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EFFECT OF MERCURY ON BEHAVIOUR OF THE FRESHWATER BIVALVES *L. MARGINALIS* IN DIFFERENT TIME HOURS

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ABSTRACT
The present study includes the behavioral changes of freshwater bivalve mollusks *L. marginalis* due to acute toxicity of mercury. Different physiological and morphologically changes were observed in experimental animals it includes protective response, foot movements and its secretion, response to external stimuli, mucus secretion of gills and diapedesis. In this concept to improve that any toxicants or any molluscicide were responsible for the alternations in behavioural of animal body. From obtained results, we concluded the toxicity of mercuric chloride was responsible for the behavioral changes in freshwater bivalve mollusks *L. marginalis*.

KEYWORDS: *Lamellidens marginalis,* mercuric chloride and behavior.

INTRODUCTION

The toxicology not only protects human and the environment from the deleterious effects of toxicants, but also to facilitate the development of more selective toxicants with clinical drugs and pesticides. According to Rostein (1959), heavy metals directly affected to the tissue and may interact with cell membrane. Mollusks are therefore of interest not only to farmers and the pesticide industry but also to ecotoxicologists as monitor species for environmental pollution. They encounter toxic materials either by contact or during feeding. Generally, the animal behavior depends on the fluctuations of environmental conditions and their capacity of animal body. The behavior of an organism is defined as an act or conducts in particular way or exact way an organism responses to stimulation of environment especially those responses that can be observed (Webster's, 2002). Some biotic as well as abiotic factors play very important role to change activities and behavior of the animals. The toxicological nature of surrounding environment was assessed with the help of behavior and metabolic changes in animals. The behavioural modification in animals can be taken as the most sensitive indicators of environmental stress (Eisler, 1979). Nimghare (1992), Shaikh (1999) and Sarojini *et.al.,* (1990), studied the effect of detergents on *Kasbora daniconium* and correlated the behaviroural changes in relation to metabolic rates. The activities like opening of operculum, extension of foot and other body parts, crawling movement were minimized when animals were exposed to folithion and lebycide (Muley and Mane, 1988). Aluminium and salicylic acid in the environment have changed the behavior of *Lymnaea stagnalis* (Compbell *et.al.,* 2000). The pesticides nuvan, emthyl parathion and thimet have changed the normal behavior of Lymnaea stagnalis (Bhide, 1998), piscicidal compounds from Cestrum species (Jawale and Dama, 2010), pila globosa (Bhidem 1987). Gokhale and Mane (1990), Shaikh Yasmeen *et al.,* (2012). studied the toxicity of molluscicide in bivalves *Lamellidens marginalis*, where they documented that, after intoxication, bivalve closed their valves, immediately after exposure to molluscicide and showed diapedesis in all exposed animals after 12 hrs. with white coagulated matter of mucus. These effects can potentially give out structural and functional changes in freshwater ecosystems (Camargo, 2003). Present study is designed to investigate toxicity of mercury on behavioural responses of freshwater bivalve mollusks *L. marginalis.*

MATERIALS AND METHODS

For the present investigation, experimental animal freshwater bivalve mollusks *L. marginalis* were collected from Jaikwadi Dam, Paithan, Dist. Aurangabad, Maharashtra, India. After collection of the animals from habitat they were brought to the laboratory and immediately the fouling biomass and mud on the shell valves were removed without disturbing the siphonal regions. The equal sized bivalves (shell length) were grouped and kept in a sufficient quantity of water (animal/liter) in aquaria with aeration for 24hrs to adjust the animal to laboratory condition (with renewal of water at interval 12 to13 hrs). No food was given this time and during experiment. After 24hrs 10 bivalves were

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exposed to different test concentration of mercury and observed the observation of bivalves under the stressed condition of mercury. At the same time controlled group run up to 96 hrs by providing natural food and aeration. For the confirmation, the whole or total experiment repeated thrice. The differentiation of behavioural changes was recorded as per the intoxication and time of exposure by considering protective behavior, foot movement, mucus secretion and diapedesis.

