Herontwerp teeltsystemen voor plaagbestrijding met verhoogde diversiteit van natuurlijke vijanden

Gerben Messelink, Wageningen University & Research

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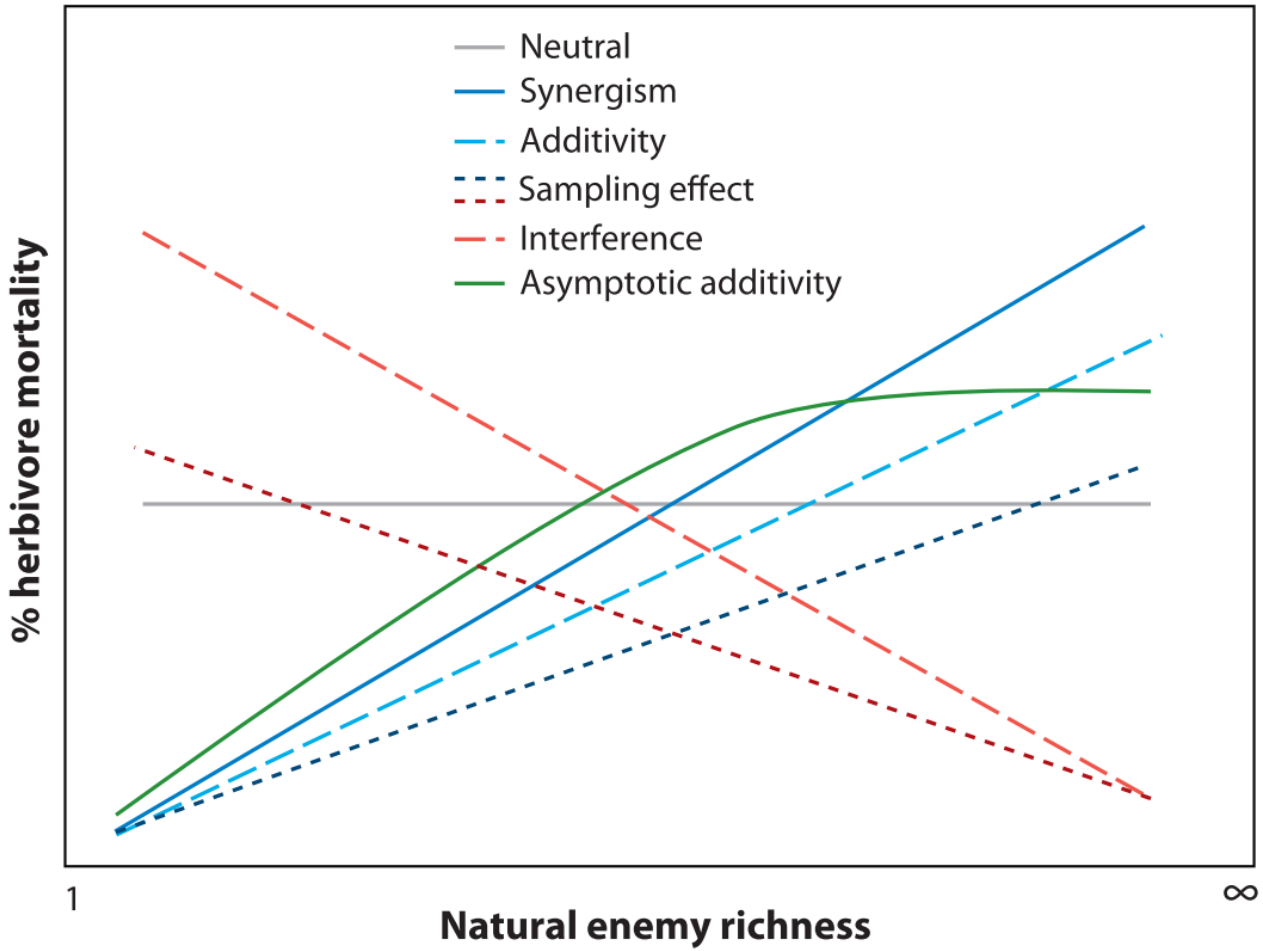
For quality of life

Kennisdag Artemis, 15 November 2023

Biologische bestrijding in kassen: waar staan we en hoe verder?

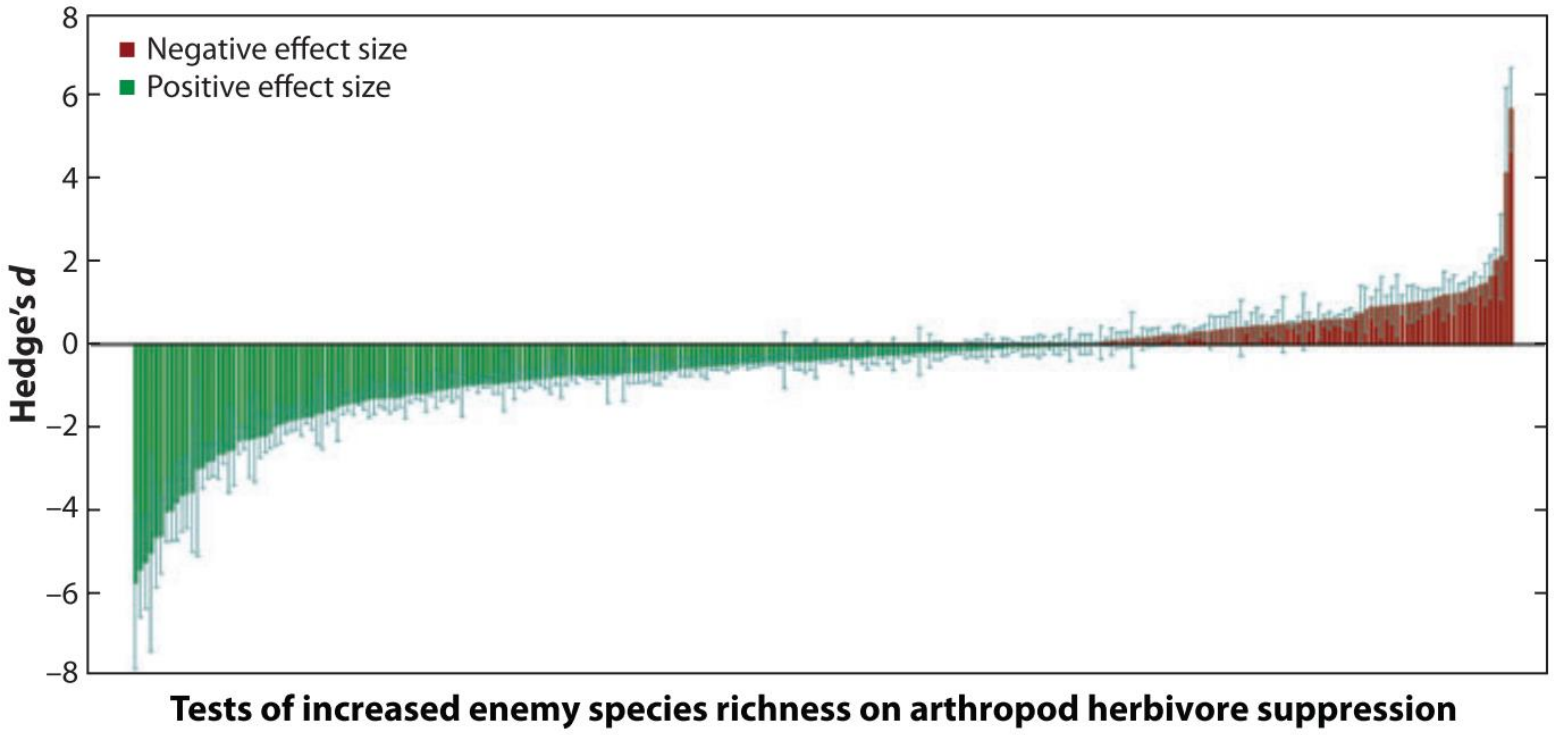
- Als sinds de Jaren 70-80 met succes toegepast, maar het wordt steeds ingewikkelder:
  - Steeds minder middelen, secundaire plagen worden primaire plagen
  - Steeds meer plagen door invasies exoten
  - Minder correctiemiddelen achter de hand
- Is diversiteit van natuurlijke vijanden belangrijk?
- Voorbeeld evolutie BB in paprika
- Wat te doen om diversiteit van natuurlijke vijanden te ondersteunen

Zijn meer natuurlijke vijanden altijd beter?



Letourneau et al. Annu. Rev. Ecol. Evol. Syst. 2009

Zijn meer natuurlijke vijanden altijd beter?



Uitkomsten op basis van 266 studies, een negatieve Hedge-d-waarde is een idicatie voor een toename in plaagbesrijding bij meer diversiteit van natuurlijke vijanden.

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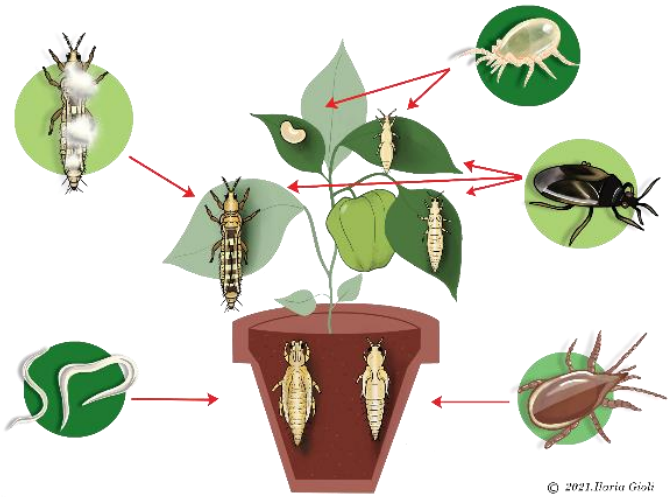
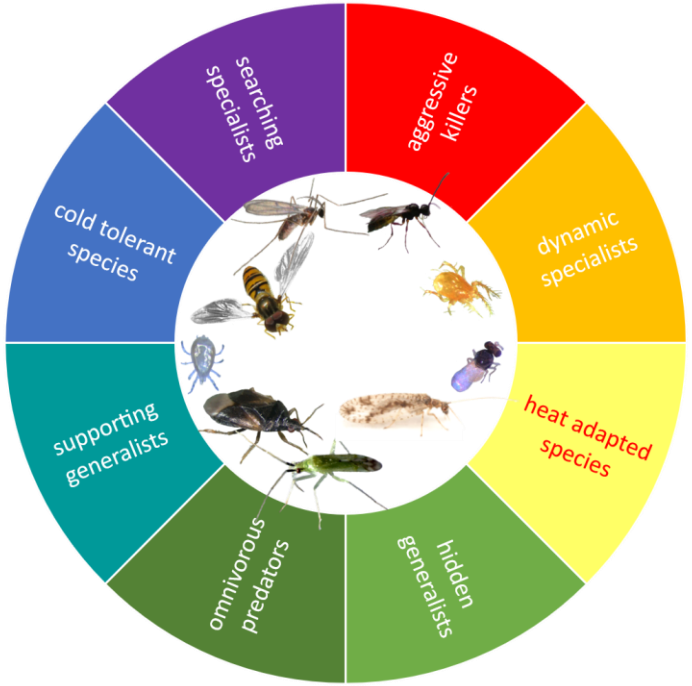
Letourneau et al. Annu. Rev. Ecol. Evol. Syst. 2009

Redenen voor meer diversiteit van natuurlijke vijanden

Hypothese 1:

- Verbeterde plaagbestrijding door complementariteit
  - Bestrijden verschillende stadia plagen
  - Verschil in activiteit gedurende de dag
  - Positie in de plant
  - Verschil in klimaatvoorkeuren
- Functionele diversiteit: Team building!





