L'effet indirect d'un ennemi naturel sur le changement de plante hôte d'un herbivore ravageur

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EMBA – Ecological Management of Bioagressors in Agroecosystems
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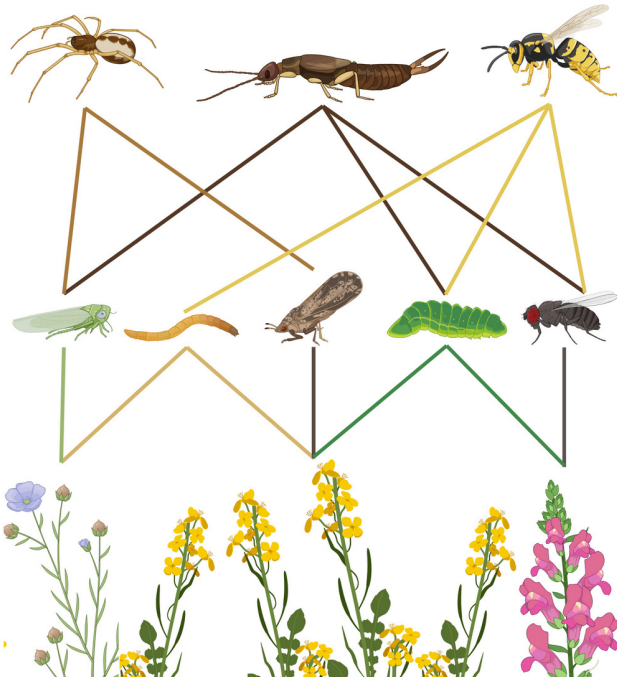
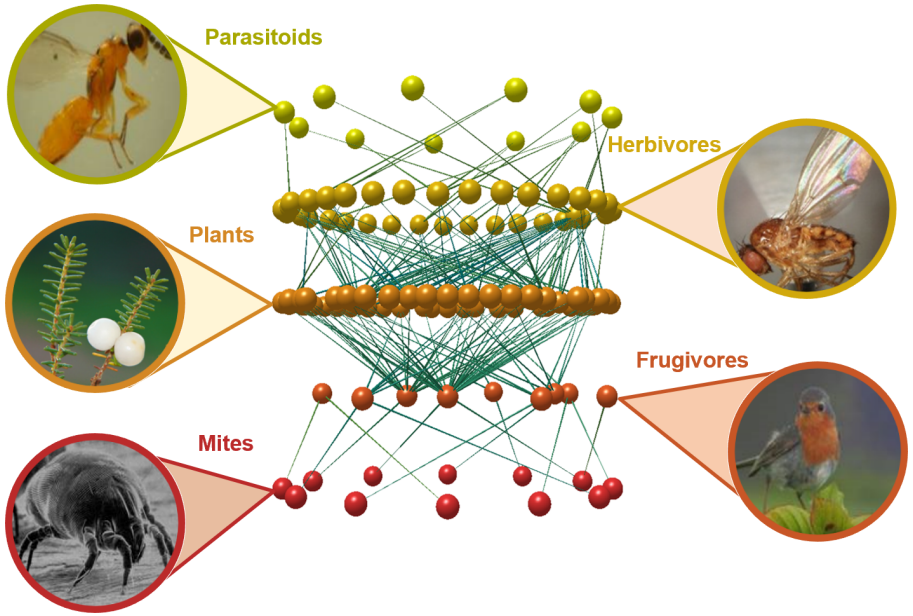
Complex interactions in agricultural ecosystems

Experimental community ecology:
- Important to gain mechanistic insights.
- How can we perform experiments in such complex system?

Indirect effect: interaction between two species **mediated by a third one**





Cuff et al 2022 – Heleno et al 2020

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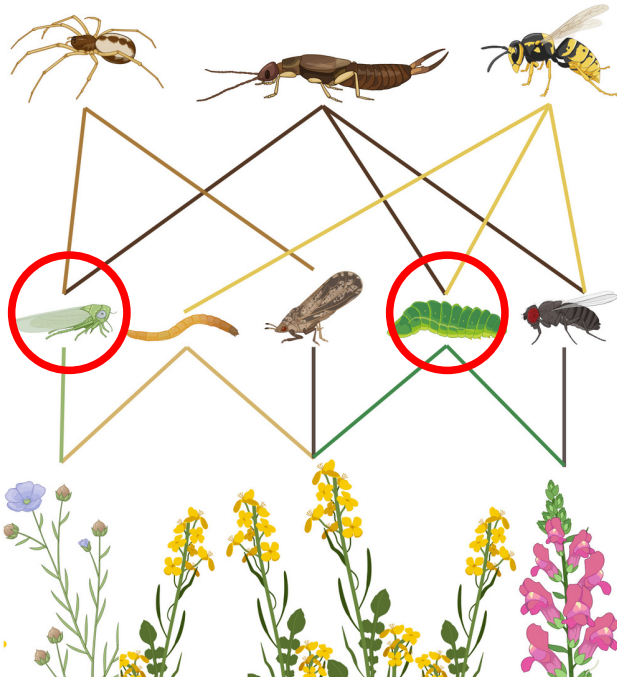
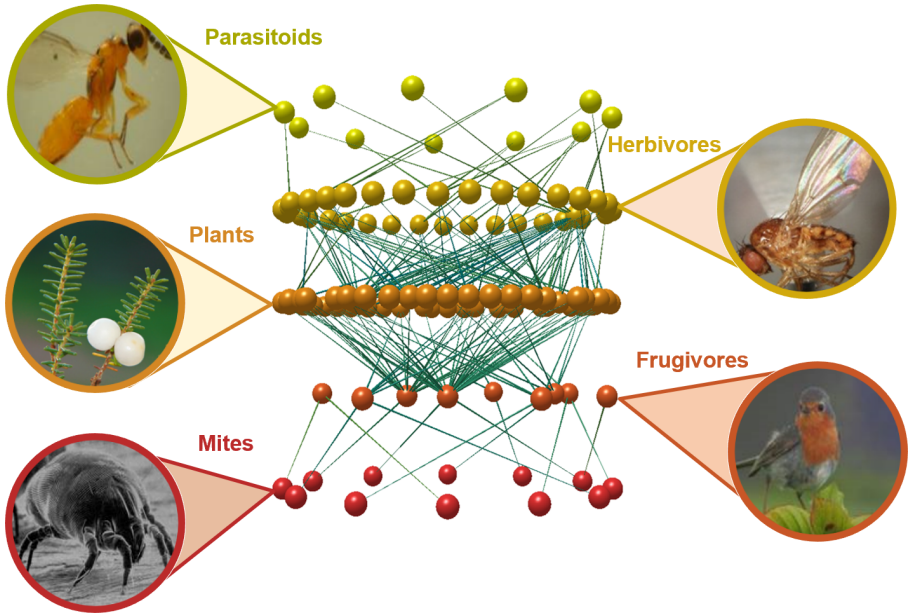


