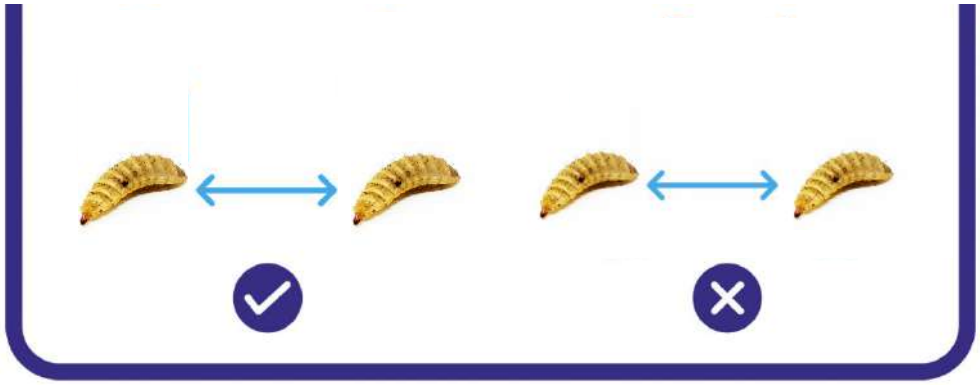
High larval density and exposure to entomopathogenic fungi adversely affect key life history traits and lead to increased immune investment in the black soldier fly.



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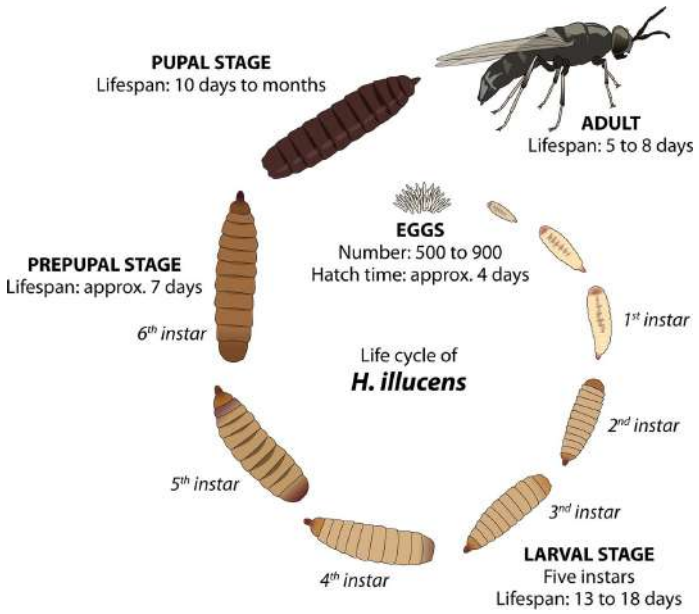
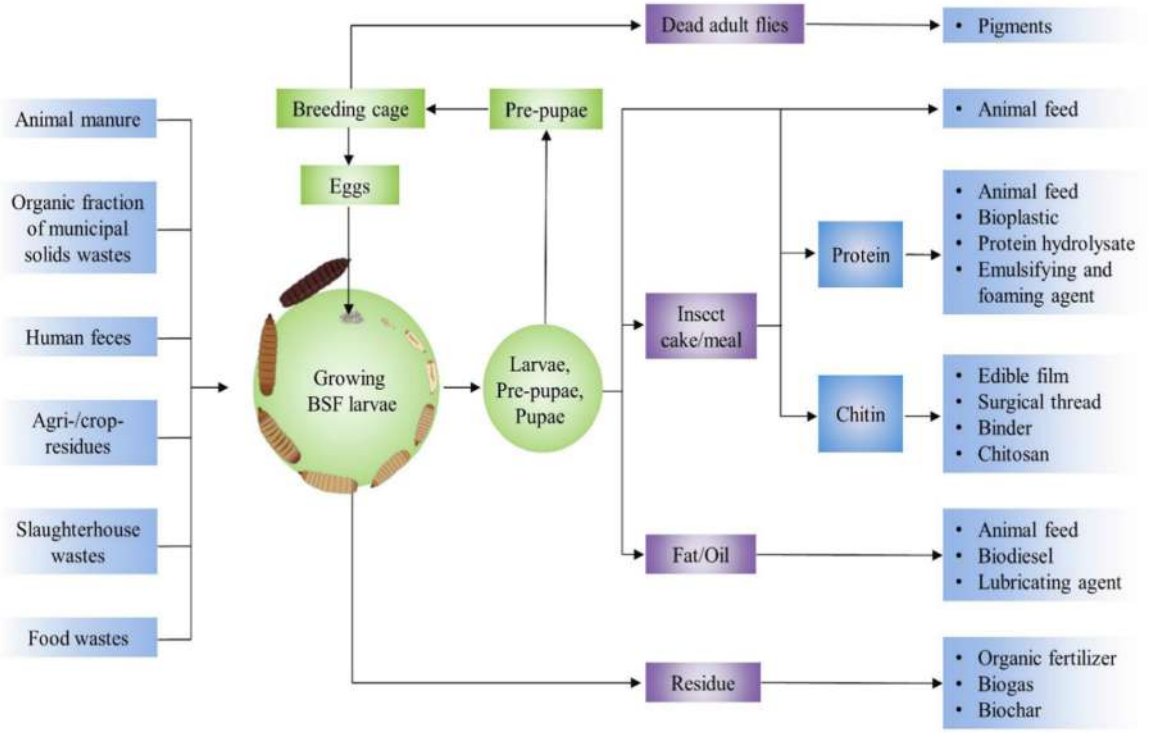
Introduction

