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Kairomone versus visual response to a predator in *Notropis heterolepis*

ABSTRACT

Fish use a number of methods to avoid detection by predators and survive. This study investigated two of these methods: visual detection of the predator and kairomones, a chemical given off by the predator that alerts the prey of its presence. We proposed to test the responses of *Notropis heterolepis* (Blacknose Shiners) to each of these stimuli given by predator Yellow Perch, *Perca flavescens.* We predicted that shiners would increase activity in response to the visual stimulus, and would decrease activity in response to the kairomone stimulus. We tested this question by exposing shiners to perch kairomones in one treatment, giving shiners a visual of the perch in another treatment, and monitoring their activity for both treatments. Our results showed no significant difference in the shiners' response to visual versus kairomone stimuli.

INTRODUCTION

Predators have evolved over time in order to better hunt their prey, while animals that are preyed upon have learned to develop defenses in order to stay alive. One way that many fish avoid predators is by paying close attention to chemical cues. A kairomone is a chemical released by one species (predator) and received by a second species (prey), that is adaptively favorable to the prey but not the predator (Ferrari et al. 2010). Kairomones can be particularly useful because they can travel through visual barriers such as vegetation or sediments, and can be detected in the dark (Mathis et al. 2003). This suggests that kairomones can be used by the prey to detect predators before they ever come into visual contact. Other studies have shown that tadpoles can determine the predator based on species-specific kairomone cues (Shoeppner & Relyea 2009). It has been suggested that minnows can determine either the relative proximity or relative density of predators based on predator odours, and that they can even differentiate individual predators in a mixture of odours (Ferrari et al. 2006). When comparing a kairomone versus visual predator stimulus, one would expect different responses to each stimulus. One study found that glowlight tetras determine threat levels primarily through kairomones and secondarily through visual cues (Brown & Magnavacca 2003). We predicted that *N. heterolepis* would have two different responses to visual and kairomone stimuli from a predator *P. flavescens*. When presented with the visual presence of the predator, shiners should increase activity, to try to flee from the predator. When kairomones from the predator are introduced, shiners should decrease activity, in order to avoid detection from the predator.

METHODS

Data Collection

N. heterolepis and *P. flavescens* were caught with seine nets. For each trial 5 shiners were placed in each tank. For the visual treatment, a predator perch, approximately 15.2 cm in length, was placed in an adjacent tank. There were 5 replicates of the visual test, and 5 controls, in which no perch was placed in the adjacent tank. One shiner in each tank was observed for 10 min before the addition of the perch, and for 10 min while the perch was in the neighboring tank. Each tank had a grid of 5cm x 5cm squares on the side. Watchers counted the number of lines crossed by one shiner to measure the activity. For the kairomone treatment, 5 shiners were placed in each tank, and there were 5 replicates. Perch were placed in a tank for 48 hours in order to let the kairomones enter the water. Lines crossed by one shiner was watched for 10 min before 180 ml of kairomone-containing water was taken from the perch tank and slowly pumped into the tank containing shiners.

Lines crossed by the same shiner were observed for another 10 min. The 5 control tanks had tank water added instead of kairomones.

Statistical Analysis

A non-parametric Kruskal Wallis test was used to analyze the data.

RESULTS

Statistical analysis showed that there was no significant effect of visual and kairomone stimuli on fish activity (H = 6.291, 3 d.f., P = 0.098; Fig. 1). The analysis shows no significant difference between visual and kairomone responses, however there is a trend in the decrease in activity in response to the kairomone stimulus.

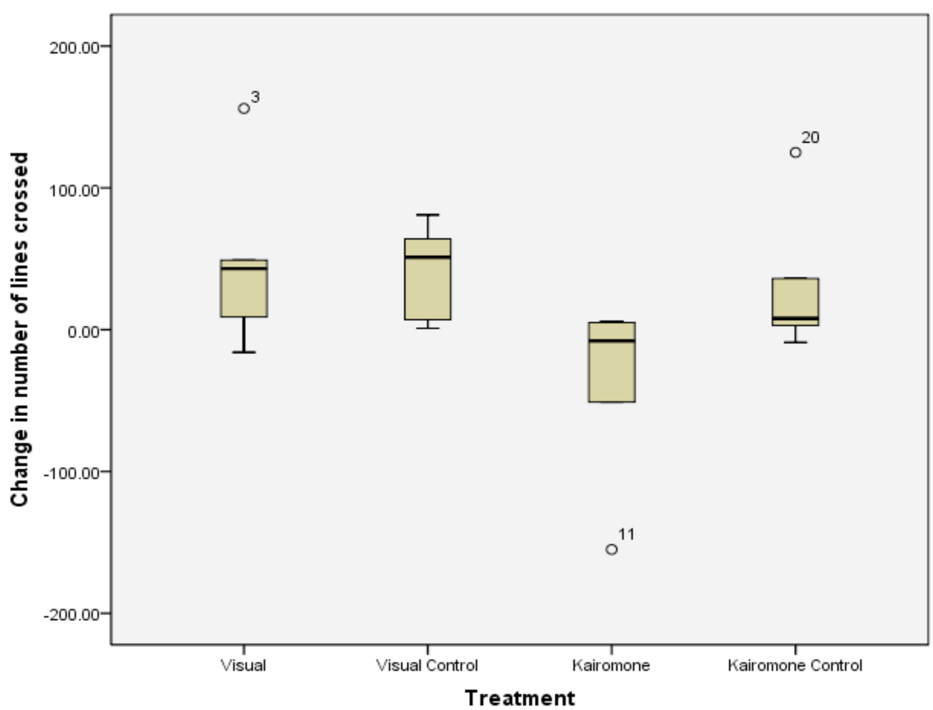

Figure 1. Median values of change in number of lines crossed by shiner for four treatments: Visual, Visual control, Kairomone and Kairomone control.

DISCUSSION

Although there was not a significant effect of visual and kairomone stimuli on fish activity, there was a trend in the data. When looking at the overall trend in the data, there was a slight decrease in activity in response to the kairomone stimulus. Other studies have found evidence that prey decrease activity in response to predator kairomones. One experiment found that larval ringed salamanders responded to predator kairomones with decreased activity in order to lower the risk of detection (Mathis et al. 2003). Another study actually found reduced activity in larval newts in response to visual stimuli (Mathis & Vincent 2000), contrary to our prediction.

The results found in our study, influenced by the activity of one individual, could have been affected by the predator's behavior or the behavior of the shiner group. It has been suggested that visual response to a predator can be dependent on the predator's posture and behavior (Brown & Magnavacca 2003); if the predator does not seem like it is hungry or about to hunt, the prey may not respond defensively. Future research in this area might test visual and kairomone stimuli simultaneously, or whether predator perch density affects shiner response. Other future research might compare prey response to stimuli from different predators, or a shoal response versus the individual response.

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