"Determination of Rate of Shell Accretion in Pesticide Induced Fresh Water Bivalve, Parreysia Corrugata"

Dr. Pramod Phirke
Department of Zoology, Fergusson College,
Pune, Maharashtra, India

Dr. S.P. Zambare
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad, Maharashtra, India

ABSTRACT

Rate of shell accretion was studied in the freshwater bivalve, Parreysia corrugata exposed to chronic treatment of pesticides; quinalphos (0.108 ppm) and thiodan (0.0708 ppm). The thickness of the accreted part was maximum at umbo, moderate in the middle and was minimum at the margin of the shell in bivalves of all three groups. Rate of shell accretion was reduced in pesticide exposed bivalves than in normal bivalves. Accreted piece of the shell found to become brittle with dull and poor nacre.

KEYWORD: Fresh Water Bivalve, Quinalphos, Thiodan, Shell Accretion

INTRODUCTION

Water is the basic natural resource and the habitat of many living organisms. Various water bodies such as seas, rivers, and lakes have been used as dumping grounds for the wastes from domestic activities, industrial activities and agricultural activities. Pesticides and other toxic chemicals cause harmful effects on varieties of aquatic organisms like, frogs, fishes, crabs, mussels, etc. The nature of toxic effects of pesticides varies greatly as they are not specific in their action (Moore, 1969). Toxicants such as pesticides routinely discharged in the water bodies create stressful situation, which influences growth and development of aquatic flora and fauna. Enadu (1994) reported that 46 types of pesticides were used to control the pests in India with increasing amount as 432 tonnes in 1954; 58,900 tonnes in 1977 – 78; 70,781 tonnes in 1990 – 91.

The genera of mussels such as Lamellidens, Indonaia, Parreysia, Corbicula, Unio, etc. are very common Indian freshwater forms. Living bivalves provide integrated information about concentration of elements accumulated from their aquatic environment in the proportion to those in the water (Lutz and Rhoads 1980). Amount of incorporation of elements can be assessed by measuring their relative concentration in the valves. The shell of the Parreysia is of nacro – prismatic type (Tevesz and Carter, 1980). Its outermost layer is periostracum and inner calcified surface includes outer prismatic layer and inner nacreous layer. Nacreous layer contains organic material such as protein, scleroproteins, polypeptides and perhaps mucopolysaccharides (Wilbur and Younge, 1964). Dodd, (1967); Carriker, (1978); Carriker, et. al. (1978) reported that, the trace and minor elements can be incorporated in shell as substitutes for calcium in the calcitic or aragonitic crystal lattice as constituents of separate mineral phases and organic compounds and are absorbed on exterior surfaces.

The shells of mussels are economically important as these are used in the production of toys, ornaments, utility articles, lime, cement, paint, etc. These are also most successfully used for the pearl production. The shells of Cypraea (cowrie) were used as money as well as ornaments. Since economically and commercially important bivalves have been continuously exposed to pesticides like Quinalphos, Thiodan, etc. which interfere with the formation and the growth of shells, present investigation work was considered to determine the effect of organophosphosphate pesticide "quinalphos" and organochlorine pesticide "thiodan" on the rate of shell accretion in fresh water bivalve, Parreysia corrugata.

MATERIALS AND METHODS:

The fresh water bivalves, Parreysia corrugata collected from dam were acclimatized in laboratory conditions. The shell of the bivalves was drilled with dentist drill of 1 mm bore at three different sites such as umbo, middle level and the margin. They were kept in three separate troughs for 5 months (i.e. 153 days). One group was maintained as a control, the second group was treated by sub lethal concentration (LC50/10 value of 96 hrs.) of quinalphos (0.108 ppm) and the third group was treated by sub lethal concentration of thiodan (0.0708 ppm). Water was changed after every 24 hours from both the control and experimental troughs. After the chronic treatment of 5 months the bivalves were sacrificed and their shells were removed. They were washed in distilled water and dried at room temperature. The accreted part from each site was removed and the thickness of the part was measured by ocular micrometer. The rate of shell accretion per month was calculated by the formula-

$$\text{Rate of shell accretion in micron per month} = \frac{\text{Thickness of accreted shell in micron} \times 30}{\text{Number of days of shell accretion}}$$

