

Concentration of metals in shrimps and crabs from Thane – Bassein creek system, Maharashtra

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Levels of Cu, Zn, Cd, Pb and Ni in shrimps and crabs from Thane-Bassein creek system were evaluated for a period of one year and reported as baseline for future monitoring of this vital ecosystem. The pattern of concentration was in the order of $Zn > Cu > Cd > Ni > Pb$. In shrimps maximum level of Cu (av 41.3 ppm dry wt) and Zn (av. 164 ppm dry wt) were observed respectively in *Metapenaeus brevicornis* from Thane creek and *Exopalaemon stylifera* from Bassein creek. The crabs, *Scylla serrata* from Thane creek showed maximum concentration for Cu (73 ppm dry wt) and Zn (376 ppm dry wt). Cd, Pb and Ni contributed very little to the percentage contribution of the metals estimated. In general the concentration of metals in shrimps and crabs were 2-11 times higher than that reported for Bombay harbour. However, the levels of these metals have not exceeded the limit prescribed for consumption.

Reports on metal concentration in shrimps and crabs under natural conditions for coastal waters of India are limited¹⁻³. The growing rate of anthropogenic waste input into the Thane-Bassein creek system leads to bioaccumulation of heavy metals in biota and their levels in economically important crustaceans and fishes have become a matter of great concern. Hence, it is important to establish the levels of heavy metals in these organisms to assess whether the concentration is within the permissible level and will not pose any hazard to the consumers. Also being the first report, the concentration levels in economically important crustaceans will serve as baseline for future ecological assessment and monitoring of Thane-Bassein creek system. This paper evaluates concentration of Cu, Zn, Cd, Pb and Ni in the tissues of the common species of shrimps and crabs found in the Thane-Bassein creek system.

Economically important crustaceans contribute a significant part of fish catch from Thane landing centre. In the Thane creek shrimps contribute 1 to 10% to the total catch which includes 6 species namely *Parapenaeopsis hardwickii*, *Exopalaemon stylifera*, *Macrobrachium rude*, *Metapenaeus brevicornis*, *Penaeus indicus* and *Exhippolysmata ensirostris*⁴. The distribution pattern of the species was discontinuous and varied between species. In the Bassein creek the contribution of shrimps were relatively higher (2.5–50%) compared to Thane creek⁴. Seven species were found in Bassein creek. All species found in Thane creek except *P.indicus* were observed in Bassein creek along with *Nematopalaemon tenuipes* and *Parapenaeopsis sculptilis*. Crabs were abundant at Thane creek contributing 2.5 to 20% of the total catch and the species represented were *Neptunus pelagicus*, *Scylla serrata* and *Charybdis*

annulata. At Bassein creek crabs contributed a negligible percentage to the total catch and the only species recorded from the area was *Charybdis annulata*.

Two locations were selected along the Thane-Bassein creek, a vital system joining the Arabian Sea through Bombay harbour at the south and via Bassein mouth on the northern side (Fig. 1). The first station was situated at the upper reaches near the Thane railway bridge while the second station was located off the Bassein. The depth at this area ranged from 6 to 12 m during different tidal

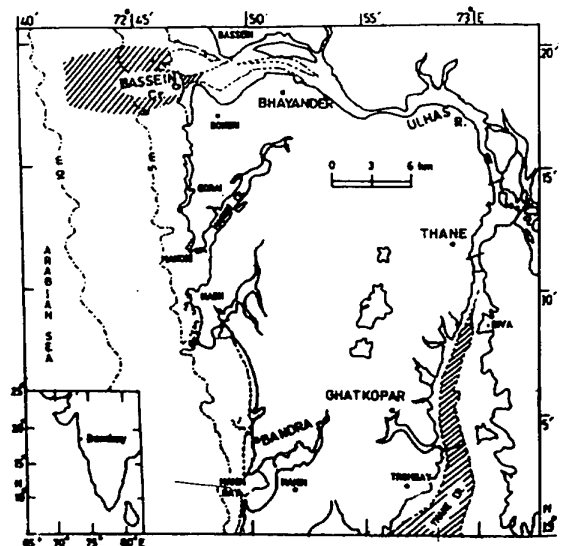


Fig. 1—The location of stations showed as hatched area.

conditions. About 350 mld (million litres/day) of sewage is received in the Bombay harbour - Thane system while the industrial waste input is about 180 mld². The Bassein creek receives about 35 mld of industrial effluents and 10 mld of sewage⁵. The water quality showed often low levels of DO at the interior part of Thane with high concentration of nutrients. At station 2 water quality is normal and comparable to a nearshore environment.