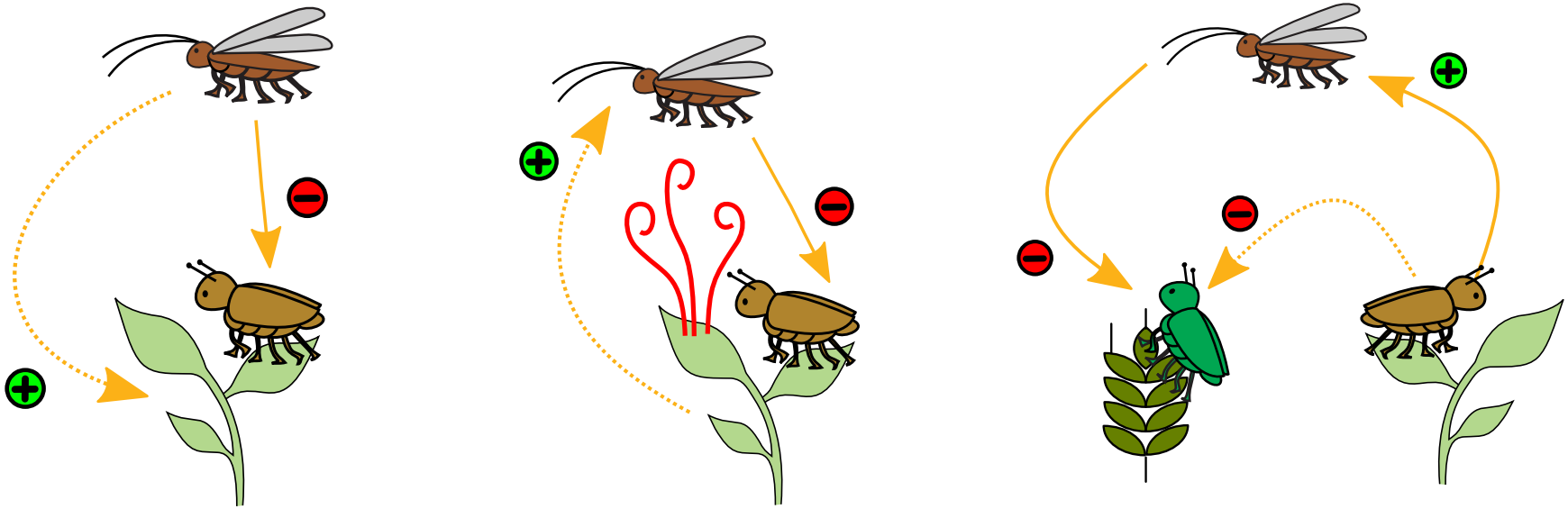


Cuff et al 2022 – Heleno et al 2020

The role of natural enemies in indirect interactions

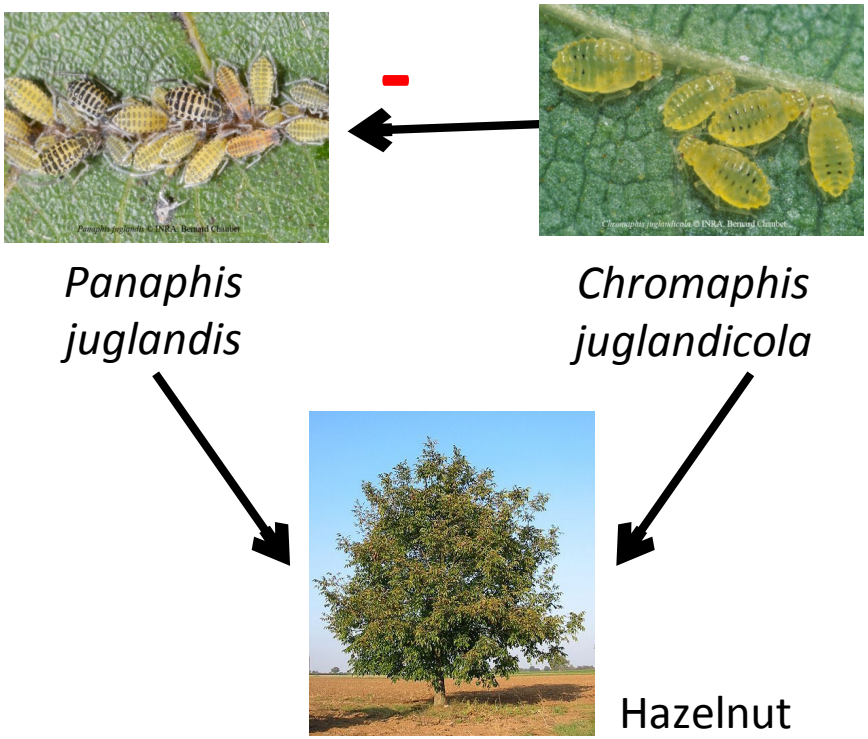
Relevant for pest control

- Trophic cascade
- Plant volatiles
- Apparent competition



The role of natural enemies in indirect interactions

Enemies modulate herbivore competition, coexistence and competitive displacement



The role of natural enemies in indirect interactions

Enemies modulate herbivore competition, coexistence and competitive displacement

"the enemy of my enemy is my friend"

- Emergence of secondary pests

Aphytis chrysomphali

+

Panaphis juglandis

Chromaphis juglandicola

Hazelnut

Enemies modulate herbivore competition and coexistence

Few experimental studies and with limited realism

– Most studies use few taxa
– Need of long-term dynamics
– Most studies done in communities with a single plant: host shift not possible
– Most studies done with clonal aphids: evolutionary changes are not possible
(poor competitor can evolve better competitive habilities)

Model system: Thrips, aphids, herbivorous and predatory mites, parasitic wasp

Phytoseiulus persimilis

Tetranychus urticae

Beans

Aphidius colemani

Myzus persicae

Tobacco

Echinothrips americanus

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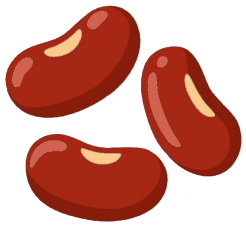
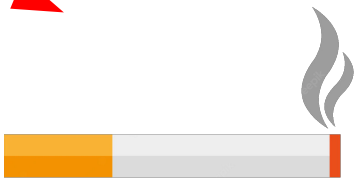


Beans



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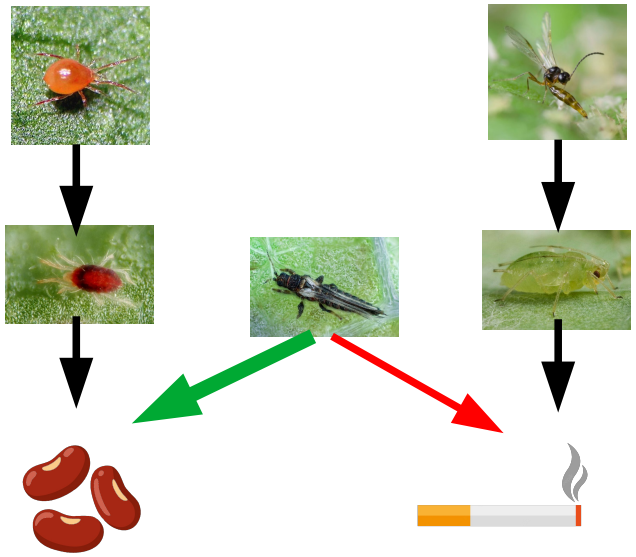


All species found on Réunion sweet-pepper greenhouses

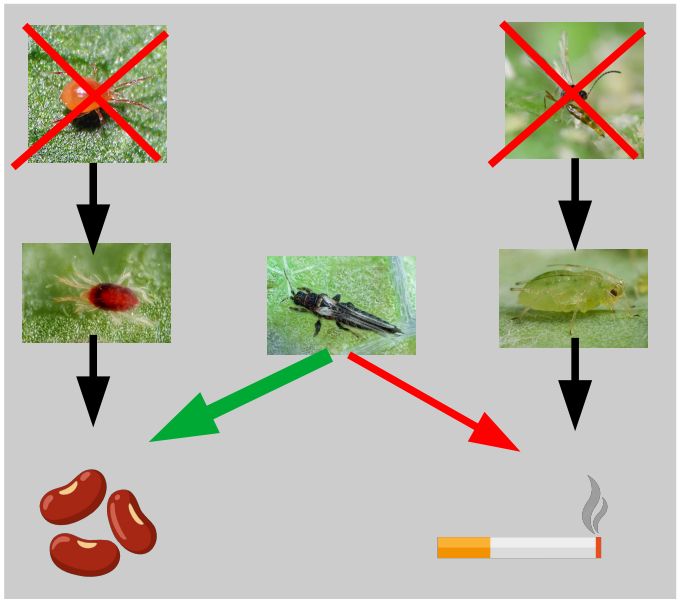
The two enemies often used in augmentative biocontrol

