Dear Editor,
I am submitting the manuscript '*Optimum growth temperature declines with body size within fish species*' for consideration to be published as an article in *Nature Communications*.

Understanding how key physiological processes such as growth, feeding and metabolism depend on body size and temperature is key for predicting impacts of global warming on individuals, populations and food webs. In growth models and mechanistic population models we often rely on interspecific estimates to characterize these relationships (1, 2). This is problematic, because growth, feeding and metabolism are individual-level processes, which are best represented by intraspecific relationships. Yet, our understanding of these relationships within species is surprisingly limited.

In this study we overcome this limitation by first conducting a systematic literature review to collate intraspecific data from warming experiments that also varied body mass (on 55 species of fish in total). Next, we applied hierarchical Bayesian models to estimate average mass and temperature dependencies of consumption and metabolic rates within species by accounting also for variation across species. We then investigated the implications of our estimated scaling relationships for individual growth and its variation across temperature using a common supply and demand growth model. Finally, we compared these predictions with independent mass-specific data on optimum temperature for body growth.

Our results show that, on average, metabolic rates increase faster with body mass than feeding rates within species, and that feeding rates are unimodally related to temperature. These two properties of intraspecific relationships lead to the prediction that the optimum temperature for growth declines with body mass within species. By using an independent data set on growth of fishes using the same protocol, we demonstrate that optimum growth temperatures indeed decline with fish body size within species, in line with the prediction based on the temperature- and size-scaling of feeding and metabolic rates.

This study provides fundamental insights to how consumption, metabolism and growth are affected by warming that are likely to be of interest to a broad readership, as these underlie how ectotherm organisms, biomass production and species interactions change with global warming. Our findings contribute to an understanding of the bioenergetic basis for the temperature-size rule and the predicted shrinking of large individuals with climate warming. Considering the different scaling relationships with size and temperature within species will also improve the estimation of energy transfer across trophic levels and rates of biomass production and hence, e.g. food production from wild fish, and how these change in the warming climate.

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

Sincerely,

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1. D. J. Marshall, C. R. White, Have We Outgrown the Existing Models of Growth? Trends in Ecology & Evolution 34, 102–111 (2019).
2. D. A. Vasseur, K. S. McCann, A mechanistic approach for modelling temperature-dependent consumer-resource dynamics. The American Naturalist 166, 184–198 (2005).