RESULTS

Behavioural changes were recorded in the freshwater bivalve mollusks *L. marginalis* in different exposure periods at 24, 48, 72 and 96 hrs. Behavioural changes occurred due to intoxication was compared with control animals. The results were as follows:

Table 1. Normal behavior of control group of freshwater bivalve *L. marginallis*

Sr. No.	Type of Response	Behavior of Normal group of bivalve
1	Protective Response	Control group of snails showed quick response.
2	Visceral body	Continuous circulation / filtration by water took place through visceral body
3	Foot movements and its secretion	Foot movement was fast. It tightly attached to the surface with the help of foot. Secretion by foot was ample as per locomotory activity.
4	Response to external stimuli	Generally they 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.
5	Mucus secretion of gills	In control group of bivalve mucus secretion by gill was not seen

Table 2. Behaviour changes in freshwater bivalve *L. marginallis* against mercuric chloride intoxication at different exposure period

Sr. no.	Types of response	Behavior of mercury intoxication group			
		24 hrs.	**48 hrs.**	**72 hrs.**	**96 hrs.**
1	Protective behavior	Tolerate toxicity with the help of operculum	Shell-values closed	Tightly closed	Tightly closed
2	Foot movements	Foot extended initially	Movement was slowed down	Foot retracted	Foot movement not seen
3	Response to external stimuli	Initially quick response	Response to stimuli was reduced	Very poor response	No response
4	Mucus secretion of gills	Mucus secretion initiated in trough	Secretion increased in trough	Mucus secretion quantitatively increased	Thick white mucus seen in trough

1. Control group:

The bivalve *L. marginalis* exposed to different test concentrations of mercury shows differential responses in behavioral pattern compared to control animals and these patterns are categorized in following conditions. The bivalve from control group through 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 faeces with little mucus appeared all the time in this group of aquarium.

Behavioral changes due to intoxication:
When the bivalve was exposed to toxicity of mercuric chloride, body parts were expanded after 24 hrs. of exposure. The bivalve released excreta in the trough. The foot of the bivalve was highly stretched. In stressful condition the mucus secretion was more in trough. The bivalve lowered response to the external stimuli sometimes they became immovable and added white gelatinous mucus.

After 48 hrs. of intoxication, bivalve discharged more amounts of excreta into the trough. Bivalve showed very poor opened the shell valves, with less response to external stimuli. Size and shape of the foot was reduced. Mucus secretion of foot was increased. The bivalve does not give response to pin touch or vibrations. White gelatinous mucus mass was secreted over the shell. The bivalves retract their body inside the shells. After 72 hrs. of exposure the bivalve lost the protective behavior. Their opening of the shells valve and remained steady. As all the body parts were retracted into the shell, the foot movement was not observed but large amount of mucus was found in the trough. The bivalve did not show any response to any mechanical stimuli. 96 hrs. of mercuric chloride intoxication, bivalve remained in same position under toxic chemical stress. They tightly closed their shell valve and foot movements were not seen. White, thick gelatinous mucus secretion observed into the trough. The valves remained widely opened with swollen foot outside the valves and the bivalves do not respond to mechanical stimulus.

DISCUSSION
In control group of our experiment, bivalves were showed normal behavior with sample mucus secretion. But intoxication of metal and mulluscicide showed increased quantity of mucus. Animals lost the response to external stimuli. Operculum was tightly closed after 72 and 96 hrs. Similarly, hypersecretion of mucus by the mucus glands of mantle was found in bivalve *L. marginalis* due to toxicity of molluscicide and in *Pila globosa* due to intoxication of DDT (Bhide, 1987). The Mucus secretion was found higher due to mercury intoxication as that of cadmium and zinc (Devi, 1996). Nanaware and Awati (2004), recorded, increased mucus secretion in gills of snail *V. Bengalensis* due to fruit extract of *Sapindus laurifolius* and synthetic pesticides Thimet 10-G and Sodium pentachlorophenate. Intoxication of toxicants altered the normal behavior of animal including, food intake, normal locomotion, reproductive behavior etc. (Cooke, 1971). Kamble (2007) documented that, animal behavior provides information about type of contamination and its concentration in the aquatic bodies. Muley and Mane (1988), observed that the behavioural changes were influenced by the toxic compounds of mercury salts in *Viviparus bengalensis*. Similar behavioural changes were observed by Gokhale and Mane (1990), in bivalve mollusks, *Lamellidens marginalis* due to fluoride and endosulfan toxicity and due to metasystox toxicity (Muley and Mane, 1987) in clams. Devi (1996) found, very similar results when intertidal gastropod *Morulas granulate* (Duclos) exposed to mercury, cadmium and zinc. Escaping behavior was recorded in *Biomphalaria glabrata* after intoxication (Nolan et.al., 1953); the distress syndrome (Harry and Aldrich, 1963); withdrawing into the shell (Cheng and Sullivan, 1973) and the ability of the snail to avoid high doses of the product when exposed to a concentration gradient (Etges and Gilbertson, 1966).

