Improving mealworm health through nutrition

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Why is this relevant? Why should we try to improve mealworm health?

No real dangers yet

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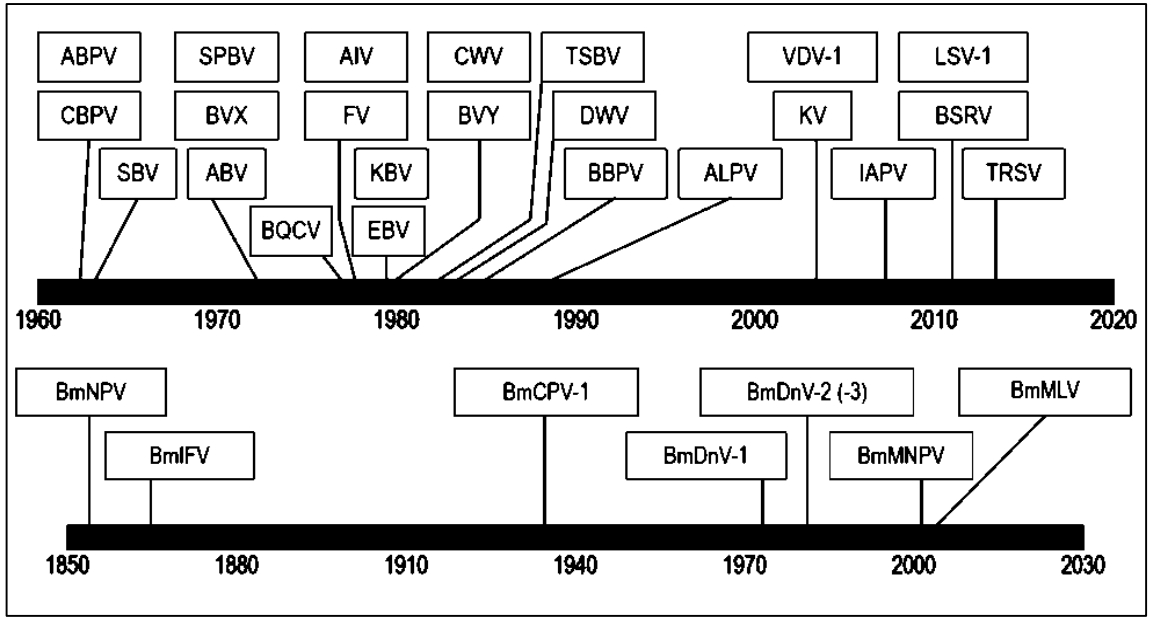
No real dangers yet **BUT:**

- **Learning** from past domestication attempts / Failures / Successes (?)

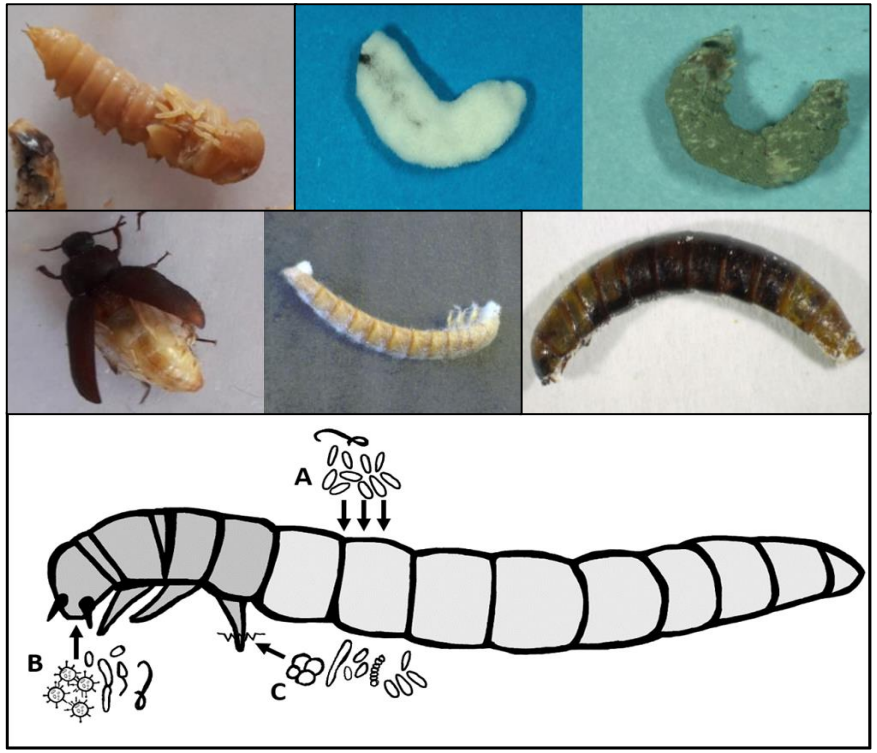


Timeline of discovery of new virus diseases in honeybees (Apis mellifera) and silkworm (Bombyx mori) Source: Eilenberg et al. 2015

Why is this relevant?

No real dangers yet **BUT:**

- **Learning** from past domestication attempts / Failures / Successes (?)
- **Future-proofing** the industry



inVALUABLE: The focal areas and work packages

- **Production** (work packages 1-3)

Focus on optimization of the production of mealworms (WP1); improving the understanding of *mealworm health and nutrition* (WP2); and development of innovative technologies for implementing cost-effective production systems through automation and monitoring of mealworm health (WP3).

