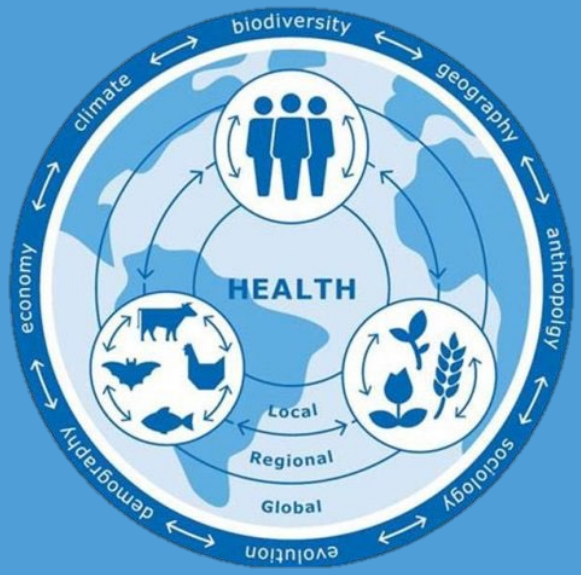
Blood-feeding midges as models for the role of microbiomes in the transmission of diseases: a Global One Health approach

24 October, 2019, Leo van Overbeek, Tim Möhlmann, Els Nijhuis, Sander Koenraadt



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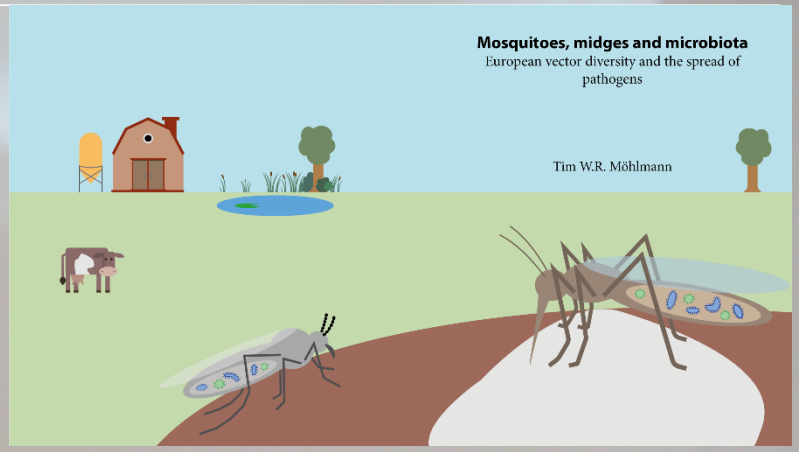
100years
1918 — 2018

Tim Möhlmann



Why a Global One Health Approach?

Vector-borne veterinary disease.

Transmission via midges

- Schmallenberg virus (SBV: Orthobunyavirus, Bunyaviridae; ssRNA virus)
- Bluetongue virus (BTV: Orbivirus, Reoviridae; ds RNA virus)

Transport

Trade

Climate change

Local environment

Livestock
- Cows (SBV)
- Sheep (BTV)

Farmers
- Food production
- Economy
- Emotion

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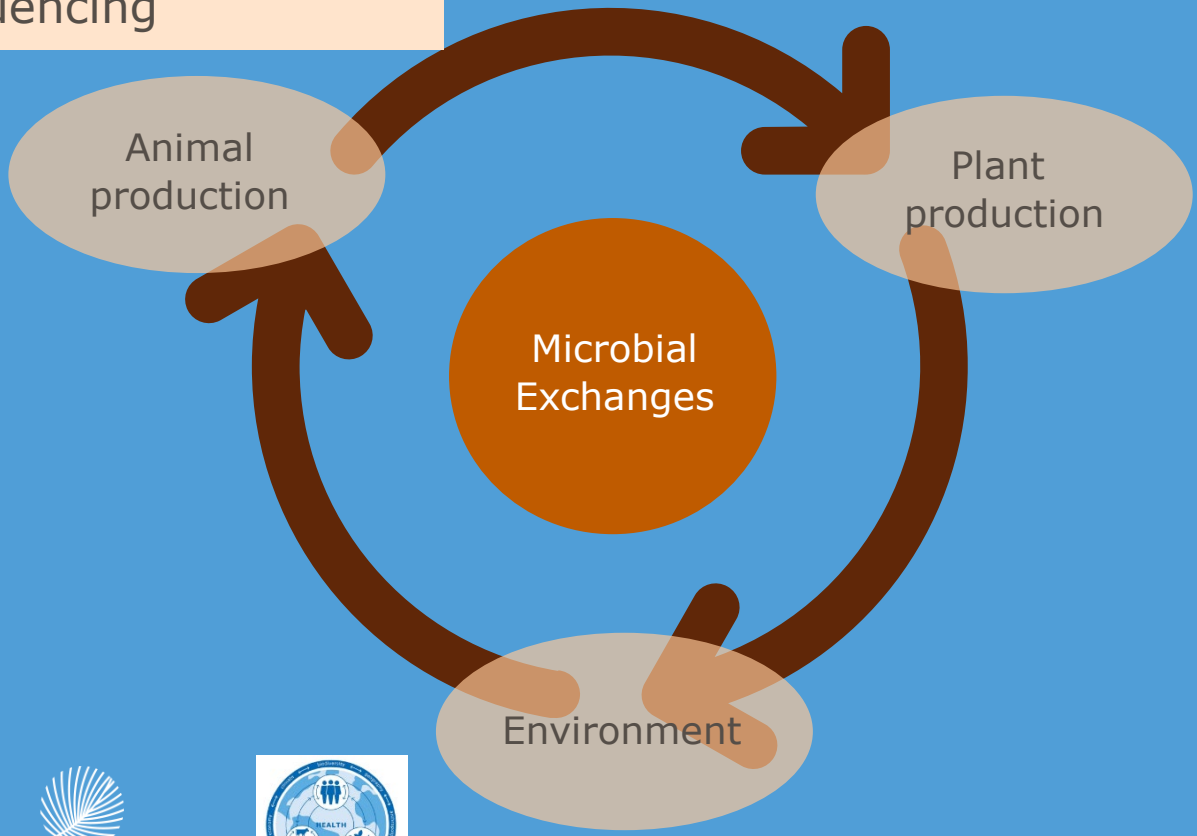
Why a Microbiome Solution?

