

Ricarda Scheiner¹, Lioba Hilsmann¹, Martin Hasselmann²

¹Behavioral Physiology and Sociobiology, Julius-Maximilians-Universität Würzburg, Würzburg, Germany

²Department of Population Genomics, Institute of Animal Science, University of Hohenheim, Garbenstrasse 17, 70599, Stuttgart, Germany

Varroa destructor threatens honeybee colonies by feeding primarily on developing bees, thereby depleting their nutrients and causing stress. It also leaves the bee more vulnerable to diseases. Conventional beekeeping removes drone brood in spring and treats colonies with formic acid in summer and oxalic acid in winter. However, the resulting constant low mite pressure prevents bees from adapting to Varroa mites, and climate change affects treatment efficiency. Sustainable beekeeping omits drone brood removal, resulting in a high temporary Varroa pressure, because the mites prefer drone brood over worker brood for development and reproduction. This high mite pressure supports the bees in adaptation to the mites. A brood interruption by queen caging and subsequent single oxalic acid treatment reduce Varroa infestation in summer. But some beekeepers are concerned about the high Varroa infestation in summer and the potential spread of pathogens with sustainable practices.

We compared honey bees from conventional beekeeping and sustainable beekeeping for Varroa load (using sticky bottom boards) and pathogen load (using high-throughput qPCR covering 18 pathogens) at three critical time points: mid-April, end of June and mid-October. Varroa load was significantly higher in April and June in colonies from sustainable beekeeping, while the two groups did not differ in October. Pathogen load differed significantly between foragers of the two beekeeping groups in June. Foragers from sustainable beekeeping had significantly higher loads of black queen cell virus, deformed wing virus B, lake Sinai virus and Crithidia mellificae. In October, however, foragers from sustainable beekeeping had lower levels of C. mellificae and Varroa destructor macula like virus than bees from conventional beekeeping practice but higher levels of chronic bee paralysis virus. Our findings suggest an important role of the Varroa mite in initiating a complex infection cascade through transfecting bees with deformed wing virus, thereby spreading further pathogens. Sustainable beekeeping has no negative long-term effects on honey bees. The temporary high Varroa load leads to a higher infection rate with other pathogens in summer but queen caging and oxalic acid summer treatment suffice to reduce Varroa and pathogen loads in time for the winter break.

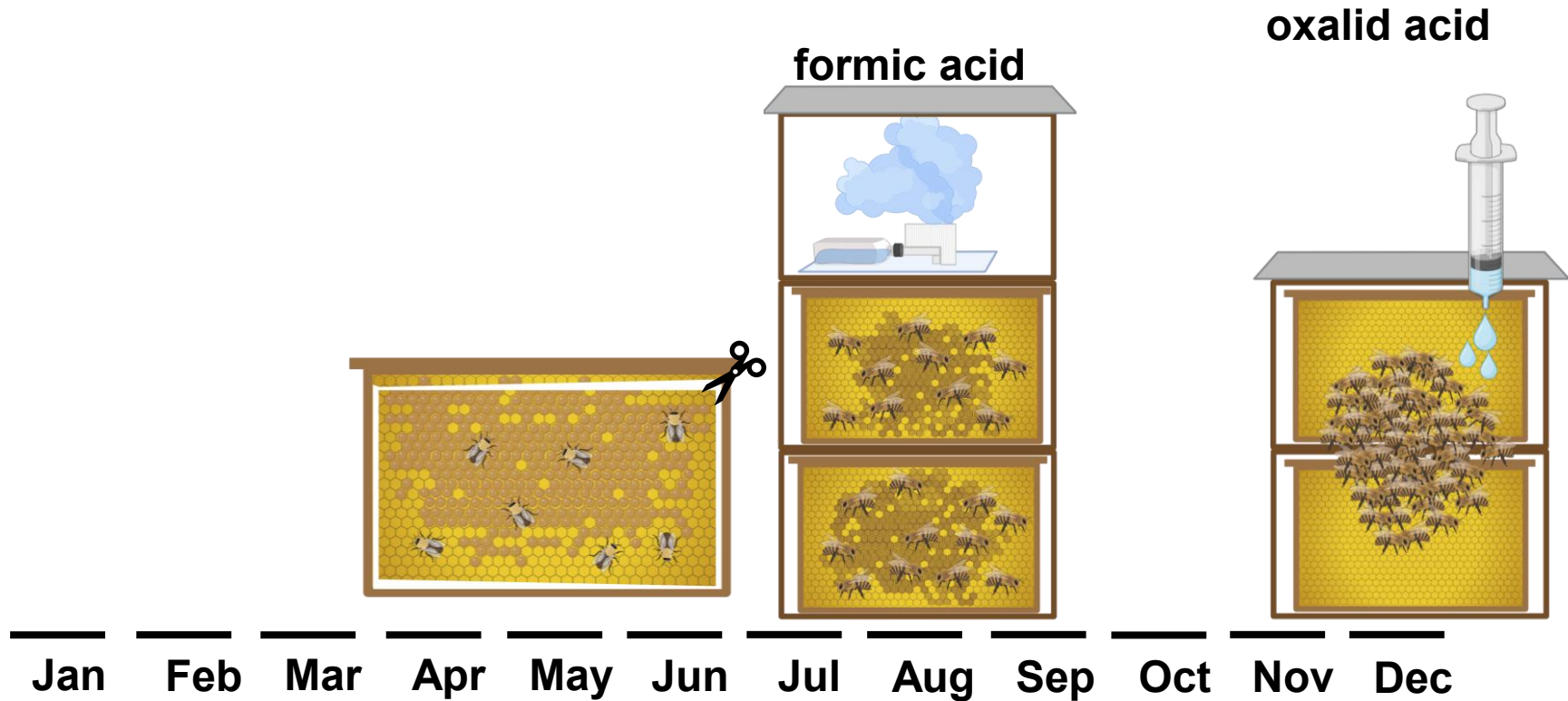


Effects of conventional and sustainable beekeeping on the pathogen load of honeybees



