Modeling the gut microbiome's resistance and resilience to climate change and infection in zebrafish

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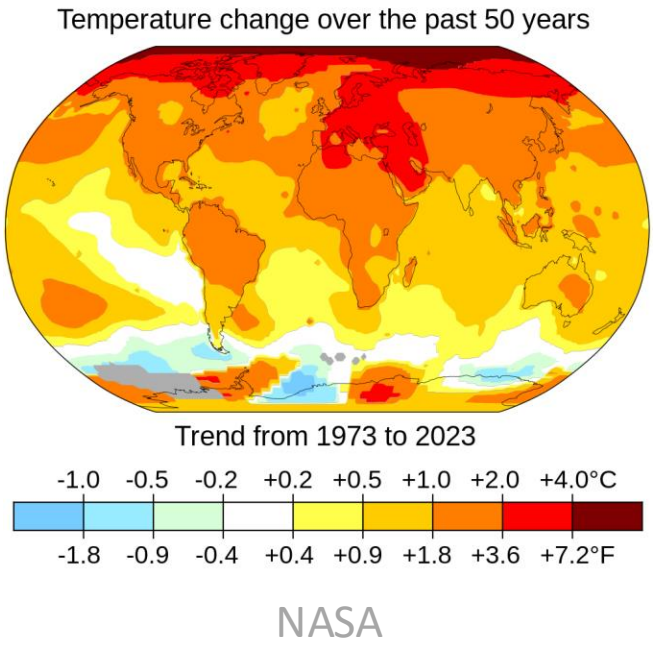
Climate change is anticipated to impact gut microbiome stability to influence host health

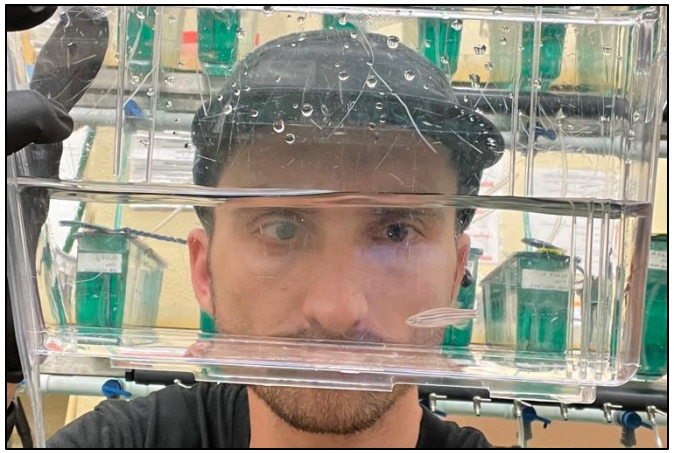
- Anthropogenic climate change increasing global temperatures impacting wildlife and humans
- Climate change anticipated to impact ecosystems and individual health
- Range of infectious agents expected to expand
- Clarify how exogenous stressors perturb microbiomes, and how climate change may modulate microbiome-infection axis

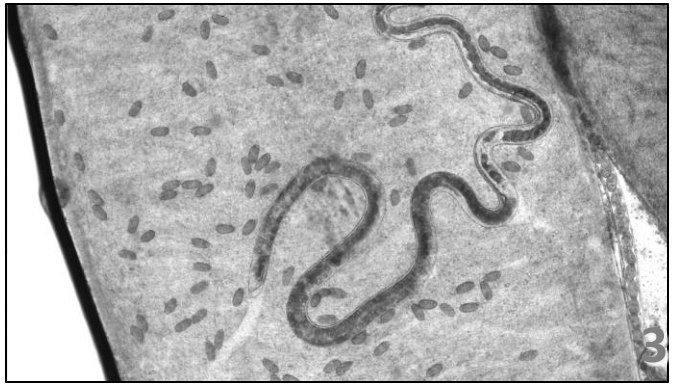


NASA

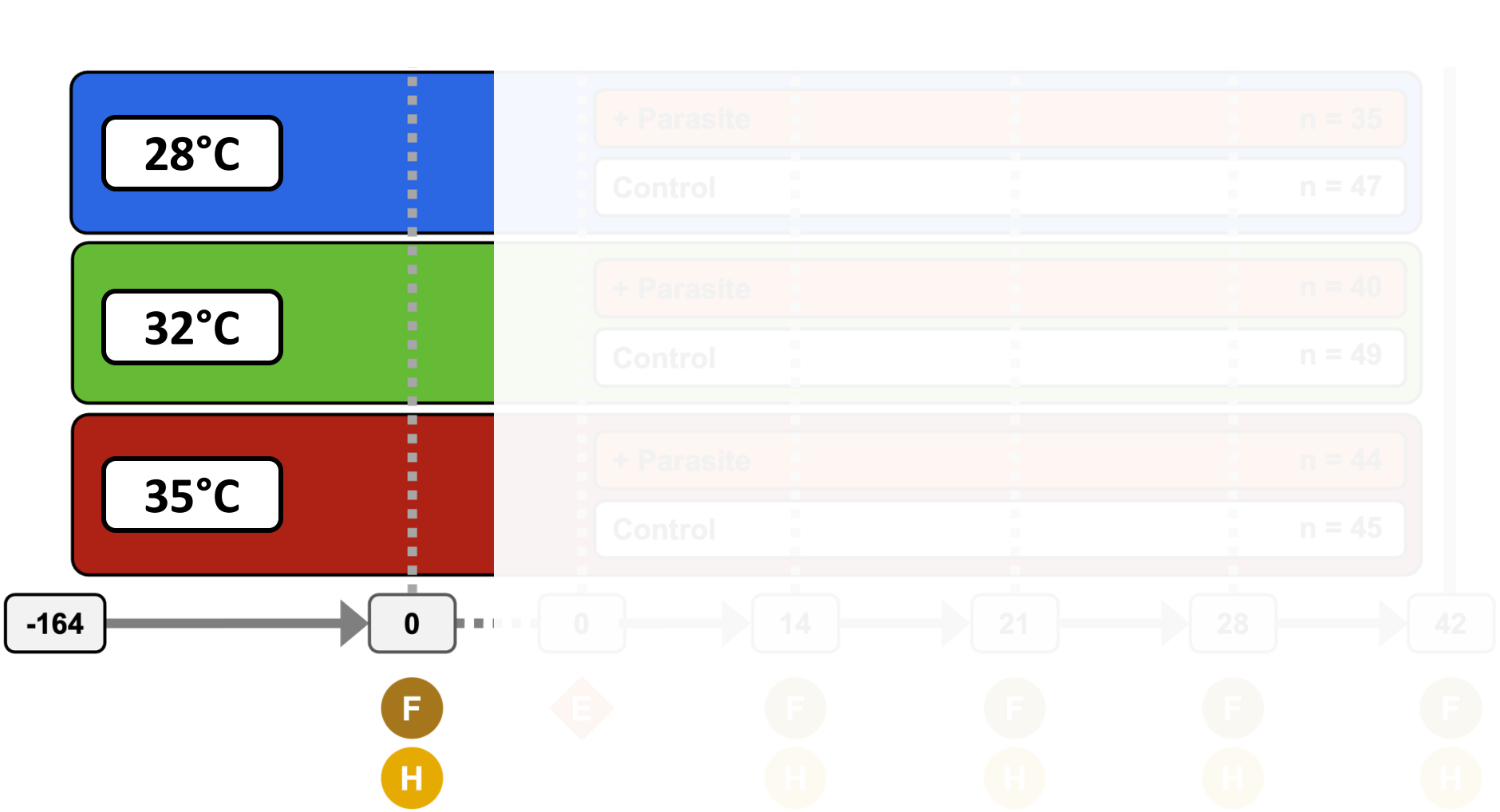
Using zebrafish to clarify how differing environmental conditions and -stressors impact gut microbiomes to influence host health

- Zebrafish are an advantageous model organism to interrogate the gut microbiome
- Prior work in zebrafish has investigated temperature and infection
- Temporal gut microbiome response to the interaction of increasing temperatures and parasite exposure is unclear
- Increasing water temperatures and exposure to a common zebrafish intestinal parasite, *Pseudocapillaria tomentosa*





Evaluating temporal microbiome responses and infection outcomes to an intestinal parasite across increasing water temperatures



Treatment

Days post exposure (DPE)

