Cold Acclimation Reduces Predation Rate and Reproduction but Increases Cold- and Starvation Tolerance in the Predatory Mite *Gaeolaelaps aculeifer*

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Introduction

The main purpose of biocontrol predators is to kill as much target prey as possible to get rid of the pest. Therefore, high rates of consumption and reproduction are major traits for predator top-down control potential. However, it is equally or even more important that released predators survive and thrive in their new environment, and preparing predators for environmental conditions may increase their performance after release in the field.

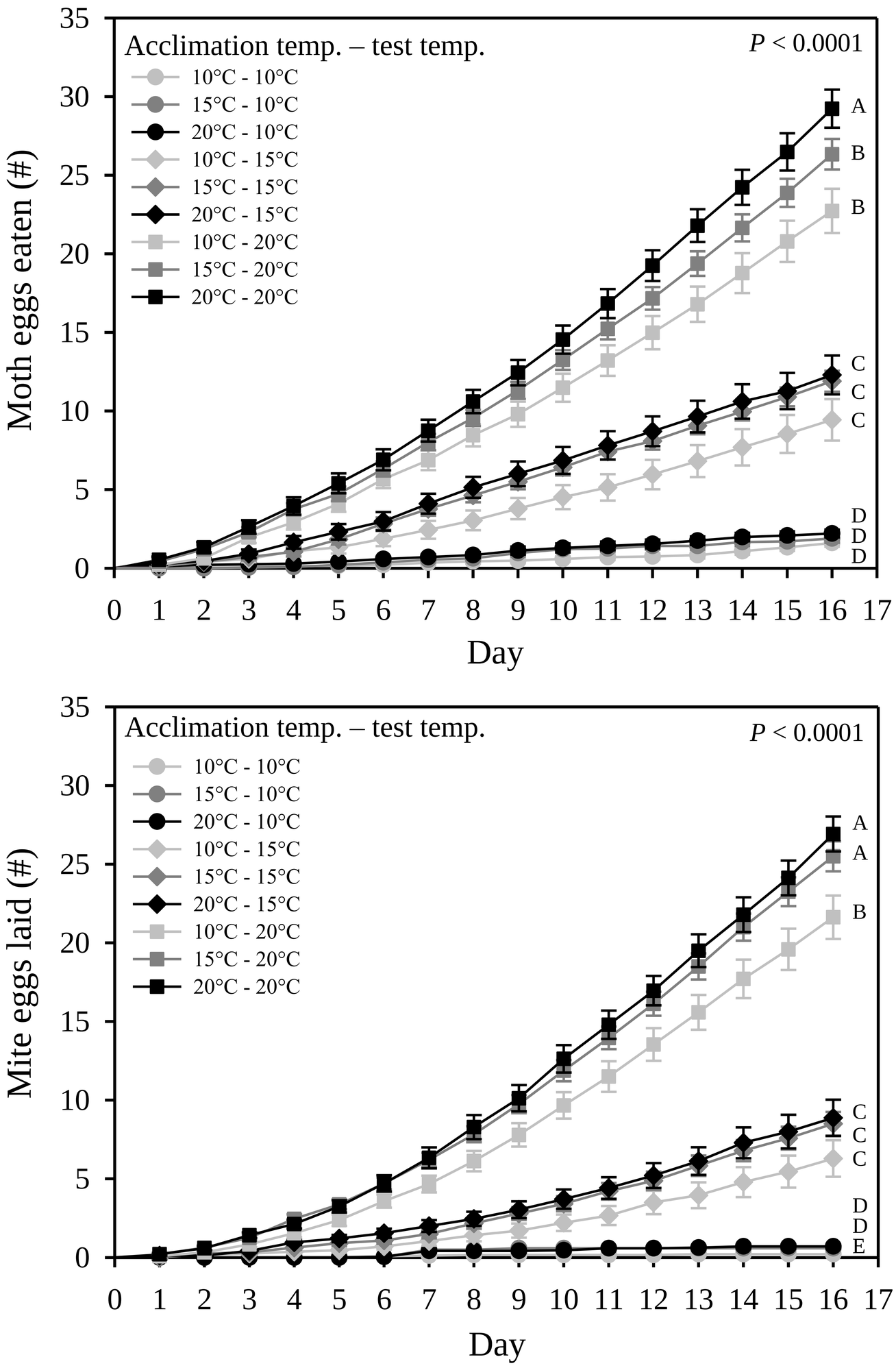
Ectotherms acclimate to thermal conditions by adjusting physiological parameters, and these adjustments substantially increase survival and performance at suboptimal temperatures. Often, however, physiological adjustments are associated with costs, and the adjustments may result in a shift in the trade-off between different physiologically regulated performance parameters. Therefore, some parameters may be positively affected by acclimation while others are down-regulated to trade-off parameters optimally in response to environmental temperature.

