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TOXICITY AND ITS EFFECTS OF SEVIN ON ANABAS TESTUDINEUS: AN OVERVIEW

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ABSTRACT

The birth of the modern pesticide era in the late 1940's was hailed as a major break-through for mankind. The philosophy that these new chemicals would stop the innumerable pests in their track thereby eradicating disease and eliminating crop reduction led to a progressive increase in their use. A belated second thought on the environmental persistence of organochlorines (new era pesticides) led to the invention of less persistent pesticides like organophosphate, carbamate and synthetic pyrethreoids.

KEYWORDS : *philosophy , environmental persistence of organochlorines.*

INTRODUCTION

Several studies on water-breathing species of fish show that the toxicity of waterborne substances increases at low levels of dissolved oxygen (Southgate et al. 1933, Downing 1954, Lloyd 1961, Pickering 1968, Hicks and Dewitt 1971, Smith and Oseid 1972, Voyer et al. 1975, Thurston et al. 1981, Gupta et al. 983 and Verma et al. 1985). Gupta et al. (1983) and Verma et al. 1985 also showed such an effect using bimodally respiring species at 5 mg $O_2.L^{-1}$.

All these studies on the effect of oxygen on toxicity have failed to consider the impact of surface access and its interaction with dissolved oxygen on toxicity. This appears to be a serious lapse because it is well established that surface access under hypoxia is important for the survival and activity of fish. Under hypoxia, water-breathing species rise to the water surface to respire at the well oxygenated thin surface film (Lewis 1970), a response termed as aquatic surface respiration (ASR) by Kramer and Mehegan (1981). During ASR, fish can reduce the frequency of gill ventilation significantly over what would be required if using the water column (Gee et al. 1978). ASR in hypoxic water improves oxygen levels in blood (Burggren 1982) and increases survival and activity (Kramer and Mehegan 1981, Kramer and McLure 1982).

DISCUSSION

Fish with bimodal respiration also depend on surface access. These species are capable of respiring both dissolved and atmospheric oxygen, and during air breathing, gill ventilation may be reduced (Johansen 1970). Bimodal respiration characterizes a diverse array of species from the tropics (Jhingran 1975, p. 790-800) which are notable for their resistance to environmental hypoxis and other stresses (Dehadrai and Tripathi 1976).

These findings in respiratory physiology and behaviour suggest that in a toxic medium, by resorting to surface use (ASR or air breathing), fish can prolong their survival by reducing the rate of gill ventilation to lower the toxin uptake through the respiratory water current. Support for such a change in respiratory mode to reduce toxin uptake comes from anecdotal evidence for the voluntary surfacing of fish when exposed to different kinds of toxins, including rotenone (Bhuyan 1968, Konar 1970, Hickling 1971, p. 95, Chakraborty et al. 1972, Davies and Shelton 1983, Tiexeira et al. 1984, Hegen 1985) and copper sulphate (kulakkattolickal personal observations on grass carp, Ctenopharyngodon idella, 1983.

There is experimental evidence that bimodal species of fish also adjust to the increased oxygen demand on exposure to toxins, by depending more on air breathing than on water breathing. Bakthavathsalam and Reddy (1983) showed that on exposure to lindane, Anabas-testudineus showed a significant increase in the rate of oxygen uptake from air with relatively little increase in the rate of oxygen uptake from water. Natarajan (1981) found a similar effect for Channa Stristus exposed to metaystox. Although both these works failed to relate the survival time of fish to oxygen uptake from air, It seems that such an increased dependency on air breathing rather than on water breathing to meet the increased oxygen demand produced by exposure to toxin, was to limit the toxin uptake as much as possible, through the respiratory water current. In addition to the studies on air-breathing fish already cited, Smatresk and Cameron (1982) have demonstrated that the gar (Lepisosteus oculatus) increased the use of atmosphere and decreased the use of dissolved oxygen on exposure to hyperosmotic solutions, and Burggren (1978) reported similar responses to dissolved carbon dioxide. So far no study has been conducted to establish the survival value of either air breathing or ASR in fish exposed to toxins in hypoxic water.

Based on the anecdotal and experimental studies already cited, I felt the need to establish the importance of surface access on survival time of fish exposed to toxins. Therefore, the main goals of this investigation were to quantify: (1) the effect of dissolved oxygen levels on toxicity of a waterborne toxin (Croton tiglium seed extract) to a water breathing species Brachydanio rerio, the zebrafish, and a bimodal species Clarias macrocephalus, (2) the role of surface access as a modifying factor of toxicity at different levels of dissolved oxygen for both species, and (3) the effect of toxin on the rate of air breathing in Clarias macrocephalus.

The original contributions of this paper are as follows:

(1) This study provides the first experimental evidence for the effect of surface access on toxicity for both air-breathing and a water-breathing species of fish.

(2) This study gives the first experimental evidence that toxicity under hypoxia is magnified for a water-breathing species of fish when surface access is denied.

(3) As an extension of previous studies showing that toxicity is increased at lower levels of dissolved oxygen, this study gives the first evidence of such as effect for a proteinaceous plant toxin on a water-breathing species of fish.

(4) This study provides the first evidence for a decrease in toxicity at very low levels of dissolved oxygen for an air-breathing fish with surface access.

These results have applications in aquaculture and sampling of wild fish populations. When applying toxins to eradicate unwanted fish from aquacultural ponds (Bhuyan 1968), selecting a time of day with high or low dissolved oxygen levels as required and preventing surface access can increase the rate of action of toxins on fish. This should reduce the quantity of toxin applied and hence should result in increased cost-effectiveness and reduced environmental contamination.

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