

## Estimates of genetic parameters for hygienic behavior in Africanized honeybees considering the maternal genetic effect

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### Introduction

The objective of this work was to estimate genetic and phenotypic parameters considering separately the genetic effect of queen and workers on hygienic behavior at 24, 48 and 72 hours Africanized *Apis mellifera* honeybee colonies.

### Material and methods

There were used 40 colonies where 21 were submitted to honey production and 19 to royal jelly production.

The queen maternal origin was controlled, the paternal one unknown, and at different times, it was considered different worker groups, but with the same mother. It was used the method of freezing capped brood.

Evaluation of hygienic behavior was performed after 45 days of confirmation of the posture and second method established by Rothenbühler (1964), Newton et al. (1975) and reviewed by Spivak & Downey (1998).

Estimates for hygienic behavior were obtained through the following formula:

$$CHx = (TO_{\text{hour zero}} - AOx) / TO_{\text{hour zero}}$$

where,

CHx is the relationship between the number of cells that were cleaned and the total number of cells covered in zero time, where x is 24h, 48h and 72 hours;

TO<sub>hour zero</sub> is the total number of cells covered in zero hour;

AOx is the total number of cells is covered where x 24h, 48h and 72 hours.

The estimation of the components of (co)variance for the characteristics of hygienic behavior in 24 (CH<sub>24</sub>), 48 (CH<sub>48</sub>) and 72 (CH<sub>72</sub>) hours was performed using the program MTGSAM (Multiple Trait Gibbs Sampling in Animal Models) developed by VanTassel & VanVleck (1995), making the Bayesian estimation using the method of Gibbs sampling.

The model allowed for the estimation of (co)variance components and genetic parameters for the percentages of hygienic behavior in 24h, 48h and 72 hours was:

$$Y = X\beta + Zu + e$$

$$\text{where, } Z = [Z_1 \quad Z_2 \quad Z_3]; \quad u = \begin{bmatrix} g \\ p \end{bmatrix} \quad e \quad g = \begin{bmatrix} a \\ m \end{bmatrix}$$

Y is the observation vector; X, Z<sub>1</sub>, Z<sub>2</sub> e Z<sub>3</sub> are the matrix of incidence of fixed effects, direct genetic, maternal and permanent environment effects, respectively;  $\beta$ , a, m, p and e are the vectors of fixed effects, direct genetic, maternal, permanent environment and random error.

The joint distribution of vectors y, g, m, and e can be described as below:

$$\begin{bmatrix} y \\ u \\ e \end{bmatrix} \sim NMV \left\{ \begin{bmatrix} X\beta \\ 0 \\ 0 \end{bmatrix}; \begin{bmatrix} V & Z\Sigma & R \otimes I_n \\ \Sigma Z' & \Sigma & 0 \\ R \otimes I_n & 0 & R \otimes I_n \end{bmatrix} \right\}$$

It was built and the credibility intervals of the regions of high density for all components of (co)variance and genetic parameters estimated at the level of 90% of credibility. Monitoring the convergence of chains was made through the use of diagnostic tests of Heidelberger and Welch, available in the library CODA (Convergence Diagnosis and Output Analysis), implemented in software R (2007).

### Results and discussion

The mean and standard deviation for hygienic behavior in 24h, 48h and 72 hours were  $0.76 \pm 0.22$ ,  $0.88 \pm 0.17$  and  $0.92 \pm 0.15$ , respectively.

Table 1 - Estimates of direct heritability ( $h^2_a$ ), maternal ( $h^2_m$ ), genetic correlation ( $rg$ ) and phenotypic correlations ( $ry$ ), their credibility intervals and regions of high density level of 90% in tricharater analysis for hygienic behavior in 24 hours (CH<sub>24</sub>), 48h (CH<sub>48</sub>) and 72 (CH<sub>72</sub>) hours in Africanized honeybees

Variables*	Estimates	Credibility intervals	High density regions
$h^2_{a1}$	0.28	0.13 – 0.46	0.12 – 0.44
$h^2_{a2}$	0.15	0.05 – 0.28	0.04 – 0.25
$h^2_{a3}$	0.24	0.13 – 0.38	0.12 – 0.36
$h^2_{m1}$	0.23	0.12 – 0.39	0.11 – 0.35
$h^2_{m2}$	0.29	0.10 – 0.56	0.07 – 0.51
$h^2_{m3}$	0.27	0.16 – 0.42	0.14 – 0.40
$rg_{1,2}$	0.49	0.13 – 0.76	0.19 – 0.80
$rg_{1,3}$	0.40	-0.08 – 0.88	0.08 – 0.72
$rg_{2,3}$	0.47	0.14 – 0.73	0.19 – 0.77
$rg_{a1m1}$	-0.12	-0.55 – 0.34	-0.57 – 0.33
$rg_{a2m2}$	0.09	-0.44 – 0.59	-0.42 – 0.61
$rg_{a3m3}$	-0.08	-0.46 – 0.32	-0.47 – 0.31

\*For all estimates, a and m, representing the direct and maternal genetic effects, respectively; and the index 1, 2 and 3, the hygienic behavior in CH<sub>24</sub>, CH<sub>48</sub> e CH<sub>72</sub>, respectively; the heritability are represented for  $h^2$ , genetic and phenotypic correlations for  $rg$  and  $ry$ , respectively.

Estimates indicated that the hygienic behavior influenced the queen during 24h, 48h and 72 hours. Quantifying the direct and maternal additive effects in the proposed model, the population available for study, was satisfactory and helped in the identification of the maternal genetic effect on Africanized honeybee *Apis mellifera*.

### Conclusion

The relative difference between the cells of cleaned dead sealed brood in up to 24 hours and with cells of dead sealed brood in zero time can be used as a selection criteria for hygienic behavior in a model that consider the maternal genetic effect.