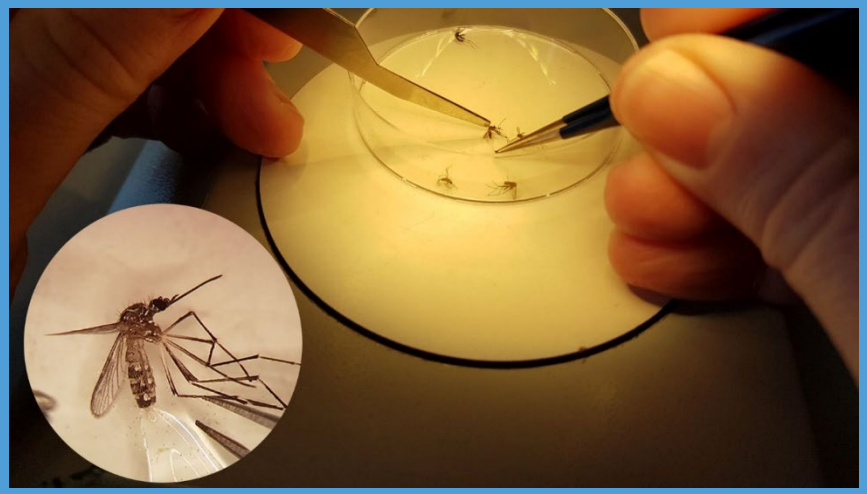
Microbiome Research

- Microbial composition
- Microbial functioning (metagenomics)

Next Generation Sequencing

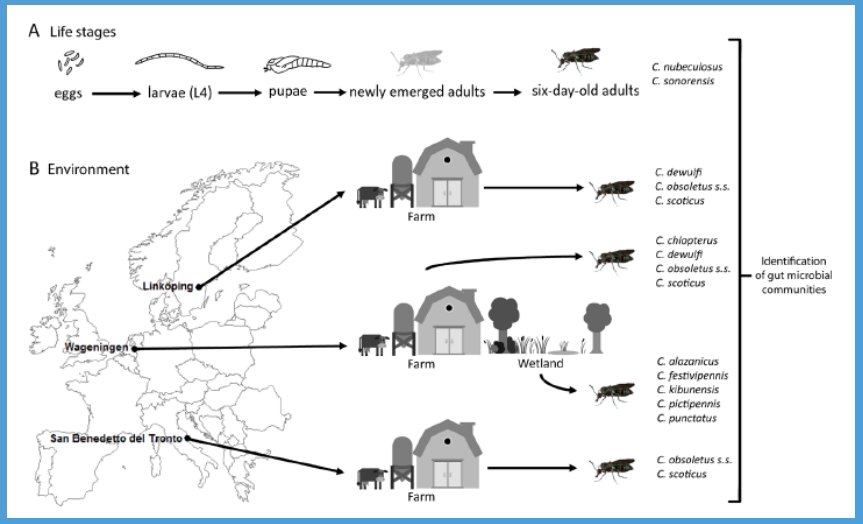


Midge (*Culicoides*) species



Laboratory-reared species:

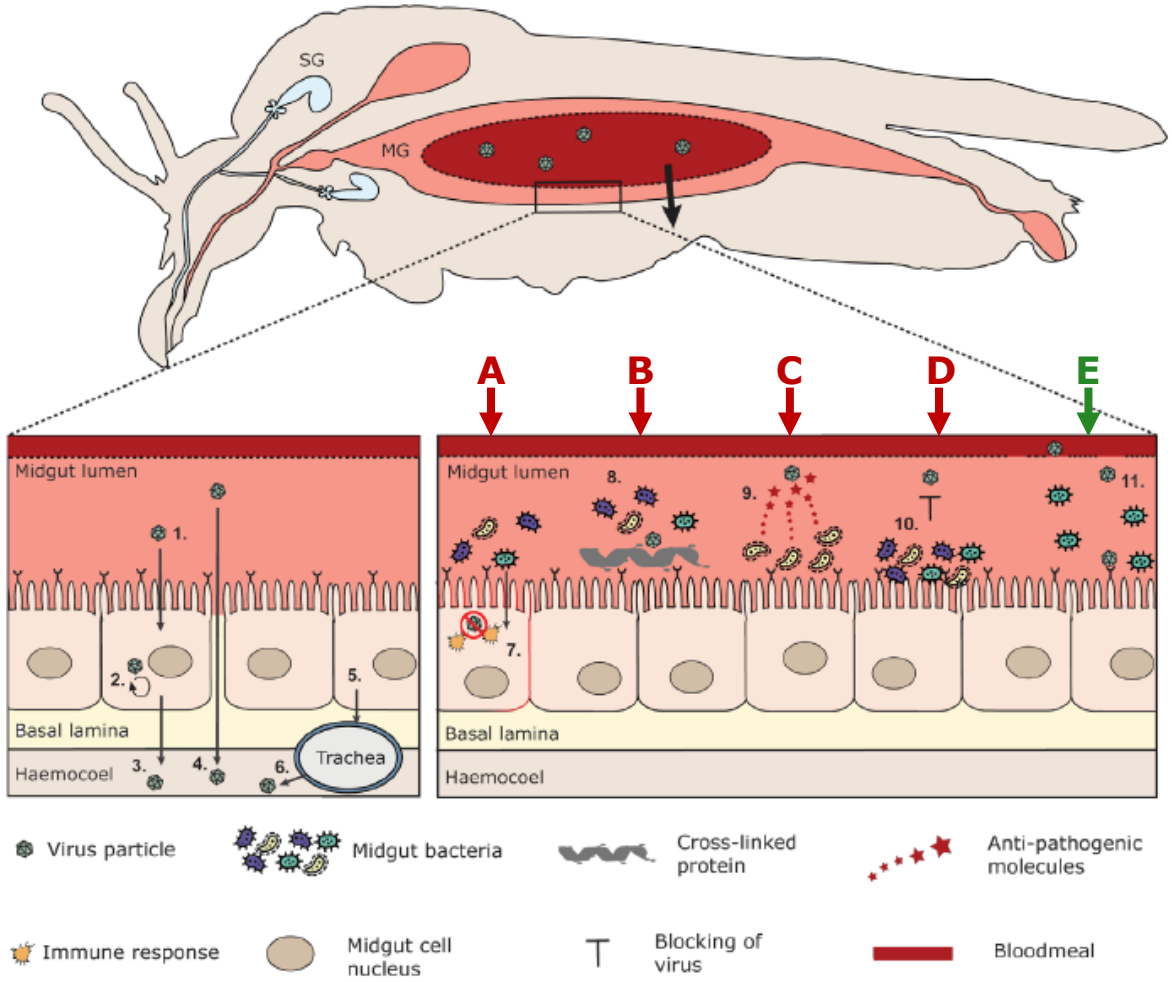
- *C. sonorensis*
- *C. nubeculosus*



Wild species: *Cullicoides* species from the Obsoletus group:

