Bull. Environ. Contam. Toxicol. (1986) 37:622–628

Bulletin of Environmental Contamination and Toxicology

Acute Toxicity of Fenthion to Freshwater Lamellibranch Mollusc, *Indonaia caeruleus* (Prashad 1918), from Godavari River at Paithan—A Biochemical Approach

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Several studies on insecticides effects on aquatic organisms demonstrate that concentrations which are not sufficient to control many species of crop pests, flies and mosquitoes, nevertheless can kill eggs and larvae of lamellibranch molluscs (Davis 1961), kill or immobilize fishes (Westman and Compton 1960; Butler 1964), decrease the productivity of phytoplankton populations (Butler and Springer 1963), and alter the tissue chemistry in molluscs (Eisler and Weinstein 1967) and fishes (Eisler 1967).

Since lamellibranch molluscs have specific ecological adaptations in aquatic ecosystems, they constitute a remarkable component in littoral ecosystems. They are suspension feeders on the primary stages of food chains and influence the organization and functioning of the ecosystems. We have undertaken series of experimental studies to assess the toxicity of widely used organophosphorus insecticides in Maharashtra State, India, such as fenthion, folithion and malathion on different species of lamellibranch molluscs like, *Lamellidens corrianus*, *L. marginalis* and *Indonaia caeruleus* from Godavari river at Paithan. Few studies of this nature have been conducted on lamellibranch molluscs (Akarte *et al.* 1985). Hence, the present study is directed to understand the effect of fenthion (lebaycid 1000 w/w) on biochemical composition of *I. caeruleus*.

MATERIALS AND METHODS

The lamellibranch mollusc, *I. caeruleus*, was collected in January 1985 from Godavari river at Paithan near Aurangabad. The animals were soon brought to the laboratory and the shells were cleaned off encrusting epifauna and kept in a reservoir under laboratory conditions for 24 h. The animals were then grouped in three sets, each containing ten animals of 4.5 to 5.0 cm in shell length. The first set served as control, the second set was exposed to predetermined nominal (LC 0) and third set to lethal (96 h LC 50) concentrations of fenthion. The nominal and lethal concentrations of fenthion for *I. caeruleus* were 7.2 and 13.6 ppb, respectively (Akarte 1985). At the end of 96 h exposure, animals of each set were sacrificed to isolate anterior mantle, middle mantle, posterior mantle, gills, hepatopancreas, foot, gonad, anterior adductor muscle and posterior adductor muscle. Each body part of animals of each set was pooled separately and three samples were drawn from it for the biochemical analyses. Total protein was estimated according to Gornall *et al.* (1949), glycogen according to Zwaan de and Zandee (1972) and lipid was extracted according to Blig and Dyer (1959). Total cholesterol was estimated as given by Kolmer *et al.* (1951). Result is reported as the mean value of three analyses and expressed as mg biochemical content per 100 mg wet weight of tissue. All the values were subjected to Student's 't' test.

RESULTS AND DISCUSSION

The pattern of distribution of the metabolites in the control group is as follows - protein : gonad > foot > anterior adductor muscle > hepatopancreas and posterior adductor muscle > posterior mantle > middle mantle > anterior mantle and gills; glycogen : middle mantle > posterior mantle and hepatopancreas > anterior mantle and gonad > anterior adductor and posterior adductor muscles > foot > gills; lipid : gonad > hepatopancreas > middle mantle > foot > anterior mantle > posterior mantle > anterior adductor muscle>posterior adductor muscle and gills; cholesterol: gonad > hepatopancreas > foot > gills > posterior mantle and anterior adductor muscle > anterior mantle and posterior adductor muscle > middle mantle (Fig. 1).

In lamellibranch molluscs glycogen is stored in considerable amount in certain tissues, while in others it is insignificant (Giese 1969). In the present study, it is observed that different portions of mantle of I. caeruleus stored different amounts of glycogen, and middle mantle was found to be the most prominent glycogen storage. The two other portions of mantle, hepatopancreas and gonad also stored considerable amount of glycogen. Apart from glycogen in lamellibranch molluscs, lipids are generally considered as energy reserves during stress conditions. The stored lipid is used in preference to glycogen during such conditions. In I. caeruleus, the gonad is the most prominent organ to store lipid. Our histological observations revealed mature sex products in the follicles store more lipid. Hepatopancreas, middle mantle and foot also stored considerable amount of lipid.

Nominal (7.2 ppb) and lethal (13.6 ppb) exposure to fenthion effected in changes in protein, glycogen, lipid and cholesterol contents in I. caeruleus (Fig. 1).

Animals exposed to 7.2 and 13.6 ppb fenthion showed significant decrease in protein content in middle mantle, posterior mantle, gonad, foot and anterior adductor muscle compared to control. The decrease was more in lethal exposure than nominal in posterior mantle, gills, hepatopancreas and gonad.

