Extreme temperatures reduce copepod performance, but increase in the gut thermophilic Proteobacteria

Quyen Vu¹, Linh Pham¹, Oanh Truong¹, Sang Tran¹, Canh Bui¹, Minh Hoang Le¹, Binh Thuy Dang¹, and Khuong Dinh²

¹Nha Trang University
²University of Oslo Department of Biosciences

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Abstract

Copepods are one of the most abundant invertebrate groups in the seas and oceans and are a significant food source for marine animals. However, copepods are also particularly vulnerable to elevated temperatures, yet it is unknown the role of the gut microbiome in shaping copepod susceptibility to warming. We addressed this fundamental knowledge gap by assessing key life history traits (survival, development, reproduction), and changes in the relative abundance of the gut microbiome in the tropical calanoid copepod Acartia sp. in response to warming (26, 30, and 34°C). Gut microbiomes of copepods were analyzed using high throughput DNA sequencing of V1–V9 of 16S rRNA hypervariable regions. Copepod performance was better at 30°C than at 26°C as indicated by higher survival, faster growth rate and development, and higher fecundity. However, all of these parameter strongly decreased when temperature increased to 34°C. We recorded 1,262,987 amplicon sequence reads, corresponding to 392 total operational taxonomic units at 97% similarity. The gut content of all copepods contained Cyanobacteria, Proteobacteria, Bacteroidetes, Planctomycetes, Actinobacteria, and Acidobacteria. Thermophilic Proteobacteria were found dominantly at high temperatures (30°C and 34°C). At 34°C, Vibrio was the only dominant group, accounting for 70% of species found in copepod guts, which may partly associated with the reduced growth and survival of Acartia sp. The next logical step is to explore the functional role of all gut bacterial groups in relation to changes in copepod fitness, which will fundamentally advance our mechanistic understanding of the adaptability of tropical copepods and, more generally, marine invertebrates to the warming climate.

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