Effect of Copper and Cadmium on the Feeding Rate of Penaeid Shrimp

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Summary: In this study we demonstrate the effect of sub lethal doses of copper and cadmium on feeding rate of larvae of two species of penaeid shrimp . It was found that feeding rate affected at metal doses lower than those affecting the survival of the shrimp larvae. The 24h Lc50 for Cu was I00ug/L and for Cd 200ug/L for mysis , however, for post larvae these values were 200ug/L of Cu and 259ug/L of Cd . We have tried to find the relationship of feeding rate and survival rate, that was found to be directly proportional to each other .Since in counting of algae cells (without labeling) ,there were some technical problems such natural division of algae cells ,feeding rate was only determined for mysis II,III and post larvae. At I0ug/L of Cu and 50ug/L only 50% Artemia nauplii were eaten by mysis and 80% by post larvae. Nevertheless, feeding rates of control samples (non-dosed larvae) were significantly higher than all exposed larvae even at lowest concentration of I0ug/L of Cu and Cd. Feeding rate of mysis II,III and post larvae was not similar at any same dose of Cu and Cd.

Introduction

In marine environment the synchronization of biological processes with the pollution of heavy metals under all ecological factors has been known for all marine biota. These processes also include feeding of marine organisms. [1].During last decayed studies about the responses of organisms to the sub lethal toxicant doses of pollutants become essential due to the alarming toxicity of pollutant not only for marine organisms but up to man via food chain .A commonly observed response to sub lethal toxicant doses is also decrease in feeding rate .However, there are also some physical factors affecting feeding rate such as temperature and salinity and food supply and an increase in water temperature is known to accelerate the feeding rates [2]. Theoretically, feeding rate together with rates of survival can be an important parameter controlling population size of a species in ocean . For the study of toxicity of heavy metal via uptake of metals to marine organisms, among all other routes food is one of the major route can be correlate with the feeding rate of marine organisms. For example a level of 500 mg Cd/kg (wet weight) have been reported in digestive gland from American lobster (*Homarus americanus*).[3].

It assumed to be important to know the feeding and survival responses of early -staged juveniles shrimps under the exposed experimental

conditions of Cu and Cd to understand the exact growth and development rate of all marine organisms. Many investigators [3-4] have demonstrated that chronic exposure to pollutants have the potential to reduce the intrinsic rate of population growth (r) of crustacean due to developmental delay.

In the present study, we simultaneously investigated the survival of the two species of penaeid shrimp at their early larval stage and effect of Cu and Cd on their feeding rate. The present study was part of a larger investigation of all physiological consequences of heavy metals on the shrimp larvae.

Results and Discussion

The percentage ratio of uneaten Artemia nauplii has shown in table I and II for *Penaeus monodon* and *Penaeus penicillatus* respectively .In beginning some experiments were conducted for feeding rate experiments for the stages of nauplii till Z III was also conducted but later on due to technical problems like either fresh was not available or algae cells were found to be broken and natural multiplication of cells, there was a confusion about all those results, therefore those results are not reported. Here results are given only mysis II, III and post larvae in relation to their survival .Analysis of variance was used to determine significant of treatment differences in these experiments .Estimated 20-24h LC_{50} values were found to be 50 Ug/L for Cu and for Cd was I00 ug/L showing post larvae was less sensitive to Cd than mysis .Feeding rate was suppressed by sub lethal concentrations of metals (Fig I and 2).Significantly the feeding rates of mysis II and M III was not different in *P.monodon* (fig. 1) on exposed concentration up to I0 ug/L .The same observation were found for five separate experiment of *P.monodon* .However, feeding rate on dosed at I00 ug/L of Cu and Cd did decrease significantly between exposed concentration and survival was significantly proportional ,However, the relationship between exposed concentration and feeding rate was found both directly and inversely proportional to feeding rate . As number of larvae dead under highest exposed concentration of Cu and Cd i.e 400 ug/L with in 2h the number of uneaten Artemia nauplii was found more than it was counted at I0 ug/L of both metals. Fewer Artemia nauplii in (P 0.0I) in exposed concentration of 200 ug/L were counted after I0h as compared to nauplii exposed to 0 and I0 ug/L of Cu and Cd. These high concentration reduced feeding rate with in 5h of exposure in contrast, at the lowest Cd exposure (I0 ug/L) feeding rate was not reduced until I2h. In fact, the differences in feeding rates exhibited for mysis II,III and postlarvae tested on different differences among doses. After completion of experiments there were many molting abnormalities observed in fed Artemia nauplii. These abnormalities consisted on broken parts of their body of leftover Artemia nauplii which were not counted during feeding rate calculation.