n = Cumulative fish / treatment

x # = Number of samples

Experimental events

E Parasite exposure

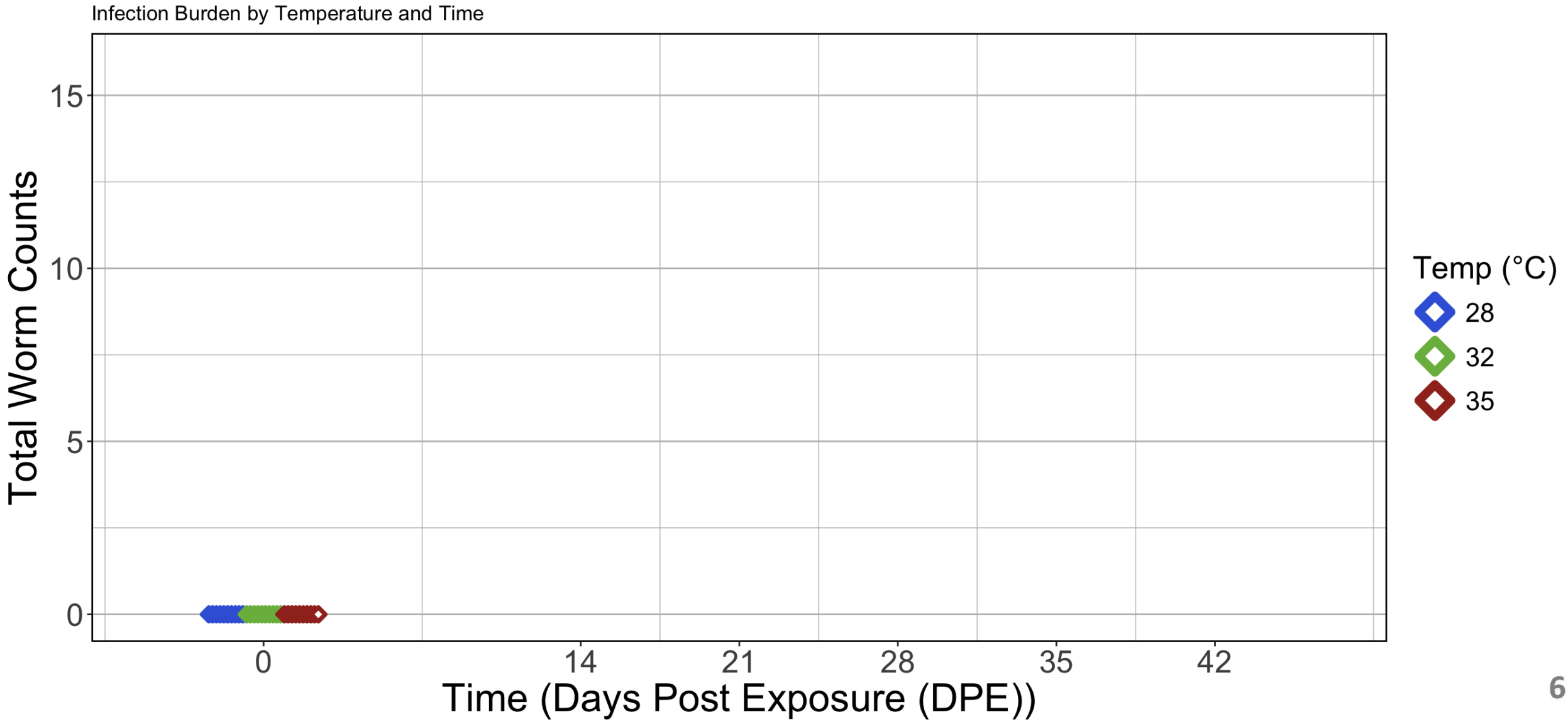
Sampling Endpoints

F Fecal

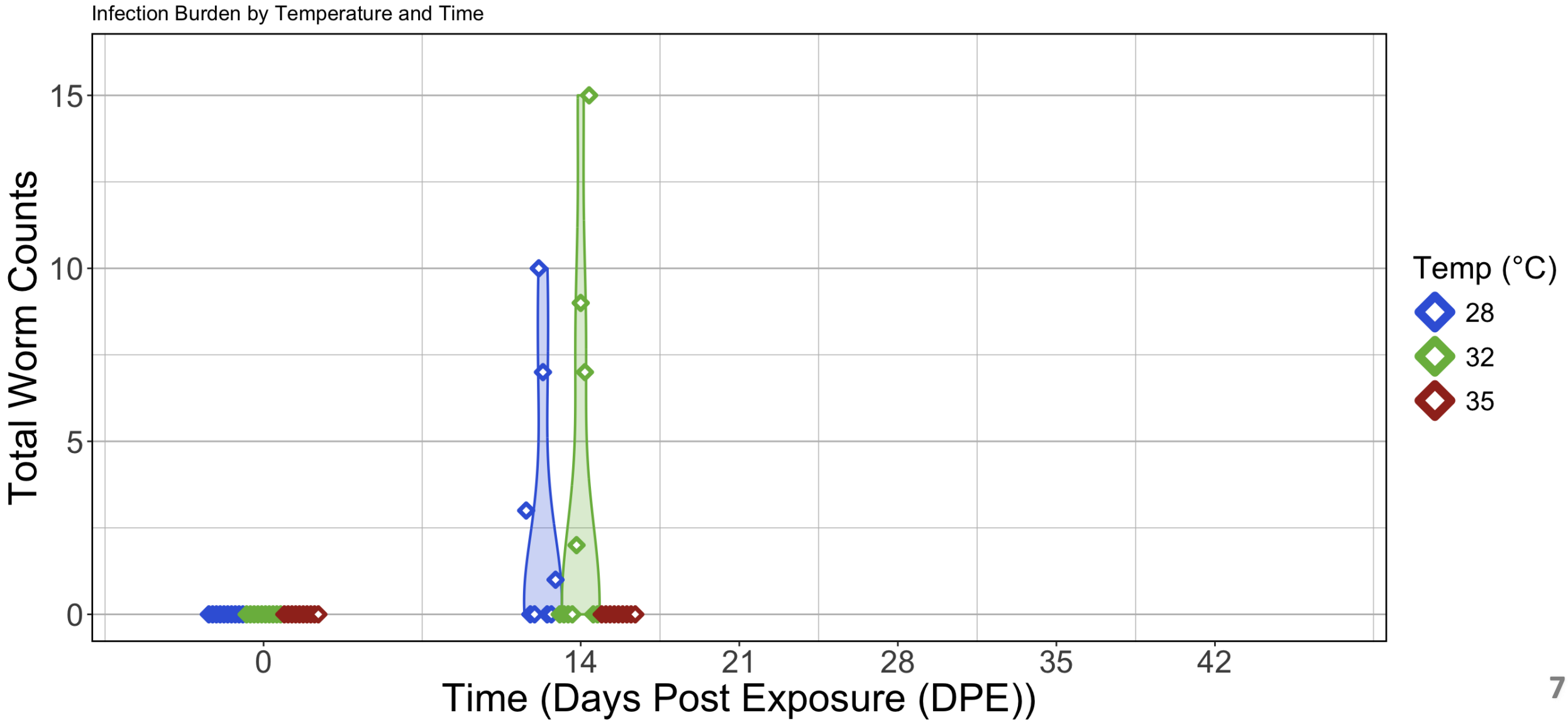
H Histopathology check

Infection Outcomes

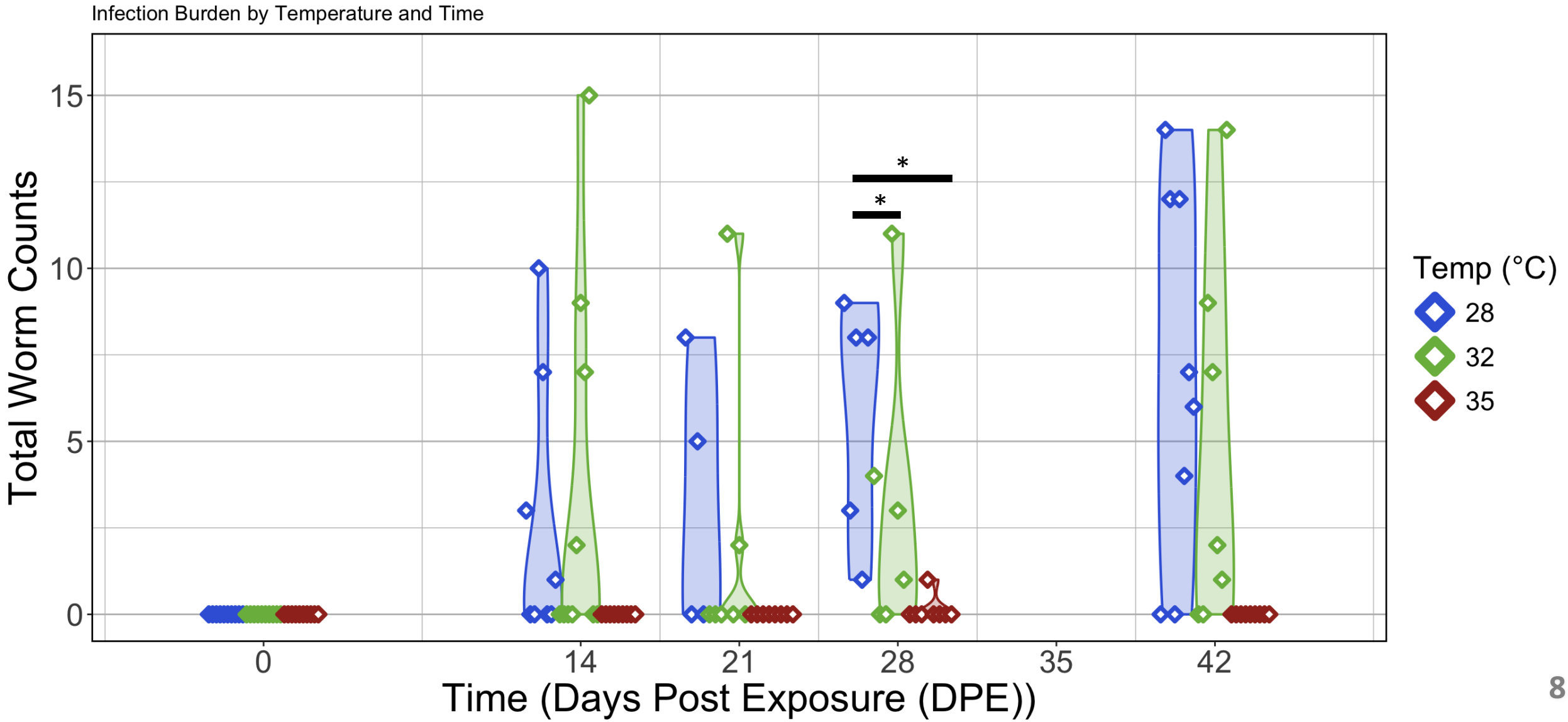
Infection burden over time by temperature group



