Sustainable insect exploitation, management and climate change

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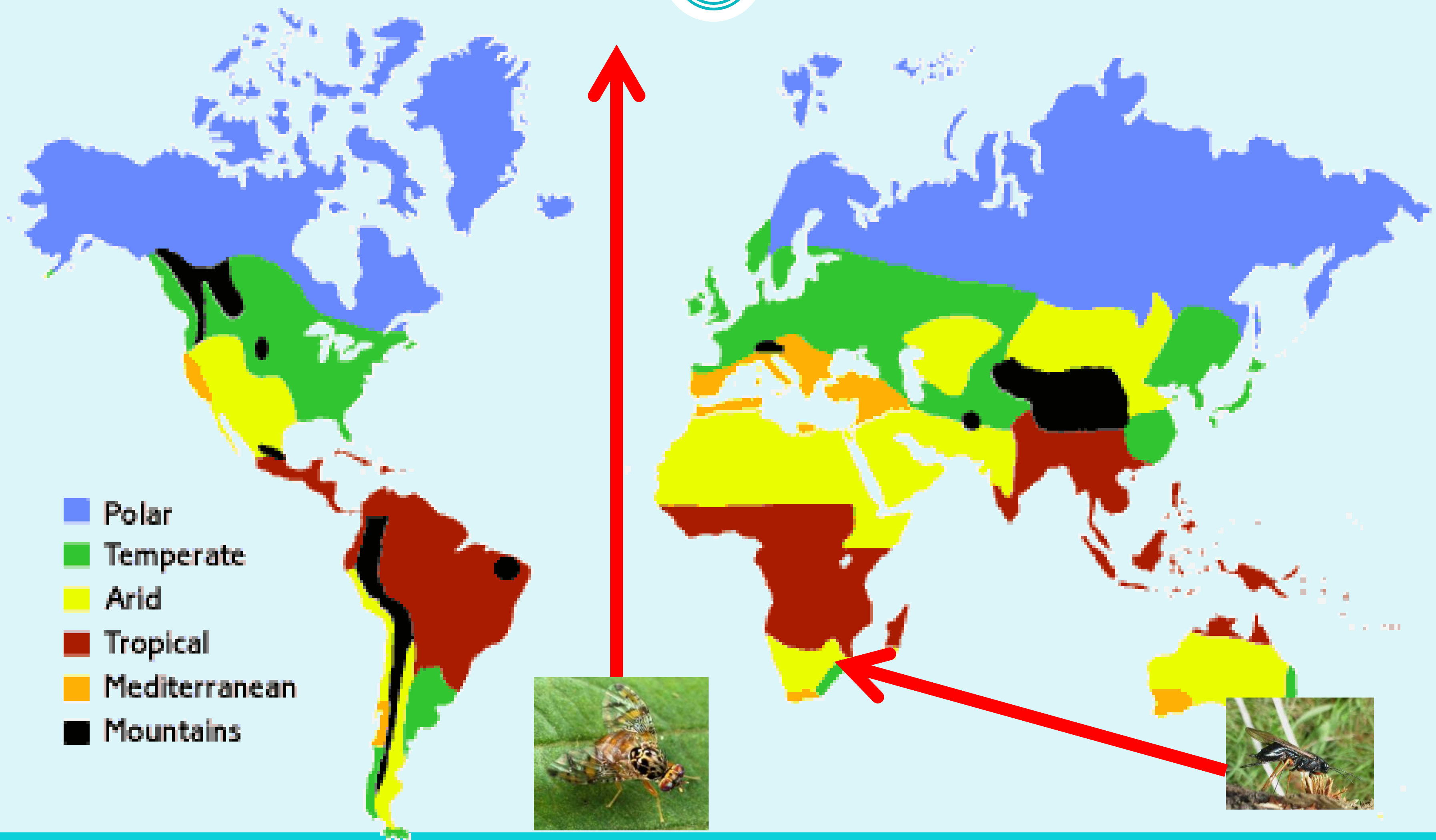
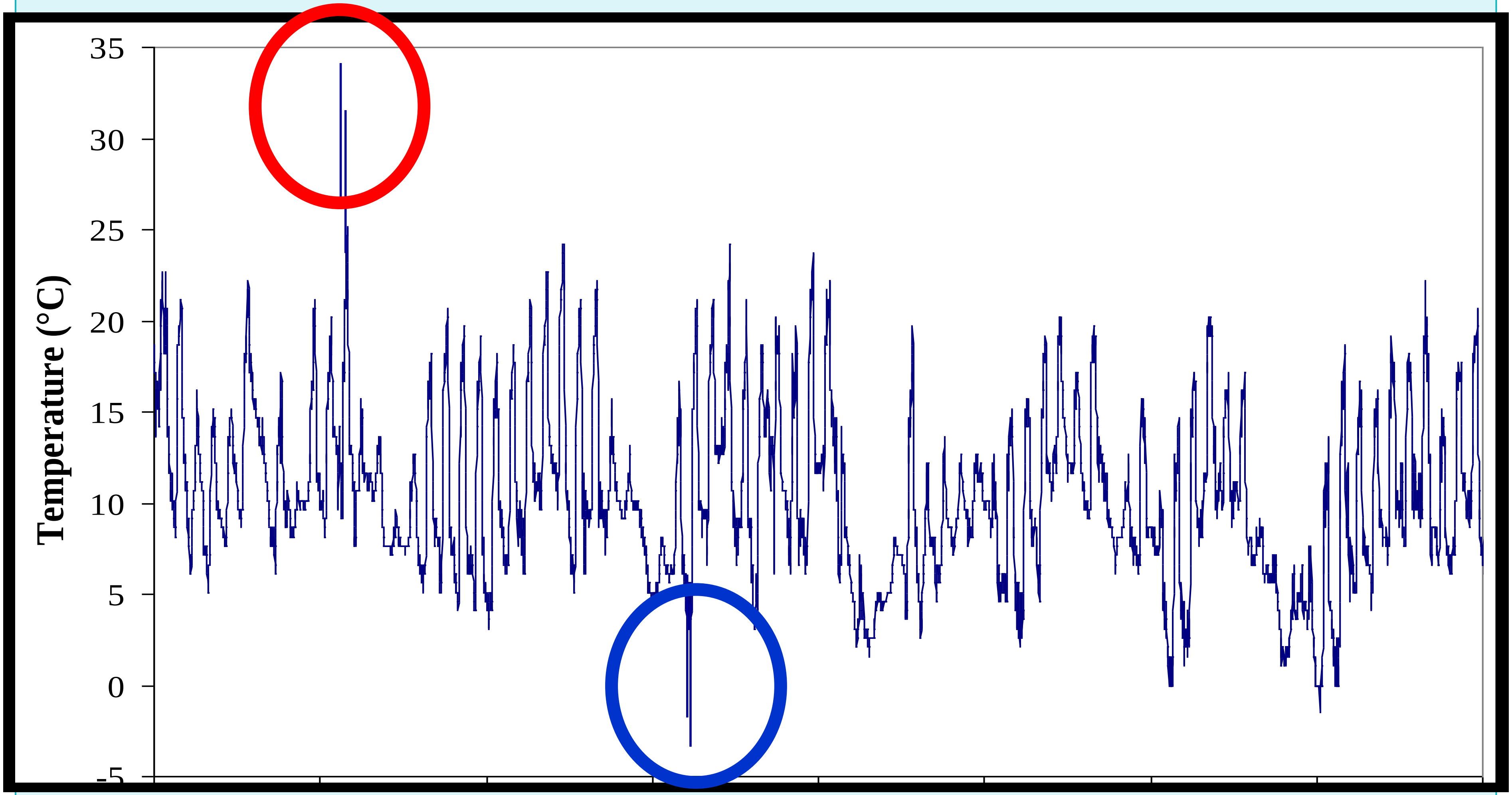
Climate is changing

