



From Soil to Squirrel: The Legacy of Lead Pollution & Its Effects on Urban Wildlife Behavior

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Background

- Urbanization threatens wildlife through the introduction of novel threats and pollution.¹
- Urban animals have higher lead (Pb) levels than rural animals.²⁻⁴
- Pb exposure increases aggressive behavior in humans⁵ and captive animals,⁶ but the relationship between Pb pollution and aggression in urban wildlife is not clear.⁷⁻⁸
- The novel challenges associated with living in an urban environment can also affect social behavior of urban wildlife.⁹⁻¹¹
- Examining two closely related species, the eastern gray squirrel and the eastern chipmunk, allowed us to investigate how species-specific traits and behaviors affect Pb exposure and behavioral responses to urban environments.

Methods

- Live-trap gray squirrels and chipmunks, collect body size measurements and tail hair samples, and place ear tags.
- Conduct a struggle test then transfer the animal to the trial box and record the animal during three behavioral tests, including a mirror image stimulation trial.
- Code the videos of behavioral trials using the software BORIS to quantify aggressive and social responses.
- Collect three soil samples (10 cm depth) at each site.
- Quantify Pb levels in soil and hair samples.

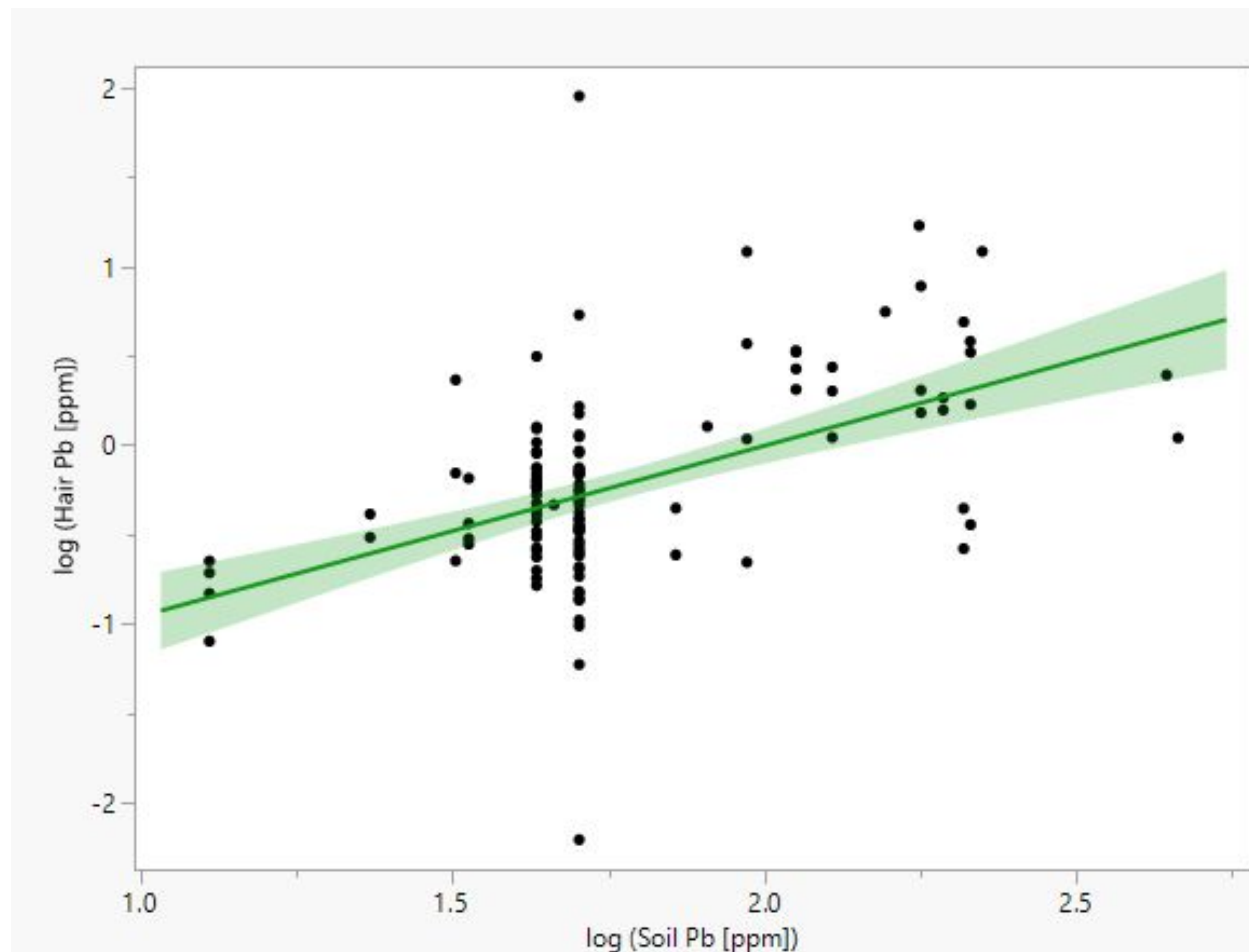


Figure 1. The soil and hair Pb content (log[ppm]) of gray squirrels and chipmunks captured. There was a significant positive correlation between hair Pb and soil Pb ($F_{1,131} = 42.3159, p < 0.0001$).

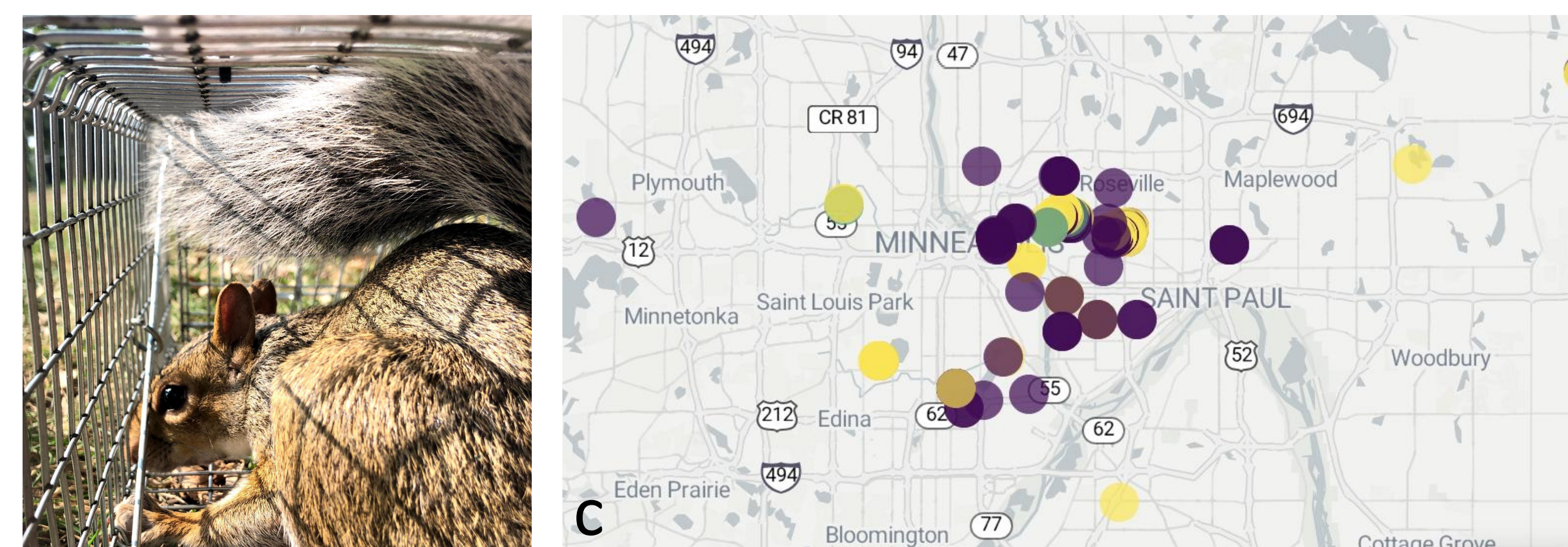


Figure 3. (a) Eastern gray squirrel in a trap. (b) Eastern chipmunk in a trap. (c) Map of the sites where squirrels (purple dots) and chipmunks (yellow dots) were trapped. Darker dots indicate a greater number of animals captured. (d) Trap baited with peanut butter. (e) Squirrel in the handling bag.

Predictions

1. Soil Pb will correlate with hair Pb.
2. Chipmunks will have higher hair Pb than squirrels.
3. Animals with higher hair Pb will be more aggressive, less likely to engage with a conspecific, and have longer struggle times than animals with lower hair Pb.