Black soldier fly (*Hermetia illucens* L.*)*



(De Smet *et al*., 2018)

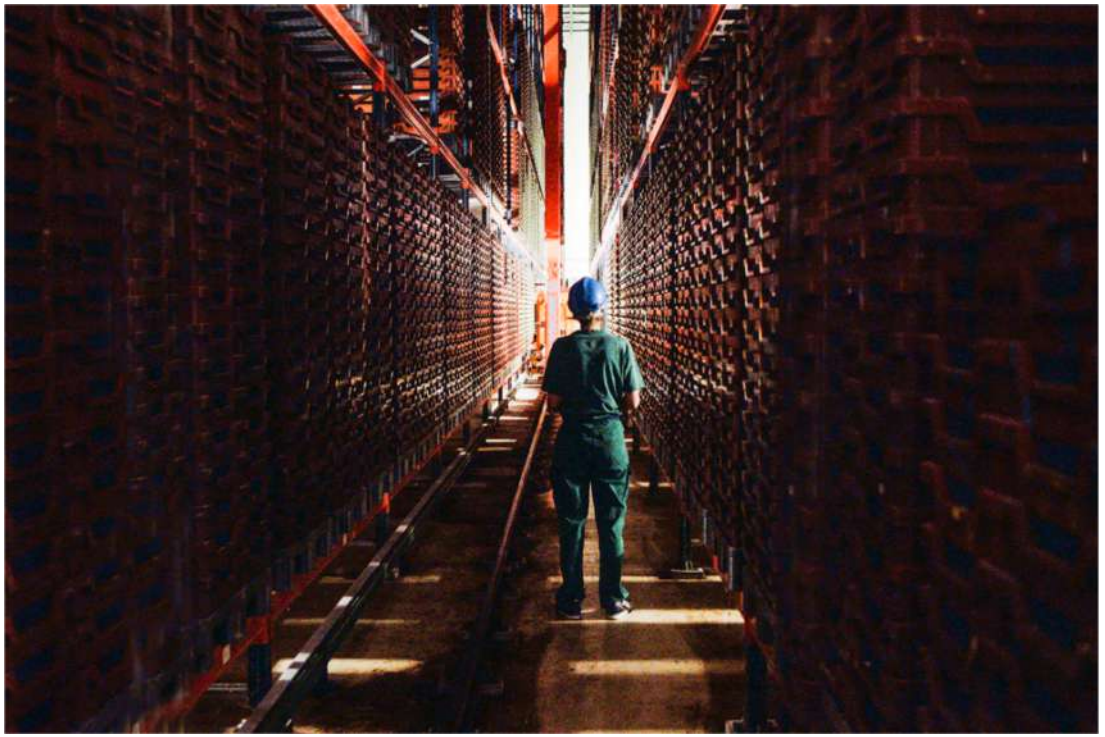
Uses of black soldier fly larvae and adults



(Surendra *et al.,* 2020)

Introduction

Insects for food and feed are currently reared on a large scale and at high larval densities



Protifarm, The Netherlands

Larval density

- It is well-established that larval density significantly impacts various life-history traits (Morimoto et al., 2022; Than et al., 2020).
- At low larval densities, survival and body size increase whilst phenoloxidase (PO) activity is lower (Barragán-Fonseca et al., 2018; Opare et al. 2022; Opare et al. 2023)
- At high larval densities, survival and body size all decrease whilst PO activity is higher (Vellau & Tammaru, 2012; Opare et al. 2022; Opare et al. 2023).