- *C. obsoletus* s.s.
- *C. scoticus*
- *C. dewulfi*
- *C. chiopterus*

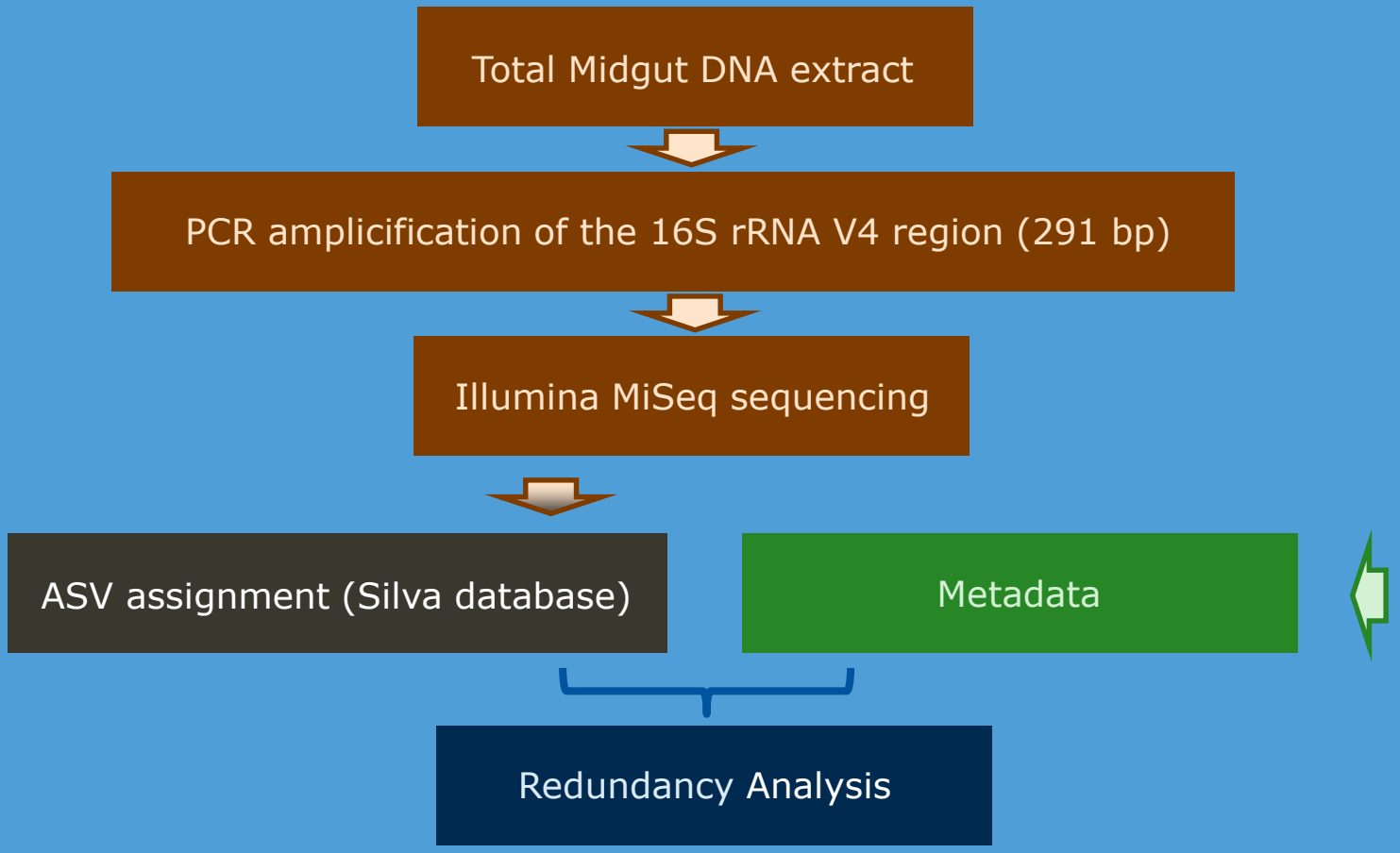
Role of midgut microbiota on virus transmission



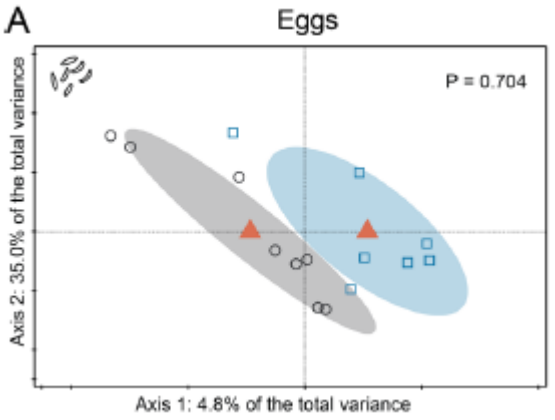
A. Antimicrobial immune response
B. Protective layer over epithelial cells
C. Antipathogenic molecules
D. Bacterial physical barrier
E. Inhibition of peritrophic membrane/ biofilm formation

