

HERITABILITY OF THE NUMBER OF OVARIOLES IN HONEY BEE WORKERS (*Apis mellifera* L.) (HYM.: APIDAE)

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ABSTRACT

Narrow and broad sense heritabilities (h^2) of the number of ovarioles in *Apis mellifera* L. workers were estimated using two distinct data sets, based on groups of half (queens inseminated by several drones) and super-sisters (single drone insemination). The values found are in the usual range for economically important characters (0.25 - 0.38).

INTRODUCTION

Chaud-Netto and Bueno (1979) and Bueno (1981) suggested that number of ovarioles in honey bee workers is a polygenically controlled character, with a relatively strong genetic component, and associated with environmental effects within colonies during larval stages of both workers and queens.

The purpose of this communication is to evaluate quantitatively this genetic component on honey bee workers, based on two different data sets.

MATERIAL AND METHODS

The first data set analyzed is furnished in Bueno (1981), and consists of ovariole numbers (left ovary, right ovary and total ovary) of 25 workers from each of 30 colonies of Africanized bees, with naturally inseminated queens. Narrow sense heritability for

total number of ovarioles was calculated by the method of Oldroyd and Moran (1983), which consists of an application of a model II one-way analysis of variance (ANOVA), and estimation of intraclass correlation (t) from between and within colony mean-squares. The value of heritability is given by dividing t by the average relatedness within colonies (r). The value for r , when analysing naturally inseminated queens, is given by $[1/(2n)] + 0.25$, where n is the number of (unrelated) drones that inseminate the queens (Page, 1986). The relationship between n and r is shown in Figure 1, and it is seen that for an elevated number of matings, changes in r are small. Estimates of n for Africanized honey bees indicate that queens mate with an average of 17.25 drones, according to Adams *et al.* (1977), and 16.1 drones, according to Lobo (1991). These values of n correspond to values of r equal to 0.2790 and 0.2809, respectively.

The second data set analyzed was furnished by Chaud-Netto and Bueno's (1979) paper, consisting of the number of ovarioles in African and Italian honey bee workers. Eleven colonies of each race were analyzed, with thirty worker pupae being evaluated

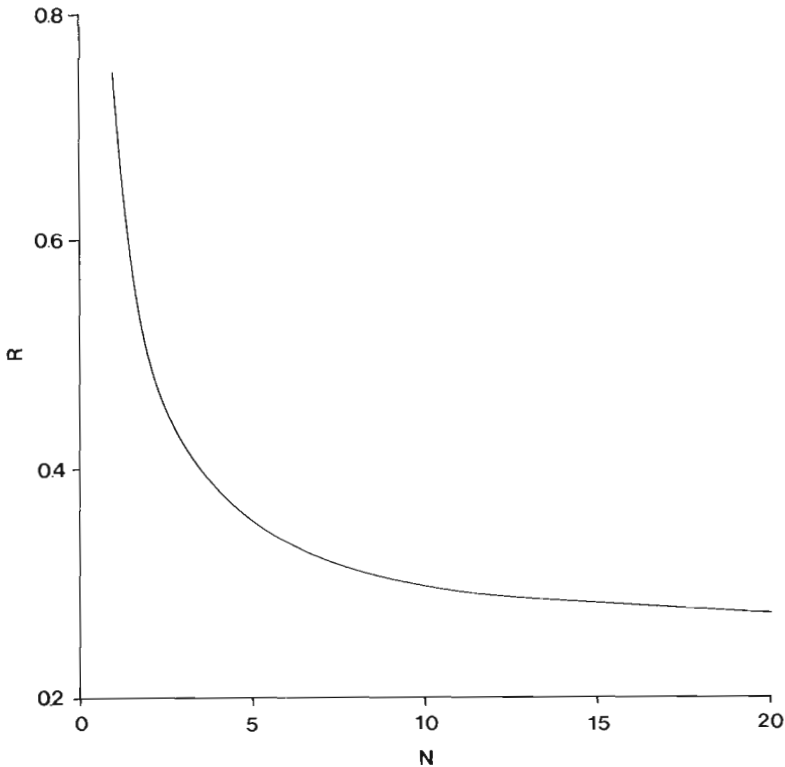


Figure 1 - Relationship between average relatedness within colonies and number of matings by the queen (unrelated drones).

for each colony. The queens in these colonies were instrumentally inseminated with a single unrelated drone of the same race (workers are super-sisters, with $r = 0.75$). The data matrix was analyzed by a mixed model two-level nested ANOVA, using race as a fixed effect (level) and colonies within race as a random effect (sublevel).