Larval density

- Exploring interactions between larval density and other environmental factors will help estimate optimal responses.

- These responses will help optimise production in mass-rearing systems.

Credit: Cyril Marcilhacy/Bloomberg via Getty

Credit: Cyril Marcilhacy/Bloomberg via Getty

Introduction

An entomopathogenic fungus (EPF) is a fungus that can kill or seriously disable insects.

The EPF *Beauveria bassiana* is among the most influential and best-studied fungal pathogens

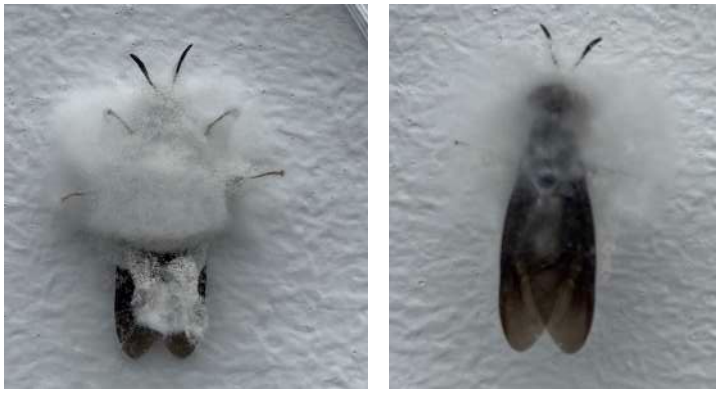
It also usually affects the same insect species across all life stages

This EPF species has successfully infected insects reared for food and feed

Mealworm infected by *Beauveria bassiana*

Adult BSFs infected by *Beauveria bassiana*

Effect of EPF exposure on black soldier fly adults



Adult black soldier fly killed by the entomopathogen *Beauvaria bassiana* first reported by (Lecocq et al. 2021)

- In BSF, it is established that larval density significantly impact various life-history and immune traits.
- It is also established that BSF adults are susceptible to *Beauvaria bassiana*
- However, larval density and entomopathogenic fungi interactions have yet to be studied in this species.

Introduction

- This study explored the interaction of larval density and EPF to help estimate optimal responses and to help appropriately optimise mass production systems.

