The Acute Toxicity of MSMA to Black Bass (*Micropterus dolomieu*), Crayfish (*Procambarua sp.*) and Channel Catfish (*Ictalurus lacustris*)

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INTRODUCTION

The use of MSMA* as a grass control herbicide along highway rights of way is highly desirable because of its economic advantage in the control of Johnson grass. Since MSMA is an arsenical, concern has arisen over the possible buildup of residues in waterways adjacent to treated rights of way. The objectives of the study were to determine the acute toxicity of MSMA to black bass, crayfish, and channel catfish. These species were selected because of the possibility of their exposure to elevated concentrations of MSMA in the environment and also because of their value to commercial and sport fishing interests.

LITERATURE REVIEW

Surface runoff acounts for a significant amount of herbicide loss (CARO and TAYLOR, 1971; WHITE, et al. 1967). That amount of the herbicide reaching water bodies is of extreme importance as it can be concentrated in bottom sediments (GILDERHUS, 1966) where it may be subject to microbial decomposition, volatilization, and translocation. Additionally, some aquatic species can concentrate herbicides by as much as one thousand fold (EICHELBERGER and LICHTENBERG, 1971).

Few laboratory investigations have been made with organic arsenic herbicides; however, the toxicity of inorganic arsenic has been reported for numerous aquatic species. Arsenic trioxide, the most common oxide of arsenic, is the primary constituent of inorganic arsenic pesticides. WIEBE (1930) found that 7 ppm arsenic trioxide was not harmful to large mouth black bass (Micropterus salmoides), small mouth black bass (Micropterus dolomieu), white crappie (Pomoxis sparoides), or bluegill (Lepomis pallidus) after 148 hours of exposure. Arsenic trioxide is, however, toxic to large mouth bass and bluegills at 10 mg/l (COLE, 1941; MCKEE and WOLF, 1963). Fish food organisms can survive 2 ppm arsenic trioxide but 2.5 ppm - 4 ppm is lethal to chironomid larvae, may fly nymphs (Caenis sp.), and fresh water shrimp (Hyalla sp.) (SURBER and MEEHAN, 1931).

*Monosodium salt methanearsonic acid

Bulletin of Environmental Contamination & Toxicology,
Vol. 14, No. 3 © 1975 by Springer-Verlag New York Inc.

Sodium arsenite, which has been used extensively as an herbicide, has reported TLM's, expressed as arsenic, for fingerling channel catfish at 24, 48, and 72 hours of 47.9 ppm, 25.9 ppm, and 25.9 ppm, respectively (CLEMENS and SNEED, 1959). Sodium arsenite TLM's, expressed as arsenic, for minnows (Notropsis hudsonius) over the same time periods were 45 ppm, 29 ppm, and 27 ppm, respectively (BOSCHETTI and MCLOUGHLIN, 1957).

Arsenic concentrations have been reported toxic at 1.1 mg/l - 2.2 mg/l for pike and perch, 3.1 mg/l for carp, and 7.6 mg/l for bass (MCKEE and WOLF, 1963). Arsenic is toxic to minnows (Phoxinus phoxinus) at 11.6 mg/l (GRINDLEY, 1946) and lethal to bluegills and crappie at 15 ppm (WARRICK, 1943).

MATERIALS AND METHODS

Static bioassays (APHA, 1971) were performed on three species of aquatic fauna: black bass (Micropterus dolomieu), crayfish (Procambarua spp.), and channel catfish (Ictalurus lacustris).

Test animals were allowed to acclimate for four days prior to the addition of the herbicide. It was necessary to isolate crayfish by plexiglass partitions in the test tank to prevent predation. Test containers consisted of metal framed, glass aquaria containing five gallons of aerated tap water. Artificial aeration was necessary since natural reaeration was insufficient in maintaining a suitable dissolved oxygen concentration in the test water. Prior experiments showed that artificial aeration did not increase herbicide volatilization from the tap water.

Following preliminary testing to determine the approximate range of the Median Lethal Threshold (TLM) at 48 hours and 96 hours, triplicate static bioassays were performed employing a logarithmic series of four concentrations. Median Lethal Thresholds reported are average values determined by the regression of data obtained in three replications (Figure 1).

RESULTS AND DISCUSSION

Fingerling black bass were found to be the most sensitive of the three species tested. Forty-eight hour and 96 hour TLM's of 1660 mg/l and 900 mg/l, respectively, were obtained indicating good tolerance on the part of the species to MSMA.