Table.1 *P.monodon*. Average percentage of survived larvae after 20-24h expose to variation measured concentration of Cu and Cd.

Conc. ug/L	Stages		
	Mysis I	Mysis II	Post larvae
Copper			
10	93	94	96
50	80	80	87
I00	70	7I	80
200	40	42	5
400	2	3	5
Cadmium			
10	94	95	97
50	80	82	88
I00	7I	73	82
200	45	48	54
400	3	3	7

Table.2 *P.penicillatus*. Average percentage of survived larvae after 20-24h expose to variation measured concentration of Cu and Cd.

Conc. ug/L	Stages		
	Mysis I	Mysis II	Postlarvae
Copper	9I	93	95
I0			
50	8I	79	85
I00	72	73	8I
200	39	40	48
400	3	4	6
Cadmium	92	94	95
I0			
50	78	8I	87
I00	69	70	80
200	43	45	50
400	4	4	8

There are various physiological consequences of heavy metals on penaeid shrimp have been known but little attention has been paid to the possible effect of heavy metals on the feeding rate of shrimp. During present study the feeding rate of shrimp larvae was altered by Cu and Cd at doses below those causing mortality (table I and 2).however, there was no notable change was observed after 5-20h exposed to I0ug/L Cu and Cd. This concentration also caused no mortality during I0-I5h .But, as concentration also