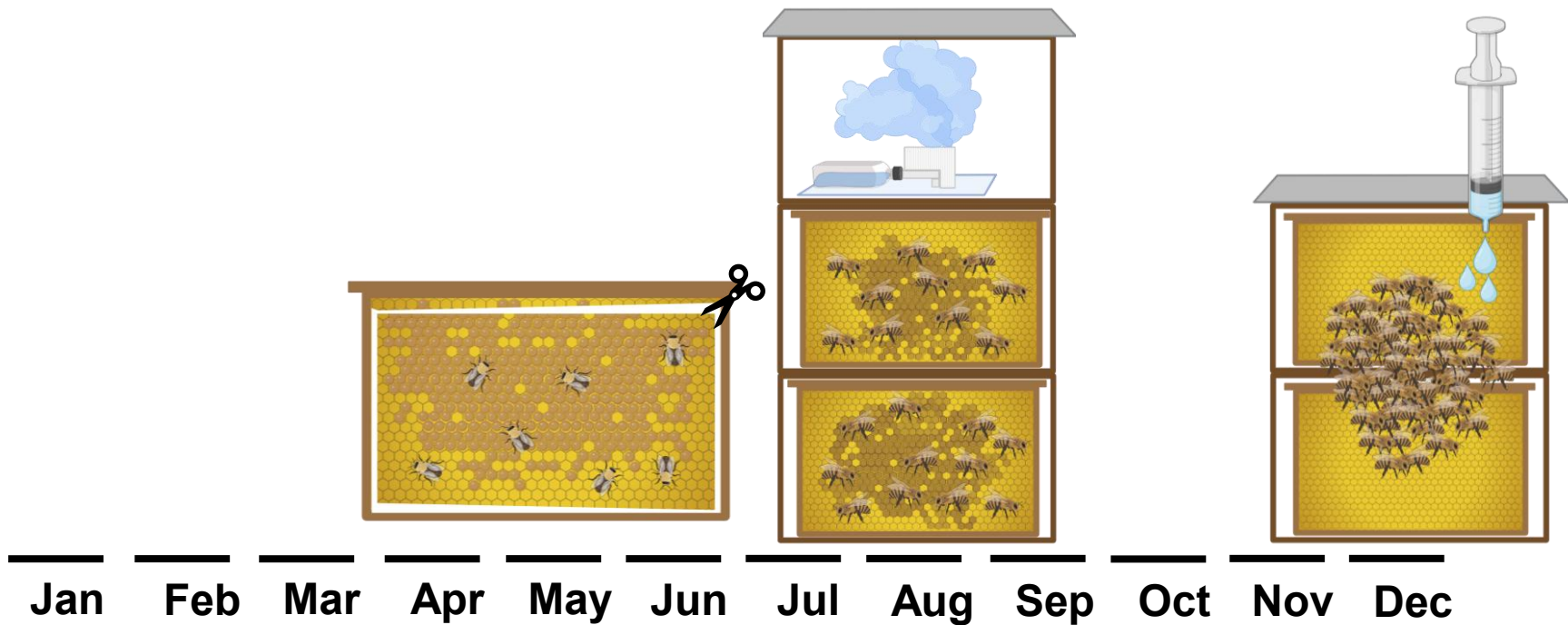
Conventional beekeeping practice

- ❖ Drone brood removal
- ❖ Summer treatment (formic acid)
- ❖ Winter treatment (oxalid acid)



Problems of conventional beekeeping

- ❖ Drone brood removal → inhibits adaptation
- ❖ Summer treatment → weather / climate change
- ❖ Winter treatment → breeding through winter / climate change



Sustainable beekeeping practice

- ❖ No drone brood removal
- ❖ Queen caging + oxalic acid in summer
- ❖ No winter treatment (unless >3 mites/day)



