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Studies on Activity Recovery in Some Mercury–Exposed Freshwater Fish by Using Selected Weeds

Sharad Shrivastava and K. S. Rao

School of Studies in Zoology, Vikram University, Ujjain, India

In spite of worldwide concern about mercury contamination in aquatic environment, relatively little effort has been expended on determining the mechanisms involved in bioaccumulation (Tsai et al 1975, Rao et al 1987). It has been found that several species of aquatic plants grow in flowing water of polluted rivers and contain higher mercury levels than the associated water phase (Dietz 1972). The aquatic weed plants absorb and incorporate the dissolved materials (both inorganic and organic compound) into their own body tissues so repidly and effectively that they are now considered for use in sewage treatment (Chaphekar and Mhatre 1981). Dhanekar et al (1984) have pointed out possible fish recovery by weed treatment. The present study evaluated the relative efficiencies of five selected weeds, in mercury toxicity removal suggesting possible methods of mercury removal from contaminated aquatic environments.

MATERIAL AND METHODS

Sarotherodon mossambicus, *Heteropneustes fossilis* and *Puntius sophore* were selected as test animals. These were collected from Government Fisheries Department, Ujjain, M.P. India. The test animals were kept in each aquarium containing ten litres of stored tap water.

The selected weeds were *Eichhornia*, *Salvinia*, *Hydrilla*, *Vallisneria* and *Marsilea* which basically represent floating, emergent and submerged types. The weeds were allowed to remain in the experimental water with the toxicant for a period of 48 hours, as this would facilitate the absorption of toxicant by the weed. The fish were then introduced. With the help of earlier experiments different lethal concentrations of mercuric chloride to the selected fish species were determined. On this basis, the five selected weeds and the fish were arranged into nine experimental groups. The details of which were as per details given under :-

1. Normal control (Tap water and fish).

2. Weed control (equal weight of 5 weeds, tap water and fish).

3. Lethal concentration (mercuric chloride, tap water and fish).

4. Combined weed experimental group (equal weight of 5 weeds, tap water, mercuric chloride and fish).

5. *Eichhornia* experimental group (*Eichhornia*, mercuric chloride, tap water and fish).

6. *Salvinia* experimental group (*Salvinia*, mercuric chloride, tap water and fish).

7. *Hydrilla* experimental group (*Hydrilla*, mercuric chloride, tap water and fish).

8. *Vallisneria* experimental group (*Vallisneria*, mercuric chloride, tap water and fish).

9. *Marsilea* experimental group (*Marsilea*, mercuric chloride, tap water and fish).

Duplicate sets of experiments were set up in parallel series for the three individual fishes with and without selected weeds. Fish mortality was observed at intervals of eight hours upto 96 hours of experimentation. Oxygen consumption rate was determined by Winkler's method. Opercular movements were recorded by counting them per minute. Locomotory activity of fish in different groups was measured in aquaria with the base marked in one cm squares (Sage 1965). The mercuric chloride absorption rate by weeds reported in the present study were based on the relative fish mortality, recovery of oxygen consumption, opercular movements and locomotary activity in combined weed and individual weed experiments.

RESULTS AND DISCUSSION

The selected three fishes were subjected to different concentrations of mercuric chloride as per details given earlier. 100% fish mortality was recorded in their respective lethal concentration(Table 1). The same fish species at the same concentration of mercuric chloride were kept in aquaria containing selected weeds as per details given in Table 1.

