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An optimised test for recording hygienic behaviour in the honeybee

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HYGIENIC BEHAVIOUR - HB

Immune mechanism of resistance to a number of important brood pathogens

BACTERIAL → AMERICAN FOULBROOD
→ EUROPEAN FOULBROOD

FUNGAL → CHALKBROOD

PARASITES → WAX MOTH
→ VARROA



Photo by Alex Wild



How to measure HB? Dead removal in 24 h



Mechanical killing - Pin killed brood test

Pros:

- cheapest

Cons:

- Physical damage
- Poor repeatability and discriminatory ability



Thermal killing-Freeze killed brood test – FKB

Pros:

- Good discriminatory ability

Cons:

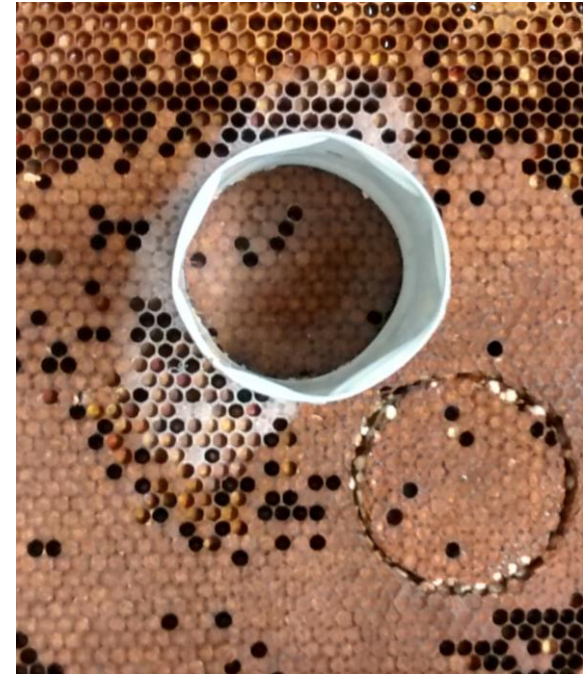
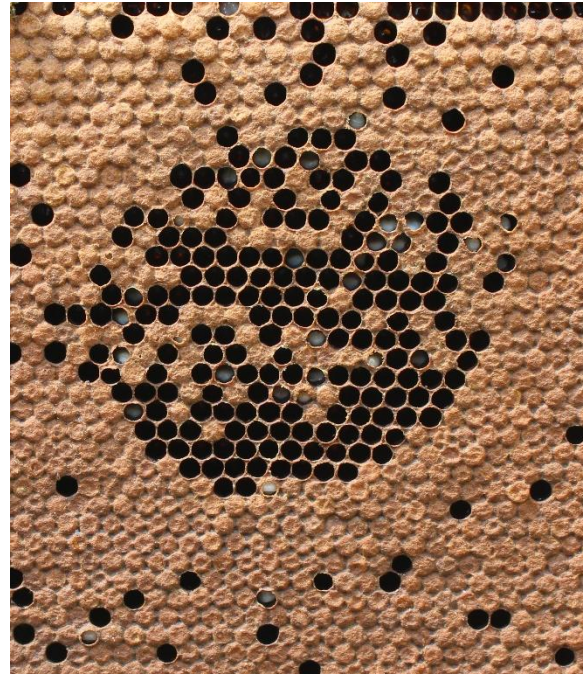
- More expensive
- Practical issues



