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Arsenic-induced physiological stress in snails

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BACKGROUND

The ASARCO copper smelter found near Tacoma, Washington has been inoperational for over 30 years, however in its 100-year long use, it has released high amounts of arsenic and lead into the surrounding environment. Previous studies have indicated that shallow lakes in the area such as Steel Lake and Lake Killarney show moderate to high amounts of arsenic (v) contamination in their water columns, respectively. This arsenic contaminates the underwater flora and fauna, such as periphyton, which is then ingested by other animals, dispersing the contaminant up the food chain.

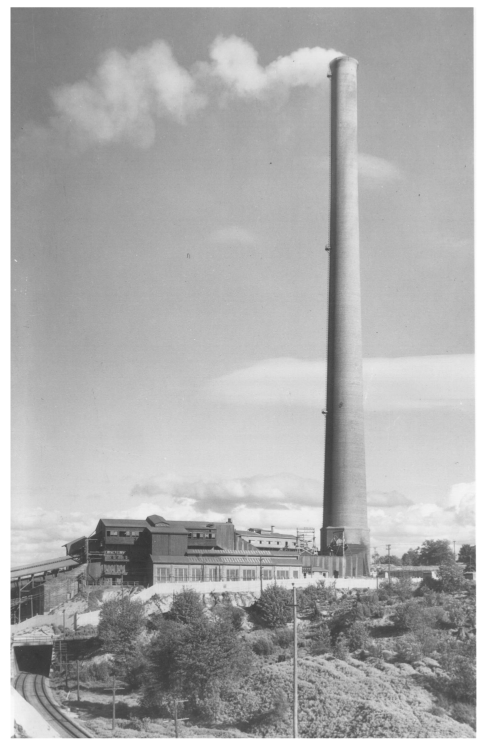


Figure 1. Former ASARCO smelter in Tacoma, WA.

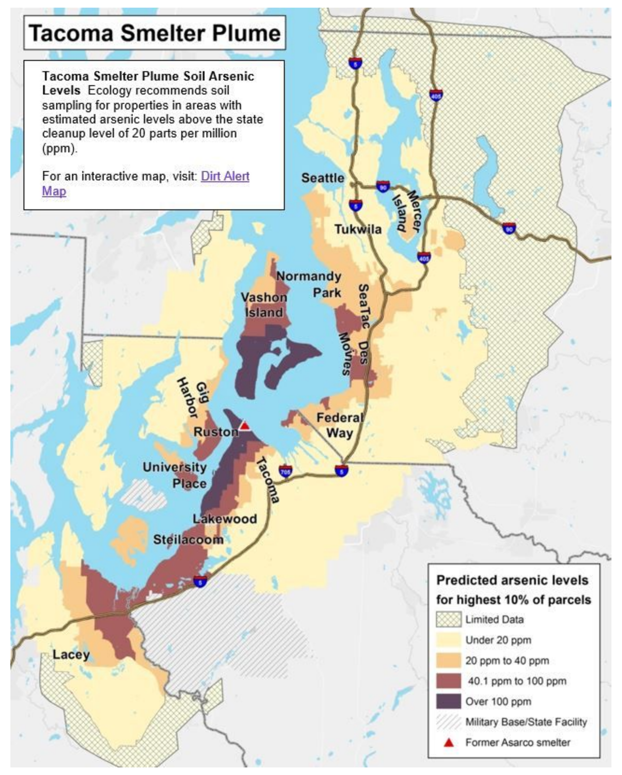


Figure 2. Map of arsenic contamination levels from the ASARCO smelter.

OBJECTIVE

This study aimed to determine if snails that were fed periphyton from each of these three lakes have a difference in expression of heat shock protein 70 (HSP70) due to the increased arsenic levels.

