Contributions of parasites to energy flow through a stream food web

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Introduction

Parasites have adapted to exploit all species on this planet and are embedded within all ecosystems. However, due to their cryptic nature, **they are often neglected in measurements of energy flow and ecosystem dynamics**[1]. Past studies have estimated parasitic contributions to the flow of energy through marine estuaries and freshwater wetlands, indicating that **the effects of parasites can be substantial enough to impact the entire ecosystem food web**[2,3]. However, it remains unknown how broadly applicable these findings are.

The goal of my research project was to **investigate the role of trematode parasites in freshwater stream energetics**, using parasite biomass as a proxy for energy flow. This involved two major aspects:

1. **Calculating ecosystem-level biomass** (dry mass) of trematode parasites and free-living macroinvertebrates, including the trematode snail host, *Juga plicifera* (Fig. 1)
2. **Comparing trematode parasite biomass to that of other aquatic organisms** that share the stream habitat

Hypothesis

The **biomass of parasitic trematodes in freshwater streams is equal to, or exceeds, the biomass of many of the stream's free-living organisms** that are known to play important ecological roles.

Figure 1: Pleated Juga (*Juga plicifera*) in the field.

Study Area & Timeline

Figure 2: Partial view of Oak Creek study site.

- Three sites in each of three creeks: **Berry, Oak** (Fig. 2)**, and Soap**
- Located within **McDonald-Dunn Research Forest**, Corvallis, Oregon, USA
  - ~11,250 acres of predominantly forested land encompassed by the Willamette River Watershed
- Timeline: **Spring and Summer months of 2015 and 2016**

Methods

- Quadrat samples to quantify **snail density and size distribution**
- Length-to-mass data to calculate **snail biomass across all three streams** (Fig. 3)
- Surber samples to quantify **the density and size distributions of the other free-living organisms** that share the stream habitat (e.g., aquatic insects)
- Literature-based allometric relationships between length and mass to estimate the **biomass of the other free-living organisms** across all three streams
- Snail dissections to estimate **trematode infection prevalence** and measure **trematode biomass**

Figure 3: Field collection of freshwater snails.

Results & Discussion

❖ Trematode Infection Prevalence

- The **proportion of snails infected was dependent on snail size**, with the probability of infection increasing dramatically with snail shell length across all three streams (Fig. 4)
- Snails showed **varying degrees and stages of infection** by the five observed trematode species (Fig. 5)
- On average, **more than 30% of infected snail biomass was comprised of trematode biomass**

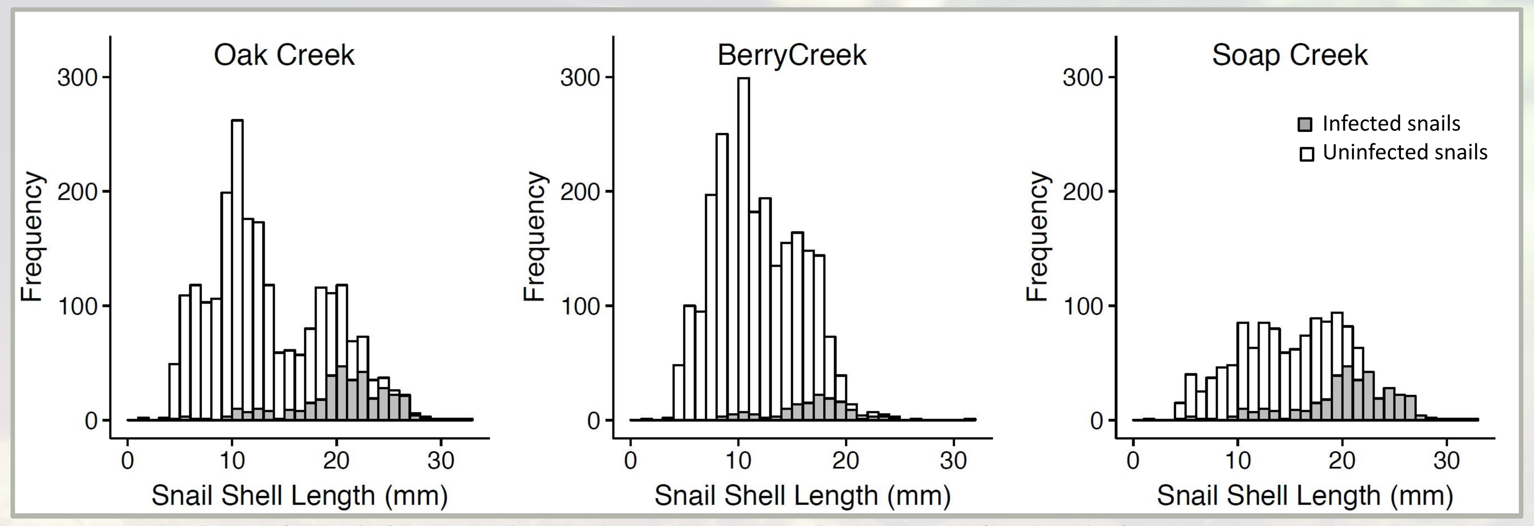

Figure 4: Size distribution of *Juga plicifera* across all sites within each stream. Gray bars represent infected snails of a given size.

