The Effect of Lead Exposure on Male Fathead Minnows

By: Elizabeth Catania and Alexis Peterson

Abstract
Lead is a common element found in water pipe lines and old paints. The purpose of this experiment was to determine if lead had a significant effect on the sexual tendencies of male fathead minnows. The data collected shows that lead exposure does lead to a decrease in secondary characteristics and sexual behaviors in males. Lead can be detrimental to many species, and the results from this experiment shows just a portion of how harmful this element can be.

Introduction
Lead is a common element found in paint, pipes, and even soil. Despite being common, the effects of lead exposure can be detrimental. When exposed to lead, males can experience lower levels of testosterone. The lead alters the male sexual hormone, which might injure the endocrine function and Sertoli cells (1). With less testosterone, fewer sexual characteristics will be exhibited by males. Due to the harmful side effects seen in humans, and since fish and humans have a fundamentally similar endocrine system, fathead minnows are used to test how lead affects males (2). Lead exposed males display less of the secondary sexual characteristic development, including banding, tubercle formation, and exhibiting a head pad (3). The expected secondary sexual characteristics and mating behaviors will not be as common in the lead exposed male minnows due to the decreased level of testosterone that occurs when lead in present.

Materials and Methods
Prior to the lab, 3 pairs of adult fathead minnows were exposed to lead nitrate at UW Milwaukee. 6 pairs (3 lead exposed and 3 control) of minnows were transported from the university to Muskego High School. After allowing the minnows to acclimate to their new environment for 3 days, observations began. Secondary sexual characteristics— dorsal fin spot, head pad, tubercles, and side bars— were recorded in the male fathead minnows. Over a duration of 5 minutes, the pairs were observed. Data was collected regarding the number of nest preps, hovers, patrosl, chases, and spawns. The data was then averaged, and a standard error of the mean was calculated (+/- 1 SEM). These numbers were then used to determine if there were any significant differences between the lead exposed fish and the control fish (figure 2).

Sources
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2. Weber, D N. “Exposure to Sublethal Levels of Waterborne Lead Alters Reproductive Behavior Patterns in Fathead Minnows (Pimephales Promelas).” Neurotoxicology, U.S. National Library of Medicine, 1993, www.ncbi.nlm.nih.gov/pubmed/8247408.
3. Yu T1, Li Z, Wang X, Niu K, Xiao J, Li B, “Effect of lead exposure on male sexual hormone” Wei Sheng Yan Jiu = Journal of Hygiene Research, U.S. National Library of Medicine, July 2010, httpswww.ncbi.nlm.nih.gov/pubmed/20726225

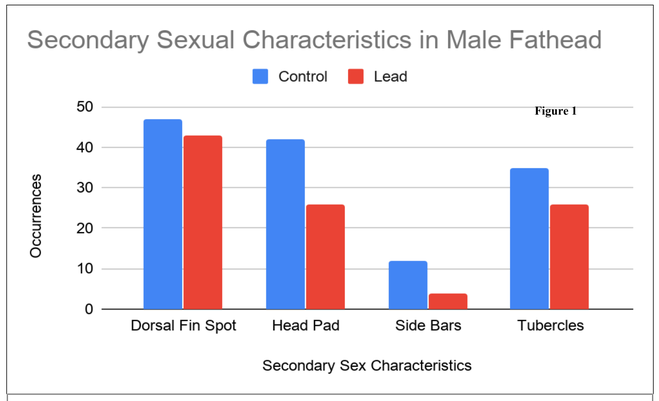

Figure 1 →
Figure 1 displays the secondary sexual characteristics in male fathead minnows from both the lead exposed tanks and the control tanks. The control fish show that the characteristics were more prominent in the non lead exposed minnows. On the other hand, the lead exposed fish, represented by the red bars, displayed less of the expected secondary sexual characteristics.

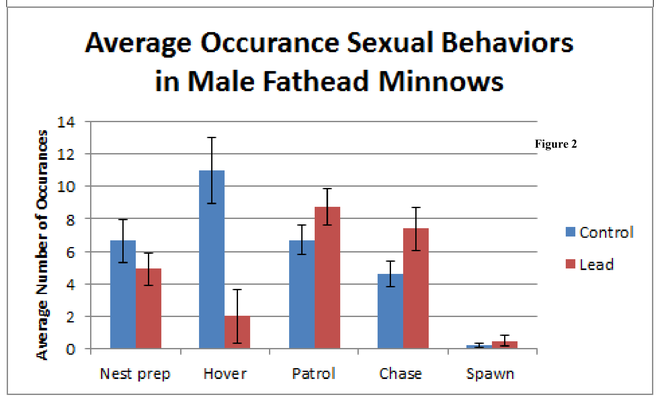

Figure 2 →
Figure 2 displays the behaviors in male fathead minnows over five minute intervals. The control fish significantly spent more time towards the top of the nest (hovering) than the lead exposed fish. The lead exposed fish displayed more aggressive behaviors towards the females including significantly more patrolling and chasing. The error bars display just how drastic the lead effects are. There is a clear distinction between the lead exposed fish and the control fish in their behaviors.

Figure 3- in this image, a male fathead minnow is in an artificial breeding chamber. This minnow is not engaged in a hover or a nest prep, but his positioning in the breeding chamber implies that sexual behaviors are about to occur.

Figure 4- In this image, the male fathead minnow is located outside of the breeding chamber. He is patrolling, which means that he has left the breeding chamber. In figure 2, the data shows that the lead exposed fish typically patrolled significantly more often than the control fish.

Discussion
The hypothesis that lead exposure significantly reduces the sexual tendencies of male fathead minnows can be supported by this research. Overall, the minnows that were exposed to lead displayed a fewer number of secondary sexual characteristics (figure 1). Compared to the control fathead minnows, the lower number of secondary characteristics lead to fewer occurrences of typical sexual behaviors in males. Hovers were significantly higher in the control fish than in the lead exposed fish. However, patrols and chases were more common among the lead exposed fathead minnows. These results could be due to the altering behavioral effects that lead has. The increased level of lead exposure increased the aggression in the fathead minnows. Since the fish became more aggressive, they were less likely to prepare the nesting chambers for mating. By patrolling and chasing off females, they made it very clear that their expected male mating behaviors were not present. Having the lead exposed fish possess less characteristics supports the claim that lead alters testosterone and sexual drive in male fathead minnows. One limitation was that these fish were only observed in a five minute time frame once every other day. If the data was collected at the wrong time of day or the control group mated outside of the observation window, the resulting data is prone to being skewed. By increasing the sample size or increasing the observation time frame, inconsistencies would become less common. The results confirmed in this experiment can help humans and their knowledge when it comes to the effects of lead poisoning. Assessing how lead changes the behaviors in fathead minnows can be applied to human health. More treatment or prevention methods can be developed, and hopefully the damage caused by lead will be reversed easier in the future.