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Varroa sensitive hygiene in naturally selected honeybee populations

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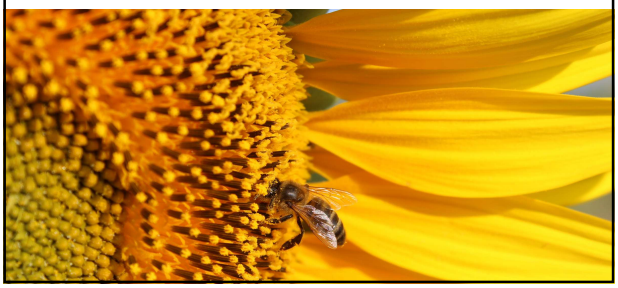


Varroa destructor

- Shift from *Apis cerana* (original host) to *Apis mellifera* (new host) probably in Eastern Russia on the first half of 20th century (Rosenkranz et al., 2010)
- Reproduces in drone and worker brood of *A.mellifera* =Exponential population growth (Oldroyd, 1999)
- Spread around the world, now almost cosmopolitan (Potts et al., 2010)
- Damage:
  - Lower protein concentrations (Bowen-Walker and Gunn, 2011)
  - Suppression of immunity (Yang and Cox-Foster, 2005)
  - Transmission of viruses (Boecking and Genersch, 2008)
- Deformed wings virus (DWV): responsible for many colony losses (Schroeder and Martin, 2012)

Selection of resistant colonies

- Since 2008, colonies kept in isolated areas:
  Tiengemeten island and **Amsterdam water dunes**

-No control treatment against Varroa
-No interference with other populations

- Important losses in the first years
- Now able to limit Varroa pressure
  = resistance/tolerance to the parasite

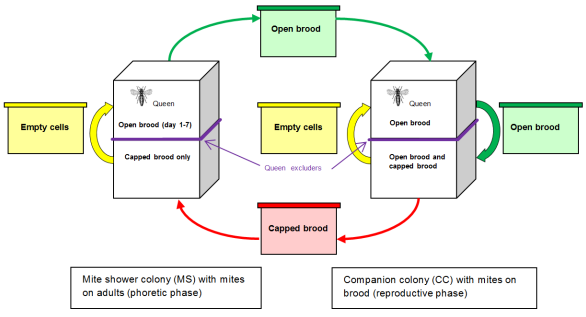
Hypothesis

H1: _Varroa_ sensitive hygiene (VSH) is higher in resistant colonies = higher parasitised pupae removal rates

Experimental set:

- 5 colonies from each group (Amsterdam Water Dunes, Tiengemeten, Control)
- Neutral brood
- Neutral mites
- Experiment took place in the Grebbedijk apiary

Mite rearing



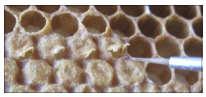
Mite collection

- Powdered sugar method (Macedo et al., 2002)

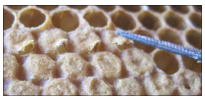
Method: Artificial infestation of mites into chosen brood cells

1. Selecting brood on the right stage

2. Opening of the cell caps

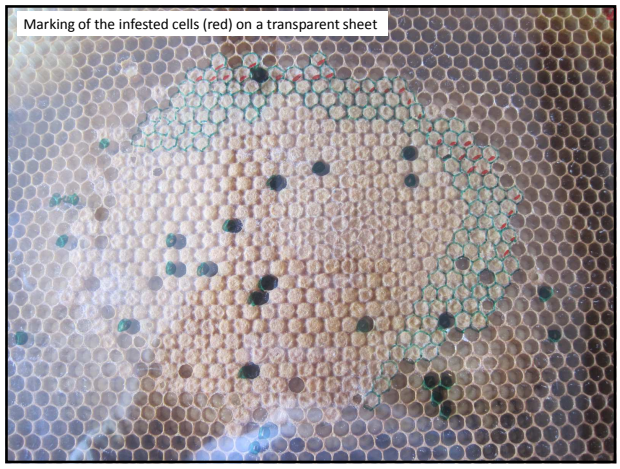


3. Introduction of the mite in the cell

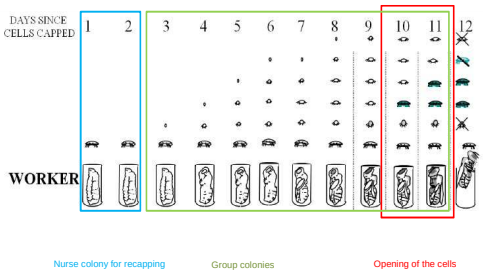


4. Closing of the cell caps

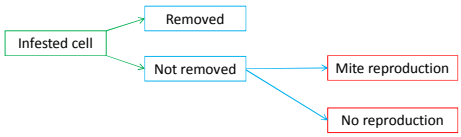
Marking of the infested cells (red) on a transparent sheet



