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Temperature-dependent shifts in herbivore performance and interactions drive nonlinear changes in crop damages

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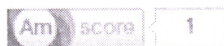
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Abstract

Understanding how and to what extent the influence of temperature on physiological performance scales up to interspecific interactions and process rate patterns remains a major scientific challenge faced by ecologists. Here, we combined approaches developed by two conceptual frameworks in ecology, the stress-gradient hypothesis (SGH), and the biodiversity–ecosystem functioning relationship (B-EF), to test the hypothesis that interspecific difference in thermal performance modulates multiple species interactions along a thermal stress (SGH) and the subsequent richness effects on process rates (B-EF). We designed an experiment using three species of herbivorous agricultural pests with different thermal optima for which we determined how temperature influences the direction and the strength of interaction and subsequent richness effects on crop damage (7 species interaction treatments × 6 temperature treatments × 10 replicates). We showed that both biotic interactions and species richness effects drive variations in crop damages along a thermal stress gradient, and thus have the potential to drive agro-system responses to climate change. To help explain and generalize underlying mechanisms of richness effects on process rates, we further proposed a conceptual model

that views interaction outcomes as shifting between positive and negative along a thermal stress depending on species thermal optima. Overall, our study demonstrates that nonlinear effects of temperature on process rates must be a major concern in terms of prediction and management of the consequences of global warming.

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