gastropod (*Telescopium telescopium*); sea cucumber (*Actinopyga mauritiana*); star fish (*Astropecten indicus*); and Auralia sp. Macro-elements studied were sodium, potassium, calcium, magnesium and phosphorus. Estimation of microelements includes manganese, copper, iron, zinc, nickle, cobalt, lead and cadmium. Iron concentration was highest in all the invertebrates followed by the zinc content. Lead was detected only in *A. muritiana* and *A. indicus*; nickle was present in *A. indicus* and *Auralia* species cobalt and cadmium were only recordedin *A. indicus* and *Auralia* sp., respectively. The concentration of metals was high enough to be alarming.

*Key words:* Pollution indicator, Macroelements, Microelements, Invertebrate.

## INTRODUCTION

Invertebrates are known as pollution indicators. Being filter feeders, they accumulte metals and other pollutants in their tissues. In non-filter feeders sequestration of various substances may be achieved through the marine food chain. Thus a pollutant, occurring in the surrounding water and sediment, may be transferred from lower animals to the animals of higher trophic levels. Magnitude of pollutant increases with the successive transference from the lower to the higher trophic levels.

In marine organisms metallic ions participate in osmoregulatory processes and biochemical reactions (through enzymes and respiratory pigments) [1,2]. Qualitative and quantitative estimation of metals in invertebrates provides a useful tool to establish and quantitate their occurrence in tissues serving as baseline for comparative future studies to determine the degree to which metallic ion concentrations have changed.

Coastal areas of Pakistan offer habitat to a wide variety of organisms. Occurrence and levels of heavy metal accumulation in these organisms have been reported to a limited extent, is quite fragmentary. Our knowledge of metal distribution in invertebrates exists only for oyster [3,4] and mussel species [5]. Recently a preliminary report has emerged on marine pollution [6] providing some useful data on the existence of metals and hydrocarbons. In addition, previous reports by Ahmed [7], Rizvi *et al.* [8] and Qasim *et al.* [9] have covered only the water and sediment components of marine ecosystem for distribution of metals in creek areas. This paucity of pertinent literature on the accumulation of metals in invertebrates has initiated to undertake work on species inhabiting the coastal areas of Pakistan.

## MATERIALS AND METHODS

Marine invertebrates collected randomly included three species of edible crabs, viz, *Portunus pelagicus* from back waters of Karachi; *P. sanguinolantus* from Clifton; and *Scylla serrata* from Korangi creek, alongwith other invertebrates, such as, *Astropecten indicus* (star fish) from Sandspit; *Actinopyga mauritiana* (sea cucumber) from Buleji; *Telescopium telescopium (gastropod) from* mangrove swamp; and Auralia sp.

*A. indicus, A. mauritiana* and Auralia sp (whole animals) and meat from *T. telescopium* and crab species (body and claw meat) were dried, pooled and ground separately for analysis. Inorganic elements were determined from wet ashed solutions prepared according to Aftab [10].

Sodium, potassium and calcium were measured through flame photometry. Atomic Absorption Flame Emission Spectrophotometer was used in the detection of magnesium, iron, copper, cobalt, cadmium, nickle, zinc and lead. Phosphorus was determined according to the colorimetric method of Lowry *et al.* [11].

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## RESULTS AND DISCUSSION

The present investigation was carried out to establish levels of metal accumulation in different marine invertebrates (Table 1 and 2) represents the distribution of macro-elements among them sodium was the most abundent metal in crabs and sea cucumber. On the other hand, magnesium and calcium were in excess in star fish (*A. indicus*) and magnesium in *T. telescopium*. Both potassium and phosphorus in *T. telescopium, A. indicus, A. mauritiana* and Auralia sp. were low against their high values observed for crab species. Exceptionally low values of calcium and phosphorus were found in swim crab, *P. pelagicus,* for males and females both. Sodium phosphorus and magnesium were generally found in excess in claw meat of all crab species and sexes, except for males (sodium and phosphorus) and females (phosphorus) of *S. serrata*. High amounts of potassium were detected in the body meat; but females of *S. serrata* showed reversed results. Comparison of macro-element concentration data with Sidwell *et al.* [12], revealed that sodium, observed in the present study, was higher, whereas levels for potassium, magnesium and phosphorus were comparable. Sodium and potassium have also been recorded in high quantities in crabs, *Nephrops norvegicus* [13] and *Carcinus meanas* [14]; mussel [5]; and oyster [3,4]. These elements have their utility as preliminary elements for osmoregulatory control mechanisms in aquatic animals. Calcium and magnesium are important components of exoskeleton of decapod crustaceans [15] and reported in large quantities in *Carcinus irroratus* [2], but usually found in low amounts in muscles. High magnesium and calcium in *A. indicus* can be attributed to its skeleton included in the estimation. Excess magnesium in *T.telescopium* could be due to its habitat; as it is a mud dwelling gastropod and was collected from mangrove swamp.

