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BEHAVIOURAL CHANGES OF FRESH WATER BIVALVE MOLLUSCS *LAMELLIDENS MARGINALIS* DUE TO ACUTE TOXICITY OF CADMIUM

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ABSTRACT
Present study includes the behavioral changes of fresh water bivalve *Lamellidens marginalis* due to acute toxicity of cadmium. The behavioral changes were more pronounced in summer and winter than in monsoon. The study revealed that the mussels are more sensitive to cadmium toxicity in summer, while they are more resonated in winter.

KEY WORDS: Behavior, Bivalve, *Lamellidens marginalis,* Cadmium

INTRODUCTION

Toxicity is known to the behavior of animals when exposed to toxic levels. The effects have been found to be multifarious and known to differ at different concentrations, viz. Pesticide intoxication may induce ineffective feeding of fish (Grant and Mehrle, 1970) and they may induce maladaptive behavior which is caused by abnormal neurophysical functions (Odum et. al., 1969). Pesticides may also effect locomotor orientation (Rand et. al., 1975) or may affect several of the behavioral expressions of the animals (Farr, 1977). Behavioral assessment of heavy metal on freshwater crab was observed by Mohd Iliyas (2012). The effect of environmental parameter is an important aspect of every animal. Measurements of physiological parameters involve the respiration metabolism, biochemical diversion feeding, excretion and behavior. Behavior affects the survival of aquatic invertebrate and reflects the integration of many biochemical and physiological processes. Therefore in the present study behavior is an important area of examine when investigating the effect of toxicants on aquatic invertebrates.

MATERIALS AND METHODS

The freshwater bivalve molluscs *Lamellidens marginalis* (90–100mm in shell length) were collected from Kutluq Lake, Daulatabad, near Aurangabad (M.S.) India. After collection of the animals from habitat they were brought to the laboratory and immediately, the fouling biomass and mud on shell valves were removed without disturbing the siphonal regions. The equal sized bivalves (shell-length) were grouped and kept in sufficient quantity of water (animal / liter) in aquaria with aeration for 24hrs to adjust the animal to laboratory conditions (with renewal of water at interval 12 to 13 hrs). No food was given this time and during experiments. After 24 hrs 10 bivalves were exposed to different test concentrations of cadmium and observed the observation of bivalves under the stress condition of cadmium.

RESULTS

The bivalve *L. marginalis* exposed to different tests concentrations of cadmium in different seasons shows differential responses in behavioral pattern compared to control animals and these patterns are categorized in following conditions. The bivalve from control group though closed the shell valves at the time of immersion in water upon the valve and protruded siphons for all the time during the experimental period. Frequently extension of siphons and foot out of the valves occurred. Continuous circulation / filtration of water took place through visceral body. The excreta or feaces with little mucous appeared all the time in this group of aquarium. Conditions of bivalve species in cadmium are defined as follow:

A. The bivalve remained with shell valves tightly closed with a lapse of time according to the test concentrations, shell valves slightly opened to promote the pallial edges.
B. The bivalve opened the shell valves and protruded the foot, two pallial edges and siphons outside the shell valves. Excreta and mucous occurred.
C. The bivalves opened the shell valves and extended the swollen outside the shell valves gentle mechanical stimulus made these bivalves to retract foot quickly and closed the valves with retraction of mantle edges and siphons.
D. The valves widely opened the shell valves and extended the swollen foot, two pallial edges and siphons outside the valves. Gentle stimulus made these bivalve to retract the foot slowly and partially closed the valves.
E. Even the bivalves died, the shell valves remained widely opened with swollen foot outside the valve and the bivalve did not respond to mechanical stimulus.

In summer, the bivalves were exposed to different test concentrations from 1.5 to 6 ppm at an interval of 0.5 ppm for determination of Lc0 and Lc50 values. At 12 hr from 1.5 to 3.0 ppm the bivalves were in condition A whereas 3.5 ppm to 6 ppm most of them in condition A and few are in condition B at 24 hr the most of the bivalves in all the test concentrations opened the shell valve and protruded the foot and pallial edges conditions B. At 36 hr most of the bivalves in all test concentrations also showed condition B. At 48 hr they show condition C and few were in conditions B, D and E were also observed in a few bivalves in 5 to 6 ppm. At 60 hr most of the bivalve showed condition C and a few from 5.5 to 6 ppm also showed conditions D and E. At 72 hr from 1.5 ppm to 3.0 ppm many bivalve showed conditions C, D and E. At 84 the bivalves from 1.5 to 2.0 ppm remained in conditions B and C whereas from 2.5 to 5.5 ppm conditions C, D and E were noticed. In 6 ppm conditions D and E were noticed. At 96 hr in 1.5 ppm conditions B and C were noticed where as in 2 ppm conditions C, D and E were noticed and from 2.5 to 5.5 ppm conditions C, D and E were noticed. Much mucous was secreted in test condition between 4.0 to 6 ppm from 60 hr, 2 ppm and 4 ppm from 72 hr and 1.5 from 84 hr. Amount of excreta decreased with lapse of time, in higher test concentrations from 60 hr onwards in 3.0 ppm from 72 hr in 2.00 ppm and from 84 hr in 1.5 ppm.