Redenen voor meer diversiteit van natuurlijke vijanden

Hypothese 2:

- Meer zekerheid dat de juiste soorten aanwezig zijn en elkaar opvangen bij uitschakeling
  - The insurance hypothesis: exosystemene blijven functioneren bij uitval van een van de soorten doordat andere soorten hun rol overnemen
  - Ecological redundancy hypothesis: verhoogde weerbaarheid en stabiliteit van het ecosystem bij verstoringen door soorten die overlappen in hun ecologische functies

Proc. Natl. Acad. Sci. USA
Vol. 96, pp. 1463–1468, February 1999
Ecology

Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis

(stochastic dynamic model/species richness/ecosystem processes/temporal variability/ecosystem stability)

SHIGEO YACHI AND MICHEL LOREAU*

Laboratoire d'Ecologie, Unité Mixte de Recherche 7625, Ecole Normale Supérieure, 46, rue d'Ulm, F-75230 Paris Cedex 05, France

Communicated by Harold Alfred Mooney, Stanford University, Stanford, CA, November 30, 1998 (received for review August 10, 1998)

esa ECOSPHERE

SYNTHESIS & INTEGRATION

Does functional redundancy affect ecological stability and resilience? A review and meta-analysis

CHRISTOPHER R. BIGGS,† LAUREN A. YEAGER, DEREK G. BOLSER, CHRISTINA BONSELL, ANGELINA M. DICHIERA, ZHENXIN HOU, SPENCER R. KEYSER, ALEXIS J. KHURSIGARA, KAIJUN LU, ARLEY F. MUTH BENJAMIN NEGRETE JR., AND BRAD E. ERISMAN

Meer studies bevestigen dit

ECOLOGY LETTERS

Full Access

Predator biodiversity strengthens herbivore suppression

William E. Snyder, Gretchen B. Snyder, Deborah L. Finke, Cory S. Straub

First published: 25 April 2006 | https://doi.org/10.1111/j.1461-0248.2006.00922.x | Citations: 233

ECOLOGY
ECOLOGICAL SOCIETY OF AMERICA

Article | Open Access

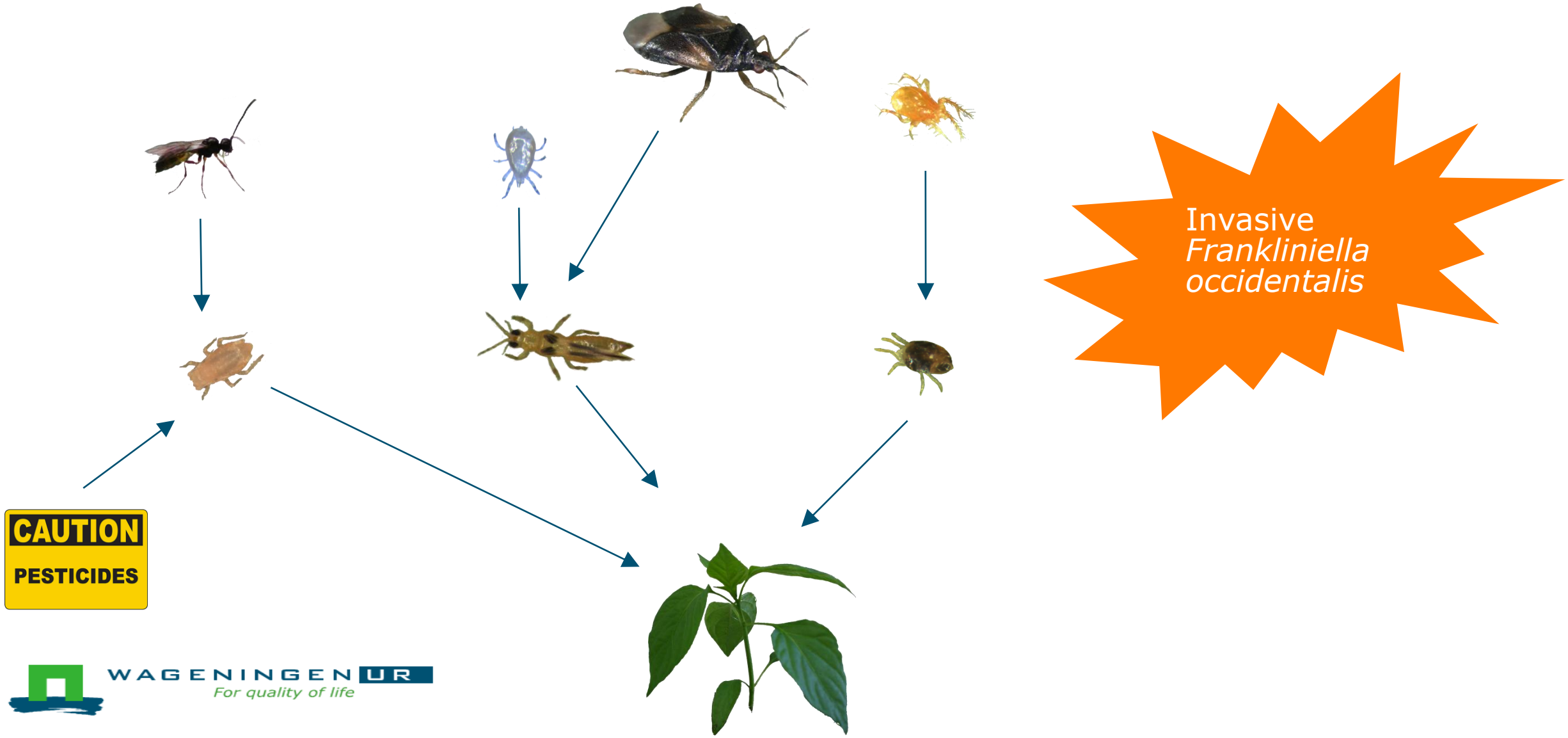
Functional diversity positively affects prey suppression by invertebrate predators: a meta-analysis

Arran Greenop, Ben A. Woodcock, Andy Wilby, Samantha M. Cook, Richard F. Pywell

First published: 04 May 2018 | https://doi.org/10.1002/ecy.2378 | Citations: 57

Corresponding Editor: William E. Snyder.

Biologische bestrijding in paprika: 1980-2000



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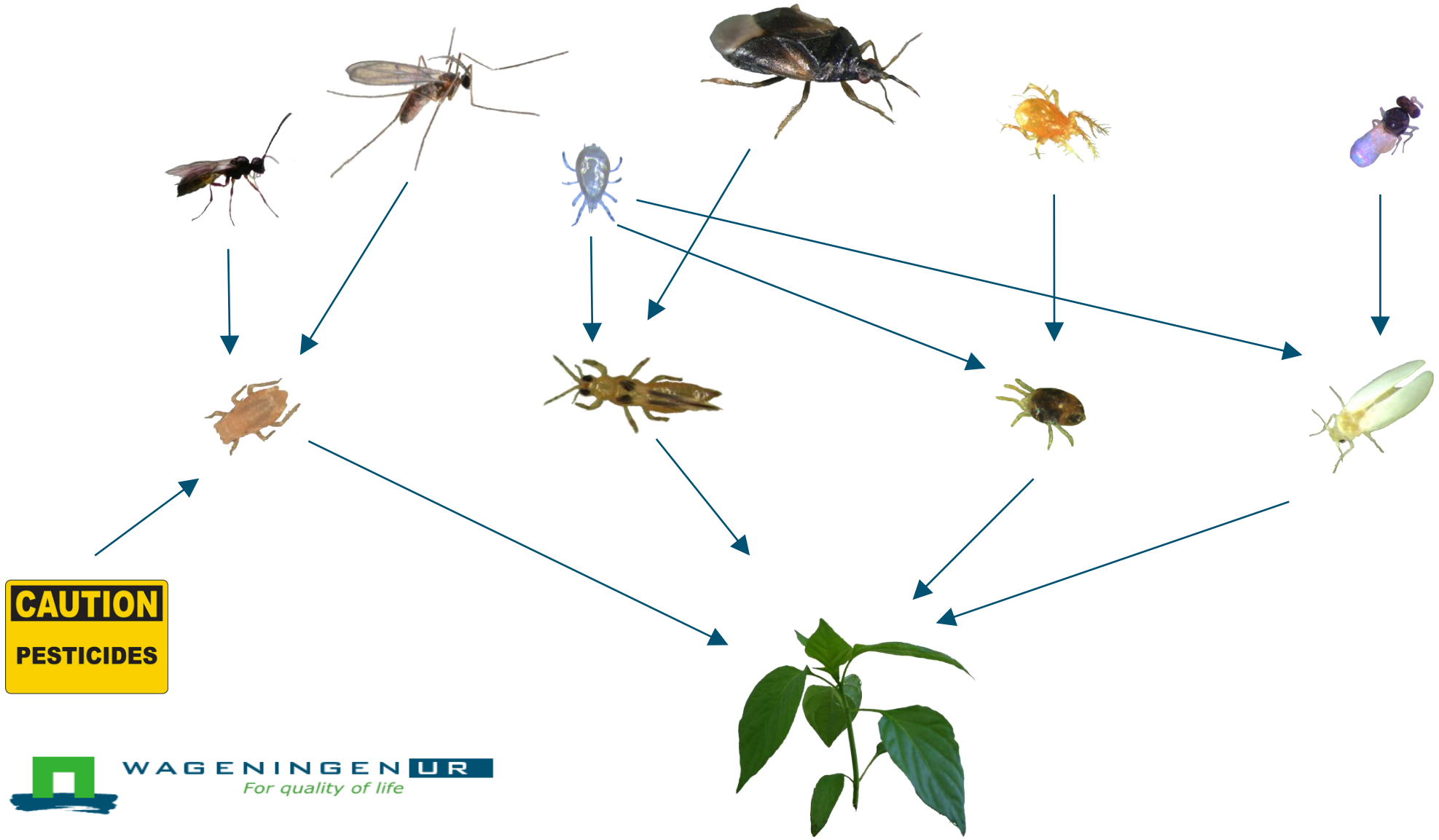
Biologische bestrijding in paprika: 2000-2010



