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Lead Induced Alterations in Scaphognathite Oscillations of Fresh Water Prawn, *Macrobrachium dayanum* (Crustacea—Decapoda)

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Abstract

Fresh water prawn, *Macrobrachium dayanum* were exposed to acute concentration, 116.46 mg/liter (96 h LC_{50} value) and sub-acute concentration, 29.12 mg/liter (25% of 96 h LC_{50} value) of lead nitrate to evaluate its effects on scaphognathite oscillations. Initially increase in scaphognathite oscillations were recorded while significant increase was noticed at final stage of experiments after both the exposures. Scaphognathite oscillations can be used as bio-marker to predict metal pollutions in water.
Key words : *Macrobrachium dayanum,* Scaphognathite oscillations, Lead nitrate.

Extensive industrialization and urbanization, intensive chemical use in agriculture and anthropogenic activities, increased heavy metal concentrations in the aquatic ecosystem thereby adversely affecting the flora and fauna (1, 2). Heavy metals are lethal because of their long half-life period, persistent accumulative and amplificative tendency in the food chain hence increasing the problem many folds (3). Among heavy metals, lead is a ubiquitous environmental contaminant and belongs to the group of most toxic heavy metal in the biosphere. It produces cumulative toxic effects if taken in small in small doses and acute toxicity in higher doses (4). Lead inters into water bodies from industrial mines and smelter discharges or dissolution of old lead plumbin (5—8). It is considered as non-specific poison affecting physiological systems and can cause brain and kidney damage, gastrointestinal distress and reproductive disorders (9, 10). Toxic effect of lead and other heavy metals on respiratory responses and ventilation has been mostly investigated in reference to fishes (11—14) while less documented in other invertebrates and crustaceans (15—17). Considering these points, present work was undertaken to evaluate toxic effects of lead nitrate on scaphognathite oscillations of fresh water prawn, *Macrobrachium dayanum* (Henderson), a potential animal for fresh water aquaculture.

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Methods

Fresh water prawns, *Macrobrachium dayanum* (Henderson) (18) were collected from river Gomti, Lucknow (UP), India, with the help of local fisherman and brought to the laboratory (N-26^{0}5´ 59´´ E-80^{0}56´ 17´´) in large plastic containers. The animals were maintained in glass aquaria of 20 liter capacity containing 10 liters of dechlorinated water having physico-chemical characteristics as follows : pH 7.66 ± 2.67, temperature 27.66 ± 0.66 C, DO 6.6 ± 0.74 mg/liter, total alkalinity 425 ± 11.36 mg/liter, total hardness 268 ± 2.67 mg/liter (19, 20). Proper aeration was provided with the help of aerators and air diffusers.

Stock solution of lead (II) nitrate [Pb $(NO_3)_2$, molecular weight 3331.21g/mole, AR grade, manufactured by E-Merck (India) Ltd., Worli, Mumbai] was prepared by dissolving weighed amount of salt in double distilled water. Lead nitrate was dissolved in water by adding, 0.3 ml/liter of concentrated nitric acid.

Adult inter-moult staged *M. dayanum* (average length 5.64 ± 0.42 cm, weight 3.261 ± 0.68 g) were used in experiments after 5—7 days of acclimation to laboratory conditions. Acute exposure was carried out on 96 h LC_{50} value(116.46 mg/liter) for 24, 48, 72 and 96 h while sub-acute exposure was carried out on

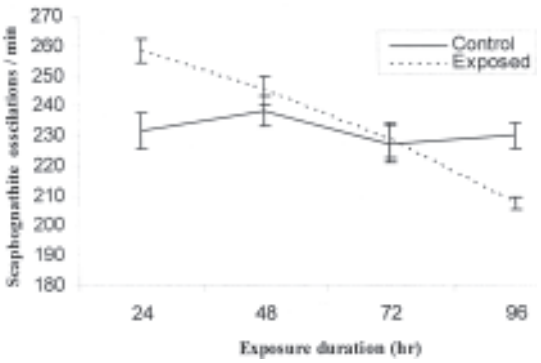

Figure 1. Effect of acute exposure of lead nitrate on scaphognathite oscillations of *M. dayanum.*