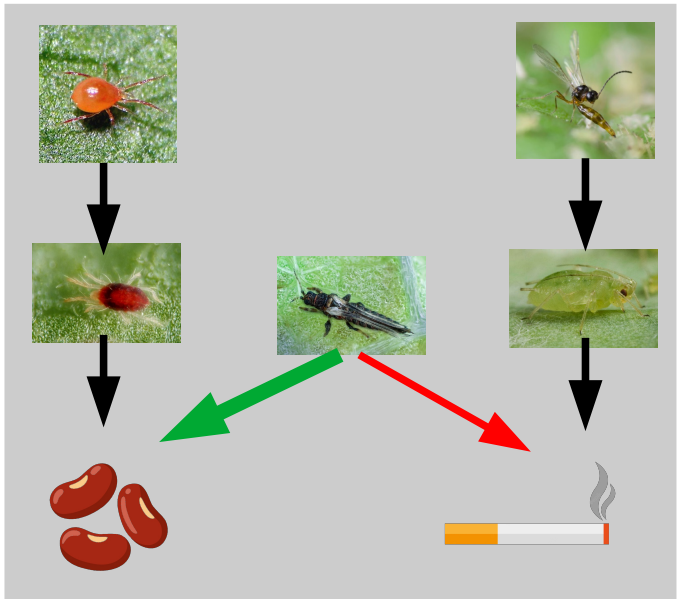
Echinothrips americanus:

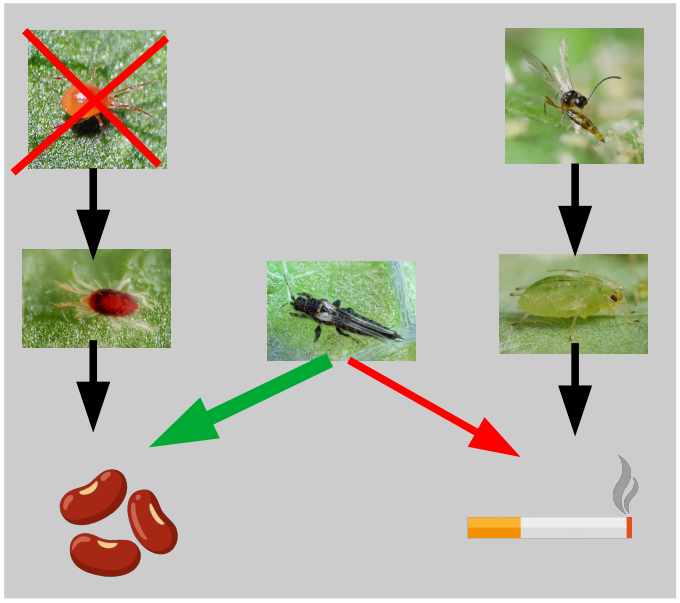
- An emerging pest – highly polyphagous
- Often on weeds
- Genetic diversity
- Poor competitor

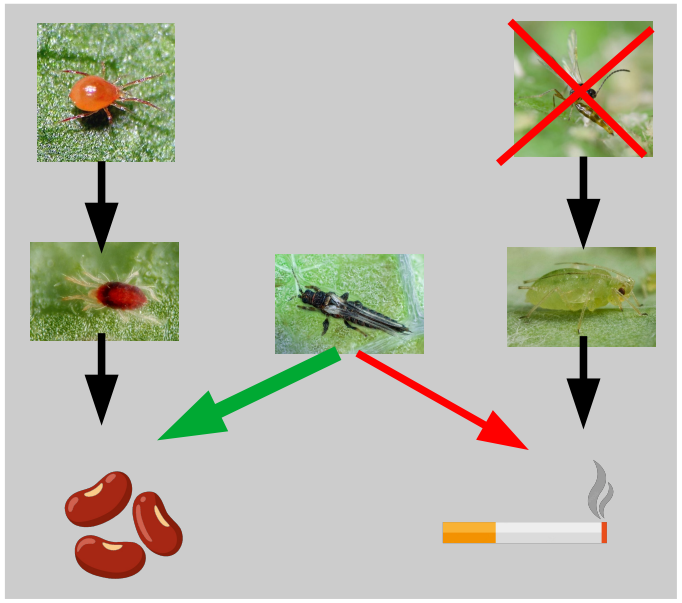
Risk of secondary pests

Model system: 4 different communities









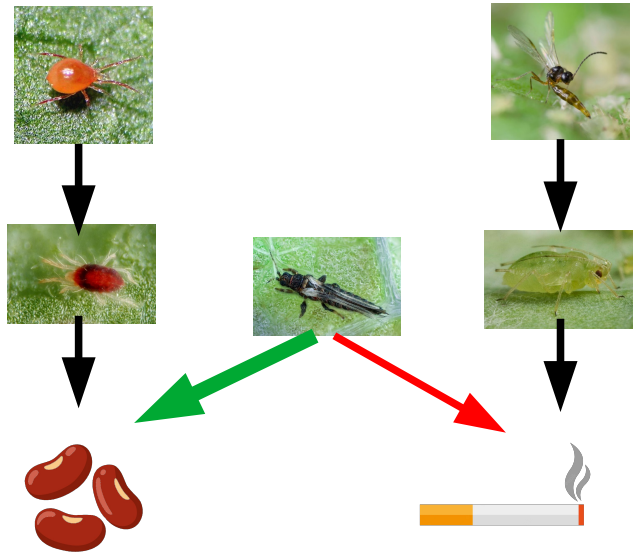
Hypotheses

1. In the absence of enemies, stonger competitors (spider-mite and aphid) will capitalise plants, but they will have low densities in their pesence

2. The poorer competitor (thrips) will survive when the enemies of superior competitors (aphids and/or spider-mites) are present

3. When the only enemy present is the aphid parasitoid, the poorer competitor (thrips) can only survive by colonising the low quality host plant (tobacco)

4. Colonisation of low quality plant (tobacco) will trigger evolutionary changes



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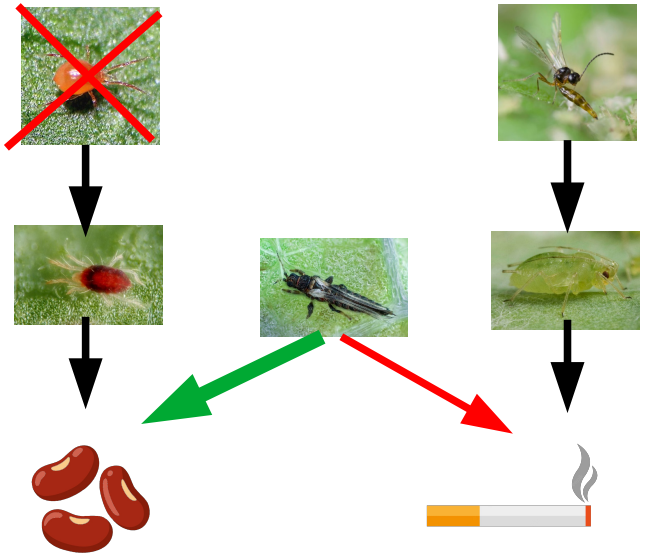