Changes in biogeography pattern



Heat and cold snaps



Implications of global change

- Short generation times
  - More generations per year
- Increased T°C and DD accumulation
  - Reduced overwintering- more pest pressure
- **Asynchrony between host-natural enemy**
  - Reduced efficacy of biological control



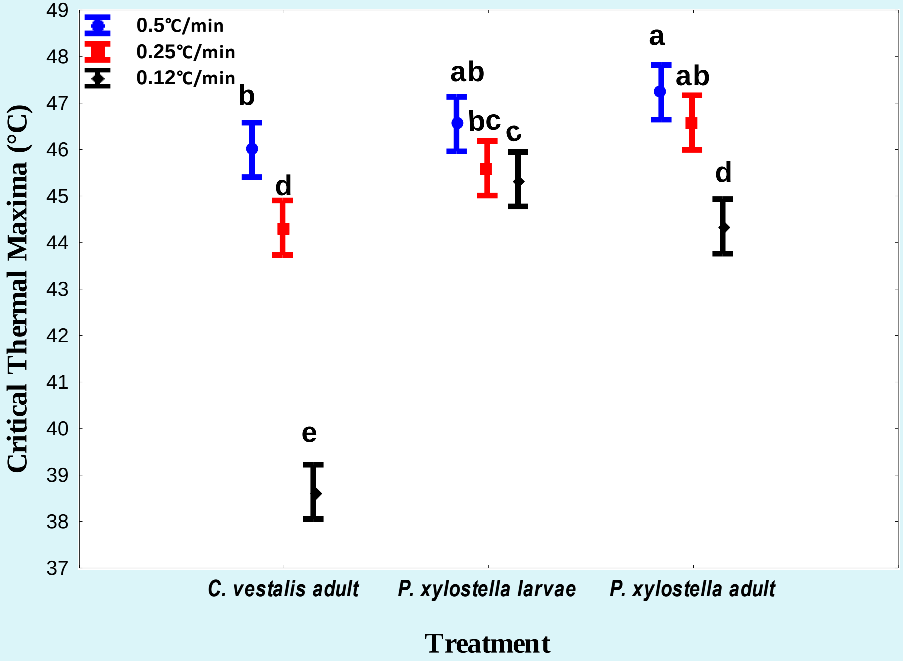

Implications of global change

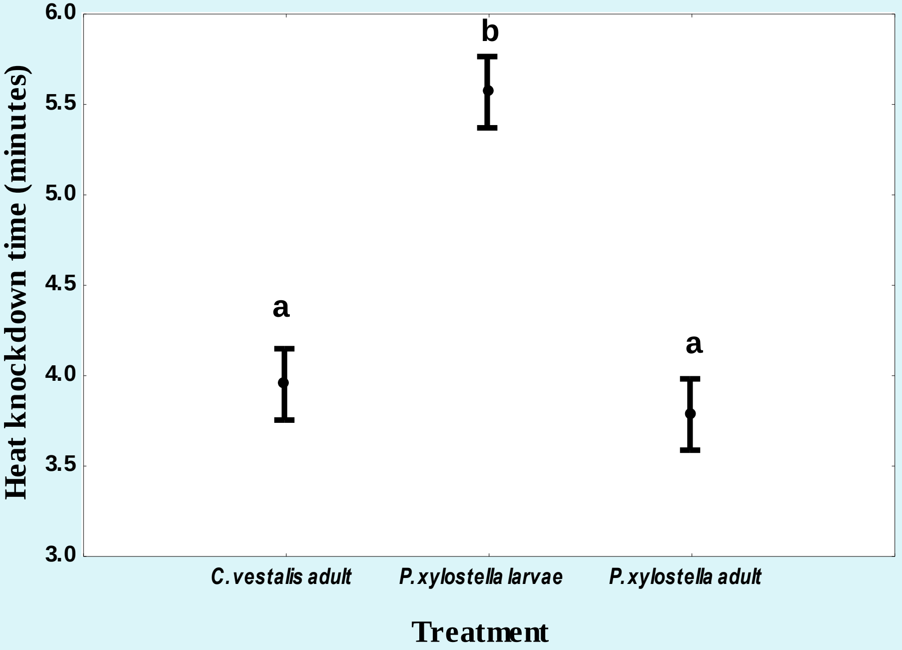
- Creation of new structures in native pest abundance
  - Emergence of 2° to 1° insect pests
    - Decreased food and nutrition security
- Modification of habitats
  - Pest colonization of new previously unfavorable habitats
  - Loss of natural enemy biological diversity/ lack of fitness/efficacy
  - Loss of ecosystem function
  - Consequence on pest management/food security



