Manaaki Whenua
Landcare Research

MANAAKI WHENUA – LANDCARE RESEARCH

How microbes affect interactions between plants and invertebrates

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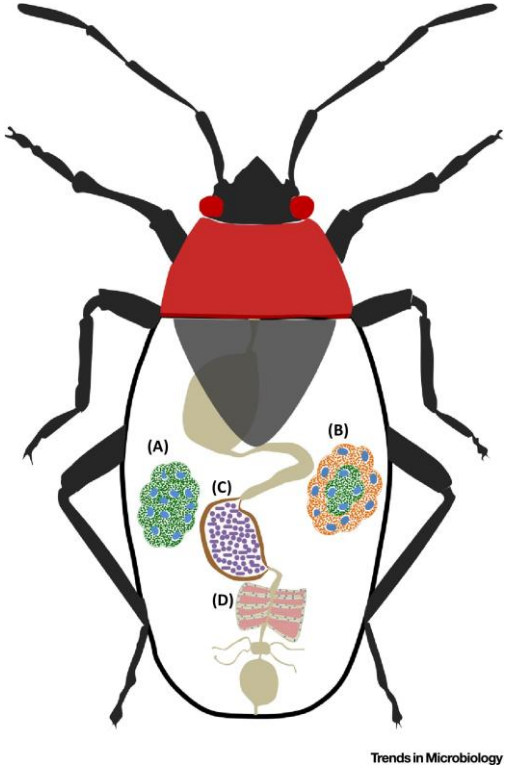
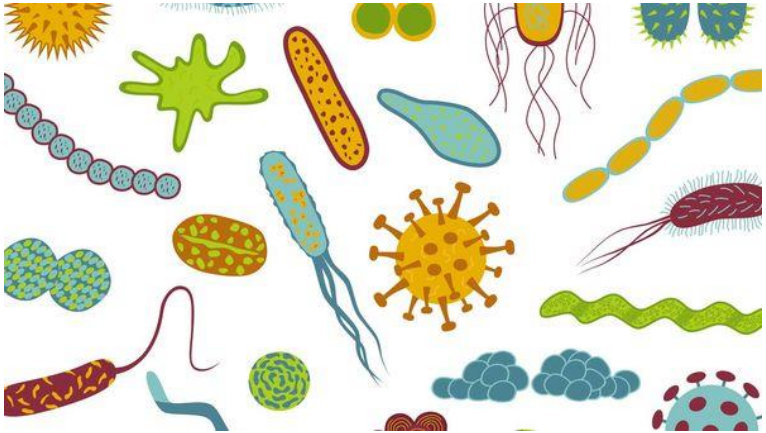
Invertebrates

- Small
- Highly mobile
- Hard to control
- Biological control agents
- Vectors for plant diseases
- Pests

Microbe-invertebrate associations





Mutualism/symbiosis: both benefit
Parasitism: harmful to the host
Commensalism: no effect on host but microbe benefits

Outline

Symbionts are essential to invertebrates

Symbionts affect plant diseases

Symbionts get replaced

Future research direction

Symbionts are essential to invertebrates

- Diet → which plants they can eat
- Fitness → which environment they can live in
- Communication → how to find food and mates

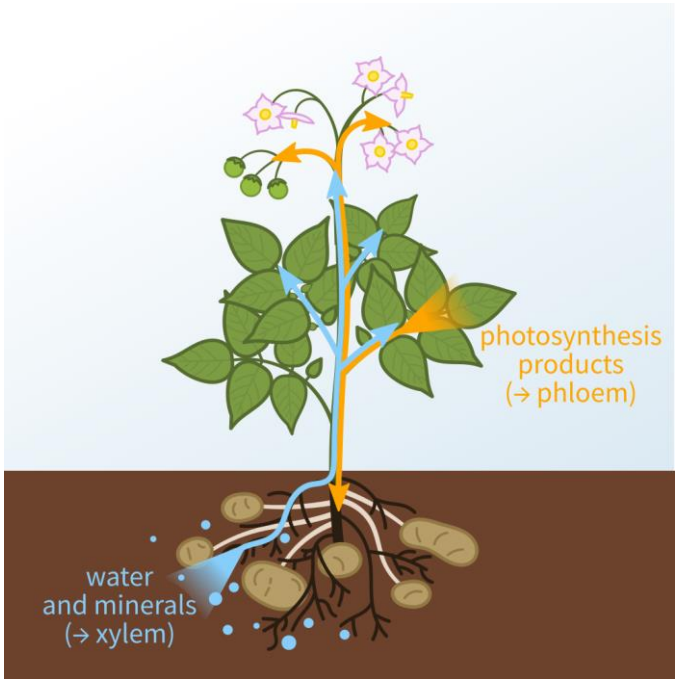
- Without symbionts → high mortality, reduced growth, sterility, slow development

(Entomologia Experimentalis et Applicata (EEA), 2019, Special Issue: *Symbionts in Insect Biology and Pest Control*)

Symbiont determines diet

- Symbiont substitutes missing nutrients for host
- Symbiont determines host range
- Adaptive evolution

Glassy-winged sharpshooter (*Homalodisca vitripennis*)



