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TOXICITY OF HEAVY METAL MERCURY ON THE ZOEAL DEVELOPMENT OF THE ESTUARINE HERMIT CRAB *CLIBANARIUS LONGITARSUS* (DE HAAN)

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ABSTRACT

The 96 h LC_{50} value was found to be 75 ppb. The chronic influence of 8 sublethal concentrations (5, 10, 20, 30, 40, 50, 60 and 70 ppb) was studied during the zoeal development. Development was completed in all the test concentrations. The overall survival rate in control and in the lowest two test concentrations (5 and 10 ppb) was 100%. In the other test concentrations, the survival rate decreased with increase in concentration. The survival rate in 20 ppb concentration was 90% and it decreased to 25% in 70 ppb concentration. The intermoult duration in all the four zoeal stages was shorter in control and it increased with increase in test concentration. In the first zoeal stage, the intermoult duration in control was 6.40 days and it increased from 6.61 days in 5 ppb concentration to 7.71 days in 70 ppb concentration. The intermoult duration in control, 5 and 70 ppb concentration for second zoea was 3.60, 3.70 and 5.50 days, for III zoea 3.30, 3.33 and 4.22 days and for IV zoea 3.40, 4.00 and 5.55 days respectively. As the overall survival rate in all the test concentrations was above 10%, the chronic concentrations of the present study fitted in with the definition of Epifanio (1979).

INTRODUCTION

MERCURY, one of the natural elements, is always present in the environment, although there is no evidence to suggest that it is essential for any form of life (Holden, 1973). Its presence in the Vellar estuary was reported by Kumaraguru (1980) in the water, sediment and biological samples. The above finding sparked off a series of works on the influence of this heavy metal on fish and shell fish. The present study relates to the toxicity of mercury on the zoeal development of the estuarine hermit crab *Clibanarius longitarsus*.

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MATERIAL AND METHODS

The 96 h LC_{50} value was found out following the method of Ahsanullah and Arnott (1978). The only deviation was that the larvae were fed with *Artemia* nauplii during the experimental period. Source of mother crabs and test procedure followed were as given in Ajmalkhan *et al.* (1986).

RESULTS

Survival rate

The 96 h LC_{50} value was found to be 75 ppb (Fig. 1). Presently the chronic influence of mercury during zoeal development was studied in 8 concentrations (5, 10, 20, 30, 40, 50, 60 and 70 ppb).

The survival rate of *C. longitarsus* zoeal stages at different test concentrations of mercury is given in Table 1. In control, 5 and 10 ppb test concentrations, the overall survival rate was 100%. Survival rate in other test concentrations was lower than in the control and as the concentrations increased the survival rate

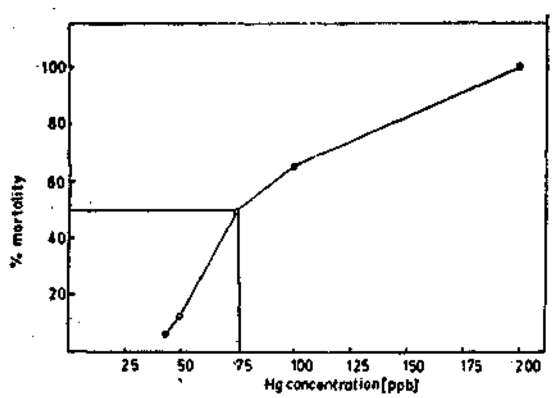

Fig. 1. 96 h LC_{50} value of mercury on I zoea of *Clibanarius longitarsus*.

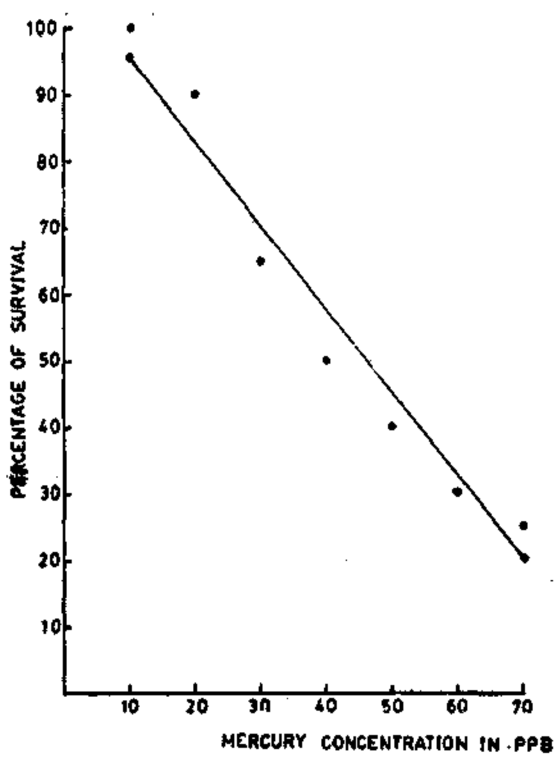

Fig. 2. Effect of mercury concentration on survival of *Clibanarius longitarsus*.