The risk of chronic exposure to toxicants under natural condition showed higher sensitivity to several toxic compounds (Oehlmann and Schlte-Oehlmann, 2002; Valenti et.al., 2006; Duft et.al., 2007; Wang *et.al.*, 2007). In the last few years the New Zealand mud snail Potamopyrgus antipodarum (Hydrobiidae mollusca) has used in exotoxicology (Duft *et.al.*, 2003; Mazurova *et.al.*, 2008; Pedersen *et.al.*, 2009) because of its partheogenetic reproduction (Mazurova *et.al.*, 2008). Water flea found most widely used aquatic invertebrates to test fluoride toxicity (Leblance, 1980; Fieser *et.al.*, 1986; Metcalfe-Smith et.al., 2003), as it showed relatively high tolerance to acute toxicity of fluoride. Effects of fluoride on animal behavior have been found in aquatic animals as apathetic behavior, loss of equilibrium and altered migratory movements (Damkaer and Ey, 1989). However, to assess long-term consequences of fluoride on the behavior of a freshwater macro invertebrate showed that, the activity of snail was impaired by intoxication of higher fluoride concentrations. The relative importance of morphological and behavioural characteristics for controlling body temperature was estimated by using a mechanistic heat-budget model (Porter and Gates, 1969; Gates, 1980; O. Connar and Spotila, 1992; Porter and Kearney, 2009). In most of rocky intertidal gastropods they keep foot attached to the substratum to maintain position on the shore, but it comes at the

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expense of increasing conductive heat flux between the foot and a potentially hot substratum (Denny and Harley, 2006). Withdrawing the foot into shell has added benefit for allowing bivalve to close their operculum, thereby reducing water loss (Mc Mohan and Britton, 1985). Nagarajah *et. al.* (1985) noticed the behavioural changes in same intertidal mollusks after exposure to water soluble fraction of diesel. The mercury and mercurial salts changed the behavior in *M. articulate* (Saliba and Vella, 1977), and in *V. Bengalensis* (Muley and Mane, 1988), Shaikh *et al.*, (2010), observed the **e**ffect of mercuric and cadmium chloride on oxygen consumption of freshwater crab *Barytelphusa cunicularis* respectively. Akarte and Mane (1988), reported that, the bivalve molluscan when exposed to different test concentration of folithion in different seasons they showed reduced shell vale movement with mucus secretion and maximum excreta.

Literature survey indicated that, the behavior of the molluscan animals were changed due to toxic compounds including pesticides, metals, phenolic compounds and oils in the surrounding medium. *Helix aspersa* was changed due to application of some organophosphrous compounds (Rorke et.al., 1974). Muley and Mane (1988), observed such behavioural changes in snail due to toxicity of mercury salts. Thickness and quantity of voluminous mucus secretions near mouth cause the death of bivalve at 240 ppm from 72 hrs. in *V. bengalensis* due to intoxication by folithion and lebaycid (Muley and Mane, 1988). In our study we found that, in control bivalve behavioural responses to external stimuli were quick and sharp. But, concentration and exposure time has changed the response in animals. In courtship behaviour, chemical intoxication has impact on release of young once in trough. Thick and whitish mucus was more in trough. We observed that, behavior changes due to toxicity of mercuric chloride 24 hrs., 48 hrs., 72 hrs. and 96 hrs. were more or less similar but comparatively the behavioural alterations recorded due to mercuric chloride intoxication was more acute in freshwater bivalve molluscs.

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REFERENCES

Akarte S.R. and Mane U.H. (1988). Toxicity of Folithin to three freshwater bivalve molluscs in different Seasons. *J. Environ. Biol.* 9: 27.
Bhide M. (1987). Toxicity of certain pesticide on the behavior mortality and on the development of freshwater snail, *Pila globosa* and their egg masses *"Trends Environment, PolluT. Pesticide Toxicol."* Jamainder Book. Agengy, New Delhi, 355-362.
Bhide M. (1998). Effect of nuvan, methyl parathion and thimet on the mortality, behaviour and reproductive performance of freshwater molluscs, *Lymnaea stagnalis. J. Environ. Biol.* 19(4):325-332.
Camargo, J.O. (2003). Fluoride toxicity to aquatic organisms: A review. *Chemosphere.* 33: 81-90.
Cheng T.C. and Sullivan J.T. (1973). The effect of copper on the heart rate of *Biomphalaria glabrata* (Mollusca: Pulmonata). Comp. Gen. Pharmacol. 4: 37-41.
Compbell M., White K.M., Jugdashsingh R.N., Jonathan P.J. and Catherine C.R. (2000). Effects of aluminium and salicylic acid on behaviour of the freshwater snail, *Lymnaea stagnalis*. *Canadian J. Fisheries Aquatic Sci.* 57 (6): 1151-1159.
Cooke C.M. and Kondo, Y. (1971). Revision on Tornatellinidae and Achatinellidae (Gatropoda: Pulmonata). *Bull. Bishop. Mns*. 221-228.
Damkaer D.M. and Dey, D.B., (1989). Evidence for fluoride effects on salmon passage at John Day Dam, Colombia River, 1982-1986. North American J. Fish. Manag. 9: 154-162.
Denny, M.W. and Harley, C.D.G. (2006). Hot Limpets: Predicting body temperature in a conductance mediated thermal system. *J. Exp. Biol*. 209: 2409-2419.
Devi, U.V. (1996). Heavy metal toxicity to an intertidal gastropod *Morula granulate* (Duclos): Tolerance to copper, mercury, cadmium and zinc. *J. Environ. Biol.* 18(3): 291-305.