Infection burden observed in fish reared at lower water temperatures



Higher water temperatures may be protective against infection burden



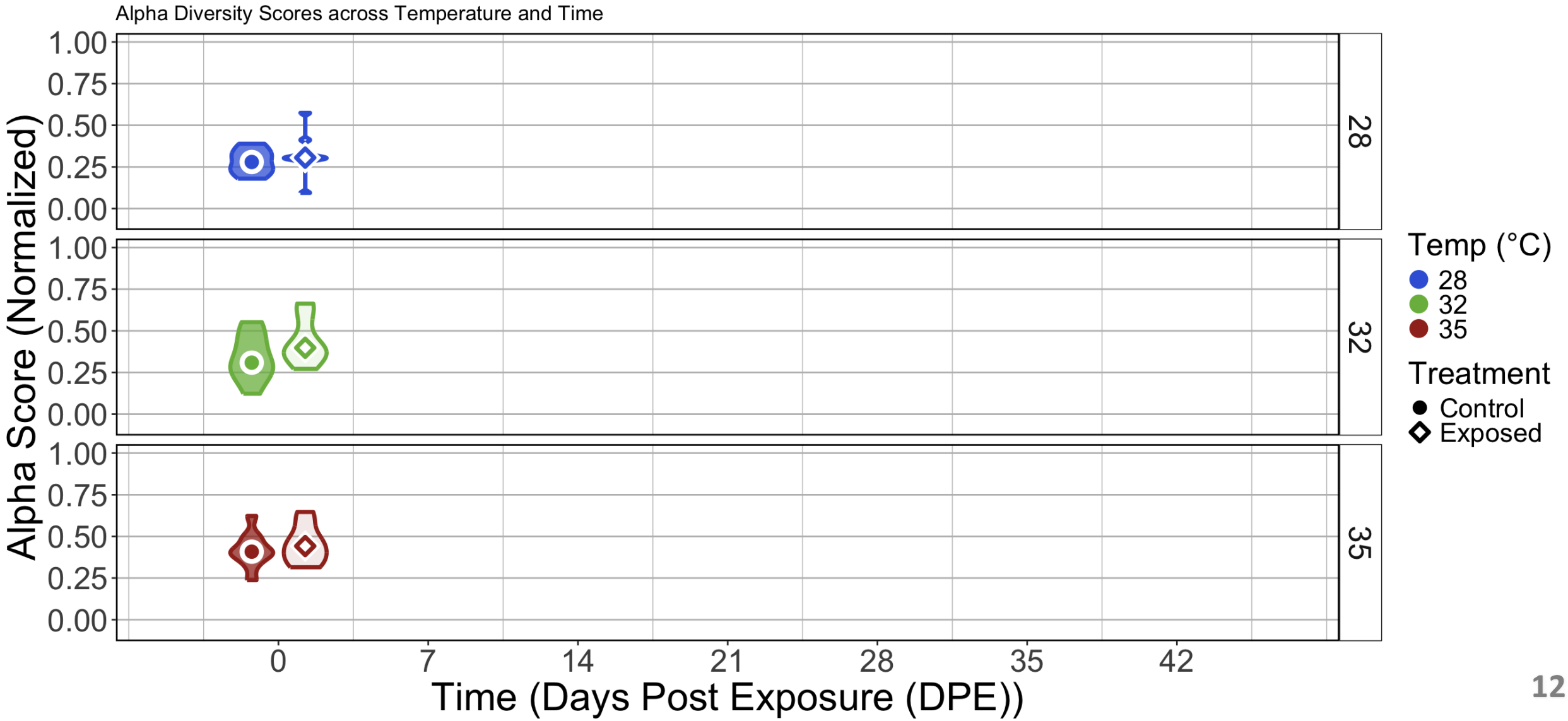
Microbiome Response

Measuring microbiome response to an exogenous stressor

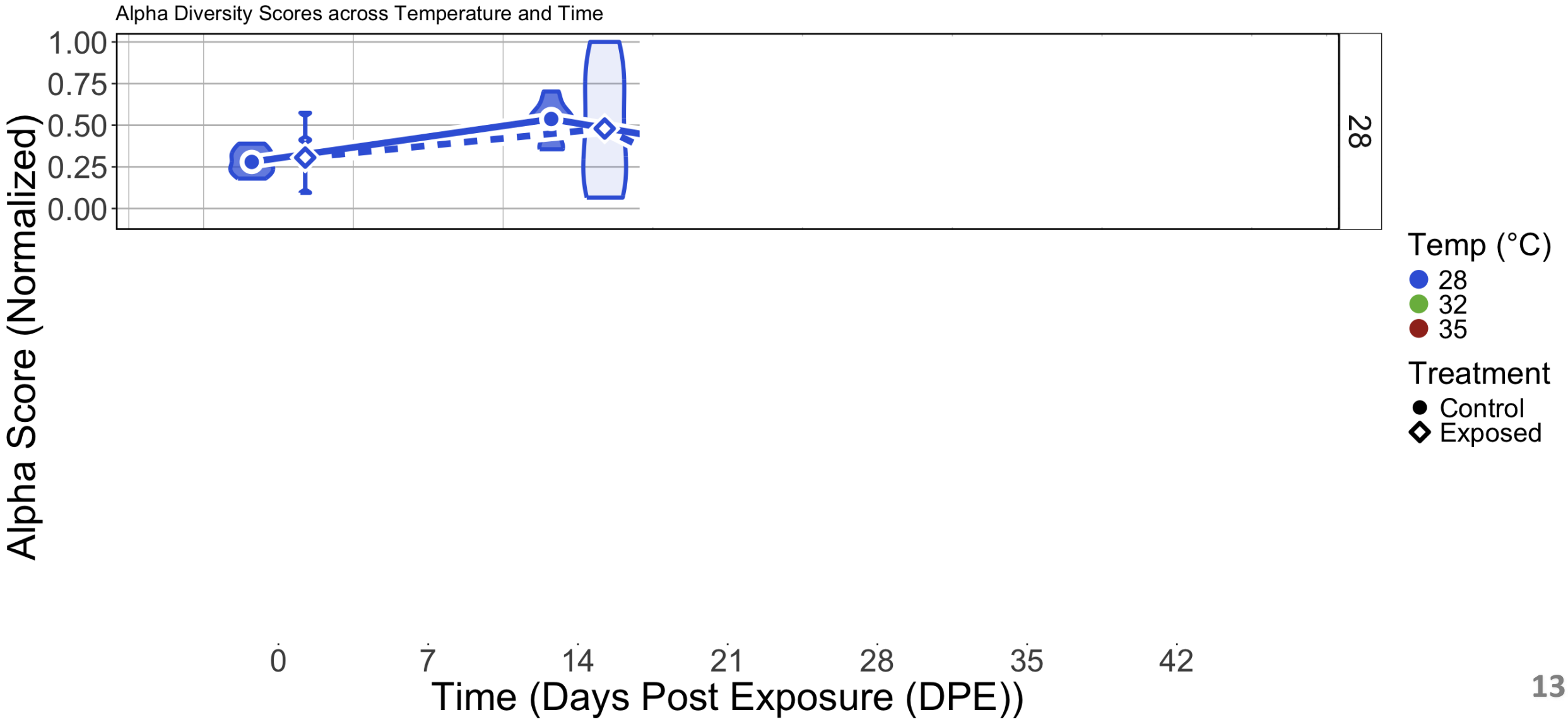
- Gut microbial diversity
- Gut microbial community composition
- Infection outcomes by microbiome response

Gut Microbial Diversity

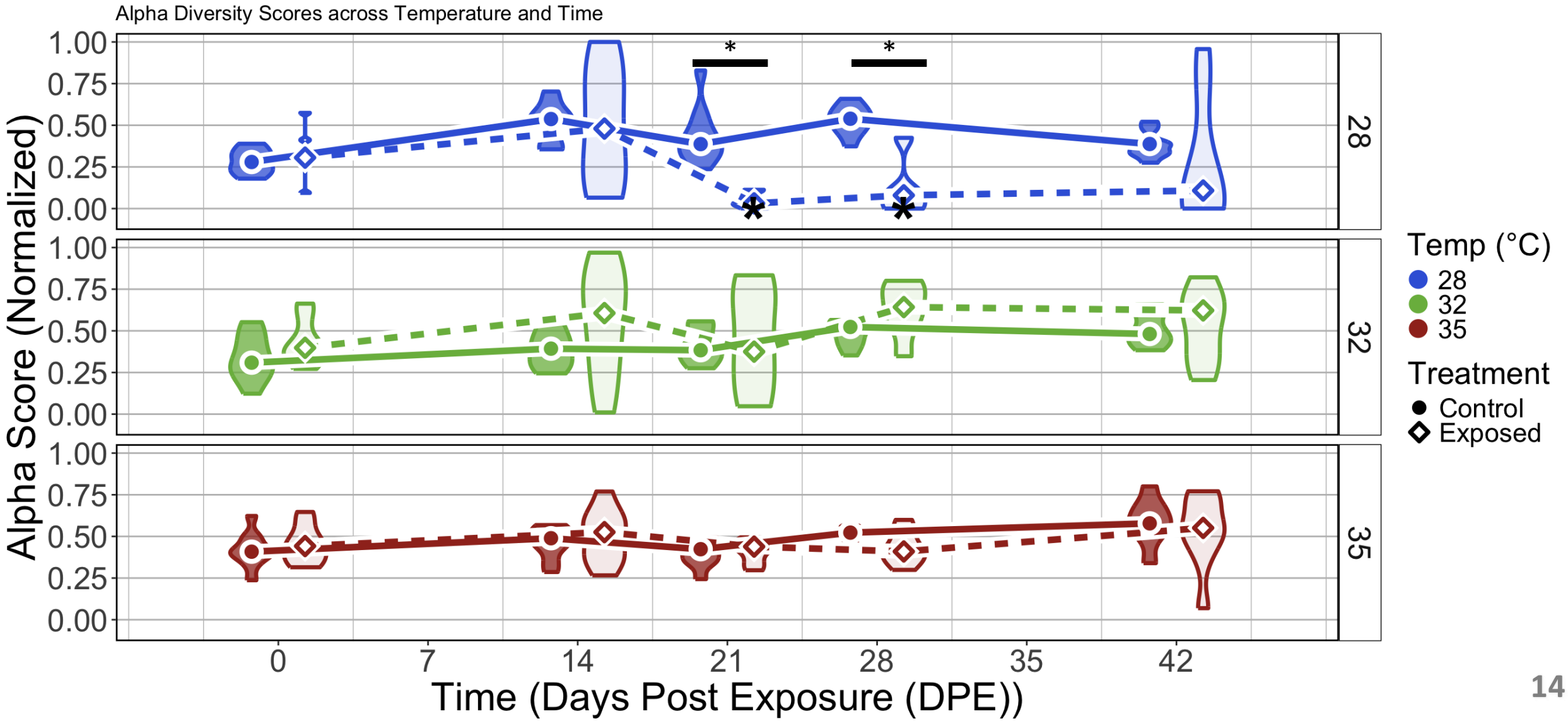
No significant difference between control and exposed fish within temperature groups at baseline sampling



Parasite exposure alters trajectory of gut microbiome diversification at lower water temperatures

