Linking Sublethal Copper Toxicity to Respiration Response in Monogonont Rotifers

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Video walkthrough, references, and supplementary materials

Introduction

• Anthropogenic pollution introduces large amounts of toxicants to aquatic habitats every year, including persistent toxicants like heavy metals [1].

• Shallow ephemeral aquatic habitats create diverse rotifer assemblages, influenced by hydroperiods and vegetation [2].

• Heavy metals are known to cause disruptions to zooplankton respiration, but these responses are not uniform and can vary in their degree [3].

• O_2 consumption (respiration) can be used as a proxy for metabolism [4].

• Existing rotifer heavy metal metabolism studies examine population dynamics, physiology markers, reproduction, metabolites, and life stage endpoints but have not investigated effects on respiration.

• Studies on *Epiphanes brachionus and Epiphanes chihuahuaensis* are limited to establishing their phylogenetic placement [5] and phenotypic plasticity response to predators [6], respectively.

Hypotheses

• Exposure to heavy metals influences respiration rates in rotifers.

• Prior long-term exposure impacts the degree of change in respiration.

Discussion

• Adult respiration rates for the four *E. chihuahuaensis* and *E. brachionus* populations show intraspecies variation and are within the range of other studied monogonont species [8] **(Supplementary Table 1 & 2)**.

• LC_{50} for each species shows support for varied toxicant response based on life-history. *E. brachionus* from the polluted environment exhibit lower copper sensitivity, whereas *E. chihuahuaensis* from polluted environment exhibit higher sensitivity, when compared to reference populations **(Figure 1)**.

• Analysis tentatively suggests rotifer respiration is affected by copper exposure, but results indicate a difference in respiration response to sublethal copper levels **(Figure 2)**.

• *Tigriopus japonicus* copepods are known to develop copper resistance over generations under sustained high concentrations in laboratory experiments [9], demonstrating zooplankton adaption to polluted habitats.

• Multigeneration cadmium-adapted *Daphnia* studies identified protective genetic mutations after 25 generations of clean lab culturing [10], showing persistent adaptation to heavy metals compared to reference populations.

Future Directions

• This research is ongoing. The addition of intraspecies control and exposure experiments may provide insight if the difference in response is species dependent, habitat related or requires additional investigation.

• Although respiration has been used as proxy for metabolism in zooplankton toxicology research [11], the heavy metal respiration knowledge gap in rotifer research should be explored as a practical solution to better understand anthropogenic impacts.

• Expand toxicant testing to other heavy metals and arsenic.

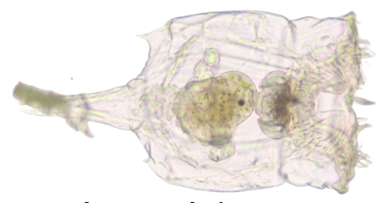
• Examine whole proteome heavy metal response expression profiles with the use of mass spectrometry.

• Perform a fitness assay to understand the impact sub-lethal heavy metal exposure has on survival, tolerance, and reproduction to rotifers.

Relevance

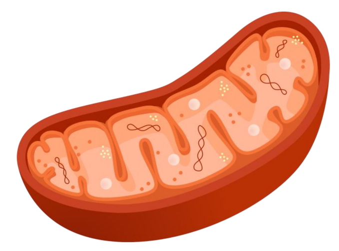
Active desert hydroperiods create ephemeral aquatic habitat for zooplankton