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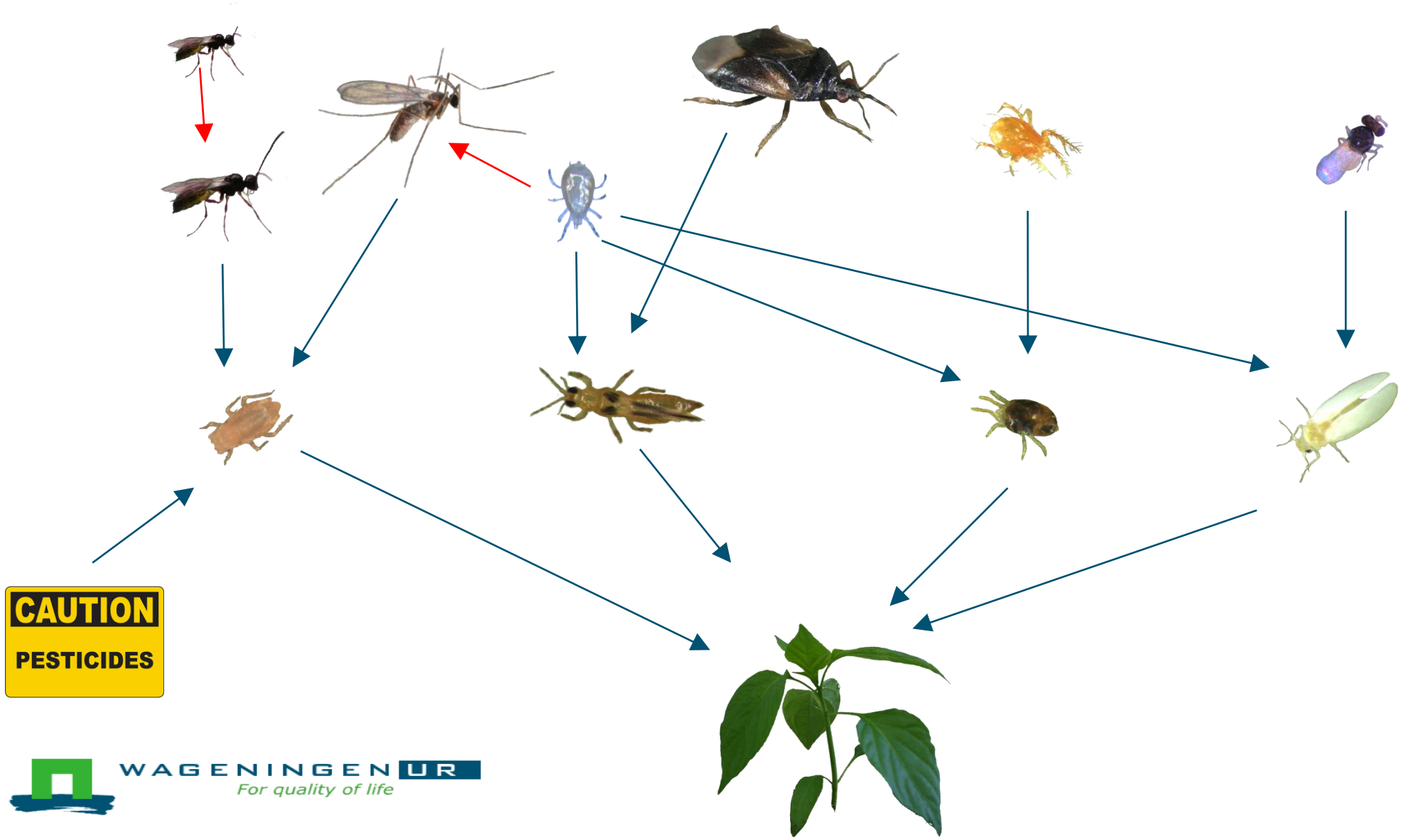
Biologische bestrijding in paprika: 2000-2010



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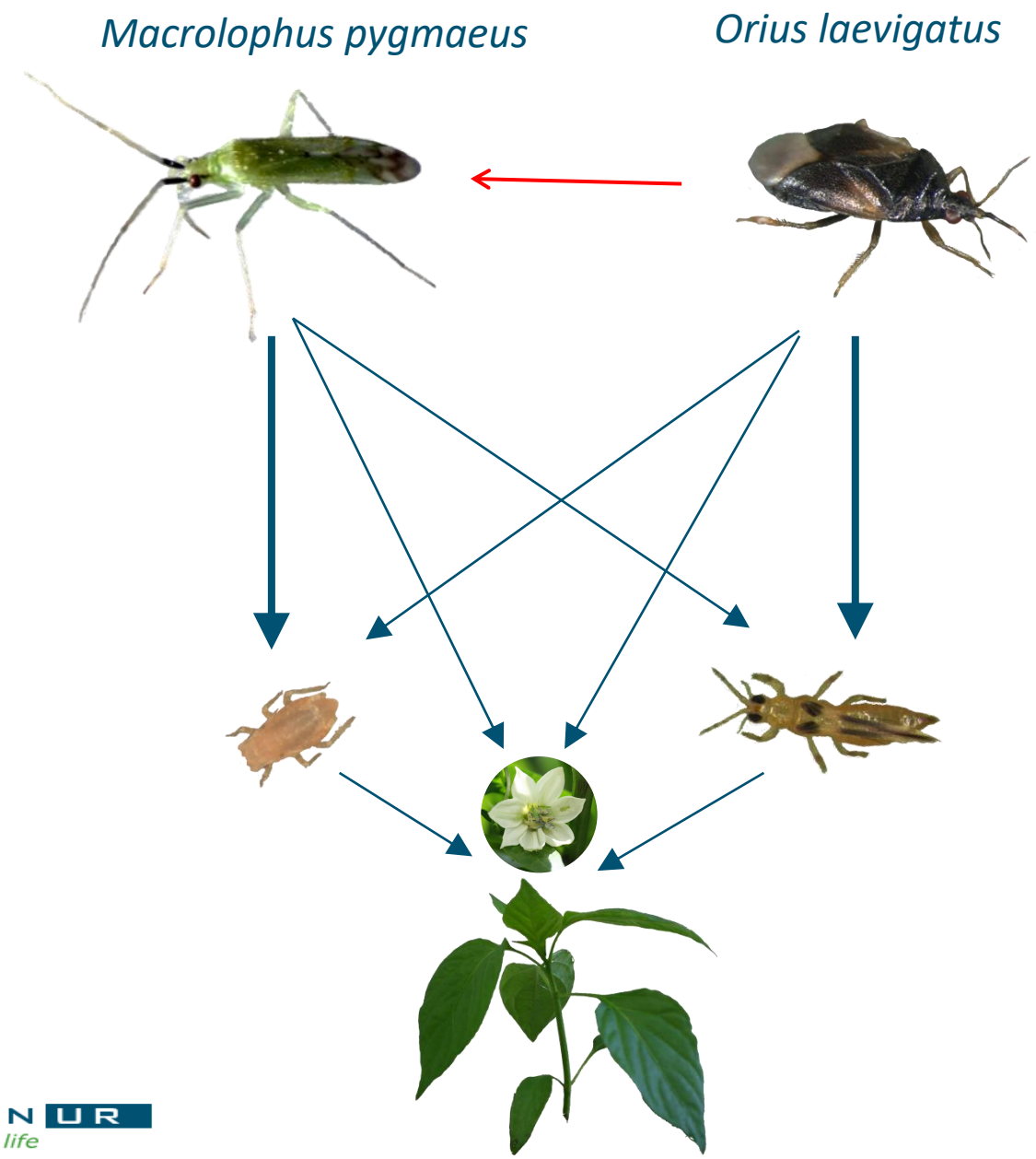

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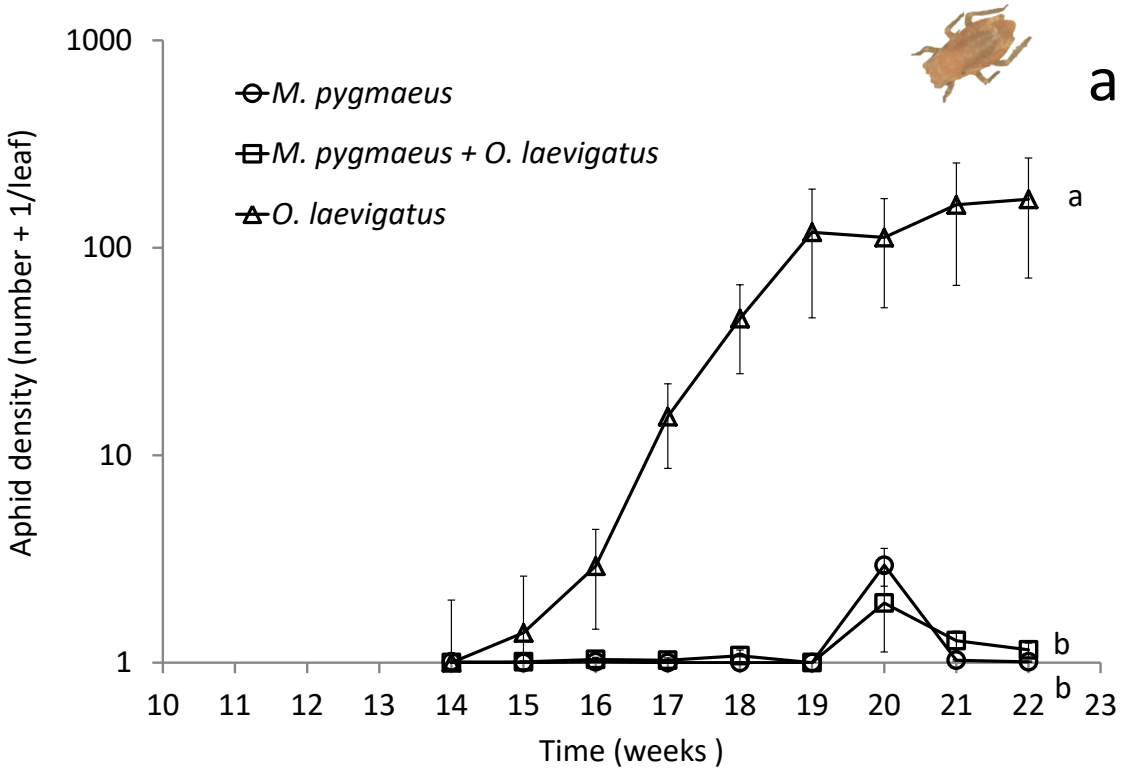
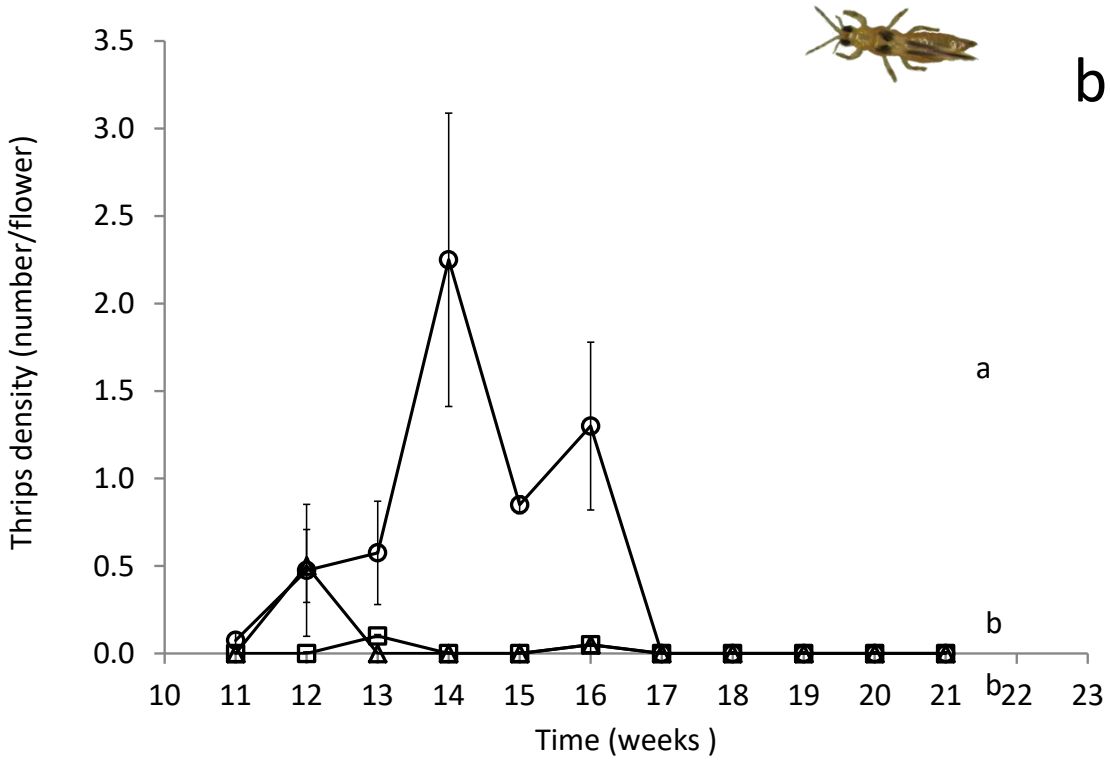
Effects on aphids and thrips