- **Processing** (work packages 4-5)

- **Product Application** (work packages 6-8)

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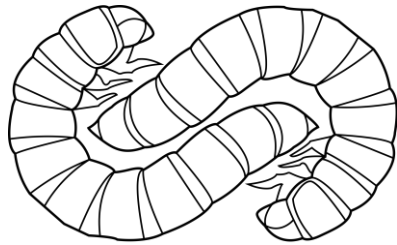
inVALUABLE: Health and Nutrition

The aim is to better our understanding of the nutritional needs of mealworms and assess the feed potential of a range of selected by-products.

Strong focus on:

- **Preventing mealworm diseases**
- **Improving overall fitness**



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How?

Investigating the Effect of Different Acid Bacteria on the Fate of *Listeria* *Staphylococcus aureus* Infection in *G*

Beneficial Protective Role of Endogenous Lactic Acid Bacteria Against Mycotic Contamination of Honeybee Beebread

Irakli Janashia[1] · Yvan Choiset[2] · Damian Jozefiak[3] · Franck Déniel[4] · Emmanuel Coton[4] · Chanishvili[1] · Thomas Haertlé[2,3,5]

Isolation and Partial Characterization of Lactic Acid Bacteria from the Gut Microbiota of Marine Fishes for Potential Application as Probiotics in Aquaculture

Sergio Alonso[1] · M. Carmen Castro[1] · Margarita Berdasco[1] · Inés García de la Banda[2] · Xabier Moreno-Ventas[3] · Alma Hernández de Rojas[1]

*obiotic *Enterococcus mundtii* *olate Protects the Model Insect *..ibolium castaneum* against *:illus thuringiensis*

*Grau[1], Andreas Vilcinskas[1,2] and Gerrit Joop[1]**

Probiotic effect of lactic acid bacteria in the feed on growth and survival of fry of Atlantic cod (Gadus morhua)

Exploitation of the Medfly Gut Microbiota for the Enhancement of Sterile Insect Technique: Use of *Enterobacter* sp. in Larval Diet-Based Probiotic Applications

Antonios A. Augustinos[1,2], Georgios A. Kyritsis[1,3], Nikos T. Papadopoulos[3], Adly M. M. Abd-Alla[1], Carlos Cáceres[1], Kostas Bourtzis[1]*

Novel lactic acid bacteria inhibiting *Paenibacillus larvae* in honey bee larvae*

Characterization of probiotic properties of lactic acid bacteria isolated from intestinal microbiota of fish

José L. Balcázar [a, b], Daniel Vendrell [a], Ignacio de Blas [a], Imanol Ruiz-Zarzuela [a], José L. Muzquiz [a], Olivia Girones [a]

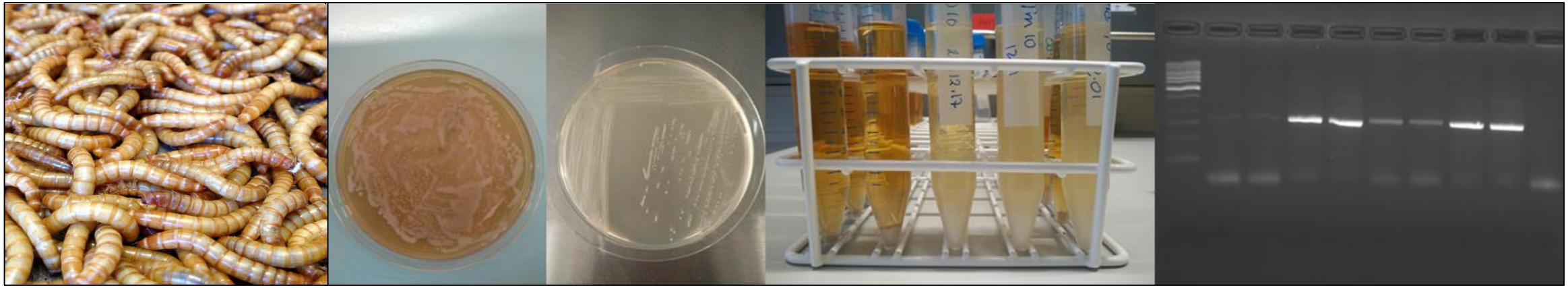
Gut lactic acid bacteria as additives for mass rearing of *Tenebrio molitor*

Expected benefits:

- **Improved survival**
- **Enhanced growth**
- **Nutritional benefits (to final consumer)**