Primary symbiont: *Candidatus* Sulcia muelleri

~~Ancient secondary symbiont:~~ ~~*Candidatus* Nasuia deltocephalinicola~~

40 MYA: *Candidatus* Baumannia cicadellinicola

(Sudakaran, Kost et al. 2017; Moran, Tran et al. 2005; McCutcheon, McDonald et al. 2009)

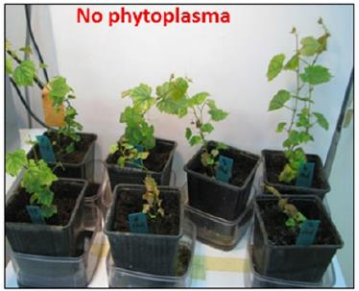
Symbionts affect plant diseases

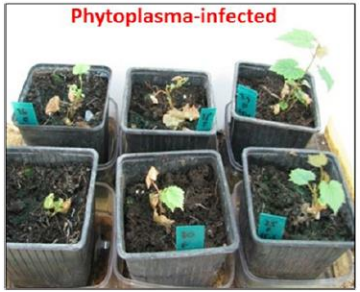
- Pathogens get moved by invertebrates from infected to uninfected plants
- Symbionts and pathogens interact (antagonistic/synergistic relationships)
- Symbionts can become pathogenic
- Symbionts affect disease spread

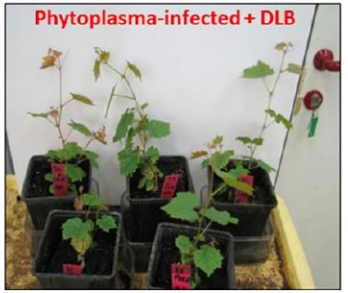
Symbiont inhibits plant pathogen

- Transmission of symbiont and pathogen
- Symbiont becomes plant endophyte and inhibits pathogen in plant

Planthopper
(*Hyalesthes obsoletus*)







Transient symbiont: *Frateuria defendens*
Plant pathogen: *Candidatus* Phytoplasma solani

(Gonella, Tedeschi et al. 2019; Iasur-Kruh, Zahavi et al. 2018)

Symbiont loss and replacement

- Symbionts have been acquired, lost and replaced many times independently during evolution
- Major driving force of ecological adaptation and evolution
- Transmission through interactions with parasitoids, parasites or predators, or via the sharing of a habitat

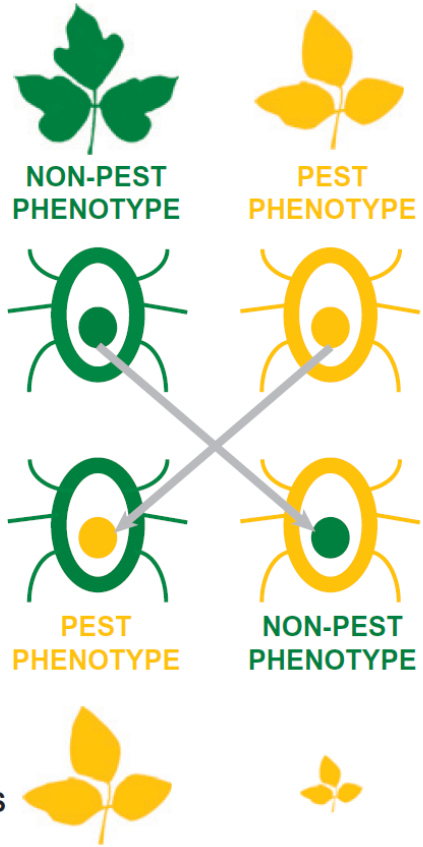
(Morrow, Hall et al. 2017; Sudakaran, Kost et al. 2017)

Symbiont replacement changes pest status

- Adaptation to nutritional resource
- Change plant specialisation / host range

(*Megacopta cribraria)*

Symbiont: C
(*Ca.* Ishikawaella capsulata)



(*Megacopta punctatissima*)

Symbiont: P
(*Ca.* Ishikawaella capsulata)

(Brown, Huynh et al. 2014; Hosokawa, Kikuchi et al. 2007)

Summary

- Symbionts play important roles in ecology and evolution → biosecurity

- To
  - Protect native environments
  - Make use of beneficial effects
  - Improve risk assessments

- We need to
  - Go beyond identification of microbes towards functional analyses

Summary

- How?
  - Combine phylogenetics, genome sequencing and population genetics
  - Analyse metabolic capabilities of host and symbionts
  - Comparative experiments on invertebrates associated with different microbes

- Future outcomes:
  - Replacing symbionts to change pest status
  - Selective inhibition of symbionts or pathogens through interrupted metabolism
  - Symbionts as biological control agents of pathogens or pests
  - Introducing symbionts to improve invertebrate biocontrol agents

Image attributions

MWLR, Bradley White

(Sudakaran, Kost et al. 2017)

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MWLR, R.E. Beever

(Gernot Kunz, https://www.hemiptera-databases.org/)

(Iasur-Kruh, Zahavi et al. 2018)

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Laura M. Boykin

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Thank you!

We are interested in further developing this research area at Manaaki Whenua and in establishing national and international connections. Please contact us if you'd like to make any suggestions or have questions:

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