Duft M., Schmitt C., Bachmann, J., Bredelik, C., Schulteoehlmann, U. and Oehlmann, J. (2007). Prosobranch snails as test organism for the assessment of endocrine active chemicals an overview and a guideline proposal for a reproduction test with the freshwater mud snail *Potamopyr gusantipodarum. Eco. Toxicol.* 16: 169-182.
Duft M., Schulte-Oehlmann U., Weltje L., Tilma M., and Oehlamann J. (2003). Stimulated embryo production as a parameter of estrogenic exposure via sediments in the freshwater mud snail *Potoamopyrus antipyrgus. Aquatic Toxicol.* 64: 437-449.
Eisler R. (1979). Behavioural responses of marine poikilotherms to pollutant. Phil. *Trans. R. Soc.* (Ser. 13, 286-507-521).
Etge, F.J. and Gilbertson, D.E. (1966). Replacement action of some chemical molluscicides on schistosomose vector snails'. *Am. J. Trop. Med. Hyg.* 15: 618-624.
Fieser A.H., Sykora J.L., Kostalos M. S., Wu Y.C. and Weyel D.W. (1986). Effects of fluorides on survival and reproduction of *Daphnia manga*. J. Water Poll. *Cont. Federa.* 58: 82-86.
Gokhale S.R. and Mane U.H. (1990). Acute Toxicity of endosulphon 35 EC to freshwater Bivalve mollusks from Godavari River at Maharashtra State, India. *Toxicol. Letters.* 23:147-155.
Harry H.W. and Aldrich D.V. (1963). The distress syndrome in *Taphinus glabrous* (Say), as a reaction to toxic concentrations of inorganic ions. *Malacologia.* 1: 283-287.
Jawale C.S. and Dama L.B. (2010). Hematological changes in the fresh water fish, *Cyprinus carpio* exposed to sub-lethal concentration of piscicidal compounds from *Cestrum* species (Family : *Solanaceae*). *Nat. J. Life Sci.* 7(1): 81-84 (2010).
Kamble N.A. (2007). Comparative studies on induced Biodiversity of three heavy metals (Cd, Pb, and Zn) on freshwater snail, *Bellameya bengalensis* (Lamarck). Ph.D. Thesis, Shivaji University, Kolhapur.
Leblanc G.A. (1980). Acute toxicity of priority pollutants to water flea (*Daphnia manga*). *Bull. Environ. Cont. Toxicol.* 24: 684-691.
Mazuro H., Jalova K.V., Kohler H.R., Triebskorn R., and Giesy J.P. (2008). Endocrine effects of contaminated sediments on the freshwater snail *Potamopyrgus antipodarum* in vivo in the cell bioassays in vintro. *Aqu. Toxicol.* 89: 172-179.
Mc Mahonm R.F. and Britton, J.C. (1985). The relationship between vertical distribution, thermal tolerance, evaporative water loss rate and behavior on emergence in six species of mangrove gastropods from Hong-kong. In the Malacofauna of Hong-kong and southern china. II, Vol. (1&2), B. Mortona and D. Dudgeon, eds. Hong-Kong University Press, Hong-Kong. Pp 563-582.
Metcalfe S.J.L., Holtze, K.E., Sirota G. R., Reid J.J. and DeSolla S.R. (2003). Toxicity of aqueous and sediments fluoride to freshwater organisms. *Environ. Toxicol. Chem.* 22: 161-166.
Muley D.V. and Mane U.H. (1987). Pesticide induced alterations in the rate of oxygen uptake of freshwater gastropods *Viviparus Bengalensis* (L). *J. Anim. Maorphol. Physiol.* 34(1&2):171-176.
Muley D.V. and Mane U.H. (1988). Seasonal variation in the toxicity of folithion and ledaycid to a freshwater gastropods. *Viviparus bengalensis* (lam) from Godavari River. M.S. India Ad. *Biosci.*1. (7). 37-46.
Nagarajah N.N., Antonette Sophia and Balasubramanian T. (1985). Behaviour of some intertidal mollusks exposed to water-soluble fractions of diesel. Mar. Pollu. Bull. 16(7): 162-271.
Nanaware and Awati A.A. (2004). Comparative studies on toxic effects of synthesis and natural molluscicide on respiratory and reproductive organs of aquatic snail Viviparus bengalensis. Ph.D. Thesis, Shivaji University, Kolhapur.
Nimghare S.S. (1992). Neuroendocrine and osmoregulatory responses of *Paratelphusa jacquemontii* (Rathbun) to pollutant stress. *Ph. D. Thesis, Amravati* University, Amravati.
Nolan M.O., Bond H.W. and Mann E.R. (1953). Results of laboratory screening tests of chemical compounds of molluscidal activity: 1. Phenols and related compounds. *Am. J. Trop. Med. Hyg.* 2: 716-752.
Oehlmann, J. and Schult-Oehlmann, U. (2002). Molluscs as bioindicators. In B. A. Markert, A.M. Breure and H.G. Zechmeister (Eds), Bioindicators and biomonicators Amsterdam: Elsevier. Pp 577-635.
Pedersen S., Selck H., Salvito D. and Forbes V. (2009). Effects of the polycylic musk HHCB on individual-and population level endpoints in *Potamopyrgus antipodarum. Eco. Toxicol. Environ. Safety.* 72: 1190-1199.

