The Effects of Copper Chloride (CuCl2) on Amphipod's Survival and Behavior

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Abstract

For our experiments, we tested the effects of copper chloride on our model organisms, amphipods. We wanted to see how a contaminant, such as copper chloride, would affect the behavior of organisms living in the contaminated area. This is important because it suggests how organisms would be affected if a chemical were to be suddenly introduced by humans. The effects copper chloride can have on humans include irritated skin, eyes, nose, lungs, and stomach (CCHSFS, 2007). In our experiment, we exposed amphipods to copper chloride and recorded the number of seconds they moved with and without a predator stimulation. We found that in the copper chloride solution, the amphipod adaptive behavior to a predator stimulation was muted. This is significant because it shows that copper chloride could affect an organism's survival and therefore affect a whole ecosystem. It also suggests that copper chloride is hazardous and could pose a threat to humans.

Introduction

Copper Chloride (CuCl or $CuCl_2$) is a metal salt and common contaminant within the environment due to such sources as pollution and spills, and has many negative effects on organisms within the environment. The effects copper chloride can have on humans include irritated skin, eyes, nose, lungs, and stomach (CCHSFS, 2007). Amphipods (Gammarus) are small freshwater crustaceans (about 4-10 mm long) that are commonly found in rivers, lakes, and ponds (The Editors of Encyclopædia Britannica, 2008). For our experiment, we tested the adaptive behaviors of amphipods when they are exposed to copper chloride. Within our experiment, we tested the question of "How do amphipods react to different copper chloride metal salt concentrations within water based on the LC50 and seconds of movements within water?". The null hypothesis for our experiment is there will be no difference between the treatment and control and the copper chloride will not have an effect on the amphipod's behavior. Our alternate hypothesis is there will be a difference between our treatment and control groups and the copper chloride will affect the amphipod's behavior. This is because the amphipods are able to sense changes in their environment such as chemicals. If they sense the chemical, then they will think they are in danger and their adaptive predator response behavior will change.

Materials and Methods

The materials that we used for this experiment are the collected amphipods, 5.2 (1.2 liter) cup plastic containers, small spoons, dechlorinated tap water, copper chloride, 150-1000 ml beakers, a 10-minute timer, a stopwatch, and proper safety equipment.

In the timed behavior experiment, we let the amphipods acclimate for 10 minutes in a plastic container with 250 ml of dechlorinated tap water or a copper chloride solution. Then, we set another timer for 10 minutes and used a stopwatch to time how much the amphipod moved. Finally, we set the last timer for 10 minutes and counted how much time the amphipod moved, and also disturbed the water with a plastic spoon every 30 seconds as a simulation of a predator. We then repeated all of the tests stated above for the other concentrations.

In the LC50 experiment, we started with a reaction experiment to see what concentrations we should use. To do this we recorded the amphipod's reaction (strong, mild, or none) in different concentrations of copper chloride. Once we decided on the concentrations, we put an amphipod in 4 containers, containing the same solution. Every 24 hours, we recorded the number of deaths, made a new test solution and transferred the amphipods. We then repeated all of these steps and did 4 trials for the 3 other concentrations. This was based on a procedure done by a UWW professor (Harrahy, 2016).

We recorded the data of the timed behavior tests and LC50 tests on a Google Spreadsheet. We were able to calculate the means, medians, standard deviations, standard errors, and p-values from our quantitative data. Then we used a t-test for our statistical methods and data analysis. The t-test is used to find the p-value and is used to show how significant or different 2 sets of data are. If the p-value is less than 0.05, than the sets of data are different which means that the values were significant. If the p-value is greater than 0.05, than that meant that the sets of data were the same or insignificant.

Results

In our experiment, the independent variable was the concentration of copper chloride within the water, and our dependent variable was the seconds the observed amphipod moved (in ten minutes). The role of our control, the 0 ppm copper chloride (dechlorinated tap water), was used to provide a basis of understanding for how the amphipods react in their normal environment. Our results showed us that, in a copper chloride concentration, amphipods are less reactive/sensitive to predation than otherwise.

Our experiments consisted of a timed behavior experiment and a controlled LC50 experiment where we recorded the mortality rates every 24 hours for all concentrations of copper chloride.

