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A SIMPLE, INEXPENSIVE IN SITU METHOD FOR ASSESSING  
ACUTE TOXICITY OF EFFLUENTS TO FISH

by

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Short Title: Method for Assessing Acute Toxicity

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TECHNICAL NOTE

A SIMPLE, INEXPENSIVE IN SITU METHOD FOR  
ASSESSING ACUTE TOXICITY OF EFFLUENTS TO FISH

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**Abstract** — Test chambers for conducting in situ fish bioassays were constructed from 8L polyethylene bottles. Yearling fathead minnows (Pimephales promelas) and young-of-the-year bluegill (Lepomis macrochirus) demonstrated greater than 50% survival in the chambers after 65 days of exposure in a reservoir, river, and creek. Fathead minnow survival was substantially greater than that of bluegills. The chambers provide a simple, inexpensive, sensitive technique to screen effluents for toxicity.

**Keywords:** biomonitoring, in situ bioassays, effluent toxicity, fathead minnow, bluegill.

## INTRODUCTION

Adequate protection of aquatic life in the receiving waters of industrial effluents cannot be ensured by effluent discharge guidelines alone. These guidelines are based on toxicity data which are available for a limited number of effluent compounds and aquatic taxa. Furthermore, unknown synergistic toxic effects and continuously changing physicochemical parameters make it impossible to consistently predict the response of an aquatic ecosystem to an industrial discharge.

The most direct and cost effective approach to the assessment of effluent toxicity is by biomonitoring. Most biomonitoring of industrial effluents in the United States during the past few years has been done using methods described by the United States Environmental Protection Agency (EPA). Standard EPA procedures usually consist of a short term (8-24-h), range finding (screening) test followed by longer term (usually 96-h) flow-through (or alternative static) definitive tests (Peltier 1978). These tests take place in a laboratory setting.

Because of its simplicity, the method described in this paper could be used in many cases to precede or preclude the definitive tests described by Peltier (1978) and mandated in numerous National Pollutant Discharge Elimination System (NPDES) permits.

## MATERIALS AND CONSTRUCTION

Test chambers (Figure 1) were constructed by cutting 12 cm x 25 cm rectangular holes from opposite sides of 8L polyethylene bottles (leaving 5cm wide support strips on both sides of the bottles). A 16 cm x 72 cm piece of 3 mm mesh screening was then wrapped around the bottle and secured using three 1.3 cm wide stainless steel adjustable band clamps. The bottom 6.5 cm of each test chamber provided a reservoir to keep the fish submerged while the chamber was being installed or removed. The chambers were anchored in situ using rope and a snap hook.

## TEST CHAMBER TRIALS

Exposure tests to evaluate the chambers were conducted in three aquatic systems in South Carolina: a reservoir (Par Pond), a creek (Upper Three Runs Creek), and a river (Savannah River). Fish used as test organisms were yearling fathead minnows (Pimephales promelas) and young-of-the-year bluegills (Lepomis macrochirus). Ten fish of the same species were placed in each test chamber. The chambers were examined frequently (usually once per day) for 65 days to assess mortality. Criteria used to establish test organism mortality were: 1) no observable opercular movement, and 2) no reaction to gentle prodding.

Results are shown in Figures 2-4. All fathead minnows remained alive in the chambers for the entire 65 days in Par Pond and Upper Three Runs Creek. One of ten fathead minnows died after 29 days of exposure in the Savannah River. Bluegill mortality

was less than 50% after 65 days of exposure in the test chamber in the three habitats. Time required for a single mortality was 28 days for Upper Three Runs Creek, 12 days for Par Pond and 2 days for the Savannah River. Fathead minnow survival was substantially greater than that of bluegills in all tests.

#### ADVANTAGES AND DISADVANTAGES

The method provides a relatively simple and inexpensive way to screen effluents for acute toxicity. The in situ method is more sensitive than laboratory methods in two respects: 1) pulse discharges of toxic substances can easily be missed when effluent is collected in grab samples and transported to a laboratory for bioassays, and 2) toxicants which dissipate rapidly, such as total residual chlorine, can be overlooked when there is a delay between collection and testing.

