

OP-156 [Bee Health]

Varroa destructor infestation levels can be predicted by brood cell recapping rate and mite non-reproduction in honeybee colonies (*Apis mellifera*)

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The genetic selection of honeybees (*Apis mellifera*) offers the beekeeping industry the possibility of combating the *Varroa destructor* parasite and thus reducing its dependence on acaricides. Indeed, some bee populations have heritable hygienic behavioural traits that allow them to resist *Varroa* infestation. However, the links between these different behavioural traits are not yet well defined, which limits genetic progress. In this context, we measured the following behavioural *Varroa* resistance traits: freeze-kill brood assay (FKB) and pin-kill brood assay (PKB), varroa-sensitive hygiene (VSH), pupae removal, mite non-reproduction (MNR) and recapping activity. Correlations between these measures show that two are negative and significant: (1) between the recapping of cells infested with *Varroa* and the total number of recapped cells and (2) between the recapping of cells infested with *Varroa* and varroa-sensitive hygiene (VSH). We also selected the best predictive model of varroa infestation levels using the "step-wise" approach based on the AIC criterion. Our model revealed that MNR and FKB were significantly related to the varroa population levels with a negative relationship, while recapping was significantly related to mite infestation levels with a positive relationship. Thus, a higher MNR or FKB score is significantly related to low levels of mite infestation in colonies at the end of August, while a higher recapping activity is significantly related to a high level of mite infestation. Our work indicates that recapping behavior could be a useful trait to aid the selection of *Varroa*-resistant bee lines but that further work needs to be done to better understand its significance.



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brood cell recapping rate and mite non-reproduction in
Honey bee colonies (*Apis mellifera* L.)

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Genetic selection at Laval University /CRSAD

Bee breeding program since 2009

Focus on :