ISSN: 2348 – 604X (p); 2348 – 6058 (e)

Porter W.P. and Gates D.M. (1969). Thermodynamic equilibria of animals with environment. *Ecol. Manoger*.39: 228-244.
Porter W.P. and Kerney M. (2009). Size, shape and the thermal niche of environment endotherms. *Proc. Natl. Acad. Sci*. USA. 106: 19666-19672.
Rorke M.A., Gardner D.R. and Greenhalgh R. (1974). Lethality and behavioral symptoms produced by some organophosphorus compounds in the *Helix aspersa*. *Bull. Environ. Contam. Toxicol.* 11:417-424.
Rostein A. (1959): Cell membranes as sites of action of heavy metals. *Fed. Proc.* 18: 1026-1038.
Saliba L.J. and Vella M.G. (1977). Effects of mercury on the behavior and oxygen consumption of *Monodonta articulate. Mar. Biol. (Berl.).* 43(3): 277-282.
Sarojini R., Machale R., and Nagabhushanam R. (1990). Biochemical changes produced as a result of zinc sulphate and copper sulphate in the muscle of freshwater crab, *Barytephusa guerini*. *Uttar Pradesh J. Zool. 10(1): 19-22.*
Shaikh F.I. (1999). Chronic toxic effects of heavy metals on some physiological aspect of *Barytelphusa cunicularis*. *Ph. D. Thesis, Marathwada University,* Aurangabad.
Shaikh F.I., Mohammad I.F., Quazi S.S., Hashmi S., Ansari N.T. and Dama L.B. (2010). Effect of mercuric and cadmium chloride on oxygen consumption of freshwater crab *Barytelphusa cunicularis. J. Aquatic Biol.* 1: 165-167.
Shaikh Yasmeen, Suryawanshi G.D., Dama L. B. and Mane U.H. (2012). Behavioural changes of fresh water bivalve molluscs *Lamellidens marginalis* due to acute toxicity of cadmium. *DAV International Journal of Science.* 1(2): 103--106. *ISSN: 2277-5536 (Print); 2277-5641 (Online).*
Valenti T.W., Cherry D.S., Curie R.J., Nerves R.J., Jones J.W. and Mair R. (2006). Chlorine toxicity to early life stages of freshwater mussels (Bivalvia: Unionidae). *Environ. Toxicol. Chem.* 25: 2512-2518.
Wang N., Ingersoll C.G., Greer I.E., Hardestry D.K., Ivery C.D. and Kunz J.L.l. (2007). Chronic toxicity of copper and ammonia to juvenile freshwater mussels (Unionidae). And ammonia to juvenile freshwater mussels (Unionidae). *Environ. Toxicol. Chem.* 26:2048-2056.
Websters New World. (2002). College Dictionary, New Millennium, 4th Ed. *IDG* Book *India Ltd.,* New Delhi-110002