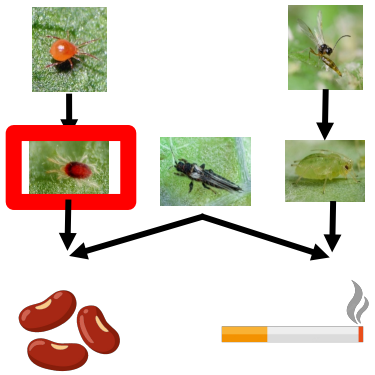
Experimental design and analyses

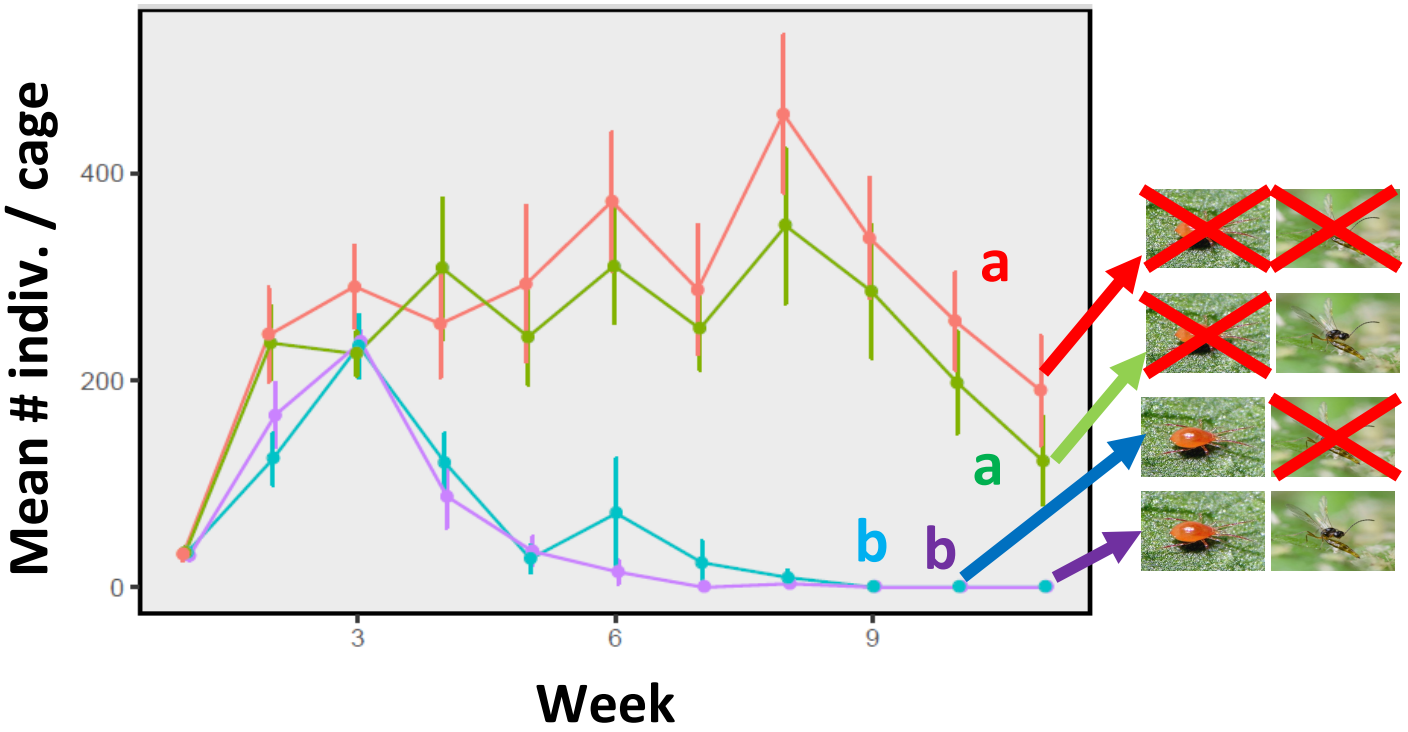
> 4 community types x 10 replicates = 40 experimental units (microcosms)
> Randomized block design
> Host plants added weekly (constant resource)
> Long-term dynamics over 11 weeks - weekly counts
> All species have short generation times
> Analysed with mixed models with temporal autocorrelation

Results: community dynamics

Tetranichus urticae (feeds on beans)

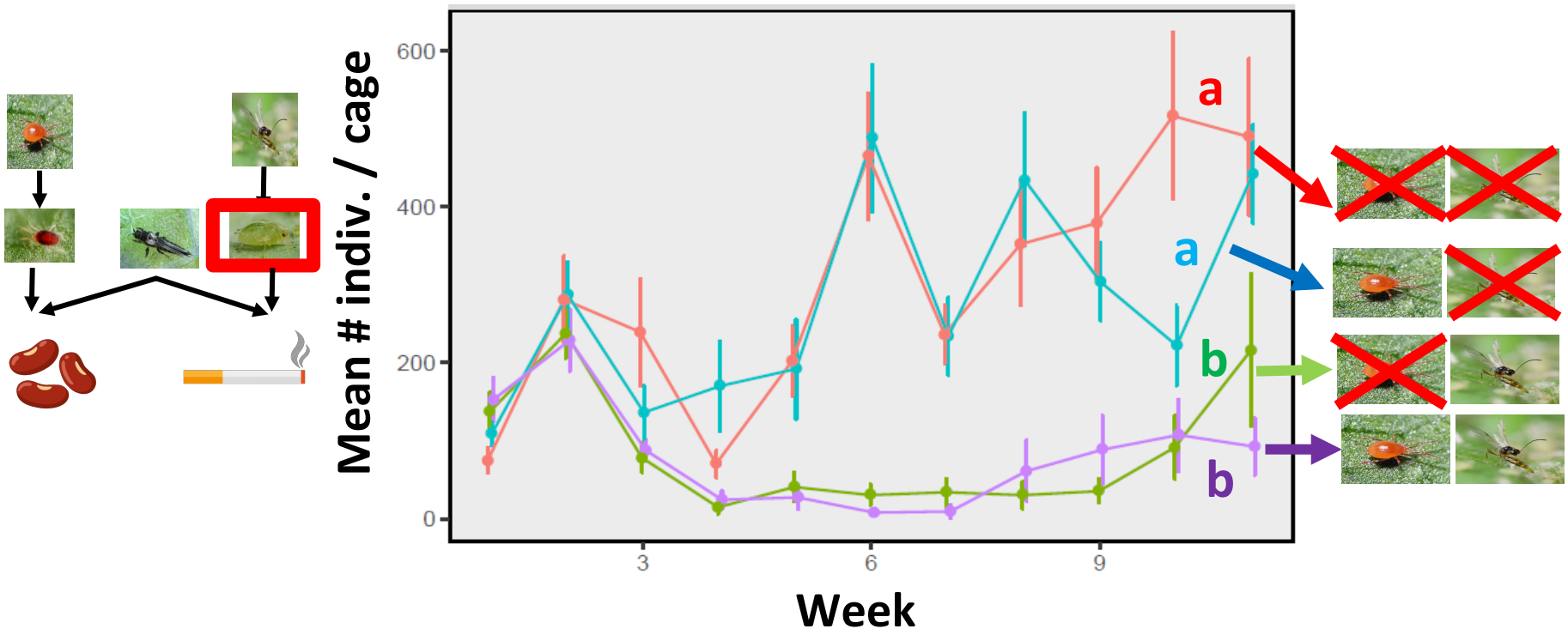
- In the presence of its enemy: low densities - extinction





Myzus persicae (feeds on tobacco)

