Behavioral and Gut Microbiome Impacts of Arsenic Exposure in Chinese Mystery Snails

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Background

- Historical smelter operations in the Puget Sound lowlands have caused persistent arsenic contamination, with concentrations exceeding 200 µg As g^{-1} in urban lake sediments (Hull et al., 2023).
- Chinese Mystery Snail is an invasive freshwater aquatic snail native to Southeast Asia and Eastern Russia.
- According to a previous study by Xiayang et al. (2024), arsenic exposure has been shown to alter the abundance of gut microbiota in snails.
- Hypothesis: Arsenic exposure might alter feeding activity of CMS and that arsenic-induced microbiome alterations contribute to these behavioral changes.

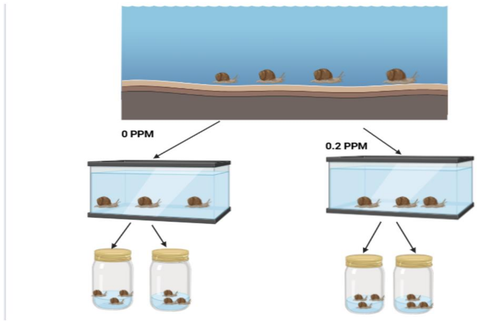
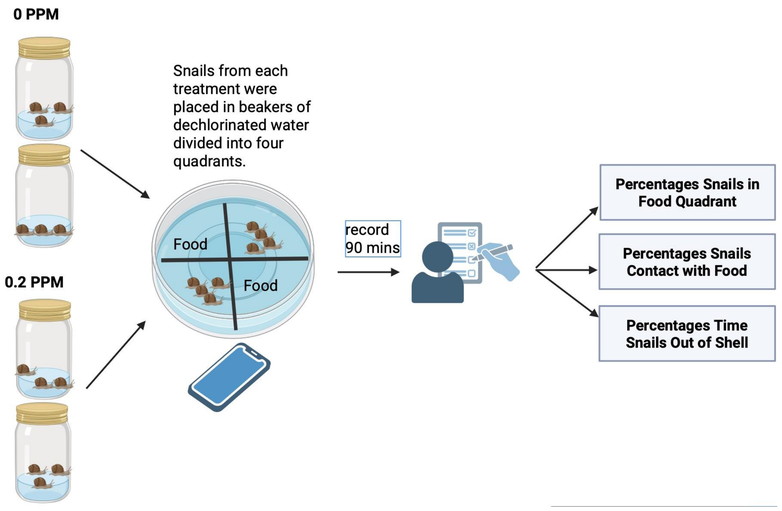


Figure 1. Background: CMS were collected from lakes, raised in control and arsenic exposure conditions in laboratory for experiment. Historical smelter operations have left persistent arsenic contamination in local lake sediments, where Chinese mystery snails (*Cipangopaludina chinensis*) reside. Snails collected from the lake were placed in laboratory aquaria with arsenic concentrations of 0 ppm and 0.2 ppm for approximately 7 weeks to simulate environmentally relevant exposures. They were then transferred to jars with corresponding treatment conditions for behavioral trials.

Method



Results

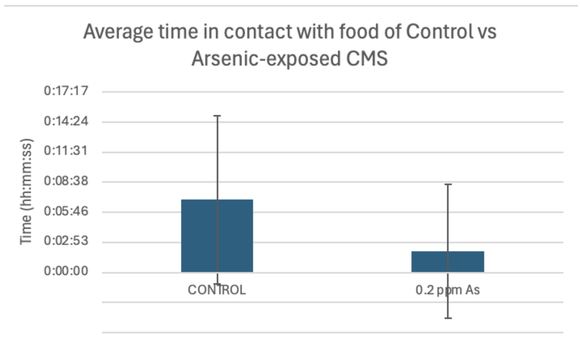


Figure 2. Average time in contact with food of control is higher than that of arsenic-exposed Chinese mystery snails (CMS), suggesting a more active feeding behavior in control snails.
Bars represent mean time (hh:mm:ss) with error bars representing standard deviation spent in contact with food during the observation period (90 min). Overall, arsenic-exposed CMS spent much less time in contact with food compared to controls. (p value = 0.02; calculated with Mann Whitney U Test, two-tailed, significance level set at $p < .05$)