In monsoon the bivalves were exposed to the different concentrations from 5 to 14 ppm at an interval of 1 ppm. Most of the remained closed (A) from 12 hr in higher test concentrations from 9 to 14 ppm. In lower test concentrations from 5 to 8 ppm. The bivalve also showed condition B. At 24 hr the bivalves from all the test concentrations showed condition B and C. At 36 hr the bivalve from 5 to 7 ppm B and C conditions, whereas from 8 to 10 ppm conditions C was noticed. From 11 to 14 ppm conditions C and D were observed. At 84 hr 5 and 6 ppm showed conditions B, from 7 to 10 ppm they showed conditions B, C and D. Where as in 11 to 13 ppm they showed conditions C and D, E was also recorded in 14 ppm. At 60 hr from 5 to 7 ppm the bivalve showed conditions A and B. Condition C was also noticed in 8.0 ppm. In 9.0 and 10 ppm they showed conditions B, C and D, whereas from 11 to 14 ppm conditions C, D and E were noticed. At 72 hr conditions D dominated and condition E was noticed, from 8.0 ppm onwards. At 84 hr from 5 to 8 ppm conditions C and D were recorded, whereas from 9.0 ppm onwards survivors showed conditions D. Condition E occurred from 7.0 ppm onwards. Much mucus was secreted between 10 to 14 ppm from 96 hr between 7.0 to 9.0 ppm from 60 hr and between 5.0 and 6.0 ppm from 72 hr. The amount of excreta decreased with lapse of time i.e. from 36 hr in 12.0 and 14.0 ppm from 48 hr in 11.0 ppm and from 60 hr in all the test concentrations. It was absent from 60 hr in 14.0 ppm, from 72 hr in 13 ppm from 84 hr in 12.0 ppm and at 96 hr in 11.0 ppm.

In winter, the bivalves were exposed to 10 different test concentrations from 8 to 17 ppm at an interval of 1.0 ppm. At 12 hr most of the bivalves closed the shell valve condition A, however a few showed condition D in all the best test concentrations, particularly from 8 to 12 ppm. From 8.0 to 10.0 ppm showed condition A and B, whereas from 11.0 ppm showed condition B and C were observed. At 36 hr in 8.00 ppm conditions A and B noticed, while from 9.00 ppm onwards B and C occurred. Condition D also occurred from 13.0 ppm onwards. Conditions C and D were observed in all test concentrations at 48 hr, mostly from 12.0 ppm onwards. At both condition C persisted in most of the bivalves, particularly from 8.0 to 12.0 and D persisted particularly from 13.0 ppm onwards. Condition E occurred in 16.0 ppm and 17.0 ppm in a few bivalves. At 72 hr, the most of the bivalves showed conditions C and D in all test concentrations and condition E was noticed from 12.00 ppm onwards. At 84 hr condition C and D were recorded, particularly condition C in 8.0 and 9.0 and condition D from 10.0 ppm onwards. Condition E occurred from 11.0 ppm onwards. At 96 hr conditions C and D were recorded between 7.0 and 9.0 ppm, whereas from 10.0 ppm onwards condition D was noticed. Condition E was recorded from 9.0 ppm. Much mucous was secreted between 15 ppm from 24 hr, in 14.0 ppm from 36 hr, in 12.0 ppm and 13.0 ppm in 11.0 ppm from 48 hr, in 10.0 ppm from 60 hr and in 8.0 and 9.0 ppm from 84 hr. The amount of excreta decreased with lapse of time, i.e. between 10.0 and 13.0 ppm and from 60 hr in 8.0 and 9.0 ppm. It was absent from 48 hr between 14.0 ppm and 17.0 ppm, from 60 hr in 12.0 ppm, from 72 hr in 13.0 ppm from 84 hr in 11.0 ppm and 96 hr in 10.0 ppm.