RESULTS

For the first data set, the intraclass correlation, calculated with the ANOVA table given by Bueno (1981), was equal to 0.1022, and we calculated the values of narrow sense h^2 and the standard errors, assuming different numbers of mates (Figure 2). For large values of n , as estimated by Adams *et al.* (1977) and Lobo (1991), there were small changes in h^2 . The estimates based on these two r values (\pm standard errors) were equal to 0.3665 ± 0.1260 and 0.3639 ± 0.1251 , respectively.

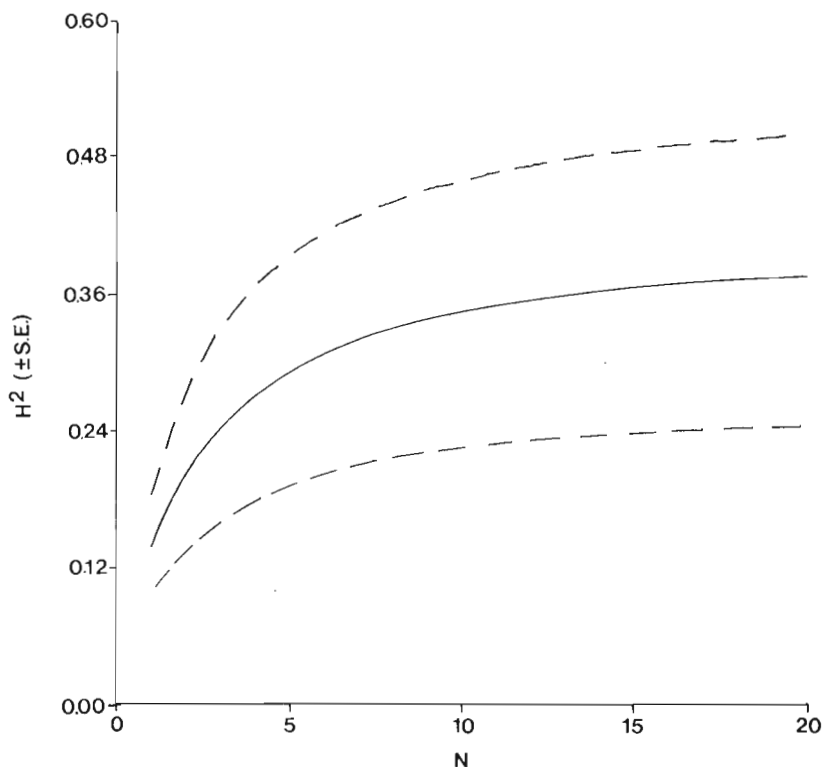


Figure 2 - Estimates of h^2 and standard errors based on ANOVA table of Bueno (1981), assuming different number of matings by the queens.

For the second data set, the intraclass correlation (among colonies within races) calculated based on the ANOVA table furnished by Chaud-Netto and Bueno (1979) and following Moritz (1985), was equal to 0.2779, and the estimated h^2 was equal to 0.3705 ± 0.1187 . It is important to note that this estimate is based on super-sister family groups, and must be viewed as a broad sense estimate because it includes dominance effects.

DISCUSSION

The two heritability estimates were very similar. The values were not very high, but were in the range usually found for economically important characters of honey bees (0.25 - 0.38) (see Collins, 1986, for a review). The estimates using Oldroyd and Moran's (1983) method possess two different sources for upward bias in the values of h^2 . The first one is due to dominance, and must be more accentuated in the second data set, with single drone insemination. The h^2 may be upward biased up to $0.666 V_D/V_P$, where V_D and V_P are the dominance and phenotypic variances (Oldroyd and Moran, 1983). This bias may be serious if the character is controlled by dominance effects. In the first data set, this coefficient was generally smaller and, assuming 16.1 mates, the h^2 may be biased up to $0.11 V_D/V_P$. Since estimates of both sets were very similar and two data sets were obtained in colonies of the same apiary (UNESP, Campus of Rio Claro), we believe that few dominance effects were acting on the character within populations. The other source of upward bias was the microenvironmental variance, since offspring in sib group are reared in the same colony. We believe that this effect was small, especially in the second data set, since general conditions of experimental colonies were standardized.

Since there is a significant genetic additive variance associate with the character analysed, response in population (mass selection) would be relatively large, and given by

$$R = (2/3) h^2 s^2_P i (1-r)$$

where R = genetic response per generation, i = intensity of selection and s^2_P = phenotypic variance (Moritz, 1985).

ACKNOWLEDGMENTS

The authors are indebted to two anonymous referees for critical reading of the original manuscript and to CNPq for the fellowships conceded to the authors during the development of this work.

Publication supported by FAPESP.

RESUMO

Nesta comunicação, valores de herdabilidade em senso estrito e amplo para o número de ovaríolos em operárias de *Apis mellifera* foram calculados, baseados em dois conjuntos de dados. Os valores encontrados situam-se dentro da amplitude encontrada para caracteres de interesse econômico (0,25 - 0,38).

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(Received December 14, 1992)