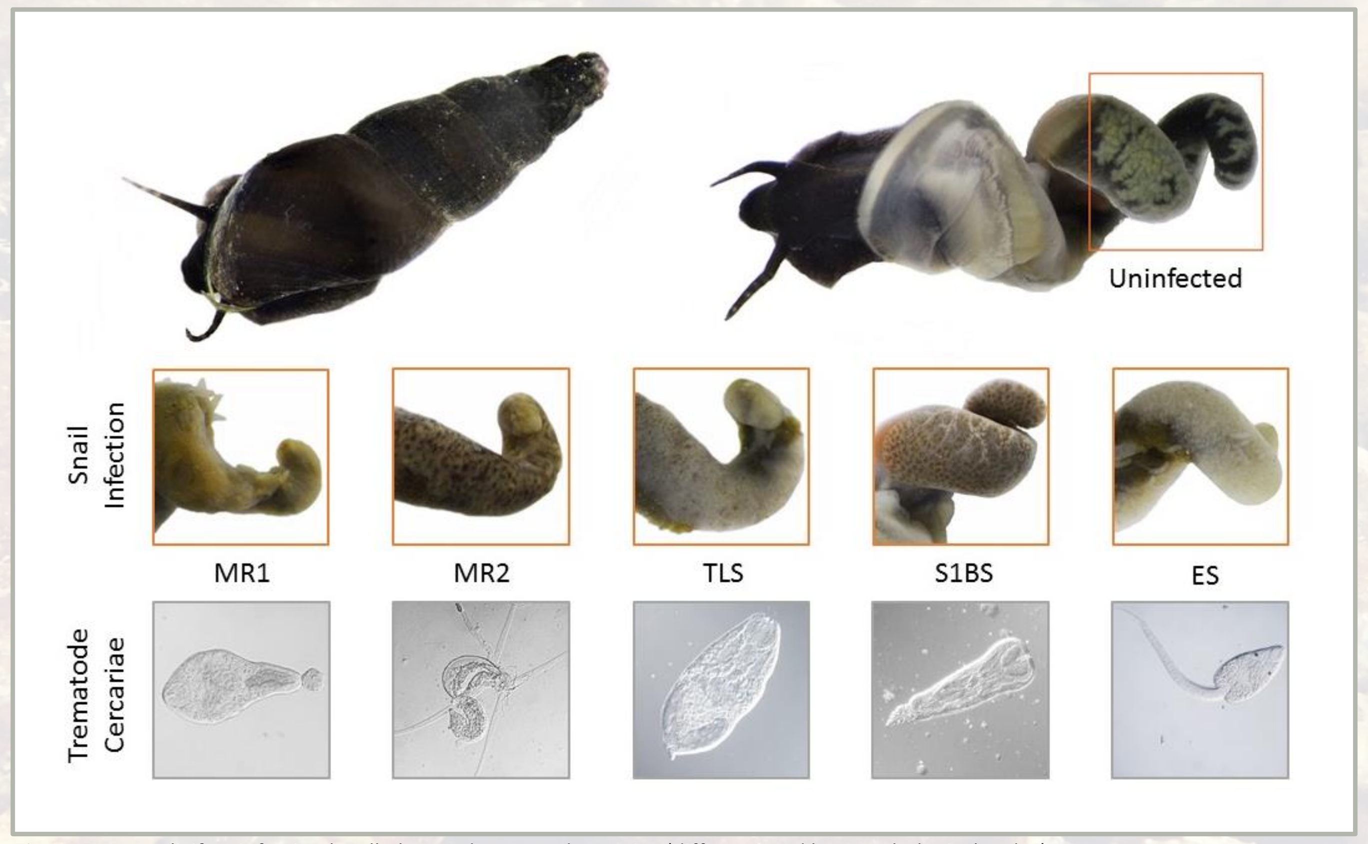

Figure 5: *Juga plicifera* infection by all observed trematode species (differentiated by morphological codes).