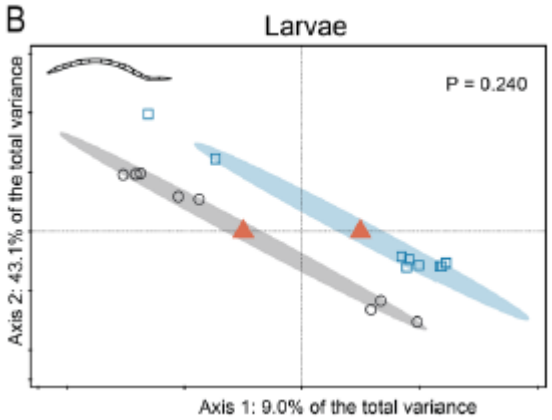
Midgut Microbiota Analysis

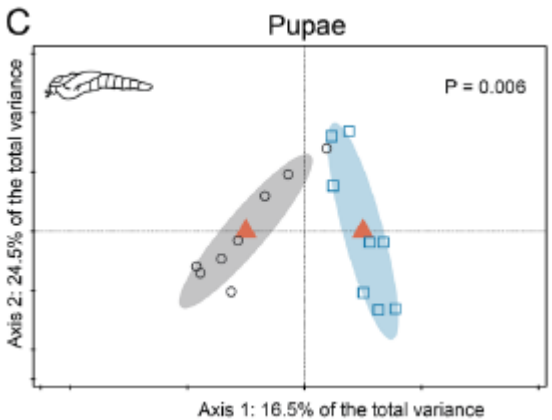
Amplicon sequencing

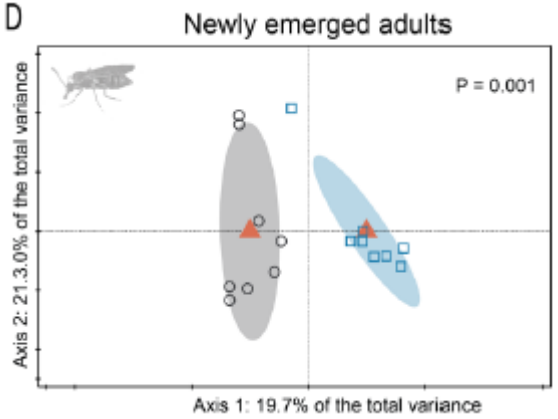


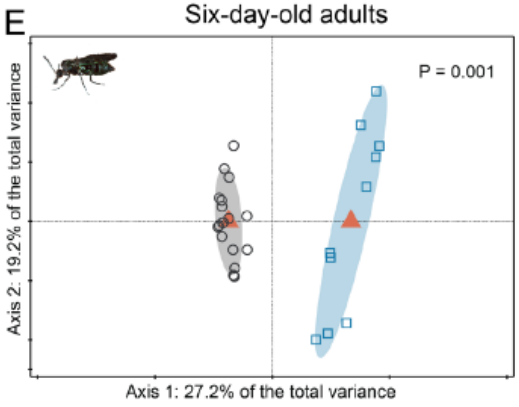
Microbial community development lab-reared species