Screening, Isolation and Identification

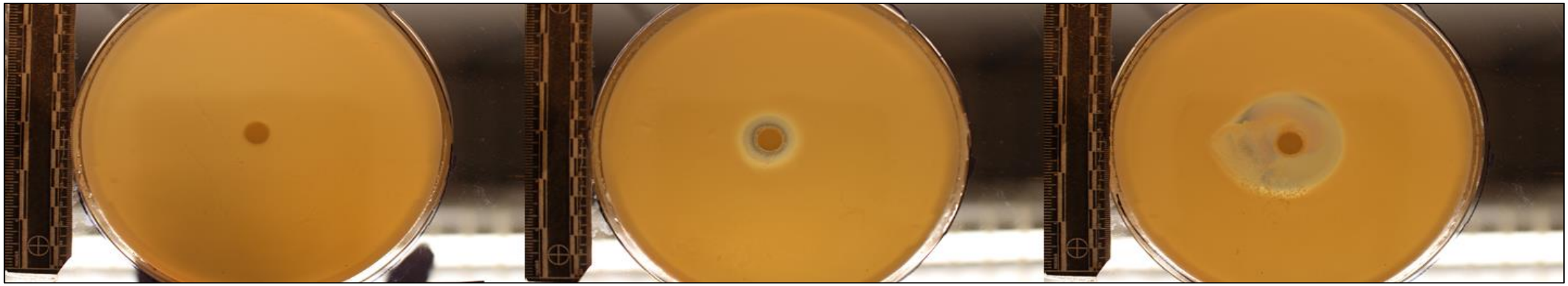
- **Dissection** of mealworm guts (focus on gut flora)
- **Culture** on selective media for Lactic Acid Bacteria (MRS)
- **Identification** using MALDI biotyper and Sanger Sequencing



In vitro antimicrobial activity

- Focus on **inhibition potential**

- Selected **pathogenic bacteria**: *Bacillus thuringiensis X3*, *Serratia marcescens*, *S. plymuthica*, *Pseudomonas aeruginosa*

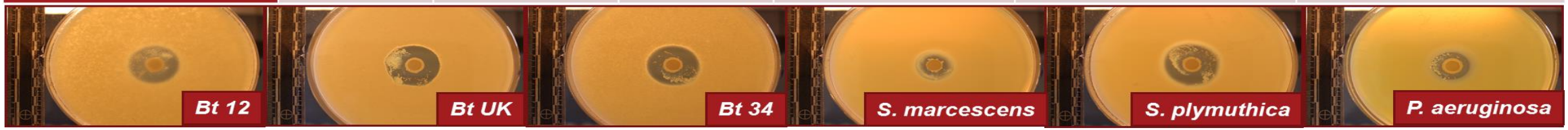


In vitro antimicrobial activity

- **Candidate selection** partly based on **growth requirements**

- ***Pediococcus pentosaceus*** strain selected for *in vivo* experiments

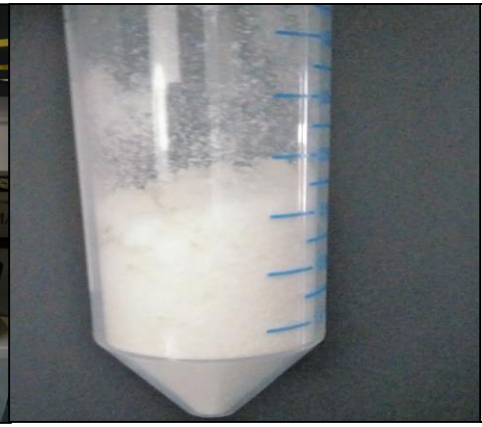
Strain	*Bt12*	*BtUK*	*Bt34*	*S. marscesens*	*S. plymuthica*	*P. aeruginosa*
Mean inhibition zone (mm)	11,3	11,7	11,5	7,8	12	8,5