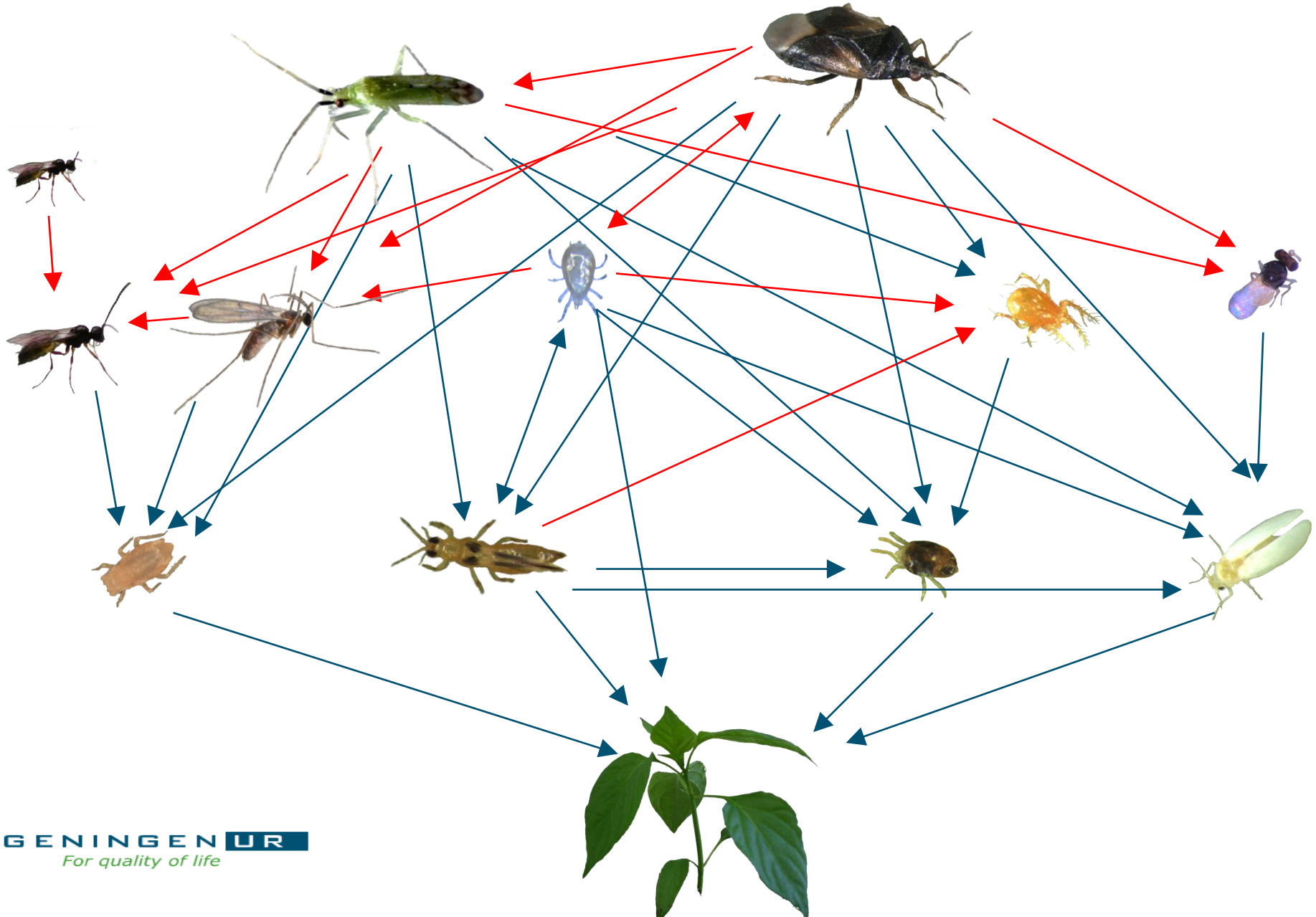




Best control of thrips and aphids when both predators are present

Messelink & Janssen, Biological Control 2014

Een nieuw voedselweb: probleem opgelost?



WAGENINGEN UR
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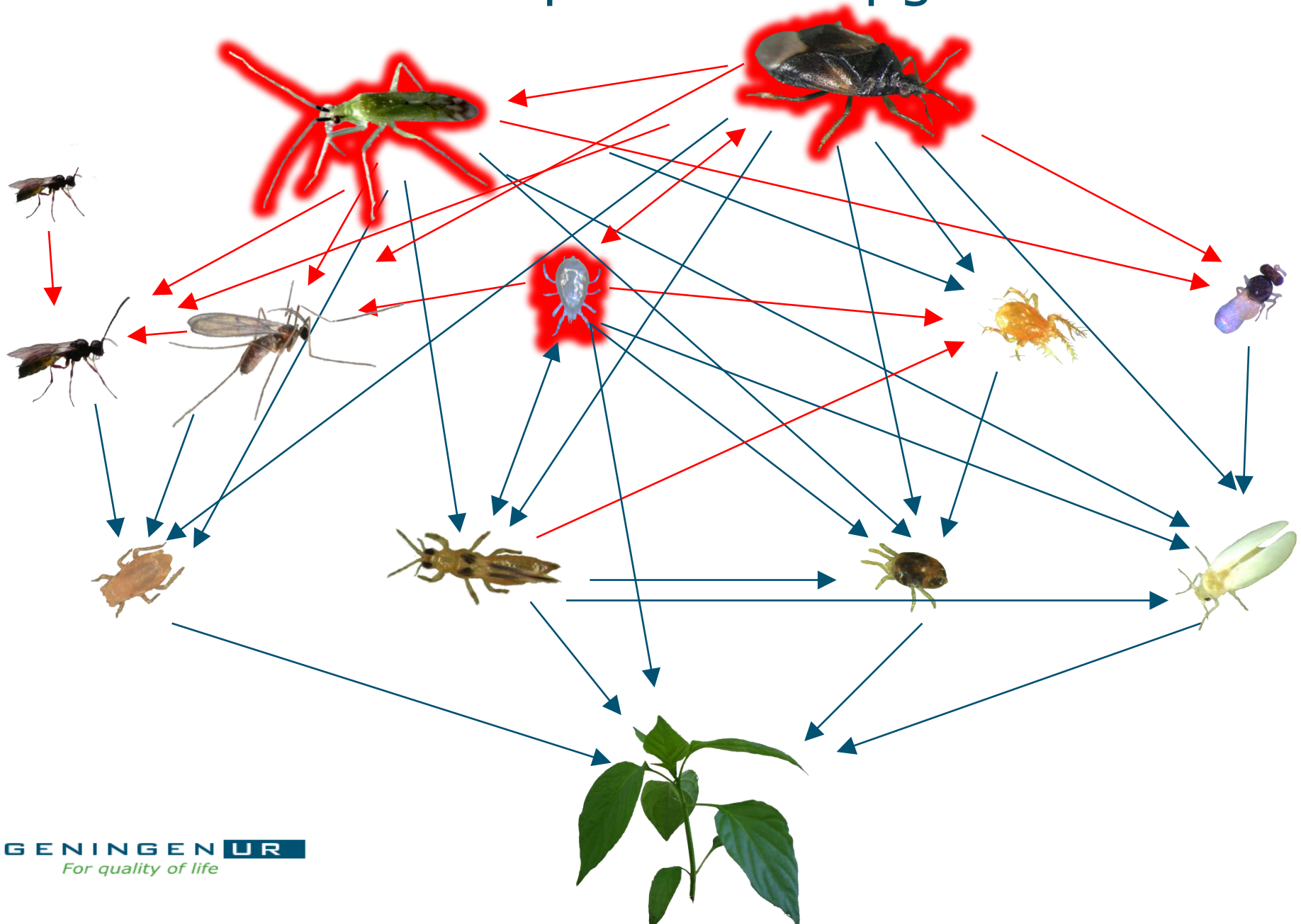

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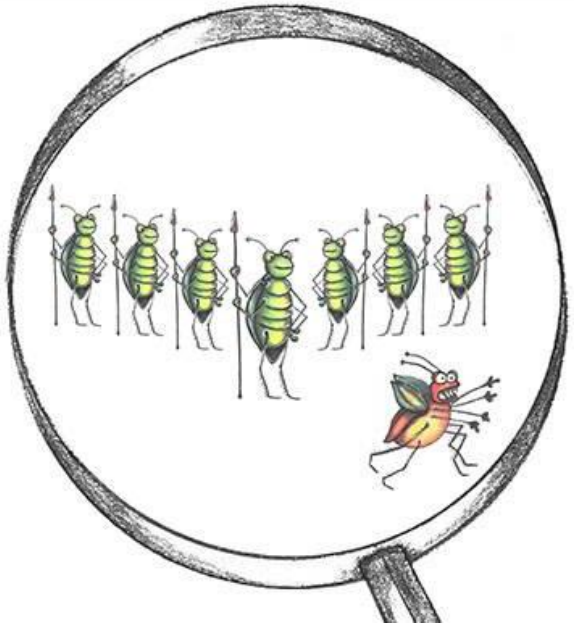
Op zoek naar complementaire soorten



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Candidate 1

Scymnus interruptus

ELSEVIER

Biological Control

Volume 51, Issue 2, November 2009, Pages 323-335

Review

Coccinellids in diverse communities: Which niche fits?

William E. Snyder

Journal of Pest Science (2021) 94:321–333
https://doi.org/10.1007/s10340-020-01265-z

ORIGINAL PAPER

Aphid predators in citrus crops: the least voracious predators are the most effective

J. P. R. Bouvet[1,2] · A. Urbaneja[2] · César Monzó[2]

Received: 12 July 2019 / Revised: 10 July 2020 / Accepted: 18 July 2020 / Published online: 30 July 2020
© Springer-Verlag GmbH Germany, part of Springer Nature 2020

- Native species
- Small size (micro) 1.5-2mm
- Less voratious than macrococcinellids
- Arrives at low aphid densities

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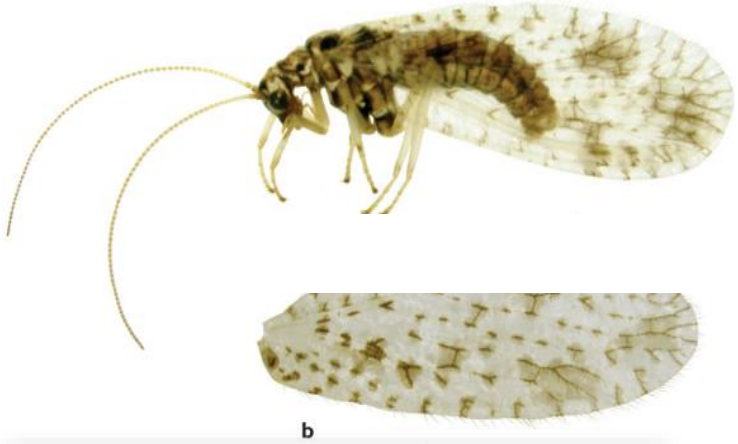
Candidate 2

Micromus variegatus



- Native species
- Little knowledge but already available as BC agent in Canada
- Recorded in low aphid infestation
- Adults feed on aphids

JOURNAL OF APPLIED ENTOMOLOGY

Original Contribution | Open Access

Combining lacewings and parasitoids for biological control of foxglove aphids in sweet pepper

M. Rocca, G. J. Messelink

First published: 22 September 2016 | https://doi.org/10.1111/jen.12355 | Citations: 16

Objectives

1. Evaluate the survival of *Scymnus interruptus* and *Micromus variegatus* on alternative food sources to improve their early establishment in the crop, prior to aphid infestations.