Shrimps and crabs were obtained every month by regular trawling at both the locations during March 1986 to February 1987. A high opening bottom trawl net of 20.7 m (636 meshes of 50 mm when stretched) was used and trawling was done for 1 h. Shrimps and crabs were segregated, kept in polyethylene bags and stored in an ice box. In the laboratory they were thawed, identified and the total length and weight were noted. Tissue was taken and dried at 70°C until a constant weight was obtained. The dried tissue was finely powdered and digested in conc. HNO₃ followed by perchloric acid⁶. The digested samples were analysed for copper, zinc, cadmium, lead and nickel using an atomic absorption spectrophotometer (make GBC 1000). Copper and zinc were determined by direct aspiration using air-acetylene flame while cadmium, lead and nickel were determined by a graphite furnace model GP 902. Along with samples, samples of fish tissue supplied by the International Laboratory of Marine Radioactivity (I.A.E.A) of Monaco was also analysed to test the accuracy of the procedure adopted. The results were in good agreement with the certified values given by I.A.E.A (error \pm 5%). The values on concentration of different metals are presented as ppm dry weight.

Even though the Thane-Bassein system receives appreciable load of trace metals the concentrations of dissolved metals in the harbour are comparable to the coastal waters of Bombay. The levels of metals considered for the present study were studied during different seasons (Table 1). It appears that the trace metals entering the bay in the dissolved state are removed from solution either by hydrolysis or by getting rapidly fixed to the particulate matter. The levels of these metals are relatively higher in Thane creek. Some enrichment of metals is also observed in sediment in Thane creek while the Bassein sediment does not reveal any excess entrapment of trace metals.

The levels of different metals showed variations among species and between stations (Tables 2 and 3). Though the observations were made for one year, each species was not continuously caught and hence seasonal comparison could not be made. Among the shrimps collected from Thane creek maximum concentration of Cu (av. 41.3 ppm) was recorded in *M.brevicornis* while that for Zn (av. 97.5 ppm) was observed in *P.hardwickii*, (Table 2). In the crab *S.serrata*, the observed maximum levels of Cu and Zn were respectively 73 and 376 ppm. In Bassein creek maximum levels of Cu and Zn in shrimps were observed in *E.stylifera*

Table 1—Levels of selected metals in water and sediment in Thane creek, Bassein and Bombay coast [Average values given in parentheses]

Area	Metals			
	Zn	Cu	Pb	Ni
	Water (μ g/l)			
Thane creek	25–30 (27)	12–17 (15)	6–7 (7)	0.8–2.0 (1.8)
Bassein	16–20 (17)	8–10 (9)	5–7 (6)	ND
Bombay coast	17–19 (18)	7–10 (9)	3–5 (4)	ND
	Sediment (ppm dry wt)			
Thane creek	190–210 (206)	135–145 (142)	20–32 (28)	128–138 (132)
Bassein	120–135 (127)	120–135 (132)	19–25 (21)	125–132 (128)
Bombay coast	130–140 (138)	105–120 (115)	08–22 (22)	120–130 (125)

(av. 29 and 136 ppm). Relatively higher levels of Cu (av. 47 ppm) and Zn (av. 164 ppm) were observed in the crab *Charybdis* sp from Bassein creek (Table 3). Cd, Pb and Ni contributed very little to the percentage contribution of the metals considered for the present study. However, on an average the maximum concentrations of these metals were high in crabs than shrimps.

Irrespective of species the pattern of concentration of different metals was comparable. The levels of Zn were the highest followed by Cu. The percentage of Zn ranged from 55 to 89 while that of Cu was from 10 to 45. The pattern of concentration was in the order of Zn>Cu>Cd>Ni>Pb. Compared to the concentration of Cu, Zn and Cd in shrimps, the observed levels in crabs were 1 to 6 times higher. The relatively higher levels of metals in crabs might be due to the confined movement coupled with bottom/shore feeding habit of these organisms.

The observed concentration of metals varied depending on the size of the species. Hence correlation was worked out between the length/weight of species and different metals. In Thane creek *Exopalaemon stylifera* and *Echippolysmata ensirostris* showed significant positive correlation between length/weight and concentration of Cu, Cd, Pb and Ni at 5% ($r = 0.49$) level of significance. In the same area *Neptunus pelagicus* significant correlation at 1% level ($r = 0.65$) was obtained between Ni and length/weight. In *P.indicus* significant positive correlation between length/weight and levels of Zn and Cd at 1% ($r = 0.63$) and Cu at 5% ($r = 0.48$) were seen.