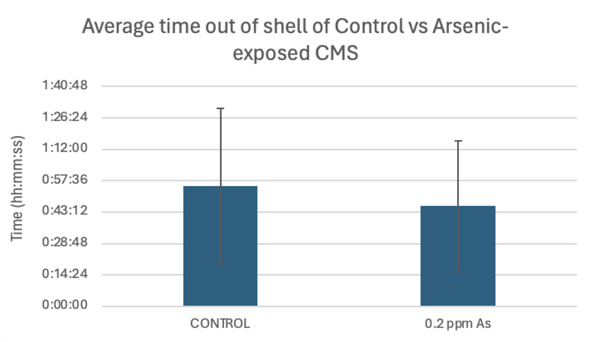


Figure 3. Average time spent out of shell by control is slightly higher arsenic-exposed Chinese mystery snails (CMS).
Bars represent mean time (hh:mm:ss), with error bars showing standard deviation over the 90-minute observation period. Overall, control snails spent slightly more time out of shell than arsenic-exposed snails (p value = 0.25; calculated with Mann Whitney U Test, two-tailed, significance level set at $p < .05$).

Discussion

- Although the average time spent in contact with food differed significantly between the control and arsenic-exposed groups, the time spent out of the shell did not vary substantially. These findings indicate that overall locomotor activity was not impaired by arsenic exposure.
- Given that general motility remained comparable between treatments, the observed reduction in CMS feeding activity is more likely attributable to disruption of chemoreceptive function rather than to physical movement limitations. This suggests that arsenic exposure may interfere with the detection or processing of chemical food cues, thereby reducing feeding behavior despite preserved locomotor capability.
- Further investigation is required to validate this interpretation and to elaborate on the specific mechanisms by which arsenic may affect sensory pathways involved in feeding.

Follow up Experiment

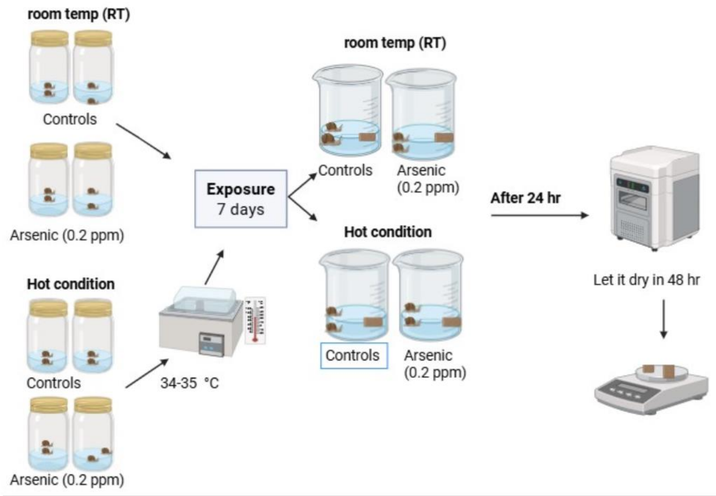


Figure 4. Follow-up experiment of water temperature's effect on snail feeding behavior.
To determine whether snail feeding behavior changes in response to seasonal shifts in water temperature, we will conduct a follow-up experiment on how water temperature affects snail feeding behavior. We will use 8 jars, with 4 controls and 4 arsenic-exposed groups; 2 jars of each group will be kept at room temperature, and 2 jars will be maintained at elevated temperature using a water bath. Exposure will last for 7 days. After exposure, each snail (replicates of 2 from each exposure group) will be transferred to an individual beaker containing a pre-weighed food portion. A 24-hour feeding assay will be conducted. At the end of the assay, food will be dried in the dessicator for 48 hours before being re-weighed to determine consumption. Feeding activity will be quantified as the amount of food consumed per snail over 90 minutes. We anticipate that higher water temperature will cause CMS to ingest more food and thereby enhance feeding activity, which will predict will contrast with the reduction in feeding we have observed under arsenic exposure.

Acknowledgments

We would like to thank Drs. Sarah Alaei and Marc Nahmani for their guidance and support throughout our research. I also want to thank my peers in TBIOMD 495 for their hard work and contributions to this experiment. Finally, I sincerely appreciate Dr. Jutta Heller for being an outstanding mentor during the creation of this poster.