Health

- Hygienic behavior
- Varroa infestation levels

Production

- Honey

Rusticity

- Spring brood development
- Winter consumption



Prof. Pierre Giovenazzo



Dr. Ségolène Maucourt



Hygienic behaviors



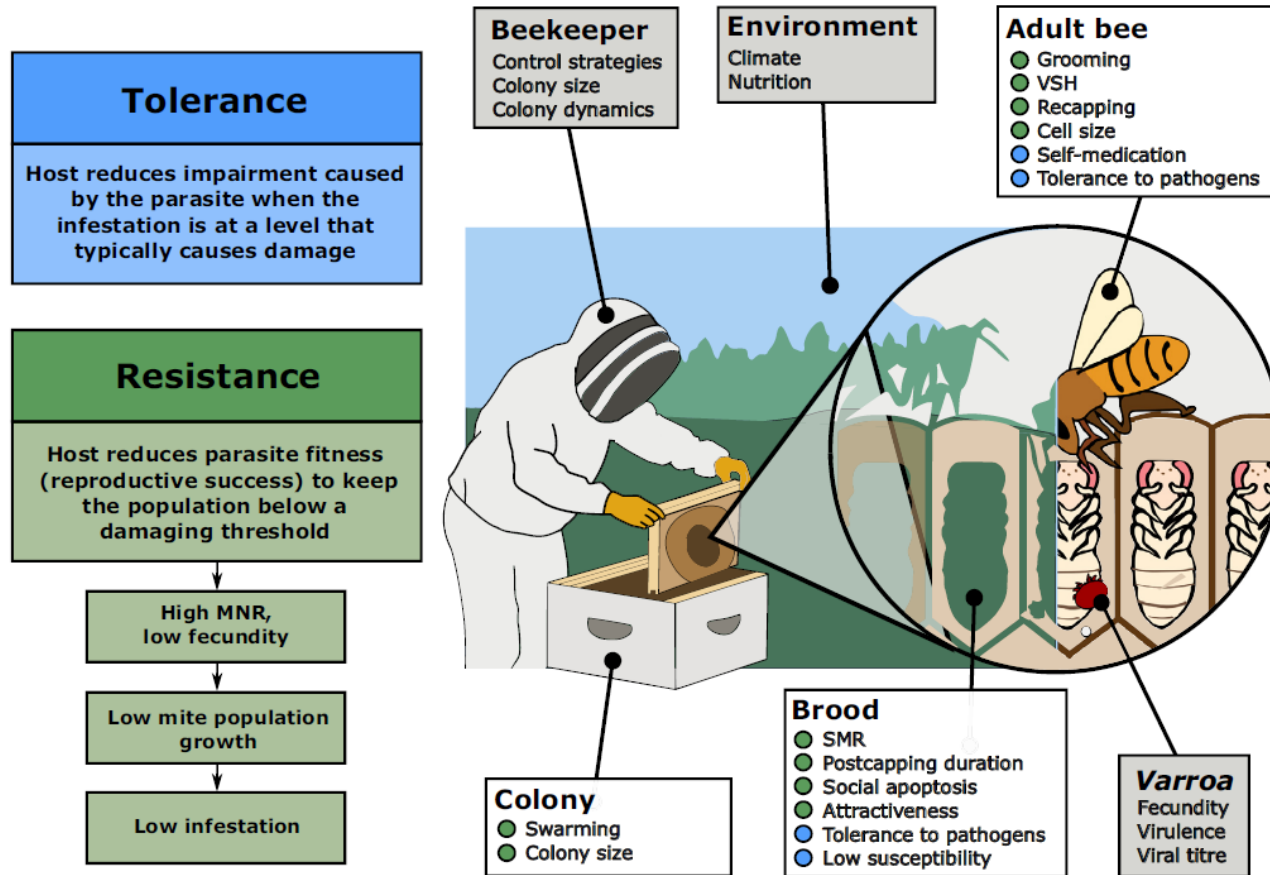
Fisrt : Detect



Next : Remove

