LEAD CONCENTRATION IN *PEROMYSCUS SPP.* AT A SUPERFUND SITE, MUNCIE, INDIANA

An Honors Thesis (HONRS 499)

by

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May 2004

Graduate May 2004
Lead Concentration in *Peromyscus* spp. at a Superfund Site, Muncie, Indiana

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ABSTRACT

I compared lead contamination in two deer mouse (*Peromyscus* spp.) populations in Muncie, IN, Memorial Drive dumpsite (MDDS) and Miller Wildlife Area (MWA). Twelve deer mice were captured (5 at MDDS and 7 at MWA) and their organs were harvested for lead analysis. A Mann-Whitney U Test was run on the obtained lead concentrations and a P-value of 0.3709 was obtained. Lead concentrations in the deer mice at the two sites were not statistically different from each other ($P > 0.05$). This could be due to decreased lead uptake from soil to vegetation to deer mice at MDDS and also immigration of uncontaminated deer mice at MDDS. However, there could be a difference in Pb levels at the two sites, but the sample sizes were too small and had high variation. A more in-depth research study should be completed to obtain more accurate results.

INTRODUCTION

Throughout the United States there are numerous dumpsites where battery casings have caused lead contamination of soil and vegetation. Little research has been done at these sites on the effects of lead (Pb) on small mammals, specifically *Peromyscus* spp. Several studies have been done on Pb contamination of small mammals from automobile exhaust. While significant amounts of Pb were not found in small mammals in these studies, it was determined that Pb can cause atrophy in the liver and kidneys, decreased
Cohen (1999) found that *Peromyscus* spp. tend to dominate small mammal communities in areas highly contaminated with Pb and other chemicals; they can make up as much as 75% of the community. However, small mammals living in these areas have lower annual survival (25-30%) than small mammals occurring in non-contaminated sites (40%) (Cohen 1999 and Allen and Otis 1998). *Peromyscus* spp. are an appropriate small mammal to study because they are easily captured, have small home ranges, high numbers, and are an important food source for predators. The objective of this study is to determine if Pb contamination in the soil and vegetation at MDDS has resulted in excessive Pb levels in *Peromyscus* spp. This is important because if high Pb amounts are found in *Peromyscus* spp. there might be high levels in other small mammals. This could potentially result in bio-magnification of Pb in predators. The hypothesis is that statistically higher amounts of Pb will be found in the *Peromyscus* spp. at MDDS.

**STUDY AREA**

This study included two sites: MDDS and MWA in Muncie, IN. Memorial Drive Dumpsite was a Pb battery dump (approximately 2 ha) that was first used as a limestone quarry until 1941, and then it was used as a dumpsite for battery casings through 1953. In 1993, the battery casings were recognized as a contamination problem. Subsequently, state and federal agencies cleaned the area and installed a concrete buffer to prevent contaminated soil from eroding into the White River. Dominant overstory trees at MDDS include maple (*Acer* spp.) and boxelder (*Acer negundo*) (Pichtel et al. 2000). The control site at MWA, a 6.5 ha property, is a bottomland forest possessing standing water over much of the area throughout the year. The site is heavily vegetated with maple
(Acer spp.) and has an understory consisting predominantly of buckthorn (Rhamnus cathartica).

Previous research at MDDS has found an average of 29,400 mg/kg of Pb in the soil, with a maximum value of 112, 500 mg/kg of Pb (Pichtel et al. 2000). Local uncontaminated soils contain Pb ranging from undetectable to 10 mg/kg. In the herbaceous and woody vegetation, Pb uptake ranged from undetectable to 1687 mg/kg, with considerably more Pb in the roots than shoots (Pichtel et al. 2000).

METHODS

I used Sherman live-traps to capture Peromyscus spp. at the 2 study areas. Traps were arranged in a 10 x 5 array with 10 m spacing. Trapping was conducted from February through April 2004. Traps were set for 5 days at MDDS and for 5 days at MWA during the following week. Traps were checked every morning. Captured Peromyscus spp. were taken to Ball State University wildlife lab and euthanized with carbon dioxide overdose. Peromyscus spp. were sexed, weighed, aged, their body lengths measured, and their organs harvested for digestion. For digestion, organs of each sample were placed in a beaker, mixed with 10 ml concentrated nitric acid, 4 ml hydrochloric acid, brought to a final volume of 100 ml, and placed on a hot plate between 95 and 105 C for twelve hours. The subsequent solution was filtered using 45 μm filter paper and again brought to a volume of 100 ml by adding distilled water.