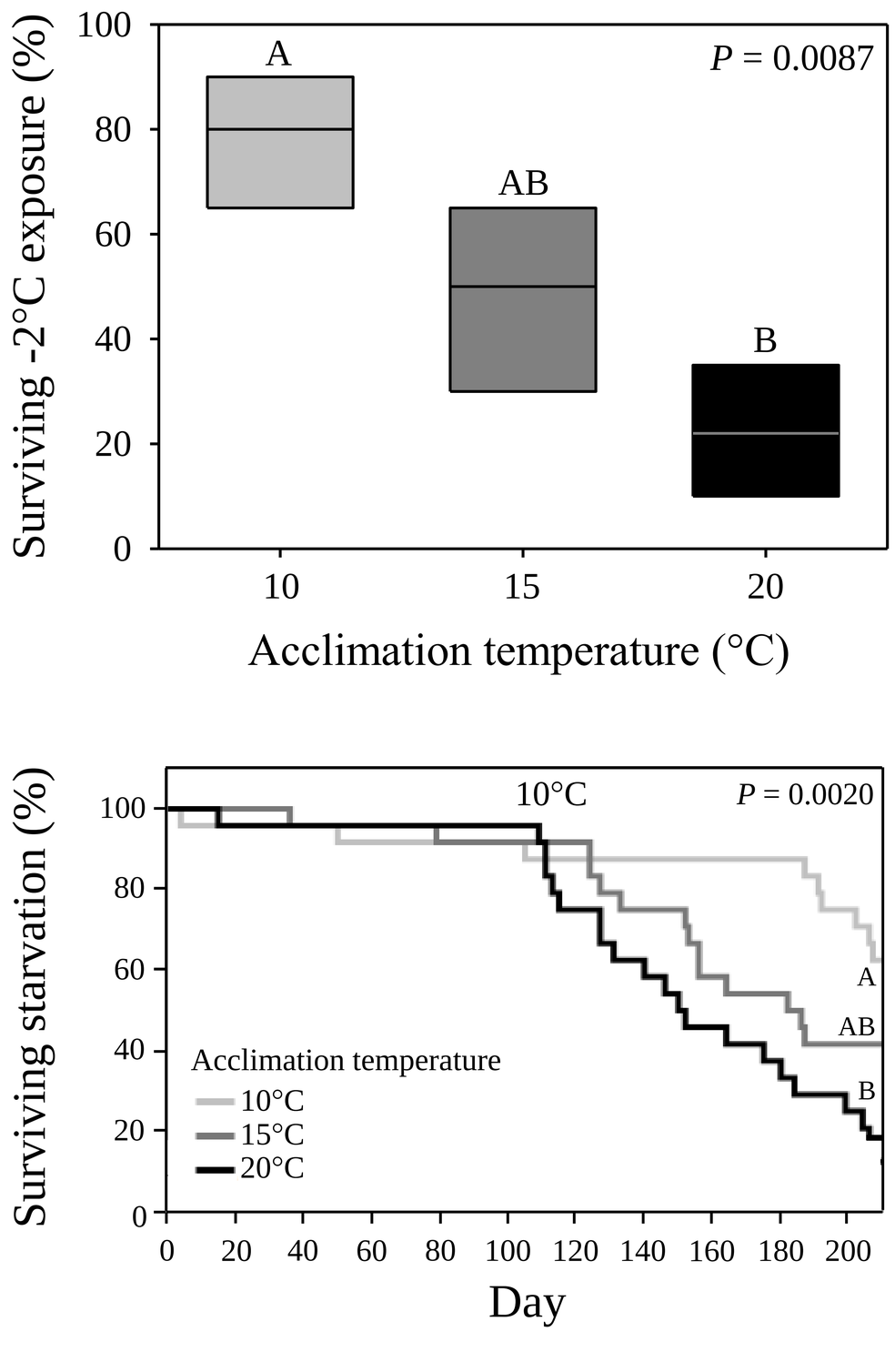
Conclusions

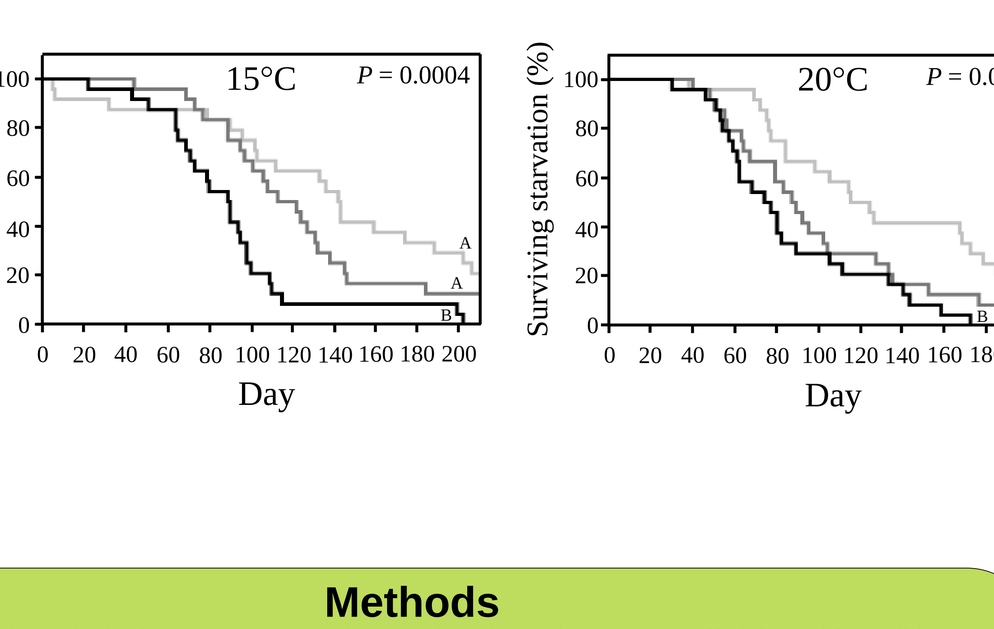
We recommend cold acclimating *G. aculeifer* before release in the field if used in a cold environment where the pest prey has not yet established in the crop, as cold acclimated mites are more thermally robust and better sustain harsh conditions of dropping temperature and low prey availability. In the temperate zone, such conditions prevail in spring when the crop is sown. To battle heavy pest infestations, however, we recommend not cold acclimating *G. aculeifer* before use even in a cold environment, as warm acclimated mites are more voracious foragers and therefore kill prey at a higher rate while they have higher reproduction and therefore higher potential population increase.

Our study also emphasizes the importance of measuring multiple traits when evaluating the overall performance effects of changing conditions, since different performance parameters are likely to trade-off and some parameters are up-regulated while others are down-regulated.

Results







Discussion

Our results show that cold acclimated *G. aculeifer* have higher tolerance to cold exposure and starvation than warm acclimated mites, but at the cost of lower rates of predation and reproduction. This is likely due to a physiological shift in the trade-off balance between reproduction and survival, as more resources are allocated toward resistance against stressful conditions in cold acclimated mites, while warm acclimated mites allocate proportionally more resources toward reproduction.