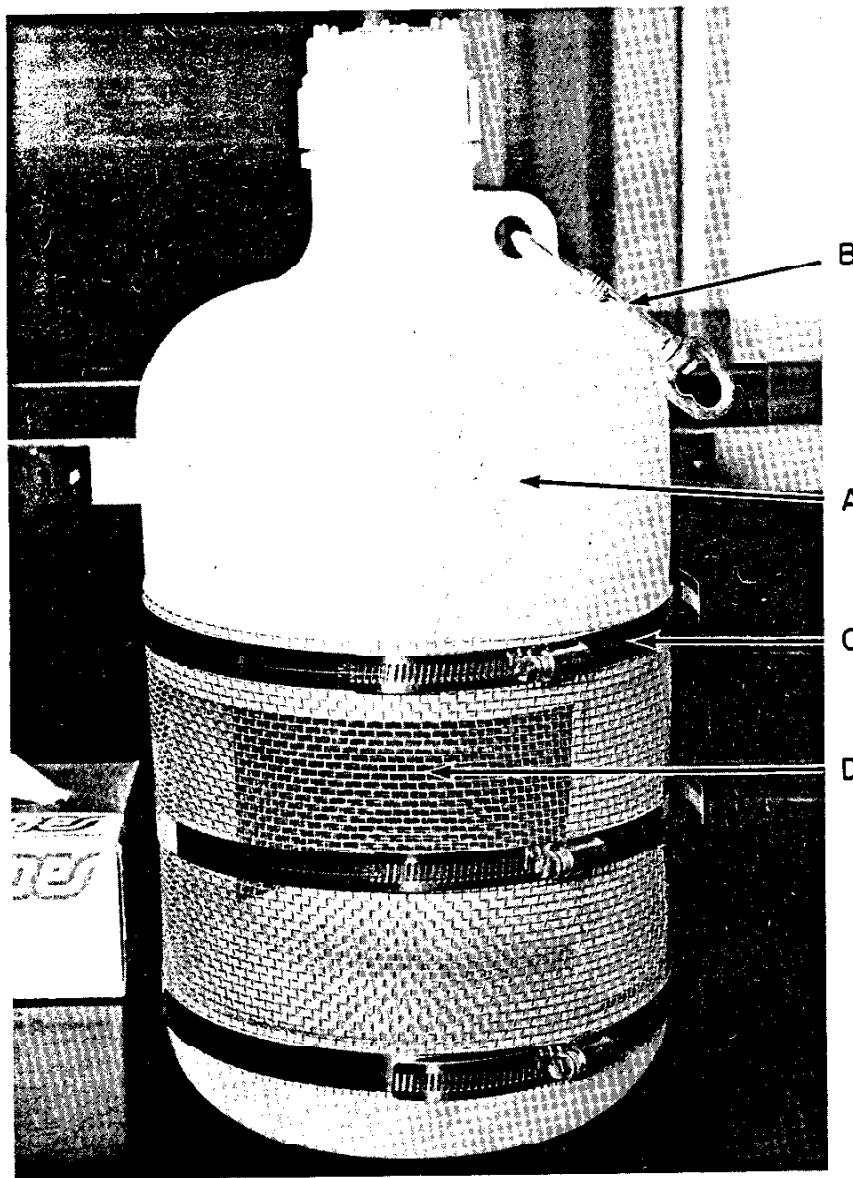
Although the in situ method is more sensitive for detecting (but not defining the extent of) mortality than bioassays conducted in the laboratory, information on mortality is limited to determining the percentage of test organisms killed after exposure to 100% effluent for a specific time period. This is in contrast to the exposure of test organisms to a variety of effluent dilutions and the subsequent calculation of LC 50's. Another limitation of the method is that test organisms must be acclimated to pH and temperature conditions similar to those of the effluent prior to initiation of the bioassays.

#### REFERENCES

1. Peltier W. (1978) Methods for measuring the acute toxicity of effluents to aquatic organisms. USEPA Environmental Monitoring Series EPA-600/4-78-012.

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**FIGURE 1.** In Situ fish bioassay test chamber: A) 8-L polyethylene bottle, B) snap hook for rope attachment; C) 1.3-cm wide stainless steel adjustable band clamp; D) 3-mm mesh stainless steel screening