Lena Frank



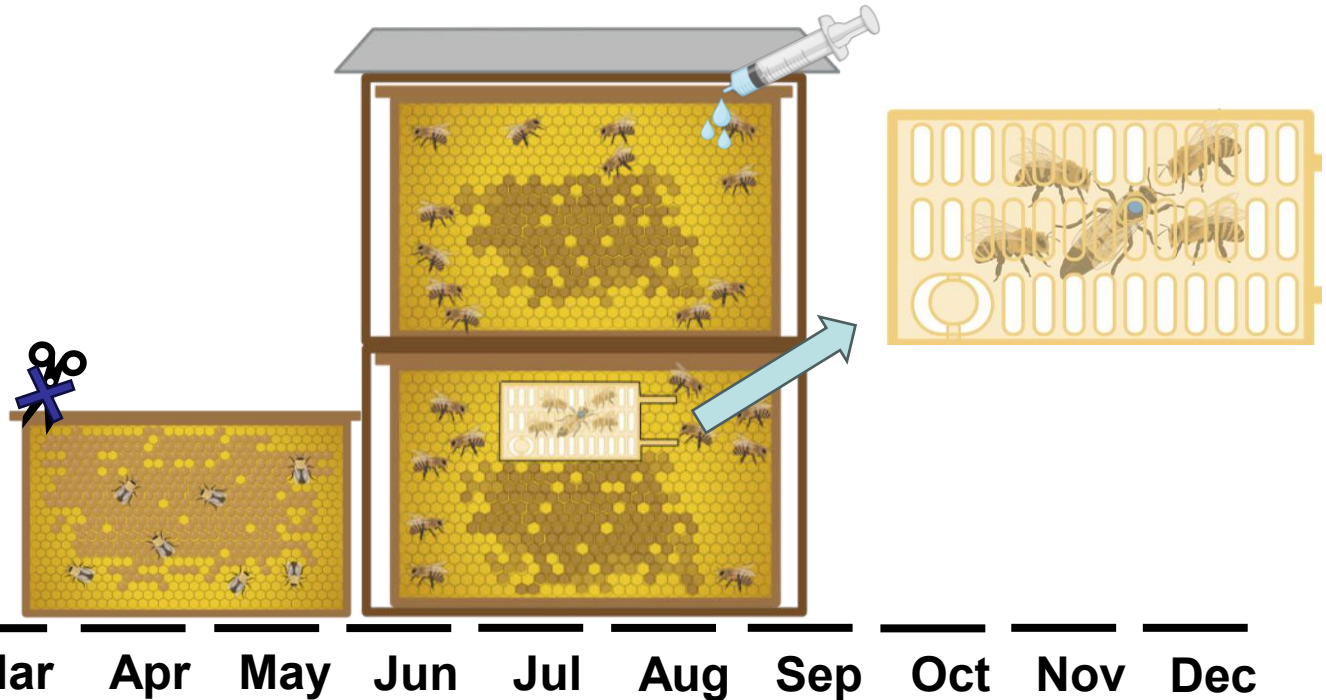
Landesbetrieb
Landwirtschaft
Hessen



Dr. Marina Meixner

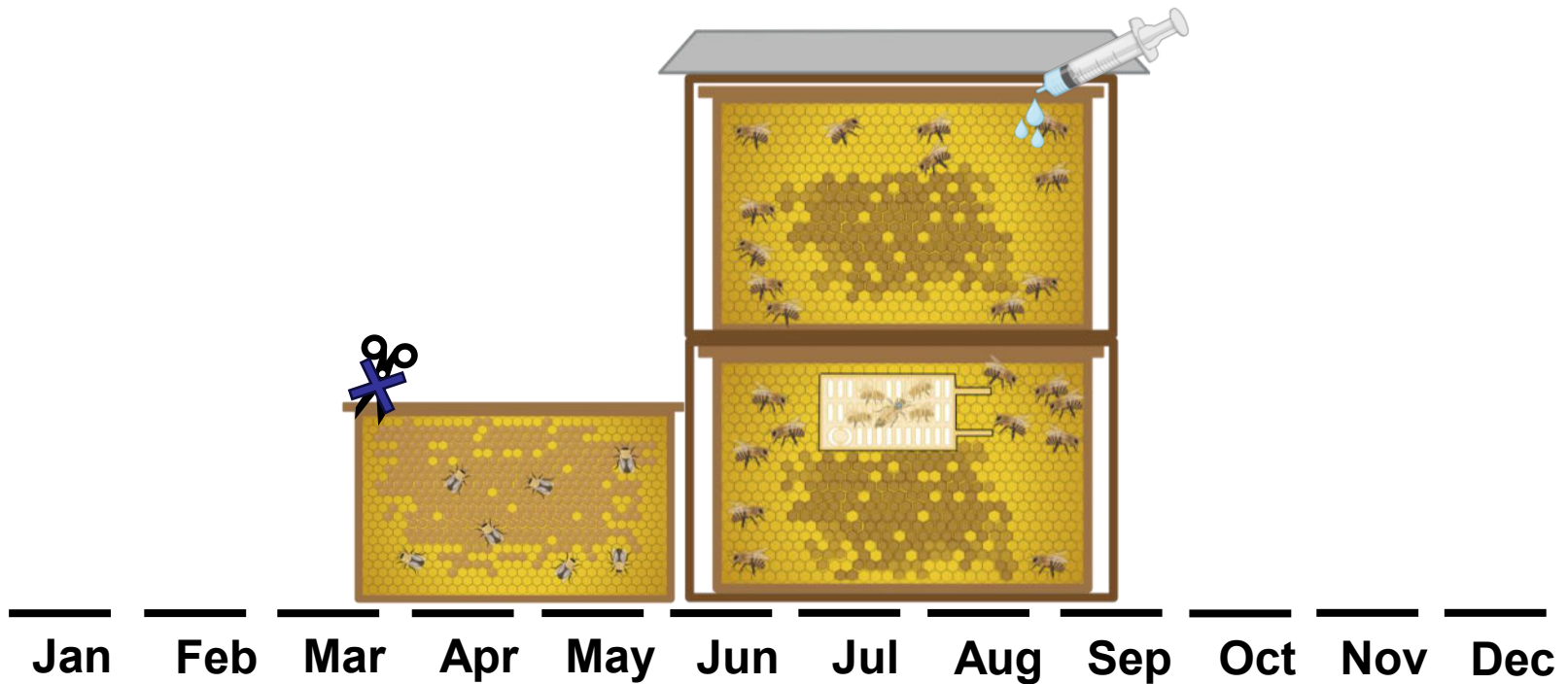


Thomas Heynemann



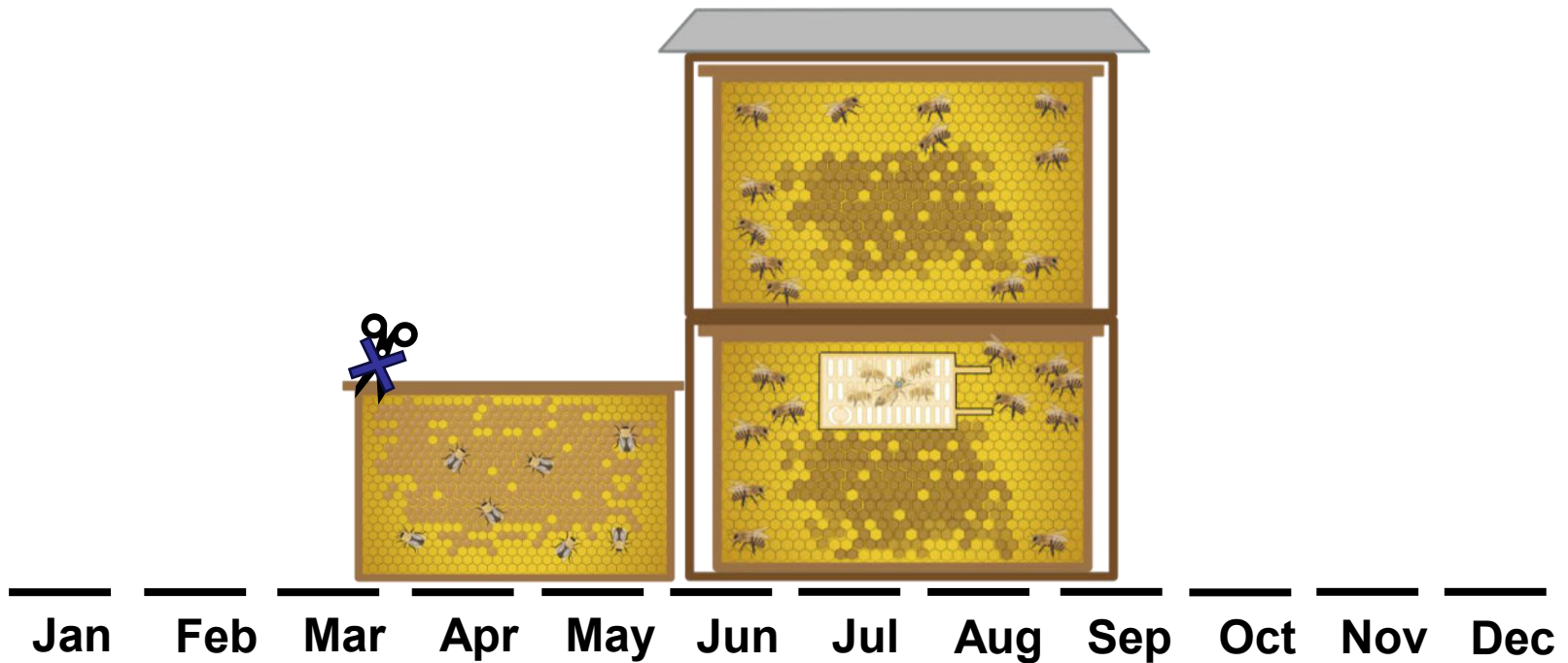
Aim

- ❖ In the long run: adaptation to Varroa
- ❖ Climate resilient treatment
- ❖ Healthy bees
- ❖ Good honey harvest



Worries of beekeepers

- ❖ Will this kill the colonies?
- ❖ Will the honey harvest drop?