Interestingly, the effects of 7 days of cold acclimation are long-lasting and rather fixed even after returning to higher temperatures. This indicates that mites could have initiated a diapause response during the cold period. Furthermore, the cold exposure could have functioned as a warning that temperatures may quickly drop even lower in the near future, and mites regulate their physiology as an anticipation that unpredictable stressful conditions may appear. One possible physiological change during cold acclimation could be a lowered metabolism.

Methods

We investigated whether preparing predatory mites (*Gaeolaelaps aculeifer*) for cold conditions by allowing them to acclimate to cold temperature would increase (or decrease) their performance at cold and benign temperatures. After acclimating adult female mites for 7 days at 10, 15, or 20 °C, we tested consumption and reproduction, as well as starvation tolerance at each of the three temperatures. Another set of mites were given 4 days of acclimation and tested for freeze tolerance by exposing them to -2 °C for 24 h and measuring survival.

Hypothesis

- We hypothesized that cold acclimation would increase performance in some traits while it would decrease performance in others, as mites would have to trade-off physiological adjustments depending on thermal conditions.

Reference: Jensen, K., Kristensen, T.N., Overgaard, J., Toft, S., Sørensen, J.G. & Holmstrup, M., 2017. Cold acclimation reduces predation rate and reproduction but increases cold- and starvation tolerance in the predatory mite *Gaeolaelaps aculeifer* Canestrini. *Biological Control*, 114:150-157.