25% of 96 h LC_{50} value (29.12 mg/liter) for 10, 20 and 30 day respectively. One aquarium containing diluent water and 0.3 ml/liter conc nitric acid only, served as control for each set. Feeding was suspended 24 h before acute exposure and through out experiment while change of exposure medium and food supply was maintained on alternate dry during sub-acute exposure. Continuous air supply was provided by air diffusers and aerators in both control and experimental aquaria in both the experiments. Both acute and sub-acute experiments were carried out according to guideline of APHA et al. (20) and scaphognathite oscillations were recorded under stereoscopic dissecting binocular microscope with the help of stop watch from both control and experimental groups. All the experiments were replicated thrice and data were statistically analyzed for student *t* test and ANOVA using Minitab software on PC.

Results

Lead nitrate induced marked effects on ventilation i.e. scaphognathite oscillations during both acute and sub-acute exposures. The results of acute exposure are summarized in Figure 1 and Table 1. The scaphognathite oscillations showed highly significant ($t = 5.56$; $P < 0.0001$) increase in experimental animals (258.20 ± 4.04) than the controls (231.60 ± 6.28) after 24 h of exposure. Thereafter scaphognathite oscillations of experimental animals showed declining trend. The differences in scaphognathite oscillations of experimental and control group were insignificant ($t = 0.23$; $P > 0.5$) at 48 h of exposure. At 72 h of exposure scaphognathite oscillations of experimental groups (228.30 ± 5.98) be came almost equal to controls (227.10 ± 6.00) while after 96 h a significant ($t = 5.91$; $P < 0.001$) decline in scaphognathite oscillations of exposed prowns (207.30 ± 2.16) was noticed as compared to the controls (230.00 ± 4.27). Over all variations in scaphognathite oscillations of exposed group were highly significant ($F = 64.14$; $P < 0.0001$) while insignificant in control group ($F = 1.45$; $P > 0.01$) through out the experiment.

Table 1. Effect of acute exposure of Lead nitrate on scaphognathite oscillations of *M. dayanum.* Values are mean ± SE ; N = 10. *** Denotes difference in means to be significant at $P < 0.0001$. ** Denotes difference in means to be significant at $P < 0.001$. NS, Denotes difference in means to be insignificant at $P > 0.01$; $P > 0.05$.

Exposure duration (h)	Scaphognathite oscillations/min (mean ± SE) Control	Exposed
24	231.60 ± 6.28	258.20 ± 4.04***
48	238.30 ± 4.98	245.10 ± 4.80^{NS}
72	227.10 ± 6.00	228.30 ± 5.98^{NS}
96	230.00 ± 4.27	207.30 ± 2.16**

In sub-acute exposure an initial increase was noticed in experimental groups which were fallowed by a sharp decline. The results of sub-acute exposure are summarized in Figure 2 and Table 2. The scaphognathite oscillations significantly ($t = 11.15$; $P < 0.00001$) increased in exposed animals (261.40 ± 2.00) than in the controls (228.20 ± 2.20) after 10 days of exposure. The scaphognathite oscillations of ex-

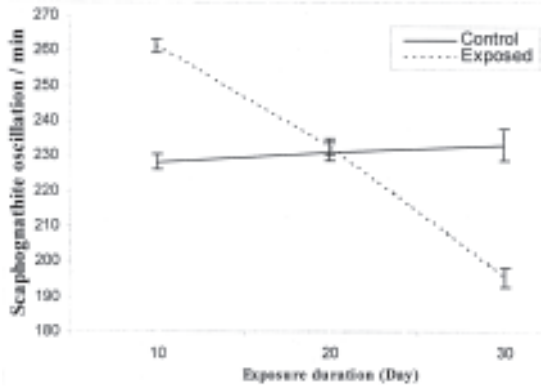

Figure 2. Effect of sub-acute exposure of lead nitrate on scaphognathite oscillations of *M. dayanum.*