At Bassein creek *N.temuipes* and *P.hardwickii* showed a significant positive correlation between length/weight and concentration of Ni at 5% ($r = 0.48$) level. In *P.sculptilis* the correlation was significant at 1% level ($r = 0.64$)

Table 2—Concentration of metals (ppm dry wt) in shrimps and crabs collected from Thane creek
[Values given are range and average in parentheses]

Species	Length (cm)	Weight (g)	Cu	Zn	Cd	Pb	Ni
<i>Parapenaeopsis hardwickii</i>	14.3-16.5 (15.4)	14.9-18.5 (16.7)	22.6-30.5 (26.6)	64.7-130.2 (94.5)	0.4-0.5 (0.5)	ND-0.003 (0.001)	0.008-0.009 (0.008)
<i>Macrobrachium rude</i>	7.5-9.5 (8.2)	1.8-3.2 (2.2)	17.1-25.5 (21.9)	50.5-70.5 (62.0)	0.1-0.3 (0.2)	0.001-0.01 (0.009)	0.002-0.01 (0.004)
<i>Metapenaeus brevicornis</i>	110.0-150.0 (120.0)	4.5-7.2 (5.1)	30.2-50.6 (41.3)	42.5-85.8 (50.7)	0.1-0.4 (0.2)	0.01-0.02 ND	(0.010)
<i>Exopalaemon stylifera</i>	5.8-9.9 (7.6)	0.6-4.5 (1.8)	28.0-47.8 (33.0)	53.9-77.4 (67.5)	0.1-0.3 (0.2)	0-0.005 (0.002)	0.003-0.009 (0.006)
<i>Penaeus indicus</i>	8.0-18.8 (14.8)	0.7-7.5 (5.5)	16.9-37.4 (25.4)	41.9-72.0 (48.4)	0.04-0.1 (0.05)	0.02-0.09 (0.06)	0.01-0.08 (0.04)
<i>Neptunus pelagicus</i>	5.7-7.5 (6.5)	13.3-16.3 (14.7)	33.4-92.8 (67.2)	43.7-260.8 (123.0)	0.1-7.9 (3.4)	0.007-0.04 (0.01)	0.05-0.07 (0.06)
<i>Exhippolysmata ensirostris</i>	8.5-10.0 (9.2)	7.0-10.0 (8.9)	17.9-22.9 (20.3)	40.9-62.7 (52.3)	0.09-0.4 (0.3)	0.04-0.06 (0.05)	0.02-0.1 (0.1)
<i>Scylla serrata</i>	5.7-14.0 (8.1)	5.8-125.0 (34.4)	56.2-90.8 (73.0)	148.0-644.2 (376.0)	0.2-1.2 (0.7)	0.008-0.02 (0.01)	0.04-0.09 (0.2)
<i>Charybdis sp.</i>	5.0-7.5 (6.5)	155.0-190.5 (175.0)	12.8-22.4 (17.8)	60.7-110.8 (97.7)	0.1-0.4 (0.3)	0.01-0.04 (0.03)	0.4-0.7 (0.5)

Table 3—Concentration of metals (ppm dry wt) in shrimps and crabs collected from Bassein creek
[Values given are range and average in parentheses]

Species	Length (cm)	Weight (g)	Cu	Zn	Cd	Pb	Ni
<i>Parapenaeopsis hardwickii</i>	7.1-17.2 (11.9)	1.5-39.0 (10.5)	6.4-31.8 (17.8)	26.8-137.1 (66.4)	0.03-1.2 (0.2)	0.01-0.07 (0.04)	0.008-0.03 (0.03)
<i>Macrobrachium rude</i>	7.2-8.6 (7.9)	2.8-6.0 (4.4)	17.8-18.2 (18.0)	50.8-69.8 (60.3)	0.2-1.2 (0.7)	0.04-0.1 (0.1)	0.007-0.1 (0.1)
<i>Metapenaeus brevicornis</i>	8.4-16.0 (11.3)	4.0-20.0 (10.4)	8.3-24.9 (15.8)	0.7-68.1 (44.3)	0.03-0.6 (0.1)	0.01-0.07 (0.03)	0.001-0.09 (0.04)
<i>Exopalaemon stylifera</i>	5.9-13.1 (9.4)	2.2-20.0 (7.9)	12.0-40.6 (28.9)	28.2-602.5 (135.7)	0.06-0.8 (0.3)	0.004-0.06 (0.02)	0.002-0.2 (0.04)
<i>Nematopalaemon tenuipes</i>	5.3-6.2 (5.7)	0.8-1.1 (0.9)	15.7-22.4 (19.9)	44.4-64.5 (51.7)	0.04-0.1 (0.1)	0.02-0.09 (0.1)	0.05-0.06 (0.1)
<i>Parapenaeopsis sculptilis</i>	8.4-15.0 (10.6)	3.0-32.0 (10.5)	10.5-37.8 (20.0)	9.2-85.0 (52.1)	0.001-1.5 (0.2)	0.01-0.07 (0.11)	0.004-0.09 (0.04)
<i>Exhippolysmata ensirostris</i>	7.1-10.0 (8.5)	1.5-10.0 (4.9)	10.3-31.6 (19.3)	0.1-76.4 (45.9)	0.04-0.7 (0.2)	0.06-0.08 (0.1)	0.04-0.2 (0.1)
<i>Carybdis sp.</i>	8.5-12.0 (10.5)	50.5-68.5 (60.0)	35.0-58.8 (46.7)	140.5-175.9 (163.8)	0.4-0.7 (0.6)	0.02-0.07 (0.05)	0.3-0.6 (0.5)