2. Assess their effectiveness as preventive biocontrol agents for aphid control.

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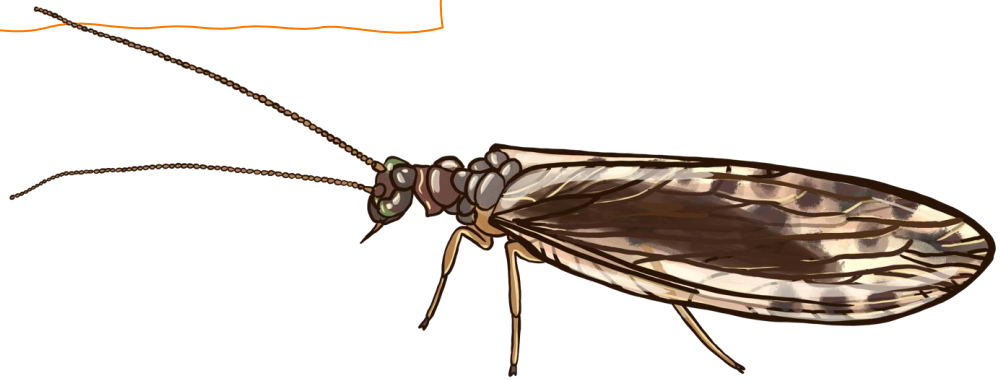
Materials and methodology

- 5 Diets: **<u>Pollen →</u>** Corn, Sweet pepper, *Typha latifolia*
  ***Artemia* cysts**
  Ephestia kuehniella
  Sweet pepper nectar+pollen (flowers)
  +2 control treatments *(with or w/o aphids)*

- 48h mated females. n=10
- 30 days



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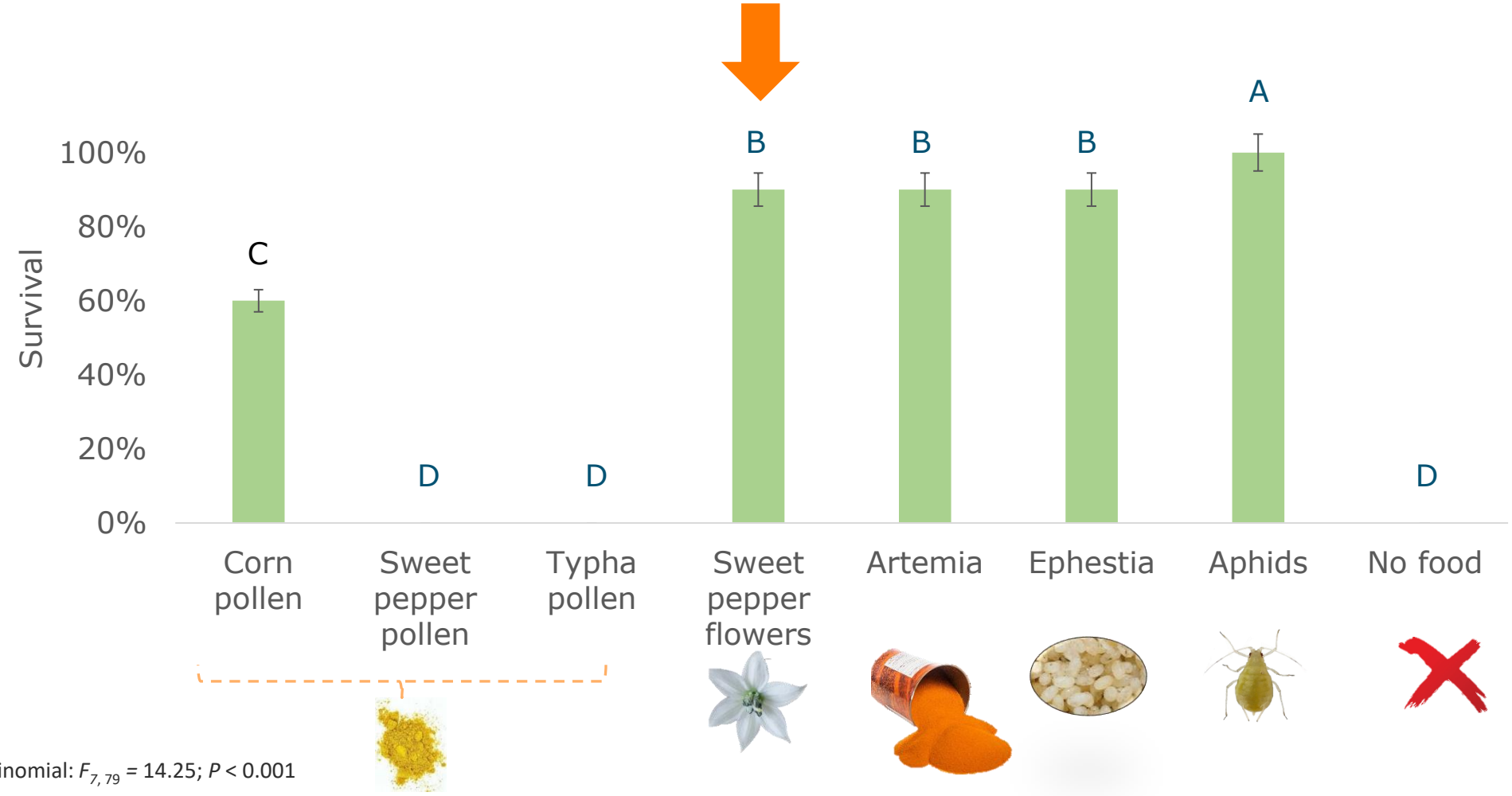
Survival after 30 days



GLM quasibinomial: $F_{7, 79} = 14.25$; $P < 0.001$

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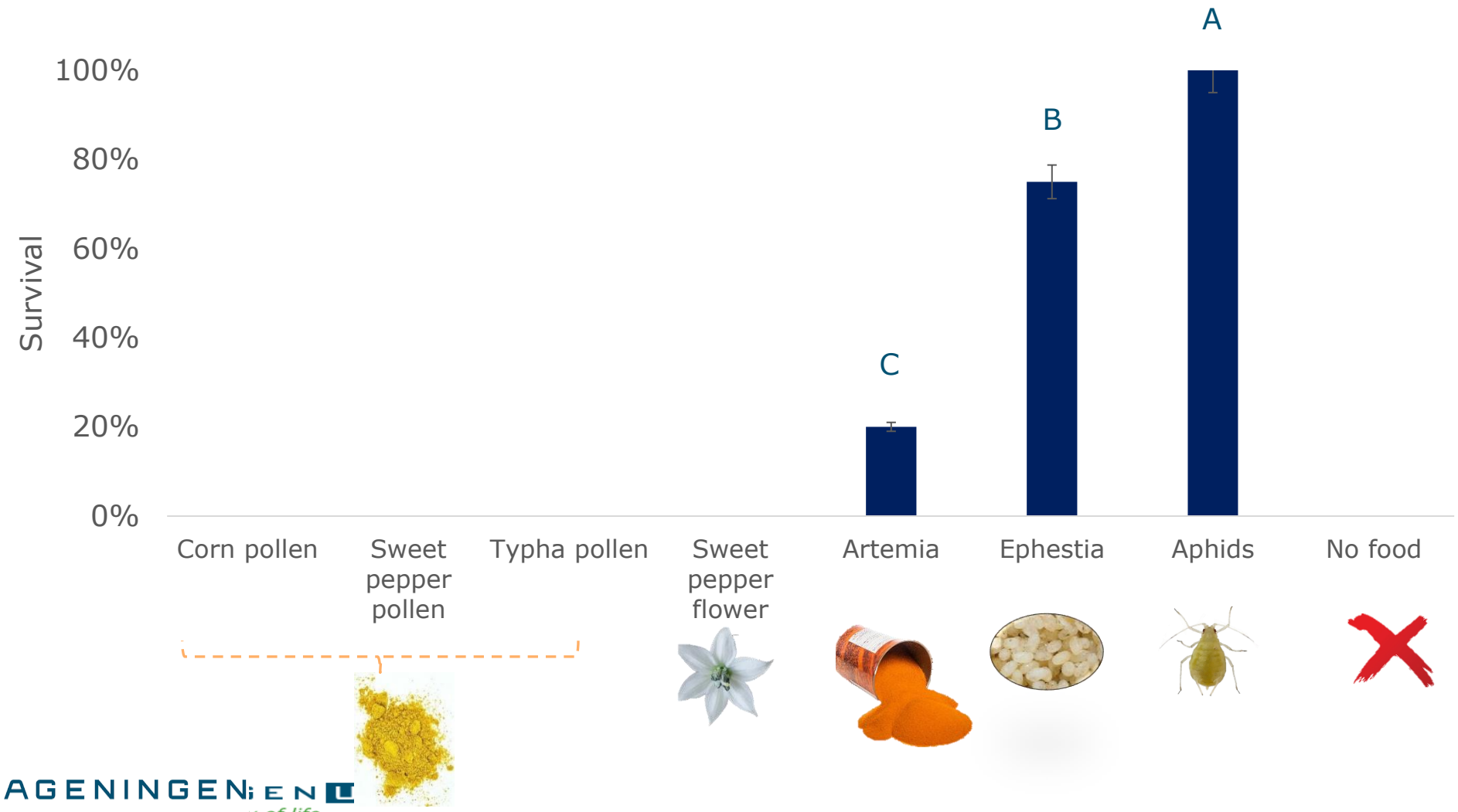
Survival after 30 days



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Greenhouse trial

- Margrethe cultivar. 8 weeks old. 3 stems per plant
- 16 walk-in-cages - 4 cages per treatments and 4 plants per cage
- TOTAL= 64 plants

Materials and methodology

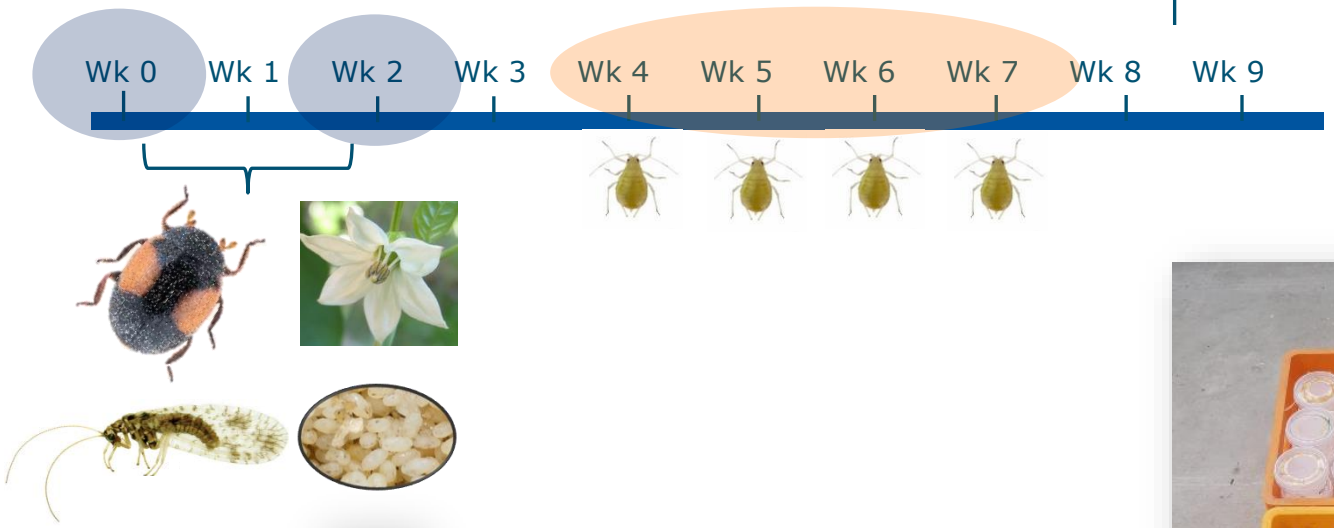
- 4 Treatments: *Micromus variegatus*
  Scymnus interruptus
  M. variegatus + S. interruptus
  Control (no n.e)

