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EFFECT OF PH ON SURVIVAL OF THE SLIMY SCULPIN, *COTTUS COGNATUS*

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ABSTRACT

The physical and chemical environment importantly influences the distribution and abundance of many organisms (Krohne, 1998). One major factor limiting fish abundance is water chemistry (Moyle and van Dyck, 1993). In this study, we tested whether pH affects the distribution of the slimy sculpin, *Cottus cognatus*, in freshwater springs of central Pennsylvania. Sculpins were transplanted from an alkaline, hardwater spring where they are abundant into relatively acidic, softwater springs where they are absent. Survival did not differ among the springs. Perhaps the transplanted sculpins were able to find sufficient food for survival in the acidic springs or were otherwise able to acclimate to the acidic conditions.

INTRODUCTION

In eastern North America, the stream and spring fish fauna is dominated by small and medium sized fishes (Matthews and Heins, 1987). The slimy sculpin, *Cottus cognatus*, is a common fish with wide distribution in lakes, cool rocky streams, and many freshwater springs (Fig. 1). They are approximately two to three inches long, with some variation, and move very rapidly along the stream bottom (Scott, 1967). The fish lies motionless for long periods of time and its coloration perfectly blends into the surroundings, making it difficult to observe. The question we asked is: "How does pH affect survival of the slimy sculpin?" Our null hypothesis was that pH should not influence the survival of *Cottus cognatus*. Our working hypothesis was that slimy sculpins should not be able to survive in springs of low pH. We hope that this study will increase our understanding of how environmental changes, such as acidification, may affect aquatic organisms.

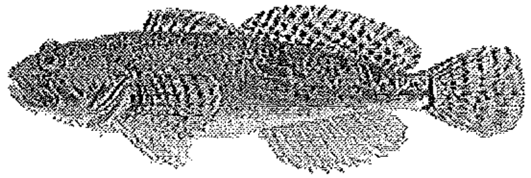

Figure 1. The slimy sculpin, Cottus cognatus

FIELD SITE

Four freshwater springs were used in our investigation of the slimy sculpin. Williamsburg Spring was originally deemed our "home" spring due to its ample sculpin abundance. However, vandalism prevented us from obtaining sufficient data at this site. Therefore, three other springs, Petersburg, Griffith, and Dubbel, were used to determine the effect of pH. Table 1 lists the pH and temperature of each spring determined in the field and in the lab. Because of the variation between field and lab pH, average pH will be used throughout the rest of this report. Although Williamsburg spring will not be used in the calculations, it is important to recognize its characteristics. Since Petersburg has many similar traits, it will be substituted as our "home" spring, though all of the sculpins used in our study originated from Williamsburg spring.

Table 1. The physical and chemical characteristics of the four study springs.

Spring	Temperature	pH (Field)	pH (Lab)	pH (Average)
Williamsburg	12.0° C	6.98	7.39	7.19
Petersburg	10.7° C	6.23	6.53	6.38
Griffith	8.6° C	4.68	4.86	4.77
Dubbel	5.7° C	4.00	4.06	4.03

METHODS AND MATERIALS

From Williamsburg spring we collected approximately 100 sculpins, which were stored in a refrigerator for two days before being transplanted. For our transplant study, we used transplant containers with mesh netting that permitted food, mainly aquatic insects and benthic invertebrates, to enter. We placed 10 transplant containers, each containing one sculpin, into each spring: Williamsburg, Petersburg, Griffith, and Dubbel. For each spring, we tested for pH using both field and laboratory pH meters. The first transplant lasted seven days. After that week, the transplant containers were retrieved and the number of living, dead, and missing sculpins was recorded. A second trial was then initiated with 10 sculpins transplanted into each spring for 11 days.

RESULTS

The results were unexpected. In each spring, the slimy sculpin was able to survive for a long period of time even at very low pH levels. Tables 2-5 show the number of sculpins found alive, the number found dead, and the number of transplant containers empty due to missing sculpins. In each spring, the total number tested was twenty. The total number of survivors for each spring is listed in Table 6. Data from Williamsburg spring were omitted from Table 6 because they were incomplete due to vandalism. No significant differences in survival were observed among the springs (Fig. 2).

Table 2. Survival of Cottus cognatus in Williamsburg spring.

Sculpins	Alive	Dead	Missing	Total
Trial 1	1	0	9	10
Trial 2	4	0	6	10
Total	5	0	15	20

Table 3. Survival of Cottus cognatus in Petersburg spring.

Sculpins	Alive	Dead	Missing	Total
Trial 1	8	0	2	10
Trial 2	9	0	1	10
Total	17	0	3	20

Table 4. Survival of Cottus cognatus in Griffith spring.

Sculpins	Alive	Dead	Missing	Total
Trial 1	9	0	1	10
Trial 2	9	0	1	10
Total	18	0	2	20

Table 5. Survival of Cottus cognatus in Dubbel spring.

Sculpins	Alive	Dead	Missing	Total
Trial 1	8	1	1	10
Trial 2	7	1	2	10
Total	15	2	3	20

Table 6. The total number of sculpin survivors at each spring. Petersburg spring = #1, Griffith spring = #2, and Dubbel spring = #3.

Number of Sculpin Survivors	Spring Number
8	1
9	2
8	3
9	1
9	2
7	3

Kruskal-Wallis Test

C2	N	Median	Ave. Rank	Z
1	2	8.500	3.8	0.23
2	2	9.000	5.0	1.39
3	2	7.500	1.8	-1.62
Overall	6		3.5	

H = 3.07 DF = 2 P = 0.215
H = 3.58 DF = 2 P = 0.167 (adjusted for ties)

Figure 2: Comparison of sculpin survival in three springs (Kruskal-Wallis Test, using data in Table 6).

DISCUSSION

Slimy sculpins, *Cottus cognatus*, are abundant in springs of high pH. The hard water provides the fish with a suitable environment, presumably due to the ample food availability (mainly amphipods and isopods). Our working hypothesis was that pH should have no effect on the survival of the slimy sculpin. This hypothesis was suggested by the absence of *C. cognatus* in acidic, softwater springs. Excluding Williamsburg Spring, due to tampering of our samples, the number of survivors at each site deviated by only three fish (Figure 2). This deviation was not significant, thus disproving our working hypothesis. Slimy sculpins can, in fact, survive over a wide range of pH (4.03 to 7.19). Our data suggest that pH is not the primary limiting factor in *C. cognatus* distribution. Rather, other factors may be important, such as poor dispersal ability of sculpins, and low availability of benthic invertebrates in soft water springs. For example, amphipods, a primary food source for sculpins, cannot tolerate pH levels lower than approximately 6.0.

Our study is a preliminary investigation of the effects of water chemistry on *C. cognatus*. It was meant as a stepping stone for further investigation into sculpin abundance. Subsequent experiments must take into consideration that the effects of pH might not become easily recognizable in only eleven days. Ideally, the procedure should be run over several months. Also, others factors might be taken into account, such as conductivity and dissolved oxygen, nitrate and heavy metal concentrations. With more data, researchers might learn why sculpins are abundant in some springs yet absent from other, similar springs. Reasons could include water pollution from any number of sources, making sculpins a useful indicator species.

ACKNOWLEDGEMENTS

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