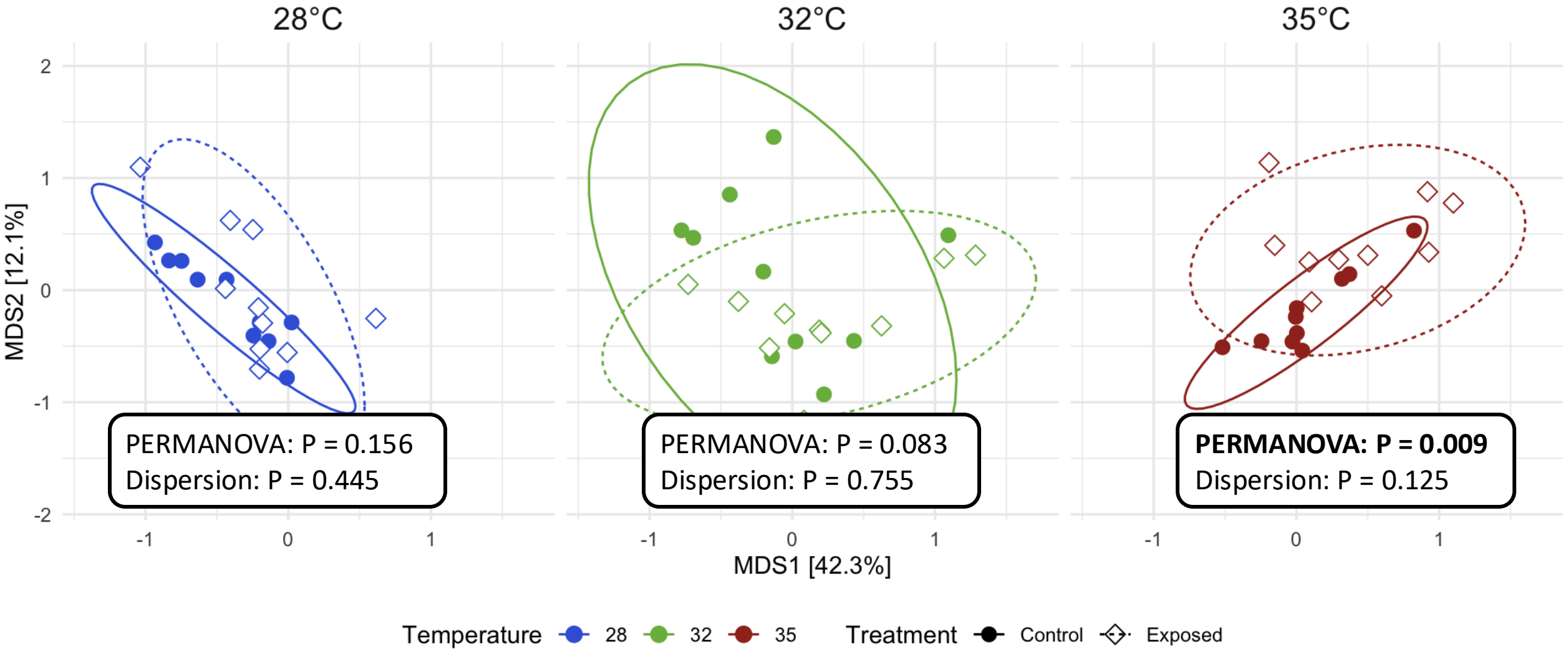


Water temperature moderates gut microbiome's sensitivity to parasite exposure



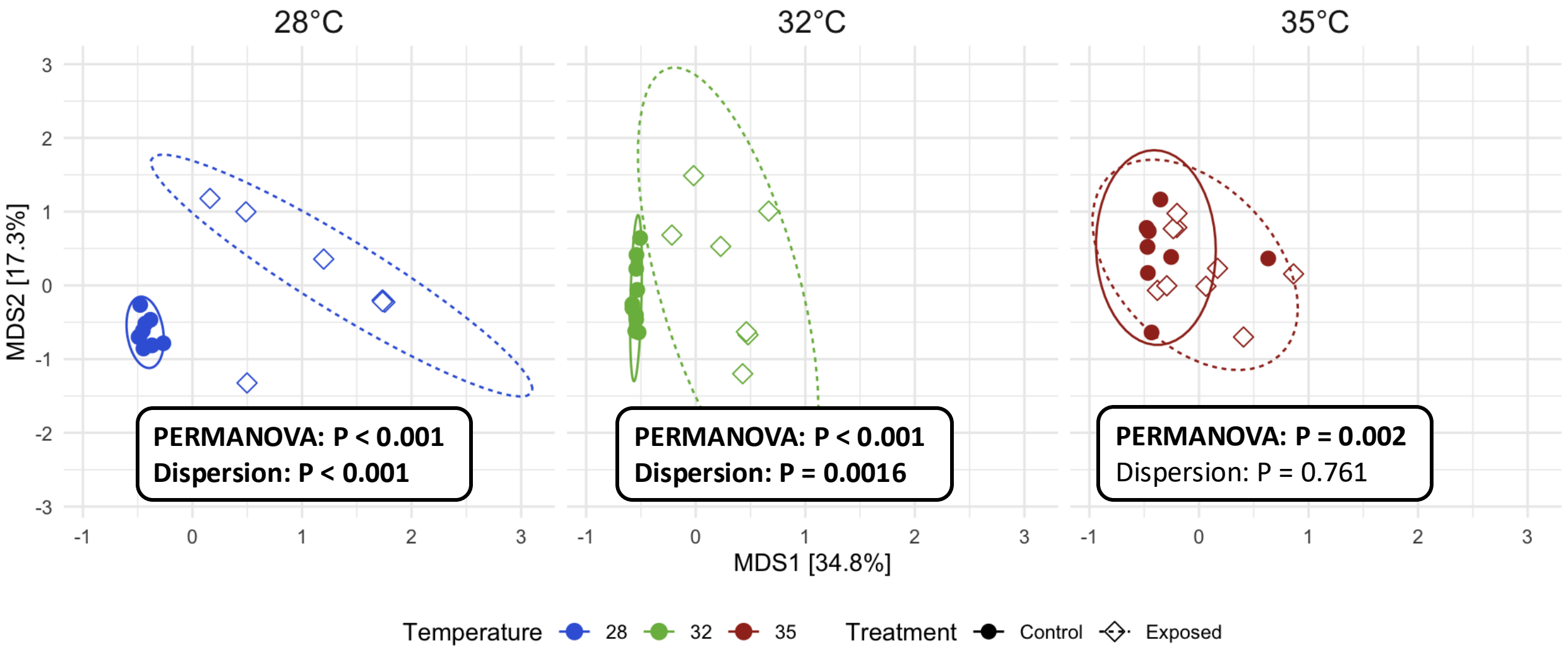
Gut Microbial Community Composition

Baseline gut microbial community composition prior to parasite exposure



60 samples & 149 taxa (Genus). PCoA dist=bray

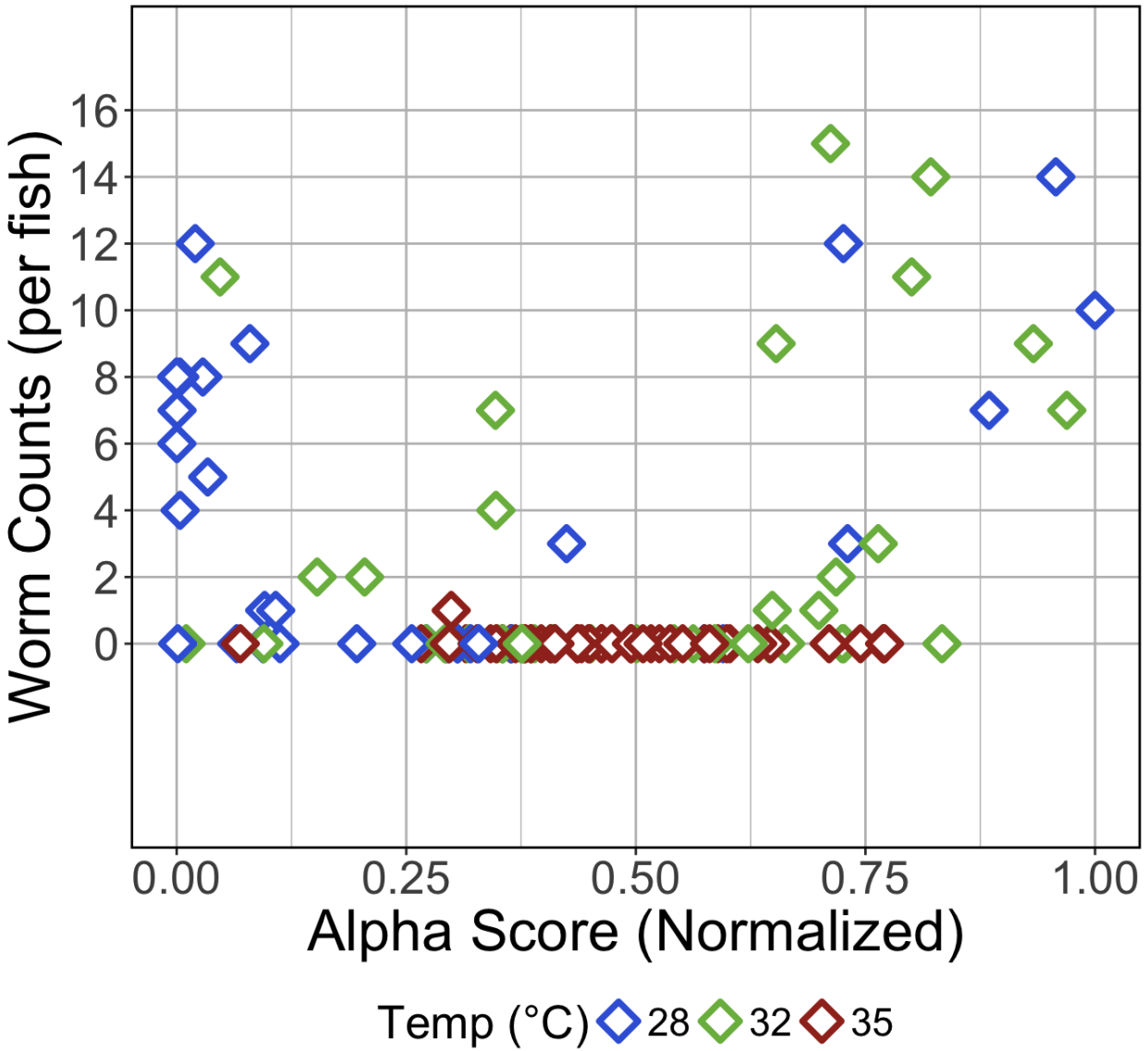
Parasite exposure restructures the gut microbiome in a water temperature dependent manner by 42 days post exposure



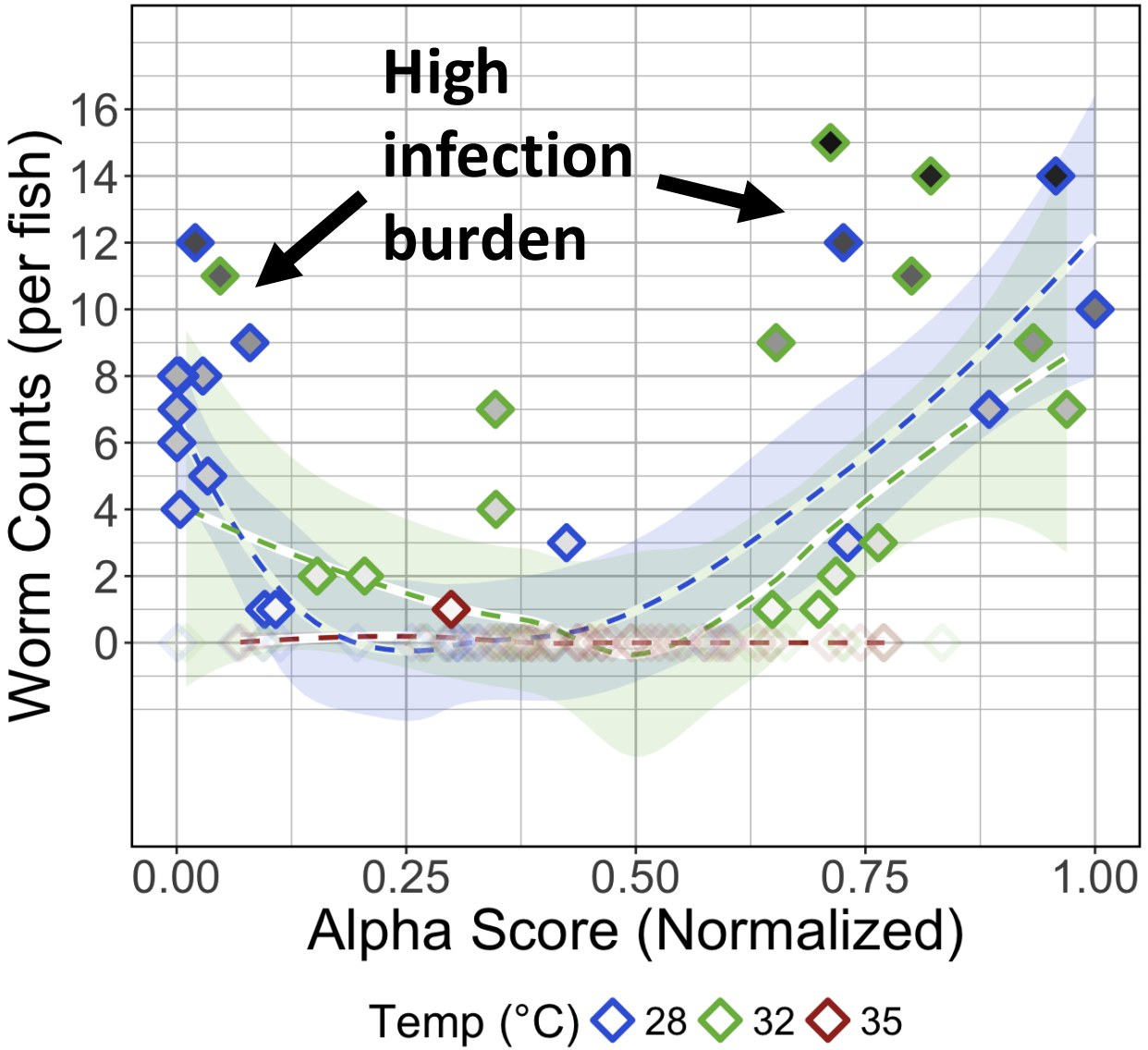
51 samples & 272 taxa (Genus). PCoA dist=bray