Materials and methodology

- Preventive releases: 12 couples of *Scymnus interruptus*
  6 couples of *Micromus variegatus* + *Ephestia*

NO APHID INFESTATION

2nd introduction 2 weeks later



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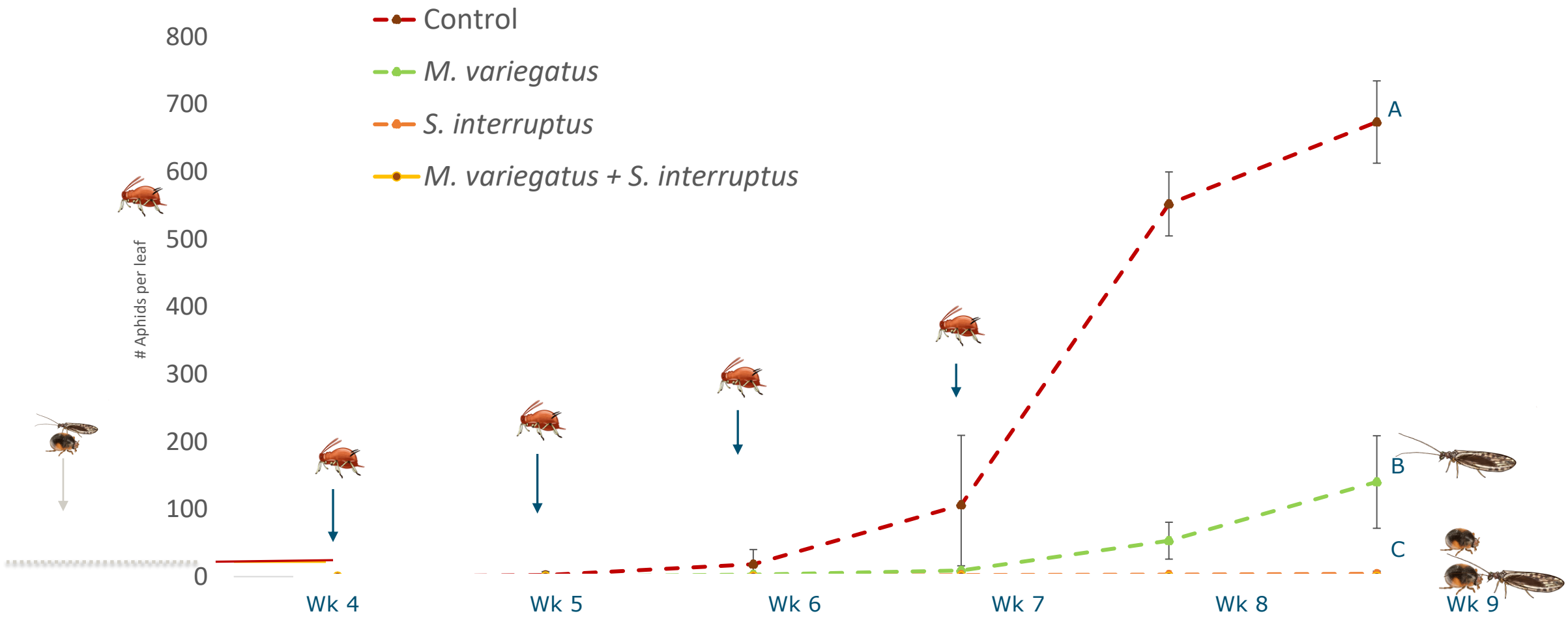
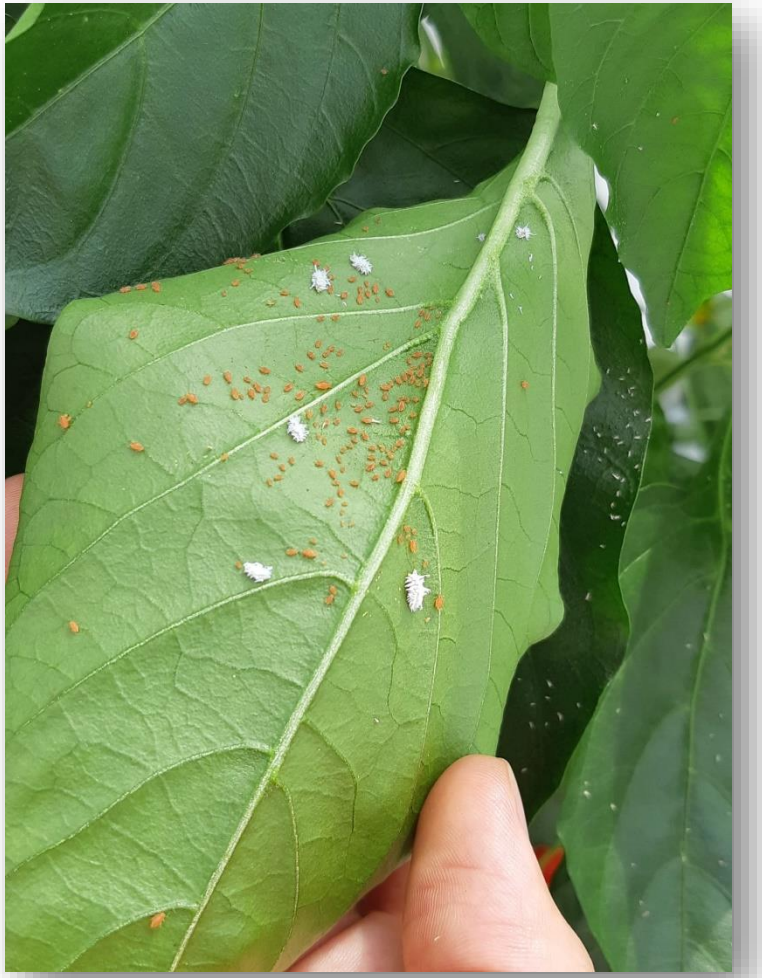
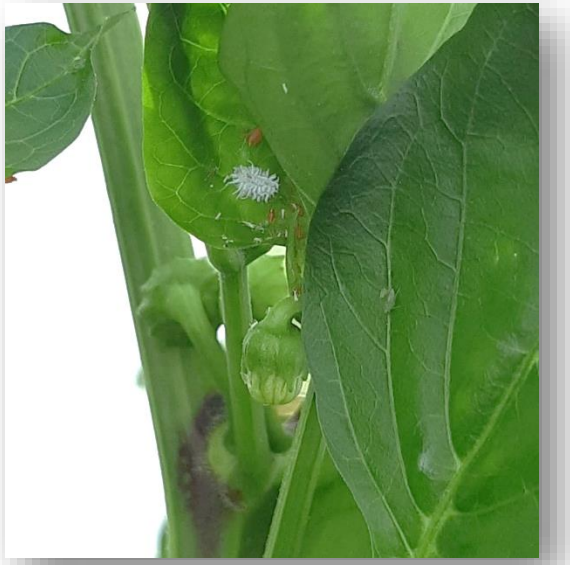
Results



GLMM Poisson: $\chi^2 = 25.69$; $P < 0.0001$

Good establishment of *Scymnus interruptus*





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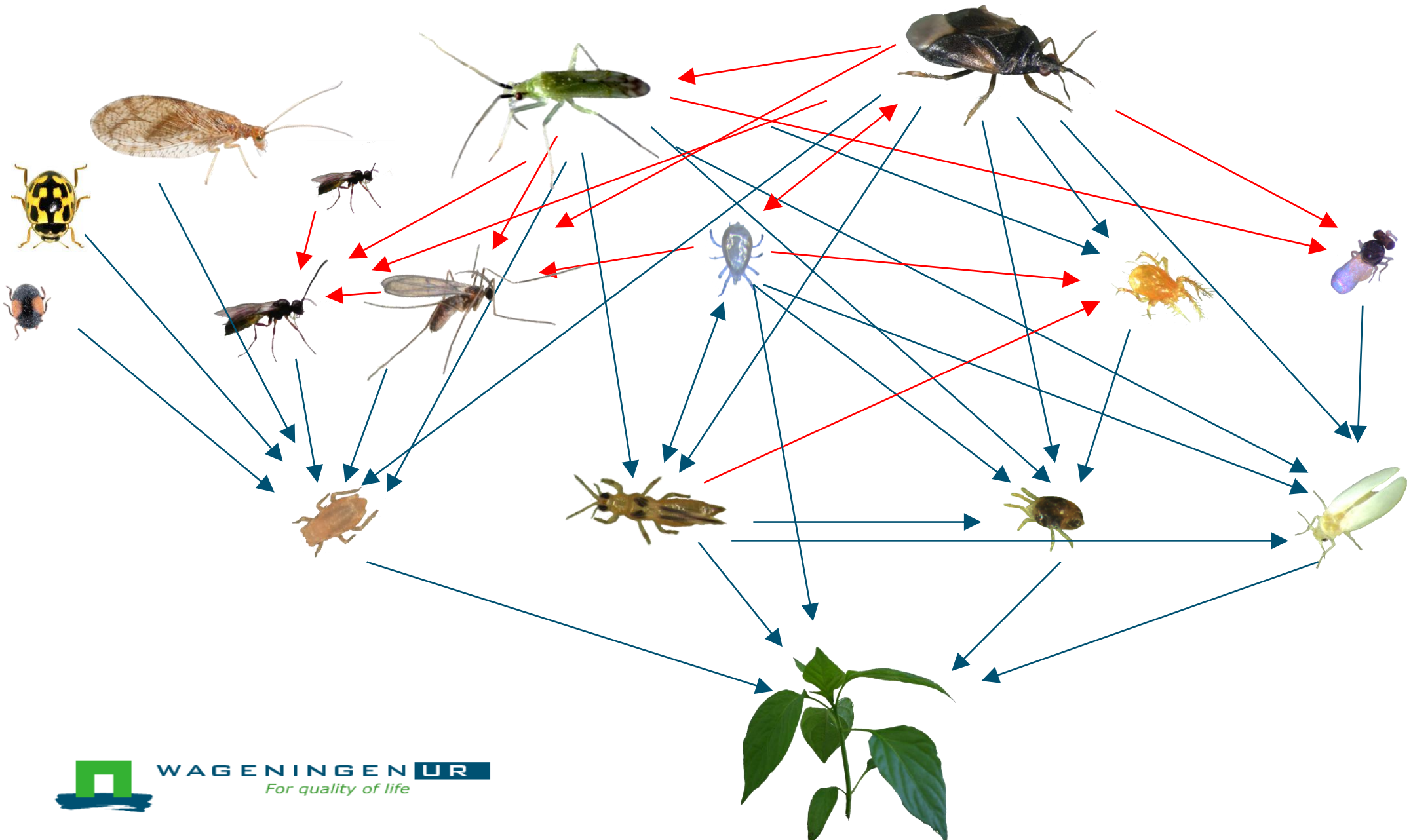
Voedselweb met aanvullende bladluisbestrijders



