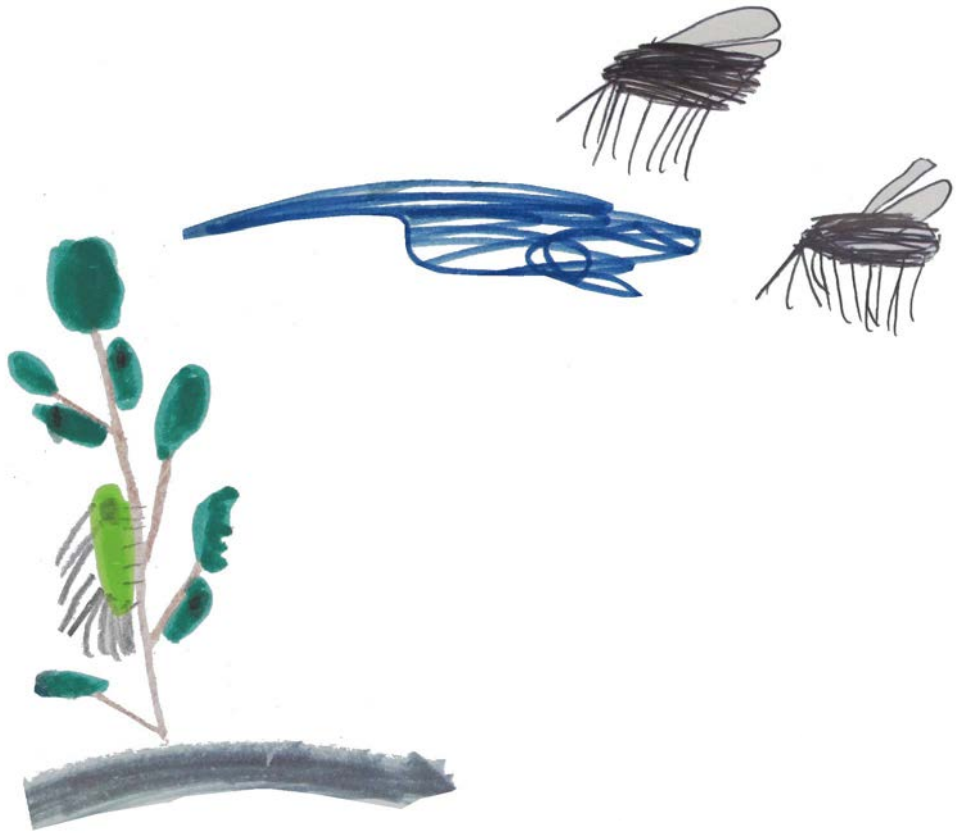
Symbionts protect aphids from parasitic wasps by attenuating herbivore-induced plant volatiles

Enric Frago
CIRAD (Agricultural Research for Development)



cirad

Animation scientifique CBGP
Avril 2019

Research career and interests

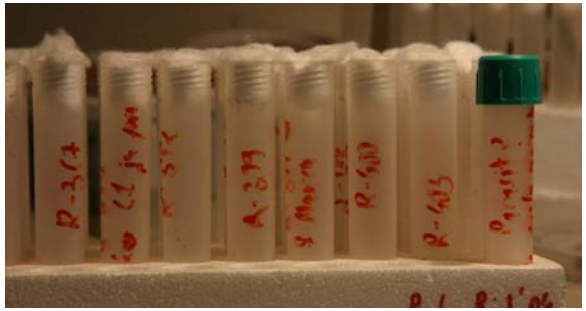
- 2004-2008: PhD, University of Valèncla (Spain) - Prof. Jesús Selfa
- 2008-2009: Research Associate, University of Valèncla (Spain)
- 2010-2012: Post-doc, University of Oxford (England) - Prof. Charles Godfray
- 2013-2015: Marie-Curie, Wageningen University (Netherlands) - Prof. Marcel Dicke
- 2016-2019: CIRAD, UMR-PVBMT, La Réunion
- 2019-??: CIRAD, UMR-CBGP, Montferrier sur Lez (France)

- **Insect community ecology**:
  plant effects and interactions with natural enemies.
- **Indirect effects**:
  apparent competition and plant-mediated interactions in insect communities.
- **Insect symbionts** and their consequences at the community level.

PhD, University of València (Spain)
with Jesús Selfa

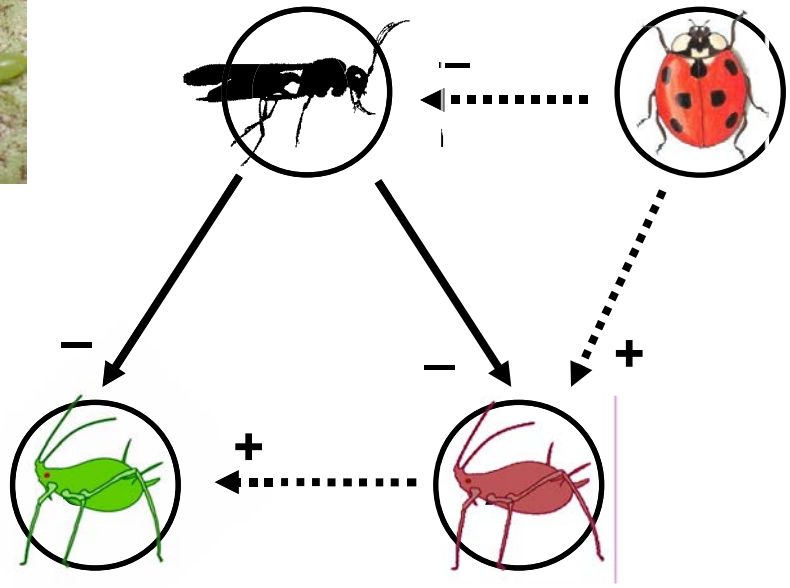
Ecology of **forest insect pests***:*

Interactions with their host plants and natural enemies



Postdoc at Oxford University (England)
with H. Charles J. Godfray

- Community ecology of aphids and their natural enemies: **long-term** dynamics
- Predator-mediated **indirect effects** in aphid communities



Marie Curie fellowship at Wageningen University (Netherlands) with Marcel Dicke

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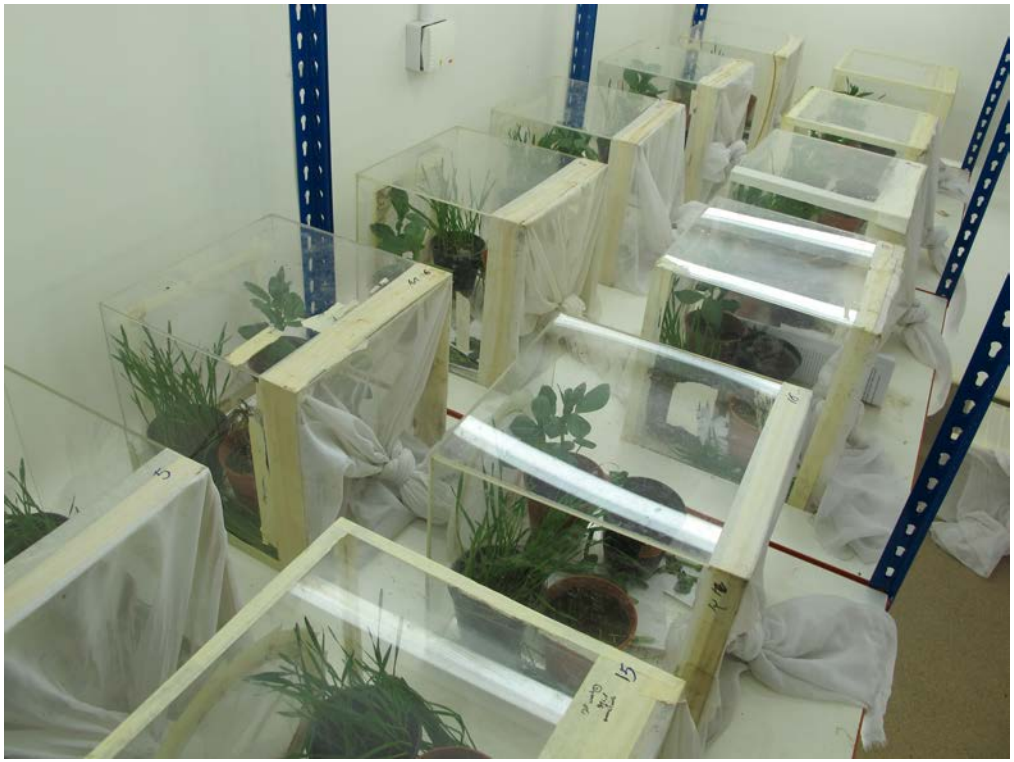
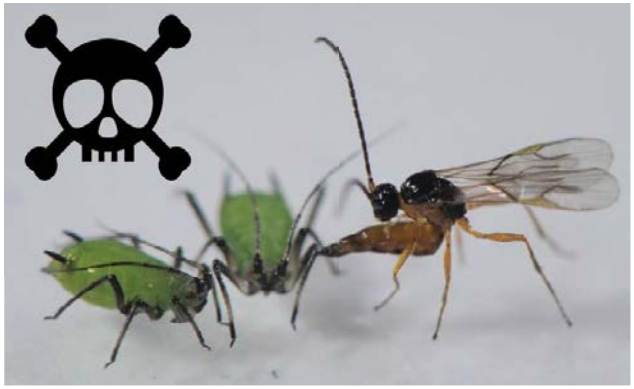
MARIE CURIE ACTIONS