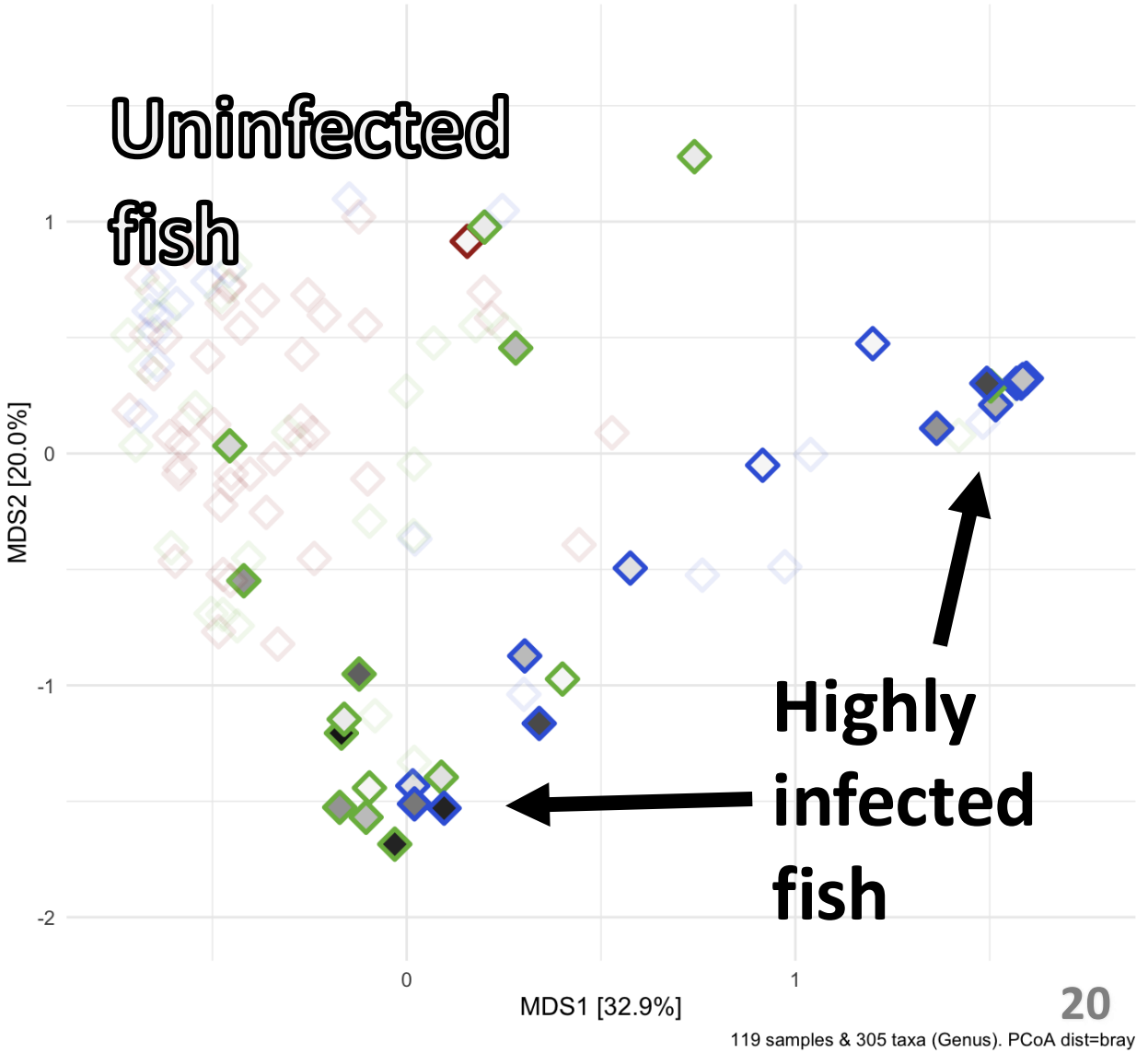
Infection & Microbiome

Non-linear relationship between infection burden and alpha diversity scores

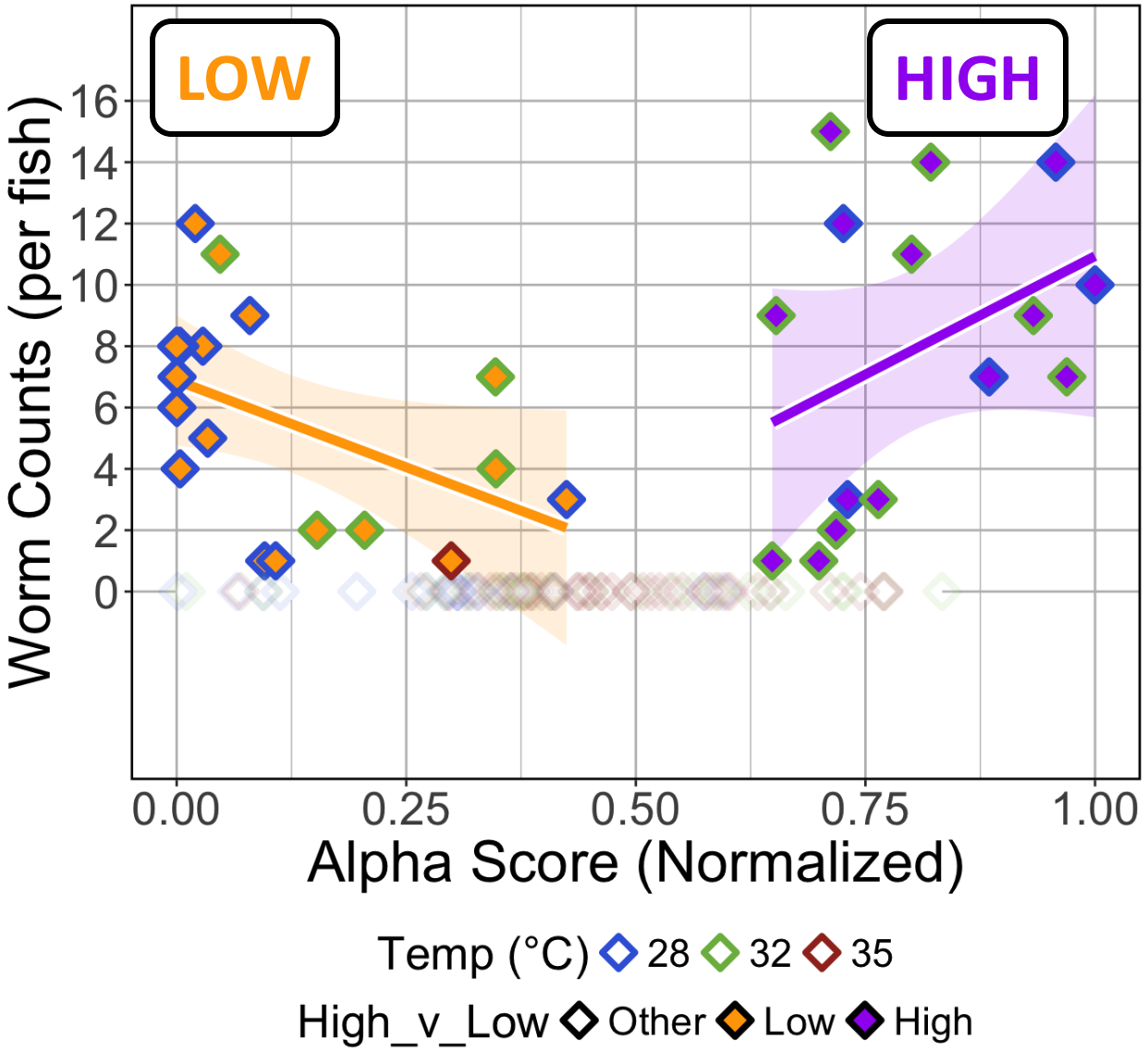


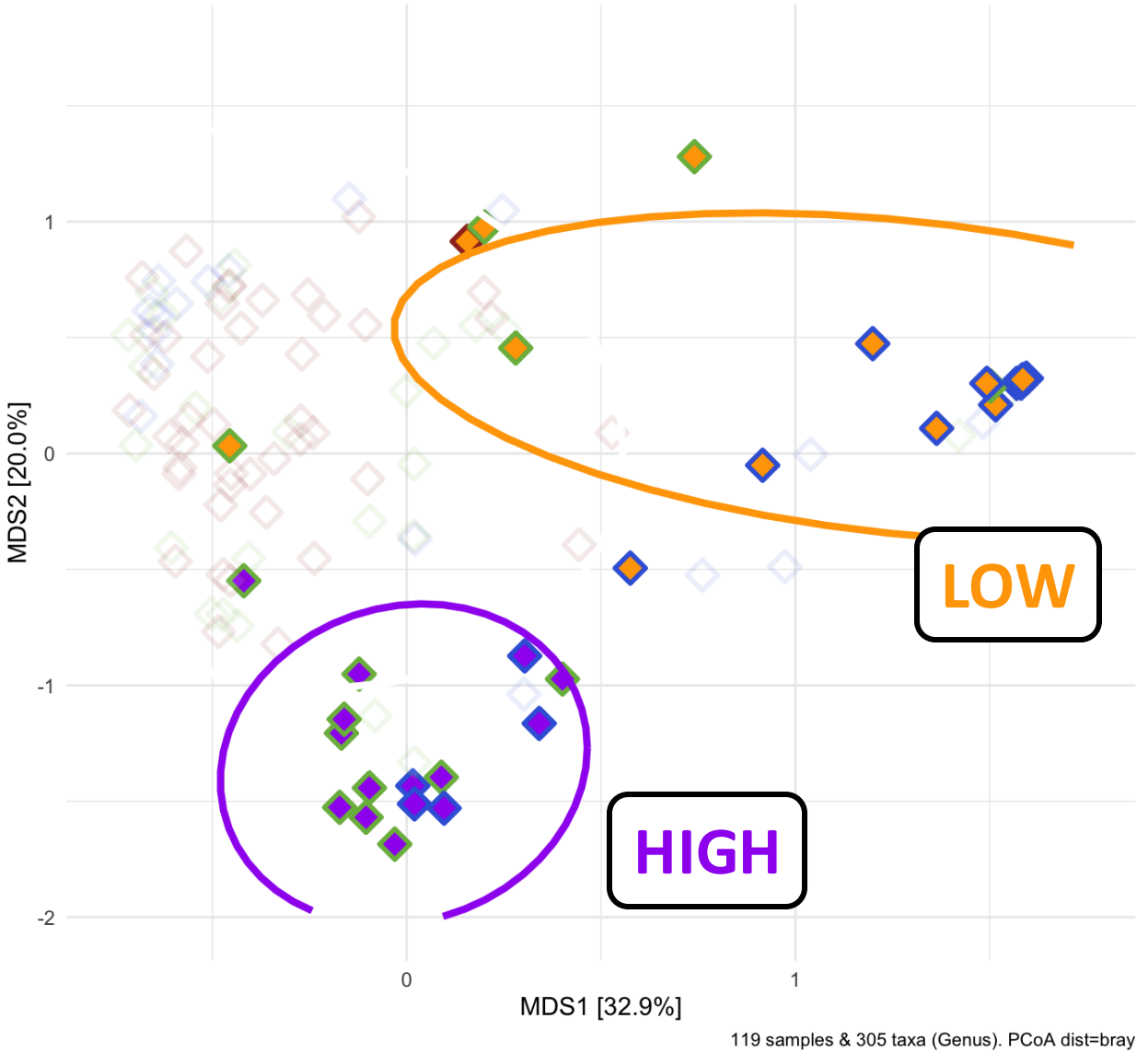
Higher infection burden in fish with lowest and highest alpha diversity scores