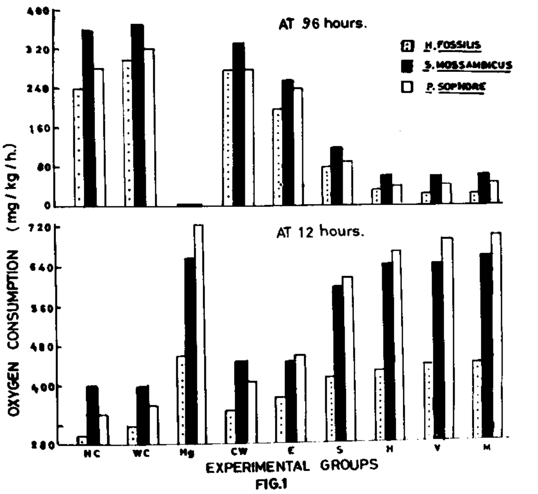

Fig.1 Oxygen consumption rate of fresh water fish in different experimental group.

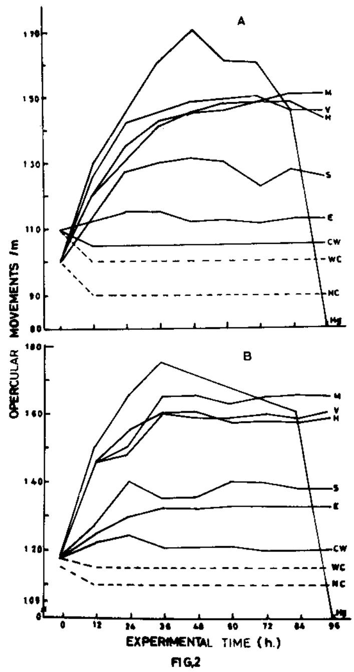

Fig.2

Opercular movements of Puntius sophore (A) and Sarothodon mossambicus (B) in different experimental group.

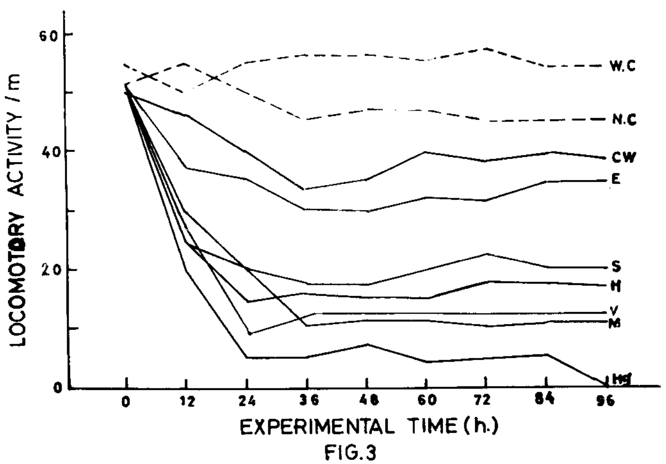

Fig.3 Locomotary activity of Sarothodon mossambicus in different experimental group.

NC - Normal control, WC - Weed control, HG - Mercury exposed, CW - Combined weed group, E - Eichhornia group, S - Salvinia group, H - Hydrilla group, V - Va;;isneria group, M - Marsilea.

Table 1. Mortality response of mercuric chloride at 96 hours to the fish when aquatic weeds were kept in the experimental tank.

Fish in mercuric chloride lethal concentration (ppm)	% mortality in mercuric chloride at 96 hours					
	Normal & weed control	Mercuric chloride exposed	Combined weed group	*Eichhornia* group	*Salvinia* group	*Vallisneria, Hydrilla Marsilea* groups
Puntius sophore 0.25	Nil	100%	Nil	20%	40%	70%
Sarotherodon mossambicus 1.00	Nil	100%	Nil	30%	90%	100%
Hetropneustes fossilis 3.00	Nil	100%	Nil	30%	60%	100%

The experimental group were equal weight (20gms) each of all the five weeds were kept containing each type of fish species separately, no mortality could be recorded (Table 1). Further experimentation with individual weed plants with different type of fish in separate group yielded low mortality rate in their respective lethal concentrations. 20 to 30% mortality was recorded in all fish in the lethal concentration containing *Eichhornia*, 40 to 90% mortality was recorded with *Salvinia*, and 70 to 100% mortality with *vallisneria*, *Hydrilla* and *Marsilea*. *Eichhornia* was established in this group as the weed having highest capacity of mercury removal from the medium. Next in order were *Salvinia*, *Hydrilla* and *Vallisneria*.