- ❖ How about their pathogen load?



Methods

- ❖ **Varroa load** (using sticky bottom boards for 2 days every 2 weeks)
- ❖ **Pathogen load** (using high-throughput qPCR) **mid-April**, end of **June** and **mid-October**
- ❖ **Honey yield**

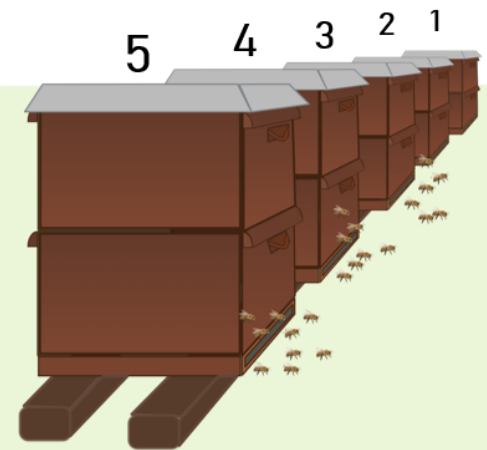
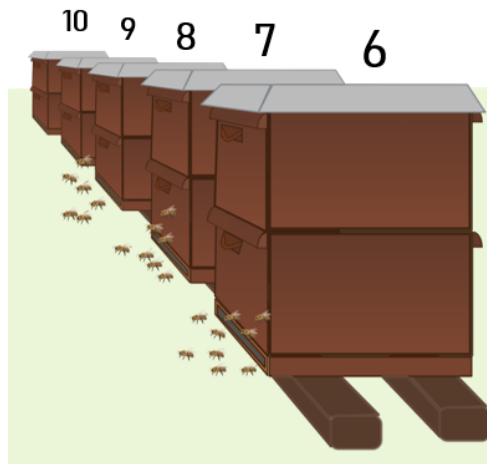
Conventionally
managed colonies



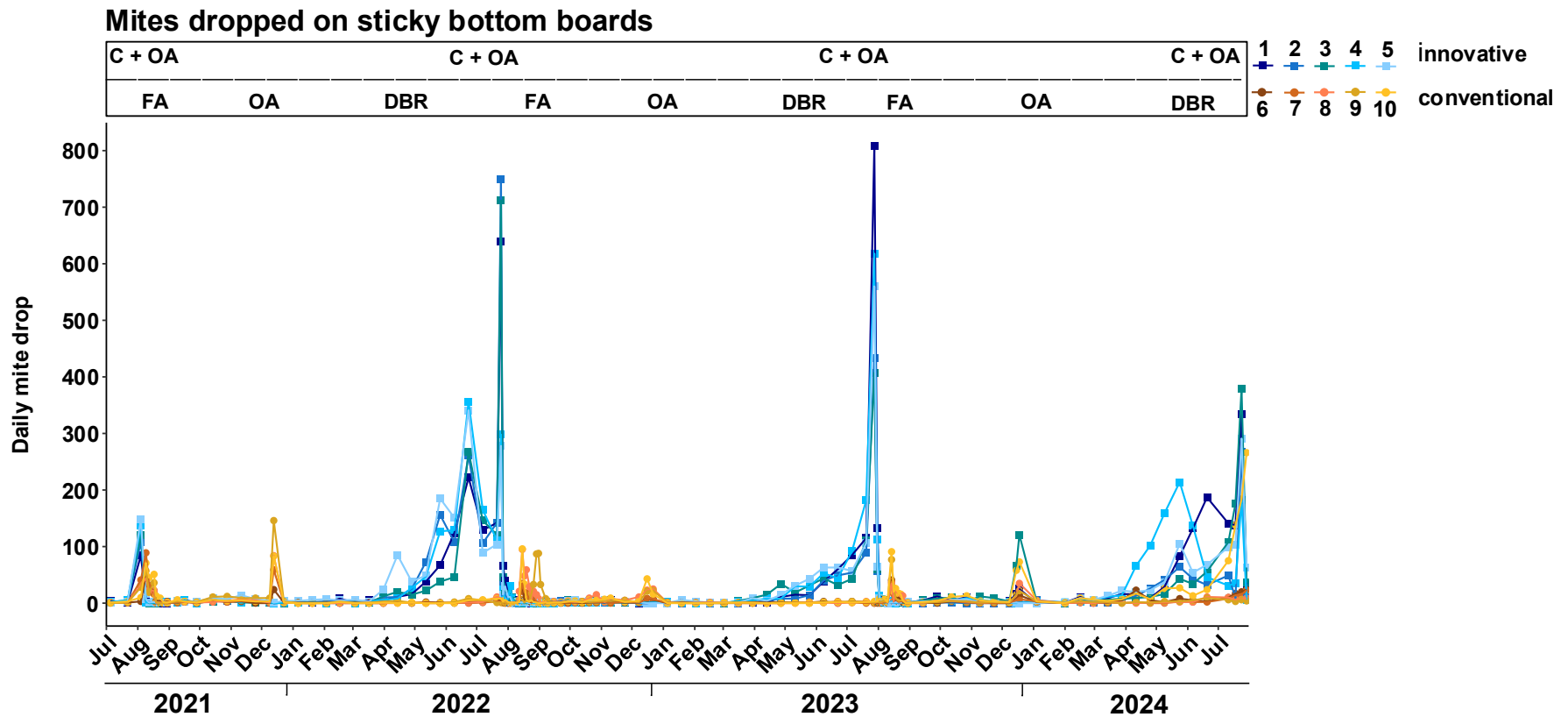
vs.