- Symbionts **manipulate plant volatiles**
- Defensive symbionts affect aphid **community dynamics and stability**



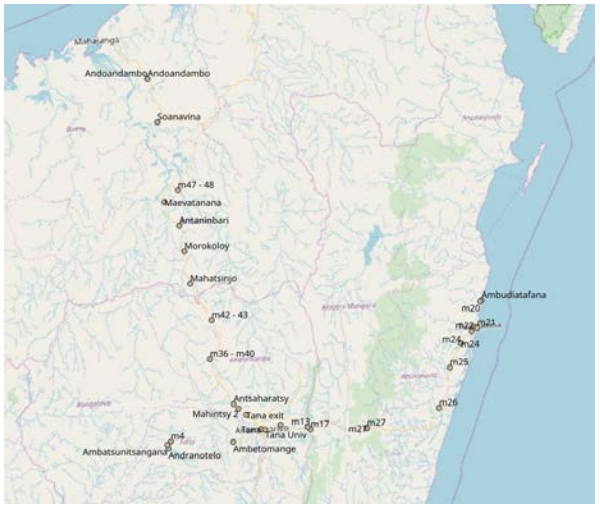


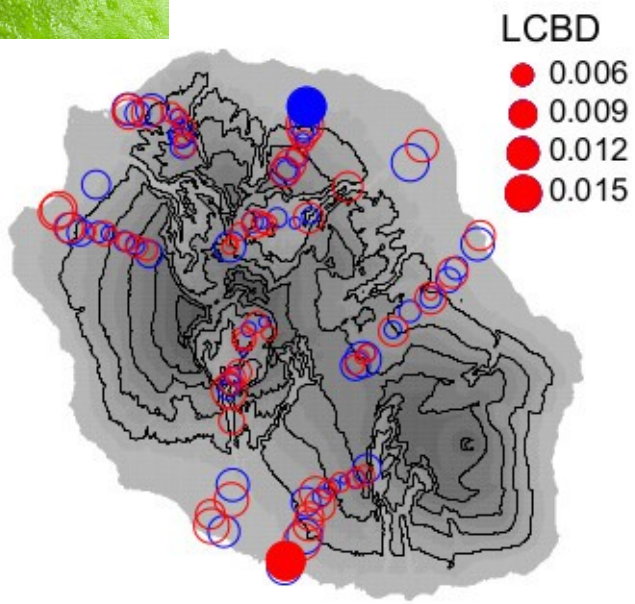
CIRAD Researcher in Réunion Island

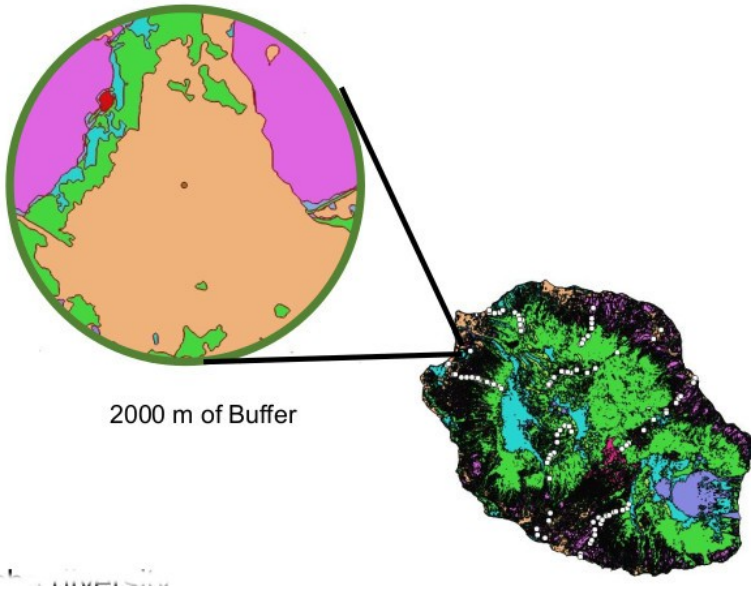
- Thrips diversity along **environmental gradients**

  Thrips as a model system to study

  diversity patterns







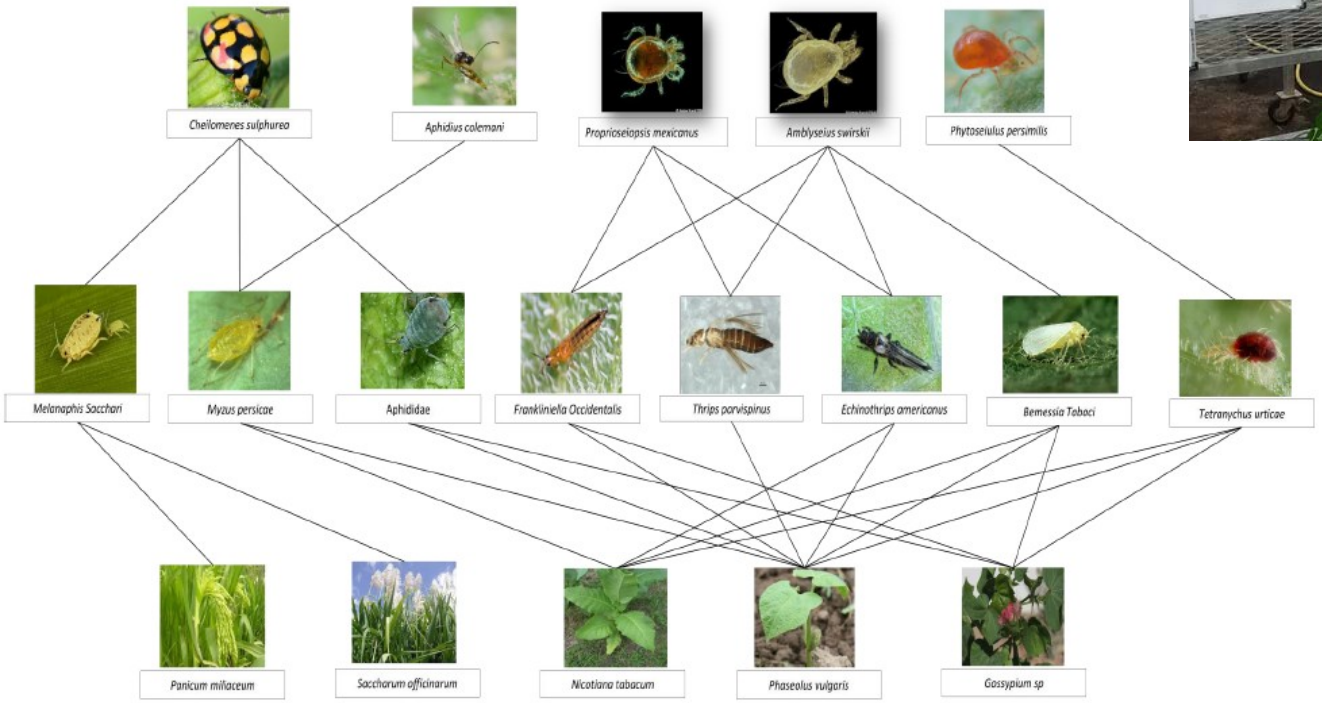
CIRAD Researcher in Réunion Island

- Thrips diversity along **environmental gradients**
- **Biocontrol** in greenhouses

