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Copper Toxicity to an Estuarine Clam (*Meretrix casta*)

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Although heavy metals occur naturally in the aquatic environment as a result of weathering and land drainage, in recent years, the usage of various heavy metal containing pesticides and fungicides has added large quantities of heavy metals such as copper to the aquatic environment. The use of copper in jewellery, copperware, antifouling paints and in a variety of other human devices has also contributed a large amount of this pollutant. Excessive additions of heavy metals to the aquatic environment could have an adverse effect both on the animals and on men who eat these animals as food. There are a number of reports on the toxicity of heavy metals to aquatic animals (CALABRESE et al. 1977), but they have dealt primarily with freshwater species and mostly fish. There are few reports on pathological symptoms in aquatic molluscs due to pollutants. The present study reports on the toxic action of the heavy metal copper on the bivalve mollusc Meretrix casta Deshayes and the copper-induced abnormality.

MATERIALS AND METHODS

The bivalves M.casta were collected from the Vellar estuary at Portonovo, S.India (Lat. 11° 29' N; Long. 72° 49' E) and were kept in 25±1‰ salinity glass-filtered estuarine water. They were acclimated for a week at 27±0.5°C and were fed, twice daily, with mixed plankton collected from the estuary. Static bioassay experiments were conducted to estimate the median lethal concentration (LC50) for 96 hour period. A series of 35 l capacity fiber glass tanks were used in the experiments. Estuarine water of 25±1‰ salinity was filtered through glass fiber filters and used as the experimental medium. Copper was added as cupric sulphate ($CuSO_4.5H_2O$) and the water was thoroughly mixed. Before being subjected to the experiments the animals were deprived of food for 24 hours. Ten animals were released in each tank. No aerators were used to avoid any alteration of the form of heavy metal added (SPRAGUE 1973). The medium was changed every 24 hours. The oxygen content of the water, pH, temperature and salinity were monitored.

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TABLE 1

Experimental conditions and copper concentrations found in the bivalves after the experiment

Copper concentration in ppm	Shell length in mm ± S.D	Temperature °C ± S.D	pH ± S.D	Oxygen ml/l ± S.D	Salinity ‰ ± S.D	Copper accumulation ppm ± S.D
Control	35 ± 3	27 ± 0.5	8±0.1	5.2±0.3	25±0.7	11.3 ± 0.6
0.20	33 ± 4	27 ± 0.5	8±0.1	5.0±0.3	25±0.6	
0.30	38 ± 5	27 ± 0.4	8±0.1	5.0±0.4	25±0.5	
0.40	35 ± 3	27 ± 0.5	8±0.2	5.1±0.4	25±0.9	1005 ± 58
0.60	34 ± 3	27 ± 0.5	8±0.1	5.1±0.3	25±0.8	
1.50	40 ± 5	27 ± 0.3	8±0.2	5.1±0.2	25±0.7	
No. of samples analysed for S.D	10	8	8	8	8	6

Note:- S.D = Standard deviation.

Mortality was recorded at every 3 hour intervals for the first 12 hours and subsequently at 6 hour intervals for at least 96 hours and as long as 50% mortality was recorded in all the dose levels to calculate the median lethal times (LT50). The LC50 was estimated by FINNEY's (1971) probit analysis using a APL program of the University of Guelph computer. The LT50 values were calculated by LITCHFIELD's (1949) method.

The animals killed in the experiments were collected, gently washed with de-ionised water after removing the shells and dried at 110°C. The animals remaining in the tanks after the experimental period were opened and studied for coagulation of mucus over the gills. All the animals were dried and analysed for copper (ALLEN et al. 1974) using a Varian Techtron AA-120 Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The data on the experimental conditions monitored throughout the study period are given in Table 1. The background concentration of copper in the estuarine water was 10 - 15 ppb which was also included in calculating the LC50 value. The 96 hr LC50 value for Meretrix casta was found to be 0.57 ppm. The median lethal times calculated for the exposures in different concentrations are given in Table 2.

TABLE 2

Median lethal times for Meretrix casta exposed to copper

Copper concentration in ppm	LT50 value in hours (with 95% confidence limits)
0.20	158 (135, 184)
0.30	112 (97, 129)
0.40	97 (83, 113)
0.60	88 (76, 103)
1.50	80 (70, 93)

In one of the animals subjected to a concentration of 0.5 ppm for a period of one week an abnormal liquid pouch was noticed on the mantle (Fig.1). In general all the animals examined in all the experimental concentration, were sluggish with a lot of mucus coagulation on the gills. Mantle and gills had turned to yellowish green in color. The concentration of copper in the soft tissues of the control animals and those subjected to experimental concentrations of copper are given in Table 1. The metal accumulation in the exposed animals was nearly a hundred times of that found in control animals.

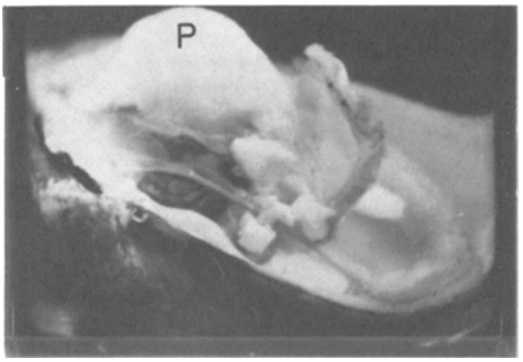

Fig.1 M.casta exposed to 0.5 ppm copper for one week. P - abnormal pouch on the mantle. x 1.3

The abnormal pouch formation on the mantle (Fig.1) in the animal subjected to 0.5 ppm copper over a period of one week indicated the toxic action of the metal on the tegument as has been suggested by MALACEA and GRUIA (1965). It was suspected that such an abnormality might have developed in some more individuals exposed to a higher concentration. However, tissue disruption caused by difficulties in opening the shell to provide an undisturbed view of the internal morphology doubtless confounded its detection in others. A vast number of phagocytes were seen in the mantle fluid, compared to control, suggesting the physiological efforts made by the animal to protect itself from the pollutant effect, which might have led to the development of abnormal pouch. Such an increase in phagocyte count has been reported earlier in oysters exposed to mercury (KUMARAGURU et al. 1978).

The 96 hr median lethal concentration of 0.57 ppm to M.casta observed in the present study is nearly 2 to 3 times greater than that observed for Mytilus edulis by SCOTT and MAJOR (1972) (0.2 ppm) and DAVENPORT (1977) (0.25 ppm). Fish are even less tolerant than these clams, e.g. 0.1 ppm for Salvelinus fontinalis (McKIM and BENOIT, 1971), 0.18 ppm for Ictalurus nebulosus (CHRISTENSEN et al. 1972). The high tolerance of bivalves to metals compared to fish could be due to their ability to withdraw their bodies into their shells, thereby reducing the penetration of the toxicant into the soft parts (CALABRESE et al. 1973). They are also relatively less active than the fish and have the capacity to accumulate large amounts of metals in their body tissues without any harm to themselves.

The LT50 values (Table 2) showed that the toxic action was rapid at the lower concentrations. The death of the animals due to the toxic action of the metal pollutant could be explained as asphyxiation caused by coagulation of mucus over the gills.

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