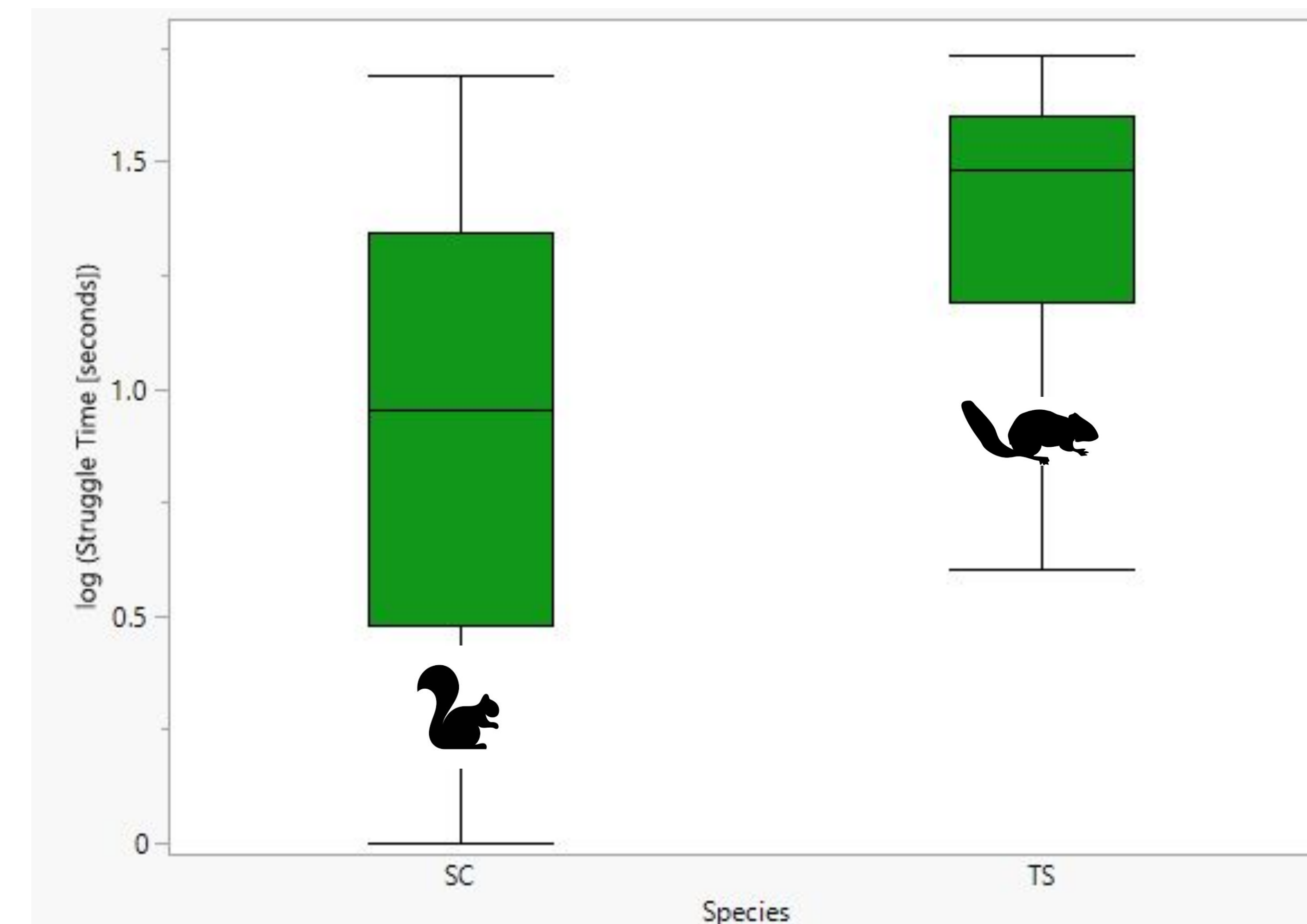


Figure 2. Struggle time for gray squirrels (SC) and chipmunks (TS). Chipmunks had a significantly greater struggle time (30.50 ± 16.03 seconds) than gray squirrels (9.00 ± 11.97 seconds) ($F = 32.9669, p < 0.0001$). Shown is a box plot of the log of the struggle time (seconds) with a centerline at the median and error bars that mark the minimum and maximum values for each species.