CIRAD Researcher in Réunion Island

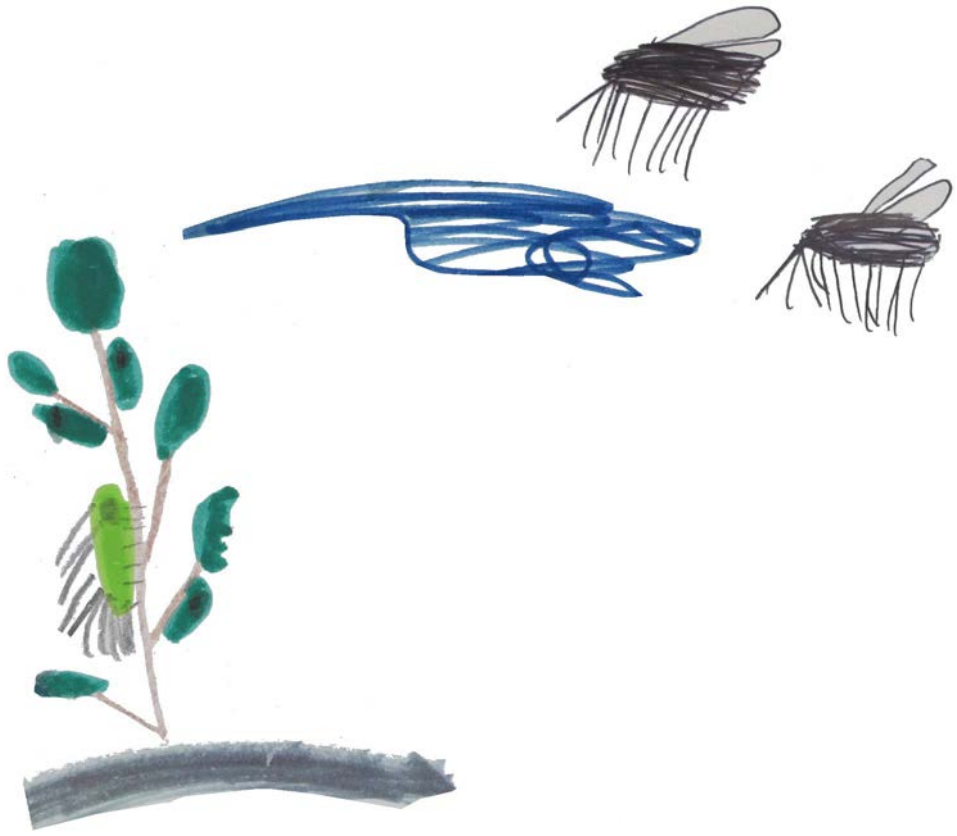
- Thrips diversity along **environmental gradients**
- **Biocontrol** in greenhouses
- **Experimental community ecology:**

dynamics and stability of arthropod communities



Symbionts protect aphids from parasitic wasps by attenuating herbivore-induced plant volatiles

Enric Frago
CIRAD (Agricultural Research for Development)



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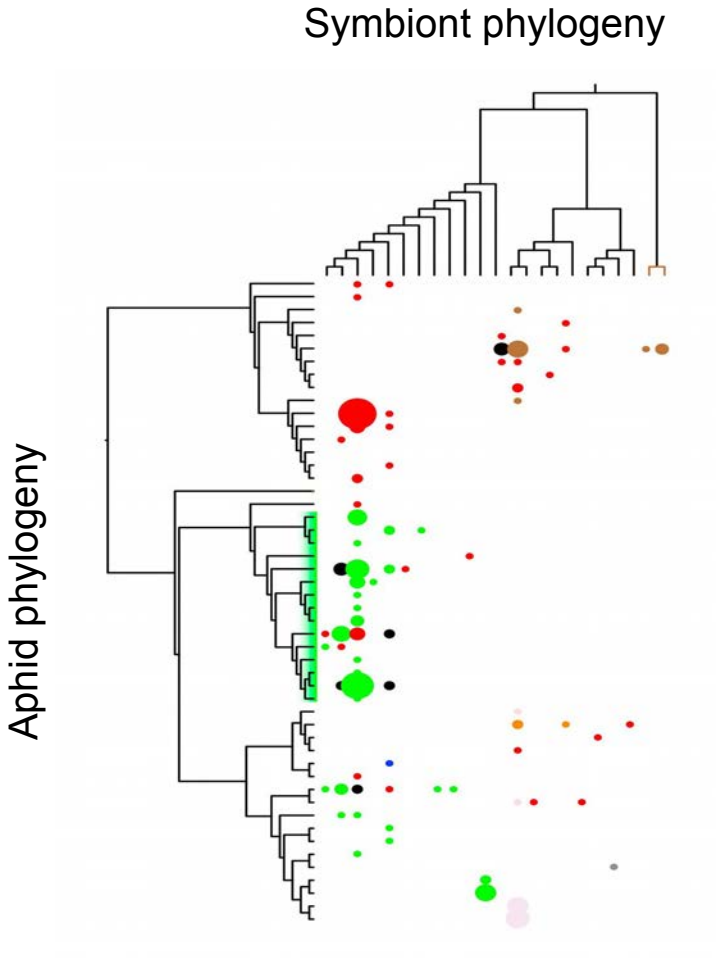
Insect symbionts

> Symbionts are present in all multicellular eukaryotes

> In insects include bacteria, fungi and protozoans, and have evolved independently in many taxa

> Source of phenotypic innovation

--> Diversification of herbivores



Janson et al (2007) *Evolution*
Henry et al (2013) *Curr Biol*

The pea aphid example

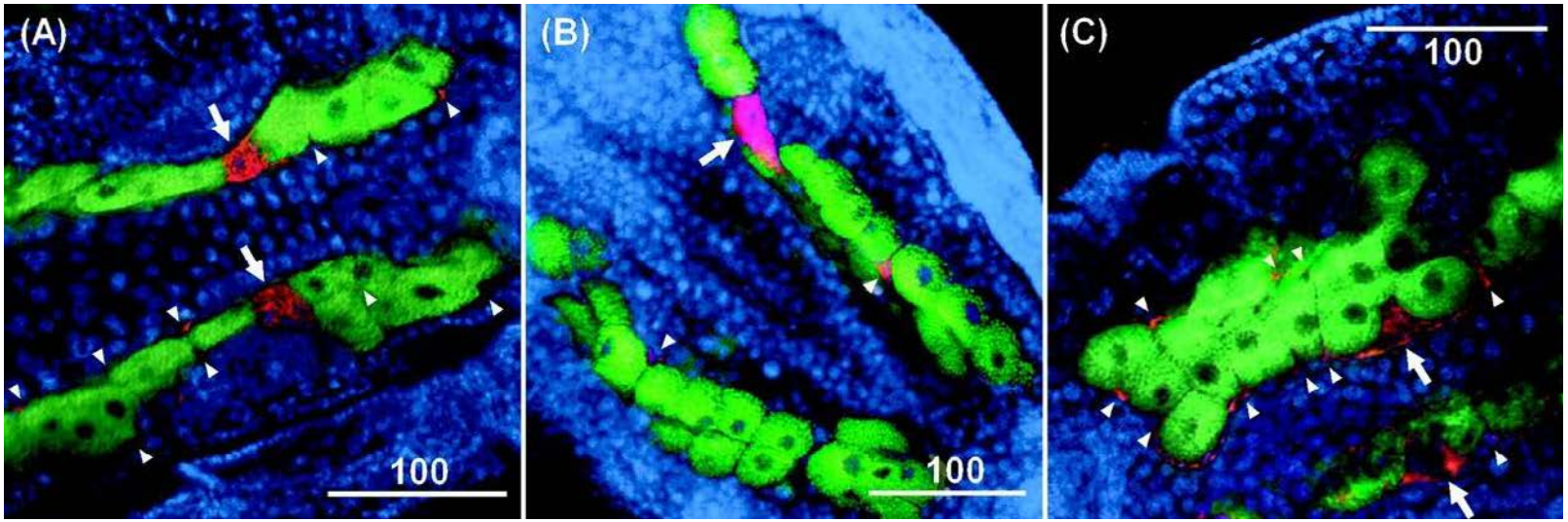
> Obligate symbiont *Buchnera aphidicola*