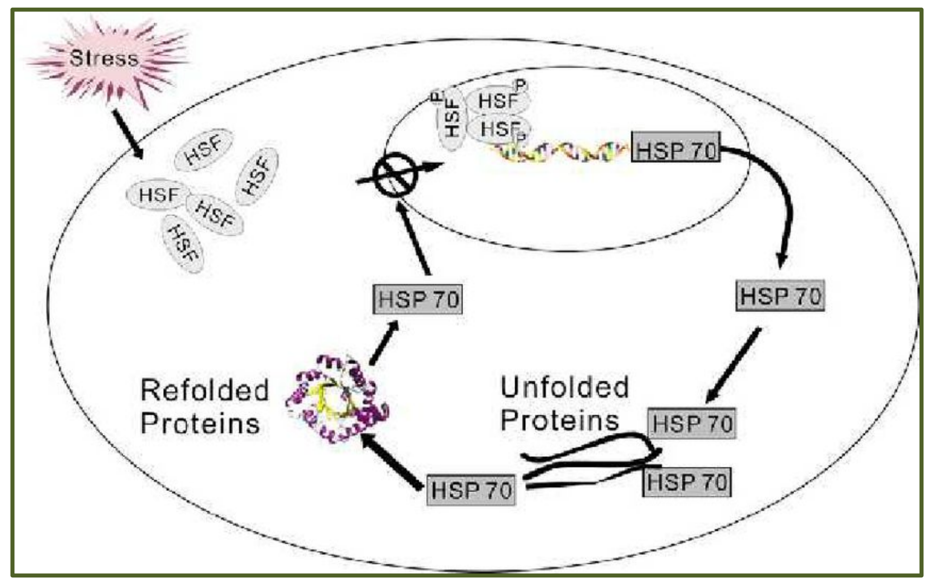
HYPOTHESIS

We have hypothesized that Lake Killarney snails will have higher expression of HSP70 due to the higher amount of arsenic contamination than Steel Lake (medium arsenic) and Lake Meridian (no arsenic).

METHODS AND MATERIALS

To assess the physiological effect that chronic arsenic exposure has on local aquatic fauna, heat shock proteins (HSPs) was utilized due to their nature of being produced in response to stressful stimuli. This study aimed to determine if snails that were fed periphyton from each of these three lakes have a difference in expression of heat shock protein 70 (HSP70) due to the increased arsenic levels. We have hypothesized that Lake Killarney snails will have higher expression of HSP70 due to the higher amount of arsenic contamination than Steel Lake (medium arsenic) and Lake Meridian (no arsenic). Frozen tissue from the head region of Chinese mystery snails exposed to Killarney, Steel and Meridian periphyton was used to conduct SDS-PAGE electrophoresis and subsequently a western blot, allowing us to quantify HSP70 expression and note differences between snails from lakes containing varying arsenic levels.

Figure 3. Physiological stress inducing expression of HSP70



RESULTS

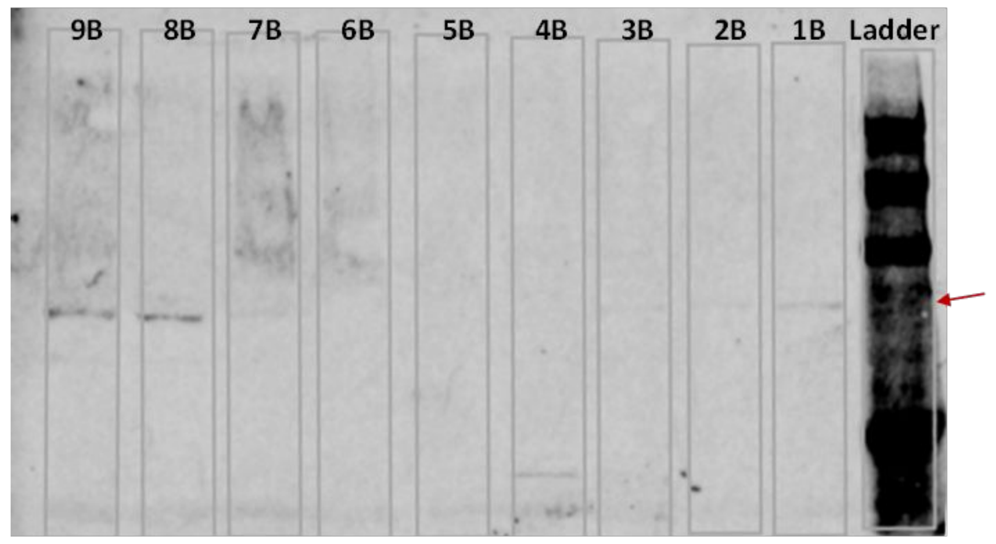


Figure 3. Western blot for HSP70 expression. Red arrow approximates 70 kDa. Snails 1, 2, 3 were fed low As periphyton, 4, 5, 6 high As periphyton, and 7, 8, and 9 periphyton with no As.