Practical and precision issues of FKB

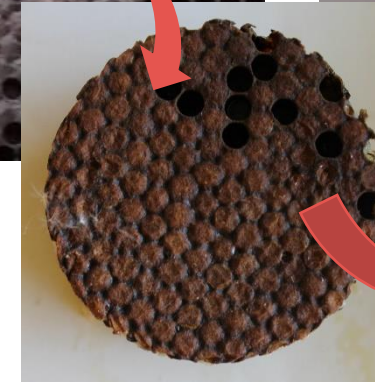
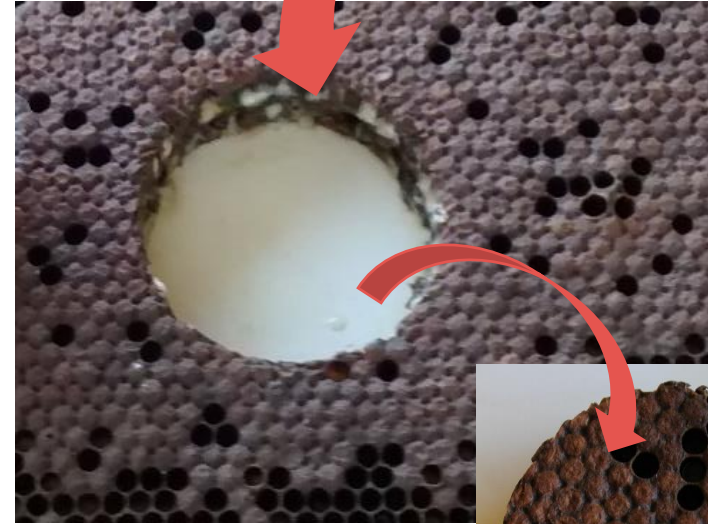
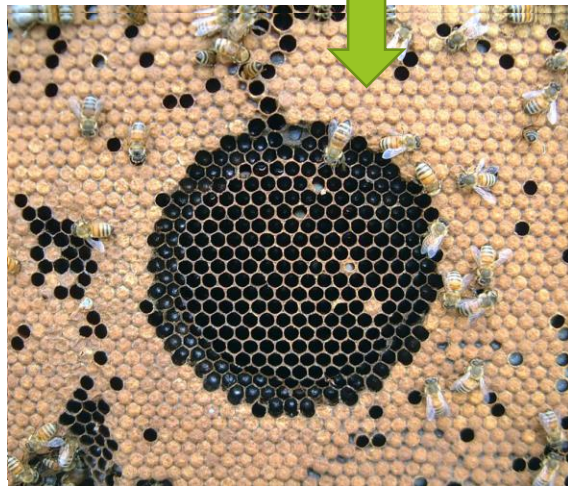


“Collateral damages”



Leakage

FKB* variant method



The tested area is cut out from the comb and frozen at a separated location

Aim of the work

1. Compare the two methods
2. Estimate genetic parameters for HB measured with the optimized method

Comparison of two FKB recording methods

- 25 colonies (no pedigree information)
- Six repetitions during spring/summer 2016
- Two test were carried out on the same comb at the same time

$$HB = \mu + \text{Time} + \text{Breeder} + \text{Colony} + \varepsilon$$



Breeding population phenotyping and genetic parameters estimation

- 151 colonies with known pedigree were phenotyped in 2017 and 2018
- HB was measured twice with FKB* during productive season

Average HB model → heritability

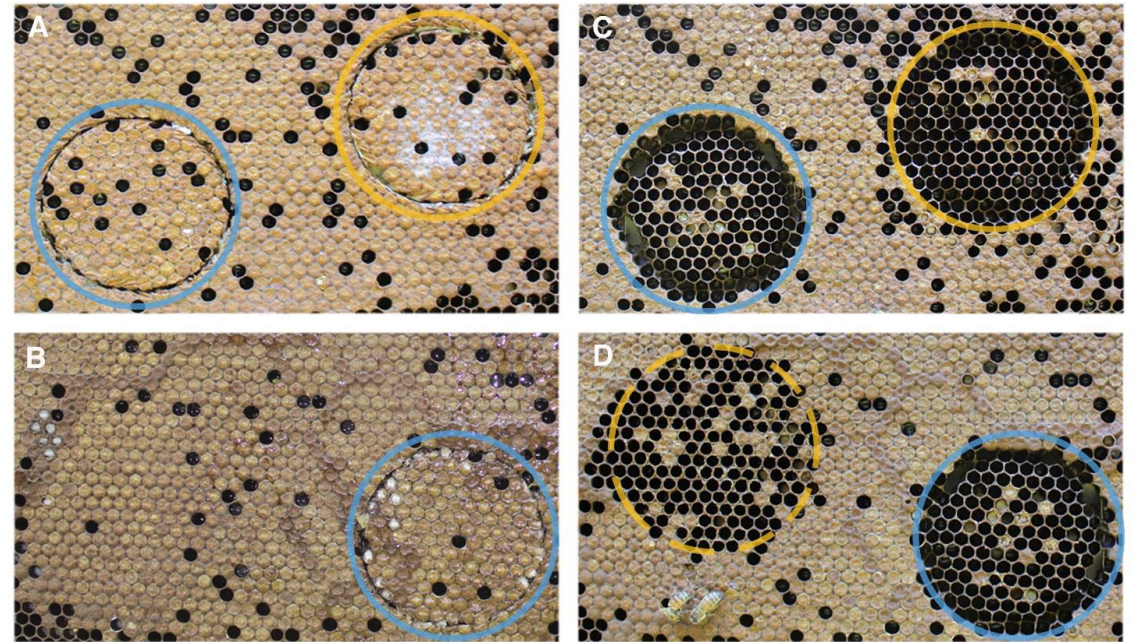
$$HB = \mu + A_{\text{Apiary}} + A_{\bar{w}} + \varepsilon$$