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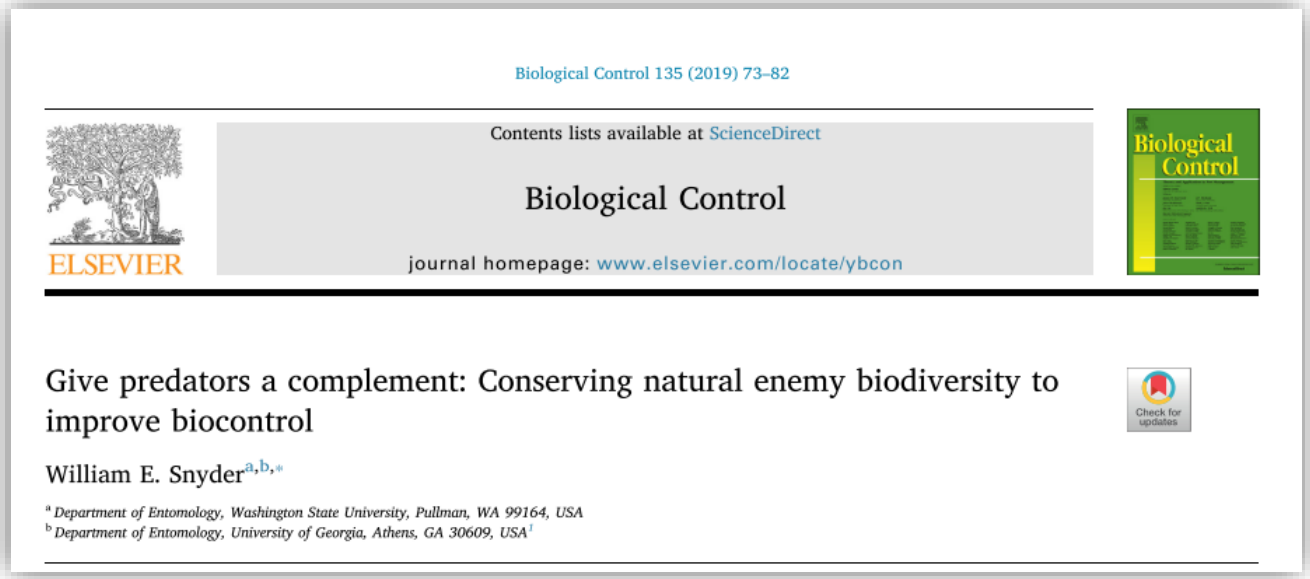
Hoe houd je al die natuurlijke vijanden in stand?

Probleem "Competitive exclusion principle":

- Soorten die concurreren om exact dezelfde bronnen kunnen niet naast elkaar bestaan, tenzij er sprake is van nichedifferentiatie
- Variatie is niches en meer habitatcomplexiteit reduceert verstorende interacties
    - Dus meer variatie in voedsel en schuilplekken!



Biological Control 135 (2019) 73–82

Contents lists available at ScienceDirect

Biological Control

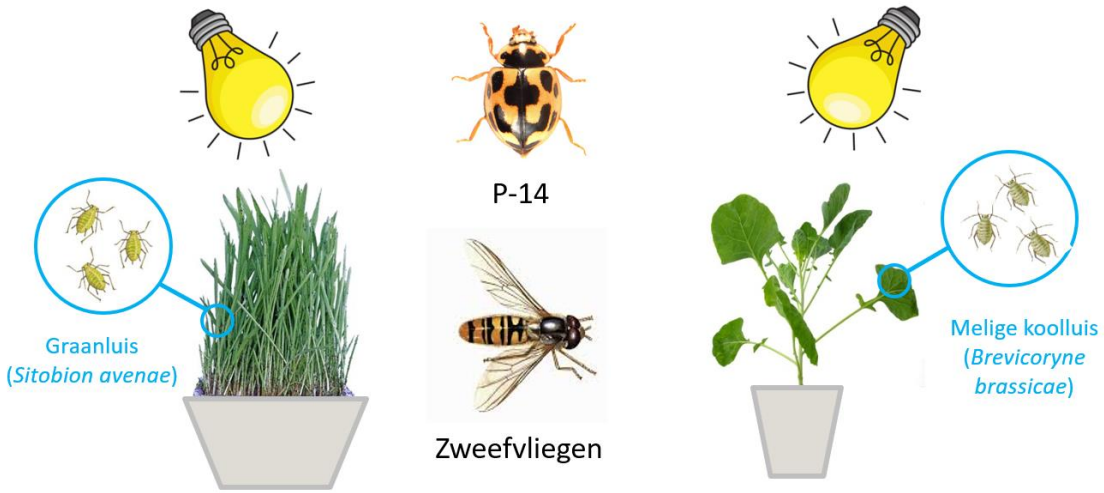
journal homepage: www.elsevier.com/locate/ybcon

Give predators a complement: Conserving natural enemy biodiversity to improve biocontrol

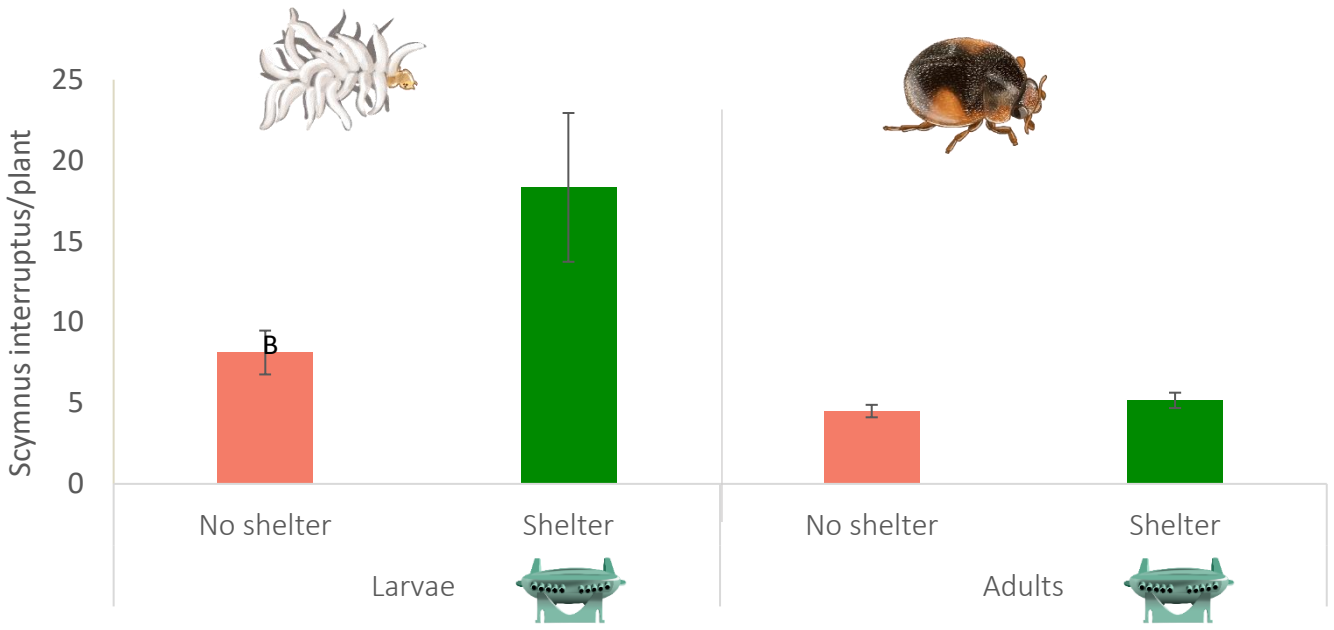
William E. Snyder[a,b,*]

[a] Department of Entomology, Washington State University, Pullman, WA 99164, USA
[b] Department of Entomology, University of Georgia, Athens, GA 30609, USA

Bijvoorbeeld met bankerplanten



Of schuildoosjes: verhoogde eileg Scymnus interruptus



Pérez-Rodríguez & Messelink, 2023. *Biological Control*

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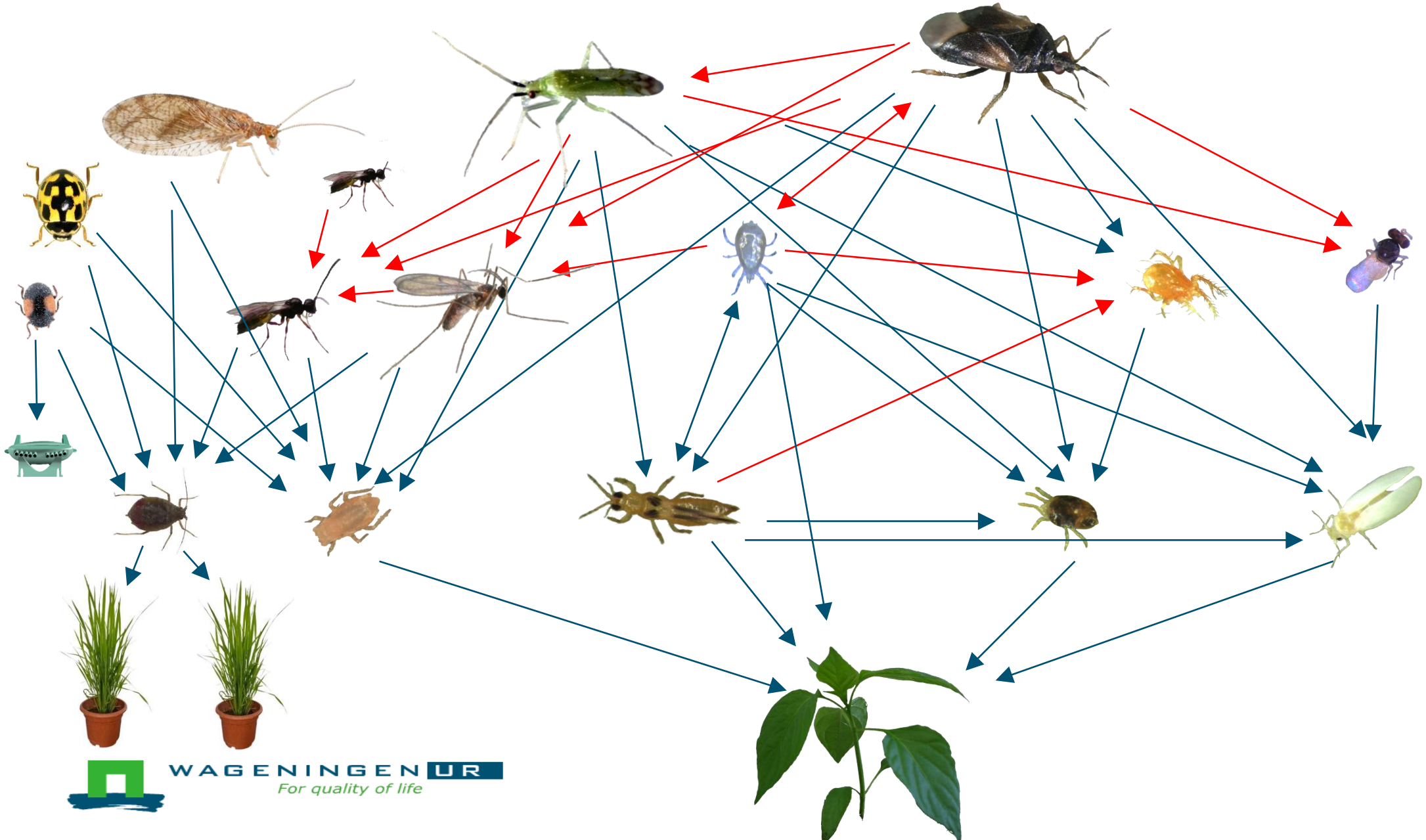

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Nieuwe uitdagingen blijven komen: 2020-heden

