The Effect of Lead Exposure on Fathead Minnows

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Abstract

The purpose of this experiment was to determine whether or not exposure to lead lowers the success rate of a Fathead Minnow to breed, engage in social reproductive behaviors, and display secondary sex characteristics. Lead poisoning is a major problem tormenting homeowners all over the U.S. due to the abundance of lead in household construction materials. The results of our experiment can be used to determine how lead can negatively affect the human reproductive system. Our results indicated that there was a notable difference in the exhibition of secondary sex characteristics between the lead exposed fish and the control fish indicating that lead poisoning inhibits the Fathead Minnow's ability to display secondary sex characteristics. Furthermore, our results indicated that the lead exposed fish exhibited significantly fewer social reproductive behaviors as compared to the control fish and were therefore deemed to have exhibited a lower success rate of breeding.

Fig. 3

Fig. 4

Introduction

Lead is a naturally occurring heavy metal found in a multitude of areas around the U.S. When exposed to this heavy metal, it becomes absorbed into the body and distributed to blood, mineralizing tissues, and soft tissues where it accumulates over time (1). Lead poisoning does not always present itself right away, but when it does the physical symptoms include abdominal pain, irritability, joint and muscle pain, and loss of appetite. While these symptoms one can potentially recover from, some effects of lead poisoning can lead to permanent neurological abnormalities in a child due to the neuroplasticity of a child's rapidly developing brain (3). The Fathead minnow was used as a test organism to study the effects of lead poisoning on both physical characteristics and social behaviors in humans. When exposed to lead, Fathead minnows tend to display fewer secondary sex characteristics and spend less time engaging in social reproductive behaviors, most notably behaviors associated with the preparation and maintenance of the nest, due to a suppressed spermatocyte production (2). As a result, it is hypothesized that when Fathead minnows are exposed to lead they will display a lowered success rate of breeding, engage in fewer social reproductive behaviors, and exhibit a fewer total number of secondary sex characteristics.

Methodology

This experiment was a single-blind study with the lead exposed fish unknown. Twelve mating pairs of Fathead minnows were acquired, six of which were pre exposed to lead nitrate. The fish were separated into groups of 3 mating pairs in each tank. Each tank was maintained at temperature of 20 degrees Celsius.

1. The Fathead minnows were observed for three weeks, alternating observation every other day.
2. Secondary sex characteristics of the males were observed and noted at each observation day.
3. The behaviors and actions of the Fathead Minnows were observed for five minutes and tallied to determine the consistency and repetitiveness of each fish to engage in social reproductive behaviors at each observation day.
4. Graphical and Statistical analysis was used to determine whether or not the results of the experiment occurred by chance or displayed a significant deviation from the control group.

Results

Fig. 1 This graph shows the difference in the appearance of secondary sex characteristics in the fathead minnows. The different secondary sex characteristics observed include: dorsal fin spot, head pad, side bars, and tubercles. The results indicate that the fathead minnows exposed to lead show fewer secondary sex characteristics than the control minnows.

Fig. 1

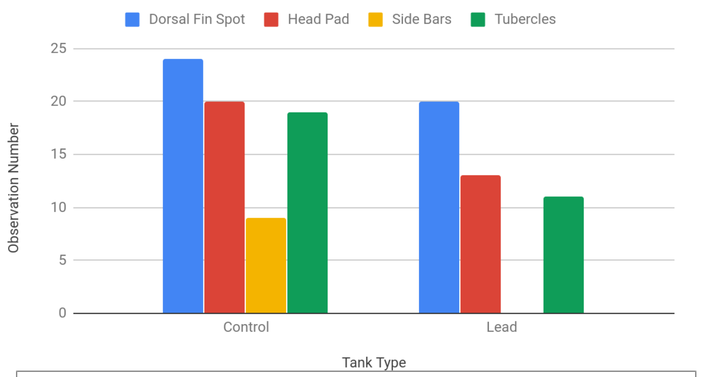
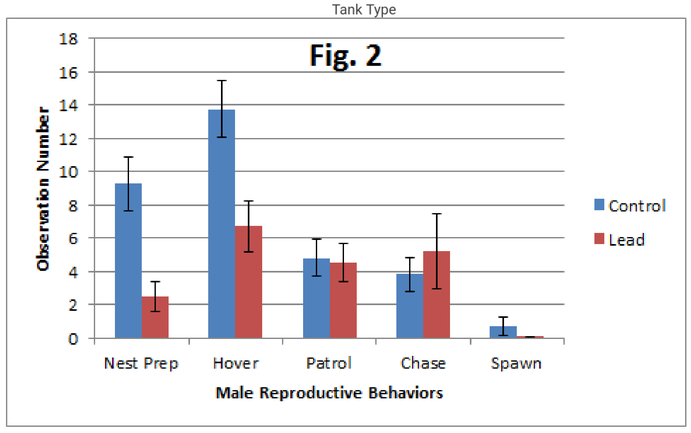


Fig. 2 This graph shows the difference in the number of male reproductive behaviors observed. The reproductive behaviors observed during the experiment include: nest prep, hover, patrol, chase, and spawn. The graph results suggest that the fathead minnows exposed to lead participated in significantly fewer nest preps, hovers, patrols, chases, and spawns than the control minnows. We used error bars indicate whether or not the difference between the environments is significant. The error bars indicate that there is a significant difference is the number of nest preps, hovers, and spawns between the two environments.



Discussion

Due to the results of our experiment, we reject the null hypothesis. The data from our experiment illustrate that the Fathead minnows exposed to lead displayed fewer secondary sex characteristics such as the dorsal fin spot, side bars, and tubercles as compared to the control minnows (Fig. 1). Moreover, the data from this experiment further illustrate that the Fathead Minnows exposed to lead engaged in fewer social reproductive behaviors as compared to the control group (Fig. 2). The data acquired from the Fathead minnows regarding their engagement in the social reproductive behaviors nest prep, hover, and spawn show that there were significantly fewer engagements exhibited for the lead exposed fish as compared to the control fish (Fig. 2). This data and information reinforces the fact that lead suppresses spermatocyte production and supports the hypothesis that lead exposed fish exhibit a lowered success rate of breeding, engage in fewer social reproductive behaviors, and exhibit a fewer total number of secondary sex characteristics. One occurrence that may have attributed to inaccurate results/error is the fish that died at different intervals of experimentation. Certain fish died at different days of experimentation and were replaced, and this may have attributed to errors/differences in our data. A limitation of this experiment was the sample size. A greater sampling of Fathead Minnows survived for the entirety of the three weeks of experimentation would have produced more accurate results. This information is important in identifying the effects of lead exposure on the human reproductive system. With this information, the team was able to conclude that lead plays a major role in altering the reproductive system of Fathead Minnows, therefore it is deduced that this type of alteration can be observed by humans. The next steps for our research would be to understand the effects of lead exposure on embryo and offspring development of Fathead minnows in order to relate that data back to the effect of lead exposure on childhood development.

References

(1) "Lead Toxicity." Environmental Health and Medicine Education, Centers for Disease Control and Prevention, 17 Apr. 2017

(2) Weber, Daniel N.Exposure to sublethal levels of waterborne lead alters reproductive behavior patterns in fathead minnows (Pimephales promelas) Neurotoxicology, vol. 14 no. 2-3, 1993, pp347-58.

(3) "Integrating Physiology and Behavior: Using Fathead Minnows to Model the Effects of Environmental Agents." *National Institute of Environmental Health Sciences*, University of Wisconsin-Milwaukee, 2012.