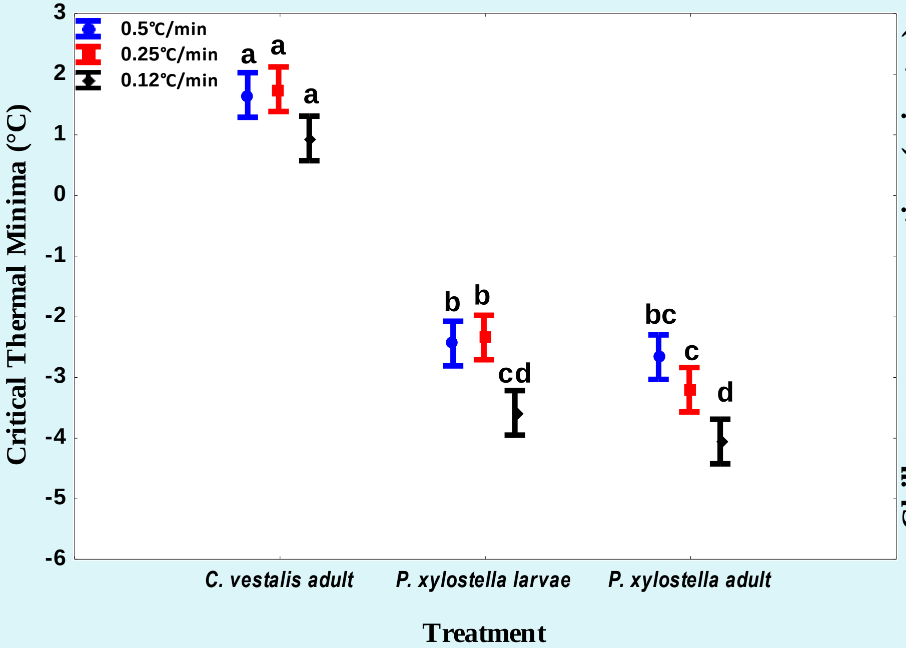

Loss coevolved basal and plastic responses to temperature may underlie trophic level host-parasitoid interactions under climate change

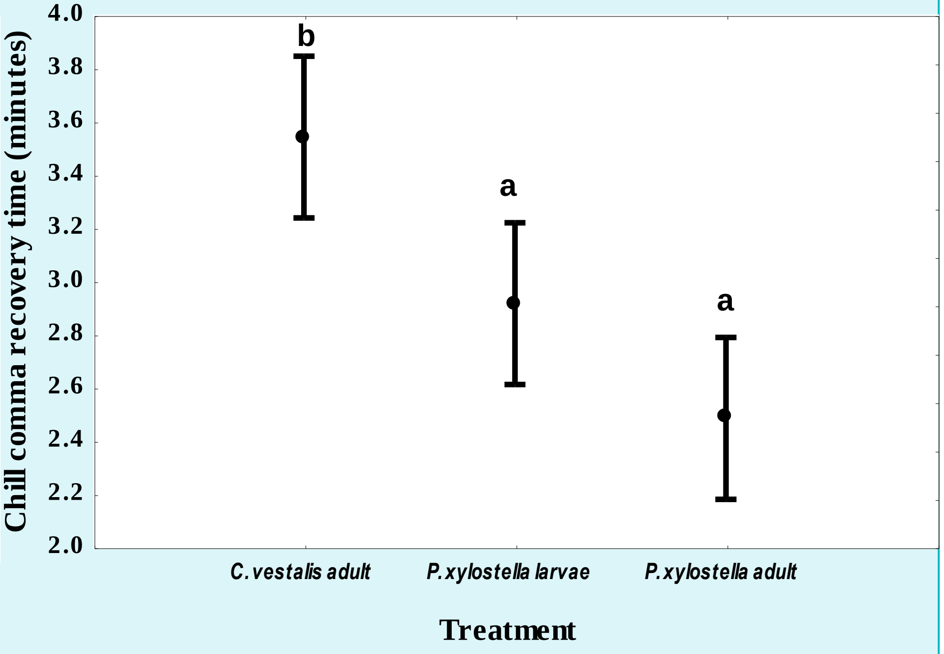
- **(1) High temperature tolerance**
- *Plutella xylostella vs Cotesia vestalis*