- In the presence of its enemy: low densities – some extinctions



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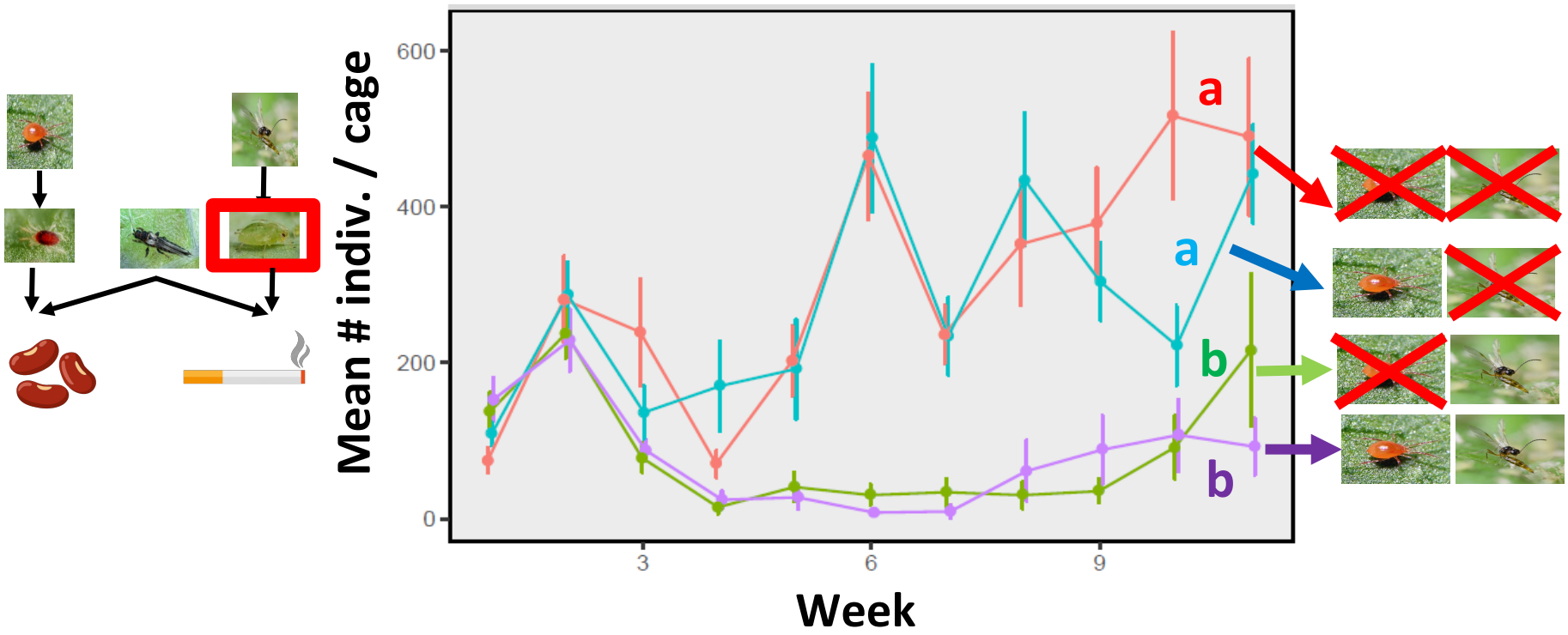
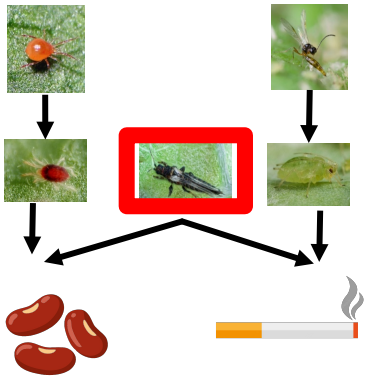
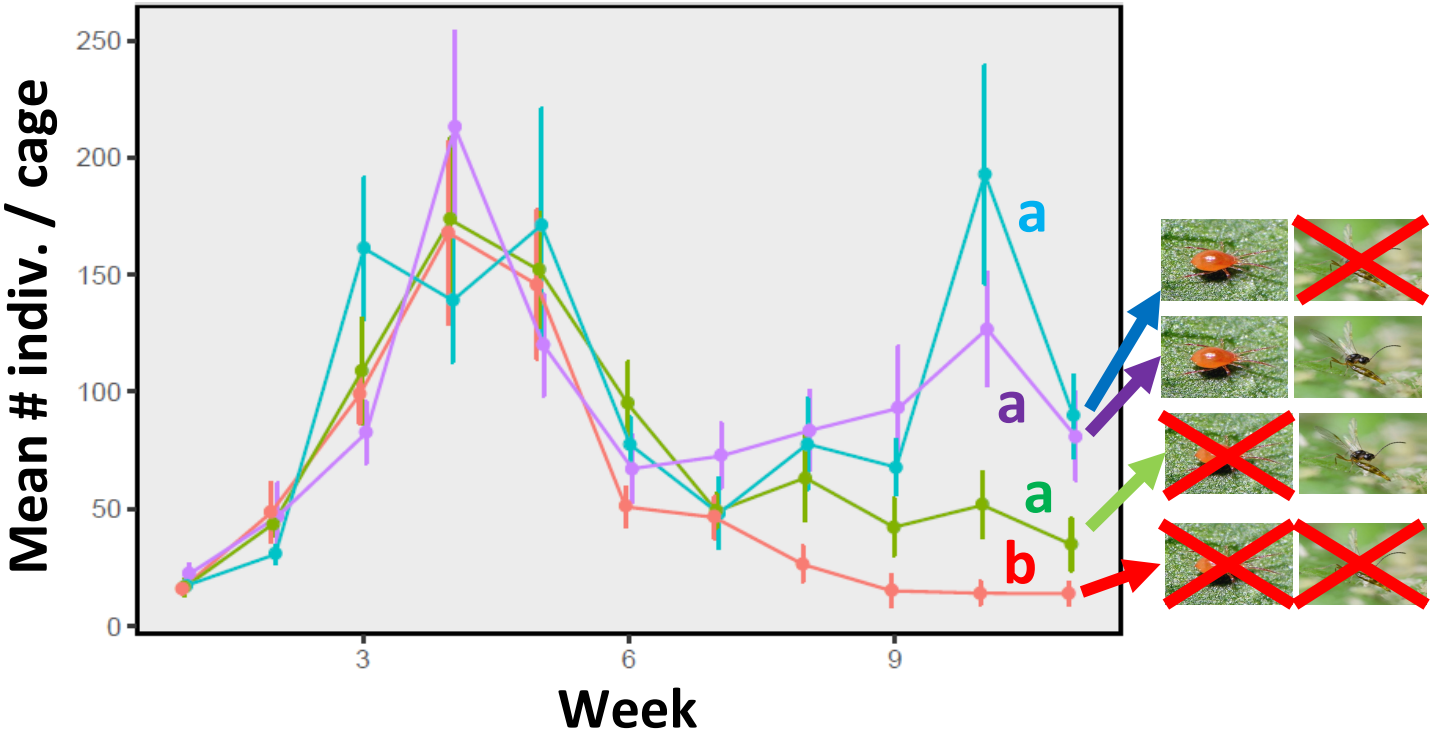


Echinothrips americanus (poor competitor - feeds preferentially on beans)

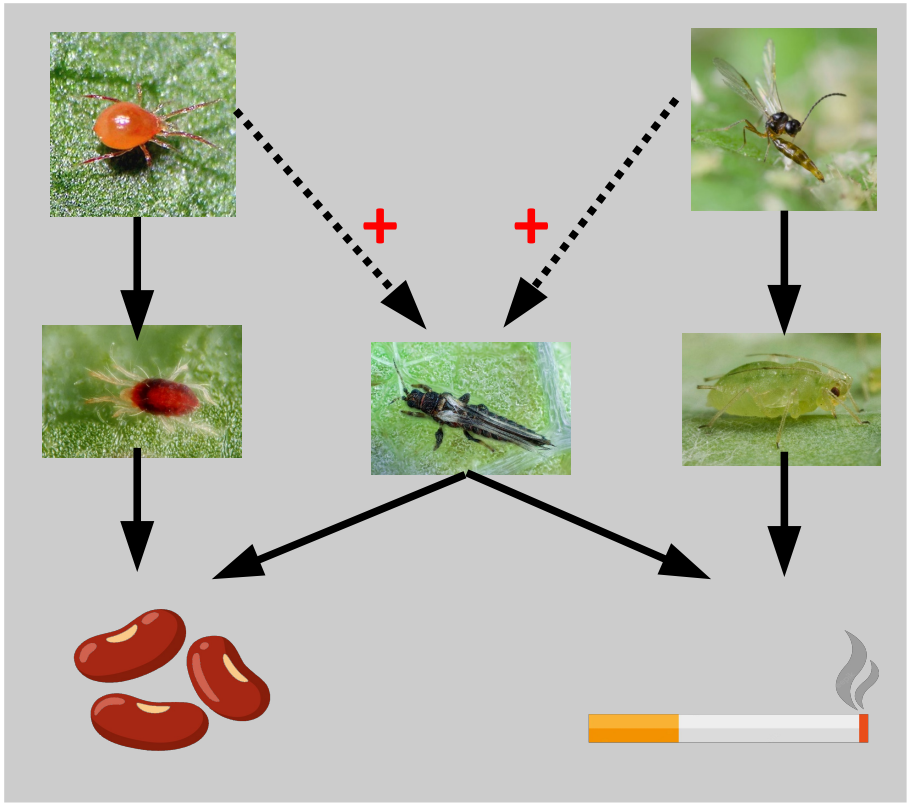
- In the presence of enemies: larger densities – it survives
- In the absence of enemies: low densities – extinctions





2. The poorer competitor will survive when aphid and/or spider-mite enemies are present. ➤ **Yes!!**

→ **Indirect positive effect of enemies on herbivore density and survival**



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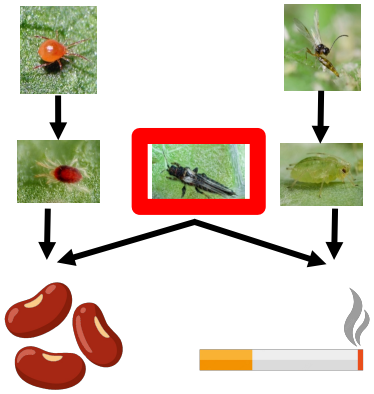