E. chihuahuaensis



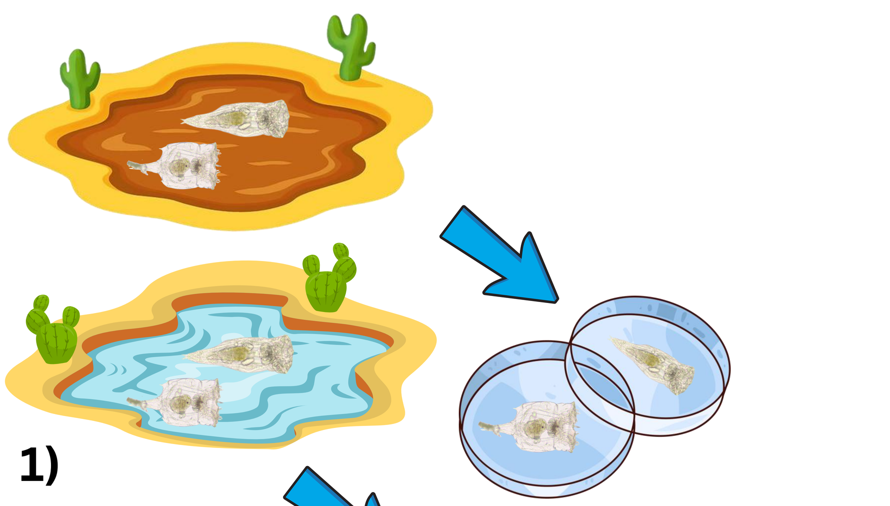
E. brachionus

Copper is environmentally relevant in the Chihuahuan desert.

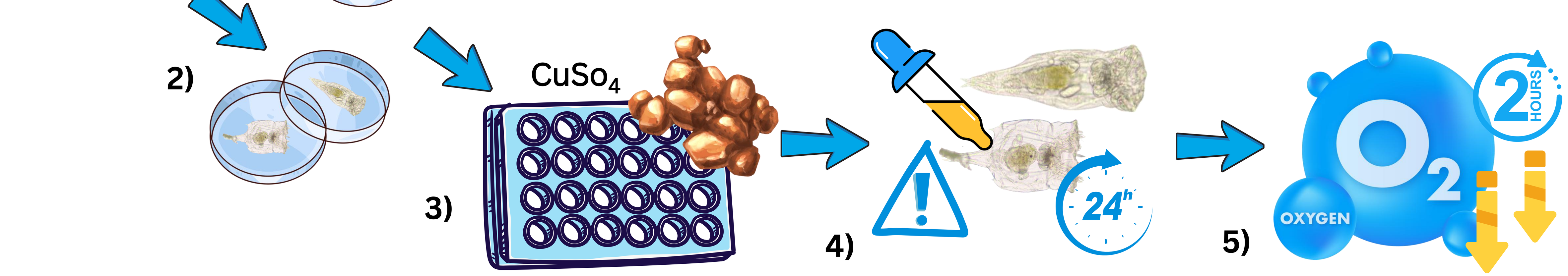


Limited rotifer metabolism studies on copper exposure

Methods



1) Collect polluted and reference ephemeral habitats rotifers
2) Culture populations in lab for long-term study
3) Expose populations to copper for 36h acute lethal concentration (LC_{50}) values [7]
4) Neonate sublethal exposure at 70% of population-specific LC_{50} and control for a 24h period
5) Measure O_2 consumption during a 2h resting period



Copper effects rotifer respiration, life-history influences sensitivity, species response varies.