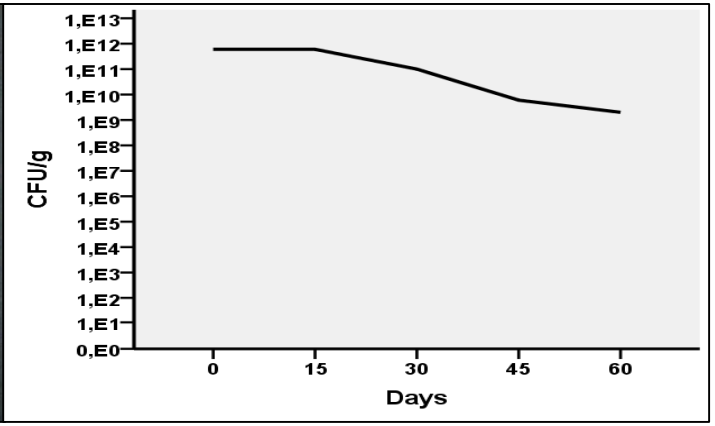


Formulation of Selected LAB Strain, *P. pentosaceus*

- **Freeze drying** enables **easy delivery** of bacteria in **existing diet**

- Improves **storage stability** and **cell viability** at rearing temperatures



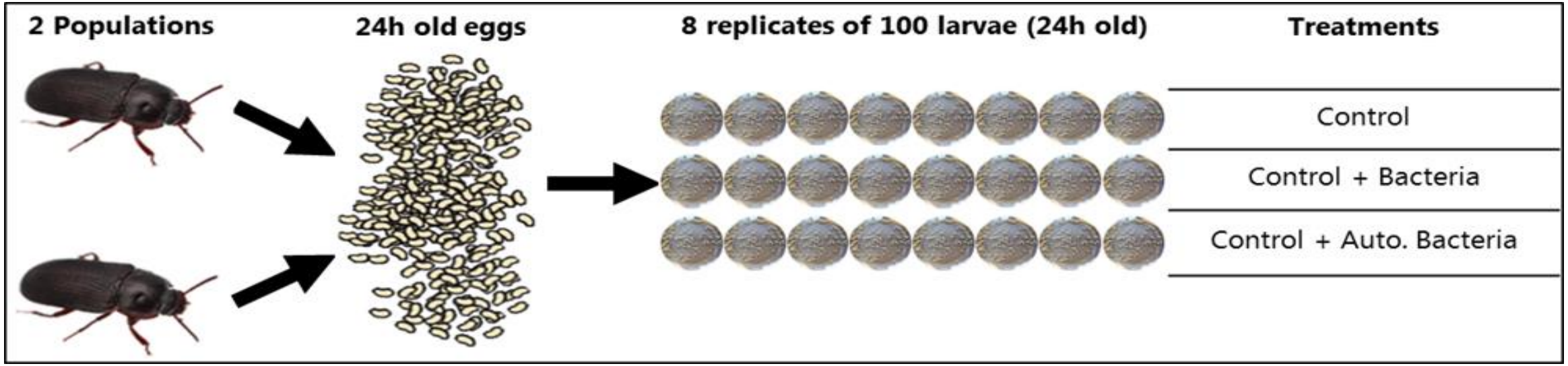


In vivo effects of *P. pentosaceus* on *T. molitor* fitness

Aim:

To test the effect of *P. pentosaceus* as a supplement on the fitness and development of *T. molitor*

Treatments:



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Aim:

To test the effect of *P. pentosaceus* as a supplement on the fitness and development of *T. molitor*

Treatments:

C	Control = ad libitum dry food (50g) and brewers'grain (variable)
CB	Control + Bacteria ($1*10^9$ C.F.U./g)
CB^-	Control + Bacteria Autoclaved

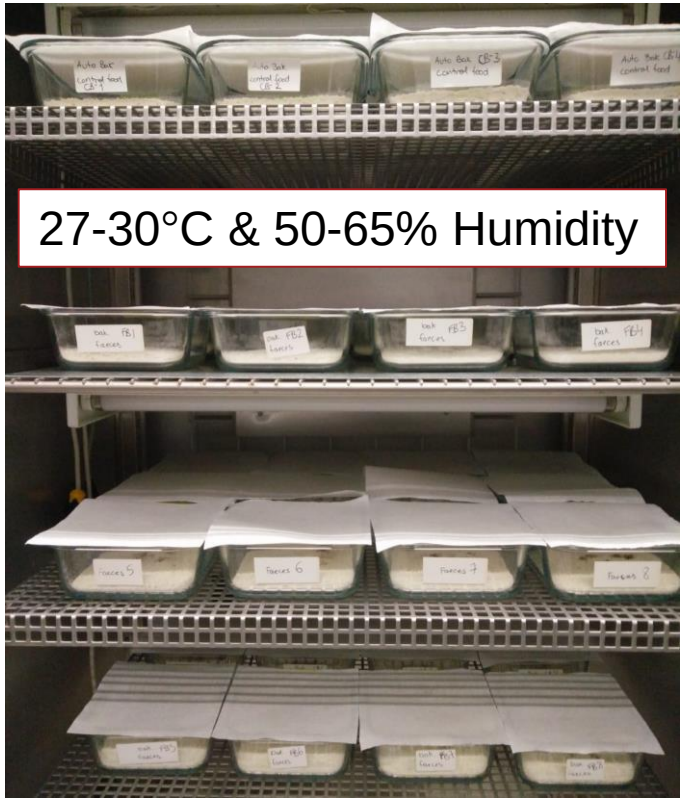
In vivo effects of *P. pentosaceus* on *T. molitor* fitness

Aim:

To test the effect of *P. pentosaceus* as a supplement on the fitness and development of *T. molitor*

Variables:

- Larval survival and weight
- Number of pupae and emerged intact adults
- Number of eggs per adult female (over 7 days)
- Adult weight
- Gut microbiome analysis (at larval harvest weight)