Hypothesis

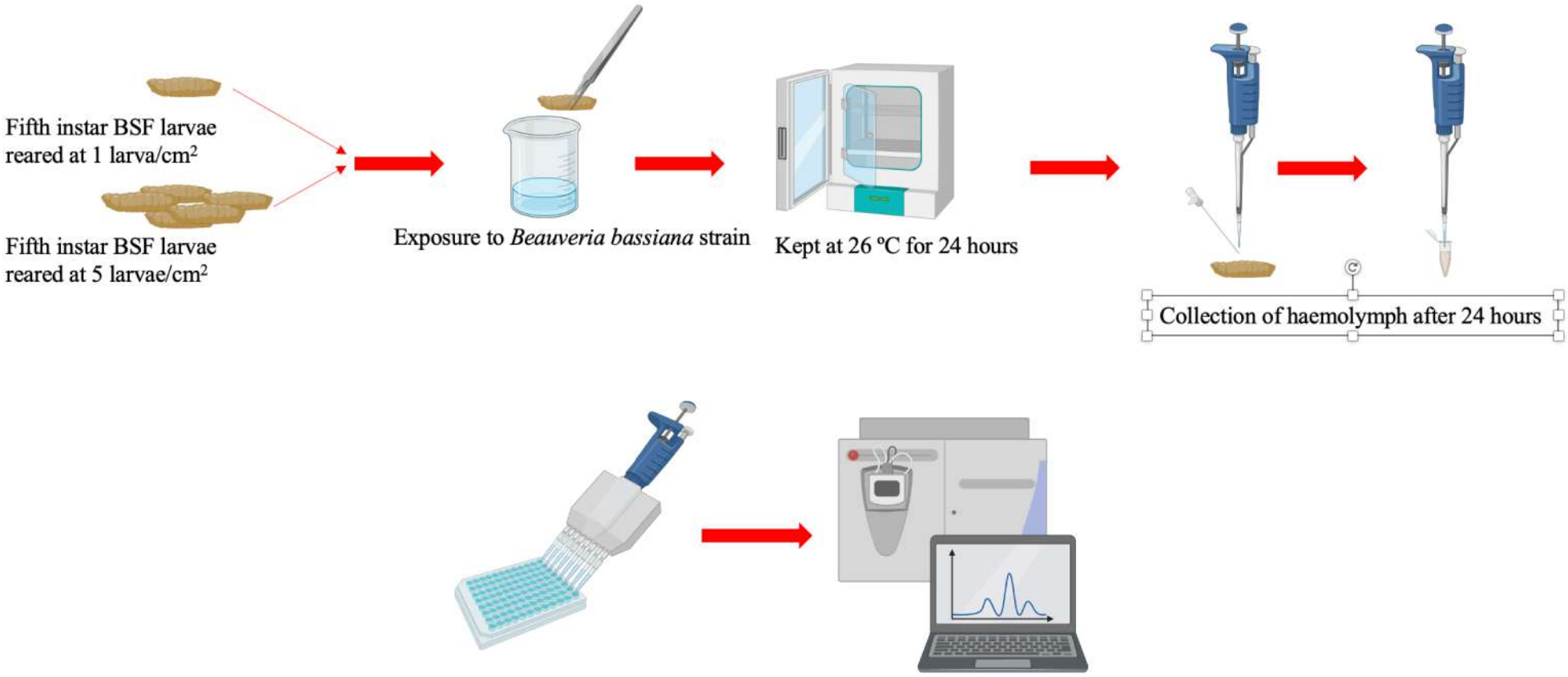
BSF larvae exposed to entomopathogenic fungi and reared at low larval densities will exhibit a lower PO activity and experience significant life-history costs.

Methods

Treatments

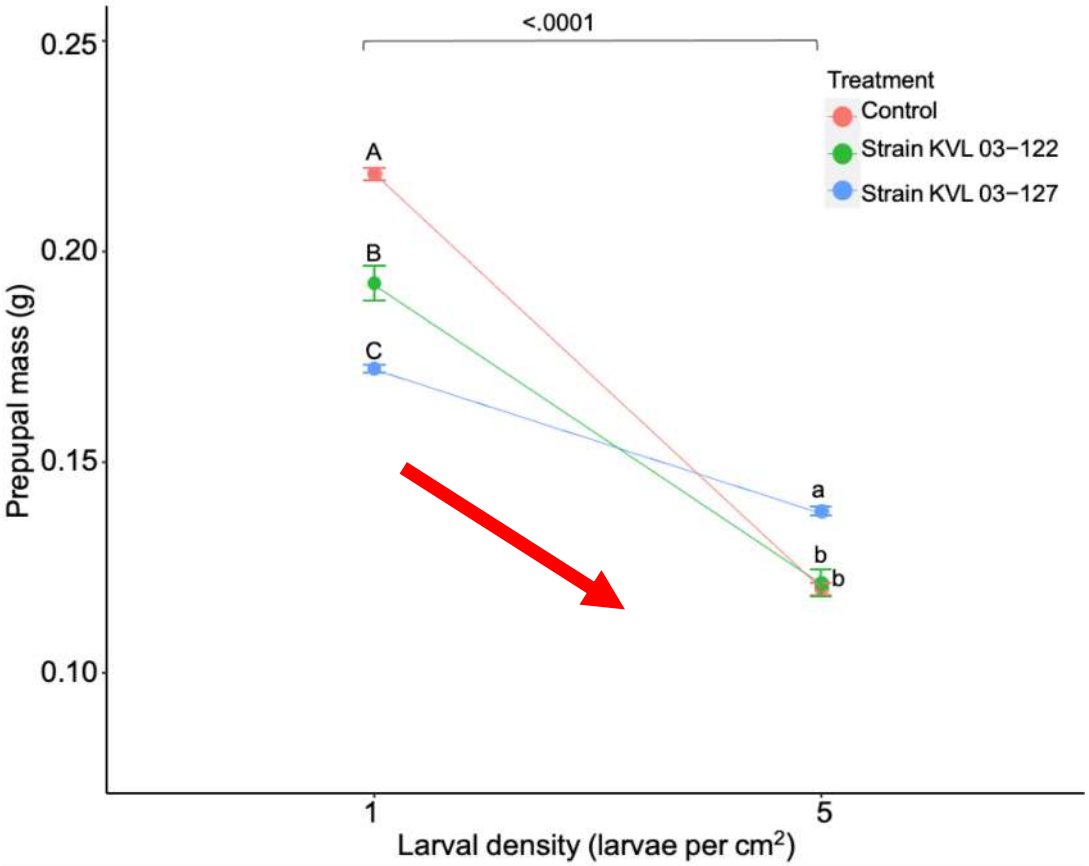
- 1 larva/cm^2 = Low density and 5 larvae/cm^2 = High density
- Exposed them to two fungal strains of *Beauveria bassiana* (KVL 03-122 & KVL 03-127) at the fifth larval instar stage
- Concentration 10^{-8}
- Recorded PO activity and select life history traits

