

## Uptake and bioconcentration of copper and zinc by the molluscs *Saccostrea cucullata* (Born) and *Cerithium rubus* (Desh) from the coastal waters of Bombay

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Rate of uptake increased linearly during the initial period of 20-30 days. Compared to the gastropod, the rate of uptake in oyster was 2.2 and 9.4 times more respectively for Cu and Zn. In oysters collected from a polluted area off Bombay coast, high levels of Zn (av 4522  $\mu\text{g.g}^{-1}$  dry wt) and Cu (av 420  $\mu\text{g.g}^{-1}$  dry wt) were observed. The concentrations of these metals in the snails were low (av 216 and 126  $\mu\text{g.g}^{-1}$  dry wt respectively).

The importance of bivalve molluscs as potential indicators of metal pollution has been well documented<sup>1-4</sup>. The concentration of metals in the soft tissue or particular organ has been generally considered as a relative measure of ambient concentrations because of the ability of these organisms to accumulate pollutants several orders of magnitude higher than the surrounding medium<sup>4,5</sup>. Despite the extensive literature available on the accumulation and uptake of metals in many species of molluscs<sup>6-10</sup> little is known on the rate of uptake of metals by molluscs *Saccostrea cucullata* (Born) and *Cerithium rubus* (Desh). The present communication deals with a comparative account of the rate of uptake of Cu and Zn by the rock oyster *S.cucullata* and gastropod *C.rubus* under laboratory conditions. The results were compared with the field data on the concentration of these metals in the respective species.

Test organisms were collected during the low tide from an uncontaminated zone off Bombay, at Mudh Island (lat. 19°9' 6"N and long. 7° 47'2"E) and specimens (75 oysters, 39-49 mm in length and 0.7-2.4 g; and 140 snails, 21 to 24 mm in length and 0.2-0.3 g) were maintained in ambient seawater and acclimatised for a week (salinity 34.5-35.5  $\times 10^{-3}$ , dissolved oxygen 6.8-7.8  $\text{mg.l}^{-1}$  and pH 7.9-8.2). Stones covered with algal growth were kept in the tanks. The algae and particles in suspension provided food for the snails and oysters. Experiments were

conducted during April-May 1982 under room temperature.

The test concentrations of Cu and Zn were selected based on the tolerance limits evaluated from 96 h LC<sub>50</sub> values. The reported permissible levels of Cu and Zn in the marine environment were 3 and 5  $\text{mg.l}^{-1}$  respectively<sup>11</sup> and these values are close to the LC<sub>50</sub> values. Molluscs were exposed to 10 and 20  $\mu\text{g.l}^{-1}$  of Cu and 50 and 100  $\mu\text{g.l}^{-1}$  of Zn for 60 days. After every 10 days, 10 oysters and 20 snails were removed from the experimental tanks as well as from the control. Experiments were carried out in duplicate. The values obtained from the control were used to measure the natural uptake through the seawater and food provided (algae and particles suspended in water) to test oysters and snails. No mortality was observed during the experimental period.

Metals in the soft tissue of organisms were estimated by wet digestion method<sup>12</sup> using atomic absorption spectrophotometer (Hilger-Watts Atomspeck, model H 1550). Blanks and standards were also treated in the same manner. A total of 3-5 samples were analysed from each lot and averages were considered. The accuracy and precision of the above analytical technique was checked by analysing reference samples of oyster MAM-1 (provided by International Laboratory of Marine Radioactivity, Monaco) and the results were in good agreement with those of IAEA<sup>13</sup>.

**Copper**—The initial concentration of Cu in the soft tissue of *S.cucullata* and *C.rubus* were respectively 200 and 129  $\mu\text{g.g}^{-1}$  dry wt. At the end of the experiment the natural accumulation in the control

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was quite low, the values being 206.5 and 129.4  $\mu\text{g.g}^{-1}$  dry wt in the respective order.

