Ants living at the edge face thermal constraints

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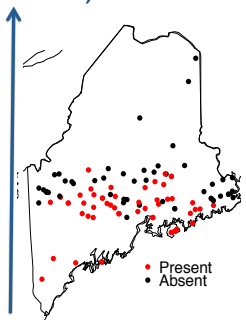
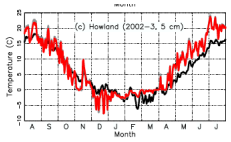
Common woodland ants (*Aphaenogaster picea*) experience **thermally stressful** environments!

Colder, more seasonal

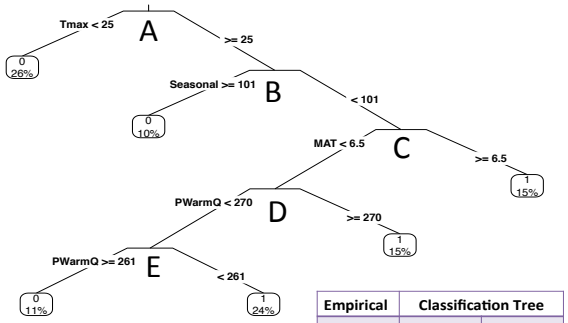




Thermal stress over long and short term (Shaefer et al. 2009)

Q1: What determines their distribution at their northern range?

Temperature and Seasonality most likely limits their northern distribution



Empirical	Classification Tree	
	Absent	Present
Absent	42	8
Present	6	46

Fig1. Classification Tree Analysis displaying four important bioclim variables (out of 19) that best predict the presence and absence of *A. picea* with a **86% accuracy!**

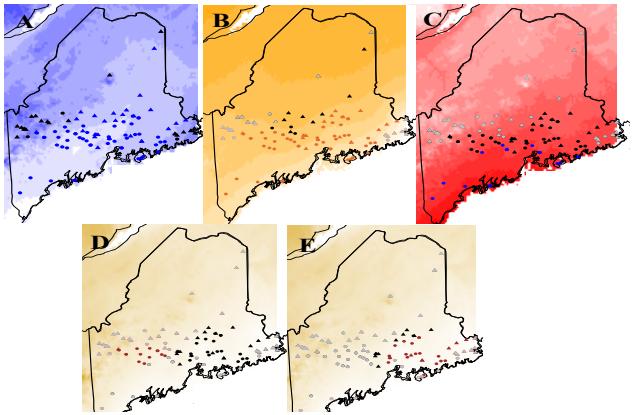


Fig2. Each panel displays the cutoffs at each node in figure 1. Circles and triangles were empirical presences and absences. Splits based on the classification tree are colored.

Q2: Are they physiologically constrained?

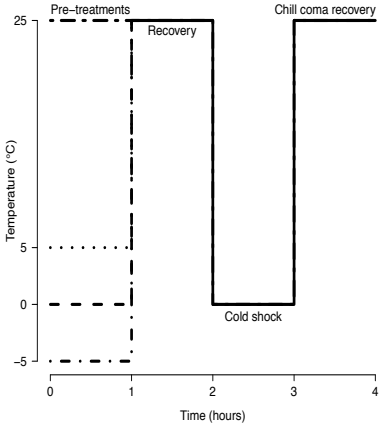


Fig3. Overview of physiological testing for cold tolerance and hardening (short term cold responses). For each colony, 2-4 workers followed each line.

Colonies from cold places cannot extend their cold tolerances → Evaluating thermal constraints → **Yes, evidence for hotter-cooler trade-off**

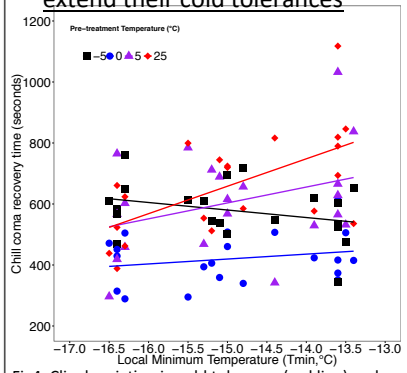


Fig4. Clinal variation in cold tolerance (red line) and hardening(difference between red and blue. There is a significant pre-treatment X Tmin interaction (ANCOVA, p<0.001).

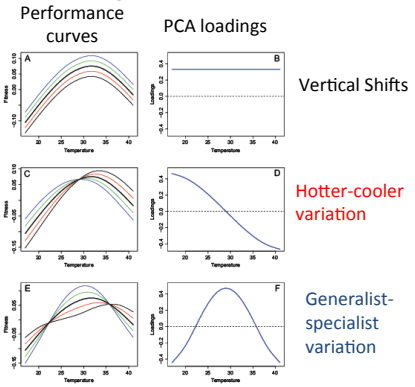


Fig5. We explored three possible ways A. picea cold tolerance metrics can vary. (Kingsolver et al. 2015, AmNat, see methods)

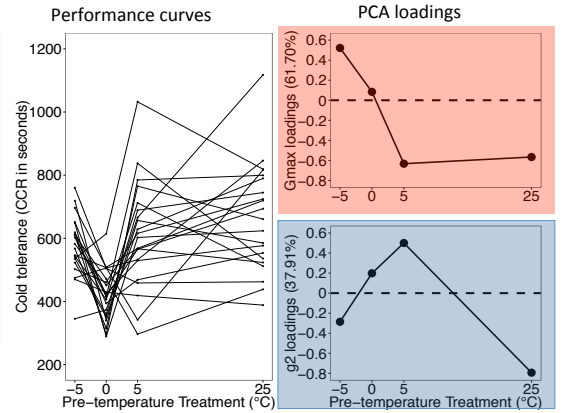


Fig6. Performance curves(left) and PCA decomposition of **G** matrix(right)

Methods summary: Presence and absence values were collated from previous field surveys and a survey done in the summer of 2015. In this survey, Megan and Jordan visited 80 sites! **They did most-all of the work on this project**. Physiological tests were performed on 20 lab acclimated (25 °C at least 1 month) ant colonies collected from Maine and Burlington, VT. We used an ANCOVA to test the effect of pre-treatment (factor), Tmin (continuous), and their interaction on chill coma recovery time. The variance covariance matrix was constructed from a MANOVA, manova(traits ~ Colony). To examine correlated responses among pre-treatments, we decomposed the variance-covariance matrix (broad sense **G**) with a PCA.

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