Higher infection burden in fish with lowest and highest alpha diversity scores





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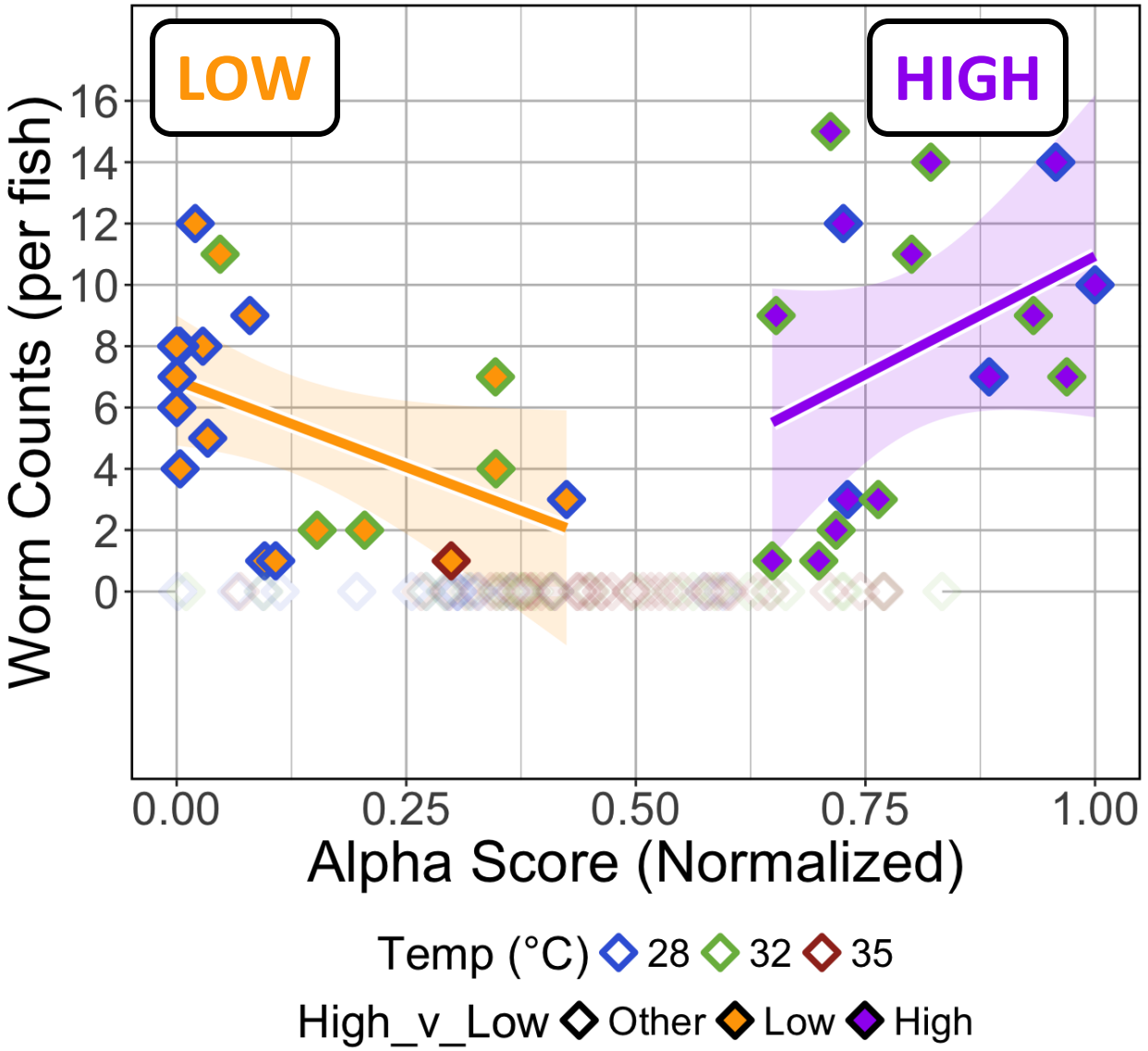
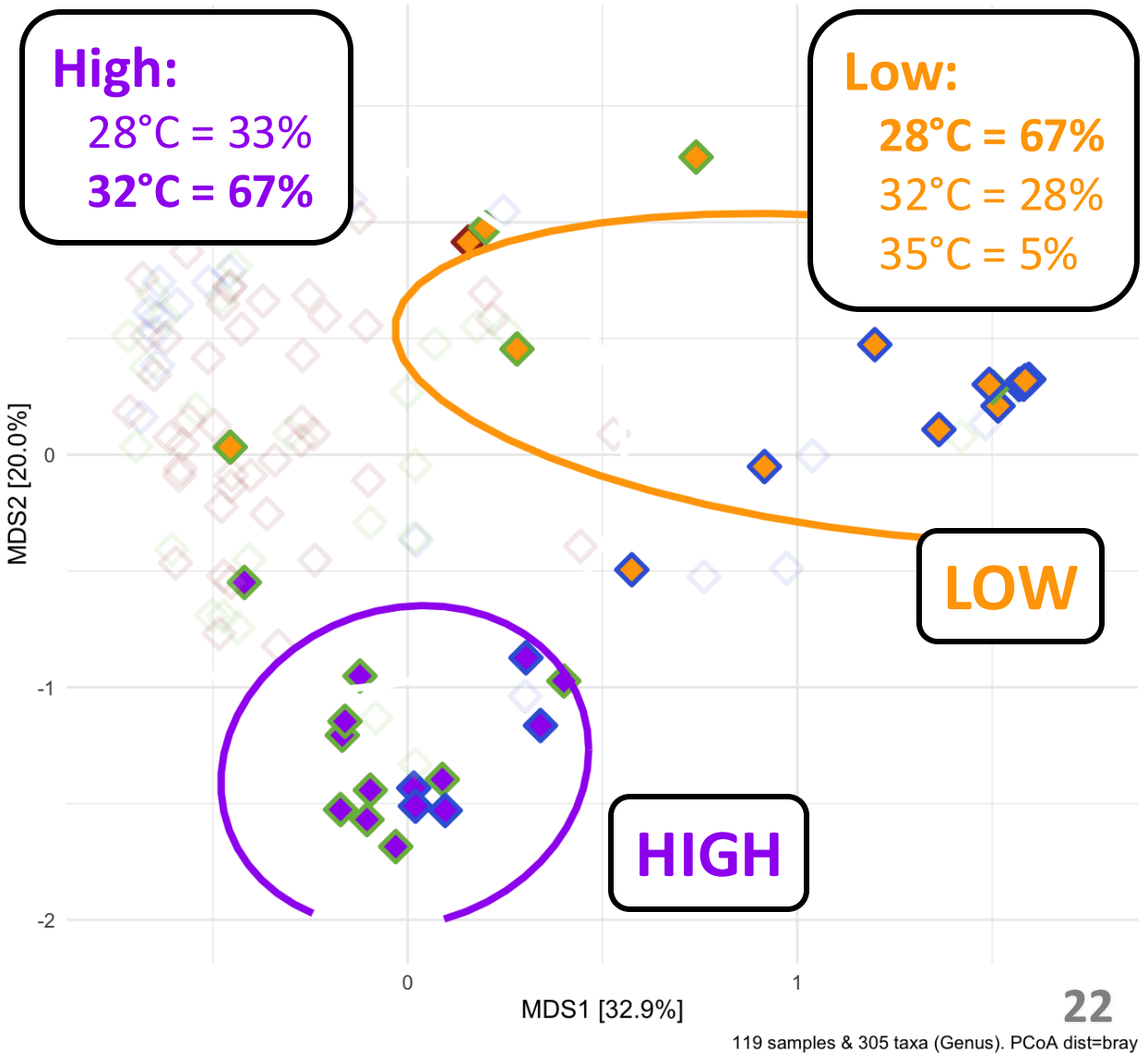
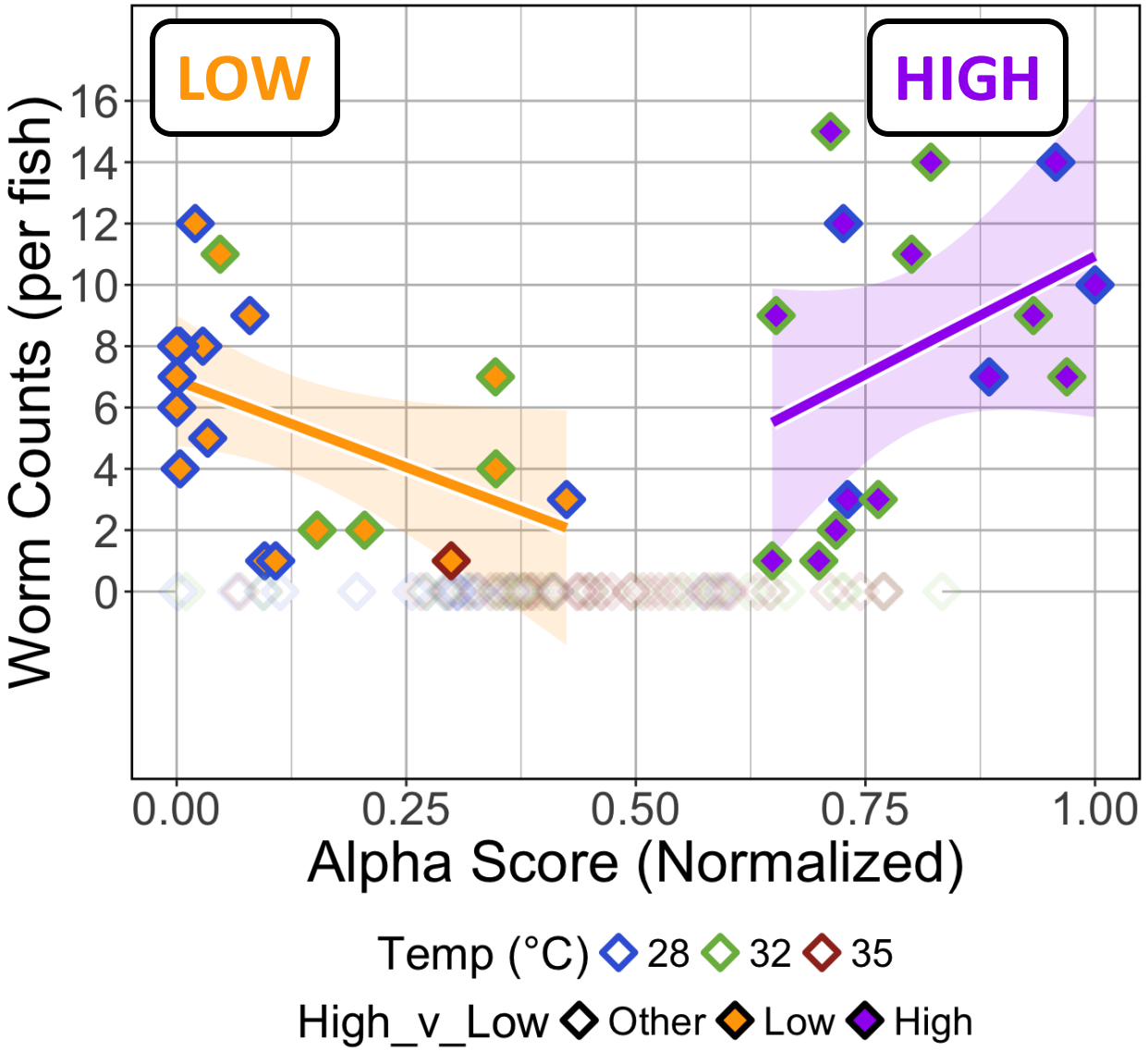
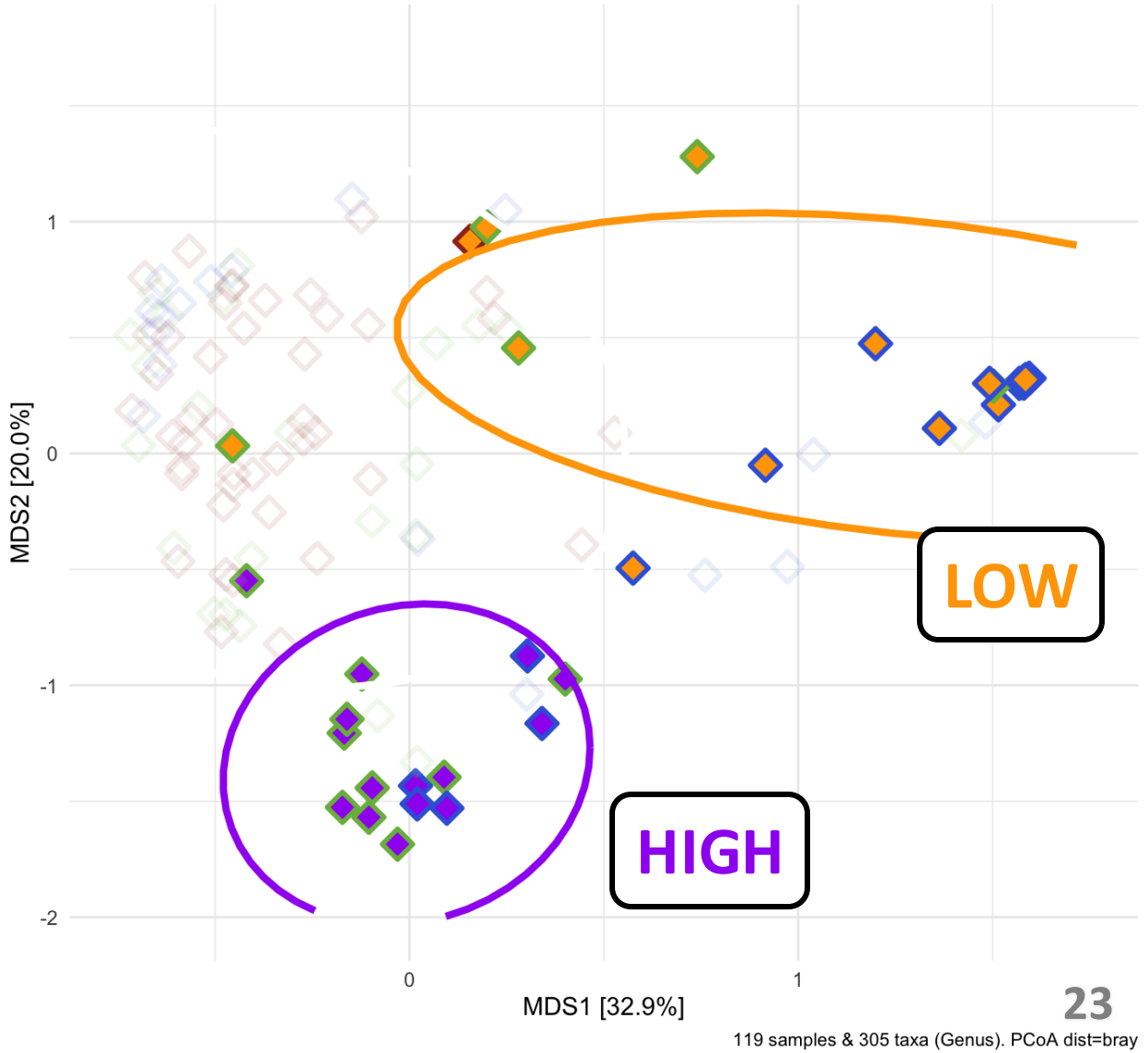




