The effects of rising temperatures on *Trichobilharzia alaskensis* shedding in freshwater snails

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Objective

Determine the high temperature threshold of *Trichobilharzia alaskensis* shedding in freshwater snails.

Introduction

Climate change affects host-parasite interactions throughout the Arctic (Kutz et al., 2014). Warming temperatures can have direct effects on the transmission dynamics and life cycles of parasites within ectothermic hosts (Molnár et al., 2017).

Trichobilharzia alaskensis is a bird schistosome that is a causative agent of cercarial dermatitis (swimmer's itch), a pustulous rash affecting freshwater swimmers.

Swimmer's Itch Life Cycle (Fig. 1)

- T. alaskensis (Fig. 2) begins as eggs in duck feces.
- The eggs hatch into miracidia and infect a snail. The parasites reproduce asexually in the snail as sporocysts.
- T. alaskensis emerges from the snail as cercariae and actively seeks a duck to infect.
- However, the cercariae can mistake a human for a duck and accidentally penetrate their skin, dying and causing an itchy rash (Soldanova et. al, 2013).

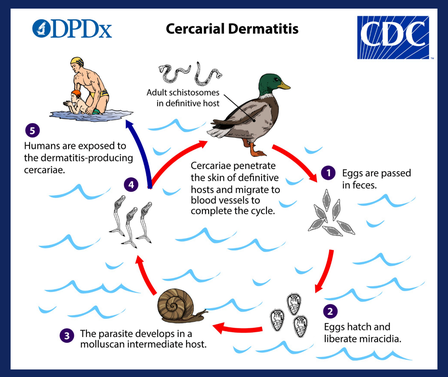

Figure 1. Life cycle of *Trichobilharzia alaskensis*

Hypothesis

1. Cercarial shedding will increase with water temperature.
2. Increased snail mortality will occur in the highest-temperature treatment.

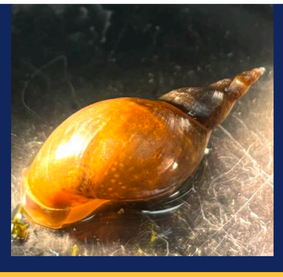

Figure 2. (Left) *T. alaskensis* shed from an *L. stagnalis* snail.

Figure 3. (Right) *L. stagnalis* snail collected from Tanana Lakes.

Methods

- We collected *Lymnaea stagnalis* snails (Fig. 3) from Tanana Lakes weekly.
- We placed snails in condiment cups under a full-spectrum light to induce cercarial shedding and determine infection.
- 114 infected *L. stagnalis* snails were placed in heated tanks.
- 38 snails were kept in each temperature group (selected based on Tanana Lakes data) with a full-spectrum light over 3 trials:
  - 23.45°C (control)
  - 25.95°C
  - 28.45°C
- Snails roamed free in the tanks for 48 hours to acclimate before being placed in condiment cups to shed (Fig. 4&5).
- We then counted cercariae in 1 mL samples from each cup to calculate shedding rates.

Figure 4. (Left) *T. alaskensis* shedding in an *L. stagnalis* snail, induced by a full-spectrum light. Each white dot in the cup is an individual cercariae.

Figure 5. (Right) Heated tank set-up used for the last 24 hours of each trial.

Results

- Mean Cercariae/mL for the control, low, and high temperature groups were 11.15, 36.54, and 68.61, respectively. There is a statistically significant difference between temperature groups, which was determined using ANOVA ($p < 0.005$, $df = 2$, F-value=6.634) (Fig. 7).

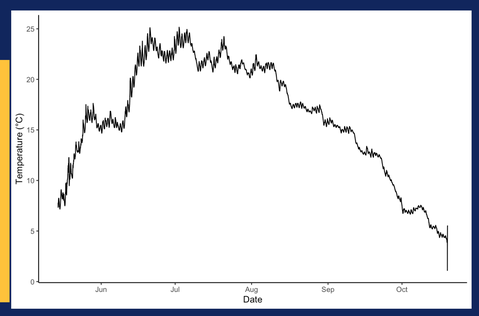

Figure 7. Tanana Lakes temperature from 05/14/2024 to 10/14/2024 obtained using a HOBO Water Temperature Pro v2 Data Logger. Logger samples were taken every 5 minutes. Maximum temperature = 24.5 °C. Minimum temperature = 1.3°C.

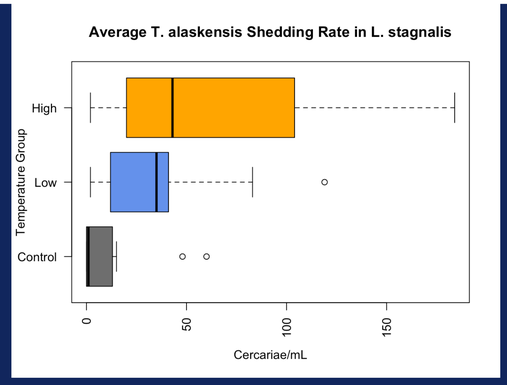

Figure 8. Mean cercarial shedding rate measured in cercariae per mL (n=38). Control, low, and high standard deviations are 5.495740, 9.103124, and 16.183459, respectively.

Discussion

- Cercarial shedding increased as water temperature increased (Fig. 8).
- As temperatures warm, we could see increased *T. alaskensis* shedding, leading to higher rates of swimmer's itch infections.
- Conversely, we could see earlier parasite shedding in the season, it must coincide with duck migration for *T. alaskensis* to continue its multi-host life cycle (Paull &Johnson, 2014).
- Ultimately, the loss of *T. alaskensis* in an ecosystem could allow for competing trematodes to become more prevalent in freshwater snails.
- There must be more work done on other T. alaskensis life stages to build accurate climate change predictions as host-parasite interactions are incredibly complex.

Future studies

- Studying the effects of high temperature on *T. alaskensis'* sporocyst stage will allow us to understand parasite development.
- Sporocysts can be extracted from freshwater snails, grown in a "fake snail" using a chicken serum cell culture, then heat-treated and studied (Fig. 9).
- Thus far, we have managed to keep a sporocyst alive for 6 days in the culture.

Figure 9. Freshwater sporocyst trial using *L. stagnalis* samples in a chicken serum culture.

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