Distribution of micro-elements in marine invertebrates is shown in Table 3 and 4. Of all the heavy metals, iron was in great abundance in all organisms studied. Its value was apparently highest in *T. telescopium and lowest in P. pelagicus.* Among crab species, *S. serrata* (mud crab) possess high iron concentration, may be a function of its habitat, as is true for *T. telescopium,* Concentration of iron in crabs was followed by zinc, copper and manganese in descending order. Nickle, cobalt, lead, and cadmium were not detected. Concentration of copper, iron and manganese were low in *P. pelagicus* as compared to the other two species. High values of iron in crab species, is in agreement with the findings of Martin [2] for *C. maenas* and *C. irroratus.* Martin has also noted the role of iron in the molting cycle.

Table 1. Levels of macroelements in tissues of marine invertebrates. (Values are mean of triplicate observations).

| Invertebrate species | Concentration (g/100g dry tissue) | | | | |
|---|---|---|---|---|---|
| | Na | K | Ca | Mg | P |
| Gastropod (*Telescopium telescopium*) | 1.70 | 0.89 | 2.96 | 13.89 | 0.21 |
| Sea cucumber (*Actinopyga mauritiana*) | 8.73 | 0.86 | 3.71 | 6.80 | 0.13 |
| Star fish (*Astropecten indicus*). | 1.32 | 0.22 | 14.44 | 13.54 | 0.07 |
| Auralia sp. | 2.91 | 0.96 | 1.88 | 7.57 | 0.08 |

Table 2. Levels of macroelements in claw and body tissues of edible marine crab.species. (Values are mean of triplicate observations.)

| Crab species | Concentration (g/100g dry tissue) | | | | |
|---|---|---|---|---|---|
| | Na | K | Ca | Mg | P |
| *Scylla serrata* | | | | | |
| Male : Body meat | 3.19 | 1.12 | 0.82 | 1.64 | 0.62 |
| Claw meat | 2.44 | 1.33 | 1.05 | 1.22 | 0.77 |
| Female : Body meat | 2.18 | 1.13 | 1.07 | 1.15 | 0.83 |
| Claw meat | 2.37 | 1.15 | 1.07 | 1.31 | 0.57 |
| *Portunus pelagicus* | | | | | |
| Male : Body meat | 3.15 | 1.55 | 0.13 | 0.06 | 0.74 |
| Claw meat | 4.04 | 1.44 | 0.11 | 0.11 | 0.60 |
| Female - Bodymeat | 2.75 | 1.59 | 0.11 | 0.04 | 0.77 |
| Claw meat | 3.48 | 1.39 | 0.12 | 0.17 | 0.56 |
| *Portunus sanguinolantus* | | | | | |
| Female : Body meat | 3.77 | 1.44 | 2.99 | 0.82 | 0.95 |
| Claw meat | 3.96 | 1.40 | 1.44 | 2.29 | 0.79 |

Table 3. Levels of microelemetns in tissues of marine invertebrates.. Values represent the mean of triplicate observations

| Invertebrate species | Concentration (mg/100g dry weight) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mn | Cu | Fe | Zn | Pb | Ni | Co | Cd |
| Gastropod (*Telescopium telescopium*) | 26.65 | 10.82 | 171.0 | 37.88 | – | – | – | – |
| Sea cucumber (*Actinopyga mauritana*) | 6.16 | 4.08 | 89.10 | 3.02 | 16.50 | – | – | |
| Star fish (*Astropecten indicus*) | 4.16 | 5.69 | 42.67 | 11.38 | 16.41 | 16.41 | 2.34 | – |
| Auralia sp. | 0.004 | 1.61 | 17.88 | 1.99 | – | 2.48 | – | 0.004 |

Table 4. Levels of microelements in claw and body tissues of edible marine crabs species. Values represent the mean of triplicate observations.