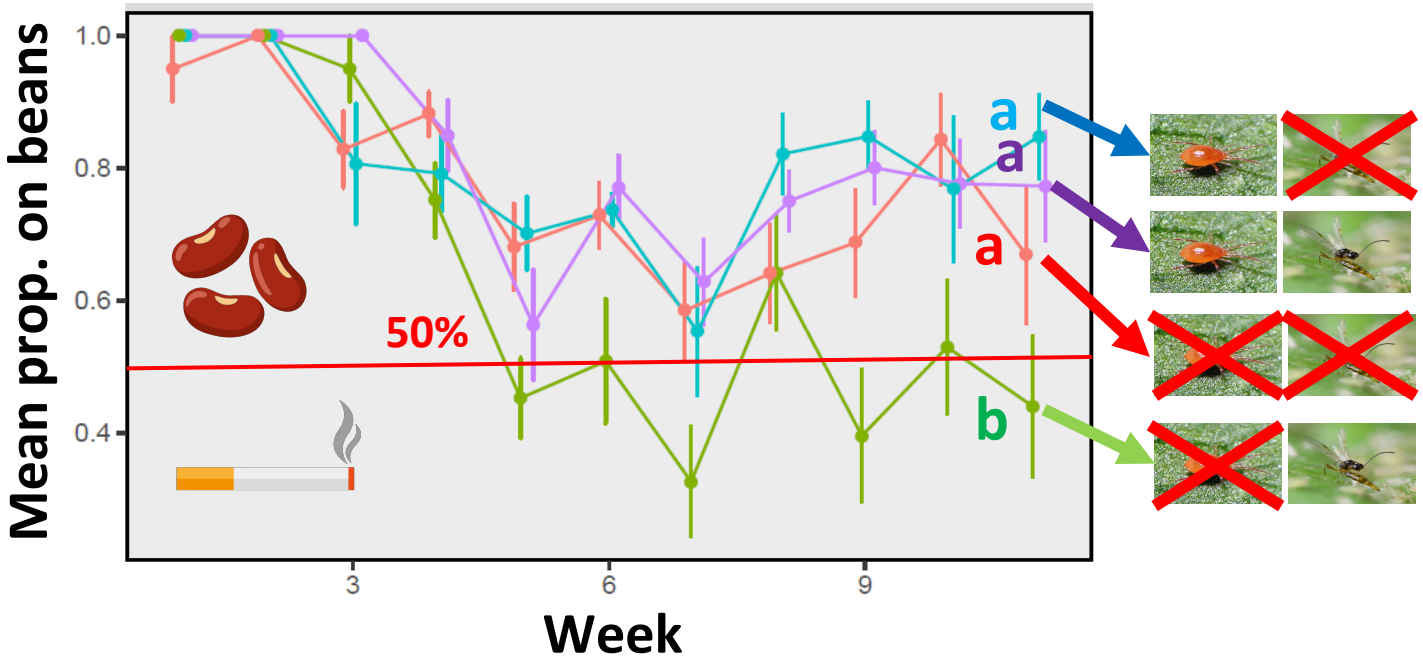

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3. When the only enemy present is the aphid parasitoid, the poorer competitor (thrips) can only survive by colonising the low quality host plant (tobacco)

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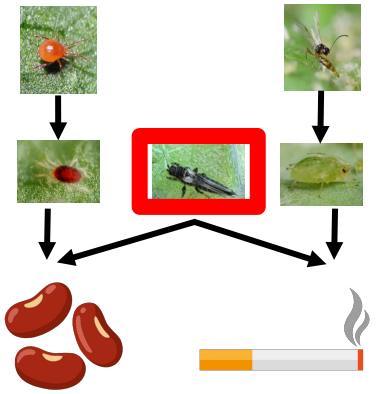

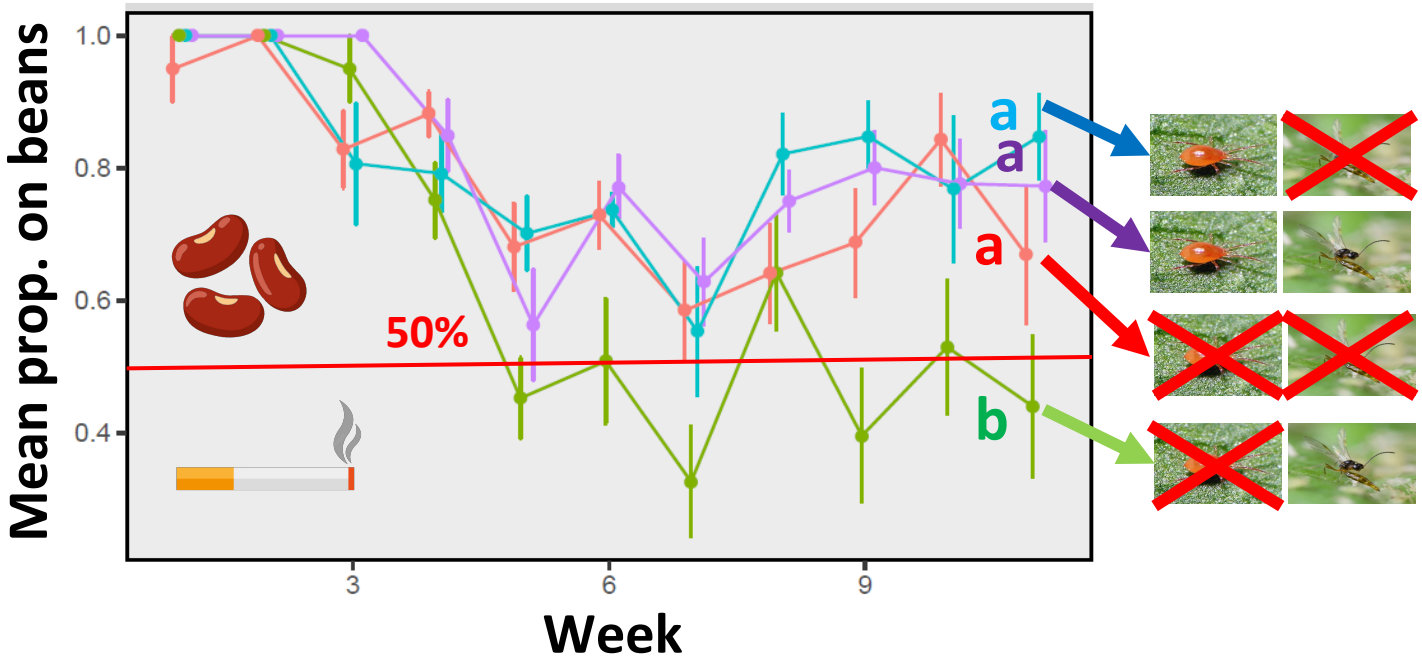

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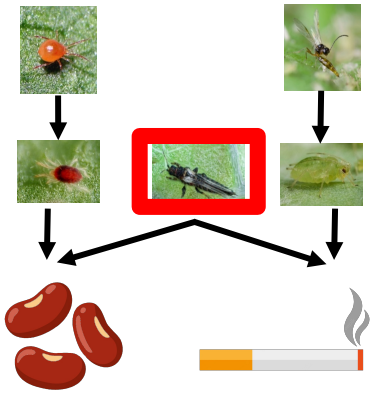