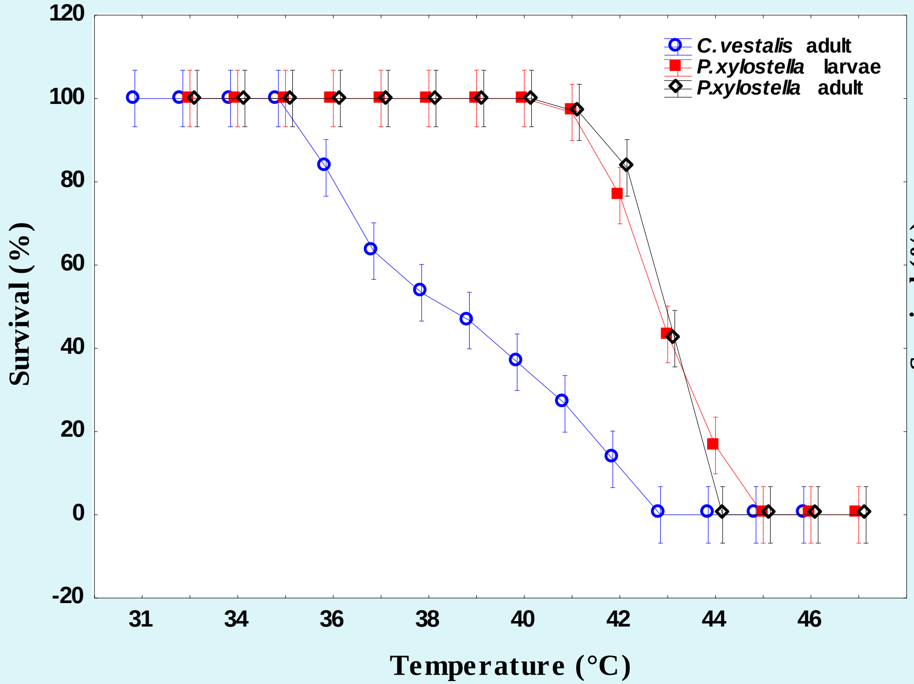


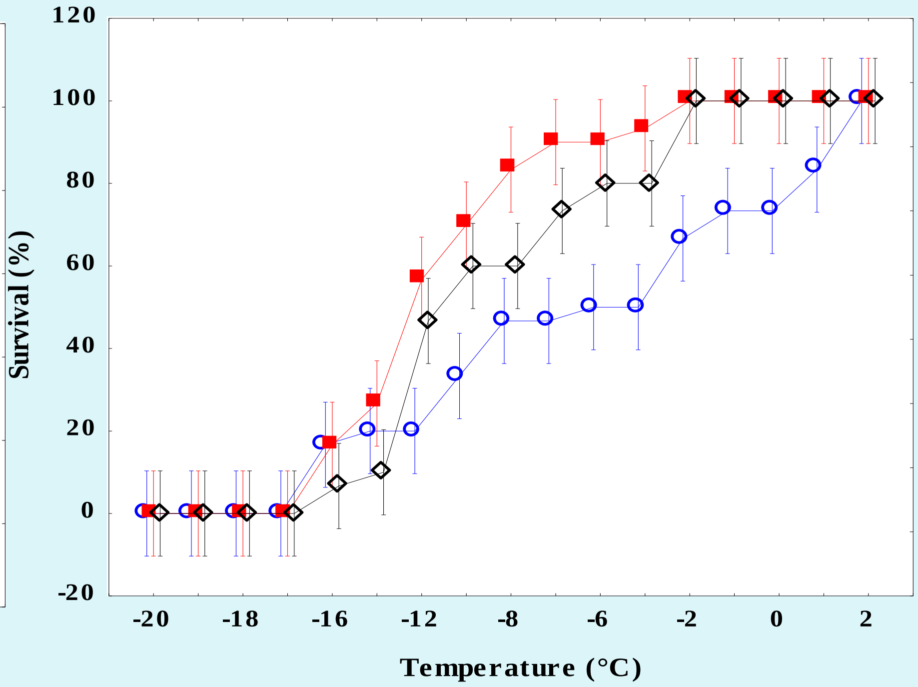
Low temperature tolerance





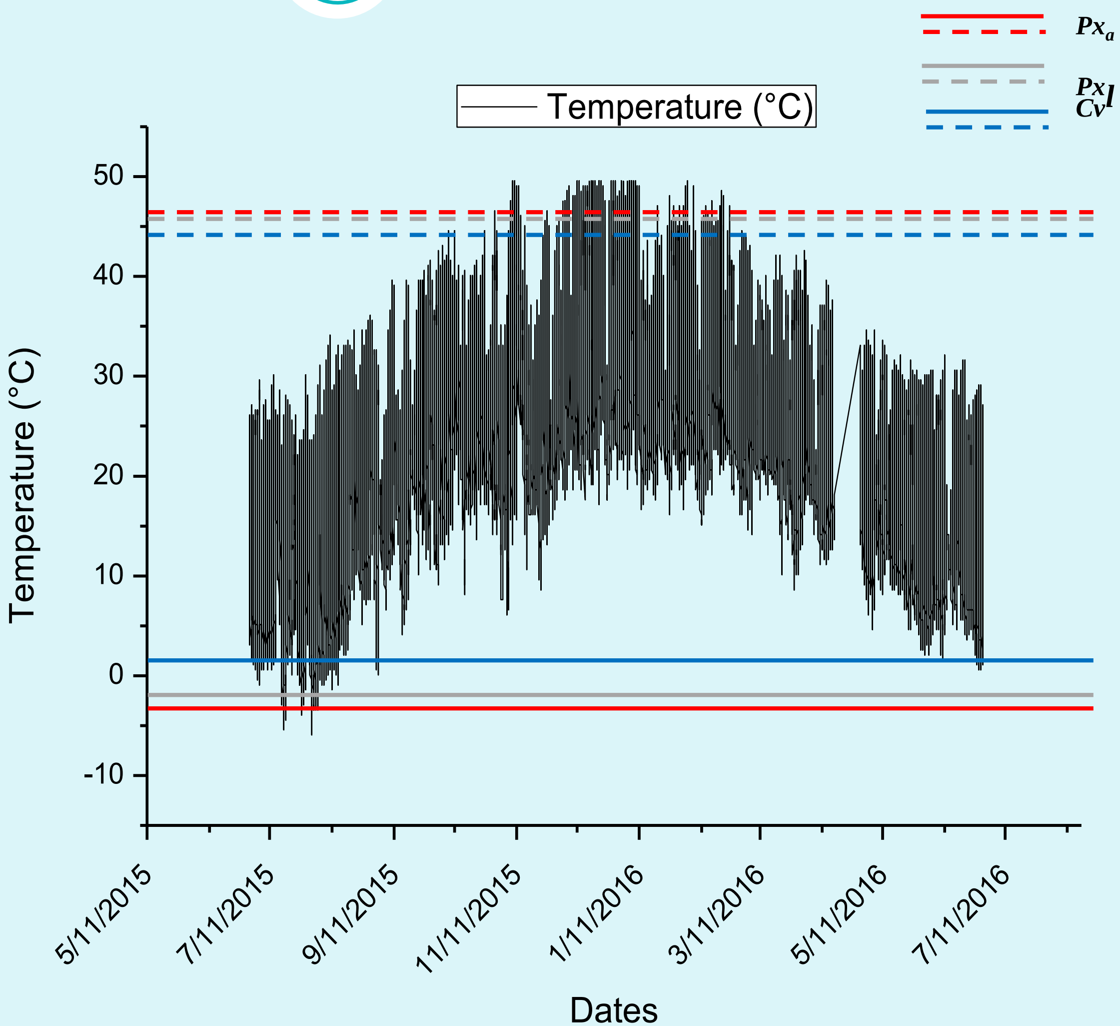
High/low temperature tolerance





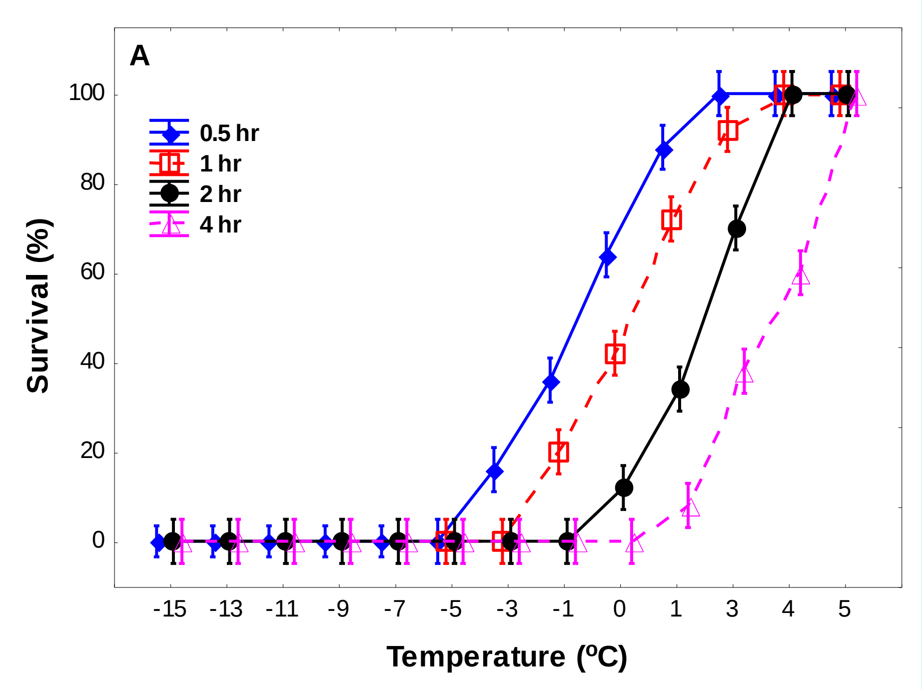
Thermal tolerance traits vs prevailing microclimates