> Seven facultative symbionts:

Protection from pathogens: *Regiella insecticola*

Protection from heat shocks: *Serratia symbiotica*

Protection from parasitoids: *Hamiltonella defensa*

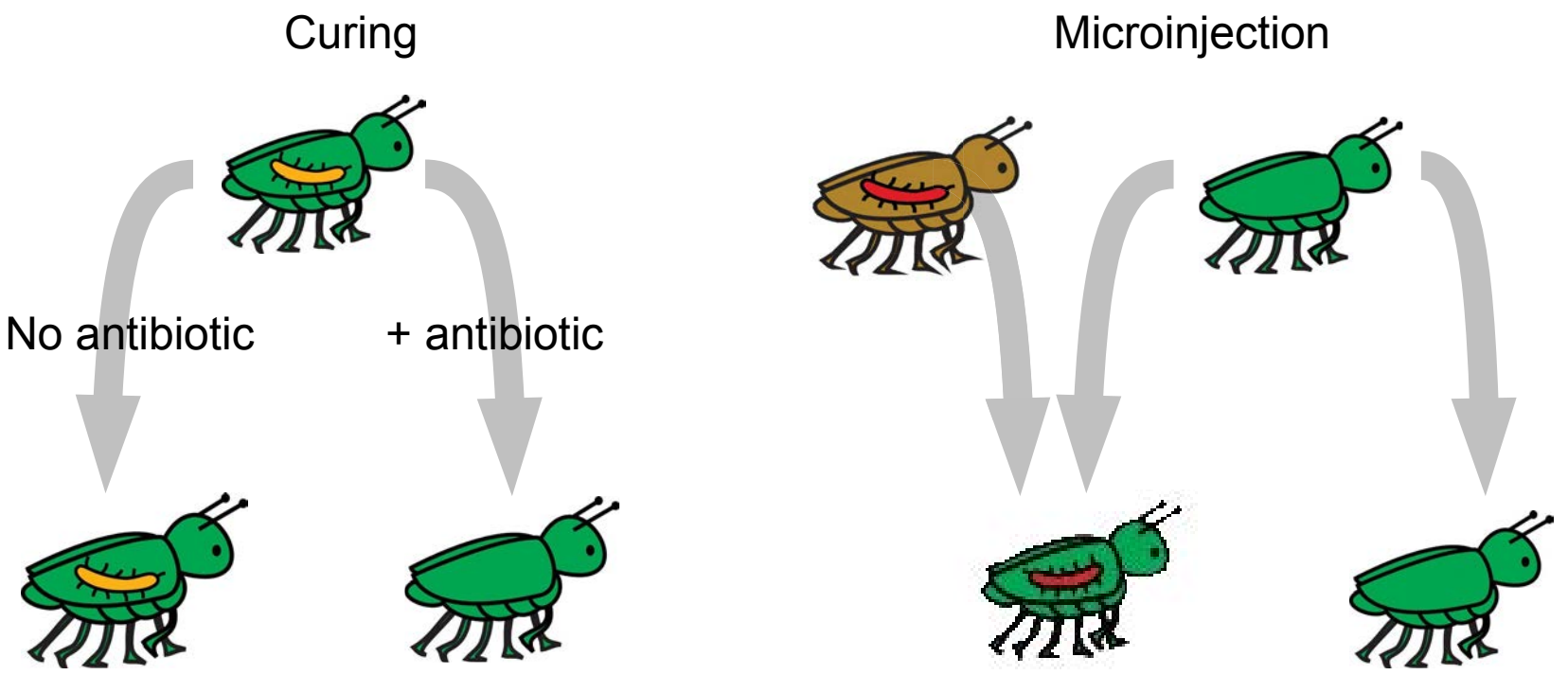


Zytynska & Weisser (2015) *Ecol. Ent.*

The pea aphid example

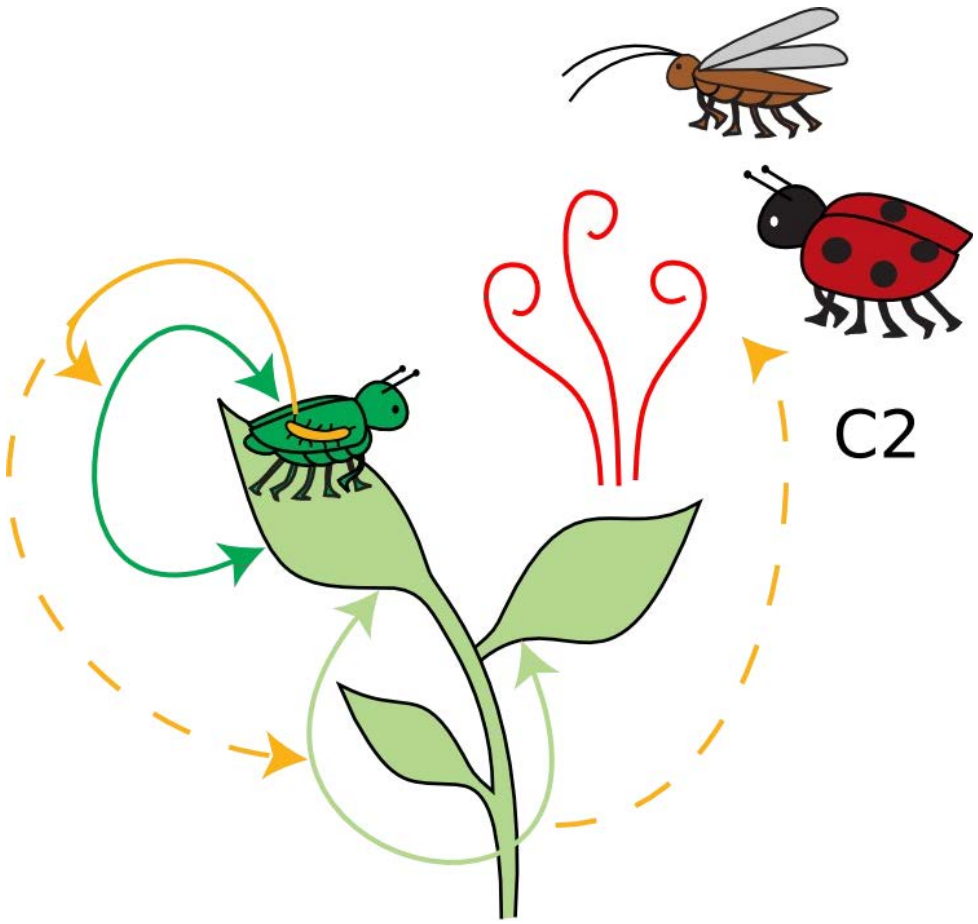
> Clonal lines in the lab (asexual reproduction)

> Aphids can be "cured" from facultative symbionts with antibiotics
or "infected" with new symbionts through microinjection



Oliver et al. (2010) *Ann. Rev. Ent*

Indirect plant defences, or "plants calling bodyguards"

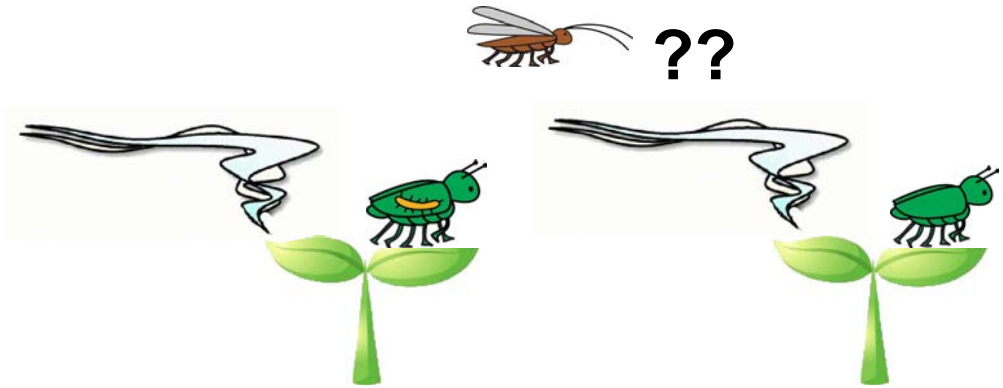


Can symbiont protection extend to bodyguard recruitment?