Preliminary Results

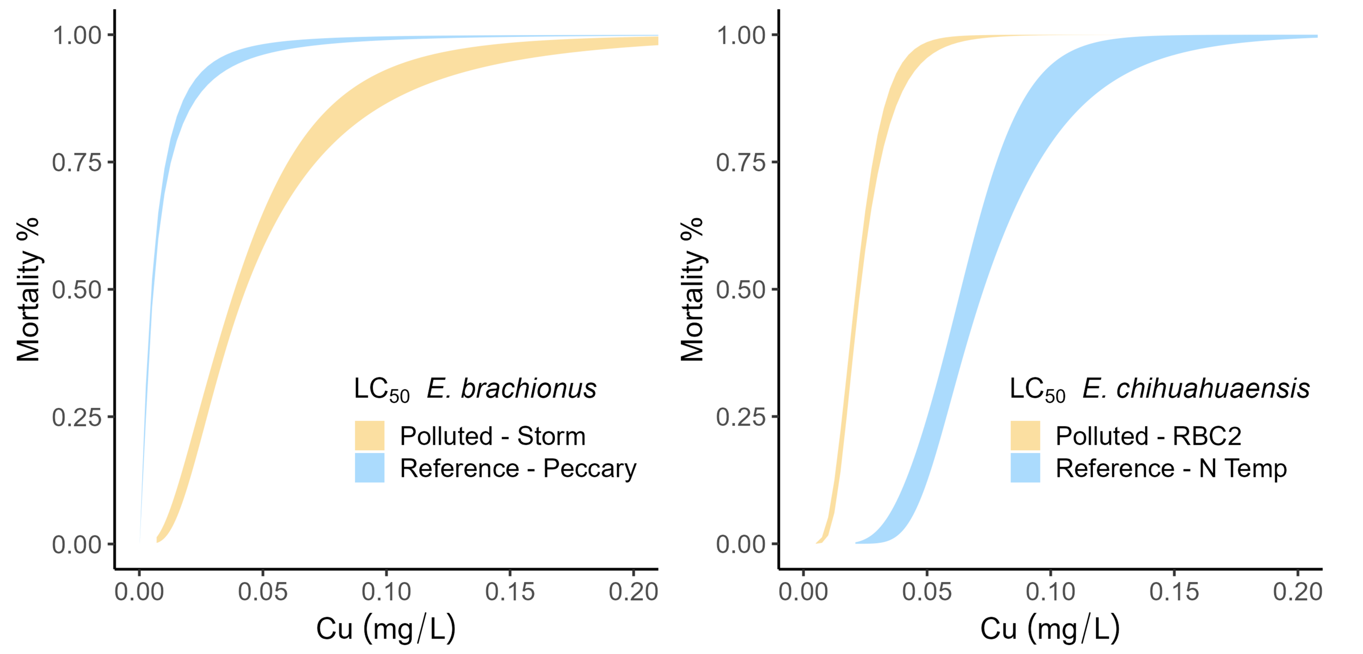


Figure 1 Neonate copper LC_{50} results across all four populations.
Left) *E. brachionus* polluted: 0.041 (± 0.005) mg/L, reference: 0.005 (± 0.001) mg/L
Right) E. chihuahuaensis polluted: 0.022 (± 0.001) mg/L, reference: 0.068 (± 0.007) mg/L
Probit analysis **p-values** < 0.001 for all four populations.

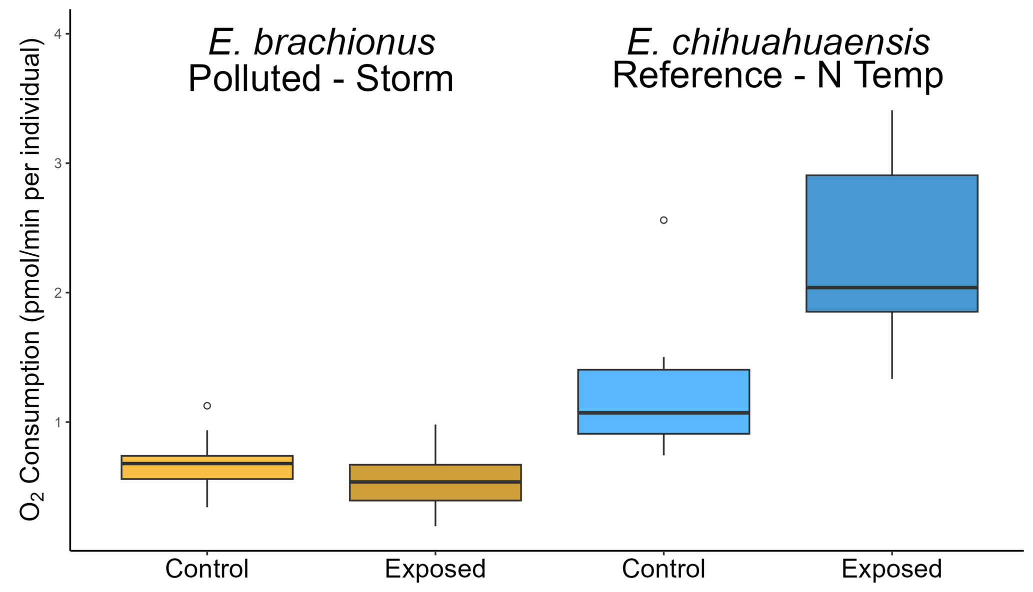


Figure 2 Neonate respiration rates for two populations. Significant differences for control and exposed groups were observed with a two-tailed t-test, **p-values <0.05**. Respiration data for remaining populations are forthcoming.

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