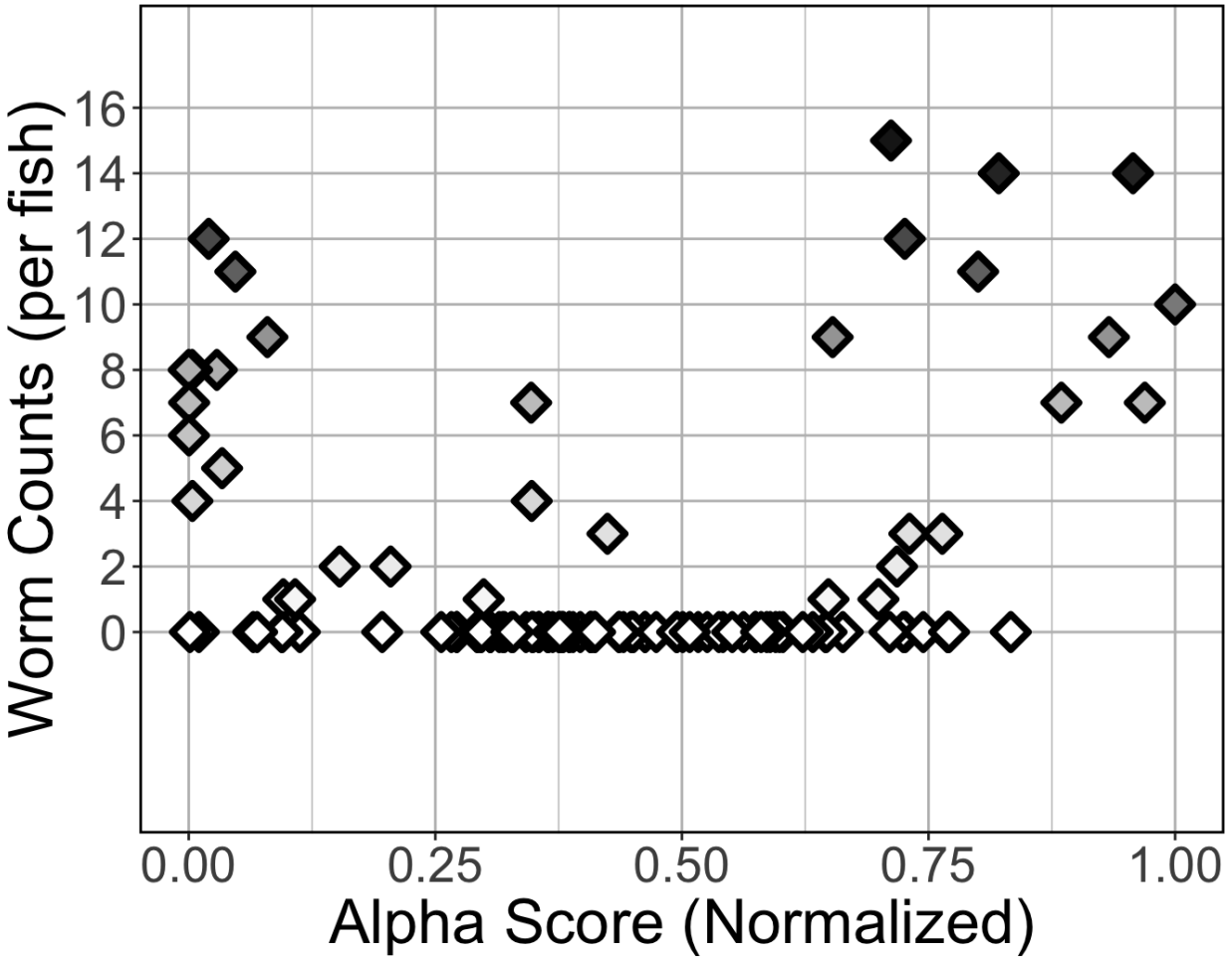
Infection outcome and gut microbiome response varies across water temperatures

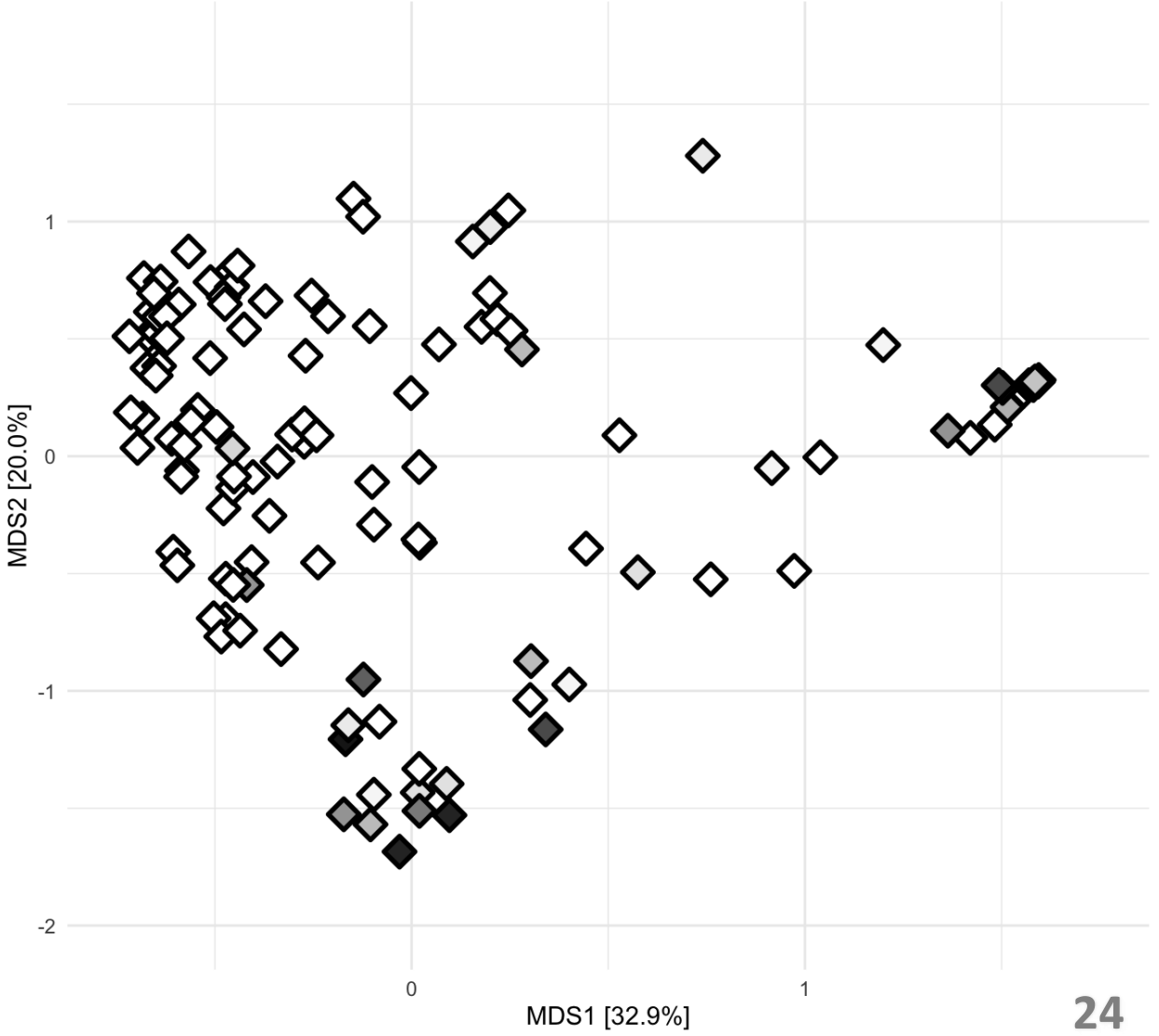




119 samples & 305 taxa (Genus). PCoA dist=bray

Ignoring environmental conditions may obscure latent patterns in microbiome responses to an exogenous stressor