Limited data are available which describe the toxicity removal by aquatic weed plants from polluted environment. Blind *et al* (1977) describe the use of algal species to detect the concentration of mercury from acutely polluted river. Mhatre *et al*. (1980) observed tolerant and accumulator species like *Pycreus* and algal species like *Stigeoclonium* and *Schizomeris* are good indicators of pollution in water. Wolverton *et al*. (1975) suggested the use of vascular aquatic plants for inorganic and organic pollution removal. Dhanekar *et al*.

(1984) reported comparative efficiencies of different weeds for mercury removal in laboratory conditions and established that Eichhornia, was having highest capability.

Oxygen consumption rate, opercular movements and Locomotory activity of fish were observed in different experimental groups. The recovery of oxygen consumption rate in the present study based on control and mercuric chloride exposed fish revealed that 5 weed containing group was having highest recovery of 98.31% whereas in Eichhornia 79.32%, Salvinia 34.5%, Hydrilla 15.52%, Vallisneria 13.8% and Marsilea 10.8% come next in order. The test animals, with a short period of their introduction in the different experimental group, exhibited signs of distress. This was however, not at all seen in the normal control and weed control group. Fish mortality was observed in mercuric chloride exposed fish (Fig. 1) at 96 hours of experimentation. Before death occurred fish were observed to lose their sense of equilibrium and turned with their belly upward making jerky movements. Finally, they sank to the bottom with no body movement and death occurred.

Opercular movement of experimental fish was observed to be greater in the normal control than in weed control. Highest hyperactivity values were observed at 36 hours after which the activity gradually decreased in mercuric chloride exposed fish as shown in fig.2. In normal control and weed control fish highest opercular movements were observed at 0 hours which decreased upto 12 hours and then attained basal level of opercular movements which indicates initial handling effect in the experimentation. The experimental group containing different weeds observed highest opercular movement in Marsilea, Valisneria, Hydrilla, Salvinia, Eichhornia and combined weed, come next in order. These results report less effect of mercuric chloride in combined weed, Eichhornia and Salvina.

As can be seen from fig.3 Locomotory activity of fish was observed higher in normal control and weed control fish. Lowest values of locomotory activity were reported in mercuric chloride exposed fish. In the experimental group containing aquatic weeds comparatively low values of locomotary activity was observed. Combined weed group had lowest activity values, and next in order were Eichhornia, Salvinia, Hydrilla, Vallisneria and Marsilea. These observations also support that weed containing group were comparatively under less toxicity stress of mercuric chloride.

The lethality of heavy metals has been ascribed to coagulation of mucous on the gill surface and the damage done to the gill tissues resulted in respiratory failure (Wobeser 1975). Increased opercular movements and decreased locomotory activity were also reported in the present study in the fish exposed to mercuric chloride (Fig.2 and 3). It is probable that such an increased values of opercular movements were associated with decreased locomotory activity and compensate for loss of efficiency in the oxygen uptake by decreasing the physiological oxygen demand and increasing the amount of oxygen passing over the branchial tissue per unit time. Menezes and Qasim (1983) and Dhanekar et al. (1984) report similar trend in the fish exposed to mercuric chloride as reported in the present study.

The present study established the relative recovery capacities of the weeds Eichhornia, Salvinia, Hydrilla, Vallisneria and Marsilea in decreasing order. Chapekar and Mhatre (1980) listed the limitations of weed culture as a pollution control method. At the same time Dhanekar et al (1984) suggested weed utilisation in mercury contaminated waters. The present study points out their relative utility in decreasing mercury contamination, barring the influence of pH (Tsai et al. (1975) temperature Wobeser (1975) Boetius (1960) and other physico-chemical factors.

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