| Crab species | Concentration (mg/100g dry tissue) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mn | Cu | Fe | Zn | Pb | Ni | Co | Cd |
| *Scylla serrata* | | | | | | | | |
| Male : Body meat | 3.78 | 14.39 | 32.89 | 32.04 | – | – | – | – |
| Claw meat | 3.56 | 11.06 | 45.61 | 24.56 | – | – | – | – |
| Female : Body meat | 3.22 | 12.92 | 39.57 | 22.34 | – | – | – | – |
| Claw meat | 2.83 | 16.37 | 49.45 | 32.92 | – | – | – | – |
| *Portunus pelagicus* | | | | | | | | |
| Male : Body meat | 1.66 | 5.47 | 13.97 | 19.68 | – | – | – | – |
| Claw meat | 1.19 | 8.28 | 17.81 | 25.75 | – | – | – | – |
| Female : Body meat | 1.31 | 6.65 | 17.94 | 15.29 | – | – | – | – |
| Claw meat | 1.19 | 10.47 | 15.87 | 25.76 | – | – | – | – |
| *P. sanguinolantus* | | | | | | | | |
| Female : Body meat | 2.34 | 8.31 | 36.27 | 17.04 | – | – | – | – |
| Claw meat | 2.62 | 9.79 | 32.75 | 23.60 | – | – | – | – |

– = not detected.

*T. telescopium* also has comparatively high manganese and zinc contents. Nickle was only found in *A. indicus* and Auralia species. Its concentration was high in *A. indicus*. Cobalt accumulation was found only in *A. indicus*. Tissues of *A. mauritiana* and *A. indicus* showed the presence of lead. Small amount of cadmium was detected in Auralia sp. only. The study shows that invertebrates behave differently with metals. It seems, from the data, that invertebrates have their own priorities for accumulation and metabolic utilization of different metals. Thus, it is important to further investigate the distribution of metals in different marine fauna and their habitat to determine the most suitable organism as metal pollution indicator. Interactions of environmental influences and marine biota, for metal concentration fluctuation, is an important factor. As we know, sea water concentration of metal ions varies with geographical location, depth and seasons [17,18], and affects metal concentration in animal tissues, as in crabs [2]; molluscs [19,20]; and planktonic species [21,22].

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## REFERENCES

1. R.J. P. Williams, Biol. Rev., **28**, 381 (1953).
2. J.L. M. Martin, Marine Biology **28**, 245 (1974).

3. A.A. Khan, R. Qasim and S. Barkati, Kar. Univ. J. Sci., **12**, 207 (1984).
4. R. Qasim, N. Aftab and S. Barkati, Pakistan J. Sci. Ind. Res. **28**,126 (1985).
5. M. Fatima, M. Phil. Thesis, University of Karachi. (1983).
6. Marine Pollution Baseline Survey in the Korangi-Phitti Creeks, Pakistan. (1987). Preliminary Survey Report. IUCN Contract No. OD/CDC/201/IAEA – Pakistan Baseline Survey. Project No. 9128. International Union for Conservation of Nature and Natural Resources, Karachi.
7. M. Ahmed, Port Qasim Pollution Study Research Project. Final Research Report. CEMB, University of Karachi (1982).
8. S.H.N. Rizvi, M. Saleem and J. Baquar, Proceedings of International Conference on the Marine Sciences of the Arabian Sea, March 1986, Karachi (In press).
9. R. Qasim, P.J. A. Siddiqui and Z. Akbar, Environmental Investigations, Korangi Fisheries Harbour Project., Dept. of Biochemistry, University of Karachi. (1986).
10. N. Aftab, M. Phil. Thesis. Dept. of Biochemistry, University of Karachi (1987).
11. O.H. Lowry, N.R. Roberts, K.Y. Leiner, M. L. Wu and A.L. Farr, J. Biol. Chem., 207, 1 (1954).
12. V.D. Sidwell, D.H. Buzzell, P.R. Foncannon and A.L. Smith, Marine Fisheries Review, Paper No. 1228, **39**(1): 1-11 (1977)
13. J.D. Robertson, J. Exp. Biol., **38**, 707 (1961).
14. H. Huddart, Comp. Biochem. Physiol., **38A**, 715 (1971).
15. P.E. Gibbs and G.W. Bryan, J. Exp. Mar. Biol. Ecol., **9**, 97 (1972).
16. J.L. M. Martin, Comp. Biochem. Physiol., **46A**, 123 (1973).
17. W.R.G. Atkins, J. Mar. Biol. Ass. U.K., **31**, 493 (1953).
18. B.P. Fabricand, R.R. Sawyer, S.G. Lingar and S. Adler, Geochem. Cosmochim. Acta., **26**, 1023 (1962).
19. C.M. Gordon, R. A. Carr and R.E. Larson, Limnol. Oceanogr., **15**, 461 (1970).
20. G.W. Bryan, J. Mar. Biol. Ass., U.K. **53**, 145 (1973).
21. L.H.N. Cooper, Proc.. R. Soc. (Ser B) 118, 419 (P).
22. T..Fujita, Geochem. J. Japan., **4**, 143 (1971).