decreased (Fig. 2) and the lowest survival rate (25%) was found in 70 ppb concentrations. The correlation coefficient value for survival against test concentration was highly significant (.9841 $P<0.01$). The regression equation for survival rate in test concentration is

Y = 108.6199 + (—1.2946 × concentration of mercury) which suggests that per ppm increase in mercury the survival rate decrease by 1.2946 per cent. In 20 ppb concentration mortality occurred only in the first zoeal stage and in the other higher test concentrations, mortality occurred in the first and fourth zoeal stages. These two zoeal stages appear to be more sensitive than the rest.

Intermoult duration

The mean intermoult duration of each zoeal stage in the different test concentrations is given in Table 1.

I Zoea

As the test concentration increased, intermoult duration also increased and the correlation was found to be highly significant (.9565, $P<.001$). The regression equation for intermoult duration can be written as

Y = 6.4682 + .0148 × concentration of mercury. Analysis of variance suggested significant differences in the intermoult duration in control and different test concentrations (F 3.21, $P<.005$).

II Zoea

Correlation coefficient value (0.9419P <0.001) suggested significant increase in intermoult duration with increase in test concentration. Analysis of variance suggested significant differences in the intermoult duration in control and different test concentrations (F 14.51, $P<0.005$). The regression equation for this stage was

Y = 3.4996 + 0.0229 × concentration of mercury.

III Zoea

In keeping line with the previous two zoeal stages here also, the correlation coefficient value (0.9873 $P<0.001$) suggested significant increase in intermoult duration with increase in

TABLE 1. *Mean intermoult duration in days of zoeal stages I—IV of* Clibanarius longitarsus *(along with standard deviation and variance) exposed to different test concentrations of mercury*

Stage	Control	5 ppb	10 ppb	20 ppb	30 ppb	40 ppb	50 ppb	60 ppb	70 ppb
I Zoea :									
Mean ..	6.4000	6.6110	6.6923	6.8182	6.8500	7.0000	7.1500	7.1875	7.7143
SD ..	0.6806	1.2897	1.0316	1.0787	0.7452	0.9428	0.7452	0.5439	0.6112
Variance ..	0.4632	1.6633	1.0642	1.1636	0.5553	0.8889	0.5553	0.2958	0.3736
Cumulative survival rate in percentage	100	100	100	90	80	70	65	55	50
II Zoea :									
Mean ..	3.6000	3.7000	3.8571	3.9375	4.0000	4.1667	4.4500	4.8000	5.5000
SD ..	0.5026	0.4830	0.3631	0.2500	0.0000	0.6183	0.6876	0.4104	1.0513
Variance ..	0.2526	0.2333	0.1319	0.0625	0.0000	0.3824	0.4727	0.1684	1.1052
Cumulative survival rate in percentage	100	100	100	90	80	70	65	55	50
III Zoea :									
Mean ..	3.3000	3.3300	3.5000	3.6429	3.8182	3.9474	4.0000	4.1500	4.2200
SD ..	0.5712	0.7071	0.5164	0.6333	0.4045	0.5243	0.4082	0.4894	0.6468
Variance ..	0.3263	0.5000	0.2667	0.4011	0.1636	0.2749	0.1667	0.2395	0.4183
Cumulative survival rate in percentage	100	100	100	90	80	70	65	55	45
IV Zoea :									
Mean ..	3.4000	4.0000	4.2000	5.1538	5.2500	5.2778	5.3000	5.3333	5.5500
SD ..	0.8433	0.3333	1.3038	0.8987	1.0351	0.4609	0.4702	1.2111	0.5104
Variance ..	0.7111	0.1111	1.6999	0.8077	1.0714	0.2124	0.2211	1.4668	0.2605
Cumulative survival rate in percentage	100	100	100	90	65	50	40	30	25

test concentration. Analysis of variance suggested significant differences in the intermoult duration in control and different test concentrations (F 6.32, $P<0.005$). The regression equation for this stage was

$Y = 3.3390 + 0.0135 \times$ concentration of mercury.