Results show thermal divergence on an economically important host-parasitoid system

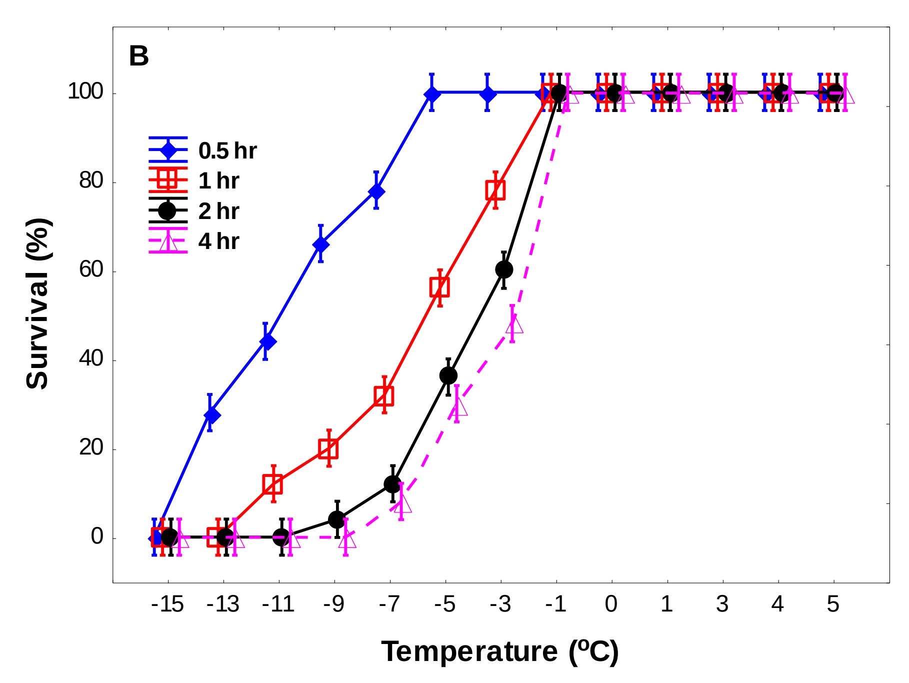


Thermal resilience may shape population abundance of two sympatric congeneric species (Hymenoptera: Braconidae)

