The Effect of Lead and Dividers on Fathead Minnow Sexual Behaviors and Characteristics

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Abstract

The conduction of this experiment was completed to determine the impact of lead on the reproductive behaviors of fathead minnows, applying our respective results to similar trends of human activity. Lead was paired with dividers in order to separate the fish and determine how multiple variables can change the reproductive patterns of fathead minnows. The fathead minnows were observed over a span of 2 weeks with observations being made every other day. One tank was exposed to no lead and had no dividers that isolated a single male and female, one tank was exposed to no lead but had dividers, a third tank was exposed to just dividers and no lead, while a final tank was exposed to both dividers and lead. Our data reveals that lead exposure, along with the presence of dividers, harms the fathead minnow reproductive abilities. These results effectively demonstrate the magnitude of various environmental variables, allowing an in depth analysis, into their effects on human reproductivity, to be formed.

Introduction

The spawning period, as well as the preparatory period, is vital in determining the secondary success of the fathead minnow offspring generation. Various processes such as, the preparation of the nesting environment by the males, sexual tendencies of both sexes, and ovule depository of the female, can all be directly impacted by the presence of certain environmental variables. Structural barriers implemented into a fathead minnow environment decreases the reproductive behaviors displayed by the males. These barriers can implement large consequences on a spawning pair of fathead minnows. Situations of isolation (abundance of barriers) or overpopulation (lack of barriers) each has their own specific effect on the behaviors of spawning minnows. Fathead minnows are socially facilitated breeders, meaning that the fish prefer to breed in large groups. The success rate of reproduction is diminished when each pair is alone.

So, when a male fathead minnow is immersed with barriers, he tends to lack conventional reproductive behaviors, partly because he is not intrigued with a large population opposite sex minnows to spawn with. On the contrary, when a male fathead minnow is placed in an environment with minimal physical constrictions, he tends to display more aggressive reproductive actions due to the presence of many female organisms (1).

It has also been determined that lead exposure alters the behaviors of the male fathead minnows. Lead directly targets the male hormone, testosterone, which is responsible for the male's sex drive. When the male's testosterone comes into contact with lead, decreased sexual tendencies and characteristics are observed (3). The surface waters in which various organisms live are very vulnerable to the contaminants of lead and other harmful metals from surface runoff, and atmospheric precipitation (2). The contraction of lead poisoning is a very prevalent and dangerous diagnosis, no matter what species is involved. It is very important we utilize the finding from the fathead minnows to gather a deeper understanding into the causes and repercussions of premature lead exposure. Children who contract lead poisoning at a young age experience delays in important cognitive and motor functions. The study of fathead minnows opens up a vast realm of possibilities, regarding preventions, or even decreasing the effects of lead exposure in a contaminated human. It is hypothesized that the fathead minnows that are exposed to multiple stressors (lead, dividers) will display fewer sexual reproductive behaviors as opposed to the fathead minnows that are only exposed to one of the stressors tested in our experiment.

Materials and Methods

The following materials were used in our experiment:

- 6 pairs of male and female fathead minnows pre exposed to lead nitrate at 1 ppm for two weeks prior to arrival at our school.
- 6 pairs of male and female fathead minnows not exposed to lead (control)
- Four ten gallon tanks with proper aquarium equipment; two tanks divided equally by two clear, perforated dividers. Each divided section equipped with semicircular PVC breeding chambers.
- Timers (stopwatches)

Two groups of tanks were used in this experiment, labeled respectively as: fish with lead contamination (Pb) and control (C). Each lead and control group was then split into separate tanks (D and N) for a collective sum of four tanks. The Pb tanks contained 12 minnows exposed to lead; the control tanks contained 12 minnows who were not exposed to lead. In relation to both colored groups, the numbers one and two were used to distinguish between tanks that contained dividers. Tanks labeled with a “D” indicated that dividers were present. Tanks labeled with a “N” indicated that no dividers were present. The first tank (Pb/D) contained lead-exposed fathead minnows; as well as, three equally dispersed dividers. The second tank (Pb/N) contained lead-exposed fathead minnows without the presence of any dividers. The third tank (C/D) contained three separated dividers and fathead minnows that had not been exposed to lead. Finally, the fourth tank (C/N) contained fathead minnows who had been exposed to lead and no dividers.