Frago, Dicke and Godfray (2012) *TREE*

Symbiont effects on indirect plant defences

1. Does the symbiont *Hamiltonella defensa* reduce wasp attraction to plants?
2. Is this response systemic?
3. Is the response mediated by plant volatiles?
4. Is this response beneficial for the aphid?
5. Do other symbionts act likewise?



Symbiont effects on indirect plant defences

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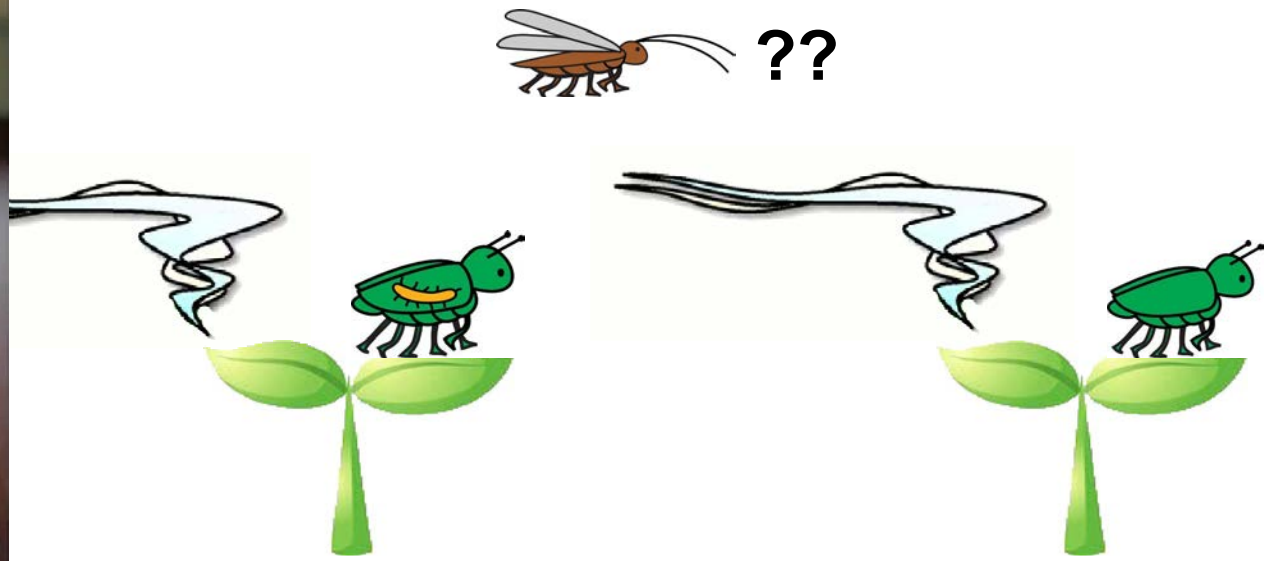

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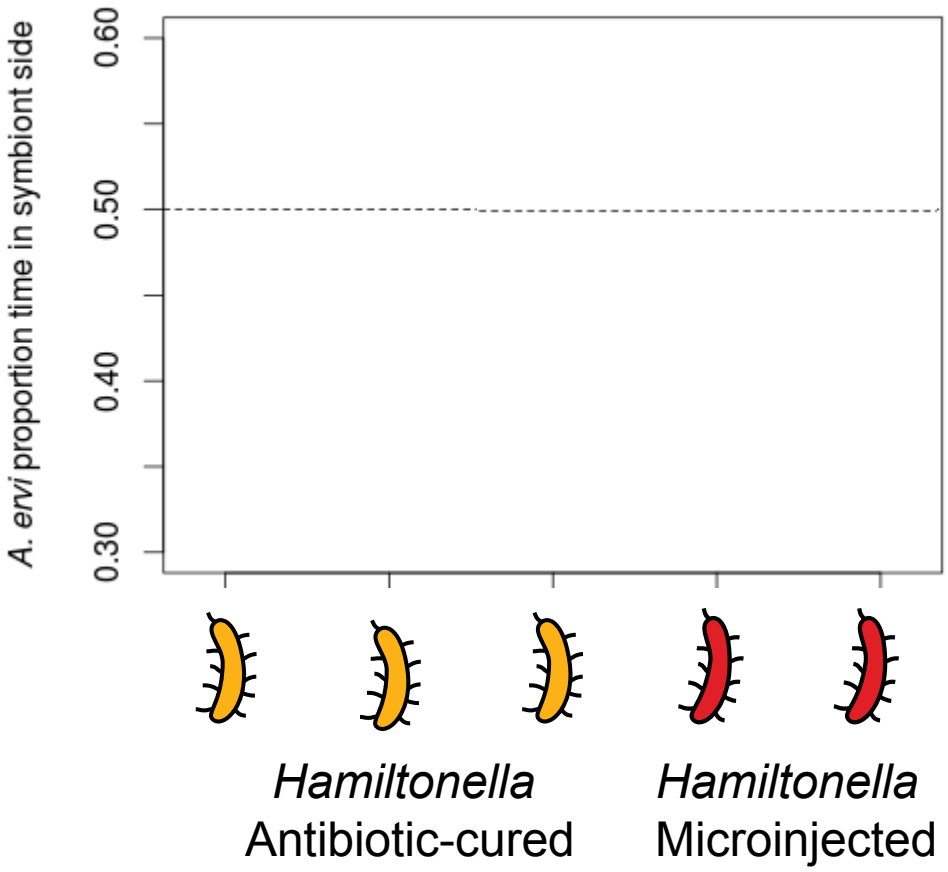

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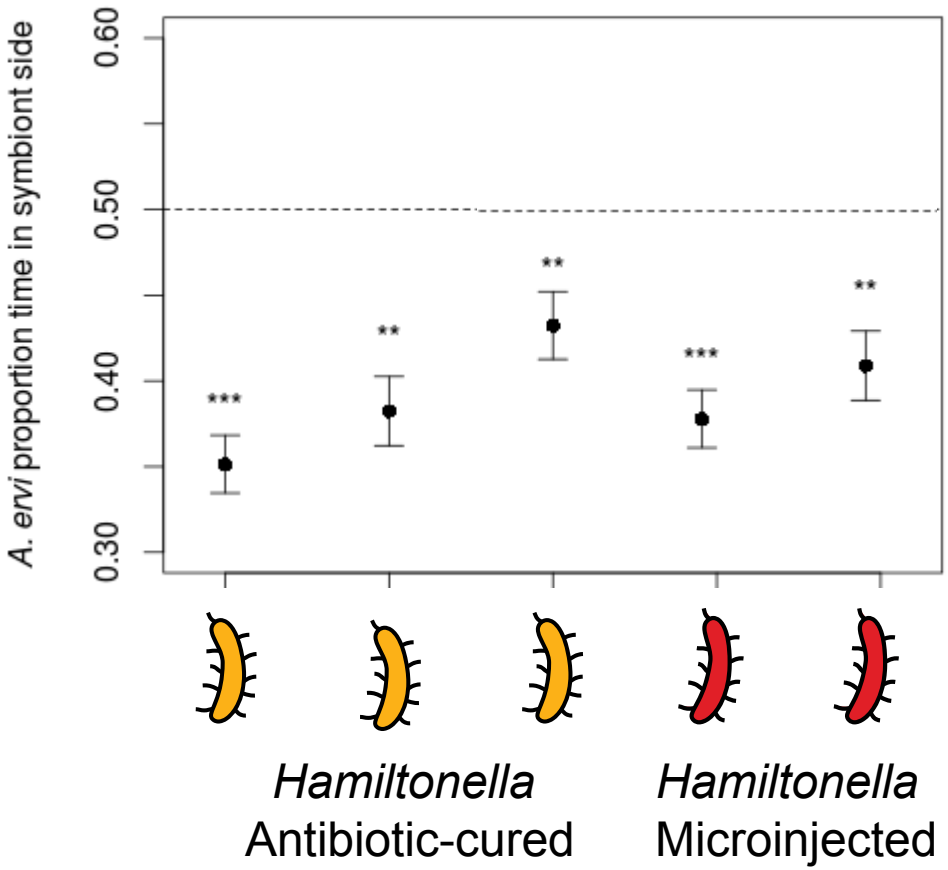

