RESPONSES OF BLACKNOSE DACE (*Rhinichthys atratulus*) AND BROOK CHAR (*Salvelinus fontinalis*) TO ACIDIFIED WATER IN A LABORATORY STREAM

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Abstract. As part of the Shenandoah National Park: Fish in Sensitive Habitats (SNP: FISH) project, movements of blacknose dace (*Rhinichthys atratulus*) and brook char (*Salvelinus fontinalis*) were examined during exposure to artificial acidification in paired channels of a laboratory stream. The objective of this study was to determine the ability of the fish to avoid depressions in the ambient pH and recognize and use a neutral-pH microhabitat refuge during acute reductions. Fish preference for a particular channel was statistically predictable based on the delivery of food. We tested fish avoidance behavior by manipulating food and the delivery of a pulse of acidified water. Both blacknose dace and brook char avoided the acid pulse (ambient pH reduced from 7.2 to 5.1) by sheltering in the pH-neutral refuge. Extensive field sampling in refuge microhabitats before and during episodic acidification is needed to determine changes in the distributional patterns of these species associated with acid precipitation events.

Key words: laboratory stream, acidified pulses, brook char, blacknose dace

1. Introduction

Water quality in many acid-sensitive streams is highly variable because of inputs of alkaline water from spring seeps and tributaries (Sharpe and DeWalle 1990). This spatial variability creates the potential for alkaline microhabitats to act as refugia for fishes exposed to periodic acidic episodes. Downstream migration and the congregation of fishes at alkaline water inputs have been reported by a number of researchers (Leivestad and Muniz 1976, Hall et al. 1980, Muniz and Leivestad 1981, Watt et al. 1983, Gagen et al. 1989). Fish in laboratory studies have demonstrated behavioral avoidance of a variety of environmental variables including low pH and high Al concentrations (Whitmore et al. 1960, Hill et al. 1981, Jones et al. 1985, Gunn and Noakes 1986). Although increased tolerance of brook char (*Salvelinus fontinalis*) to low pH through acclimation has been documented (Guthrie 1981), most researchers have not accounted for the effect of variables such as food availability, or sensory and physiological acclimation to extreme conditions (Gunn 1986). In addition, few researchers have studied the responses to acidification exhibited by nongame fishes (Charles 1991).

In this study, the effect of water acidification on movement of blacknose dace (*Rhinichthys atratulus*), and brook char indigenous to an acid-sensitive stream (Paine Run) of Shenandoah National Park (SNP), Virginia was tested in the paired channels of a laboratory stream. The objective of this study was to determine the ability of fish to avoid depressions
2. Materials and methods

Ninety young-of-year brook char, 52-81 mm total length, and one-hundred thirty adult blacknose dace, 52-78 mm total length, were collected from Paine Run by electrofishing and maintained in aerated aquaria. Experiments were conducted from August 31 through December 31, 1994 in the paired channels of a laboratory stream that was enclosed in a black plastic shroud equipped with viewing ports (Figure 1). Marks were placed along the inside walls to divide the channels into six zones of equal surface area (0.43 m²). Although inputs of food and acid alternated between channels, zone 1 was always closest and zone 6 furthest from the input. The bottom of the stream was covered by a single layer of washed stream gravel.

Water from head tanks was gravity-fed into separate areas at the head of each channel. As determined from 10 trials using a dye tracer, water moved uniformly down each channel and water did not mix between channels. Current velocity was 0.30 ± 0.05 m/s. An acid solution (100 ml H₂SO₄ in 400 ml H₂O) was used to reduce the ambient pH of a selected channel from 7.2 to 5.1 (-4 ± 0.1 unit) during an experimental trial. The acid solution was mixed with the gravity-fed water in the selected channel via a peristaltic pump (Masterflex Tubing Pump Drive Fixed Speed Model 7543-20, Cole-Parmer Instrument Company).

Fifteen fish were randomly selected for each trial. Fish were introduced into the downstream end of the laboratory stream and allowed 5 min to adjust before beginning each experiment. Fish were allowed to move freely between channels and among zones of the laboratory stream. Fish in each zone were counted every 30 sec for 30 min. Fifteen preliminary trials (no food or acid additions, 900 observations) were run with each species to assure that fish were not using either channel preferentially. Thirty trials (1800 observations) were run with each species, first with food additions to one of the paired channels (i.e., a brine shrimp suspension delivered via another peristaltic pump), and then with food and acid additions together in a channel for a total of sixty trials per species. Trials with food alone were used to determine if food affected fish distribution. Trials with food and acid combined were used to determine if fish actively avoided acidic conditions in an otherwise favorable environment.

We used a G-test to evaluate differences in the distribution of fishes (Sokal and Rohlf 1995). For preliminary trials without food or acid additions and for food-only trials, we hypothesized that the fifteen fish in a trial would use all six zones of the laboratory stream uniformly (i.e., on average 2.5 fish observed per zone over the course of a trial). In trials