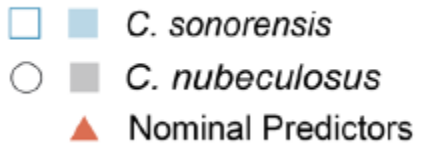




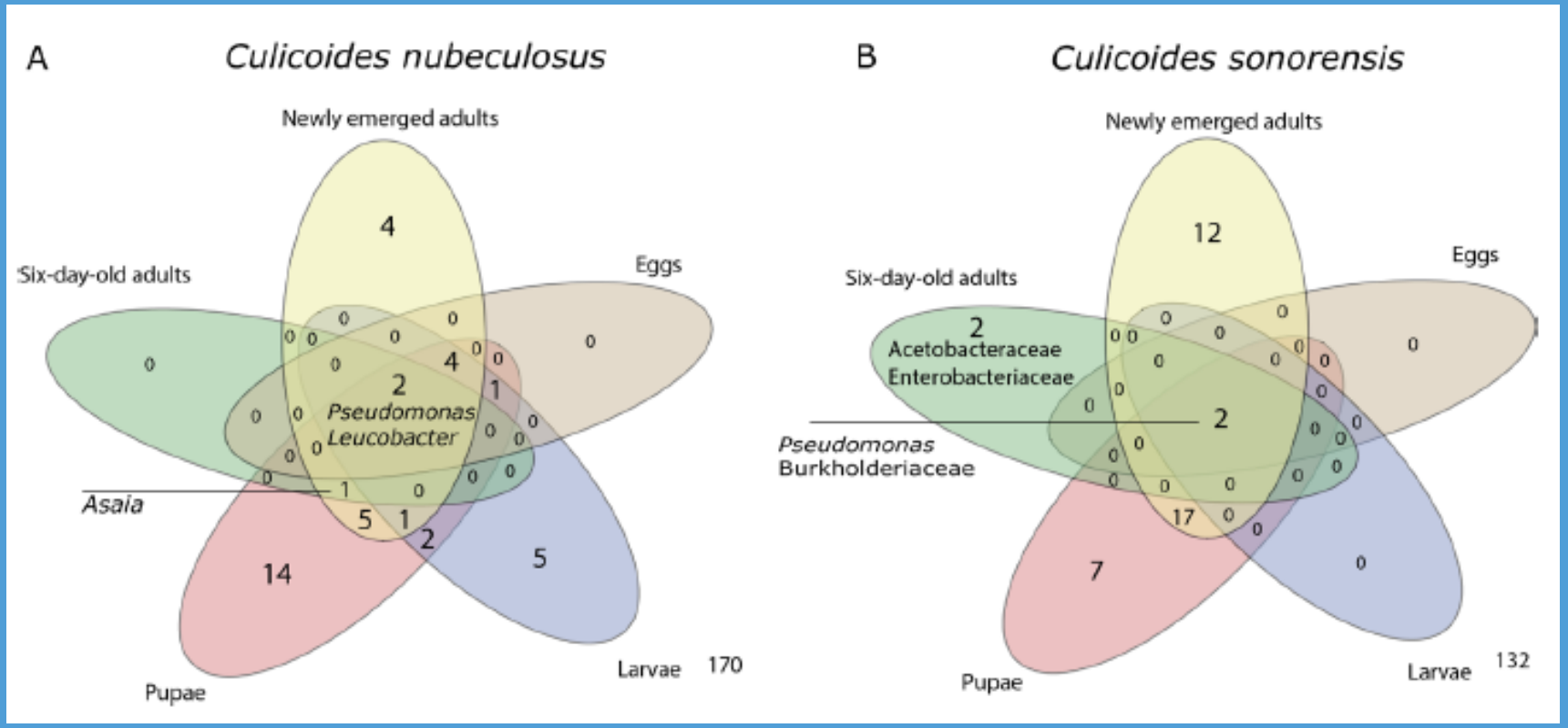




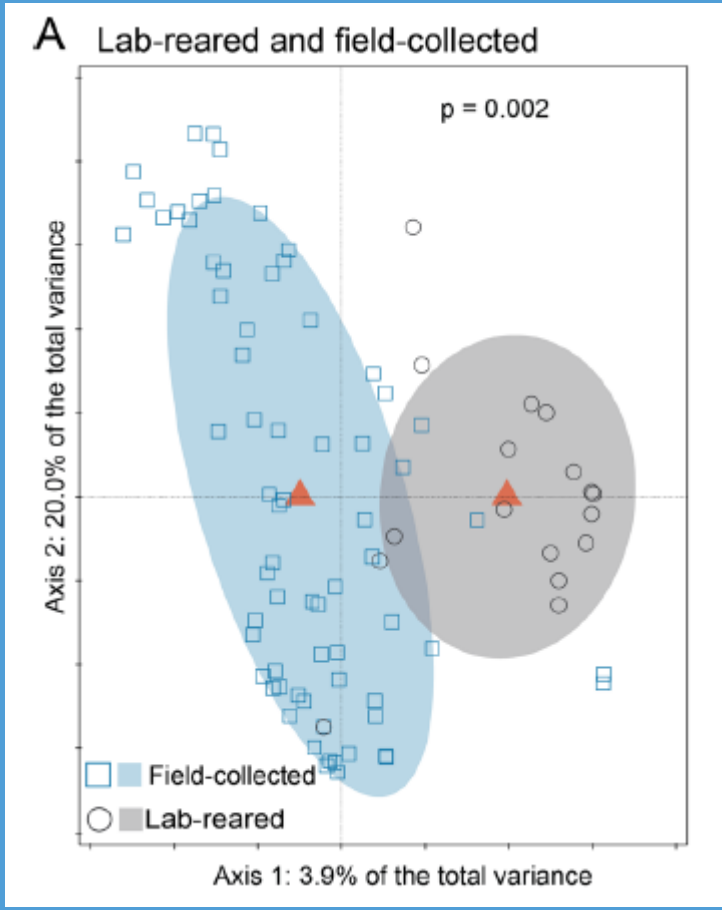


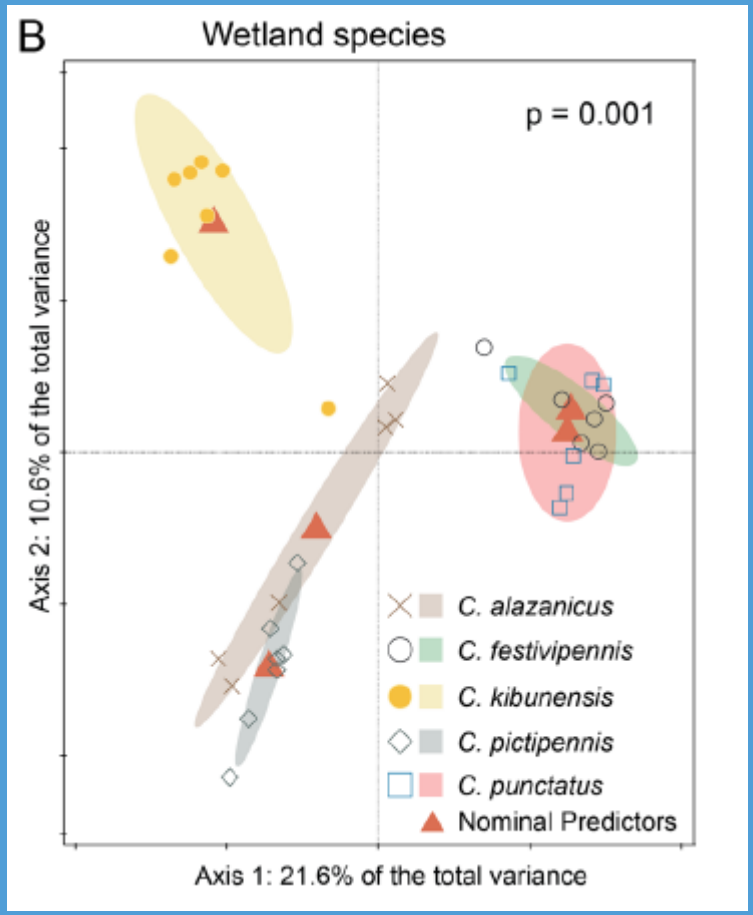


Microbial composition lab-reared species

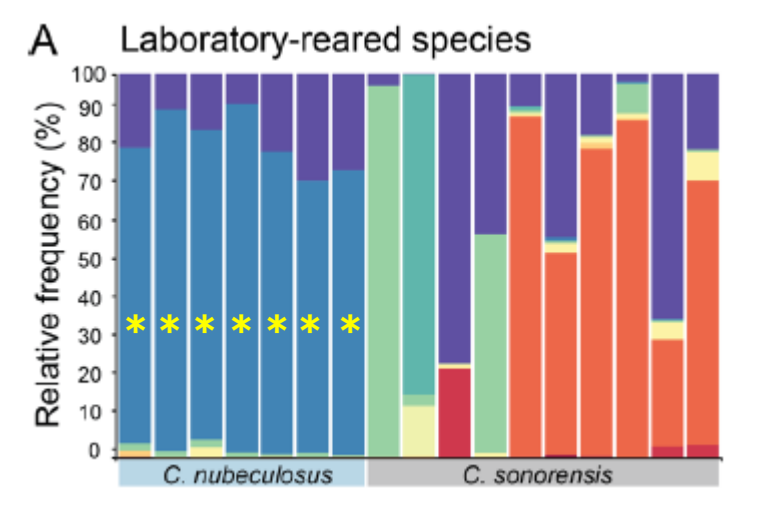


Lab-reared versus wild caught species



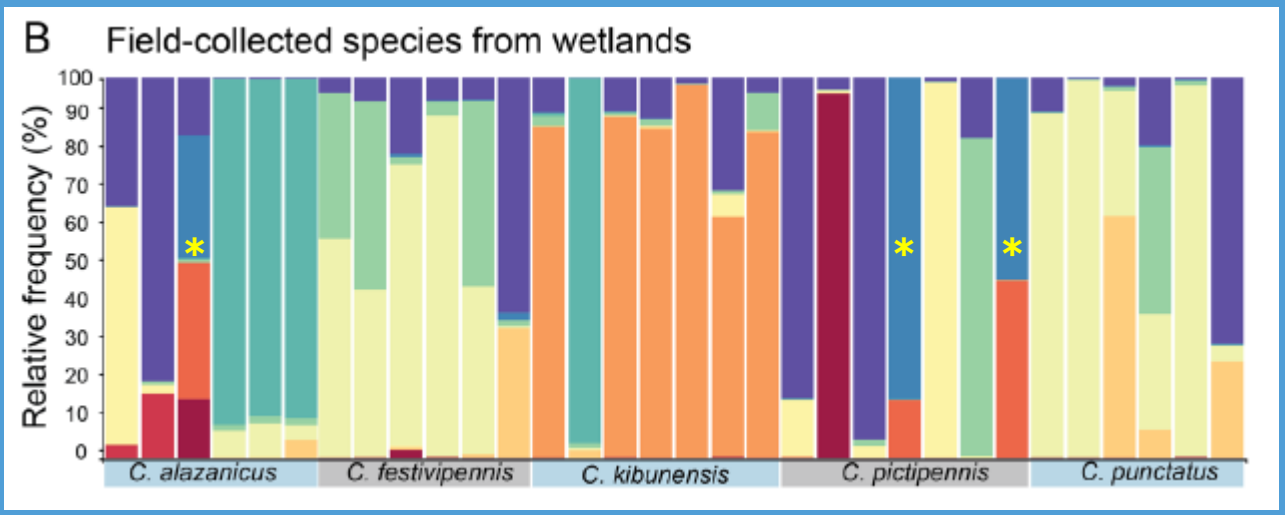


Microbial composition in midges

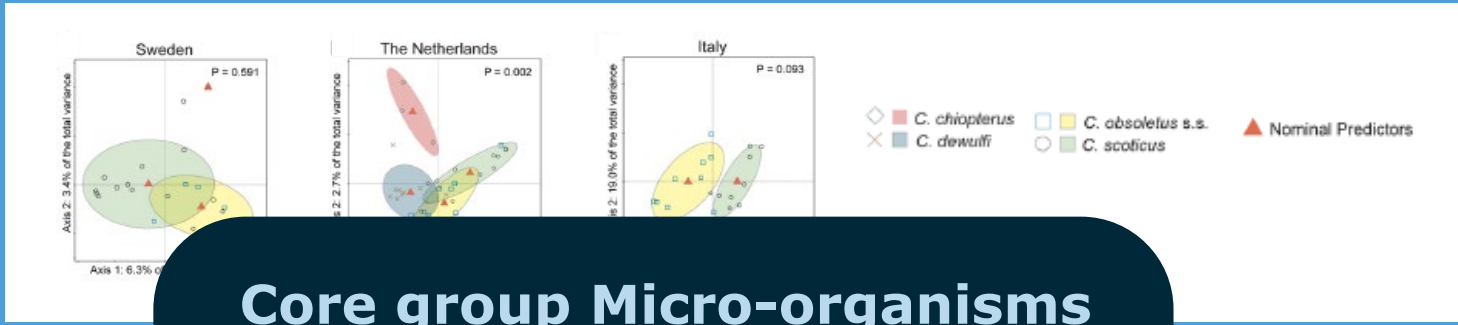


* *Acetobacteriaceae (Asaia)*

- Proteobacteria; Alphaproteobacteria; Acetobacterales; Acetobacteraceae; *Asaia*
- Proteobacteria; Alphaproteobacteria; Rickettsiales; Rickettsiaceae; *Rickettsia*
- Proteobacteria; Gammaproteobacteria; Pseudomonadales; Pseudomonadaceae; *Pseudomonas*
- Proteobacteria; Alphaproteobacteria; Rickettsiales; Anaplasmataceae
- Bacteroidetes; Bacteroidia; Cytophagales; Amoebophilaceae; *Candidatus_Cardinium*
- Proteobacteria; Gammaproteobacteria; Betaproteobacteriales; Burkholderiaceae
- Proteobacteria; Gammaproteobacteria; Enterobacteriales; Enterobacteriaceae
- Proteobacteria; Alphaproteobacteria; Rickettsiales; Anaplasmataceae; *Wolbachia*
- Proteobacteria; Alphaproteobacteria; Acetobacterales; Acetobacteraceae
- Proteobacteria; Gammaproteobacteria; Betaproteobacteriales; Aquaspirillaceae; *Aquaspirillum*
- Proteobacteria; Alphaproteobacteria; Sphingomonadales; Sphingomonadaceae; *Sphingomonas*
- Other Taxa