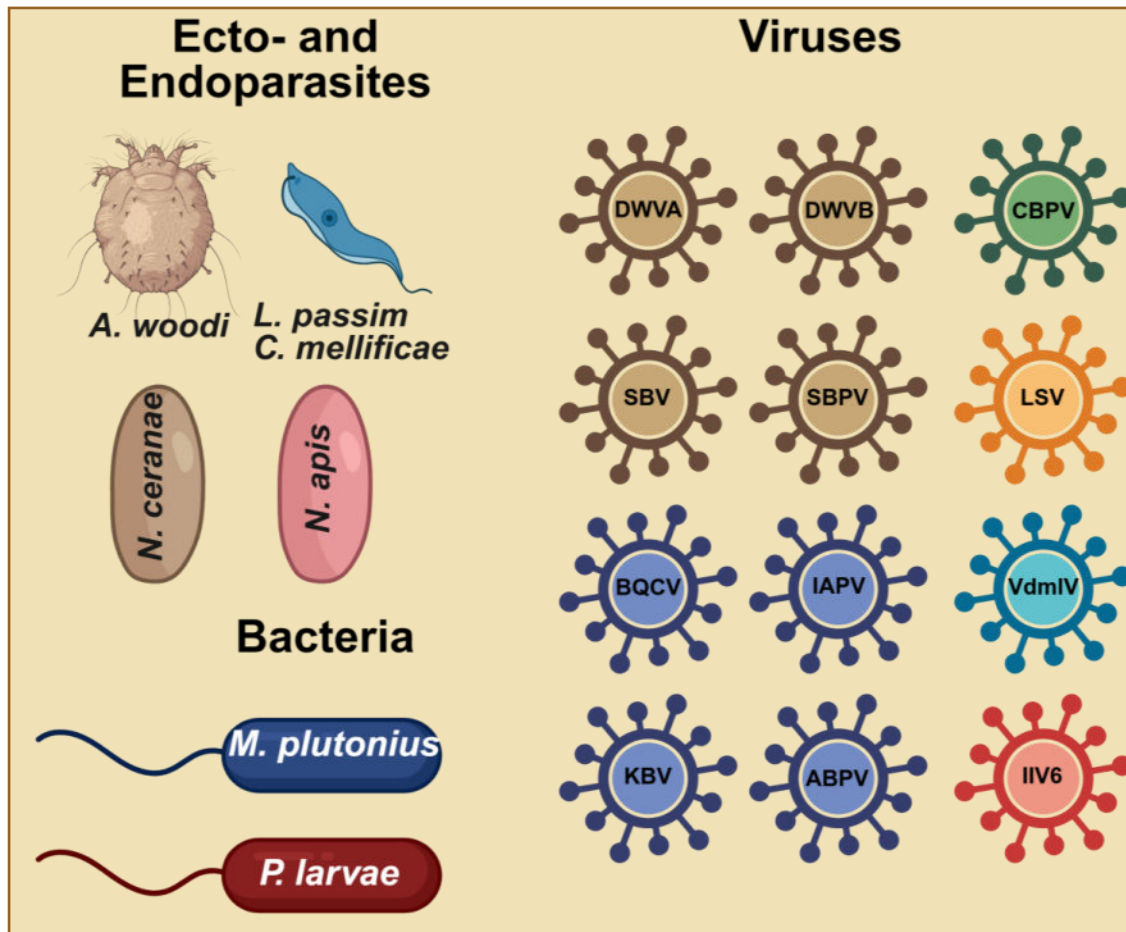


Innovatively
managed colonies



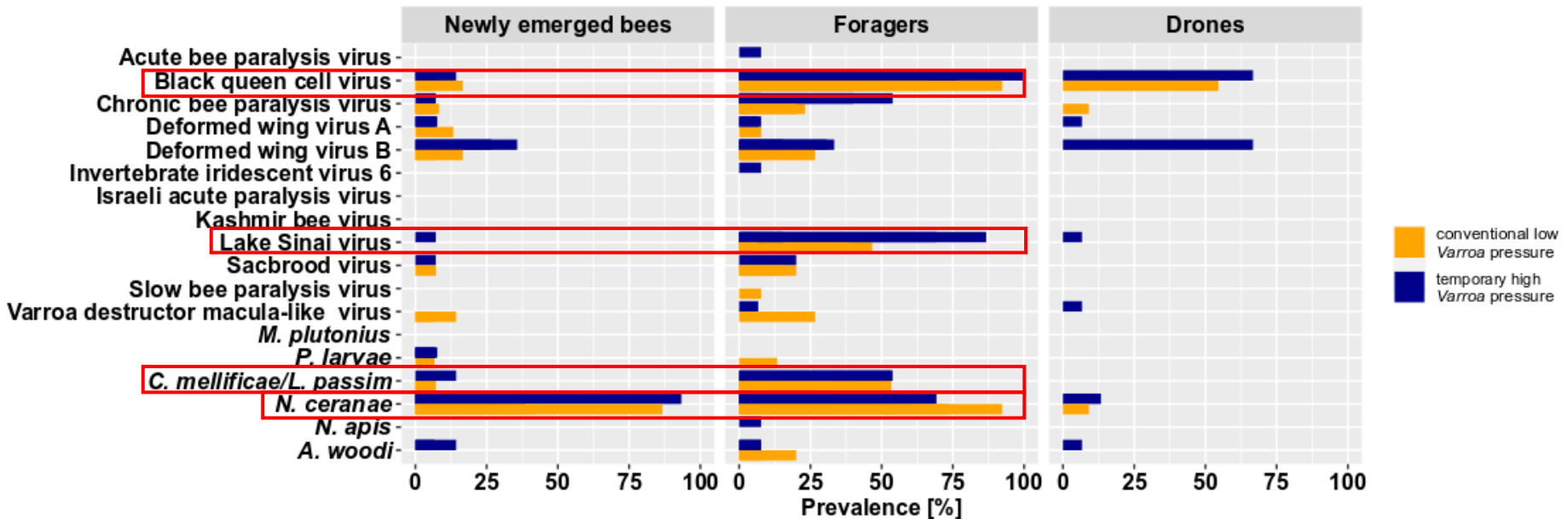
Results: Varroa load





Acarapis woodi
Lotmaria passim
Crithidia mellifica
Nosema
Melissococcus plutonius
Paenibacillus larvae
 Deformed Wing Virus A,B
 Chronic Bee Paralysis Virus
 SacBrood Virus
 Slow Bee Paralysis Virus
 Lake Sinai Virus
 Black Queen Cell Virus
 Israeli Acute Paralysis Virus
 Varroa destructor macula-like
 Virus
 Kashmir Bee Virus
 Acute Bee Paralysis Virus
 Invertebrate Iridescent Virus 6

Pathogens are most abundant in foragers

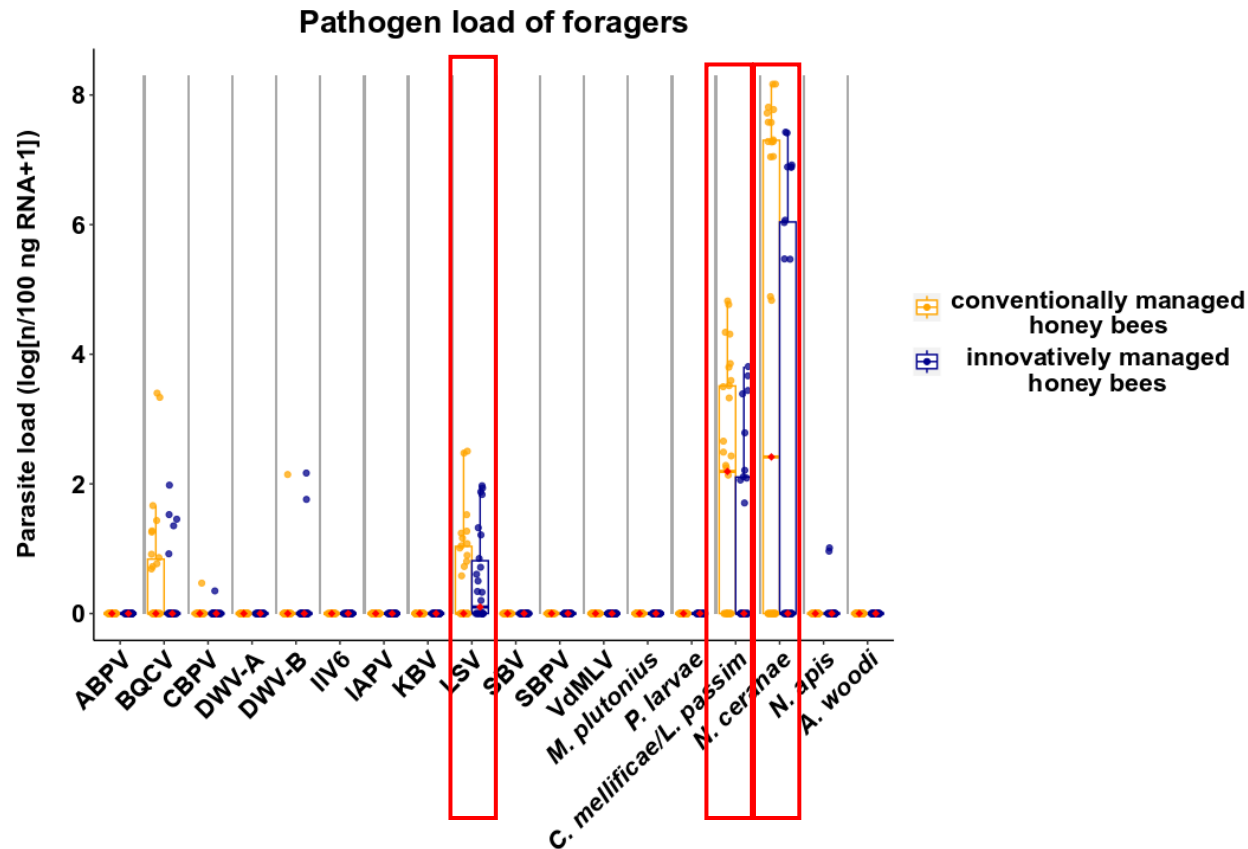


Newly emerged: *N. ceranae*

Foragers: Black queen cell virus, *N. ceranae*, *Crithidia mellificae/Lotmaria passim*, Lake Sinai virus, DWV-B