Genetic selection of hygienic behavior(S) could help reduce mortality related to *Varroa destructor* in northern climate

Varroa resistance traits



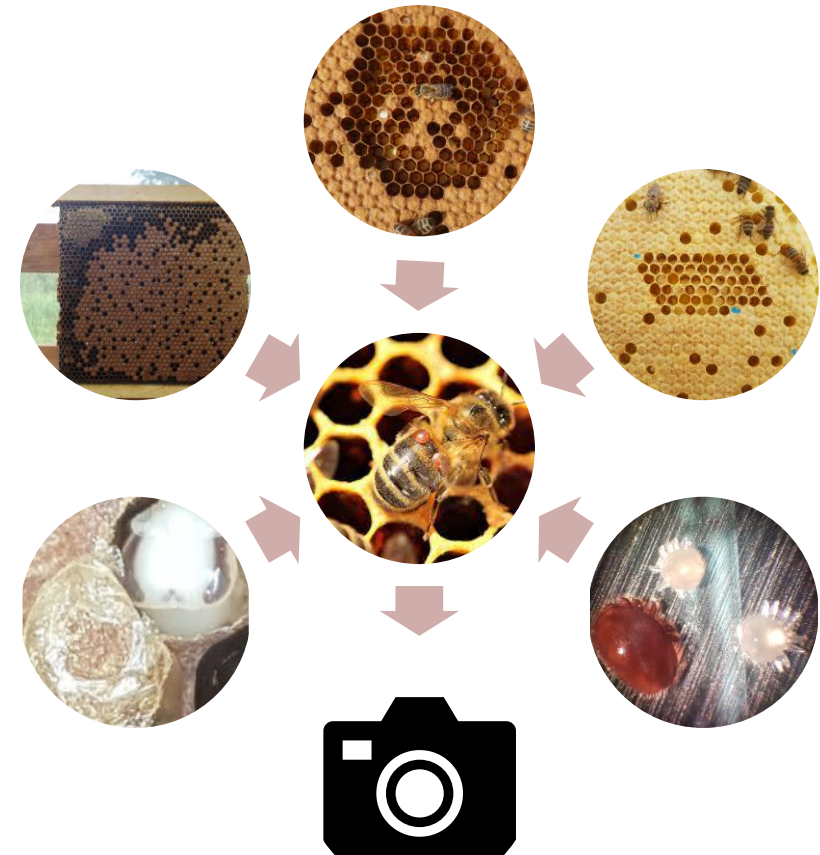
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No universal mechanism offers resistance to Varroa and different bee populations have different combination of traits

