Lead Exposure on Caenorhabditis *elegans*

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Abstract

Lead is a metal which interferes with a variety of body processes and is toxic to many organs in humans and other animals. Recently, in Flint, Michigan the water has been an issue and high concentrations of lead have been found in several homes. This can have a harmful effect on humans, especially children. To learn more about the effects lead can have on organisms, C. *elegans* worms were dosed with lead at concentrations that have been measured in Flint. C. *elegans* were dosed with two different concentrations of lead based on the "allowed" amount in municipal water systems and the highest concentration found in the Flint, Michigan household water. Their behavior was studied to have a better understanding of potential neurological effects in humans. This research was conducted with D'Youville College professors and undergraduate students whose interest and concern in heavy metal toxicity in the environment led to the completion of the project.

Introduction

The human nervous system has three main functions: sensory input, integration, and motor output. We performed two sets of experiments to test the effects of lead exposure on sensory and motor functions of C. *elegans*. To examine whether lead exposure altered motor function of C. *elegans*, we recorded the number of times the nematodes thrashed per minute when submerged in water. The data suggest that exposure to a high concentration of lead may alter the locomotive ability of C. *elegans*, consistent with previous reports in the literature that lead exposure can alter motor function. There was no significant difference in number of thrashes per minute between nematodes that were exposed to the low level of lead and no lead, suggesting that the EPA suggests action at a low enough concentration of lead before there are harmful motor effects. The data from the food search assay suggests that exposure to lead does not alter the sensory ability of C. *elegans* to smell and locate their food source.

Rationale

Heavy metal toxicity is important to study for environmental reasons. Heavy metals, such as lead, are found naturally in the Earth. Over time, they become concentrated as a result of human caused activities and can enter plants, animals, and human tissues through inhalation, diet, and other forms of exposure. The water in Flint, Michigan is a lead crisis currently happening, and traces of lead as high as 1,000 ppb have been reported in household water. The EPA sets an action limit of 15 ppb, although no concentration is considered safe. At these levels, public health is a serious concern. Children and adults were being exposed to these high levels of lead. To determine the effects lead can have on organisms, C. *elegans* were exposed to different lead concentrations. C. *elegans* were dosed 24 hours prior to testing their behavioral effects.

Methods & Materials

Caenorhabditis elegans wild type strain N2 were maintained on nematode growth medium (NGM) plates seeded with E. coli OP50 as a food source at 20°C.

Thrashing Assay: After 24 hours of 0, 15 ppb, or 1000 ppb lead exposure, nematodes were individually placed in distilled water. After a 1 min recovery period, the number of thrashes in 1 min were recorded. One thrash was counted when both the head and tail bent in the same direction. Thirty nematodes were measured for each condition, picked at random from repetitions of each condition.

Food Search Assay: After 24 hours of 0, 15 ppb, or 1000 ppb lead exposure, 2-4 nematodes were moved at a time to specialized food plates. Each specialized food plate contained a ring of food on the surface with no food in the center of the ring. Nematodes were placed within the center of the ring approximately 5 mm from the food. The number of nematodes that had left the center and entered into the food ring was counted every 30 seconds until all nematodes had entered the food ring. At least fifty nematodes were measured for each condition, picked at random from repetitions of each condition.

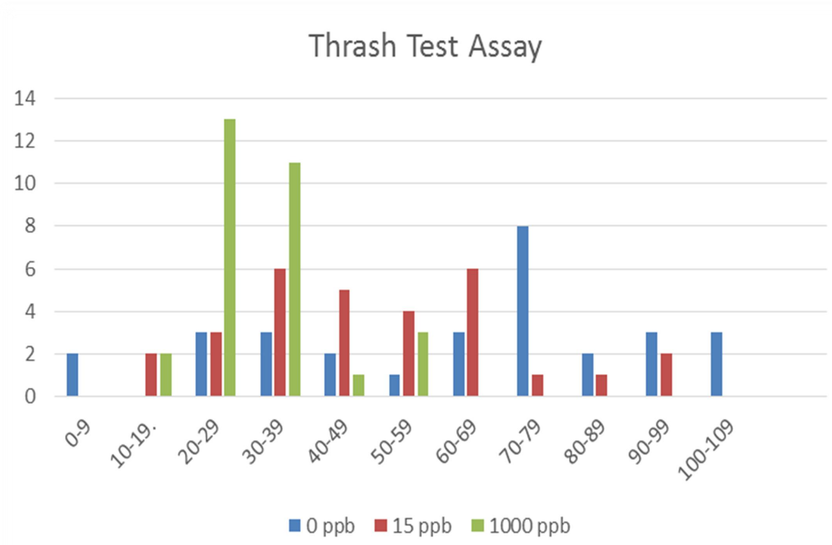

Figure 1: Thrash Test Assay

Results

C. *elegans* exposed to a high dose of lead (1000 ppb) thrashed 48% fewer times per minute than control nematodes that were not exposed to lead at all, and 36% fewer times than nematodes exposed to the EPA action level low dose of lead (*$p < 0.05$, student's t-test). (Figure 1)

To examine whether lead exposure altered sensory function of C. *elegans*, food search assays were performed to examine sense of smell. There was no significant difference among the groups of C. *elegans* exposed to different concentrations of lead and not exposed to lead at all in the amount of time observed for C. *elegans* to find their food source ($p > 0.05$, student's t-test). (Figure 2)

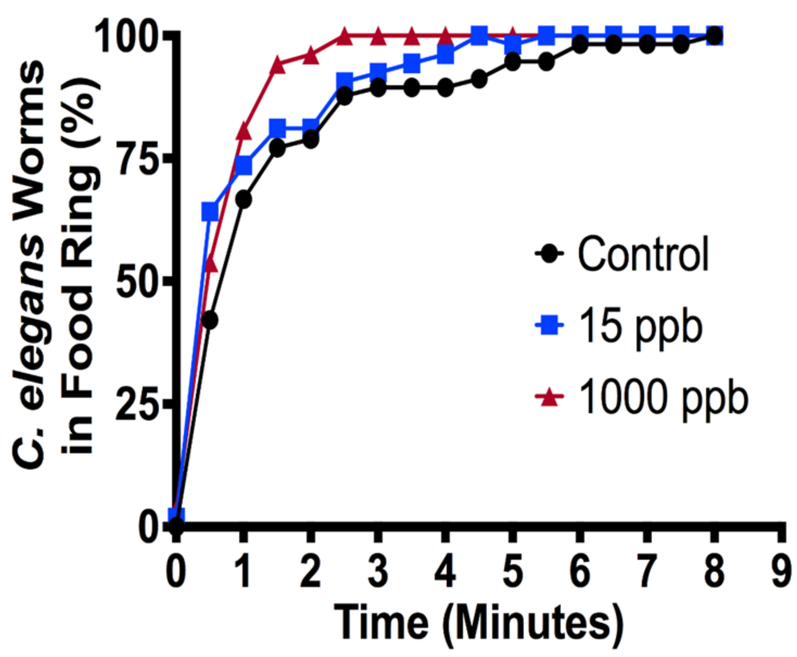

Figure 2: Food Test Assay

Conclusion

Motor Response: C. *elegans* thrashed significantly less when they were dosed at 1,000 ppb lead in comparison to control or 15 ppb lead.
Sensory Response: C. *elegans* were still able to find their food source even after being subjected to low and high levels of lead.

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