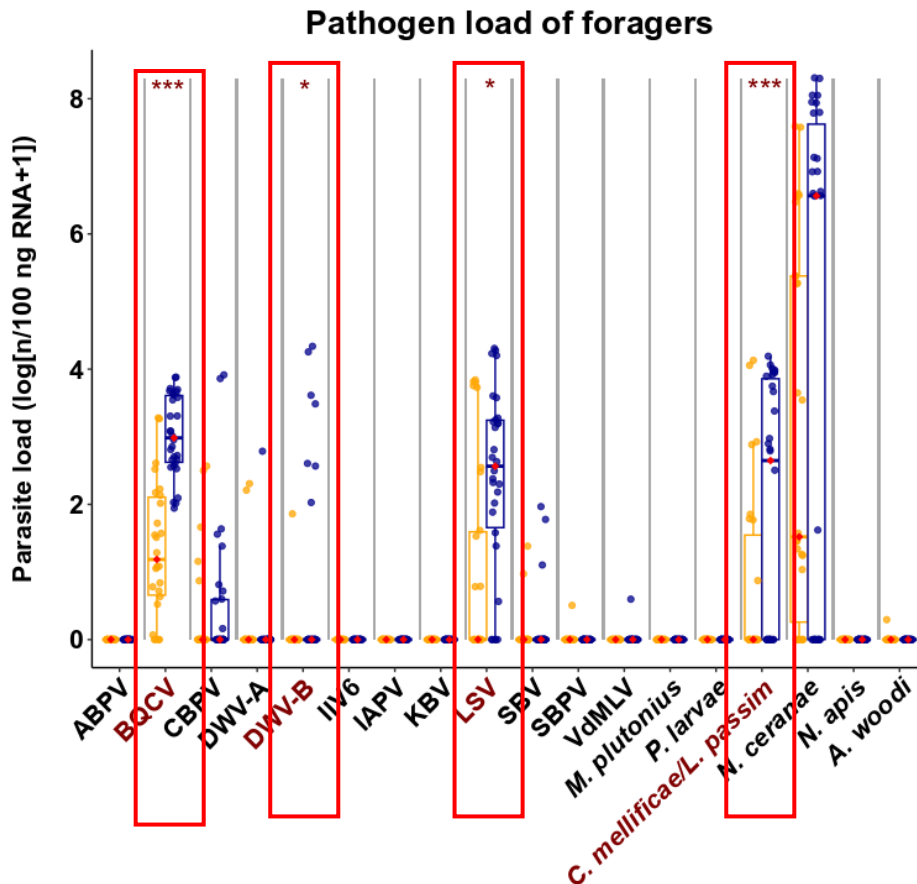
Drones: BQCV, DWV-B

Pathogen loads in spring do not differ between beekeeping methods



Abundant: *N. ceranae*, *Crithidia mellificae*/Lotmaria passim, Lake Sinai virus

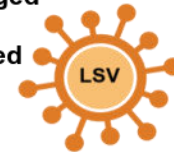
Pathogen loads in summer: sustainable > conventional