When compared with control, glycogen content in 7.2 ppb fenthion exposed animals decreased significantly in all of the body parts, except foot. In animals exposed to 13.6 ppb fenthion, the content decreased in all of the body parts, except hepatopancreas and anterior adductor muscle, wherein the content increased than control. Compared to animals exposed to 7.2 ppb fenthion, glycogen content in those exposed to 13.6 ppb fenthion showed a significant decrease in gonad, foot and posterior adductor muscle; in anterior mantle, middle mantle, posterior mantle, gills, hepatopancreas and anterior adductor muscle it showed a significant increase.

Lipid content in gonad and foot of animals subjected to nominal exposure decreased significantly, while in other body parts it significantly increased compared to control. In lethal exposure, gonad showed a significant decrease in the content compared to control. Other body parts showed significant increase in the content. Anterior mantle and middle mantle of animals exposed to 7.2 ppb fenthion showed a significant decline in lipid content, whereas posterior mantle, gills, hepatopancreas, gonad, foot and the adductor muscles showed a significant increase in the content than those exposed to 13.6 ppb fenthion.

Compared to control, hepatopancreas and foot of the animals exposed to 7.2 ppb fenthion showed a significant decrease in cholesterol content, whereas middle mantle, posterior mantle and gills showed a significant increase. In animals exposed to 13.6 ppb fenthion, a significant increase in cholesterol content, than control, was observed in anterior mantle, middle mantle, gills, hepatopancreas, anterior adductor and posterior adductor muscles. Animals exposed to 13.6 ppb fenthion showed a significant increase in cholesterol content in anterior mantle, hepatopancreas, foot and posterior adductor muscle than those exposed to 7.2 ppb fenthion. In posterior mantle and gonad of the animals exposed to 13.6 ppb fenthion, cholesterol content decreased compared to 7.2 ppb fenthion exposed animals.

Nominal and lethal exposure to fenthion caused changes in glycogen content of all the body parts of I. caeruleus. The break down of glycogen in most of the body parts is probably due to the inhibition of glucose-6-phosphatase or supressed gluconeogenesis. The body parts like hepatopancreas, anterior adductor muscle (in lethal exposure) and foot (in nominal exposure) showed increase in the glycogen content. This suggests that in these body parts glycogenolysis is inhibited or that gluconeogenesis and glycogenesis are increased to some extent resulting in an increased level of glycogen to keep the reserve energy in depot tissue and muscle. This is in agreement with the studies conducted by Grant and Mehrle (1973). These authors have shown that low levels of endrin might usually stimulate certain physiological processes whereas higher dietary doses might cause inhibition or exhaustion (as related to an adaptive mechanism) in fish. Inhibition of liver glycogenolysis in rainbow trout exposed to ednrin (Menzie 1972), increase in liver glycogen of Scorpaena porcus exposed to lindane (Escoubet and Vincente 1975) and changes in serum protein and glycogen of rainbow trout exposed to endrin (Grant and Mehrle 1973) were reported earlier.

In lamellibranch molluscs the conversion of glycogen into fatty acid or triglyceride reserves via triose phosphate entry in the glycolytic sequence and to the production of pentose sugars for nucleic acid synthesis as well as the necessary intermediates for lipogenesis is well documented (Gabbott 1976). Chaudhary *et al.* (1981), while studying the long term exposure of technical grade malathion on Heteropneustes fossilis observed that the water and lipid contents of whole body and ovary decreased, while liver lipid content decreased and liver water content increased. Recently, Swami *et al.* (1983) also suggested a shift in carbohydrate and protein metabolisms to lipid synthesis in freshwater mussels exposed to pesticides. The breakdown of protein increased more in lethal exposure of I. caeruleus in all the body parts due to fenthion stress. This breakdown along with the increase in glycogen content might be responsible for lipid alteration which might also be responsible for increased lipid content in hepatopancreas and both adductor muscles. A dual nature of disturbances in the reserves occurred in certain tissues. Thus, the possible mechnism for increase in lipid content in these body parts might be due to the increased lipid synthesis with changes in the type of synthesis, diminished degradation of lipid, increased mobilization of lipid and diminished transport of lipid away from these body parts. An alternative scheme for anaerobic metabolism in lamellibranch molluscs, in which redox balance is maintained by the simultaneous utilization of both carbohydrate and protein has been proposed by Hochachka and Mustafa (1972) and Hochachka *et al.* (1973). Krebs (1972) has shown that there is a significant loss of stored energy while converting pre-stored glycogen into lipid. lipid is a more concentrated form of energy and there is an increase in buoyancy due to its lower density when compared to carbohydrate and protein (Gabbott 1976). The consistent decrease in glycogen and lipid in certain tissues of fenthion exposed I. caeruleus might account for their utilization for energy. Amongst lipids phospholipids are actively degraded (Harper *et al.* 1977). This is seen particularly in gonad, foot, anterior adductor muscle and middle mantle of I. caeruleus exposed to both nominal and lethal concentrations of fenthion. Gonad particularly showed increased lipolysis. Thus, the present study reveals disfunctions of physiological processes critical for the survival of I. caeruleus exposed to fenthion. Certain tissues that showed increase or decrease in glycogen and lipid contents due to fenthion toxicity may actually stimulate certain physiologic processes. However, special attention needs on the glycogen and lipid metabolic pathways distrubed due to pesticides in this lamellibranch mollusc.

