The fight for survival: how copepods adapt to a warming planet.

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More than ever, global change is threatening the planet, with marine ecosystems particularly at risk as seawater temperatures rise rapidly and the frequency of marine heatwaves increases worldwide. These changes have profound implications for marine food webs, particularly for the zooplankton, which form a crucial link in these ecosystems. Copepods, a dominant and ecologically essential group of zooplankton, play a key role in marine food web dynamics. Understanding how environmental changes including rising temperatures, decreasing salinity, and ocean acidification affect copepods is vital, as shifts in their life history traits - such as development time, fecundity, and nutritional value - can cascade through the entire ecosystem. For future predictions, multigenerational studies have emerged as crucial for understanding the long-term effects of environmental stressors on aquatic ecosystems. Recent research also highlights the importance of phenotypic plasticity and adaptive capacity in coping with environmental changes, with evidence that multigenerational plasticity can enable recovery within just a few generations under certain conditions.
Our study adopts a novel approach by strictly separating copepod generations to evaluate temperature effects under dynamic and realistic conditions. More specifically, life-history parameters, FA profiles and global DNA methylation patterns were measured for three different temperature treatments at the end of every generation, over the full duration of the experiment that lasted 108 days covering five generations. This innovative design ensures precision in assessing the impact of temperature stress while exploring the interplay of generational effects, energy allocation, and metabolism. Among other things, we found that reproduction success decreases significantly with temperature stress. At a certain temperature, the reproduction success decreases so drastically that the copepods are not able to maintain their population.

Our findings advance understanding of transgenerational plasticity, thermal stress-induced metabolic changes, and their broader implications for marine ecosystems. By integrating phenotypic plasticity into predictive ecological models, we aim to enhance the accuracy of assessments of species resilience and sensitivity, offering valuable insights into the future of marine biodiversity in a rapidly changing world.

Keywords
Climate Change; Reproduction; Copepods; Zooplankton; Life-history Parameters; Fatty Acids; Ecosystem; Transgenerational; Multigenerational; DNA Methylation