Symbiont effects on indirect plant defences

2. Is the response systemic?

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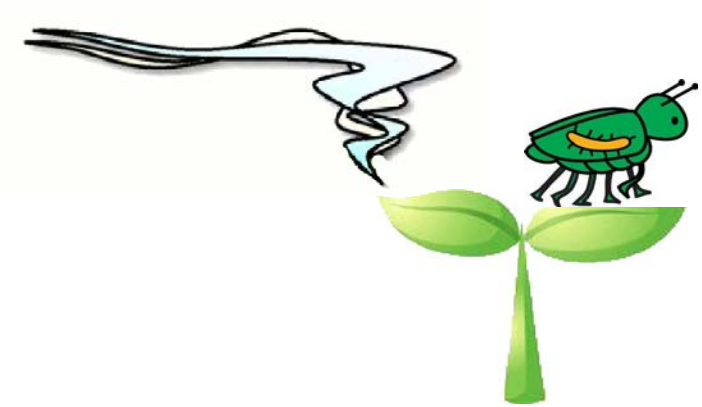

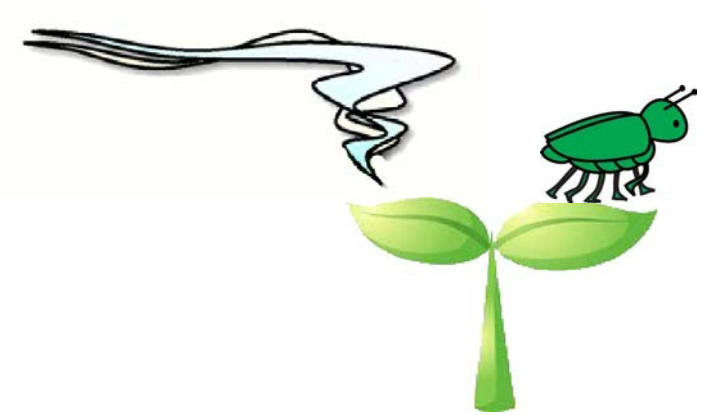

Symbiont effects on indirect plant defences

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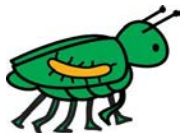

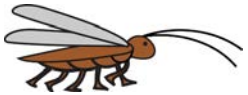

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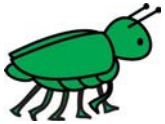
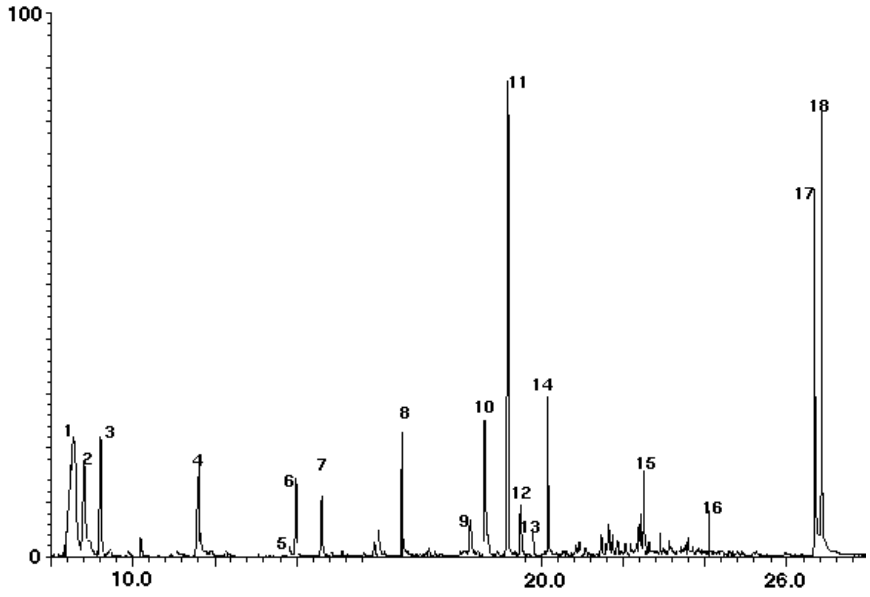


Symbiont effects on indirect plant defences

3. Is the response mediated by plant volatiles?



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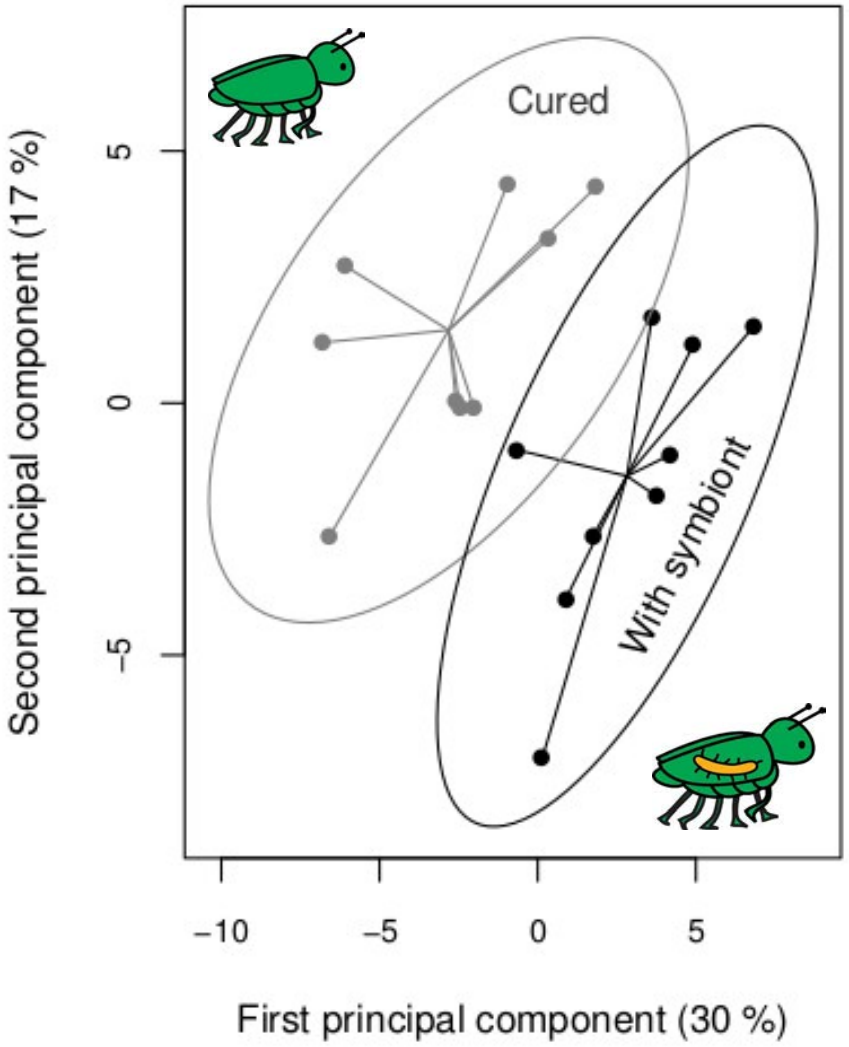
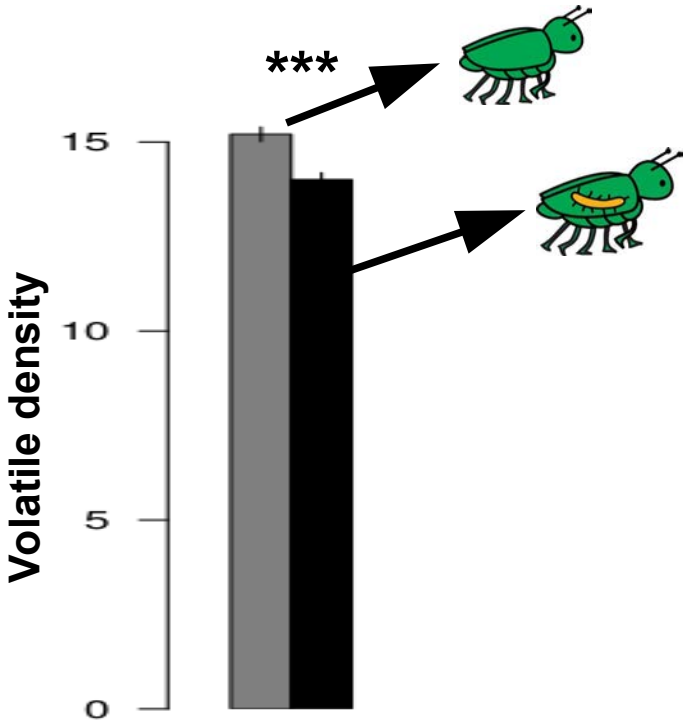