- *Cotesia flavipes & Cotesia sesamiae*



Cotesia sesamiae



Cotesia flavipes

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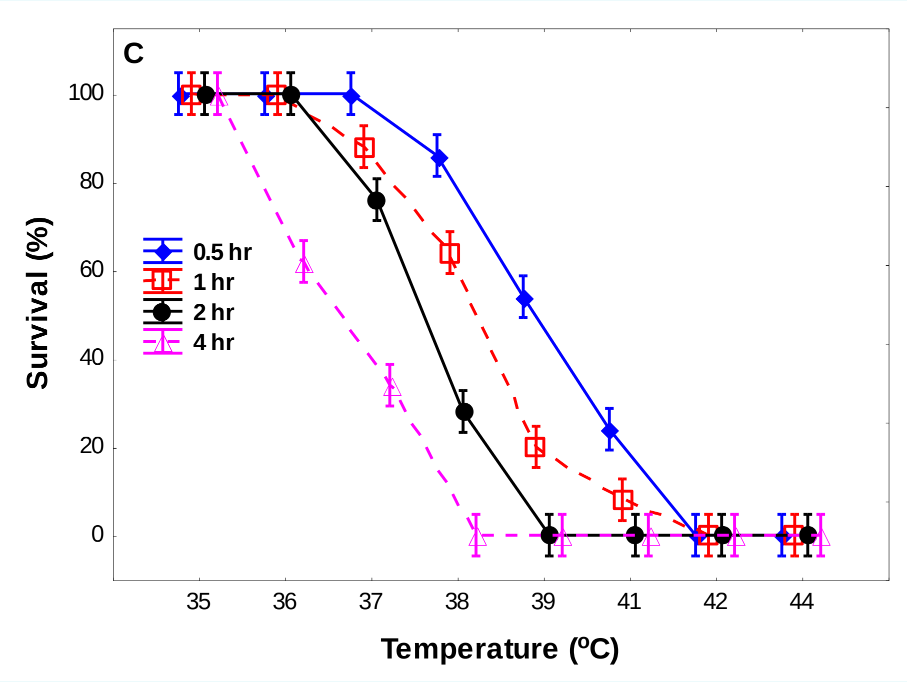
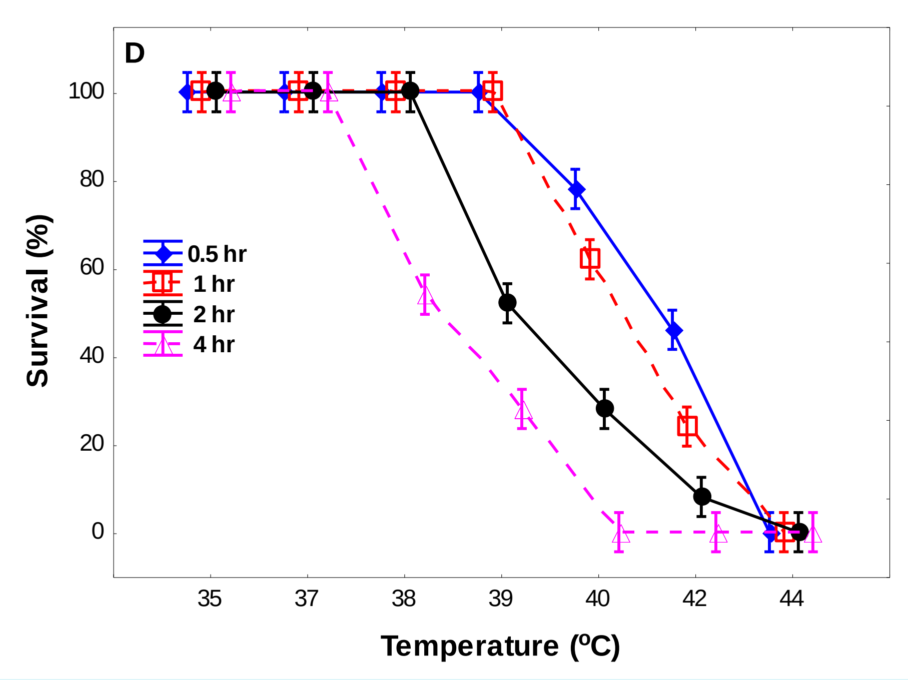
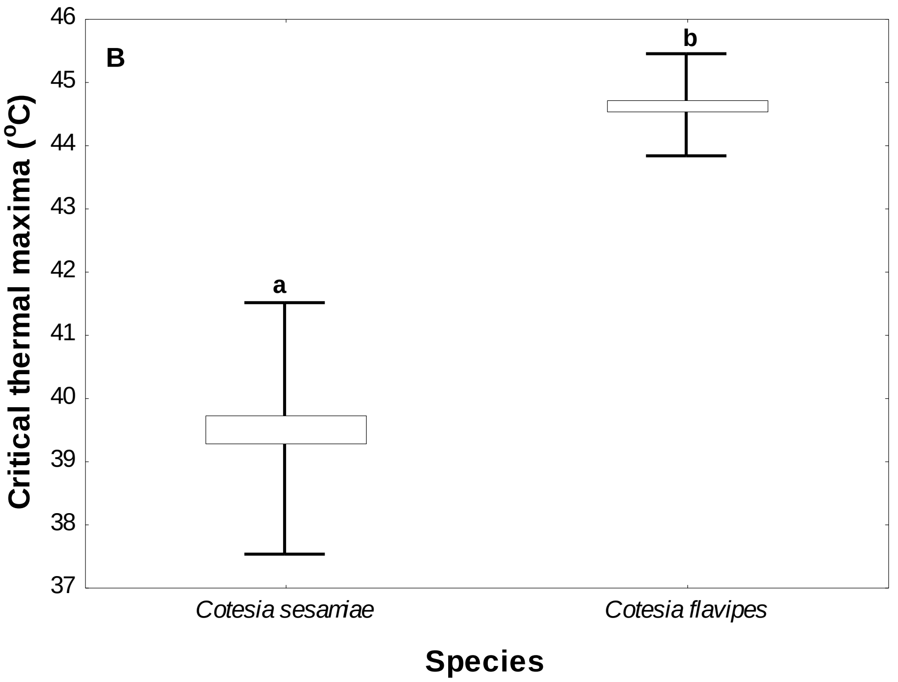