Mondet et al., 2020, Honey bee survival mechanisms against the parasite *Varroa destructor*: a systematic review of phenotypic and genomic research efforts

Goal

Improve knowledge of the **links between behavioral traits** that contribute to varroa resistance and social immunity in colonies within the UL-CRSAD bee breeding program



Variables

Colony performance

Hygienic level: freeze-kill brood assay

Hygienic level: pin-kill brood assay

Mite infestation level (phoretic) end of honey flow season

Experimental high mite infestation level set-up

Varroa-sensitive hygiene (VSH): change in brood infestation rate following handling by the workers expressed as a % of the initial infestation rate (Villa et al., 2009)

Mite non-reproduction (MNR): % non-reproducing mites (Büchler et al., 2017)

Recapping behavior: % of brood cells opened and then closed following manipulation by the workers

Colony performance



Hygienic level : Freeze-kill brood with
liquid nitrogen. Reads 24h later
2 repetitions



Hygienic level : Pin-test brood assay.
Reads 9h later
2 repetitions

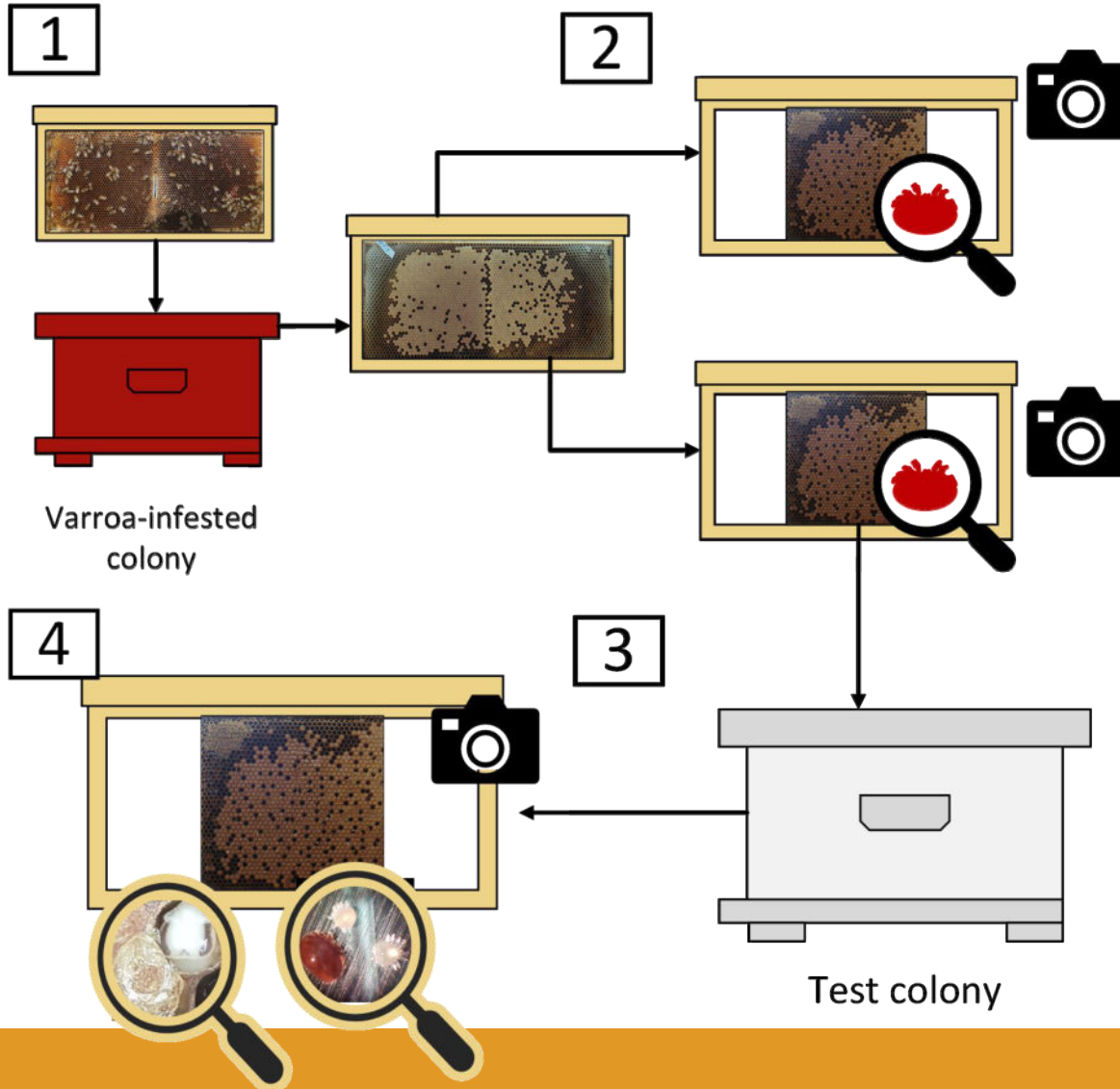


Ethanol wash for varroa
infestation level
300 bees

Performed at the same time on colonies

Experimental high mite infestation level set-up

Insert modified frame in varroa-infested colony until brood is freshly capped



Separate frame as to get 2 halves. Check 150 cells for initial mite infestation level and take picture of the frame

Check 150 cells for varroa infestation and recapping activity. Evaluate 35 SIC

Leave the half-frame in test colony for 7 days

Traits overview

Variables	Mean (%)	SE	Min	Max
Hygienic testing				
Freeze-kill brood assay (FKB)	88.0	1.9	51.3	100.0
Pin-kill brood assay (PKB)	52.9	2.7	20.5	77.0
Varroa-sensitive hygiene (VSH)	45.7	4.2	0	88.9
Pupae removal	15.1	1.2	2.5	38.0
Mite non-reproduction (MNR)	31.4	1.8	12.8	60.5
Recapping activity				
Total cells recapped	43.4	3.5	15.5	95.7
Recapped cells infested by varroa	30.3	2.5	6.1	57.6
Varroa infestation	0.6	0.1	0	2.6

