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Dear Editors,

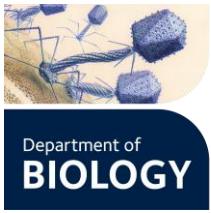
Please find enclosed our manuscript "**Competition constrains parasite adaptation to thermal heterogeneity**" for consideration as a Letter for publication in *Evolution Letters*. This work has not been published in any form, and I have the consent of my co-authors to submit the paper to *Evolution Letters*. All sequence data included in this manuscript has been deposited in the NCBI Sequence Read Archive.

Thermal heterogeneity plays a key role in shaping species' evolutionary trajectories. Temporal thermal heterogeneity is expected to favour intermediate, generalist phenotypes that can maintain growth across a broad thermal range but have sub-optimal growth at any single temperature. Yet, thermal variation typically occurs in the presence of additional selection pressures which may interact to constrain thermal adaptation. Whether species can adapt to thermal heterogeneity whilst under co-selection by other selection pressures remains unclear.

In this study, we propagated competing lytic viral parasites (bacteriophages ϕ 14-1 and ϕ Luz19) of *Pseudomonas aeruginosa* under fluctuating temperatures (37–42°C) in monoculture and in co-culture. We compared populations evolved under fluctuating temperatures concurrently with those evolved under a static regime (37°C and 42°C), the latter presented in a separate publication (DOI: 10.1101/2025.09.25.678511). Without competition, fluctuating temperatures favoured intermediate thermal phenotypes in the phage ϕ 14-1 and resulted in more variable evolutionary outcomes compared to static conditions. However, co-selection from fluctuating temperatures and competition led to restricted thermal adaptation, slower evolutionary rates, and fewer putative adaptive mutations in the ϕ Luz19 competitor. Our study highlights the potential for reduced adaptive capacity in interacting communities amidst global climate change.

Recent work on key topics mentioned in this paper have been published in *Evolution Letters* including evolution in variable environments (1,2), and interactions between competition and abiotic selection pressures (3). We believe our findings would complement these studies and be of broad interest to evolutionary ecologists and microbiologists interested in community responses to heterogeneous environments.

On behalf of all authors,
Samuel Greenrod & Kayla King



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References

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