Table 2. Effect of sub-acute exposure of Lead nitrate on scaphognathite oscillations of *M. dayanum.* Values are mean ± SE ; N = 10. *** Denotes difference in means to be significant at $P < 0.0001$. NS, Denotes difference in means to be insignificant at $P > 0.05$.

Exposure duration (Day)	Scaphognathite oscillations/min (mean ± SE)	
	Control	Exposed
10	228.20 ± 2.20	261.40 ± 2.00***
20	231.10 ± 2.74	232.40 ± 2.36^{NS}
30	233.00 ± 4.57	195.40 ± 2.87***

posed animals showed declining trend and be came almost equal (23240 ± 2.36) to the controls (231.10 ± 2.74) after 20 days of exposure. Thereafter a highly significant ($t = 7.04$; $P < 0.0001$) reduction in scaphognathite oscillations of exposed animals (195.40 ± 2.87) was noticed compared to the control animals (233.00 ± 4.57) after 30 days of exposure. The over all variations in scaphognathite oscillations of exposed groups were highly significant ($F = 39.36$; $P < 0.0001$) while were insignificant ($F = 23.36$; $P > 0.05$) in controls from 10 to 30 days.

Discussion

Scaphognathite or baler is exopodite of maxillae and movement of which helps in respiration by drawing freshwater current over gills (21). The results of present study revealed that scaphognathite oscillations show initial increase fallowed by significant decrease in prawns exposed to lead nitrate for both acute and sub-acute exposures. Scaphognathite oscillations in decapod crustaceans have been widely studied in reference to wide range of stimuli i.e. tactile, chemical, thermal and hypoxic rate of breathing structure (22, 23). Scaphognathite activity is also affected and influenced by various environmental conditions and toxicant or stressors present in the aquatic environment hence can be used as a sensitive biomonitoring technique for aquatic bodies (24, 25).

In present study scaphognathite oscillations shows permanent declining trend. Scaphognathite oscillations show initial increase after 24 h and 10 days fallowed by decrease at 48 h and be come near equal to control at 72 h 20 days and below control at 96 h and 30 days of exposure of lead nitrate.

Initial increase of scaphognathite oscillations may be due to avoidance reaction fallowed by hypoxia due to metal induced irritation and coagulation of mucus on gill surface. It is well known that metals precipitate mucus which forms thick coat on gill surface causing asphyxiation and prevents further entry of metals in to gills (26—28).

The decrease in scaphognathite oscillations in later stage of experiment may be due to altered carbohydrate metabolism (29) or due to alteration in muscle fibers operating scaphognathite (30). The decrease in scaphognathite oscillations may also be the result of some neurological impairment. Inhibition of acetylcholinesterase activity, an enzyme responsible for synaptic transmission, is well reported in crayfish after lead and cadmium exposure (31), may also be true for altered scaphognathite oscillations in *M. dayanum.* Almost similar alterations in ventilatory structures have been reported in fishes (11—14) and in other invertebrates (15, 16) after exposure to various metallic compounds. Recently, Sen et al. (17) reported almost similar findings in fresh water prawn, *Macrobrachium dayanum* after cadmium exposure.

In the present study scaphognathite oscillations were found to be affected in response to the lead nitrate in surrounding medium. Smaller fresh water prawns like *M. dayanum, M. lamarrei* have wide distribution throughout India. Due to their translucent colors scaphognathite oscillations can be counted without dissecting and sacrificing the animals. Therefore, these prawns can serve as good bio-monitoring tool and scaphognathite oscillations can serve as good bio-marker, particularly in response to metallic pollution like lead.

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