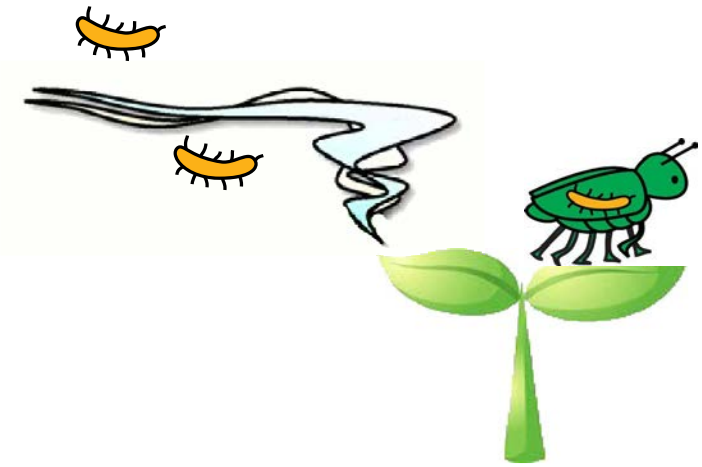
--> Change in composition

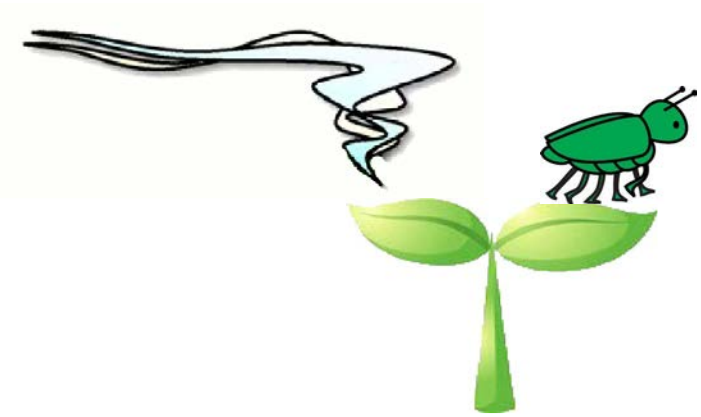
--> Overall reduction of volatiles



Symbiont effects on indirect plant defences

4. Is this response beneficial for the aphid?





Symbiont effects on indirect plant defences

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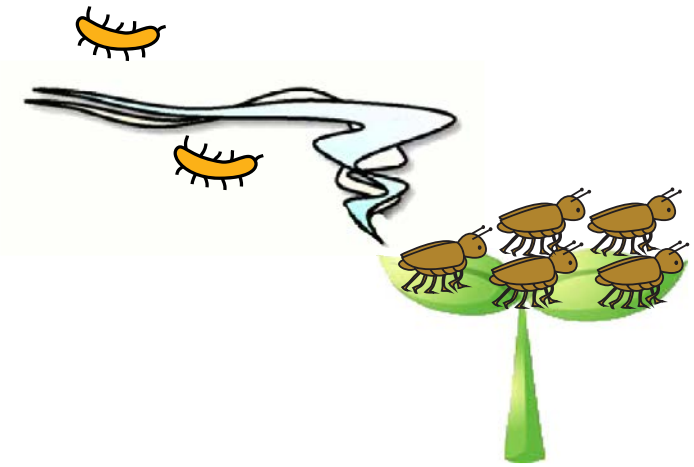

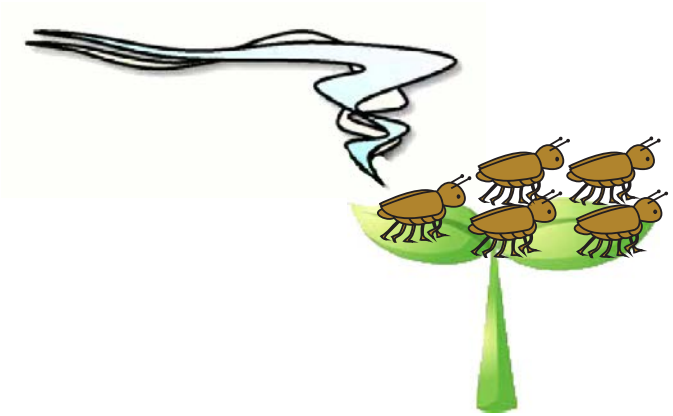

Symbiont effects on indirect plant defences

4. Is this response beneficial for the aphid?

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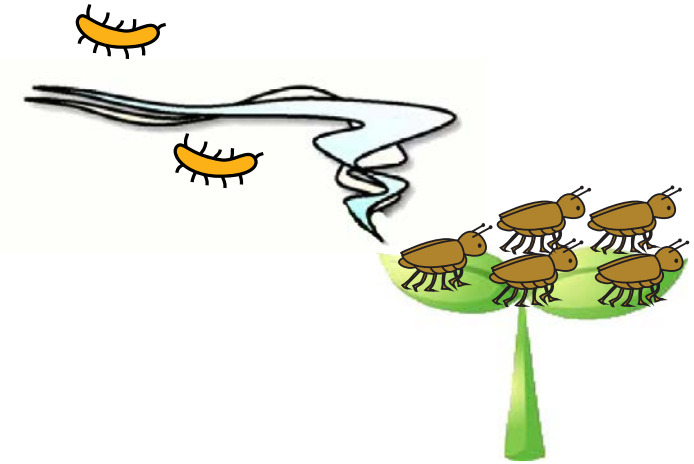

