CHEMICAL SIGNALS FROM THE SKIN OF RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) ELICIT PHYSIOLOGICAL AND CELLULAR STRESS RESPONSES

[1]Dominic Toa
[1]Faculty of Agricultural Sciences, University of British Columbia,
144-2357 Main Mall, Vancouver, BC, Canada V6T 1Z4
Phone: (604) 822-4910
E-mail: domtoa@hotmail.com

[1]Nil Basu [1,2]Luis O.B. Afonso [1,2]George K. Iwama
[1]Faculty of Agricultural Sciences and AquaNet, The University of British Columbia, 248-2357 Main Mall, Vancouver, BC, V6T 1Z4, Canada
[2]Institute for Marine Biosciences, National Research Council, 1411 Oxford Street, Halifax, NS, B3H 3Z1, Canada,

EXTENDED ABSTRACT ONLY - DO NOT CITE

Several aquatic organisms, including fish, release chemicals that may serve as alarm signals (Mirza et al, 2001). However, the function of the chemical signals is not clear. Several fish species utilize chemical alarm signals to warn conspecifics of a predation threat (anti-predator response) (Pfeiffer, 1982; Smith, 1992). The chemicals that elicit anti-predator responses, or "fright response", in nearby conspecifics are generally produced, or contained in the epidermal cells (Smith, 1992). There are reports showing that the receivers (nearby fish) of the chemical alarm signals responded by changing behavioral (Brown and Goding, 1997; Smith, 1992) and physiological states (Rehnberg and Schreck, 1986). The goals of the present study were to determine whether a chemical signal, released by rainbow trout, would elicit a physiological (heamatocrit, plasma cortisol, and glucose levels) and cellular stress response (liver 70kDa heat shock protein), in their conspecifics.

We exposed rainbow trout for one hour to; 1) skin extract from a non-stressed fish, 2) skin extract from a stressed fish, 3) water from a stressed fish, and 4) head tank water as the control. There were 2 replicates per treatment and 5 fish in each treatment. To prepare the skin extract from non-stressed fish, 5 grams of epithelium from a fish in the stock tank was collected from the dorsal section of the juvenile fish along the lateral line and placed in 100 ml of distilled water. Then the tissue was homogenized by Polytron homogenizer (Polytron, Switzerland), filtered, further diluted to 4L, and added to the test tanks. For preparation of stressed fish skin extract, a juvenile rainbow trout was first physically stressed by being chased in a bucket of water for one minute before the epithelium was sampled. For the water from a stressed fish, a juvenile rainbow trout was netted and placed in a 4L bucket of water, chased for one minute and the water was filtered and directly transferred into the test tanks. One-hour after adding the water to the test tanks, we sampled for blood and liver from each fish. Then we determined haematocrit (% red blood cells), plasma cortisol, and glucose levels as physiological stress responses, and liver Hsp70 levels as cellular stress response. Results are reported as mean $\pm$ SEM. Data was analyzed by ANOVA and to discern differences among treatments ($P< 0.005$), the Student-Newman-Keuls test was applied.

Plasma cortisol levels were significantly increased in fish exposed to water from a stressed fish and to the skin extract of the non-stressed fish (Fig. 1). All treated groups represented significantly higher haematocrit levels than the control group., and plasma glucose levels remained fairly constant in all treatments and there were no significant differences (data not shown). Hepatic Hsp70 levels were significantly higher in the group exposed to the water from a stressed fish (Fig. 2).

Our results demonstrated that juvenile rainbow trout elicited a stress response when exposed to conspecific chemical alarm signals. It has been shown that rainbow trout increased anti-predator behavior (fright response) when exposed to conspecifics skin extract (Brown and Smith, 1997). The authors suggested that this response would likely increase their chance of survival by reducing the risk of detection. In our study we did not examine the behavioral fright response but it is well known that stimuli that produce fright, discomfort, and pain generate a

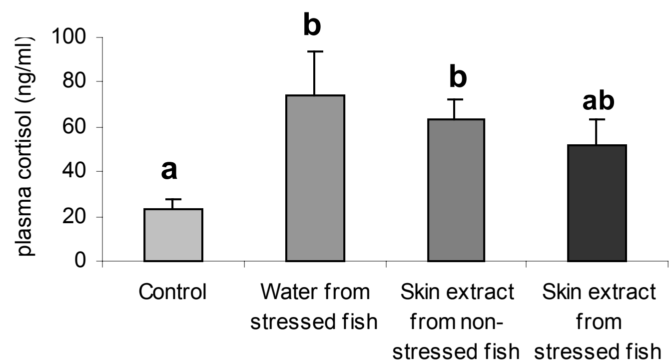

Fig 1: Effects of chemical stimuli on plasma cortisol levels in Rainbow Trout

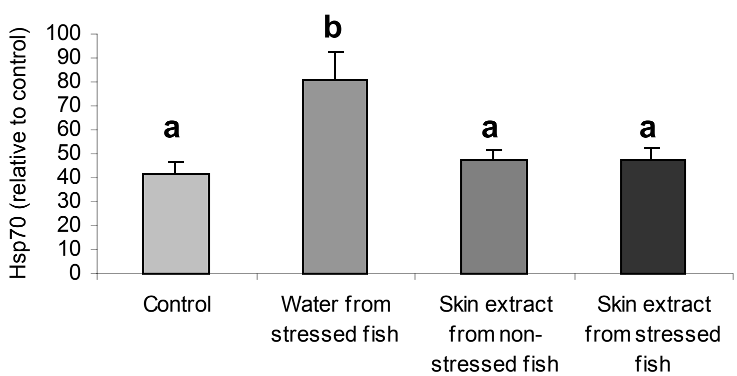

Fig 2: Effects of chemical stimuli on hepatic Hsp70 levels in Rainbow Trout

stress response reaction in fish. Therefore, the increase in cortisol and hepatic Hsp70 levels we observed indicates that fish elicited physiological changes probably in an attempt to compensate for the challenges imposed upon it. Further examination of the physiological, cellular and behavioral responses under the exposure to chemical alarm cues, as well as determination of the chemical component functioning as the alarm cue, may add new insights to understanding the functional importance of chemical alarm signals in fish under stress.

Acknowledgments

This research was supported by an operating grant from the Natural Sciences and Engineering Research Council of Canada (NSERC) and AquaNet (Networks of Centres of Excellence) to GKI. I am grateful to Dr. Kazumi Nakano for her critical review of this paper. I also express my thanks to all the students working in George Iwama's lab for their ideas and assistance in making this project successful.

References

Brown, G.E. and J.–G.J. Goding. 1997. Anti-predator responses to conspecific and heterospecific skin extracts by threespine sticklebacks: alarm pheromones revisited. Behavior 134: 1123-1134.

Mirza, R.S., Scott, J.J. and D.P. Chivers. 2001. Differential responses of male and female red swordtails to chemical alarm cues. J. Fish Biol. 59: 716-728.

Pfeiffer, W. 1982. Chemical signals in communication. *In* chemoreception in Fishes. Edited by T. Hara Elsevier, Amsterdam. Pp. 307-326.

Rehnberg, B.G. and C.B. Schreck. 1986. Chemosensory detection of predators by coho salmon (oncorhynchus kitsutch): behavioral reaction and the physiological stress response. Can. J. Zool. 65: 481-485.

Smith, R.J.F. 1992. Alarm signals in fishes. Rev. in Fish Biol. Fish 2:33-63.