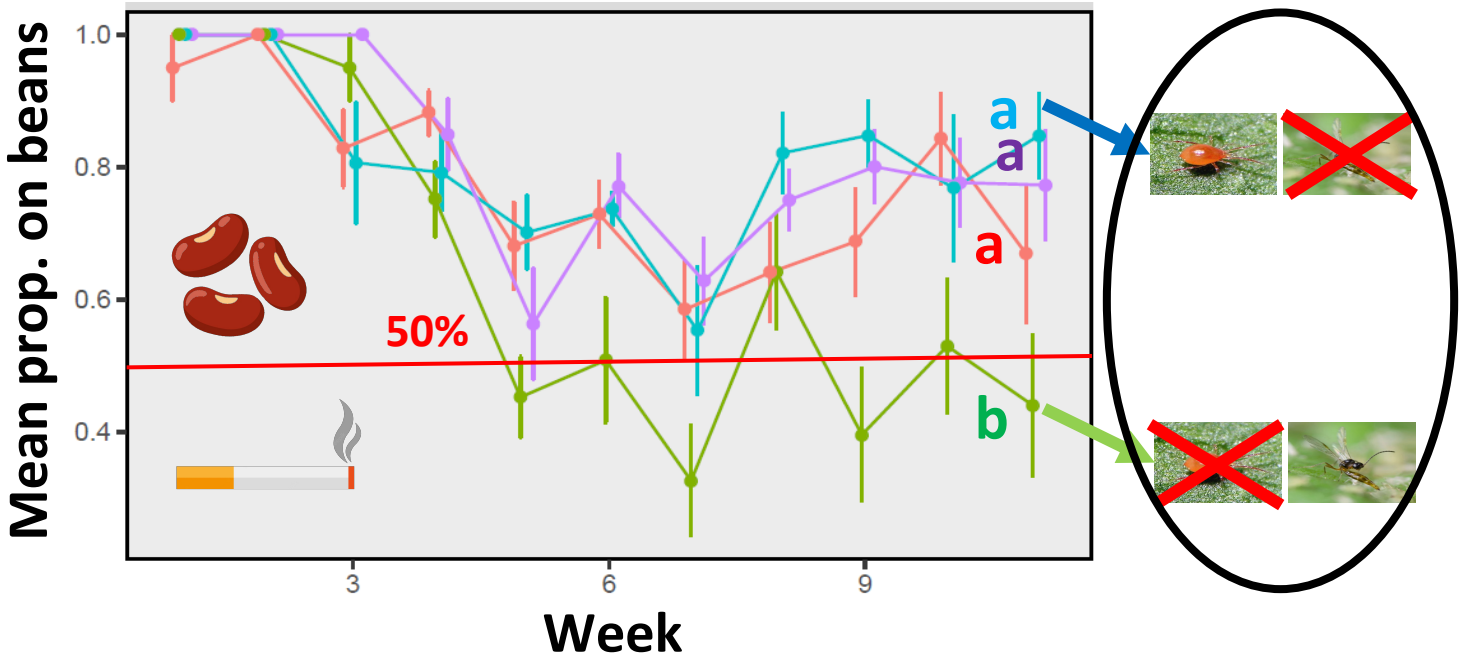

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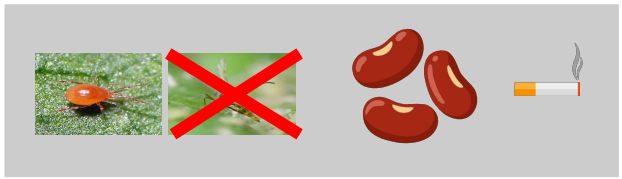
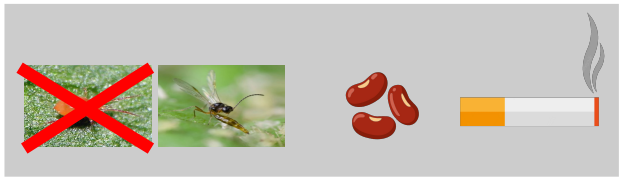


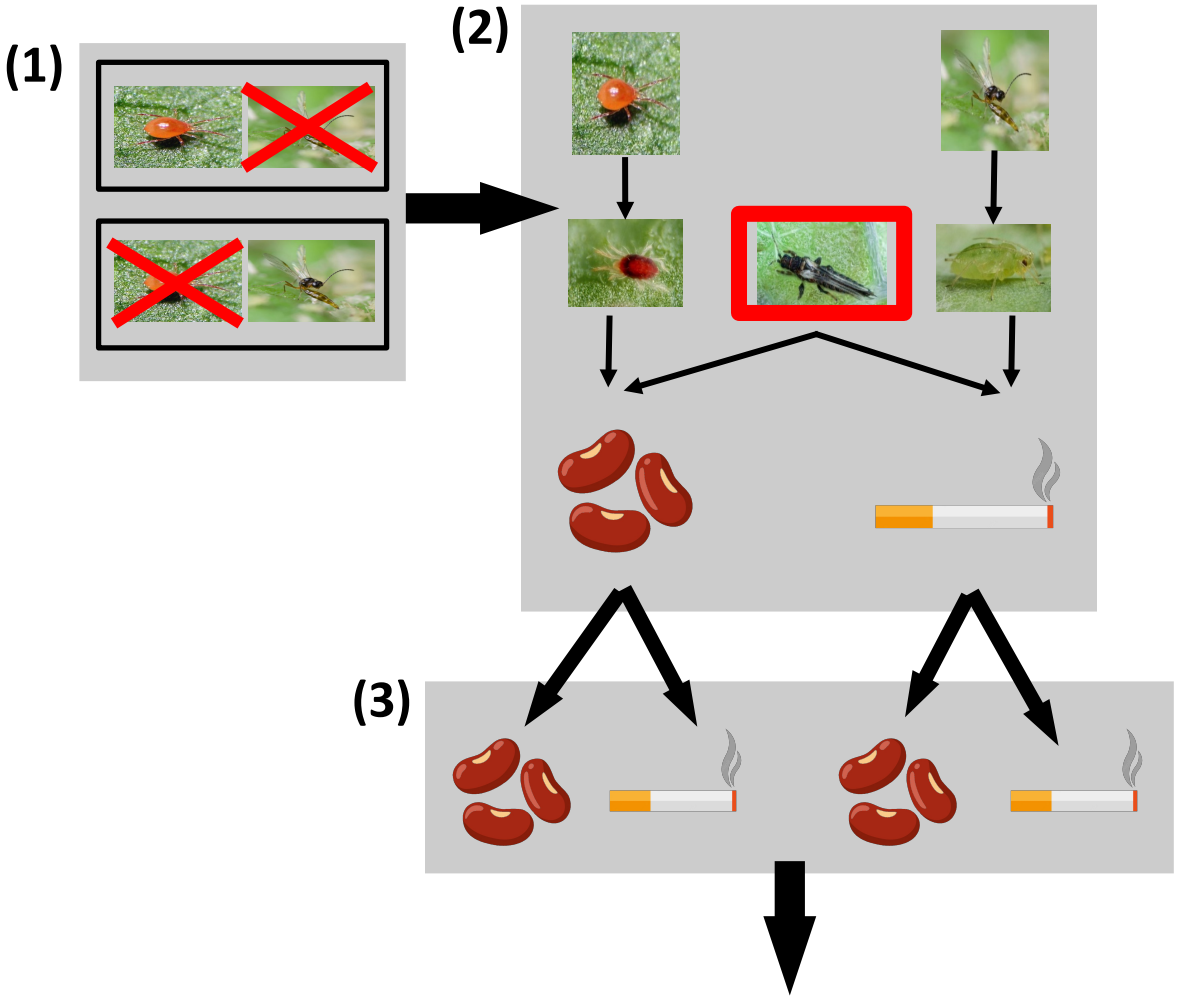
Good fitness on beans
Low fitness on tobacco



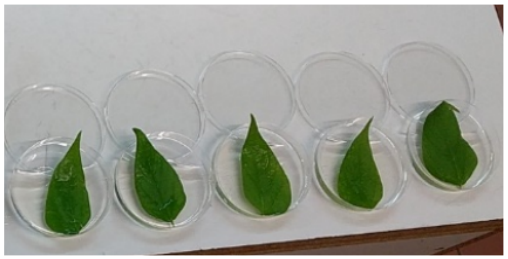
Good fitness on tobacco
Costs on beans
(evolutionary trade-off)

