Thermal performance curves and thermal niche (mis)matches have a stronger structuring role in tri-trophic food webs than temperature-size rule

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Résumé

Warming climate affects aquatic ectotherms directly by altering individual vital rates and indirectly through changes in body size and environmental feedbacks. Body size of many aquatic ectotherms declines at higher temperatures, known as the Temperature-size rule (TSR), but little is known about how these organismal responses jointly affect the community level. Community responses to environmental drivers can be abrupt, as exemplified by catastrophic collapses of top predators caused by size-structured trophic interactions. Here we model the structure and dynamics of a tri-trophic food chain with size- and temperature-dependent vital rates and species interaction strengths to explore how direct kinetic effects of temperature and temperature-size rule affect the community structure and its propensity to catastrophic collapses along resource productivity and temperature gradients. We find that community structure and the propensity to collapse are primarily driven by the direct kinetic effects of temperature on consumer growth and ingestion rates and on predator feeding rate, whereas the impact of TSR in consumers and predators on community structure is limited. We also show that mismatches between consumer and predator thermal niches play a determinant role in the community structure along environmental gradients, mitigating current predictions about sudden predator collapses under warming.

Mots-Clés: temperature, size rule, thermal niche mismatch, metabolic ecology, warming, emergent Allee effect, trophic chain

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