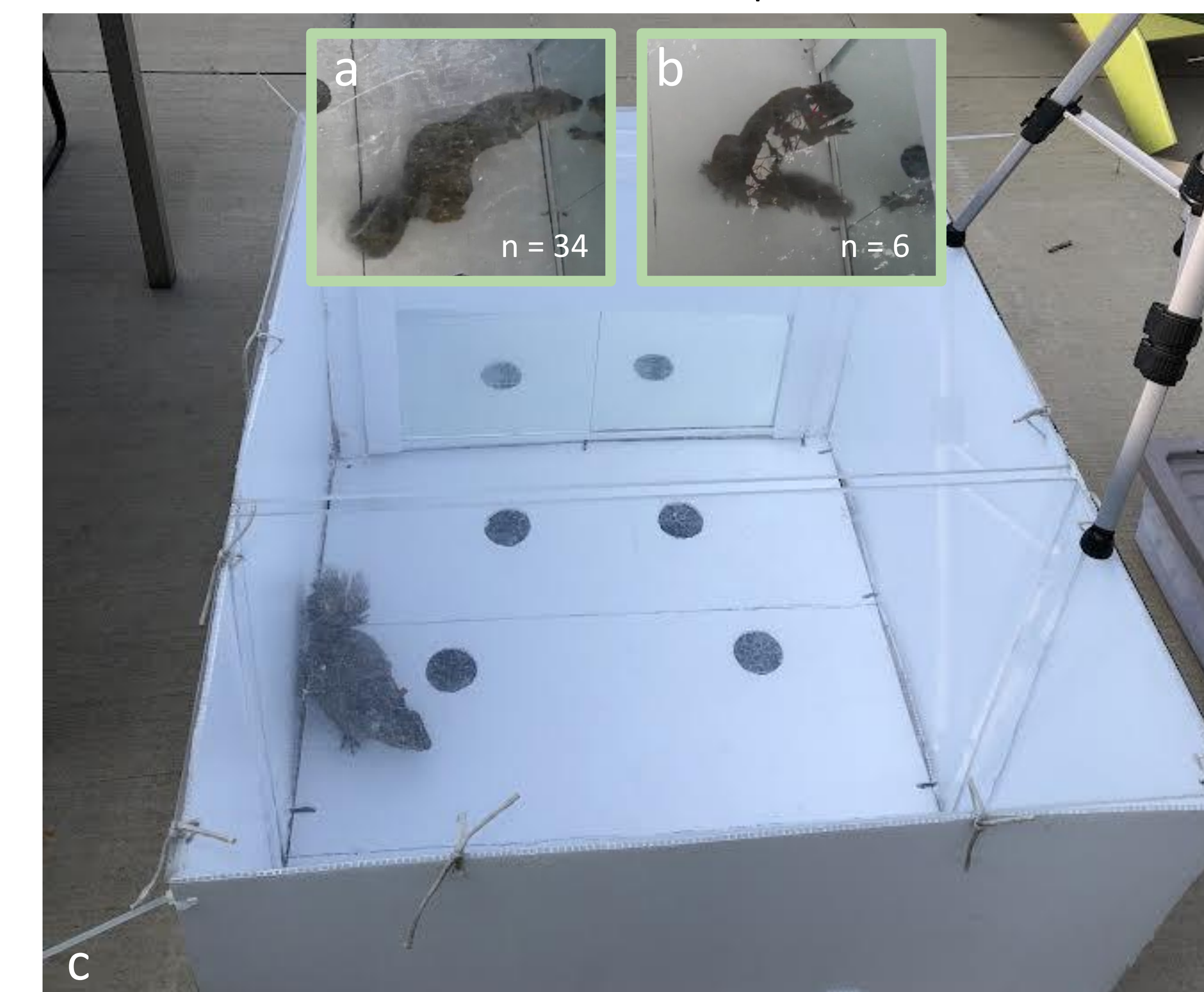


Figure 4. (a) A squirrel displaying a social response to its reflection. (b) A squirrel an aggressive response to its reflection. (c) The trial box with the mirror exposed.

Discussion

- This is correlational evidence that gray squirrels and chipmunks accumulate Pb from the the soil.
- Pb accumulation likely occurs through consumption of Pb-contaminated plants and arthropods.¹⁵⁻¹⁶
- There may be no difference in Pb accumulation between species because chipmunks may be exposed to soil with lower Pb levels than squirrels.¹⁷
- Pb exposure does not predict docility, aggressive behavior, or likelihood of engaging with a conspecific.
- Aggression is not a common behavior in urban squirrels and chipmunks, which may be because nonaggressive responses are adaptive in urban environments where animals must tolerate higher population densities.

Future Directions

- Use more extensive soil sampling to better measure soil Pb exposure for chipmunks.
- Measure aggression in gray squirrels and chipmunks through direct observation of interactions.

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