Age Specific Behavioral Variability of Creek Chub Minnows after Exposure to Various Chemicals

The Power of AND | University of Wisconsin Eau Claire

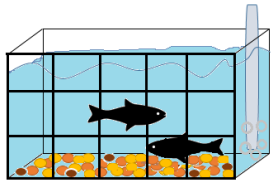
Michael Wold, Mackenzie Flynn, Taren Leiztke, Andrew Fischer, Leah Radeke, and Dr. David Lonzarich,
Biology Department University of Wisconsin Eau Claire

Introduction and Objectives

An unknown constituent of skin extract from fish of the superorder Ostariophysi (minnows, catfishes, suckers) causes conspecifics to elicit an alarm behavior.[1] We define alarm behavior as an increase in movement and bottom use and a decrease in feeding. Chondroitin sulfate has been proposed as the agent responsible for this behavior.[2] But earlier work in our lab examining the response of Zebrafish (*Danio rerio*) to this odorant has suggested that it might instead be more likely associated with foraging behavior.

In this study, we explored two still unresolved questions regarding the behavioral effects of alarm odorants on fish behavior. Using a common Wisconsin fish, the Creek Chub (*Semotilus atromaculatus*), we set out to characterize the behavioral responses of Creek Chub to the putative alarm chemical – chondroitin sulfate, and to evaluate the merits of a hypothesis[4] that the nature of the response of fish to alarm odorants is modified with age.

To evaluate the effects of chondroitin on the behavior of test subjects, our experiments included two other odorants – conspecific skin extracts, which have been shown in previous work to elicit alarm behaviors in chub, and bile salts, which have been implicated in fish foraging behavior.[3]



Experimental tanks were either 5 or 10 gallons in size. To measure fish movement and distribution in the tanks, gridlines (10 x 10 cm) were drawn on the tank wall. Odorants were introduced through PVC tubes located in the rear corner of tanks

Methods

- Solutions of skin extract and chondroitin sulfate were made using conventional methods.[2] A saturated solution of bile salt was used.
- Movement was quantified by the number of times a gridline was crossed.
- Feeding behavior was counted as strikes at the surface or digging in gravel.
- The percentage of time spent in the top, middle, or bottom sections of the tank was calculated to give a value for location.
- Experimental tanks of 5 and 10 gallon sizes were used with four small fish (< 80 mm) or two large fish (>150 mm), respectively. Length can be used as a proxy for age in fish.[5]

Results

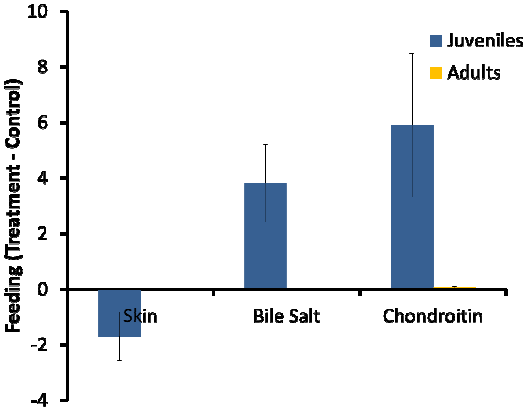


Figure 1. Feeding behavior posttreatment minus control per minute (+SEM) in Creek Chub. N=18 Skin, N=13 Bile Salt, N=15 Chondroitin. Treatments consisted of 20 ml of prepared solutions.

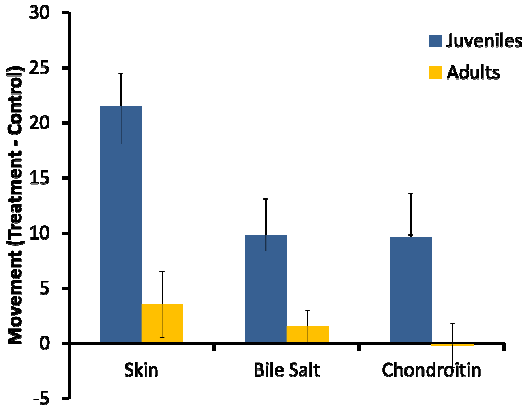


Figure 2. Gridlines crossed posttreatment minus control per minute (+SEM) in Creek Chub. N=18 Skin, N=13 Bile Salt, N=15 Chondroitin. Treatments of 20ml of prepared solutions.

Discussion

Feeding behavior upon exposure to chondroitin was more similar to that of bile salt but all treatments differed with a p-value < 0.05 (Fig. 1). We also saw a significant difference, p-value < 0.05, in movement between treatments with chondroitin mirroring values generate by bile salt (Fig. 2). This goes against evidence that suggested chondroitin elicits an alarm response.[2] Ontogenetic factors seem to have a strong effect on odorant responses as shown in both Fig. 1 and Fig. 2 where differences between fish size was significant with a p-value<.05. Our evidence shows that chondroitin does not elicit an alarm response and that there are age dependent changes that cause different behaviors.

Next we will continue to explore the claims challenged in this study by looking more closely at neural stimulation. We have developed protocols to detect neural stimulation in the olfactory bulb which is important in detecting odorants. With data on the location of stimulation between large and small from chondroitin, bile salt, and skin extract stronger evidence about their effect can be generated.

Photograph of stained olfactory bulb

Acknowledgments

This study was funded by the UWEC Blugold Commitment Program. We are grateful for their support.

References

1. Pfeiffer W. Distribution of fright reaction and alarm substance cells in fishes. *Copeia*. 1977(4):653-665
2. Mathuru AS, Kibat C, Cheong WF, et al. Chondroitin fragments are odorants that trigger fear behavior in fish. *Current Biology*. 2012; 22(6):538-544.
3. Buchinger TJ, Weiming L, and Johnson NS. Bile salts as semiochemicals in fish. *Chemical Senses*. 2014. 39:647-654.
4. Lonnstedt OM, McCormick MI. Chemical alarm cues inform prey of predation threat: the importance of ontogeny and concentration in a coral reef fish. *Animal Behaviour*.2011;82(2):213-218.
5. Fridriksson A. On the calculation of age-distribution within a stock of cod by means of relatively few age-determinations as a key to measurements on a large scale. *Rapports et Procès-Verbaux des Réunions du Conseil Permanent International pour l'Éxploration de la Mer.* 1934;86:1-5.

We thank the Office of Research and Sponsored Programs for supporting this research, and Learning & Technology Services for printing this poster.