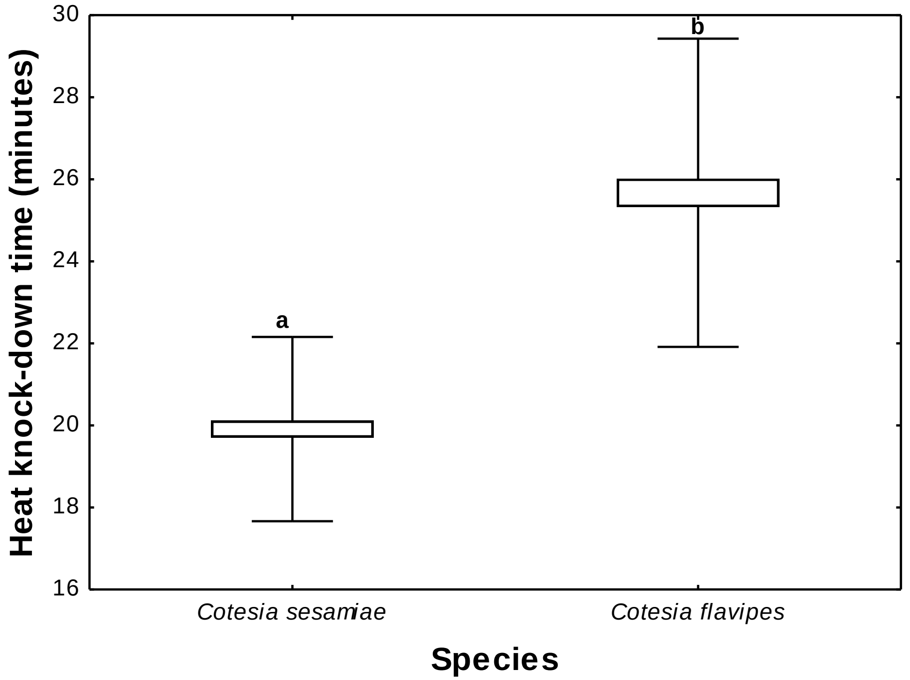
Cotesia sesamiae



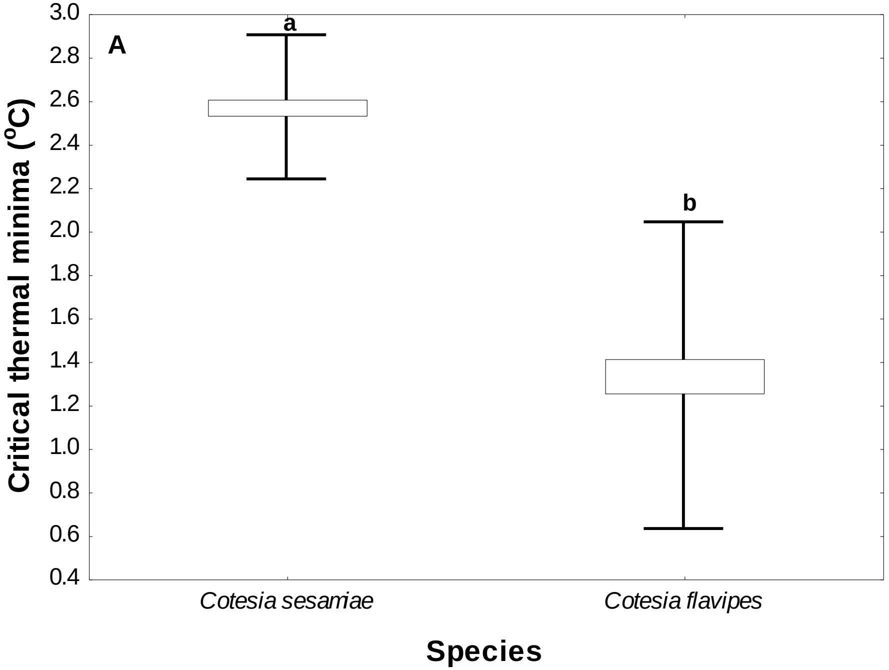
Cotesia flavipes

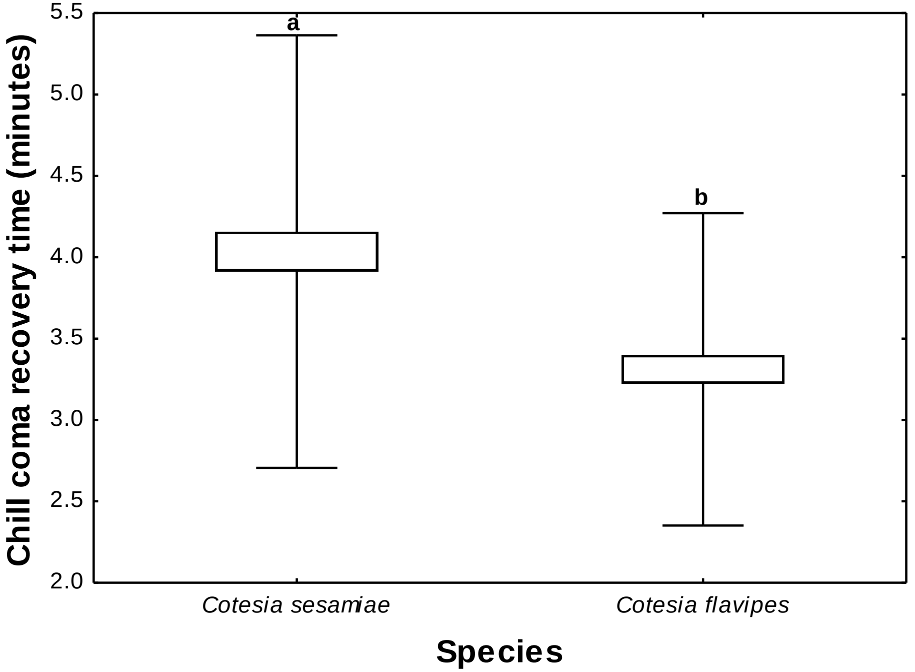
High temperature tolerance





Low temperature tolerance

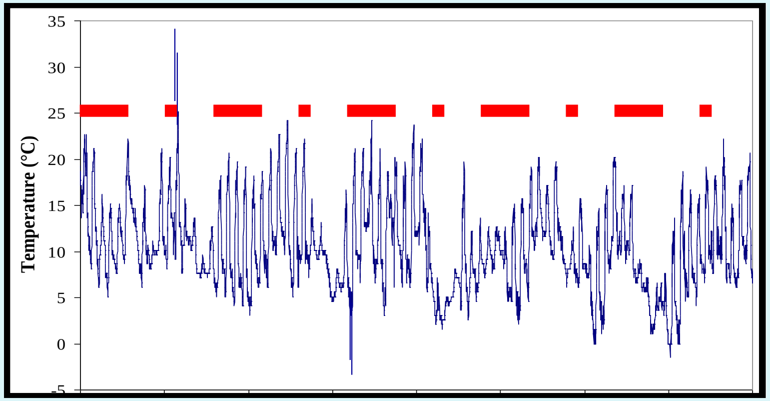




Way forward

Use of evolutionary physiology?

- Phenotypic plasticity **(=thermal preconditioning)**
  - As a method of improving insect mass rearing techniques
  - For improvement of biocontrol programs.
    - Through evolutionary resilience



Take T°C in 'bug' factory

Against T°C in natural habitat

And consequences of fitness and efficacy of mass reared natural enemies for biocontrol??

Detailed reading

PLOS ONE

RESEARCH ARTICLE

Thermal resilience may shape population abundance of two sympatric congeneric *Cotesia* species (Hymenoptera: Braconidae)

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Abstract

Basal and plasticity of thermal tolerance determine abundance, biogeographical patterns and activity of insects over spatial and temporal scales. For coexisting stemborer parasitoids, offering synergistic impact for biological control, mismatches in thermal tolerance may influence their ultimate impact in biocontrol programs under climate variability. Using laboratory-reared congeneric parasitoid species *Cotesia sesamiae* Cameron and *Cotesia flavipes* Cameron (Hymenoptera: Braconidae), we examined basal thermal tolerance to understand potential impact of climate variability on their survival and limits to activity. We measured upper- and lower-lethal temperatures (ULTs and LLTs), critical thermal limits [CTLs] (CT_{min} and CT_{max}), supercooling points (SCPs), chill-coma recovery time (CCRT) and heat knock-down time (HKDT) of adults. Results showed LLTs ranging -5 to 5°C and -15 to -1°C whilst ULTs ranged 35 to 42°C and 37 to 44°C for *C. sesamiae* and *C. flavipes* respectively. *Cotesia flavipes* had significantly higher heat tolerance (measured as CT_{max}), as well as cold tolerance (measured as CT_{min}) relative to *C. sesamiae* ($P<0.0001$). While SCPs did not vary significantly ($P>0.05$), *C. flavipes* recovered significantly faster following chill-coma and had higher HKDT compared to *C. sesamiae*. The results suggest marked differential basal thermal tolerance responses between the two congeners, with *C. flavipes* having an advantage at both temperature extremes. Thus, under predicted climate change, the two species may differ in phenologies and biogeography with consequences on their efficacy as biological control agents. These results may assist in predicting spatio-temporal activity patterns which can be used in integrated pest management programs under climate variability.