Repeatability model → heritability and repeatability

$$HB = \mu + \text{Time} * A_{\text{Apiary}} + A_{\bar{w}} + pe + \varepsilon$$

Results - visual comparison

- ✓ Reduces collateral damage
- ✓ Faster
- ✓ Cheaper



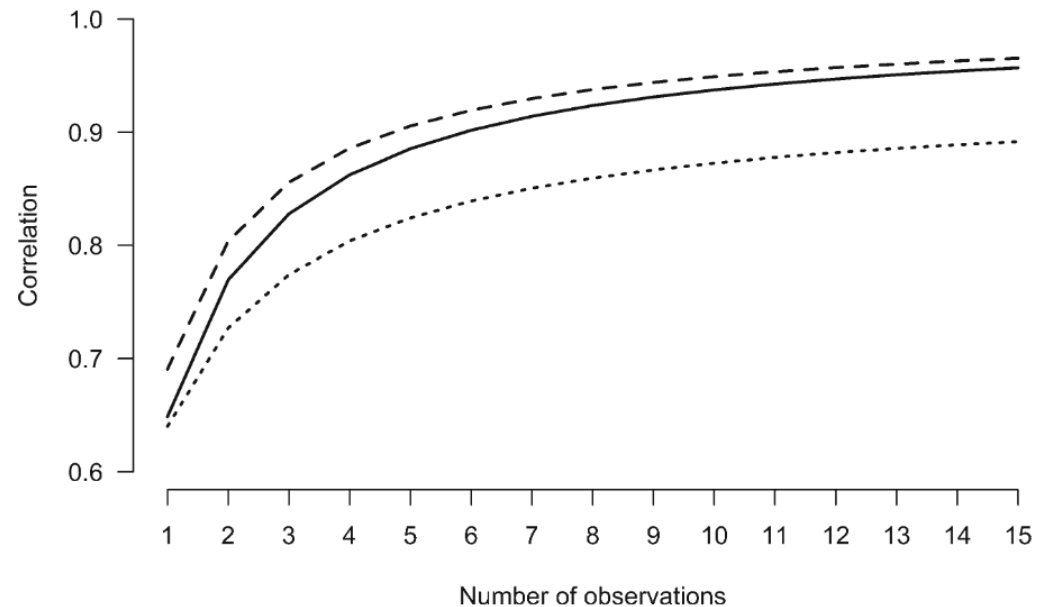
Visual comparison FKB* vs FKB standard

Table I. Practical aspects of the FKB and FKB* methods

	FKB	FKB*
Liquid nitrogen	~3 colonies/l	~8 colonies/l
Time	15–20 min/colony	7–10 min/colony
Tubes (cylinders)	2 for each colony	1 for all colonies
Tested area	1 side	2 sides
Photo analysis	2/colony	4/colony

Results - methods parameters comparison

	FKB	FKB*
Var (C)	0.016 (0.008)	0.012 (0.005)
Var (e)	0.022 (0.005)	0.013 (0.003)
Var (P)	0.038 (0.008)	0.024 (0.005)
r	0.42 (0.15)	0.48 (0.13)
r_P	0.64 (0.09)	
r_C	0.93 (0.13)	
r_e	0.42 (0.12)	



FKB* resulted **more repeatable and accurate**

FKB and FKB* showed a **high correlation for the colony effect**, therefore they measure the “same trait”

To accurately measure HB the test should be **repeated at least twice**

Results - heritability and repeatability

	Average model	Repeatability model
Var (w)	0.007 (0.005)	0.007 (0.005)
Var (pe)	–	0.0003 (0.0039)
Var (e)	0.011 (0.004)	0.022 (0.003)
Var (P)	0.018 (0.002)	0.029 (0.003)
h^2	0.37 (0.25)	0.23 (0.16)
r	–	0.24 (0.09)
$\bar{r}_{\hat{A},A}$	0.50	0.50

Heritability for the average FKB* is 0.37, indicating good prospects for genetic improvement of HB in the studied population

Conclusions

- **FKB*** is a method which **optimizes time and costs** for HB phenotyping → suitable for large scale phenotype collection in the context of breeding program



Hygienic behaviour in honeybees: a comparison of two recording methods and estimation of genetic parameters

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