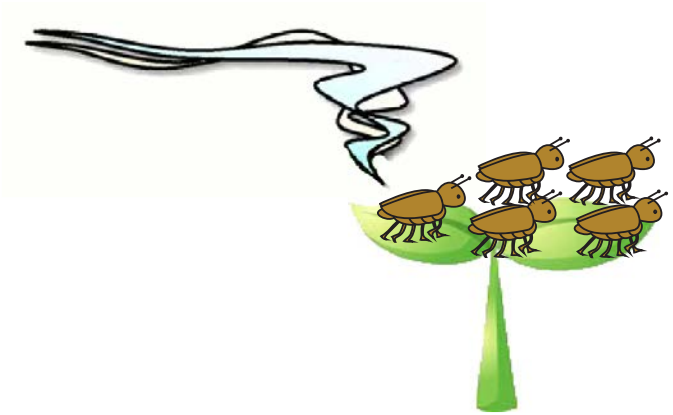

Symbiont effects on indirect plant defences

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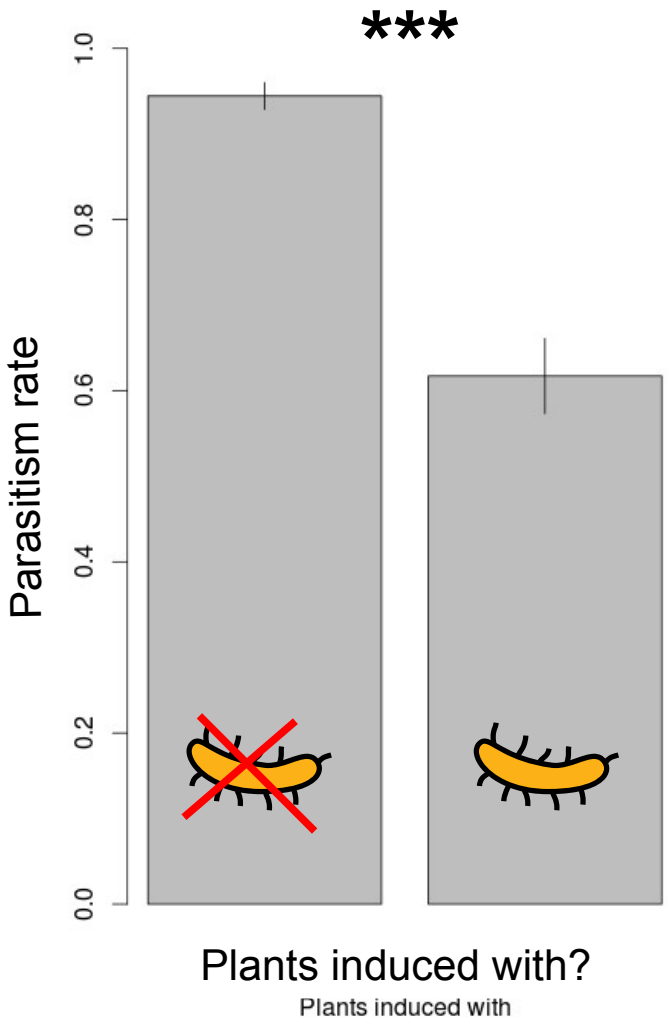
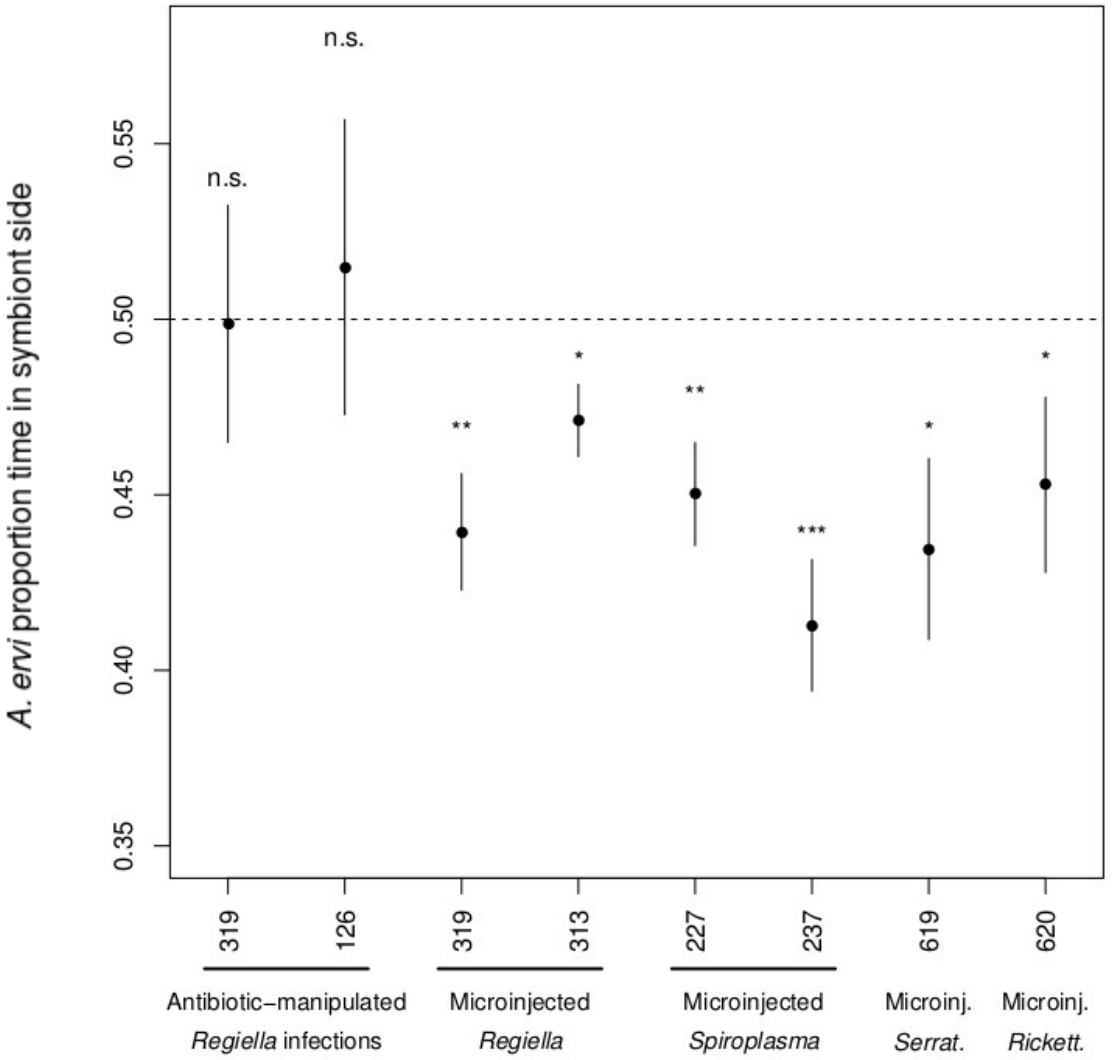


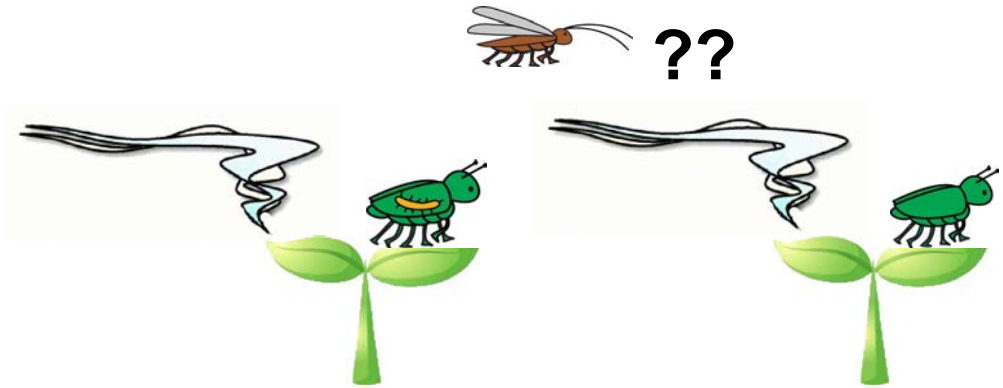
Symbiont effects on indirect plant defences

5. Do other symbionts act likewise?



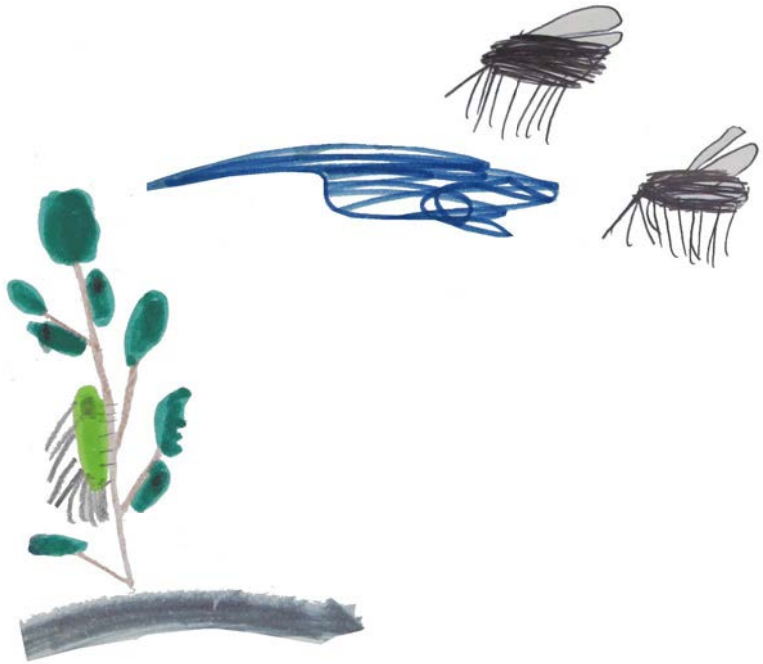
Symbiont effects on indirect plant defences

1. Does the symbiont *Hamiltonella defensa* reduce wasp attraction to plants? **Yes!**
2. Is this response systemic? **Yes!**
3. Is the response mediated by plant volatiles? **Yes!**
4. Is this response beneficial for the aphid? **Yes!**
5. Do other symbionts act likewise? **Sometimes...**



People involved:

Wageningen (NL) and Oxford (UK):
Mukta Mala, Chengiao Yang,
Berhane Weldegergis,
Marcel Dicke, Rieta Gols
Ailsa Mc Lean, H Charles J Godfray



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MARIE CURIE ACTIONS

More information:

E. Frago, M. Mala, B.T. Weldegergis, C. Yang, A. McLean, H.C.J. Godfray, R. Gols, M. Dicke **(2017)** Symbionts protect aphids from parasitic wasps by attenuating herbivore-induced plant volatiles. **Nature Communications**.

E. Frago, M. Dicke & H.C.J. Godfray **(2012)** Insect symbionts as hidden players in insect-plant interactions.
Trends in Ecology & Evolution.

Twitter @EnricFrago