- nieuwe invasieve plagen

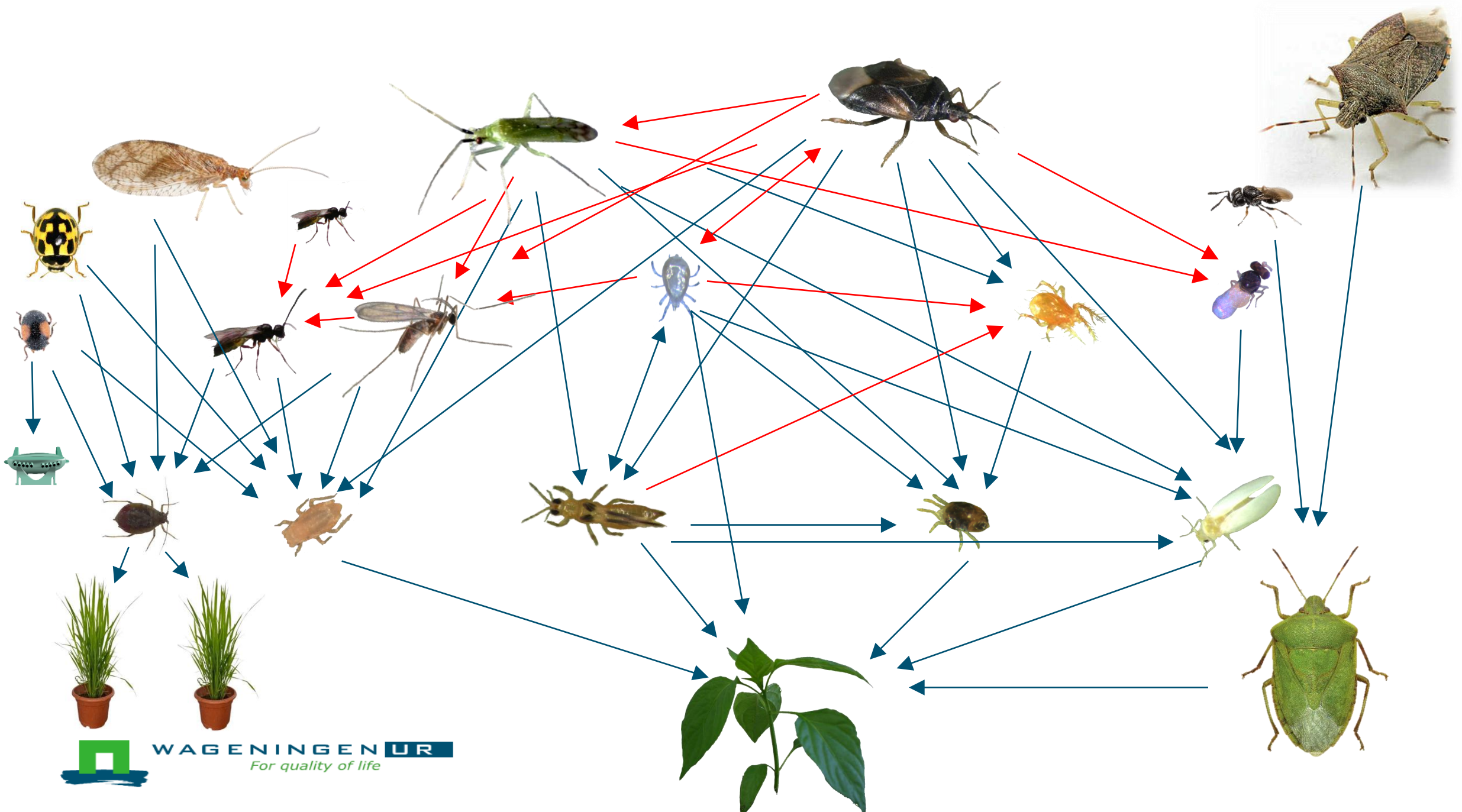
Nezara viridula

Thrips parvispinus

Nieuwe mogelijkheden voor biologische bestrijding van *Nezara viridula*

Podisus maculiventris

Trissolcus basalis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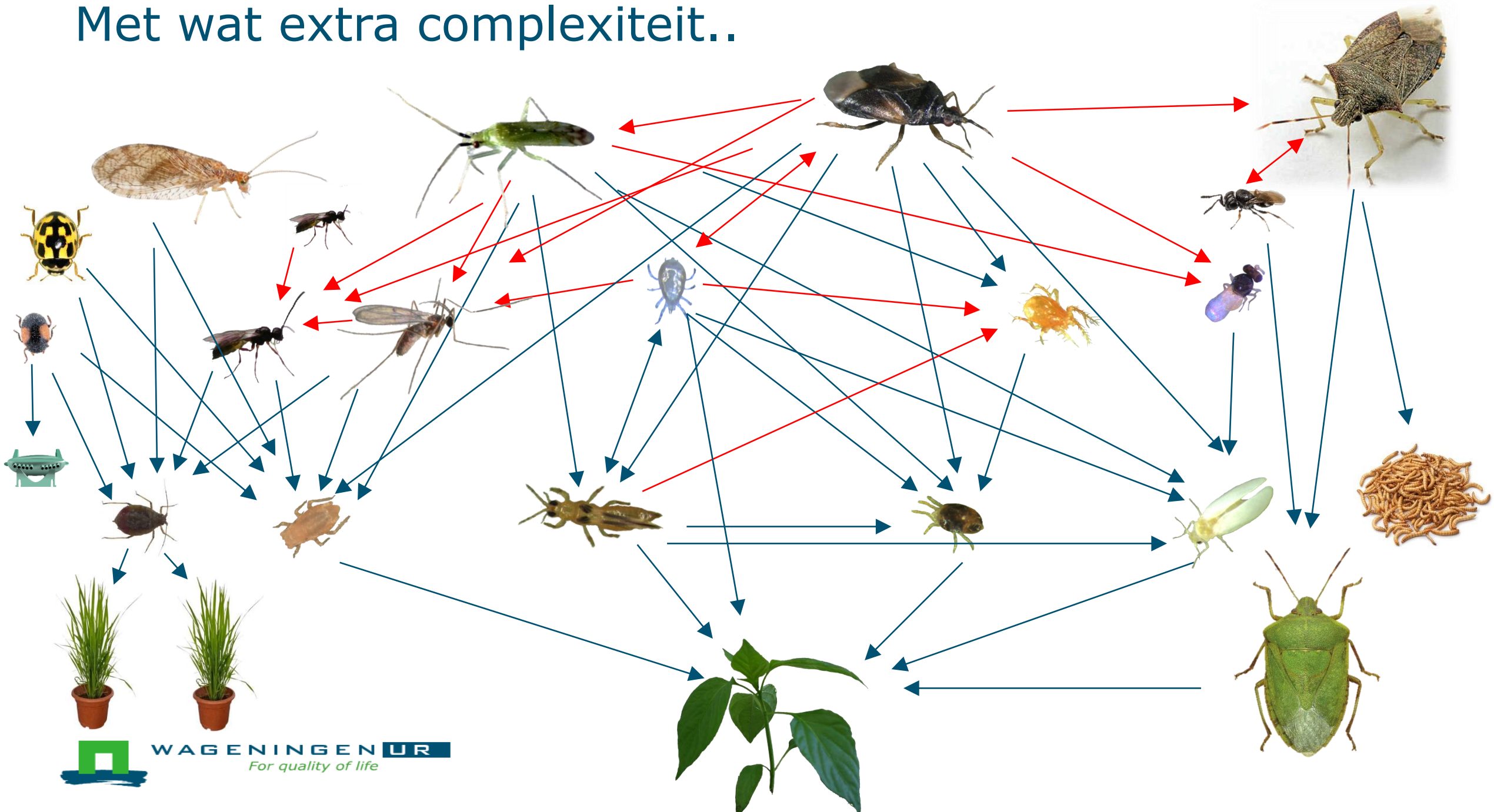
Met wat extra complexiteit..



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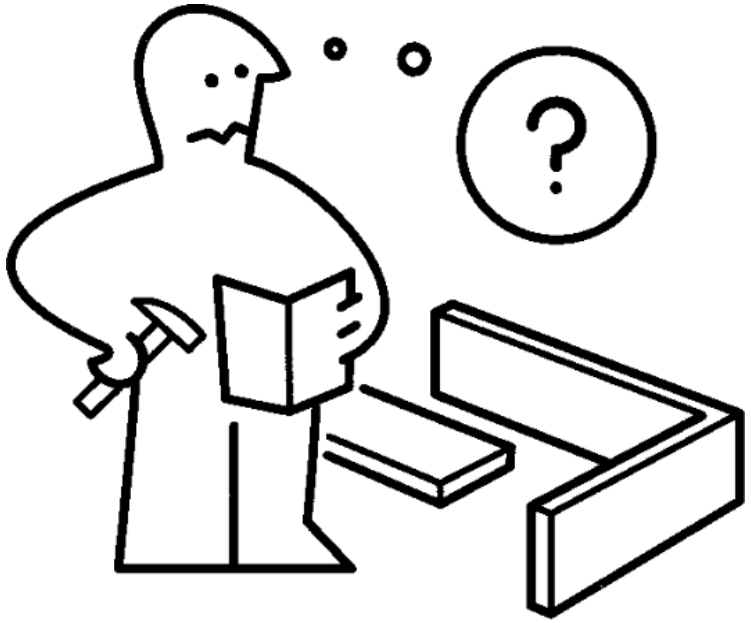
Hoe verder?



Biologische bestrijding wordt ecosysteemmanagement!

- natuurlijke vijanden die passen bij het gewas, elkaar zoveel mogelijk aanvullen en ondersteund worden met voedsel en schuilplekken
- Belangrijk interacties te begrijpen en verstorende interacties te beperken met niche-differentiatie

Lopend onderzoek: herontwerp teeltsystemen

- *Kennisimpuls Groene gewasbescherming en Bestuivers*
  - Casus aardbei, tomaat en potplanten
  - Hoe kan het teeltsysteem worden aangepast voor verhoogde weerbaarheid?
    - variatie in voedsel, schuilplekken, habitat
    - variatie in natuurlijke vijanden

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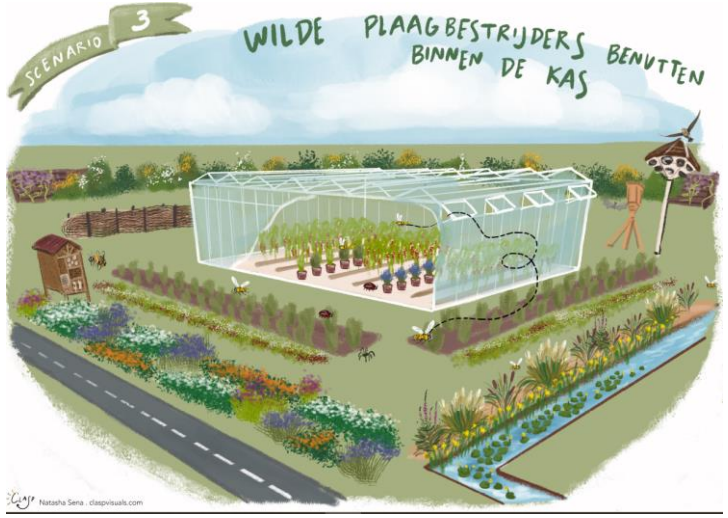
Ministerie van Landbouw,
Natuur en Voedselkwaliteit

Nieuwe PPS Biodiversiteit in en om de kas



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Dank voor de aandacht!

Stichting Kennis in je Kas

Glastuinbouw Nederland
morgen groeit vandaag

TOPSECTOR
TUINBOUW & UITGANGSMATERIALEN

WAGENINGEN UR
For quality of life

Ministerie van Landbouw, Natuur en Voedselkwaliteit

Viridaxis

BIOPLANET

KOPPERT
BIOLOGICAL SYSTEMS