To the editorial board:

Thank you for considering our manuscript (“Thank you next: demographic consequences of partner diversity and turnover in a multi-species ant plant mutualism”) for publication in The American Naturalist.

This work highlights the importance of multi-species and mechanistic approaches to studying mutualisms. We advocate (as many have before us) for a multi-species approach to analyzing mutualisms as many occur in broad contexts and pairwise studies can over- or underestimate the benefits of a partner. Theory predicts that if all partners are true mutualisms (the benefits outweighing the costs of the interaction), increases in diversity of partners should increase the benefits received by the focal mutualist. The mechanistic theories say there are three primary ways diversity can benefit the focal mutualist: complementarity, sampling effect, and portfolio effect. Complementarity can explain positive diversity effects when different partners offer different types of benefits (i.e. pollination vs. defense); Sampling effect can explain positive diversity effects when there is a hierarchy of benefits across partners (i.e. there is a single partner which causes the largest fitness increase); Portfolio effect can explain positive diversity effects when partners respond asynchronously to environmental stochasticity (temporal or spatial). No study, to our knowledge, has previously considered all these mechanisms at once.

In this manuscript, we parameterize a multi-level integral projection model (IPM) to understand the demographic effects of multiple partners and identify what mechanisms explain the benefits of partner diversity (if there are any) in a long-lived extra-floral nectar producing cactus (*Cylindropuntia imbricata*) and its multiple ant partners. We consider the effects of each ant partner on individual vital rates (i.e. growth and survival) using Bayesian hierarchical models. These models then go into our multi-level IPM and allow us to estimate the long-term population growth (considered as an estimate of population fitness) of the cacti with every possible combination of ant partners (including counterfactual ones). Finally, with these fitness estimates, we were able to determine if there is a benefit to diversity and what mechanisms explain this. Not only are our methods novel in the mechanisms included, but so are the results. We found that while ant presence increases population fitness significantly at observed levels, there are no strong benefits of partner diversity and there is actually a slight cost of diversity in the full ant scenario (the scenario observed in the field).

We believe this study is well suited to Am Nat because it integrates observational field data, populational demography, and biodiversity ecology to investigate the dynamics and importance of mutualistic partner diversity from a biodiversity perspective. This paper includes long-term field data, conceptual novelty, sophisticated modeling, and novel results. It is our hope that this work advances the understanding of diversity in mutualisms by offering a new finding. We believe this work emphasizes the importance of integrating vital rate and patner identity into population level models in the field of mutualisms to paint a fuller picture of the dynamics of a system.

We have opted out of a double-blind review because this paper builds upon our previous work (another IPM using this same dataset published elsewhere) so our identities could be easily deduced. Our identities are also obvious from our GitHub repo, where we direct reviewers to find all data and code to reproduce our analyses.

Sincerely,

Ali Campbell

Tom Miller