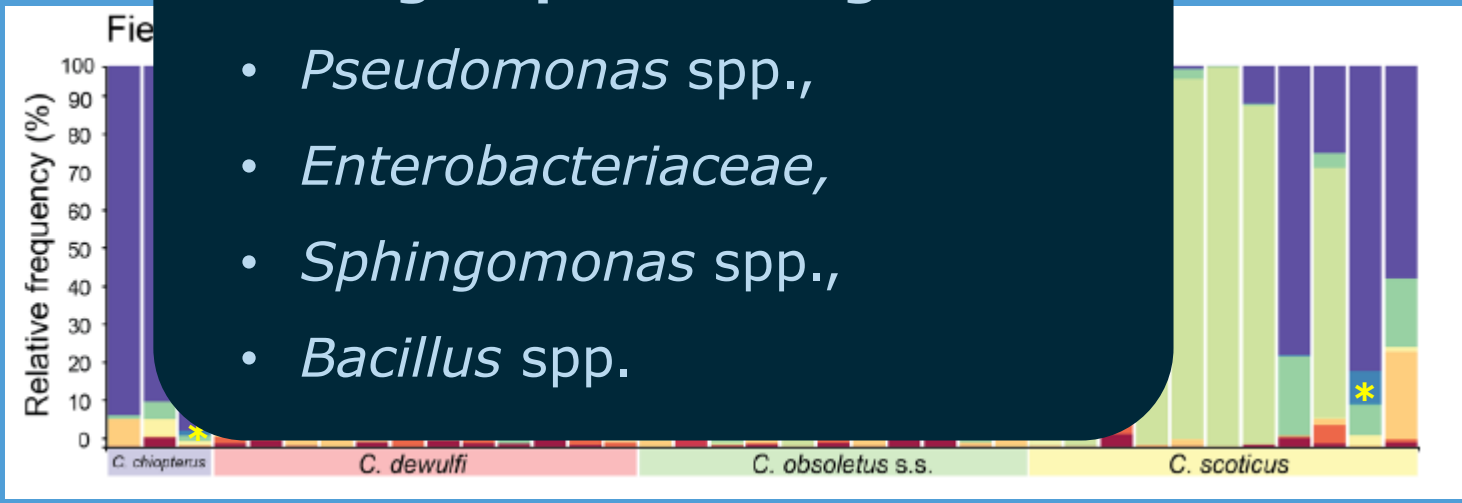


Microbial composition *Obsoletus* group



Core group Micro-organisms

- *Pseudomonas* spp.,
- *Enterobacteriaceae,*
- *Sphingomonas* spp.,
- *Bacillus* spp.



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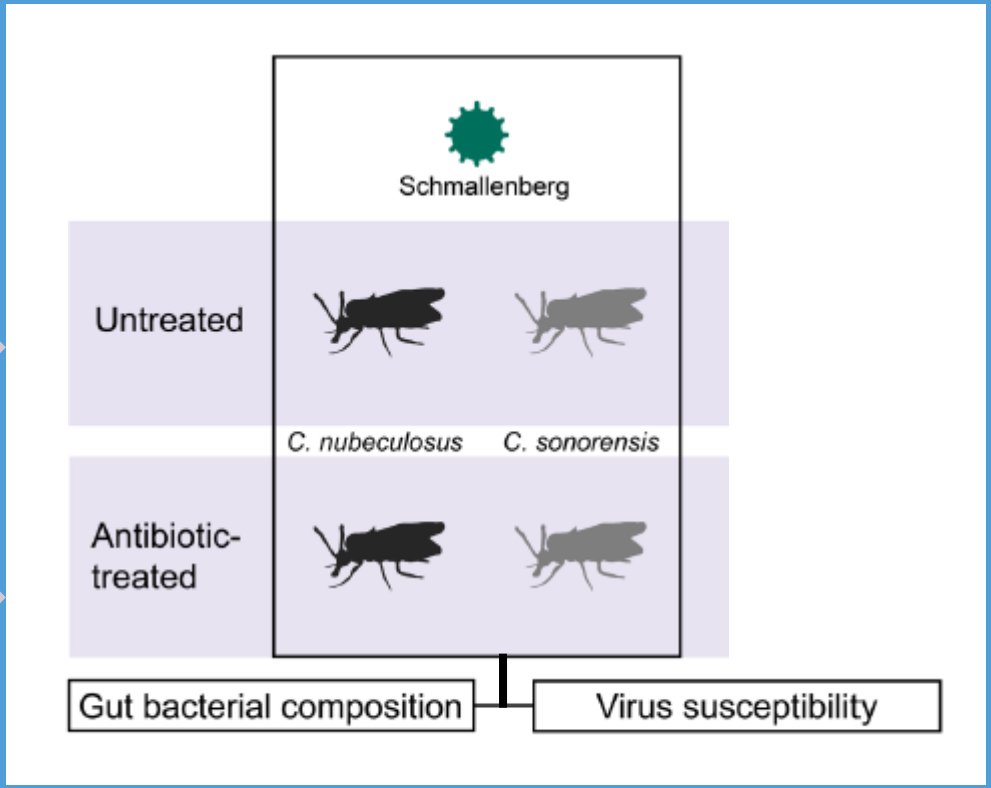
Proteobacteria; Alphaproteobacteria; Sphingomonadales; Sphingomonadaceae; *Sphingomonas*
Other Taxa