In vivo effects of *P. pentosaceus* on *T. molitor* fitness

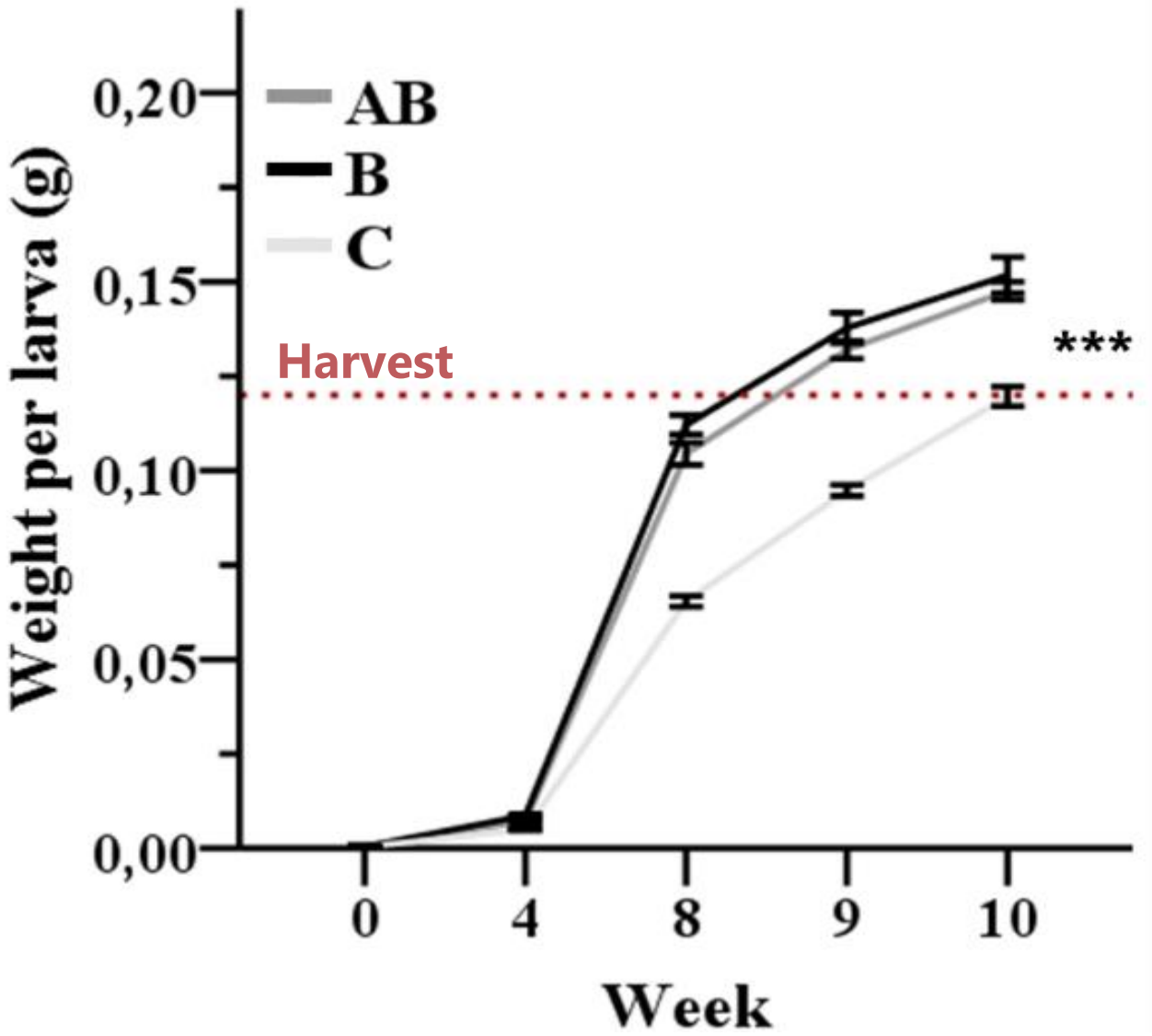
Results:

Larval weight

Bacteria

Autoclaved Bacteria

Control



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Number of intact emerged adults

Bacteria

Autoclaved Bacteria

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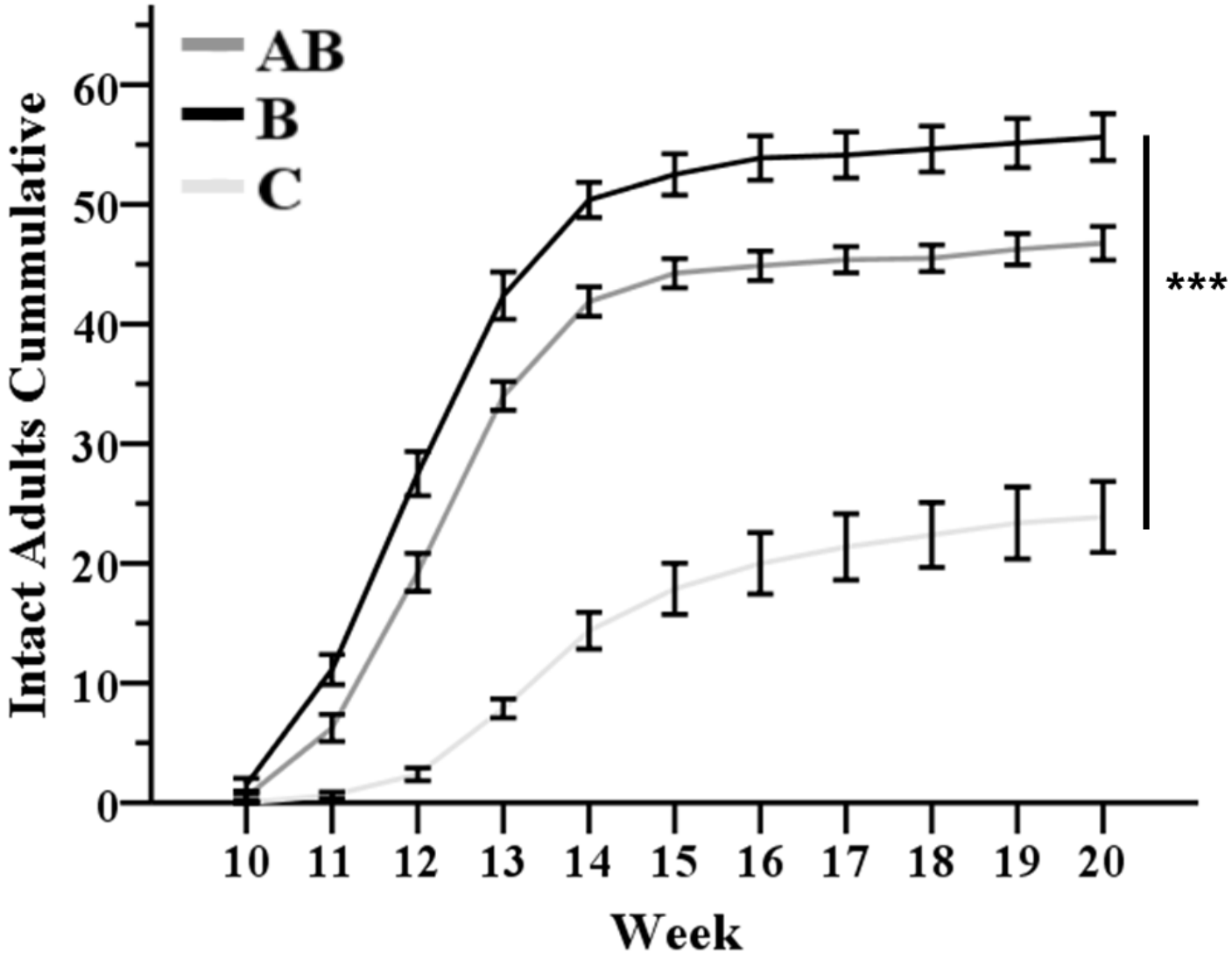