OBSERVATIONS:

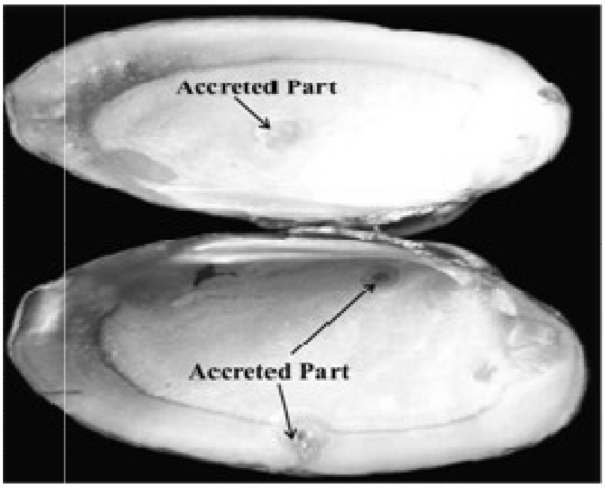
The results regarding the rate of shell accretion per month in Parreysia corrugata shown in figure 1 and are cited in table number 1. It is maximum at umbo region than in middle and at marginal region. The rate of shell accretion in the bivalves of control group is 32.142 µ / month at umbo region, 31.338 µ / month in the middle and 24.780 µ / month at the marginal region. Whereas in bivalves exposed to quinalphos, the rate of shell accretion is 31.153µ / month at umbo, 24.923 µ / month in the middle and 22.107 µ / month at the marginal region. The rate of shell accretion in thiodan exposed bivalves found to be 27.674 µ / month at umbo, 21.060 µ / month in the middle and 20.300 µ / month at margin. Accreted piece of the shell became brittle with dull and poor nacre. The thickness of the accreted part was maximum at umbo, moderate in the middle and was minimum at the margin of the shell in bivalves of all three groups.

Table 1: Rate of shell accretion in freshwater bivalve, Parreysia corrugata after chronic exposure to quinalphos and thiodan

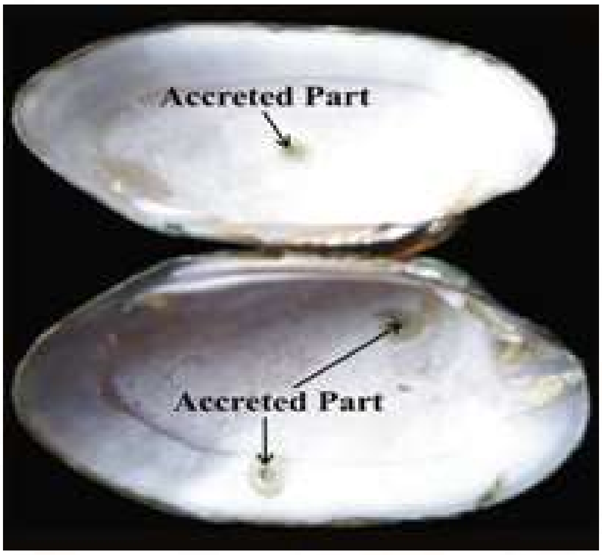
Dose	Rate of Accretion (microns per month)		
	Umbo	Middle	Margin
Control	32.142±1.23	31.338±1.58	24.780±1.16
Quinalphos (0.108 ppm)	31.153±1.59^{NS} (-3.076)	24.923±1.98** (-20.47)	22.107±1.45* (-10.78)
Thiodan (0.0708 ppm)	27.674±1.58* (-13.90)	21.06±1.74** (-32.79)	20.3±1.68* (-18.07)

1. Thickness of accreted shell expressed as µm/ month.
2. ± indicates standard deviation of three independent replications.
3. (+) or (-) % variation over control
4. Significance: * P < 0.05; ** P < 0.01; *** P 0.001; ^{NS} = Non-significant

Figure 1: Photographs showing shell accretion in Parreysia corrugata of control, quinalphos and thiodan exposed groups.