DISCUSSION

In the present study however, the values obtained fresh water bivalve molluscs *Lamellidens marginalis* from Lc0 and Lc50 during 96 h are for greater the above values. The difference in susceptibility of the same species cadmium is mainly accounted for the lentic environment is Daulatabad fort swamp because it has been reported that the bivalve species living in lentic environment are comparatively more adapted to the resistance to capacity polluting substances than those living in lotic environment the study of animal behavior may provide a sensitive method for establishing acute and sub-acute toxic concentrations of various polluting substances in aquatic medium, since behavior is an integrated expression of diversity of biochemical and or physical processes behavior disabilities have been shown to rise from exposure to pollutants at concentrations well below lethal concentrations (Weirand Hine, 1970; Anderson, 1971; Cooke, 1971) by activity, reproduction and behavior etc.

Previous investigations (Lossanoff, 1939; Barnes, 1955) emphasized that the activity of certain mussel species, least ways under special laboratory conditions, can be interpreted for a relative time as continuous from 2 to 3 hours till 15 –

20 hrs, namely the closed the mussels get from time to time for a period of some hours into certain degree of toxic concentration and value closed tightly. Thus, the animal is more or less separated from the surrounding water and with respect to its valve movement it is in complete rest. Salanki and Lukacsovics (1967) stated that partially and rhythmic valve movement in freshwater bivalves, including the quick closure and opening of the valves may cause increased water passage, partly for the time of rest period when the valves are tightly closed for hours supposedly there is water passing through the gills correspondingly also filtration stops. It is thus obvious that the effect of certain factor influencing filtration activity (temperature, pollution) cannot be interpreted as affecting only the activity of cilia but it can be an essentially important factor related to the behavior. In the present study, the control animals could show immediate shell valve opening after immersion in water and the behavior reactions of *L. marginalis* were rhythmic and periodic with extrusion of mucus and excreta is almost equal quantity throughout the experimental period. On the other hand *L. marginalis* exposed to cadmium tightly closed the shell-valves for about first 12 hrs and during the later period no quick closure of the shell valves occurred particularly in high concentrations of cadmium like Lc50 in different seasons. In the present study, it is further observed that animals became active after about 24 hrs exposure to cadmium Lc0 concentrations and later could open the shell-valves and extended the body parts like those in the control. After about 72 hrs due to cadmium shell-valves were exposure not being closed. The possible cause of the permanent opening of the shell-valves and loss of the ability of the adductor muscles to contract after prolonged cadmium exposure could be due to the inhibition in the activity of a calcineurin like Ca2+ regulated phosphotase. The coagulated film anoxia theory in bivalve molluscs was stated by earlier workers (Wastfall, 1945; Schweiger, 1957). The death of animals would have occurred due to (I) interfilament space stuffed and the blood circulation in the gill got affected which might ultimately have lead to heart block and subsequent death.

However, shell valves, adduction to overcome stress in ubiquitous among the bivalves (Manley, 1983). In the present study failure is normal behavior in *L. marginalis* in Lc0 test concentrations in different seasons when compared to controls probably reveals the disfunctioning in ionic regulation even when the valves are fully opened / closed. It has been observed further in the present study that *L. marginalis* exposed to different test concentrations of cadmium showed diapedesis in the form of extrusion of white coagulated matter with much mucus, particularly more in summer than monsoon. It is of interest in this view to note that this species is more sensitive to the cadmium stress in summer than monsoon season.

The physio-chemical factor of the water also plays an important role in toxicity studies. It was observed that all the species of molluscs under present study were sensitive to cadmium in summer than monsoon and winter. It is not only due to test concentrations but the high temperature and low oxygen tension altered the tolerance limits. Behavior affects the survival of aquatic organisms and reflects the integration of many biochemical and physiological processes. Studies on some aspects have been reported by Holden (1973) in case of fishes. Such behavioral studies are rarely reported in the case of bivalve molluscs (Akarte, 1985). It has been reported earlier that the clams close the shell valves when stimulated by a toxic compares or by any change in the environment (Simon, 1953). In the present study, similar was the case for first 12 hrs period of exposure to cadmium, but later on clams opened the shell valves for respiration and food intake. As the cadmium penetrated inside the body, the clams widely opened the shell valves and could not close again till the death. This probably leads to an anoxic condition (Mulley, 1985).

The behavioral changes were more pronounced in summer and winter than in monsoon. Diapedesis in the amount of excreta increased during the early period of exposure in all test concentrations and later it decreased. On the contrary, the amount of mucus showed reverse pattern. The study revealed that the mussels are more sensitive to cadmium toxicity in summer, while they are more resonated in winter. The reason for this has been attributed to the environmental promoters like decreased water level, high temperature, low oxygen content and increased hardness and alkalinity. Besides this, the lentic environment of the mussel appears to have some role in determining the summer sensitivity to the cadmium toxicity.

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