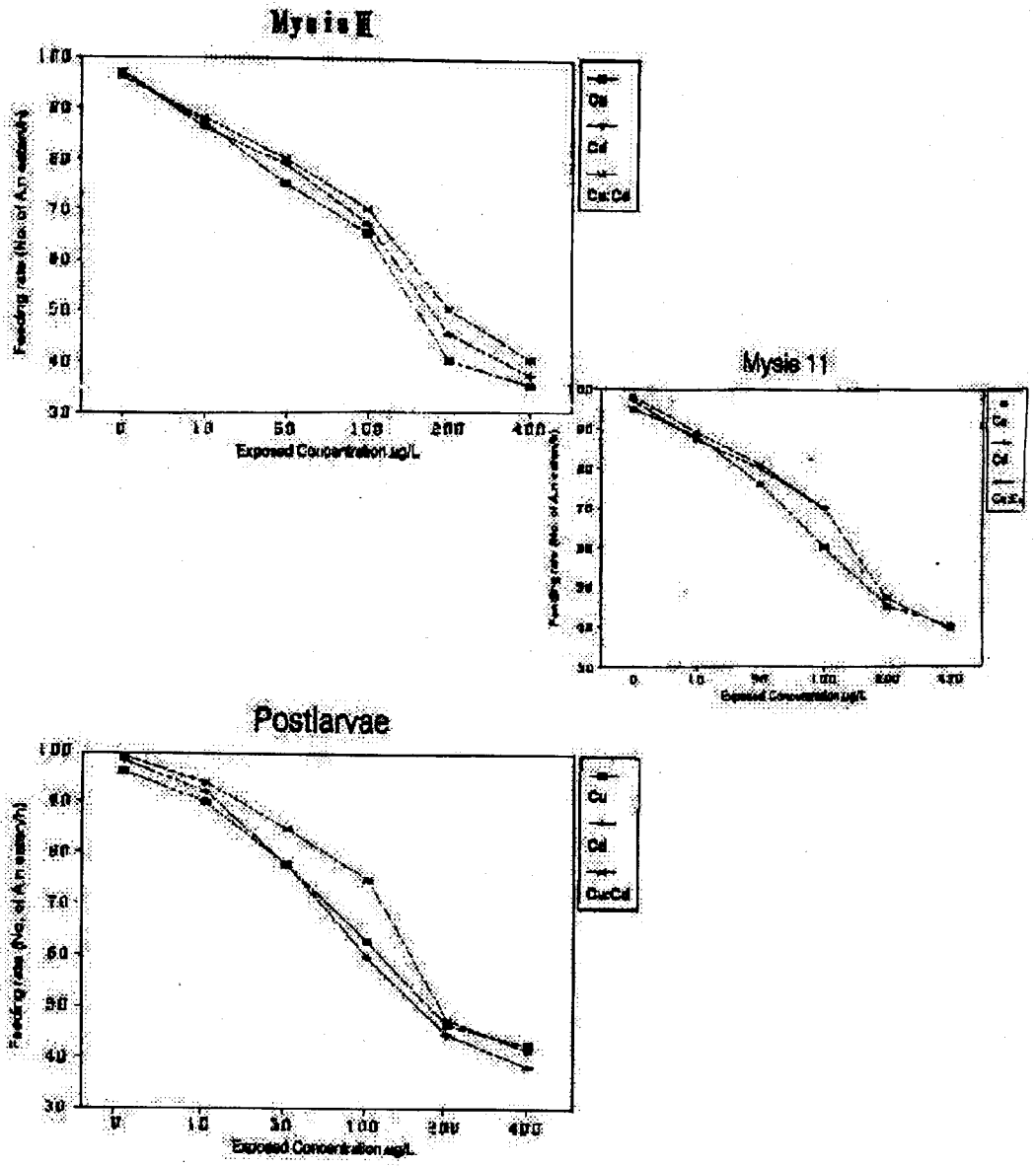

Fig. 1 Mean feding rate (± SD) of *P. monodon* larves exposed to various concentrations of copper and cadmium as well as mixture for 20-24h.

increased feeding rate decreased without any direct relationship with survival .In general, feeding rate also depends upon food density ,regardless of time of day and experimental conditions [5]. Therefore, during this study sufficient amount were supplied in each beaker, therefore mortality due to starvation or reduction in feeding rate could not correlate to the decrease in feeding due to pollutant effects.

The mechanism which caused decreased in feeding rate of shrimp can not be explained clearly that weather it is due to high amount of exposed metals was accumulated in Artemia nauplii or due to permeability of these metals directly from media to their body causing irritation towards feed or lack of hunger of larvae. However, the survival decrease as concentration of metals increased have been