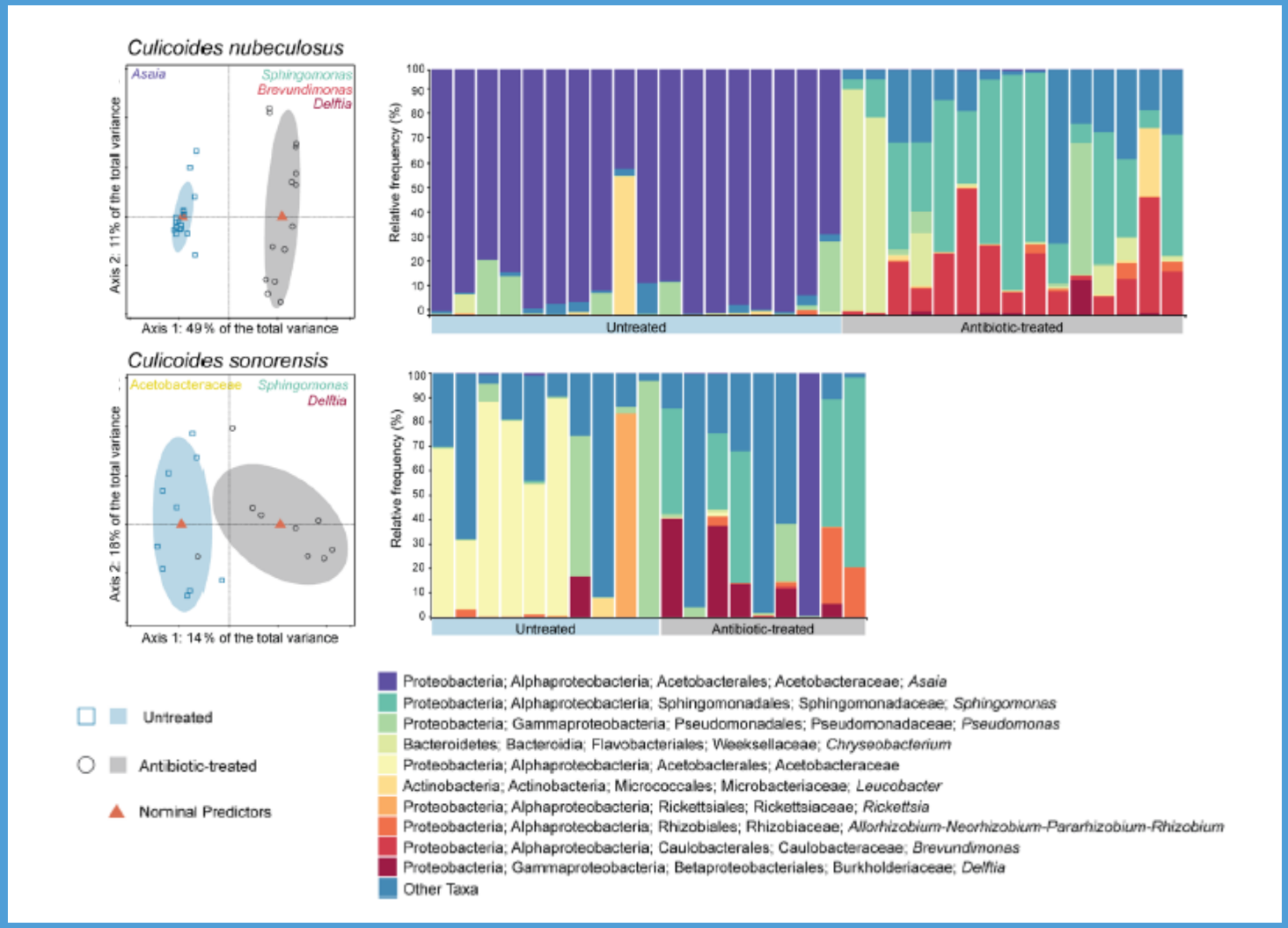
Effect of microbiome manipulation on virus transmission

Glucose

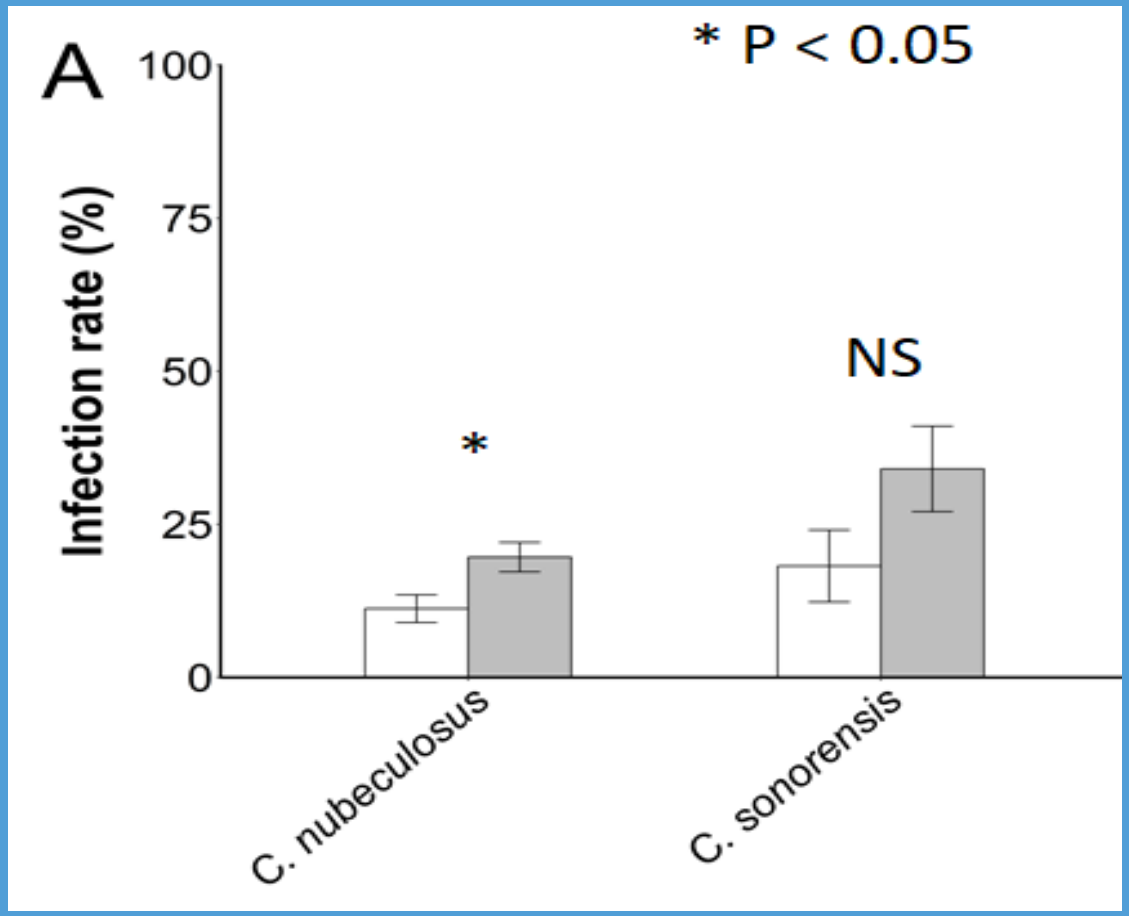
Glucose + 10 ppm penicillin and streptomycin



Effect antibiotics on microbial composition



Effect antibiotics on SBV transmission



Key outcome

- Microbial composition in the midgut of midges depend on:
    1. Species type
    2. Developmental stage
    3. Habitat of origin/ food source
- *Asaia* spp. (*Acetobacteriaceae*) dominates bacterial communities. Especially in lab-reared midges.
    - Possibly related to food source (glucose)
    - Role is, up to now, relatively unexplored
- Antibiotic treatment impact bacterial community composition and SBV transmission
    - What is the role of the microbiome on SVB transmission?

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