The infection of juvenile three-spined stickleback with a cestode parasite differs between host populations and years and increases over the winter

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Background

- In southcentral Alaska stickleback populations have colonized freshwater habitats repeatedly and independently, resulting in a freshwater adaptive radiation[1].
- In freshwater, oceanic stickleback first encounter *Schistocephalus solidus*, a trophically transmitted cestode with a complex life cycle (Figure 1).
- *S. solidus* has a long evolutionary history of parasitizing freshwater stickleback but is not viable in marine environments[2].
- Some stickleback populations appear to have persistently low parasite loads, some have consistently high loads, and some exhibit extreme fluctuations across years.
- Two possible, but not mutually exclusive explanations are :
  1. Freshwater stickleback populations experience different ecological contexts that affect either the abundance or spatial distribution of infected copepods.
  2. The host fish have evolved different levels of resistance to the parasite in different lakes.

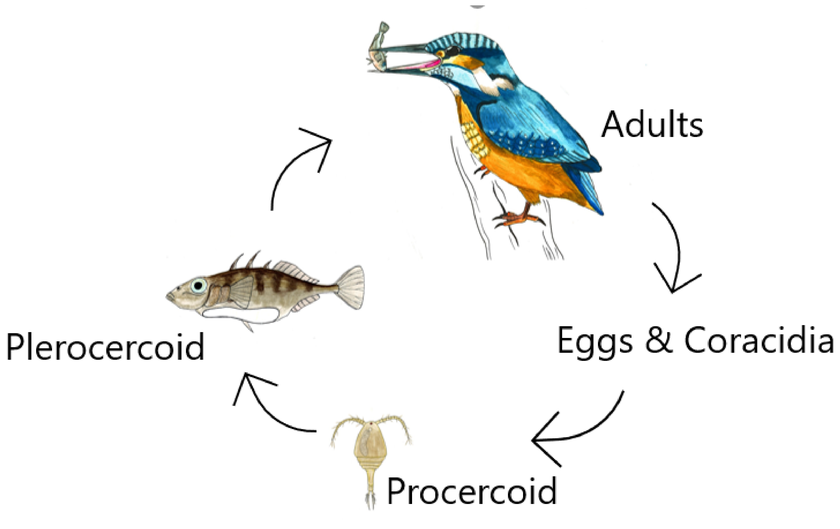

Figure 1:The three-host life cycle of the cestode *Schistocephalus solidus*, with a cyclopoid copepod as the first intermediate host, the threespine stickleback as the second specific intermediate host and a warm-blooded vertebrate, typically a fish-eating bird, as the final host.

Objective

This study was conducted to determine the infection rate in young-of-year stickleback with *S. solidus* and how it develops over the winter.

Methods

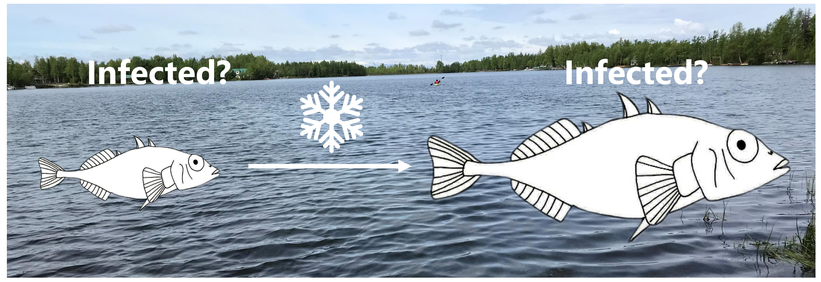

Figure 2: Young-of-year stickleback were collected in August 2018 and 2019. Adult stickleback were collected in June 2019 and 2020. Samples were dissected and the infection status was determined. Adult stickleback were grouped based on their standard length and the distribution was visually assessed to estimate the size that seems to separate age-1 and age-2 stickleback.

Results

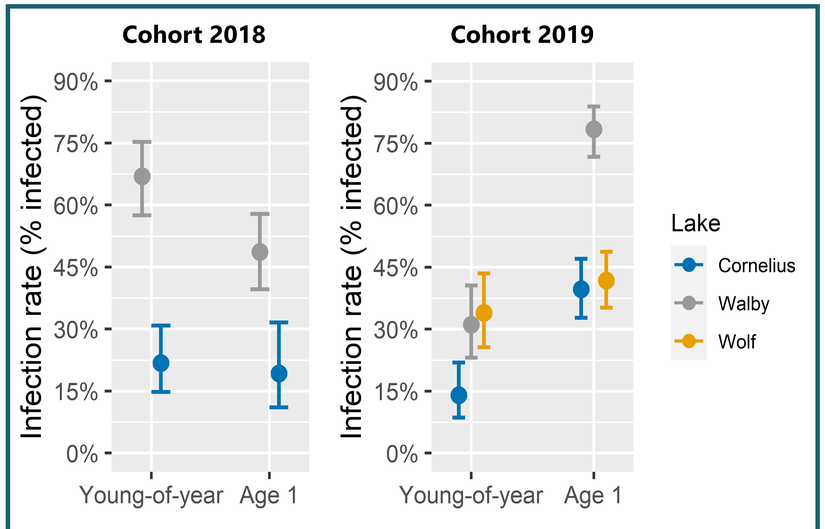

Figure 3: Probability of being infected as young-of-year fish and at age 1. Depending on the year, the infection rate in young-of-year stickleback was between 10-20% for the low infection population and between 30-70% for the high infection populations. For the 2019 cohort, infection rate increased dramatically over the winter, while it did not change in the 2018 cohort.

Discussion

- *S. solidus* infecting young-of-year stickleback find themselves in hosts that are too small for the parasite. The parasite must allow it's hosts to grow after infection, or the parasite won't be able to reach its definitive size and with that sexual maturity.
- The infections seems to continue under the ice cover.
- We see strong evidence that parasite loads can vary substantially from year to year [3,4].
- Stickleback from the "low" infection lake in this study (Cornelius Lake) already show lower infection rates than fish from the "high" infection lake (Walby Lake) during late summer. It seems that whatever mechanisms are responsible for this difference are already at play early during the stickleback life.
- We might need to re-evaluate the timing of *S. solidus* infections and age of stickleback hosts used in laboratory infection studies.

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[1] Bell MA, Foster SA (1994) Introduction to the evolutionary biology of the treespine stickleback. In: The Evolutionary Biology of the Treespine Stickleback (Ed. By Bell, MA & Foster SA) pp.1-27. Oxford: Oxford University Press **[2]** Simmonds NA, Barber E (2016) The effects of salinity on egg development and viability of *Schistocephalus solidus* (Cestoda:Diphyllobothriidea) J Parasitol 102:42-46 **[3]** Heins DC & Baker JA (2014). Fecundity compensation and fecundity reduction among populations of the three-spined stickleback infected *by Schistocephalus solidus* in Alaska. Parasitology 141(8):1088-1096. **[4]** Heins DC & Baker JA (2003). Reduction of egg size in natural populations of threespine stickleback infected with a cestode macroparasite.J Parasitol 89(1), 1-7.

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