between the above two parameters. *P. hardwickii* and *M. brevicornis* showed significant positive correlation between length and concentration of Pb at 1% ($r = 0.65$) level. In *P. hardwickii* and *P. sculptilis* a correlation significant at 5% ($r = 0.48$) level was found between weight and concentration of Pb. In *E. ensirostris* a positive correlation between weight and concentration of Cu at 5% ($r = 0.49$) level of significance was seen.

The worked out correlation indicates that the larger the species the higher will be the concentration of metals. It also suggests that the Thane-Bassein creek system was receiving continuous input of these metals which got accumulated in the crustaceans.

The observed value of Cu in shrimps and crabs are comparable to that reported for the nearshore waters of Goa while that for Zn were 8 times higher in the present study¹. The values of Cu and Zn obtained in the present investigation irrespective of species were respectively about 2 and 5 times higher than the values reported for the shrimps from Bombay harbour². From the same area, the values of Cu in crabs were comparable while the levels of Zn were 11 times higher in the present study. Although levels of heavy metals in natural waters are extremely low in Thane creek indicated marginal enhancement. Cu (av. 142 $\mu\text{g/g}$) and Zn (av. 206 $\mu\text{g/g}$) accumulation in sediment are very high. This enhanced levels of metals in the creek

Table 4—Cumulative concentration of Zn, Cu, Cd, Pb and Ni (ppm/dry wt) in different species

Species	Thane creek	Bassein creek
Shrimps		
<i>P.hardwickii</i>	124.4	90.8
<i>E.stylifera</i>	100.6	148/5
<i>M.rude</i>	84.1	78.9
<i>M.brevicornis</i>	92.2	59.8
<i>P.indicus</i>	73.7	—
<i>E.ensirostris</i>	77.8	55.0
<i>N.tentipes</i>	—	71.7
<i>P.sculptilis</i>	—	72.4
Crabs		
<i>N.pelagicus</i>	193.5	—
<i>S.serrata</i>	402.5	—
<i>Charybdis</i> spp	116.3	211.6

must have influenced the observed higher levels of metals in organisms from the creek than the reported value of Matkar *et al.*² from the harbour.

The standards for metal contaminants in crustacean tissue have been given by Franklin⁷ as 120 mg/kg 400 mg/kg, 4 mg/kg and 1.2 mg/kg dry weight respectively for Cu, Zn, Pb and Cd. The observed values in different species of shrimps indicated that the levels have not exceeded the permissible limit prescribed for consumption⁸. However, in crabs the levels are relatively high and Cd in *N.pelagicus* has exceeded the limit on some occasions (Table 2).

The average cumulative concentration of Zn, Cu, Cd, Pb

and Ni (ppm/dry wt) for different species of shrimps and crabs are shown in Table 4.

In general, the values were slightly higher for the species (shrimps) found in the Thane Creek than in the Bassein creek. However, irrespective of species, on an average, the total concentration indicates marginal difference between Thane (91.3 ppm) and Bassein creek (82.4 ppm). The feeding habit and the ability of species to metabolize various metals are the major factors that decide the level of metals. The relatively high level of metal concentration in crabs suggests the less effective elimination of Cu, Zn and Cd by these animals.

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References

- 1 Zingde M D, Singbal S Y S, Moraes C F & Reddy C V G, *Indian J Mar Sci*, 5 (1976) 212.
- 2 Matkar V, Ganapathy S & Pillai K C, *Indian J Mar Sci*, 10 (1981) 35.
- 3 Qasim S Z & Sen Gupta R, *Mar Pollut Bull*, 19 (1988) 100.
- 4 Jyothi E A & Nair V R, *J Indian Fish Ass*, 20 (1990) 7.
- 5 NIO, *Wastewater disposal and submarine outfall studies around Bombay with M/s. Metcalf and Ed. Environmental Engineering Consultants*, Joint Venture for BMC, Technical Report, 1978.
- 6 F A O *Manual of methods in aquatic environmental research*. Part 4 1977, pp 31.
- 7 Franklin A, *Aquatic environmental monitoring report*. MAFF Direct Fish Res Lowest oft, 1987 (16), 38.
- 8 Krishnamurti A J, *Studies on selected metals in marine organisms from the coastal waters of Bombay*, 1991. Ph.D thesis, Andhra University, India.