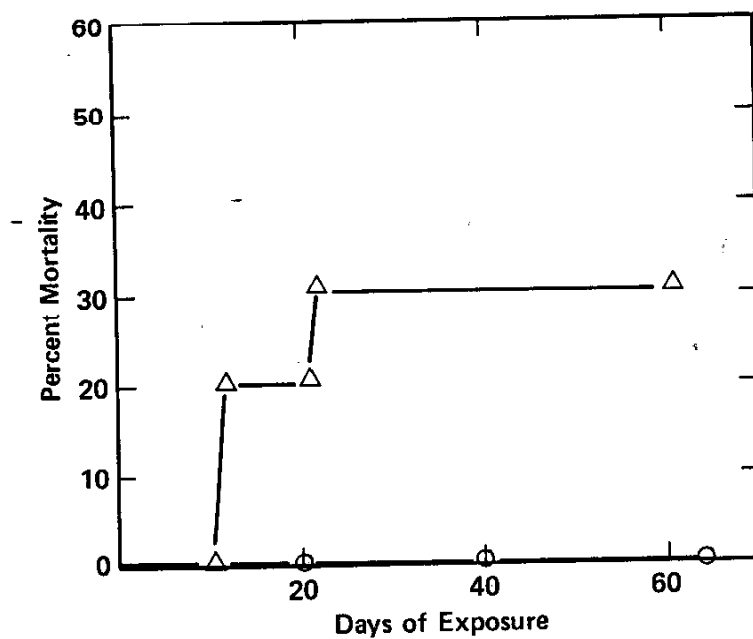


FIGURE 2. Mortality of bluegills  $\Delta$  and fathead minnows  $\bullet$  in in situ bioassay test chambers in Par Pond

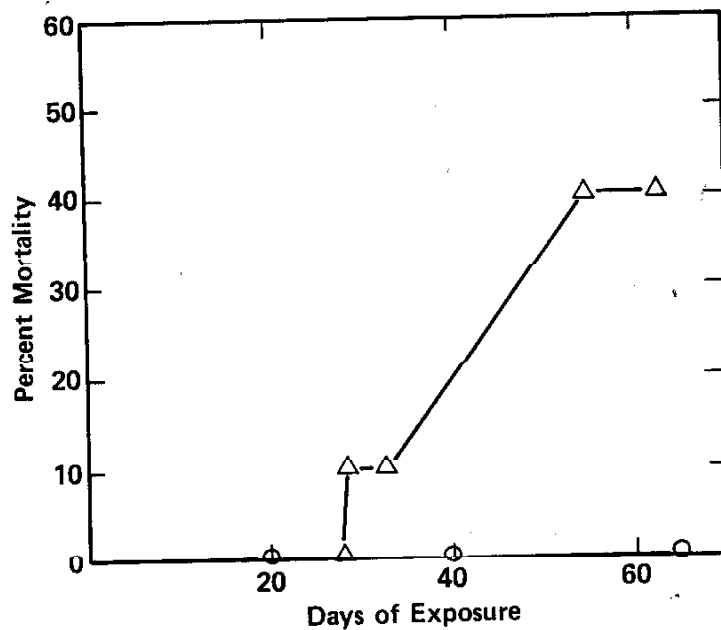


FIGURE 3. Mortality of bluegills  $\Delta$  and fathead minnows  $\circ$  in in situ bioassay test chambers in Upper Three Runs Creek

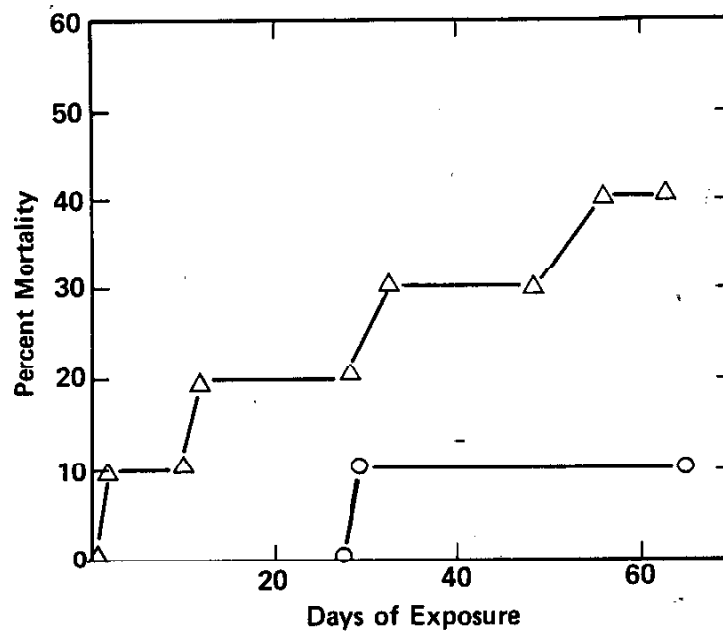


FIGURE 4. Mortality rate of bluegills  $\Delta$  and fathead minnows  $\circ$  in in situ bioassay test chambers in the Savannah River

#### FIGURE LEGENDS

FIGURE 1. In Situ fish bioassay test chamber: A) 8-L polyethylene bottle, B) snap hook for rope attachment; C) 1.3-cm wide stainless steel adjustable band clamp; D) 3-mm mesh stainless steel screening

FIGURE 2. Mortality of bluegills and fathead minnows in in situ bioassay test chambers in Par Pond

FIGURE 3. Mortality of bluegills and fathead minnows in in situ bioassay test chambers in Upper Three Runs Creek

FIGURE 4. Mortality rate of bluegills and fathead minnows in in situ bioassay test chambers in the Savannah River