

Spatial patterns in the brood combs of *Nannotrigona testaceicornis* (Hymenoptera: Meliponinae): male clusters

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Genet. Mol. Res. 8 (2): 577-588 (2009)

Received December 12, 2008

Accepted January 26, 2009

Published May 19, 2009

ABSTRACT. Genetic models of sex and caste determination in eusocial stingless bees suggest specific patterns of male, worker and gyne cell distribution in the brood comb. Conflict between queen and laying workers over male parentage and center-periphery gradients of conditions, such as food and temperature, could also contribute to non-random spatial configuration. We converted the positions of the hexagonal cells in a brood comb to Cartesian coordinates, labeled by sex or caste of the individuals inside. To detect and locate clustered patterns, the mapped brood combs were evaluated by indexes of dispersion (MMC, mean distance of cells of a given category from their centroid) and eccentricity (DMB, distance between this centroid and the overall brood comb centroid) that we developed. After randomizing the labels and recalculating the indexes, we calculated probabilities that the original values had been generated by chance. We created sets of binary brood

combs in which males were aggregated, regularly or randomly distributed among females. These stylized maps were used to describe the power of MMC and DMB, and they were applied to evaluate the male distribution in the sampled *Nannotrigona testaceicornis* brood combs. MMC was very sensitive to slight deviations from a perfectly rounded clump; DMB detected any asymmetry in the location of these compact to fuzzy clusters. Six of the 82 brood combs of *N. testaceicornis* that we analyzed had more than nine males, distributed according to variations in spatial patterns, as indicated by the two indexes.

Key words: Brood combs; Male clusters; *Nannotrigona*; Randomization; Spatial distribution