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Dear Editor,

I am submitting the manuscript ‘*Size-based ecological interactions drive food web responses to climate warming*’ for consideration to be published as a research report in *PNAS*.

Predicting the consequences of climate warming on food webs requires acknowledging food, size and temperature dependences of life history processes, such as body growth, maturation and reproduction. Recent studies show that feedbacks between food-dependent individual life history processes and population size structure are not only ubiquitous in nature, but also shape population and community dynamics and structure1,2,3,4. Temperature affects physiological processes, but we do not know how this translates to food web dynamics and structure in changing climates, as that requires accounting for the feedbacks between direct effects of temperature and food-dependent life history processes. This constitutes a major limitation in our understanding of how a changing climate impacts food webs.

Here we show how linking food-, size- and temperature-dependent life history processes to community dynamics leads to novel understanding of food web responses to climate warming. Using a dynamic stage-structured biomass model of a tri-trophic food-chain, we find that stage structure and size-dependent interactions can alter general predictions of responses to warming from studies ignoring these processes and population structure, in particular that warming can destabilize food webs through collapses.

Specifically, we find that (i) increasing temperatures can induce alternative stable states (bistability) in the food-chain due to Allee effects, which exposes predators to increased risk of sudden collapse, (ii) whether warming stabilizes or destabilizes the community depends on size-dependent ecological interactions within and between species and the current temperature regime, and (iii) interactive effects of temperature and body size reduce the scope for predator persistence compared to scenarios with independent effects. Our novel findings of how warming affects community dynamics and stability are due to consideration of consumer stage structure and the size dependence of life history processes, and are thus not possible to obtain in unstructured models, which still dominate the literature.

This study highlights the importance of ecological interactions, food-dependent life history processes and intraspecific variation for shaping food web responses to climate change. It is therefore likely to attract attention from a broad range of the *PNAS* readership, including scientists interested in mechanisms underlying ecological processes and/or global change impacts, as well as alert the broader audience to how climate warming may destabilize and restructure natural food-webs.

We are grateful for your consideration of our manuscript, and we look forward to hearing from you.

Sincerely,

Max Lindmark, on behalf of all co-authors  
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1Persson L, De Roos AM (2013) Symmetry breaking in ecological systems through different energy efficiencies of juveniles and adults. Ecology 94(7):1487–1498. 2Ryabov AB, De Roos AM, Meyer B, Kawaguchi S, Blasius B (2017) Competition-induced starvation drives large-scale population cycles in Antarctic krill. Nat Ecol Evol 1:0177. 3Lindmark M, Huss M, Ohlberger J, Gårdmark A (2018) Temperature-dependent body size effects determine population responses to climate warming. Ecol Lett 21(2):181–189.). 4De Roos AM (2018) When individual life history matters: conditions for juvenile-adult stage structure effects on population dynamics. Theoretical Ecology. doi:10.1007/s12080-018-0374-3.