The regulation of all four tanks was monitored by our teacher, to ensure the consistency of variables such as temperature, light exposure, amount of fish in each tank, pH of the water,

and other variables. Observations were recorded in groups of two. The observation period spanned 14 school days, with observations being recorded every other day (total of 7 observatory days). Between the efforts of our two group members, physical characteristics were examined and recorded first. We then recorded the behaviors (refer to figure 1) of the minnows in our assigned tanks. The collection of this data then allowed us to create averages for each category collected upon, eventually translating those results into a standard error of the mean statistical test (SEM). The following graphs and figures reflect our analytical findings.

Results

The setup of the experiment allowed for minnow observations to be conducted without confusion over which variable was present. Four tanks were used in this experiment. The tanks were labeled respectively under two categories: Pb and C (portraying lead contamination) and the numbers “1” and “2” (presence of dividers). Two independent variables were present in this experiment. The primary independent variable in our experiment was the contamination of lead, and the secondary variable that we changed was whether dividers were placed within the tanks. The presence of minnow sex characteristics and presence of eggs in nesting chambers were also recorded. The controlled system shown below represents the tanks with no additional stressors (lead and dividers) so that accurate comparisons could be made between the effects of lead and physical obstructions on the fathead minnows.

The graphs below reveal the percentage of physical sex characteristics and the average number of behavioral sex characteristics exhibited by the fathead minnows over the fourteen day observation period. The specific number of minnow behaviors was recorded (as well as the tank conditions) and a mean of the data was conducted prior to constructing the graphs. The graph displaying the behavioral features shows that the influence of lead heavily decreases the

minnow's tendency to convey sexual movement. The double stressed fish performed reproductive behaviors in quantities that were not significantly greater than just the minnows exposed to lead or dividers.

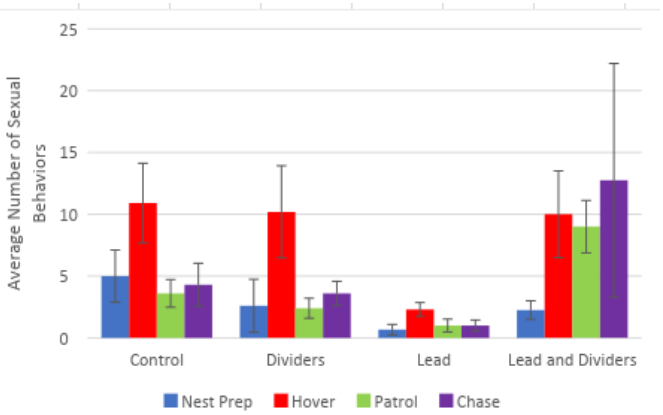

Figure 1: Average Number of Male Reproductive Behaviors--nest preparation, hover, patrol, chase, and spawn--per 5 minutes: Each bar was graphed with error bars of 1 +/- SEM. This graph shows that lead and dividers each played a non-significant role in the sexual behavior of the minnows.

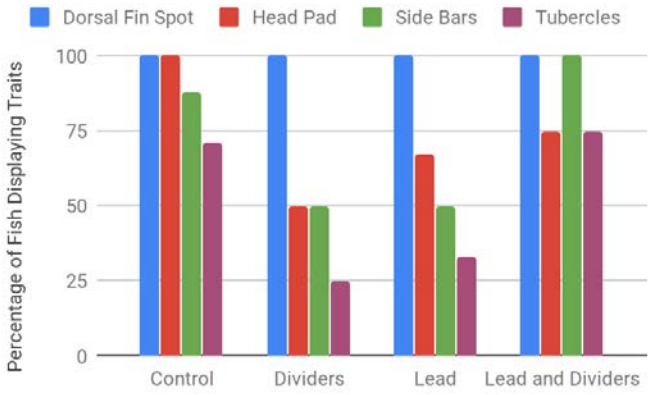

Figure 2: Comparison of secondary sex characteristics being shown in each tank. The control group displayed the highest percentage of headpads, while the lead and divider group displayed the highest percentage of side bars and tubercles.