The total uptake of Cu by the oyster *S.cucullata* in test concentrations of 10 and 20  $\mu\text{g.l}^{-1}$  for a period of 60 days was respectively 155.42 and 178.18  $\mu\text{g.g}^{-1}$  dry wt (Fig. 1 A). Remarkable difference was not observed in the average accumulation of Cu in 10  $\mu\text{g.l}^{-1}$  (av 2.71  $\mu\text{g.g}^{-1}$  day $^{-1}$  dry wt) and 20  $\mu\text{g.l}^{-1}$  (av 2.97  $\mu\text{g.g}^{-1}$  day $^{-1}$  dry wt). However at lower concentration maximum uptake was during the first 20 days, whereas at higher concentration peak uptake (4.19  $\mu\text{g.g}^{-1}$ .day $^{-1}$  dry wt) was recorded during the last 20 days.

In *C.rubus* the uptake of Cu in 10  $\mu\text{g.l}^{-1}$  and 20  $\mu\text{g.l}^{-1}$  test concentrations (Fig. 1 C) was respectively 75.88  $\mu\text{g.g}^{-1}$  dry wt (av 1.265  $\mu\text{g.g}^{-1}$  dry wt) and 77.97  $\mu\text{g.g}^{-1}$  dry wt (av 1.299  $\mu\text{g.g}^{-1}$  dry wt). An upward trend in per day accumulation of Cu reaching maximum towards 20th-40th day was noticed at low concentration. At high concentration per day uptake showed an increasing trend at the initial 20 days. Thereafter the accumulation rate gradually decreased.

**Zinc**—The initial concentration of Zn in the soft tissue of *S.cucullata* and *C.rubus* was respectively 1700.12 and 168.44  $\mu\text{g.g}^{-1}$  dry wt. Natural accumulation in the control at the end was 1710.4 and 169.11  $\mu\text{g.g}^{-1}$  dry wt in the same order.

In 50  $\mu\text{g.l}^{-1}$  concentration of Zn, *S.cucullata* accumulated 1006.84  $\mu\text{g.g}^{-1}$  dry wt of Zn in 60 days (Fig. 1B) giving a per day accumulation of 16.78  $\mu\text{g.g}^{-1}$  dry wt. Total accumulation of Zn in 100  $\mu\text{g.l}^{-1}$  concentration was 1044.76  $\mu\text{g.g}^{-1}$  (av 17.41  $\mu\text{g.g}^{-1}$  day $^{-1}$ ). By the end of the experimental period the oyster accumulated higher concentration at 100  $\mu\text{g.l}^{-1}$  test concentration than that kept at 50  $\mu\text{g.l}^{-1}$  concentration.

In *C.rubus* the total accumulation of Zn at 50 and 100  $\mu\text{g.l}^{-1}$  concentrations was found respectively as 99.13 and 118.79  $\mu\text{g.g}^{-1}$  dry wt (Fig. 1D) with the corresponding averages of 1.652 and 1.98  $\mu\text{g.g}^{-1}$  dry wt. Per day accumulation was high during the initial 20 days at low concentration whereas at 100  $\mu\text{g.l}^{-1}$  concentration though there was an increase in per day accumulation during the initial period maximum accumulation was noticed towards the end of the experimental period.

In general, the trend in uptake of Cu by oyster and snails indicated an increasing trend during the initial period (20-30 days) and later the values showed a decreasing or fluctuating trend. For Zn at 100  $\mu\text{g.l}^{-1}$  concentration both snails and oysters indicated steady increase in uptake rate. However, at 50  $\mu\text{g.l}^{-1}$  concentration there was initial increase for the first

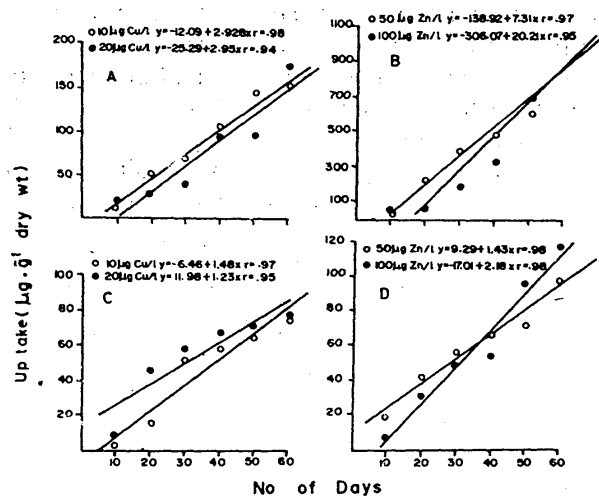


Fig. 1—Uptake of copper (A), zinc (B) in *S.cucullata* and *C.rubus* (C-D) at different concentrations in relation to time

half of the experimental period followed by a decreasing trend. Regression analyses of Cu and Zn in relation to time indicate a linear relationship in both the species (Fig. 1) and similar observations were also reported<sup>6,14</sup> while absence of such a correlation for Zn has been reported by Chan<sup>9</sup>.