Frame after sealing of the cells by bees



Data collection



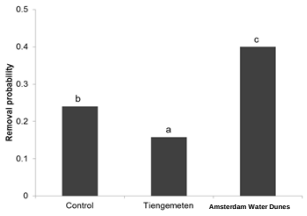
Photos: **Katousha Shoep**

Expected results: higher removal rates in Tiengemeten and Waterdunes colonies

Data analysis

- 750 cells successfully infested
- Cells considered **independent** from each other
- Binary distribution (removed/ not removed)
- Generalised mixed model with:
  -Colony as a **random factor**
  -**Repeated measurements** over time

Results: Removal rates



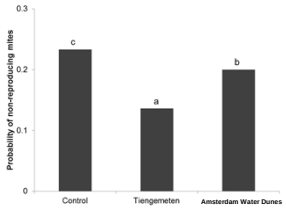
AWD: 40%

TG: 15.8%

C: 24%

- Removal probability higher in Waterdunes colonies, but not in Tiengemeten

Results: Varroa reproduction



AWD: 20%

TG: 13.6%

C: 23.3%

- Non reproduction higher in Control and Waterdunes BUT assessed with remaining cells only

The role of viruses

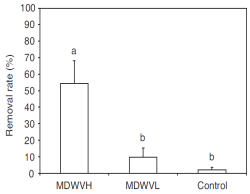
- "The final breakdown of a honey bee colony (...) is an effect of virus infections rather than the effect of direct parasitation through *Varroa* mites" (Rosenkranz *et al.*, 2010)

Bee with symptoms of DWV: crippled wings and shortened abdomen (Rosenkranz *et al.*, 2010)

- Deformed Wings Virus (DWV) responsible for many colony losses (Schroeder and Martin, 2012)
- DWV -transmitted through food
  -present in other species
  -no symptoms observed
- Symptoms occur in **interaction with *Varroa***
- Major role in host-parasite interactions

Is VSH against viruses?

- What are the triggers of VSH? -Mites?
  -Pupae?
- Schöning *et al.*, 2011: **VSH is damage-dependent**
- The smell of brood parasitized with mites carrying high DWV is **clearly distinct**



Schöning *et al.*, 2011:

MDWVH: mites with high DWV
MDWVL: mites with low DWV
Control: brood with no mites introduced

10 colonies selected for high VSH
On each comb 30 groups of 3 cells

The virus fights VSH

OPEN

Antennae hold a key to *Varroa*-sensitive hygiene behaviour in honey bees

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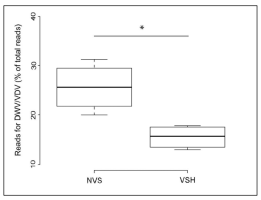
Fanny Mondet[1,2,3], Cédric Alaux[1], Dany Severac[4], Marine Rohmer[4], Alison R. Mercer[2] & Yves Le Conte[1]

Virus particles

-accumulate in the antennae
-prevent expression of genes related to VSH



Relative abundance of DWV and VDV-1 in the antennae of **VSH** bees and Non VSH bees (**NVS**)

Virus diversity affected by *Varroa* mites

- Extend of the damage done on the pupae depends on:

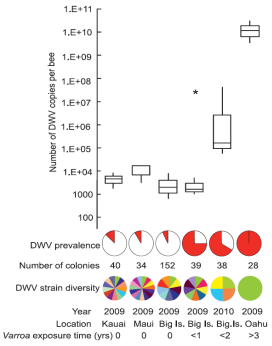
-the **ability of the mite to transmit viruses**
-the **ability of the viruses to replicate** within the mite prior to transmission

Therefore **the strain of the virus** makes a difference

Martin *et al.*, 2012: Evolution of virus diversity after the arrival of *Varroa* in Hawaii

Year	2009	2009	2009	2009	2010	2009
Location	Kauai	Maui	Big Is.	Big Is.	Big.Is.	Oahu
Varroa exposure time (yrs)	0	0	0	<1	<2	>3

Virus diversity affected by *Varroa* mites



Martin *et al.*, 2012 observed the evolution of DWV diversity during the years following the arrival of Varroa in Hawaii

-loss of diversity
-increase of DWV prevalence
-increase of virus loads

- The most virulent strains prevails

Conclusions

- **different mechanisms** to fight *Varroa* mites
- The viruses do not seem to be a problem for those colonies
- Strain B (VDV-1) more abundant in resistant colonies

Continuous work

What is the role of viruses in this host-parasite interaction?

- What are the virus strains found in mite samples?
- Does VSH selects for a specific strain?
- Do different strains lead to different symptoms?

Thank you!

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