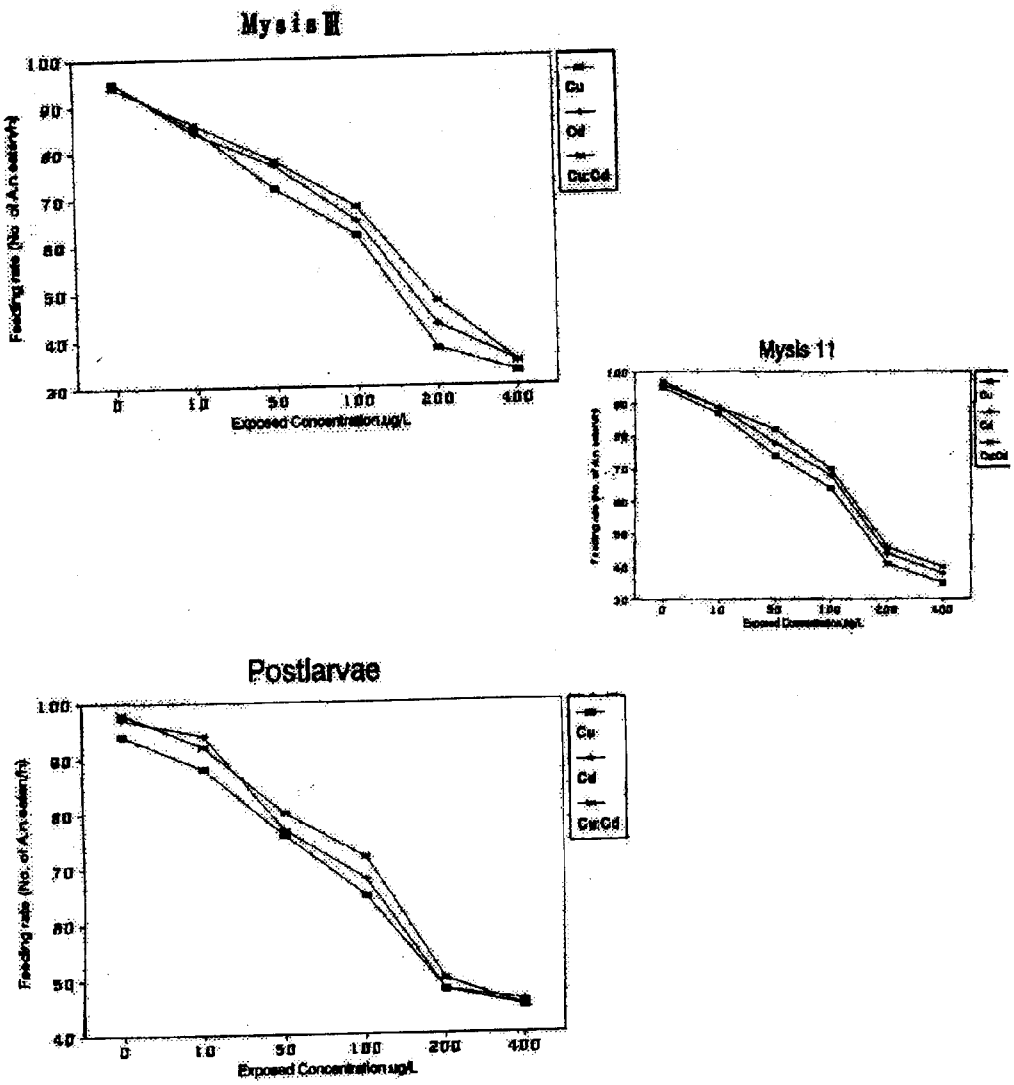

Fig. 1 Mean feding rate (± SD) of *P. penicillatus* larves exposed to various concentrations of copper and cadmium as well as mixture for 20-24h

confirmed the accumulation of metals directly from media these metals may or may not regulated shrimp larvae as many authors have reported that Cd in not regulated by decapod crustacean. [6-7]. Caused Cd were also exposed in their I:I mixture because there is some degree of biological control of the intake of both metals in lobsters either through a detoxification mechanism or metal-metal interaction [8].

We found feeding rate, very important factor for development to be most useful variable for detecting the effect of Cu and Cd on penaeid larvae. There have been few studies on the effects of sub lethal heavy metals on feeding rate of shrimp larvae. However, metals do retard growth of other marine crustacean [9]. At level below the LC 50 confirmed by present study .The decrease of feeding rate of larvae along with increased concentration of Cu and Cd confirmed the toxicity of Cu and Cd for marine plankton as stated by many authors [10-11]. The mean rate of the protozoea -zoeal stages Dunaliella tertiolecta Butcher of pelagic shrimp was 805

cals/individual/h and the mean assimilation was I0.1% of calories ingested .The feeding rate of adults Lucifer ingested about 42 Artemia nauplii per day, the mean assimilation was 22% of Artemia calories ingested and the postlarval stages of Sergia Lucens ingested I9-70 Artemia nauplii approximately 3-45% of its own weight per day. [12].These values were provided a good comparison between exposed larvae and control sample. In control the mean feeding rate was observed approximately 12-35 Artemia nauplii per day for mysis and I6-55 for postlarvae. In samples exposed at 400 ug/L these values were reduced up to 25% for one hour and for Cd was 30%. In this concentration mortality rate was found to be 88% and at the end of experiments a big number of Artemia nauplii were present due to high rate of mortality. Our study on feeding rate highlights a pollutant effect, which has been till now little considerable, yet needs extensive work. It was concluded that Cu and Cd had significant effect on feeding rate and increased mortality due to increased exposed metal concentration caused a considerable effect on feeding rate .it is evident from this study feeding is not also only sensitive indicator of pollutant stress but also including among parameters of ecological significance potentially having profound implications at other marine organisms populations in ocean

Experimental

These experiments were completed for mysis II, III and post larvae up to stage of V .All specimen were obtained from a hatchery plant of Xiamen University and then exposed to different concentration of Cu, Cd and 1:1 mixture of both metals. In the laboratory, few experiments were also done for Z I, II, III and mysis I by feeding algae especially *Sargassum fallax* and *skeletonema costataum* and then tended gradually to be omnivorous after the zoea 1 stage when ate Artemia nauplii [13]. All Artemia sp. raised on algal diets when fed to Penaeus monodon Post larvae ,resulted in better prawn survival and prawn body weight .[14]. Undoubtedly, the penaeids have to feed on phytoplankton in certain periods of the early larval stages and presumably this behavior relates to the adults vertical distribution which is shallower. In each beaker of all experiments approximately 200-300 Artemia nauplii were supplied for 20 prost larvae and 40 mysis.

The number of feed particle was determined by counting the number of algal cells per unit volume of sample sea water microscopically using a haemocytometer, whose bottom surface was marked with 5 or I0 mm grid. Number of Artemia nauplii was counting visually by taking one drop from the culture chamber on a white plastic plate with help of a bulb on the back. After completion of feeding experiments all uneaten Artemia were removed with a small scoop net and then counted on separately either same way or by using a microscope .The feeding rate was calculated by observed decrease in the amount of food in container with grazer relative to that in control containers without grazer during the experiment.

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