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Loss of coevolved basal and plastic responses to temperature may underlie trophic level host-parasitoid interactions under global change

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ABSTRACT

Climate change has complex impacts on insect life history traits, biogeography, survival, population dynamics and host-parasitoid seasonal phenologies that affect their synchrony. This is more pronounced in tropical southern Africa, where global warming may be relatively high. While some work on *Plutella xylostella* (L.) temperature tolerance has been reported, none focussed on African field insect populations and implications of trophic level interaction on biological control. To determine how climate change may affect coevolved trophic level interactions in a host-parasitoid trophic system, we compared the basal thermal tolerance of wild F_1 populations of the parasitoid *Cotesia vestalis* (Haliday) to two life stages of herbivorous host *P. xylostella* (L.), a global economic pest of brassicas. Our results showed significantly lower *C. vestalis* critical thermal limits ($P < .001$) compared to the host. Similarly, the parasitoid heat knockdown time and chill comma recovery time tolerance were significantly lower than that of the host ($P < .001$). Lethal temperature assays revealed significantly lower survival rates ($P < .001$) for *C. vestalis* at both upper and lower temperature scales. Observed differential basal temperature responses may offset coevolved host-parasitoid synchrony through differences in host-parasitoid phenologies. Hence, future biological control programmes should aim at 'creating' resilience and climate-fitness in natural enemies through enhancing evolutionary potential to buffer them from the changing climate. This is the first report detailing trophic level thermal tolerance of *P. xylostella* and larval parasitoid, *C. vestalis*, focussing on ecological service implications of the field-wild parasitoid populations on the herbivore host.

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