During this process, all possible precautions were taken to minimize the risk of sample contamination. Digested mixtures were sent to Hoosier Microbiological Laboratory (HML), Muncie, IN, and tested for elevated levels of Pb. A Mann-Whitney U Test was used to determine if a difference existed in the Pb levels of Peromyscus spp.
between MDDS and MWA. I used an α level of 0.05 to determine statistical
significance.

RESULTS

I captured 5 Peromyscus spp. (3 males and 2 females) at MDDS and 7 (3 males
and 4 females) at MWA (Table 1). Lead concentration in Peromyscus spp. did not differ
between the two study sites (Table 2). Memorial Drive Dumpsite had a mean (± SE) Pb
concentration of 1.602 ± 0.955 mg/kg and a maximum of 5.212 mg/kg, while MWA had
a mean Pb concentration of 0.317 ± 0.031 mg/kg and a maximum of 0.417 mg/kg
(Table 1).

DISCUSSION

No difference in Pb levels of Peromyscus spp. between the sites implies that lead
in the soil and vegetation at MDDS was not significant enough to contaminate
Peromyscus spp. This is a reasonable conclusion since only 33% of Pb in the soil
(112,500 mg/kg) was incorporated into the vegetation (1687 mg/kg) (Pichtel et al. 2000).
Moreover, Mierau and Favara (1975) reported that 90% of Pb ingested by small
mammals passes through their digestive system. Thus, Peromyscus spp. would not be
expected to have considerably high Pb tissue levels at MDDS.

Despite no statistical difference between sites, I did note extreme variation in Pb
levels among Peromyscus spp. within the contaminated site (Fig. 1). Perhaps a larger
sample size, having potentially less variance, would allow for more accurate conclusions
about Pb contamination at MDDS. The high Pb values found at MDDS could indicate
several things. First, some areas of MDDS could be more contaminated than other areas,
allowing more lead to be ingested by some Peromyscus spp. than others at the site.
Additionally, immigrant Peromyscus spp. from non-contaminated areas might have been captured and resulted in some Peromyscus spp. having lower Pb levels at MDDS. A study by Schroeder et al. (1965) reported that adult rats in uncontaminated areas have a Pb concentration level between 0.33 and 0.48 mg/kg. At my two study sites, 10 out of 12 samples had Pb levels within this range (from 0.21 to 0.42 mg/kg), further indicating Peromyscus spp. at MDDS are not excessively contaminated. Schroeder et al. (1965) also reported that rats that had Pb fed to them in lab conditions had concentrations 0.62 mg/kg and higher. Two samples at MDDS had Pb levels high enough to be considered contaminated (1.91 and 5.21 mg/kg); indicating lead could potentially be accumulating in some of the Peromyscus spp. in the area. Thus, some Peromyscus spp. at MDDS that have excessive Pb levels could be more susceptible to disease and high mortality at a young age (Schroeder et al. 1965 and Allen and Otis 1998).

MANAGEMENT IMPLICATIONS

This study exhibits the need for more research to be done. Low sample sizes reduce the power of my statistical tests. I recommend that additional sampling be done during warm weather. This will enhance capture results. The results of the new study will dictate what actions should be taken at MDDS. If Pb contamination of Peromyscus spp. is confirmed the area should be further treated to remove Pb. However, if significant levels of Pb are not found within Peromyscus spp. the area should be left alone.

ACKNOWLEDGEMENTS

I owe great thanks to Dr. Thomas Morrell for advising me throughout all steps of my research project, allowing me to use his equipment, and for his willingness to offer assistance whenever I needed help. To Mark Finkel for helping in the daunting task of
data collection. To the Honors College for providing me with a Fellowship to cover expenses incurred during the project. To Hoosier Microbiological Lab for their willingness to test the samples for lead and for graciously answering all of my questions.

**LITERATURE CITED**


Table 1. Location, weight, sex, and Pb concentration (mg/kg) in *Peromyscus* spp. captured at Memorial Drive Dumpsite and Miller Wildlife Area, Muncie, IN, from February to April 2004.

<table>
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<tr>
<th>Sites</th>
<th>Organ Weight (g)</th>
<th>Sex</th>
<th>Pb (mg/kg)</th>
</tr>
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</tr>
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<td></td>
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<td>M</td>
<td>5.212</td>
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<td></td>
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<td>M</td>
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<tr>
<td></td>
<td>9.7</td>
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Table 2. Sample size, median Pb concentration (mg/kg) and results of Results Mann-Whitney U Test comparing Memorial Drive Dumpsite and Miller Wildlife Area, Muncie, IN, from February to April 2004.

<table>
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<th>P-value</th>
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<td>Miller Wildlife Area</td>
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</table>
Figure 1. Dot graph of Pb concentration in *Peromyscus* spp. at Memorial Drive Dumpsite and Memorial Wildlife Area, Muncie, IN, from February to April 2004.