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Dear Ideas & Perspectives Editors:

Phenological mismatch—the consequences of shifts in the timing of species interactions—is an expanding area of research critical to predicting the consequences of climate change for communities and ecosystems. However, after decades of theoretical (2,3) and empirical studies (4,5) including from single systems and meta-analyses, there is little consensus. To date, most research has failed to identify repeatable mechanistic patterns across systems.

In our I&P paper, we propose this failure is due to a disconnect between the underlying ecological theory (i.e., match-mismatch hypothesis) and the phenological responses to climate change currently documented. To advance progress in this field we:

1. Review the diverse array of potential mechanisms underlying the match-mismatch hypothesis.
2. Show how the type of data currently collected by researchers testing or applying the mismatch hypothesis in the context of climate change rarely provides a strong test of the hypothesis.
3. Show how baselines—which are rarely defined—are critical to mechanistic understanding and robust predictions.
4. Highlight how new approaches that emphasize the underlying theory can move the field towards accurate predictions of phenological mismatch driven by climate change.

This proposal uniquely combines empirical and theoretical approaches, including a review of 41 phenological mismatch studies to support our arguments.

By highlighting the data-theory discrepancy on the topic of phenological mismatch, our paper will help shape the future path of the field. It will also provide the framework for building the required depth in evidence across studies to determine general quantitative patterns and their underlying mechanisms, an approach not currently possible given the current state of the field.

This paper is authored by experts on phenological synchrony and phenological methods who bring a combined 20 years of experience in this area. This review has not been submitted elsewhere, and we welcome the opportunity to submit it to *Ecology Letters*.

Sincerely,

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References

1. Kharouba, et al. (2018) Global imprint of climate change on marine life. *Nature Climate Change* 3:919-925.
2. Johansson et al. (2015) The eco-evolutionary consequences of interspecific phenological asynchrony- a theoretical perspective. *Oikos* 124:102-112.
3. Bewick et al. (2016) How resource phenology affects consumer population dynamics. *The American Naturalist* 187:151-166.
4. Borcherding et al. (2010) Match or mismatch: the influence of phenology on size-dependent life history and divergence in population structure. *Journal of Animal Ecology* 79: 1101-1112.
5. Plard et al. (2014) Mismatch between birth date and vegetation phenology slows the demography of roe deer. PLoS Biology 12:e1001828.