In our experiment, we tested behavior and LC50 of our amphipods in a controlled manner. At first, we used the concentrations 10, 40, 70, and 100, but all the amphipods died. We then used the concentrations 0.1, 0, 1, and 5, and found more than half of those dead within 24 hours (except for the 0.1 ppm copper chloride, with 3 dead at 24 hours). This played a big role in our decision for 0.1 being the concentration in our behavior experiments, as we know that it is not lethal in a short amount of exposure time (24 hours).

For our behavior tests, we reject our null hypothesis and accept our alternate hypothesis. The data values for control and predator simulation for 0 ppm copper chloride were significantly different in the t-test, whereas in the 0.1 ppm copper chloride, those data values were concluded to be the same. The p-value were 0.0159 for the 0 ppm control vs predator, and the p-value for the 0.1 ppm copper chloride was 0.1429. The amphipods show less of a difference with and without a predator simulation in 0.1 ppm of copper chloride.

Our intent within the experiments were to measure the health of our model organism (amphipods) to model the side effects of varying copper chloride concentrations on organisms and the environment. We think that our experiment and its results directly reflect that motive, as behavior times are very important to organisms. The fact that the behavior times were different in copper chloride means that it may pose a possible threat to other organisms as well.

Discussion

The data that we have found within the experiments we conducted is important because it connects to the fundamentals of conservation and diagnosis for disaster. If we learn about the effects of copper on organisms within a controlled environment, we can better learn the effects of copper chloride contamination within natural environments and also (to an extent) our own environments.

The patterns we perceived within our data were mostly found within our behavioral tests on the amphipods within contaminant as compared to tests within dechlorinated tap water. The amphipods, within control environments, reacted to the predation simulation distinctly differently than without predation (see Fig. 1). However, in chemical, the amphipods exhibited no different behaviors when in predation rather than in control (see Fig. 2). Therefore, we reject our null hypothesis and accept our alternate hypothesis Unfortunately, however, within our experiments we didn't observe a significant LC50 value, and thus our next steps within the experiment would be to rectify this, finding a significant value for our LC50 tests and creating a better lethal concentration for us to use within analysis of environments (see Fig. 3).

This means, within our interpretation, the chemical affects the amphipods ability to react to predation and undermines the evolutionary adaptations of the amphipods, and thus we reject our null hypothesis and accept our alternate hypothesis. This effect could severely impair the survival rates of the amphipods, and if the effect carries over to other organisms, could debilitate entire environments. The reasoning that supports this is as such; our results and t-tests show that without the chemical, the amphipods moved less when they were stimulated (by a predator simulation) than when not stimulated (see Fig. 1). However, within the chemical, they did not show any significant reaction to the predators when in comparison to the control experiments (see Fig. 2). This is our evidence; our reasoning behind our claim, however, is that the amphipods not reacting to predation in chemical, but reacting without, clearly shows a relationship between the reaction for the amphipods and the chemicals. If the amphipods do not react to predation in the chemical, that means that the chemical has debilitated the systems that decide those reactions or disable the amphipod from doing so. A number of theories, however, could be attributed to this behavior; within our background research on the topic, we found that copper chloride impairs the respiratory system of certain organisms, and if this effect is also seen within amphipods, they may stop moving to gather more oxygen with their limbs to filter it through their gills ("CCHSFS", 2007).