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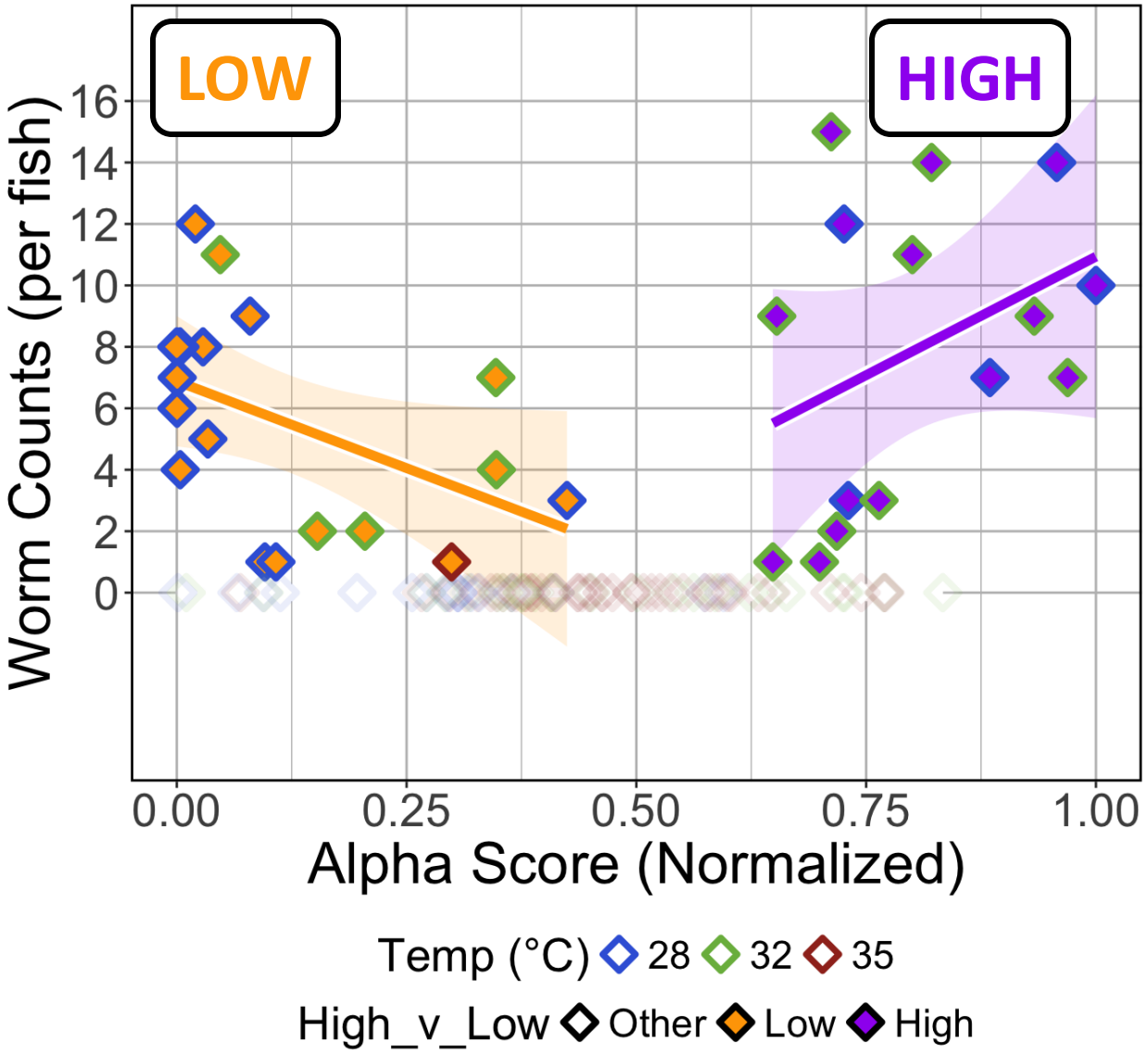
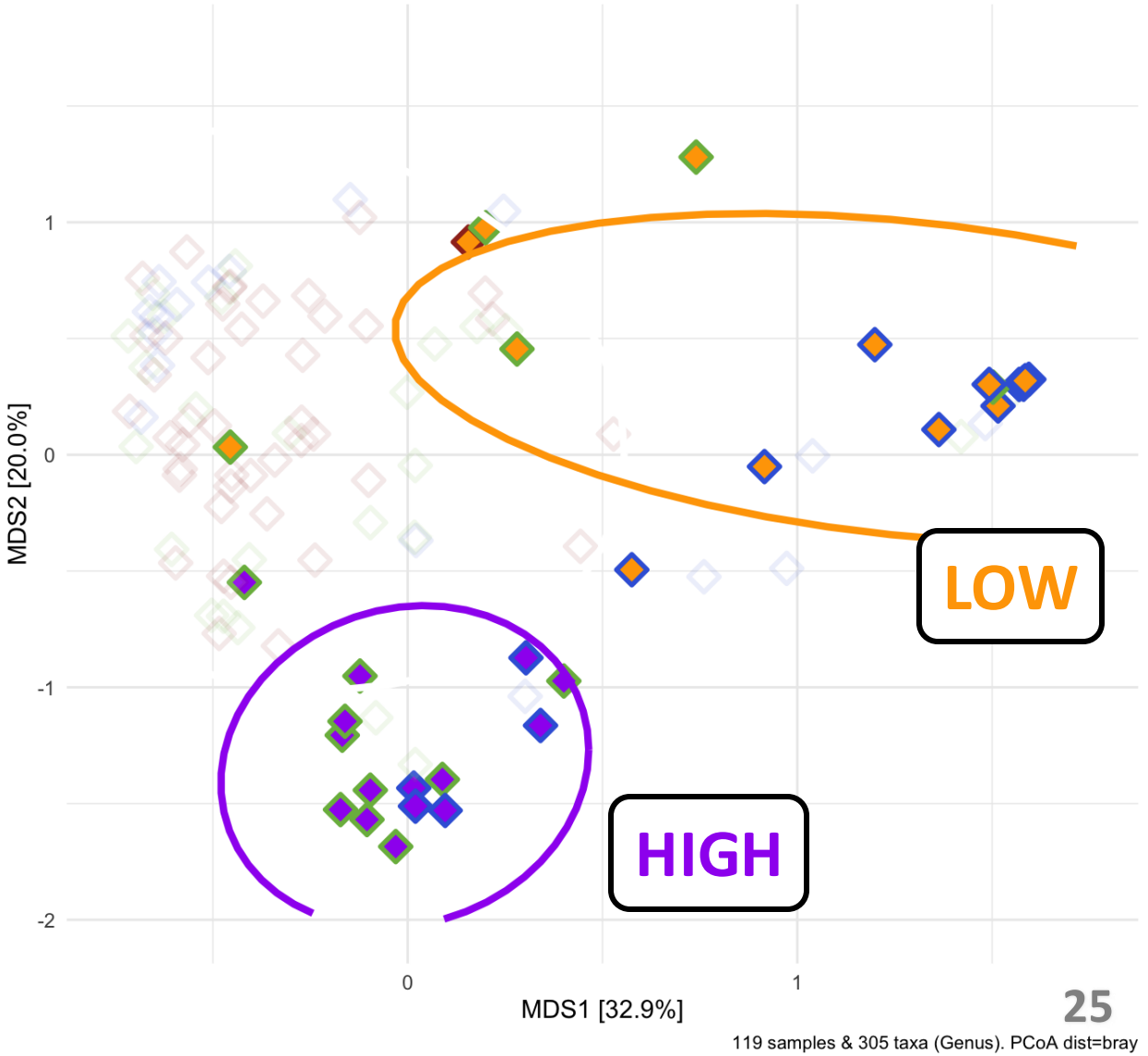
Considering environmental conditions reveals nuanced microbiome responses to an exogenous stressor

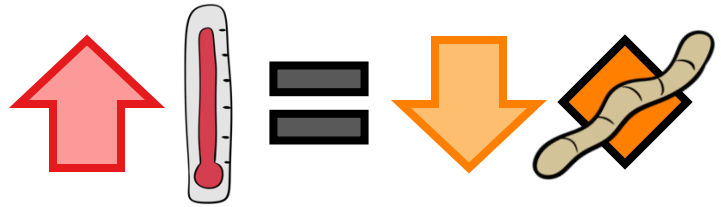




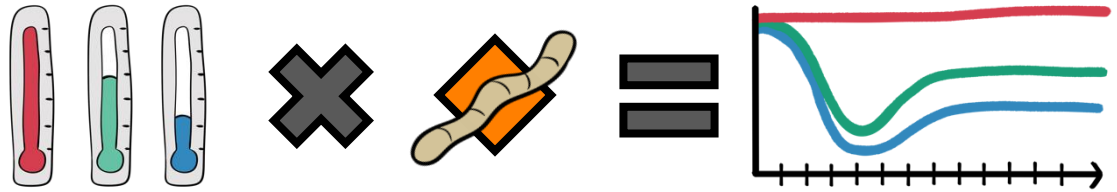
119 samples & 305 taxa (Genus). PCoA dist=bray

Background contextual landscape shapes microbiome response to exogenous stressors

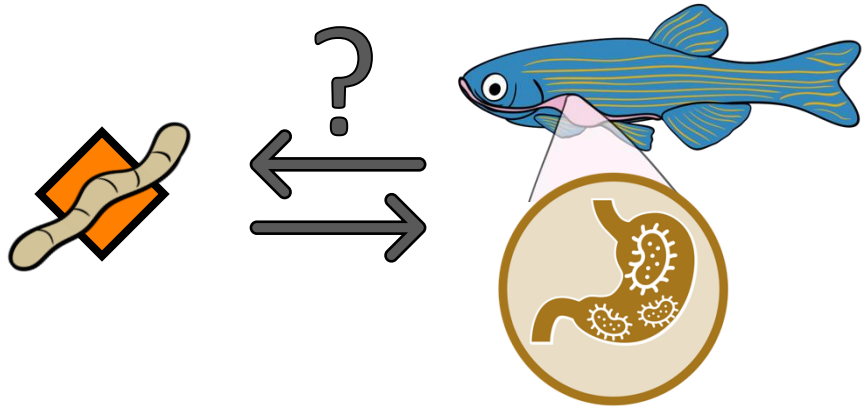
- Infection burden and sensitivity of the gut microbiome is highest among fish reared at lowest water temperatures



- Microbiome's buffering capacity against exogenous stressors may be environmentally contingent



- More work is needed to clarify causal direction between gut microbiome-infection axis, and new measures of temporal response



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Seeking a postdoc summer 2025

Multi-omic microbiome bioinformatics

Thank you!

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