$p < 0.001$ ***



$p < 0.05$ *



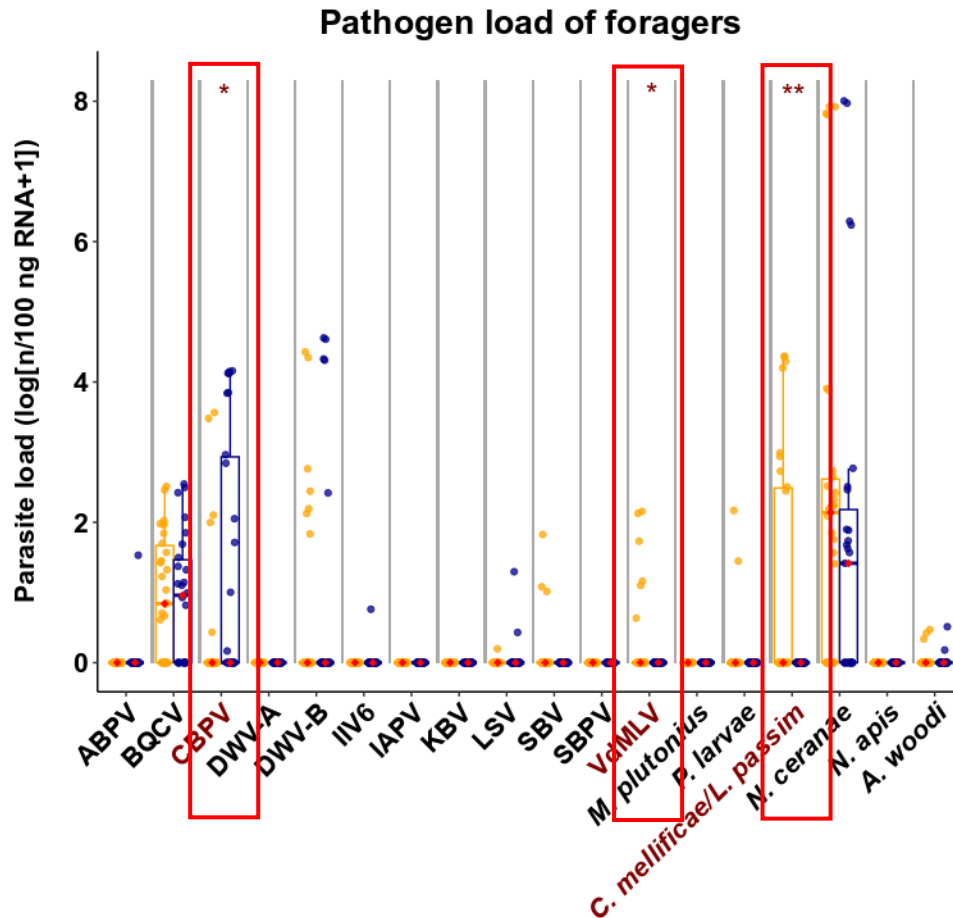
$p < 0.001$ ***



$p < 0.05$ *

L. passim
C. mellifica

Pathogen loads in fall



$p < 0.05 *$



$p < 0.05 *$



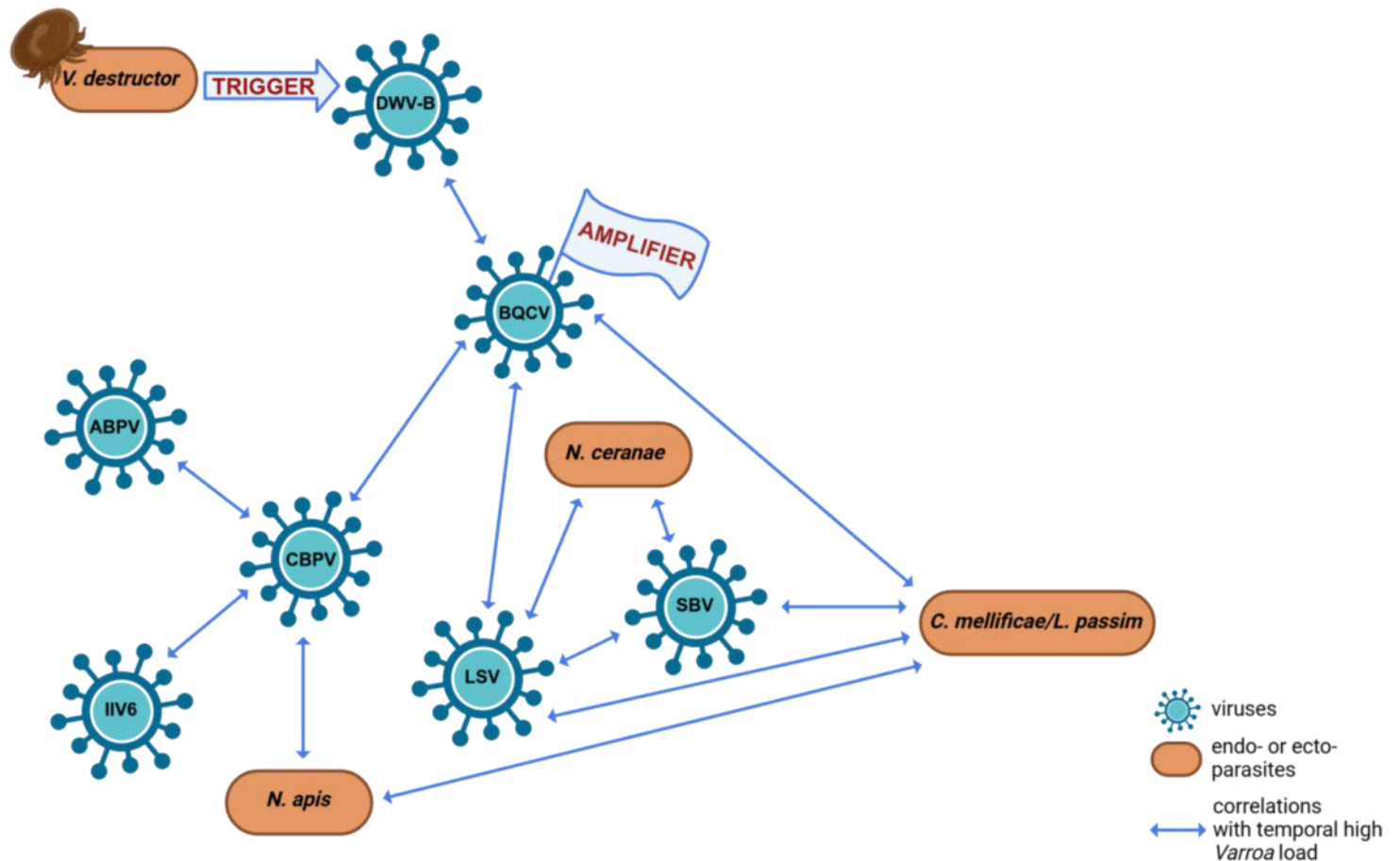
$p < 0.01 **$

L. passim
C. mellificae

Wilcoxon Rank-Sum test

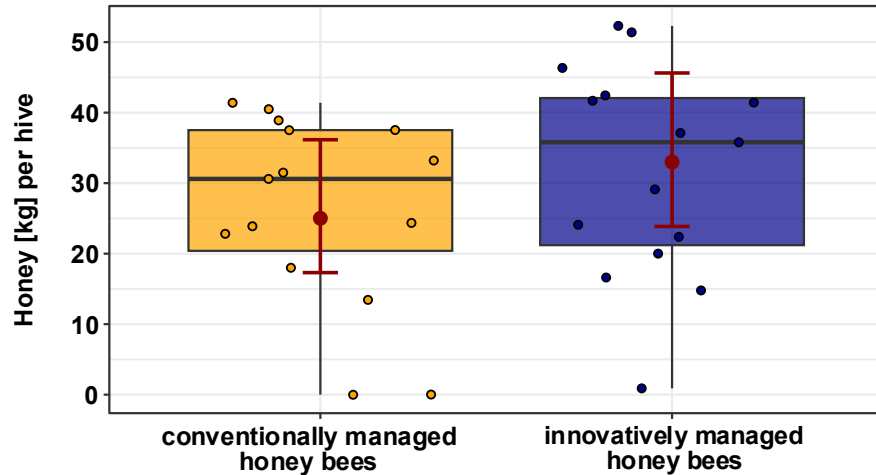
Correlations between pathogens

Significant correlations between honey bee pathogens based on qPCR data

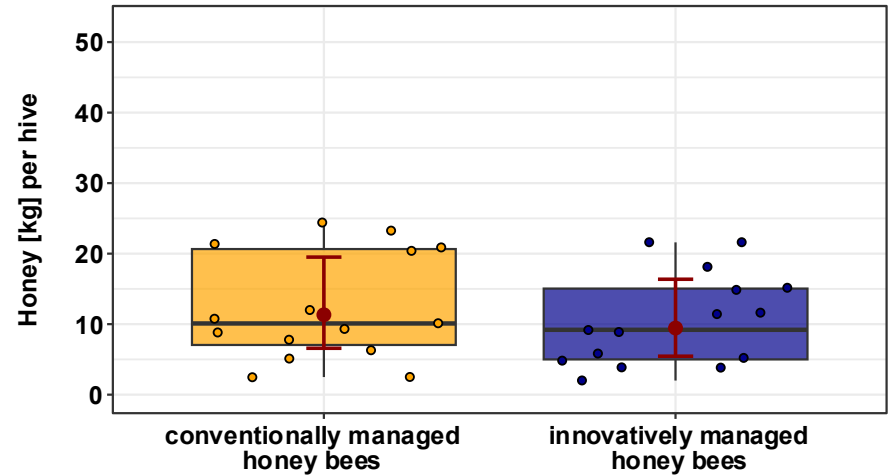




Honey yield in spring



Honey yield in summer



Honey yield $\text{glmm}(\text{honey} \sim \text{treatment} + (1|\text{year}) + (1|\text{hive}))$; Spring: $p > 0.05$; Summer: $p > 0.05$

Sustainable beekeeping

- Drone brood in hive increases mites and pathogen load in summer
- Oxalic acid + queen caging highly effective
- Reduced pathogens before overwintering
- Healthy winter bees
- No honey loss



Uni Würzburg



Lioba
Hilsmann



Dr. Sylvie
Vandenabeele



Dirk Ahrens

Uni Hohenheim



Prof. Dr. Martin
Hasselmann



Dr. Patrick
Kohl

Gefördert durch



Bundesministerium
für Ernährung
und Landwirtschaft



aufgrund eines Beschlusses
des Deutschen Bundestages



Lena Frank



Landesbetrieb
Landwirtschaft
Hessen



Dr. Marina Meixner



Thomas Heynemann



Dr. Martin Gabel