Mixed species of red swamp and white river crayfish were slightly less sensitive to MSMA than black bass. The Median Lethal Threshold (TLM) at 48 hours was 5100 mg/l and at 96 hours 1100 mg/l. Differences in sensitivity from bass are small and the species could be considered similar in response to the compound.

The channel catfish was the most tolerant of the three species tested. Forty-eight hour and 96 hour TLM's of 4700 mg/l and 3050 mg/l, respectively, were obtained indicating a roughly three fold increase in tolerance over black bass.

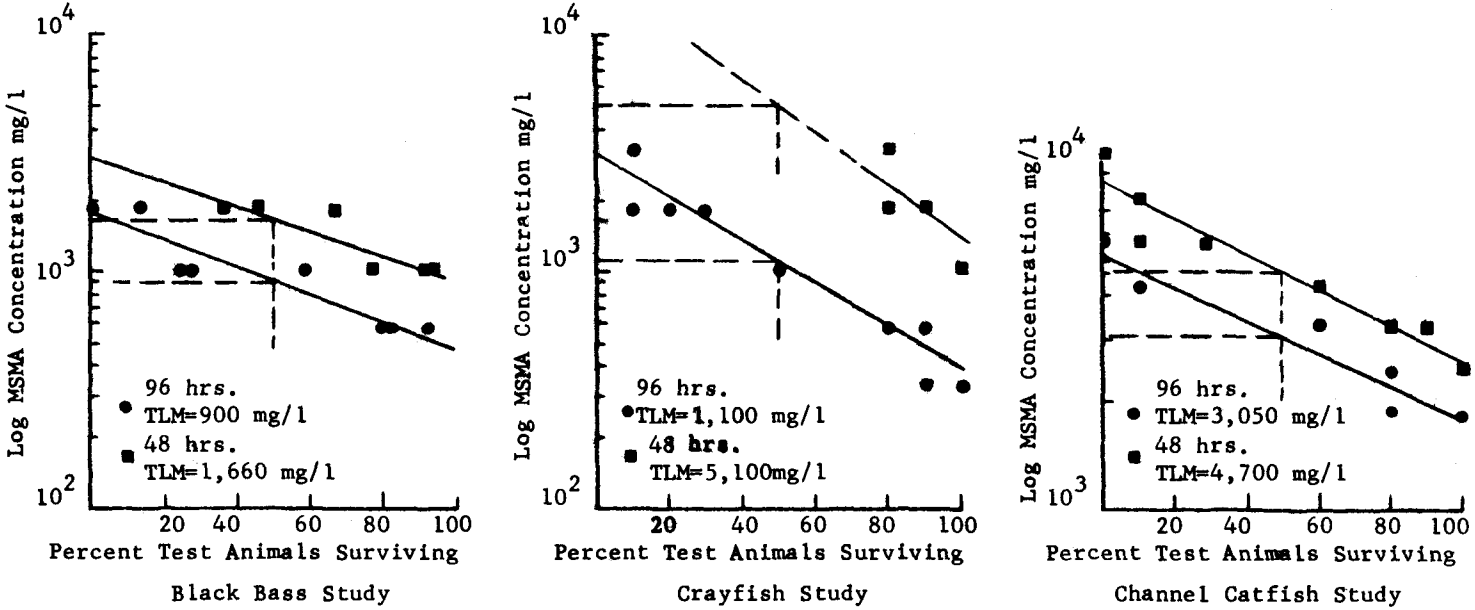

Fig. 1. Toxicity of MSMA to selected freshwater species.

The three species tested showed good tolerance to MSMA with sufficiently high 48 hour and 96 hour TLM's as to suggest few problems arising from acute toxicity with routine field application. However, it is important to note that tolerance to MSMA does not preclude the possibility of concentration of the herbicide by the organism and there is no information of the toxicity of the degradation product(s) of the herbicide formed on microbial demethylation in the field.

While it would appear that the organisms tested can withstand high levels of the MSMA, it should be noted that testing was carried out under standard laboratory conditions. Toxicity of the herbicide would be expected to vary with the environmental stress under which organisms might be placed during exposure. Further, tolerance of other species and juveniles has not been determined and could be at considerable variance with those tested in this study.

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