To the Editorial Board,

Thank you for considering our manuscript "Microbial symbionts buffer hosts from the demographic costs of environmental stochasticity" for publication as a Letter in *Ecology Letters.*

In this manuscript, we demonstrate for the first time that microbes can buffer hosts against increasingly variable environments. Host-microbe associations are everywhere, and their discovery and characterization are defining themes of 21st century biology. Yet, long-term experiments that track host-microbe interactions through temporal environmental fluctuations are rare, which limits forecasts of host responses to increasing environmental stochasticity under global change. We integrate data from a unique, taxonomically replicated, long-term field experiment with statistical and demographic models to uncover a novel mechanism by which microbial symbionts act as mutualists to their hosts: buffering against the costs of environmental stochasticity.

As hypothesized, symbionts generally reduced variance in fitness, at the same time that they increased mean fitness, the mechanism that has dominated previous research. While all symbioses were mutualistic, life history traits associated with pace of life explained differences among hosts in the magnitude of variance buffering. These results robustly emerged from 14 years of data from symbiont removal experiments spanning seven plant species and their Epichloë fungal endophytes, for which we estimated symbionts' effects on inter-annual variances of vital rates, and then parameterized stochastic structured population models. Contributions to overall fitness from symbiont-mediated variance buffering were modest compared to mean effects under current climate conditions. However, simulations of increased environmental stochasticity, as expected under global change, forecast that variance buffering will become increasingly important in the future, outpacing benefits to mean fitness, and further strengthening the host-symbiont mutualism.

This work sits at the intersection of two timely and rapidly moving sub-disciplines – host-microbe interactions and ecological responses to climate variability – and is therefore well-suited to the wide readership of *Ecology Letters*. Our novel demonstration of variance buffering and its consequences for host fitness will have important implications for understanding the evolution of host-symbiont mutualisms of all types and for predicting organismal responses to future climate change.

Thank you for your careful consideration of our submission, which is distinct from all recent work by the authors. This work is a unique contribution identifying variance buffering for the first time as a mechanism by which symbiosis may result in mutualist benefits. In line with *Ecology Letters* flexible policy for initial submissions, the attached manuscript is written following *PNAS* formatting guidelines (including a combined Results and Discussion section), and could easily be reformatted to meet the journal's guidelines during a potential revision.

Sincerely,

Joshua Fowler
Shaun Ziegler
Kenneth Whitney
Jennifer Rudgers
Tom Miller

Novelty Statement

This work identifies variance buffering for the first time as a mechanism by which microbial symbionts may engage in mutualism with hosts. Previous research by senior authors Rudgers and Miller has developed theoretical and empirical understanding of context-dependent demographic benefits of vertically transmitted symbioses. The present manuscript is the first to consider host-symbiont interactions in stochastic environments, made possible by our unique long-term experimental manipulation of the symbiotic partnership for multiple host species. That symbiotic partners can use either mean effects and/or variance buffering to engage in mutualism has important consequences for the evolution of life history strategies to cope with environmental stochasticity, and for predicting organismal responses to future environmental variability.