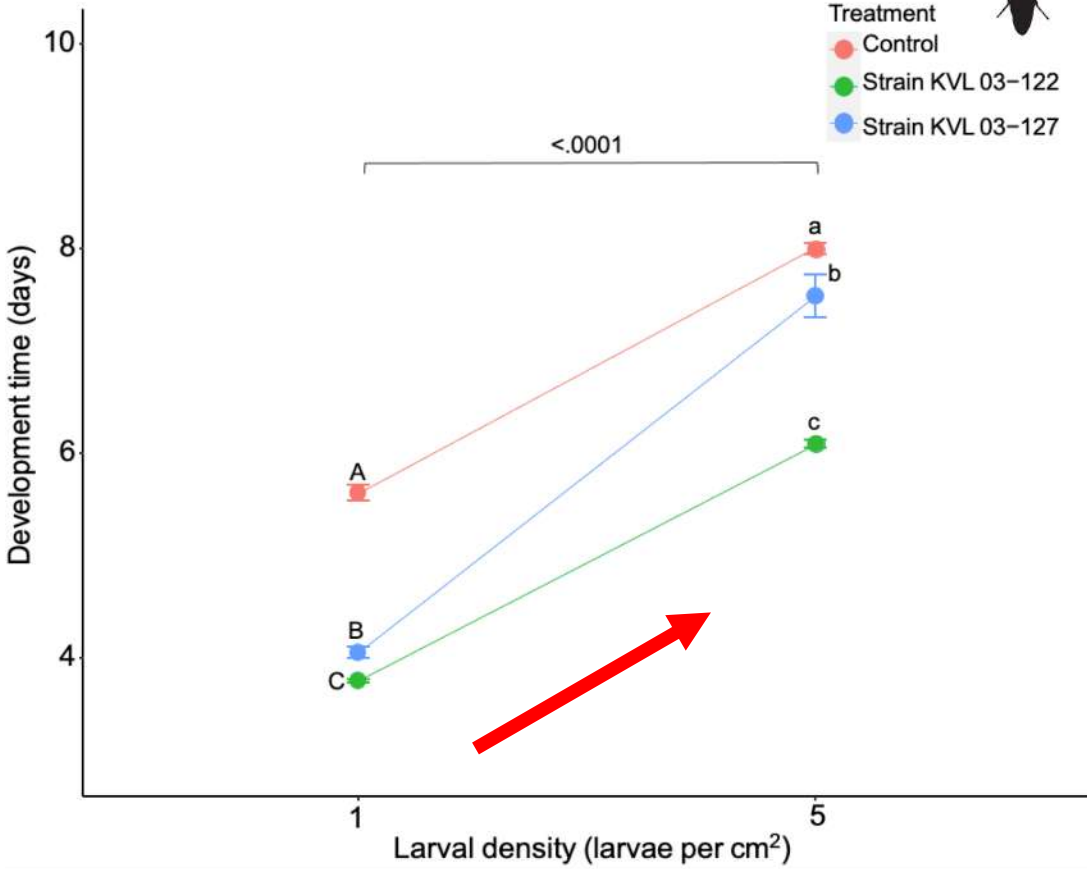
Methods



Measurement of phenoloxidase activity using a spectrophotometer

Results

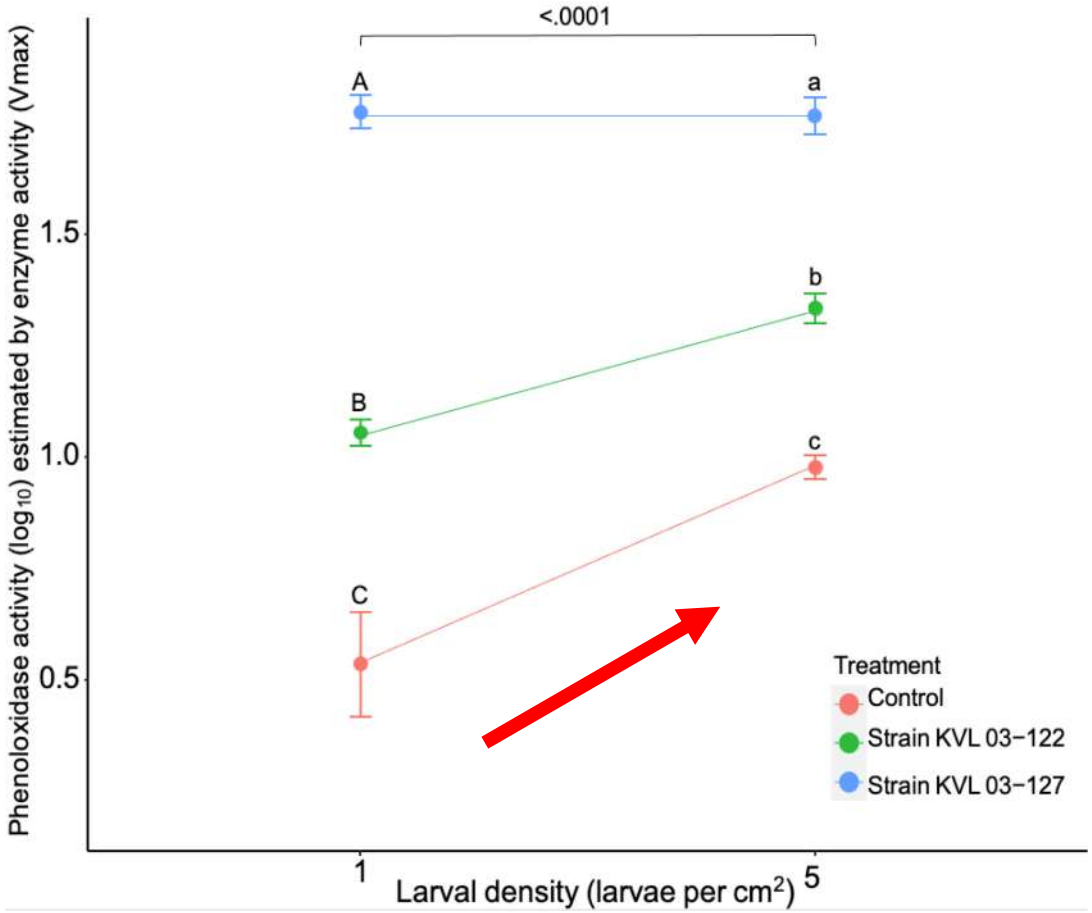




- Prepupal mass was higher when BSF larvae were reared at low larval density and exposed to an EPF treatment.
- Significant Interactions were observed between larval density and EPF.

- Development time was extended when BSF larvae were reared at high larval density and exposed to an EPF treatment.
- Significant Interactions were observed between larval density and entomopathogenic fungi.

Results



- PO activity was higher when BSF larvae were reared at high larval density and exposed to different EPF strains.
- Significant Interactions were observed between larval density and EPF.

Discussion and Significance

- High larval density triggers immune responses but imposes fitness costs, highlighting trade-offs between immunity and growth.
- BSF larvae appear to engage in therapeutic feeding in the presence of multiple stressors.
- Exposure to EPF further exacerbates life-history costs while enhancing immune defense.

Conclusions

High larval density and EPF exposure enhance immunity but at significant life-history costs.

Trade-offs between growth, survival, and immunity should be considered in BSF mass-rearing systems.

Notes for BSF breeders

- Refine production protocols, ensuring that rearing conditions maximize biomass yield and maintain larval health.
- Select strains or genotypes with natural resistance to pathogens while minimizing trade-offs in growth and productivity.
- Screen and breed strains that are more tolerant of high densities and pathogen exposure.

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- Thank you for your attention!