N= 34 colonies

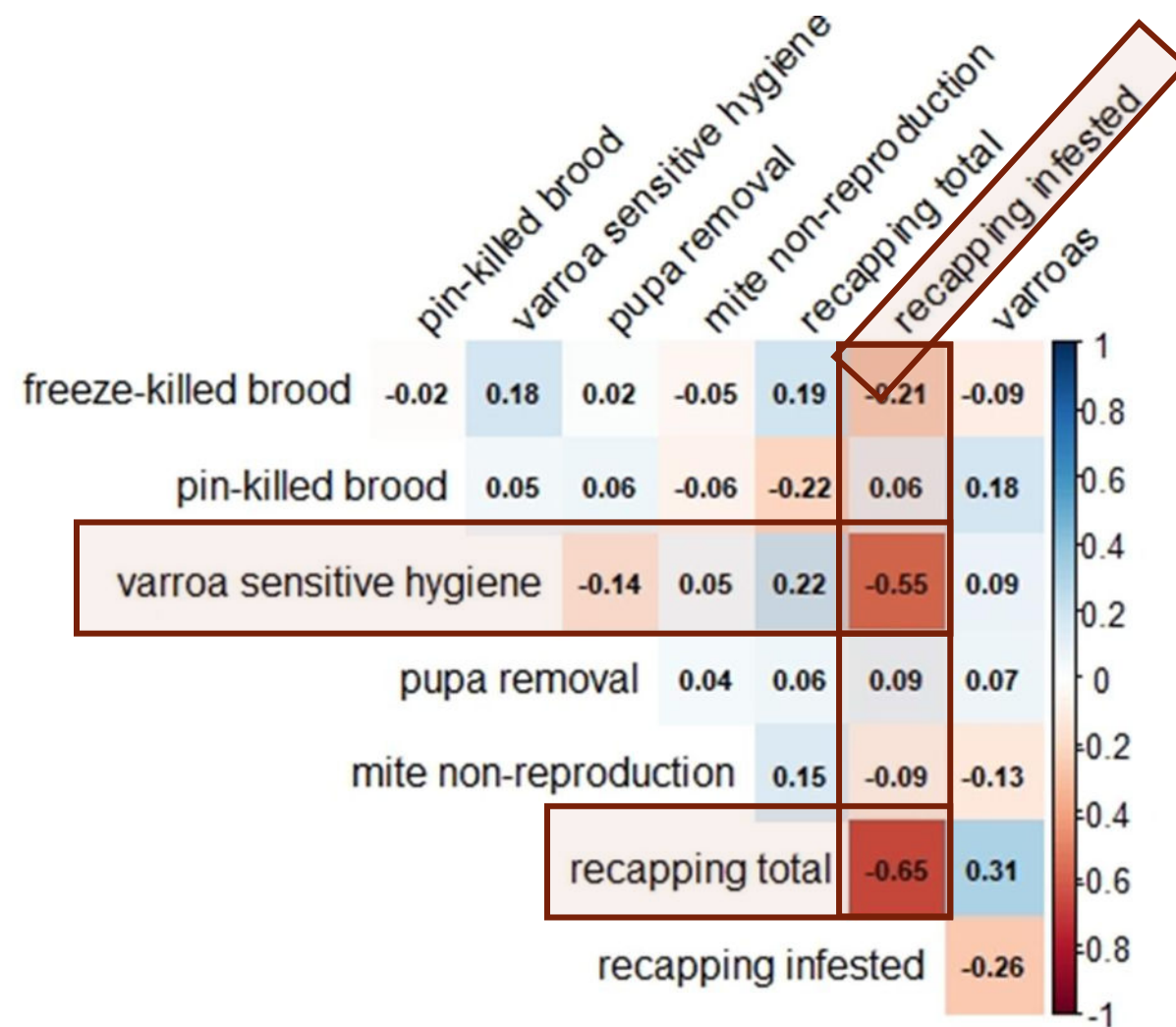


Correlations

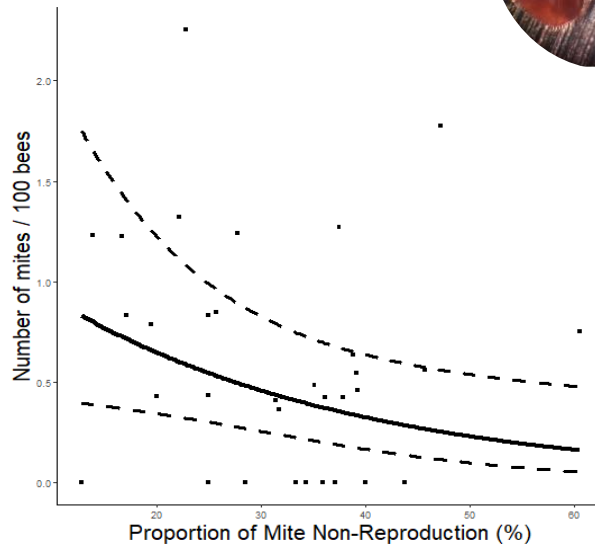
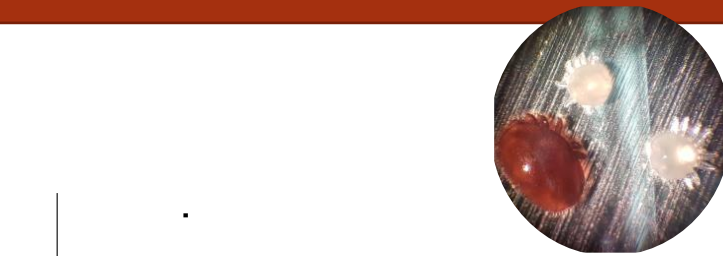
Correlations between variables using Spearman's rank-order coefficient