IV Zoea

The trend was as seen in the previous three zoeal stages. The correlation coefficient value was 0.8620 ($P<0.01$). Analysis of variance showed a F value of 15.06 ($P<0.005$). The regression equation for this stage was

$Y = 4.0010 + 0.0262 \times$ concentration of mercury.

Whole development

The duration required for the completion of zoeal development in control was 16.7 days. The duration increased with increase in test concentrations and in 70 ppb concentration it was 22.98 days. The correlation coefficient value (0.9782 $P<0.001$) showed significant increase in duration with increase in test concentration. The regression equation for whole development in different test concentration was

$Y = 17.31 + 0.0773 \times$ concentration of mercury.

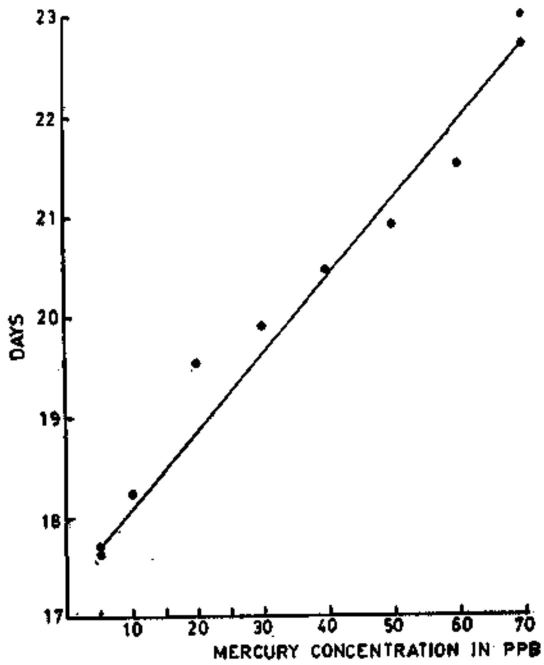

Fig. 3. Effect of mercury concentration on duration of zoeal development in *Clibanarius longitarsus*.

Discussion

Epifanio (1979) defined sublethal concentrations of pollutants. Presently as the survival rate in all the test concentrations is above 10‰ these perfectly fit in with the above definition.

Survival rate

In the present study with increase in test concentration of mercury, survival rate of larvae decreased. Similar results have been reported elsewhere. Decoursey and Vernberg (1972) studied the effect of mercury on survival of *Uca pugilator* larvae and found that the number of larvae surviving in higher concentrations of mercury was very few. Shealy and Sandifer (1975) exposed the larvae of grass shrimp *Palaemonetes vulgaris* to different concentrations of mercury for 48 hours and studied their development. They observed reduced survival to the postlarvae in high concentrations of mercury. In another study by Rosenberg and Costlow (1976) on larvae of *Callinectes sapidus* and *Rhithropanopeus harrisii*, survival of developmental stages was significantly lower in higher concentrations of cadmium.

Studies demonstrating the effect of heavy metal on larval development of decapod crustaceans are very few, but many such investigations were carried out with pesticides (Shealy and Sandifer, 1975). Such studies (Bookhout and Costlow, 1975; Bookhout *et al.*, 1972, 1976) suggested that the pollutants which were absorbed by the larvae were released into the blood stream and this caused mortality in some unknown way. Some larval stages were found to be more vulnerable than others. Megalopa was found to be more susceptible in some species (Bookhout and Costlow, 1975 ; Bookhout *et al.*, 1972, 1976) and in another species (Shealy and Sandifer, 1975), mortality was high among zoeae and megalopa. Thus different species of crabs showed sensitivity to the same pollutant at different stages of development. Moreover to compare the sensitivity of different stages, it will be better if each zoeal stage is introduced into the test medium afresh. In the present study only the overall effect of heavy metal mercury on zoeal development was studied in *C. longitarsus*.

Intermoult duration

Presently with increase in test concentration, the overall time required for the completion of zoeal development also increased. Shealy and Sandifer (1975) also reported delayed moulting and extended development time in the larvae of *Palaemonetes vulgaris* when the mercury test concentration increased. Slower moulting and longer development time observed presently is attributed to stress due to pollutants which exert an action on the mechanism which regulates morphological and moulting changes thus slower development of larvae as observed elsewhere (Bookhout *et al.*, 1972).

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