❖ Biomass Estimates

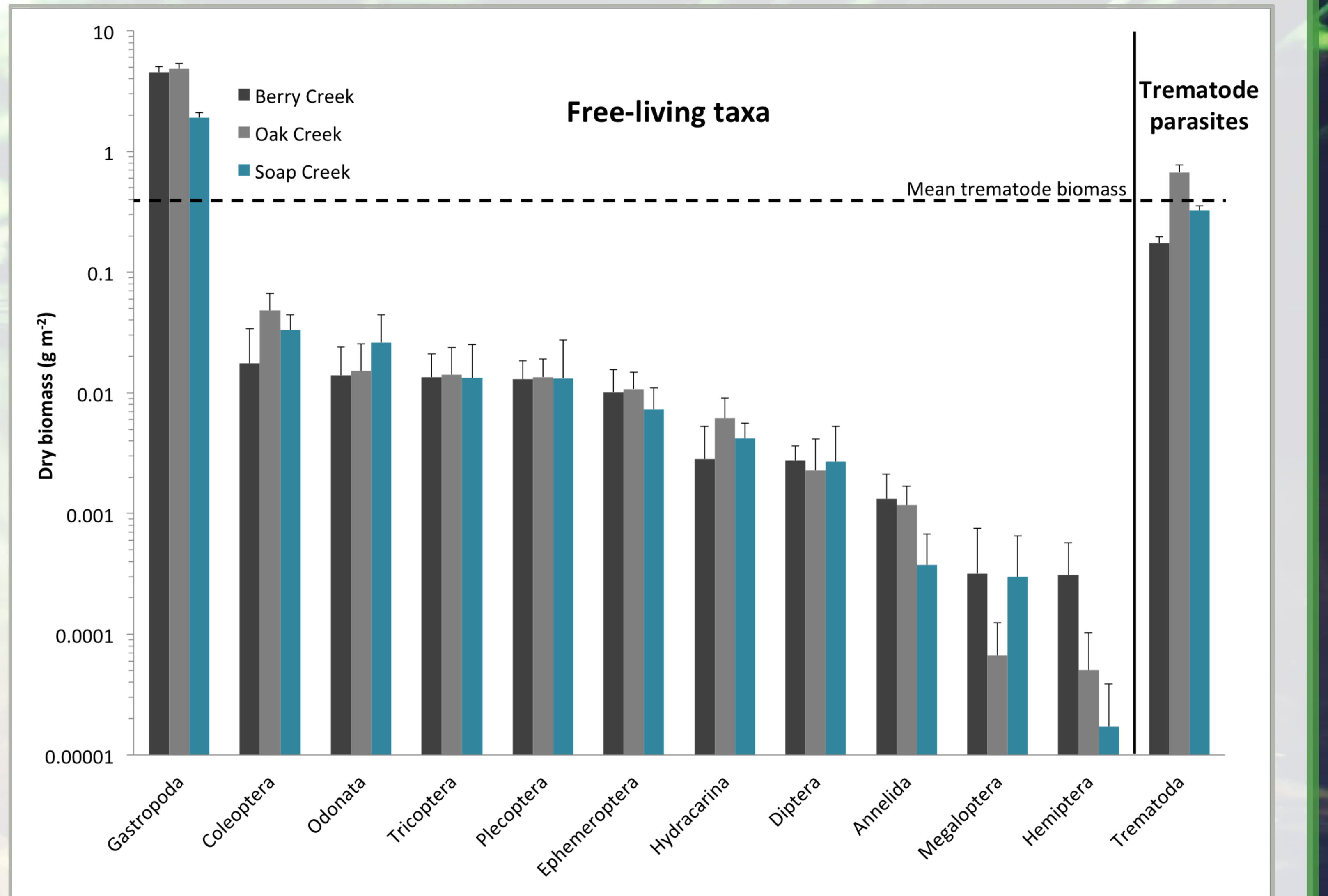

Figure 6: Biomass of aquatic invertebrates across all sites within each stream; data is log transformed. Biomass of free-living organisms are shown on the left and trematode parasite biomass is shown on the right. Dashed line represents the mean trematode biomass across all three streams. Error bars indicate + standard error.

- The **biomass of the trematode parasites** in all three streams **exceeded the biomass of the major free-living invertebrate taxa**, excluding their snail host (class Gastropoda; Fig. 6)
- **Snail biomass dominated the standing crop biomass** in all sites, comprising between $1x10^2$ to $2x10^5$ times more dry mass per m^2 than that of any other invertebrate taxa (Fig. 6)
- Trematode biomass ranged between 4% to 17% of the total snail biomass, **making trematode parasites the second largest biomass contributor** of all the aquatic macroinvertebrates
- Overall, **the average trematode biomass exceeded**, not only the biomass of all the individual free-living aquatic macroinvertebrates (aside from *Juga plicifera*), but also **the biomass of these taxa combined**

Conclusion

My results indicate that **parasites contribute a significant amount of biomass to freshwater streams** and are therefore likely to **assume important roles in energy flow capable of surpassing that of many free-living organisms**. Important questions for future research include:

1. How do these results compare to the other significant biomass contributors that share the stream habitat (e.g. crayfish and vertebrates)?
2. What are the impacts of trematodes on snail fecundity, mortality, behavior, and growth and how does this affect stream ecosystem dynamics?
3. What is the annual production of cercariae (free-living trematode larval stage that leaves the snail host to seek the next host) into the stream? Is this biomass also significant?

Resources

1. Marcogliese 2004. EcoHealth. 1:151-164.
2. Kuris et al. 2008. Nature. 454(7203):515-518.
3. Preston et al. 2013. Journal of Animal Ecology. 82(3):509-517.

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