(A) Shell accretion in *Parreysia corrugata* of Control group



(B) Shell accretion in Quinalphos exposed *Parreysia corrugata*

(C) Shell accretion in Thiodan exposed *Parreysia corrugata*

DISCUSSION:

Shell valves in the bivalves are protective device which protect internal soft and delicate body from adverse situation in the environment. Freshwater bivalves have been continuously exposed to pollutants and toxicants discharged in the water bodies. It may influence the formation and growth of the shell. Annuli on the surface of shell provide information about age and growth rate in bivalve molluscs. There are different views regarding the development of annuli on the shell surface of the bivalvres. Many investigators reported formation of one growth annulus in each year (Lutz and Rhoads, 1980; El Moghraby and Adam, 1984). This view is supported by few workers (Negus, 1966; Ghent et. al., 1978; Haukiojo and Hakala, 1978). In median length mussel, Lampsilis radiata, formation of only half of an external annulus was formed per year and no external annuli was formed even after several years (Downing et. al., 1992). Jones (1983) stated that internal annuli may be more reliable than external growth lines in estimation of age and growth. The distance between these rings indicates the annual growth performance of individual bivalves (Mac. Curdy, 1954). Calcium plays an important role in shell growth and normal metabolism in marine bivalve molluscs. Vander and Puymbroeck (1966) found 80% calcium incorporation in freshwater gastropod, Lymnea stagnalis from food rich surrounding water. Calcium incorporation in excised mantle tissue and shell in marine bivalve was also studied by Jordery (1953).

Spreading of elements in the shell depends on structural (Carriker et. al., 1980 a) and chemical (Buchardt and Fritz, 1978; Carriker et. al., 1980 b) changes in the shell of bivalve caused due to environmental fluctuations. Fouling, adsorption and weathering of shell surface also influence the spreading of elements in the shell (Rosenberg, 1980). Incorporation of calcium in the shell is however affected by contamination in the water. Cellular volume of outer mantle epithelium reduces in freshwater bivalve, Anodonta cygnea incubated with pollutants for 8 months. It leads to significant decrease in secretory activity of mantle due to exposure to toxic agents and this has implication for the shell calcification process (Manuel Lopes – Lima et. al. 2006). Many trace and minor elements in water body are adsorbed to, or incorporated in, suspended particulate matter (Bopp and Bigs, 1981). Metals are concentrated in the shell to a greater extent when they are combined with suspended materials (Imlay, 1982). Moura et. al. (2001) concluded that, the increase of calcium contents with Cu and Cd incubation in Anodonta cygnea might be due to acidosis which can create abnormal conditions for shell formation.

The chemical constitution of shell of bivalves is dependent on concentrations of dissolved elements in the culture water (magnesium, Lorens and Bender, 1977; Calcium, Sick et. al., 1979). Calcium, which is the major cation in the shell, probably influences the incorporation of other elements in shell, but the intensity of its effect and a type of elements affected are not yet studied (Odum, 1957; Romeril, 1971).

The mussel strongly collects calcium even from soft water and deposits it mainly in the mantle in the form of extensive masses of small spherules (Pekkarinen and Volovirta, 1997). The shell of the Parreysia is of nacro – prismatic type (Tevesz and Carter, 1980). Its outermost layer is periostracum and inner calcified surface includes outer prismatic layer and inner nacreous layer. Nacreous layer contains organic material such as protein, scleroproteins, polypeptides and perhaps mucopolysaccharides (Wilbur and Younge, 1964). The stressful situation created due to pesticide exposure in the water body, disturbs the secretary activities of the mantle and in turn the formation of different layers including nacreous layer; the mother of pearl, the rate of shell accretion decreases.

The pollutants and toxic substances including pesticides interfere with the spreading of elements and deposition of calcium in the shells of bivalves and also alter the cellular organization of the mantle epithelium leading to reduced secretion of nacreous layer. The lustrous quality of the nacre is also poor. Overall it is resulted into decrease in the rate of shell accretion with dull and brittle accreted piece in pesticide exposed bivalves than in normal bivalves.

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