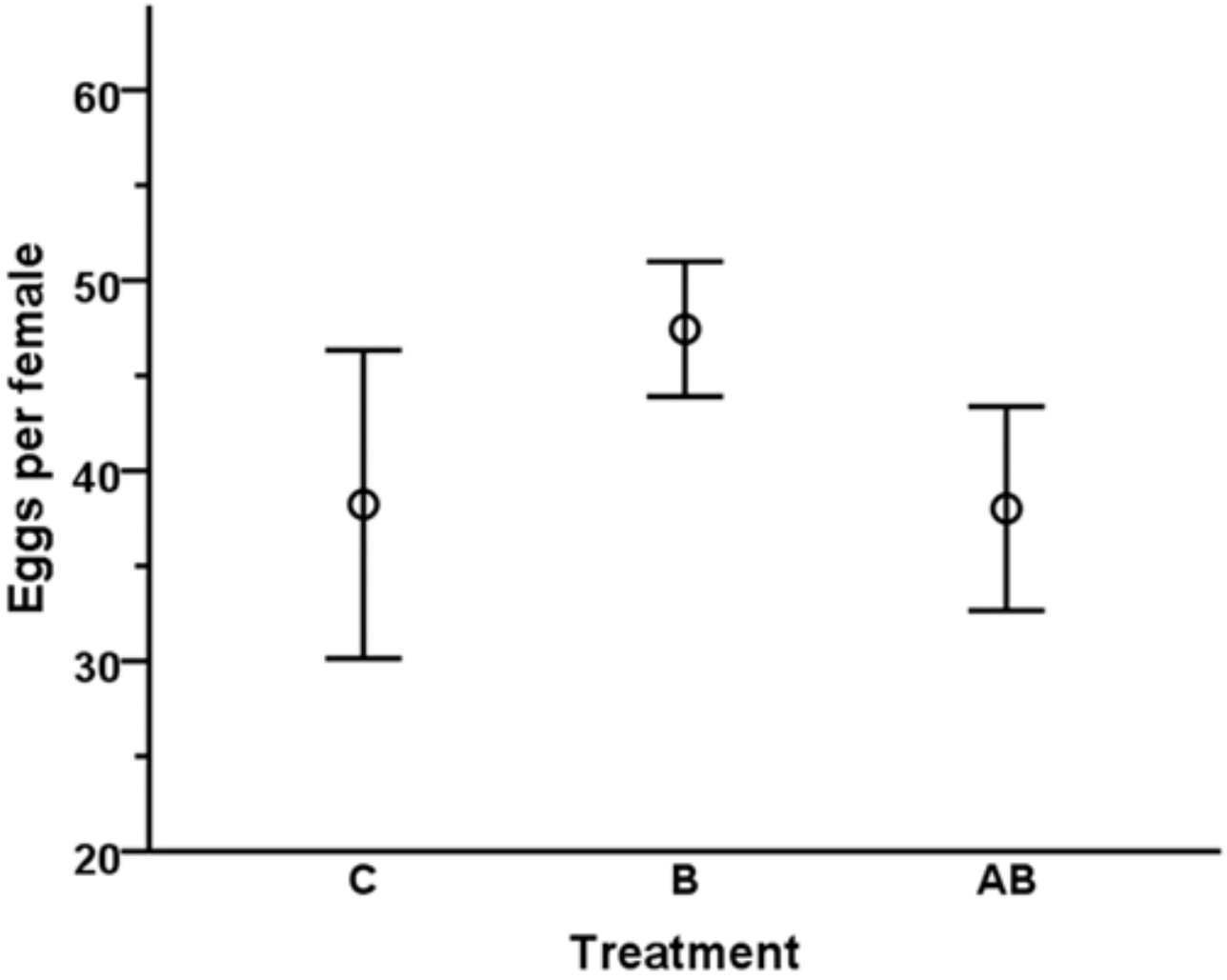
In vivo effects of *P. pentosaceus* on *T. molitor* fitness

Results:

Number of eggs per female over 7 days

No significant differences:

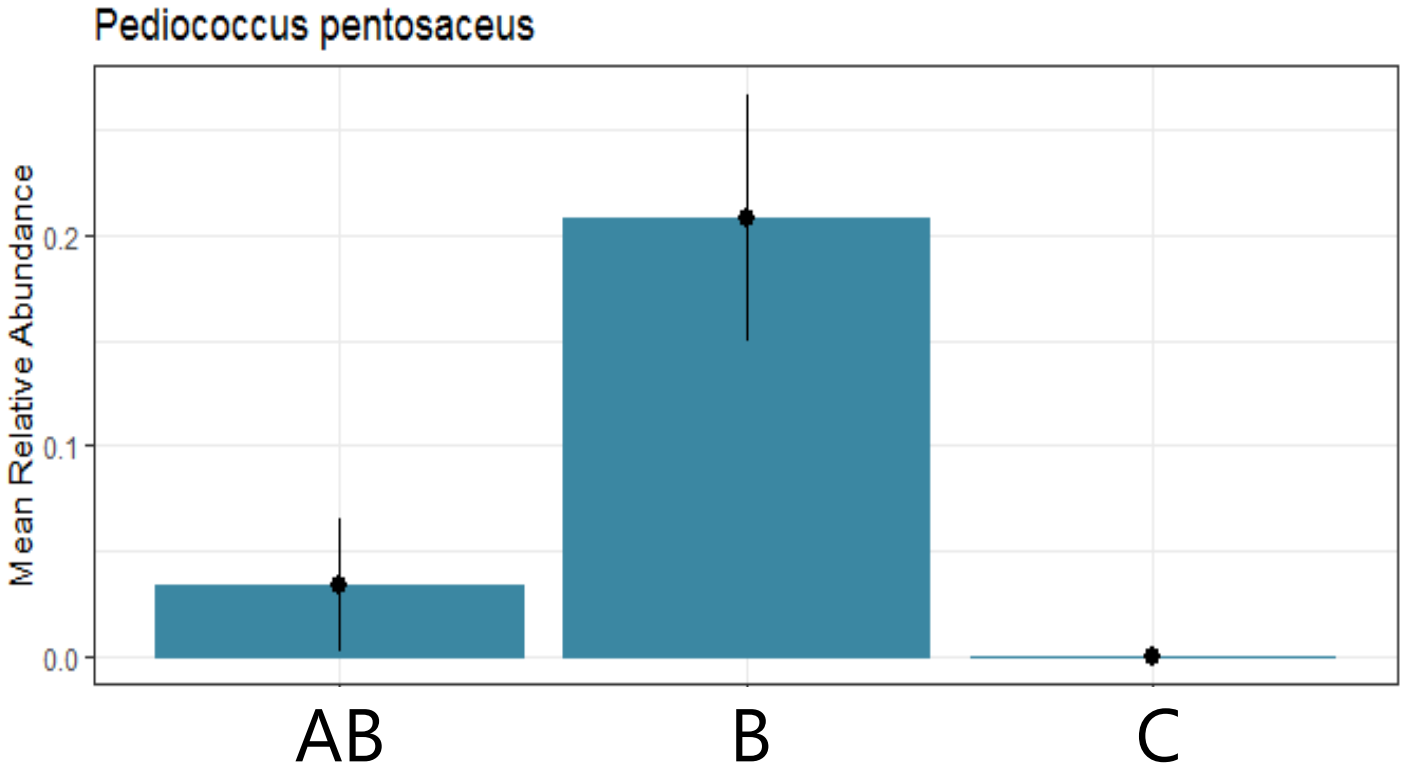
- More replicates?



In vivo effects of *P. pentosaceus* on *T. molitor* fitness

Results:

Microbiome sequencing, Relative abundance



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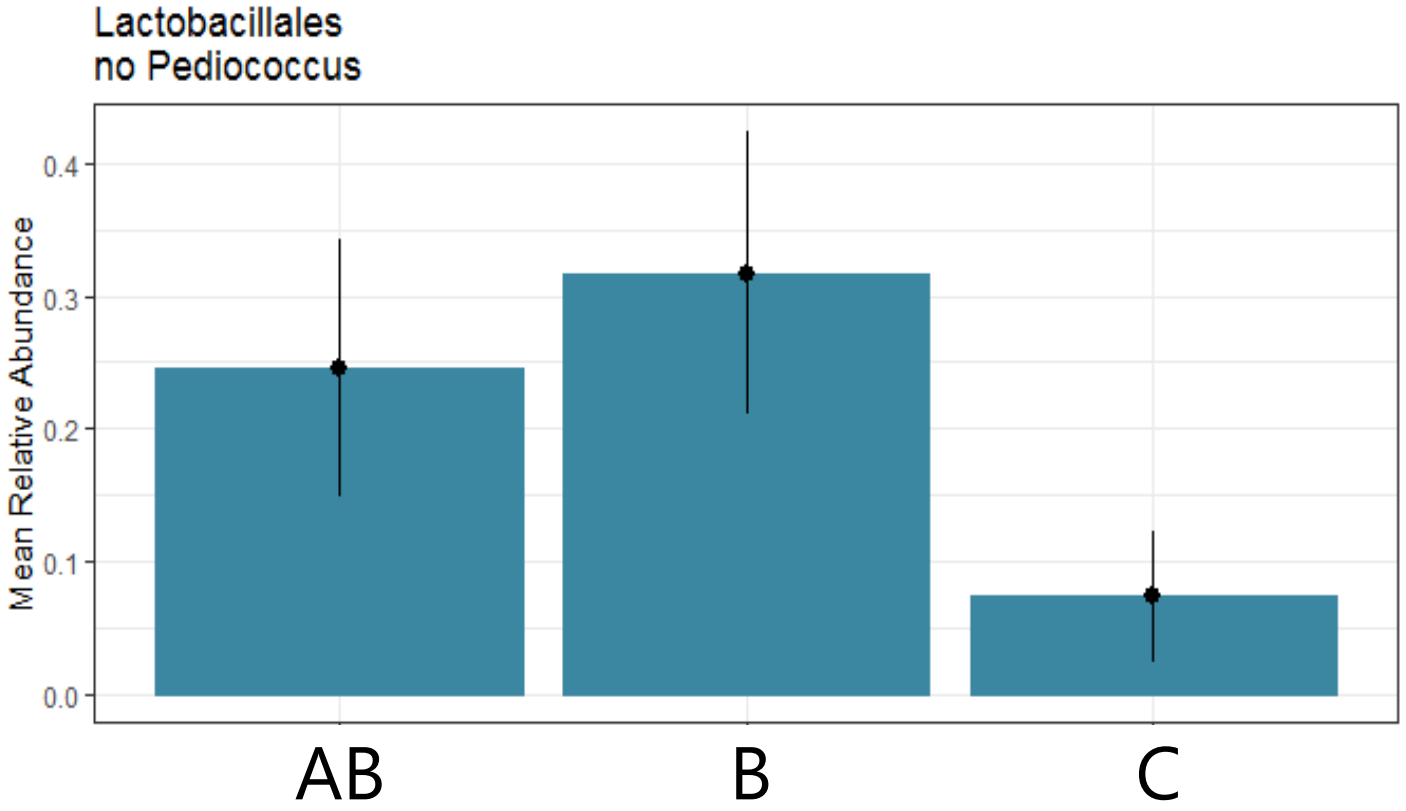
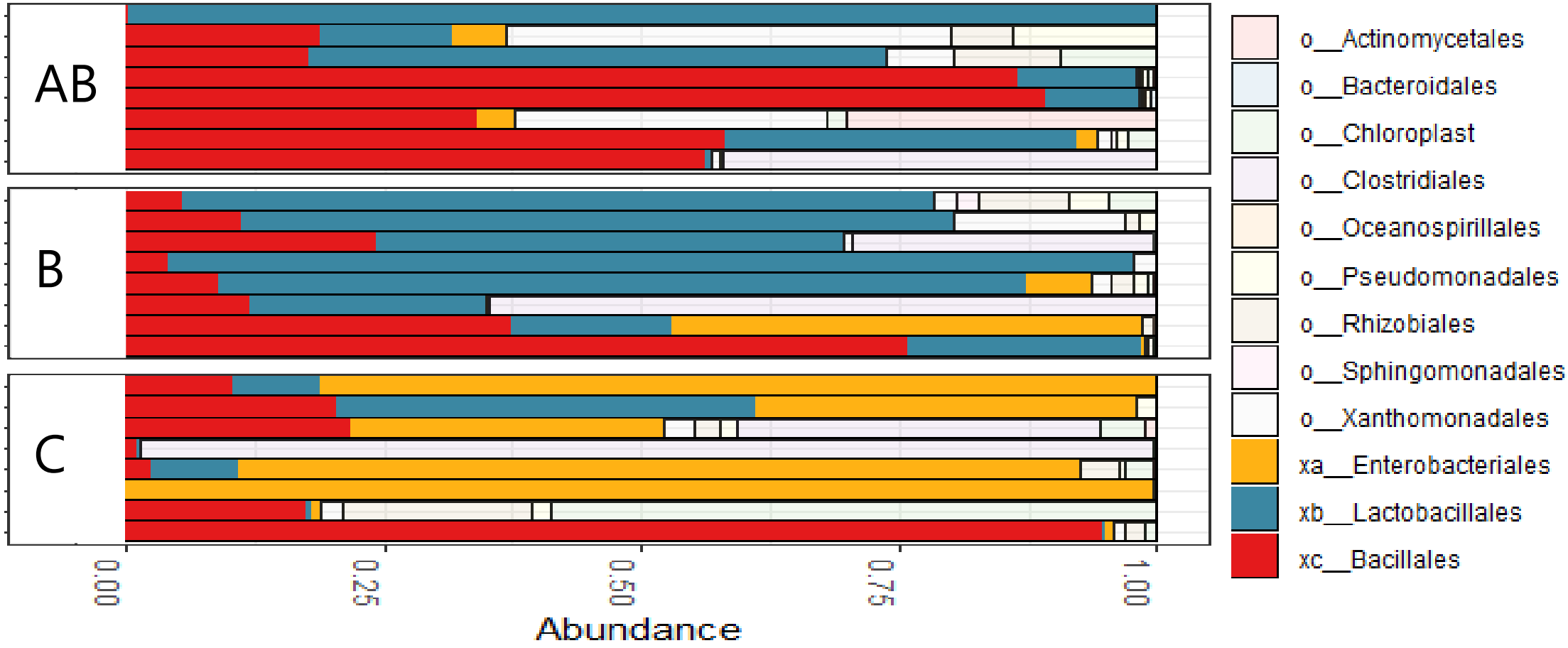


In vivo effects of *P. pentosaceus* on *T. molitor* fitness

Results:

Microbiome sequencing, Relative abundance (Order level)



Conclusions and future perspectives

- Identification of pathogens and threats ongoing

- Lactic acid bacteria showing potential as probiotic additives but:

- Further *in vivo* experiments needed to determine

  Pathogen protection
  Dosage
  Inter-generational effects
  Effects at production scale

THANK YOU

Everyone from inVALUABLE

Jørgen Eilenberg

Annette Bruun Jensen

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