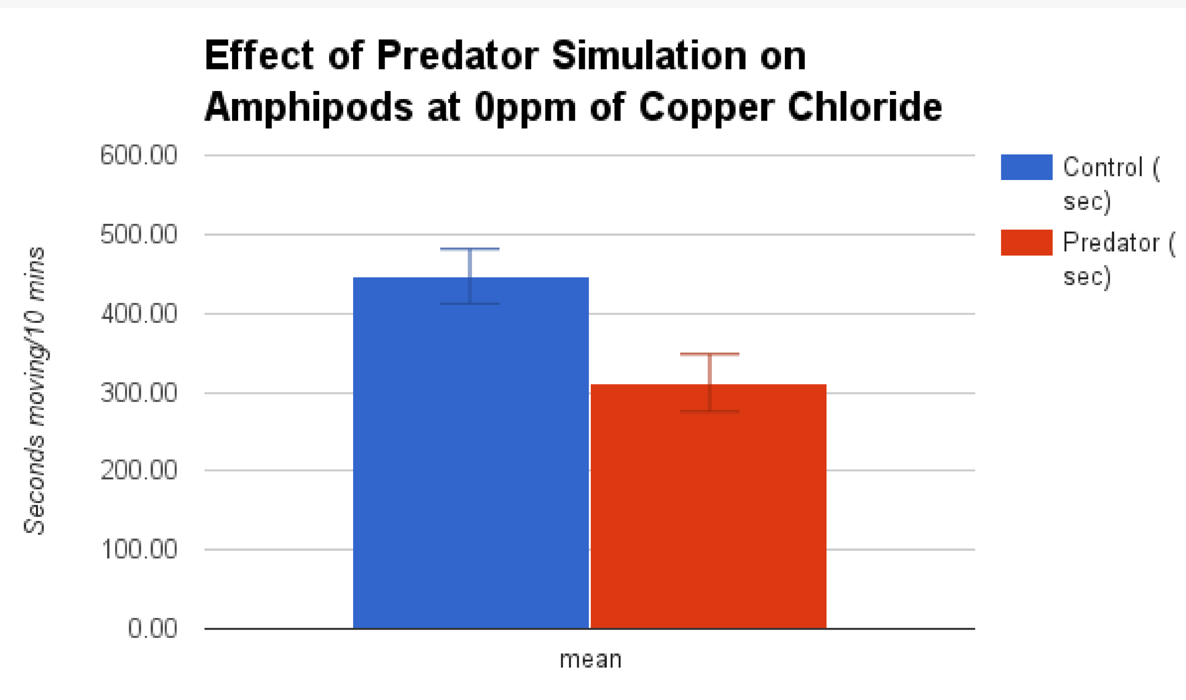

Figure 1

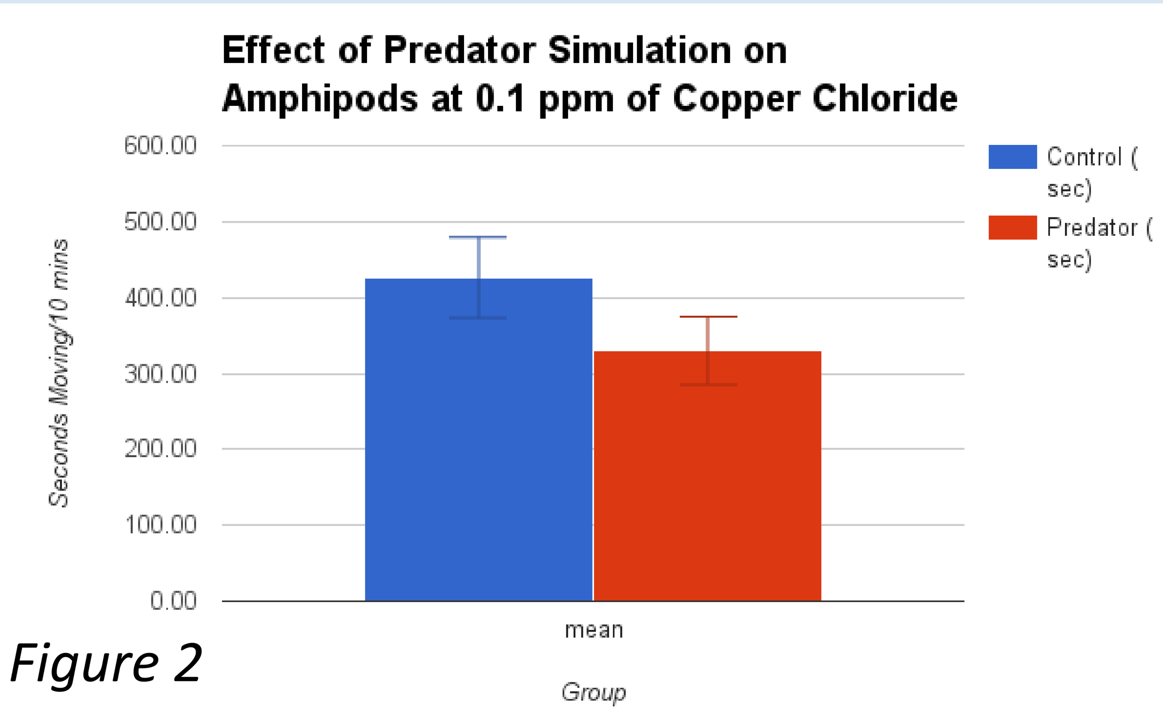

Figure 2

LC50	Day 1	Day 2
0	0	2
0.1	3	4
1	4	4
5	4	4
10	4	4
40	4	4
70	4	4
100	4	4

Figure 3

References

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