Echinothrips americanus

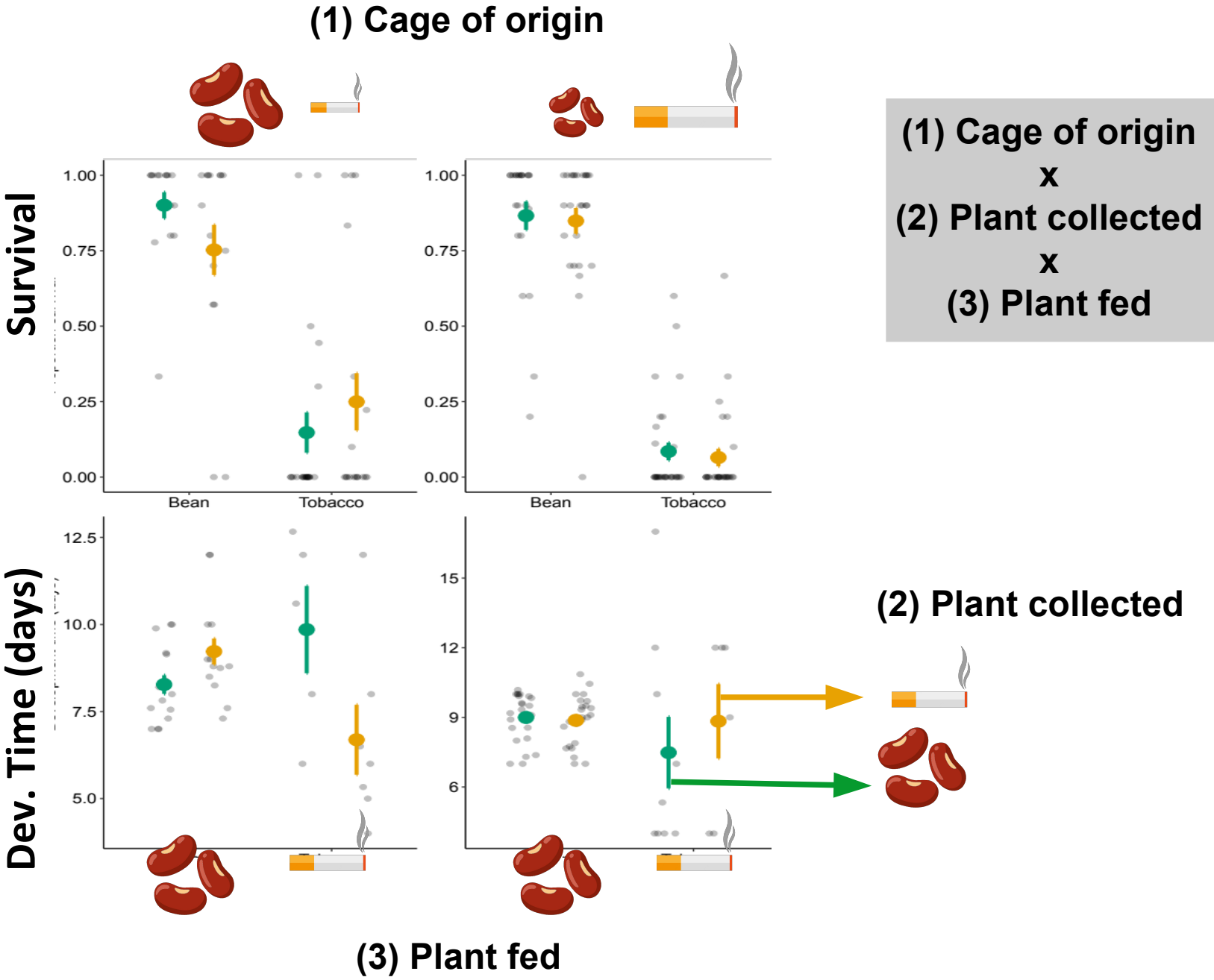
Exp. design: *Echinothrips americanus* adaptation after host shift



(1) Cage of origin
x
(2) Plant collected
x
(3) Plant fed



Echinothrips fitness: survival and development time on Petri dishes at F2



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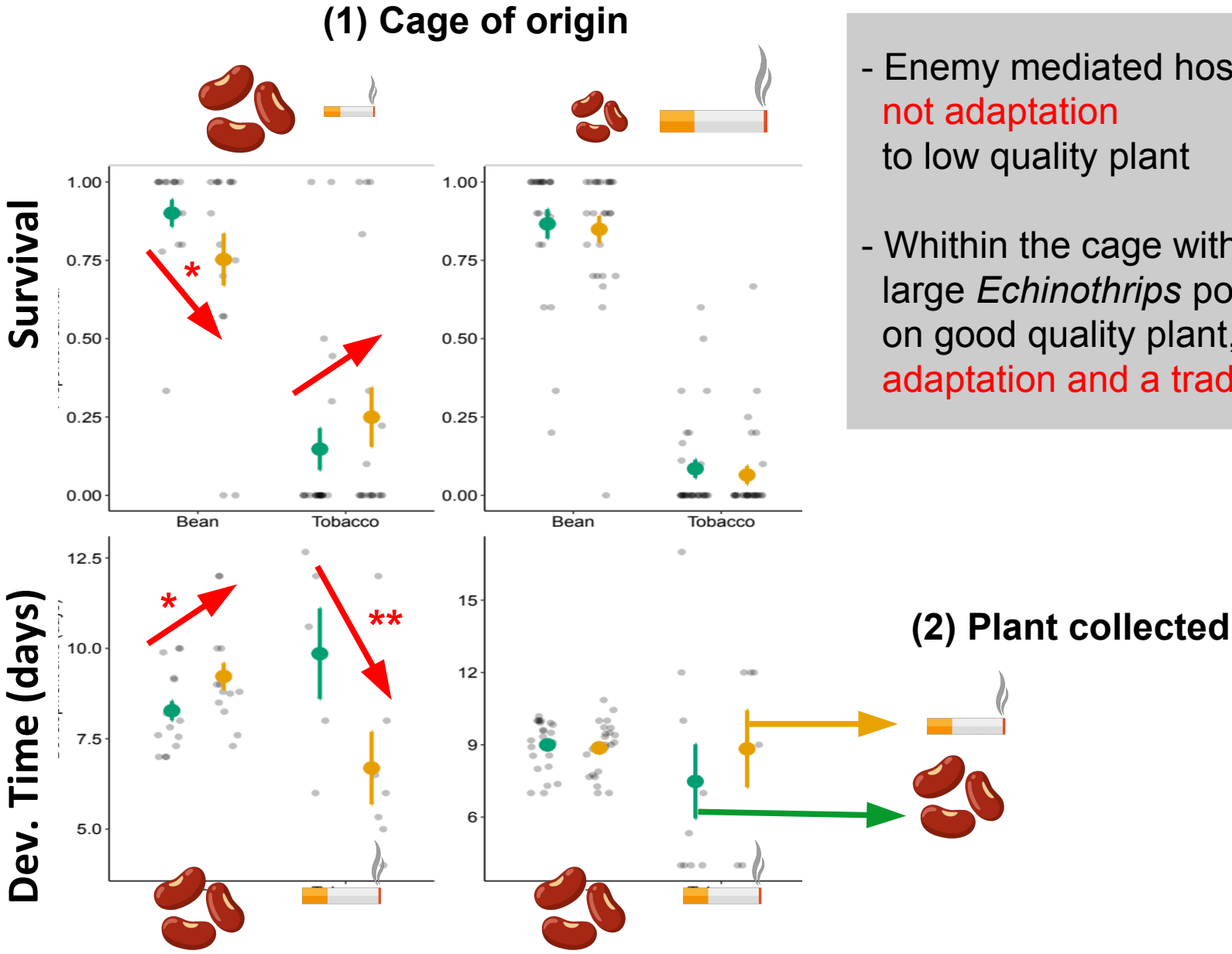

- Enemy mediated host shift:
  not adaptation
  to low quality plant

- Whithin the cage with large *Echinothrips* pops. on good quality plant,
  adaptation and a trade-off

Take home message

1. In the absence of enemies, stonger competitors (spider-mite and aphid) will capitalise plants, but they will have low densities in their pesence
   ➤ **Yes!!**

2. The poorer competitor will survive when aphid and/or spider-mite enemies are present.
   ➤ **Yes!!**

3. When the only enemy present is the aphid parasitoid, the poorer competitor (thrips) can only survive by colonising the low quality host plant (tobacco)
   ➤ **Yes!!**

4. Colonisation of low quality plant (tobacco) will trigger evolutionary changes
   - ➤ No adaptation – strong cost of feeding on low quality host
   - ➤ Adaptation only possible when large populations on quality host

➤➤➤ Biocontrol and eco-evolutionary dynamics: risk of secondary pests

Thanks to:
Karim Tighiouart.
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CIRAD, UMR CBGP, Montpellier, France

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