Figure 3: A minnow involved in a tank that was apart of the testing done with dividers. This minnow is isolated from all other fish with the exception of a single female.

Figure 4: Minnows involved in the testing done without dividers. These minnows are able to interact with all the other minnows in the tank as opposed to only one female.

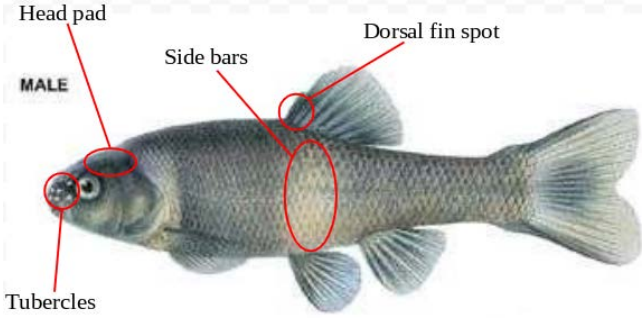

Figure 5: The different secondary sexual traits that were tracked during the duration of the experiment.

Discussion

Upon the collection of our data and the conclusion of this experiment, it has been determined that imposing lead and physical barriers does not significantly impact the reproductive behaviors of a male fathead minnow. The results of this experiment does not support the hypothesis. Upon closer examination of our data, it has been determined that a combination of multiple stressor--lead and dividers--does not have an adverse effect on the reproductive tendencies of male fathead minnows. It is possible that lead or physical barriers pose may pose an individual effect on the fish. For example, one could propose the idea that lead alone heavily decreases reproductive behaviors based on our results. However, due to the lack of significance in our results, we are unable to accept the hypothesis, which previously stated that the fathead minnows exposed to *multiple* stressors will display fewer sexual reproductive behaviors as opposed to the fathead minnows that are only exposed to one of the stressors tested in our experiment. In correlation to material previously mentioned, pieces of our results support the research mentioned in the introductory statement. One could conclude from our results that the testosterone levels of the fish in tank Pb2 were increasingly lowered due to the fact that they were only exposed to lead. The fish that were kept in the lead tank without dividers experienced a twenty-four percent decrease in sexual activities compared to the controlled group. Thus, this matches the information previously stated that the male's testosterone is blocked when contaminated by a lead-based substance.

Many limitations and erroneous situations arose during this experiment and are subject to change during future experiments. One possible limitation was the amount of time alloted for observation. Tanks were only observed every other day for intervals of five minutes at a time. It is possible that different minnows became more or less active during different times of the day,

and since we only viewed them under a small window of time, valuable information may have been missed. As mentioned in the introduction, barriers impose specific effects when large or small *sample sizes* are involved. Since this experiment contained only a small, variable amount of fish, minnow behaviors may have been heightened or depressed based on the amount of fish present in the tank. Another source of error present was the death of minnows within the tanks. In the tank of fish that were exposed to lead and lacked dividers death of the minnows occured. This shrunk the already small sample size due to the fact that we were unable to observe the behaviors that may have been presented by these dead fish. One factor that skewed our data in this experiment was the presence of a minnow who displayed very divergent behavior compared to the other fish. One of the fish exposed to both lead and dividers was tallied to perform 40 chases in one five minute interval. The rest of the fish in that tank performed no more than ten. However, we were forced to incorporate this data, even though it may have skewed our results.

Lead contamination still proves to be a widespread epidemic in our country and in many other countries around the world. The continuation of life-saving research may provide the answers needed to put an end to the ravaging symptoms of lead induced illnesses across the globe. It is vitally important that research, similar to ours, is conducted to determine whether additional environmental factors induce lead-related symptoms, and the possibility for the creation of medicines and cures.

References

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