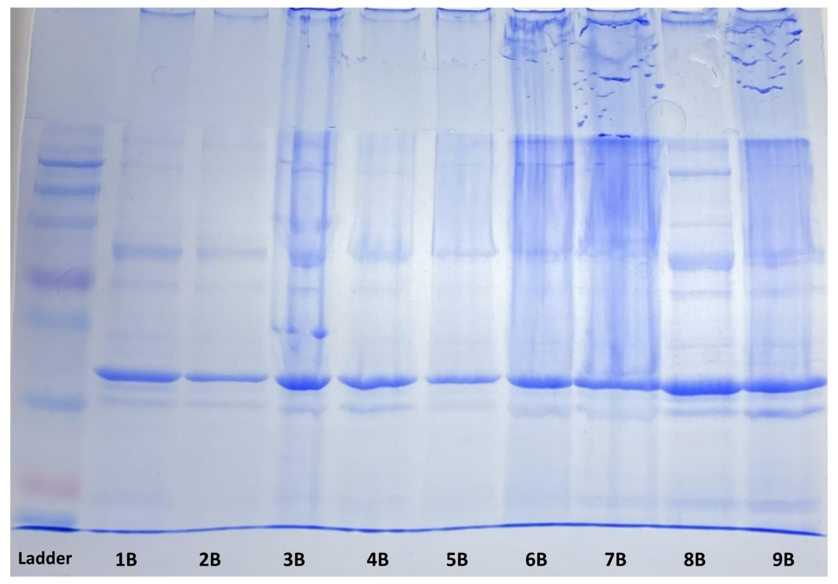


Figure 4. Coomassie blue staining of gel electrophoresis results. Unequal loading of bands which could contribute to error in results. Possibly from loss of sample

Our results concluded that HSP70 was the most prevalent in samples retrieved from Lake Meridian. Additionally, the findings concluded that there was a low expression of HSP70 within the Killarney samples and overall no expression among the Steel samples. These results do not support our initial hypothesis that arsenic (v) exposure increases HSP70 expression. This could be due to another stressor present in Meridian that was impacting the snails, leading to higher stress response.

Periphyton/plant location	Relative HSP70 expression in snails (0, +, +++)
Lake Meridian	0 (foot, mantle), + (gut), +++ (head)
Lake Killarney	0 (foot, gut, mantle), + (head)
Steel Lake	0 (foot, head, mantle), +++ (gut)

Figure 5. Compiled data of HSP70 expression in various regions of the snail. Snails were fed periphyton and plants from lakes containing varying levels of arsenic.

FUTURE DIRECTIONS

Possible next steps would be testing how antibiotics affect the metabolism of arsenic and subsequent stress response in snails. This can be done by introducing antibiotics to juvenile snails followed by arsenic exposure, then, testing HSP70 expression and comparing the antibiotics. The purpose of this is to mirror the increasing prevalence of antibiotic contamination in lakes from wastewater and runoff. This could contribute to the high uptake of arsenic as the gut microbiota would be disrupted from antibiotic ingestion.

REFERENCES

Asarco Tacoma Smelter Site - (3657). [accessed 2022 May 24]. https://apps.ecology.wa.gov/cleanupsearch/site/3657.

Figure 1. Enhanced expression of the HSP70 gene persists in response to... ResearchGate. [accessed 2022 May 24]. https://www.researchgate.net/figure/Enhanced-expression-of-the-HSP70-gene-persists-in-response-to-the-stress-as-initiated-by_fig1_247000034

ACKNOWLEDGEMENTS

Special thanks to our peers for allowing us to share their combined data, to Dr. Alaei for organizing and managing this study, and to the Gardell lab for the initial snail feeding experiment.