Acknowledgements. This work is supported by Department of Science

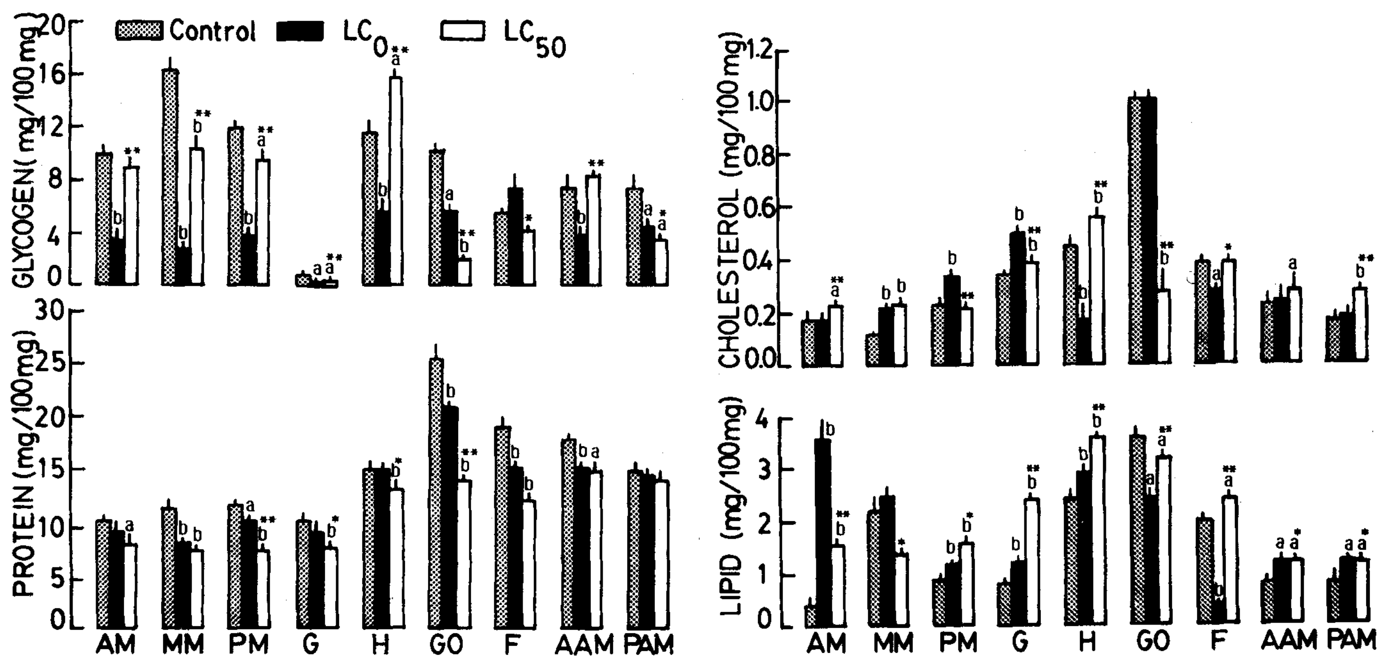

Figure 1. Changes in biochemical composition of different body parts of *I. caeruleus* after exposure to nominal (7.2 ppb) and lethal (13.6 ppb) concentrations of fenthion (lebaycid 1000). a-significantly different from control at 5% probability; b - significantly different from control at 1% probability; * significantly different from nominal exposure at 5% probability; ** significantly different from nominal exposure at 1% probability. AM - anterior mantle; MM - middle mantle; PM - posterior mantle; G - gills; H - hepatopancreas; GO - gonad; F - foot; AAM - anterior adductor muscle; PAM - posterior adductor muscle. Vertical bars are standard errors of the mean (n = 3).

and Technology, Government of India in the form of a Molluscan Toxicology Research Project. The authors acknowledge the financial support. We thank Mr. Aniruddh Desai for preparing the figure.

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Received September 13, 1985; accepted May 13, 1986.