Uptake of metals also depends on the food habits of the test species. *C.rubus* is a herbivore while *S.cucullata* is a filter feeder and this appears to be directly influencing the uptake rate. Concomitantly enhanced uptake rate was observed in oysters than the snails. For Cu the uptake rate is 2-2.3 times more in *S.cucullata* compared to *C.rubus* while for Zn uptake increased by a factor of 8.8 to 10.

The uptake rate for Cu in 20  $\mu\text{g.l}^{-1}$  concentration was higher by 0.38 and 0.034  $\mu\text{g.g}^{-1}$ .day $^{-1}$  dry wt for *S.cucullata* and *C.rubus* respectively than the lower concentration of 10  $\mu\text{g.l}^{-1}$ . Similarly for Zn the enhanced uptake rates at 100  $\mu\text{g.l}^{-1}$  concentration compared to 50  $\mu\text{g.l}^{-1}$  concentration for *S.cucullata* and *C.rubus* were respectively 0.629 and 0.328  $\mu\text{g.g}^{-1}$ .day $^{-1}$  dry wt. However, increase in uptake rate was not proportional to the increase in concentration suggesting higher accumulation of metals at lower concentration of the medium. Test on analysis of variance between the accumulation of Zn in *S.cucullata* and *C.rubus* indicated significant difference ( $F 13.52$ ,  $P > 0.001$ ,  $df 122$ ). Between metals Zn accumulation was very high in *S.cucullata* ( $F 11.61$ ,  $P > 0.001$ ,  $df 122$ ).

**Concentration in field samples**—Levels of Cu were higher in *S.cucullata* during April than March and May (Table 1). Difference in the concentration of Cu between male and female did not indicate significant difference in both the species. Irrespective of sex the

average values in *S. cucullata* and *C. rubus* were respectively 420 and 126  $\mu\text{g.g}^{-1}$  dry wt.

Zn content was high in oyster, and difference in concentration between male and female was limited. The average concentration in oysters was 4522  $\mu\text{g.g}^{-1}$  dry wt. In *C. rubus* also sexwise difference in the concentration of Zn was not seen and the average concentration was 216  $\mu\text{g.g}^{-1}$  dry wt.

Concentration of Cu and Zn in other oyster species reported earlier<sup>15-17</sup> is given in Table 2. It would appear that the high levels of Zn in oysters suggests that the area under study is affected by pollution. Minor difference in trace metal concentration observed in male and female agrees with the earlier observation of Latouche & Mix<sup>18</sup>. The magnitude of accumulation of Zn in molluscs supports its importance as indicator of marine pollution. The accumulation of Cu and Zn in *S. cucullata* was 3.3 and 21 times higher respectively than that observed in *C. rubus* and this tendency was in accordance with the results of the laboratory experiment.

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Table 1—Mean concentration of Cu and Zn ( $\mu\text{g.g}^{-1}$  dry wt) in *Saccostrea cucullata* and *Cerithium rubus* from Bombay coast

Month	<i>S. cucullata</i>		<i>C. rubus</i>	
	Male	Female	Male	Female
Copper				
March '82	373±11	260±8	102±3	157±5
April	653±20	605±18	118±3	123±4
May	304±90	327±10	130±4	126±4
Zinc				
March '82	5003±250	4903±245	227±7	252±8
April	4919±236	5100±255	215±6	201±6
May	3194±144	4015±193	198±6	206±6

Table 2—Concentration of Cu and Zn ( $\mu\text{g.g}^{-1}$  dry wt) in other oyster species

Species	Cu	Zn	Source
<i>Crassostrea madrasensis</i>	70-205	—	Sankaranarayanan et al. <sup>15</sup>
<i>Crassostrea glomerata</i>	4.4-380	97-900 (unpolluted) 9000 (polluted)	Greig et al. <sup>16</sup>
<i>Crassostrea gryphoides</i>	—	171-403	Bhat et al. <sup>17</sup>
<i>Saccostrea cucullata</i>	420	4522	Present study