Only 2 significant correlations were found
amongst 28 pairs of variables:

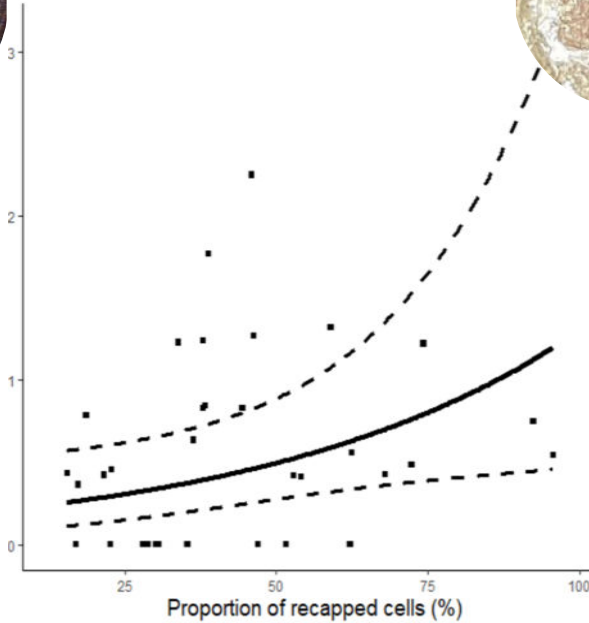
1. VSH and Recapping % of mite-infested brood cells : -0.5 ($p < 0.001$)
2. Recapping % of all brood cells and Recapping % of mite-infested brood cells : -0.65 ($p < 0.001$)



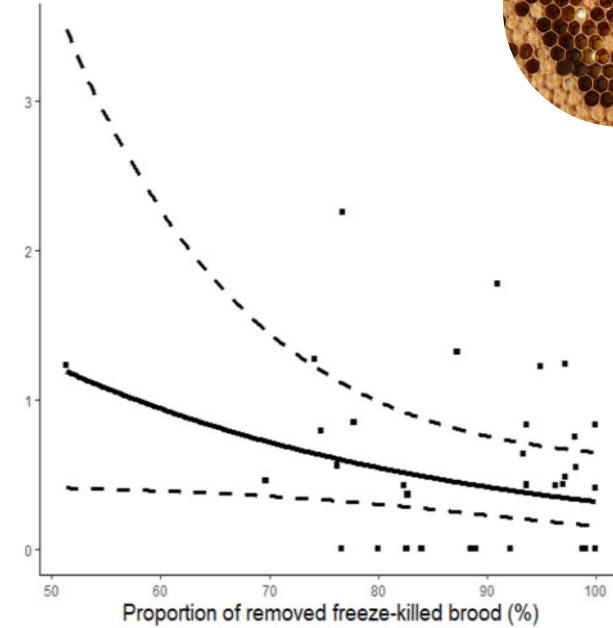
Predictive model



GLMER : Estimate -3.46, SE 1.47,
Z-value -2.35, p-value 0.019



GLMER : Estimate 1.929, SE 0.84,
Z-value 2.29, p-value 0.022



GLMER: Estimate -2.72, SE 1.378,
Z-value -1.98, p-value 0.047

Poisson generalized linear mixed model was used to study the effect of the different hygienic behaviors on colony infestation by *V. destructor*

Perspective and next steps



Recapping trial on 123 colonies (2024):

- No relationship with varroa
- Very low recapping levels with this method

Continue to monitor hygienic (freeze-kill) and varroa populations in breeding program

We will not invest more in monitoring the other traits at the moment

Acknowledgements



Questions?
Join me : marie-lou.morin.1@ulaval.ca



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