



Maternal influence on the acceptance of virgin queens introduced into Africanized honey bee (*Apis mellifera*) colonies

G. Moretto¹, J.C.V. Guerra¹, H. Kalvelage² and E. Espindola²

¹Departamento de Ciências Naturais, Universidade Regional de Blumenau, 89.010-971 Blumenau, SC, Brasil

²Centro de Referência em Pesquisa e Extensão Apícola - Epagri/Cepea, 88032-001 Florianópolis, SC, Brasil

Corresponding author: G. Moretto

E-mail: gmoretto@furb.br

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ABSTRACT. The oviposition potential of honey bee queens decreases with age, therefore it is important to replace old queens with younger ones on a periodic basis. However, queen replacement is problematic, especially in Africanized honey bee colonies, since many introduced queens are not accepted, and virgin queens are less easily accepted than are mated queens. We assessed the influence of genetic origin (queen mother) on the acceptance of queens, when they were introduced as virgins into Africanized honey bee colonies. For this purpose, 12 daughter queens from each of 11 mother queens with no degree of kinship among themselves were introduced. Introductions were made monthly, for 12 months, though the winter months of June and July were not included, as there is little brood and drones are rare in winter. There was some seasonal variation in the acceptance rates; generally there was greater acceptance in months with good honey flows. However, the acceptance of introduced queens was influenced by their origin. The rate of acceptance of daughter queens from the 11 different mother queens varied significantly, ranging from 33 to 75%. There appears to be a genetic influence of the mother queen on the introduced queen acceptance rate.

Key words: Africanized bees, Queen acceptance, Mother queen effect

INTRODUCTION

The various production activities involved in apiculture are greatly influenced by the population of adult bees that forms each bee colony. Colonies with larger populations usually perform better than those with smaller populations. Although the worker population of each bee colony also depends on food availability (nectar and pollen), oviposition capacity is very important for the generation of populous hives (Moeller, 1958; Anonymous, 1986).

The longevity of a queen depends on its reproductive potential, and its permanence in the colony is related to its oviposition capacity, which affects colony viability and vitality. The queen is naturally replaced when the spermatozoa stored in its spermatheca are depleted (Severson and Erickson, 1989). The mean permanence of the queens in the colony varies according to region, being up to two years in temperate climate regions and approximately six months in tropical climate regions (Crane, 1990).

Since productive performance is associated with the queen's oviposition conditions, it is important that colonies destined to production have queens with the ability to generate populous colonies. Several factors determine the quality of a queen and the number of ovarioles, and the size of the spermatheca affects longevity (Szabo, 1973).

Generally, the oviposition potential of a queen decreases with its age, with young queens laying a larger number of eggs within a given period of time. Thus, beekeepers, by knowing the age and performance of their queens, can intervene in the natural process of replacement, i.e., they can exchange an old queen with a younger one, with the desired characteristics at the appropriate time.

Mated (fecundated) queens are usually better accepted than are virgin queens. However, beekeepers who wish to introduce mated queens acquired from queen producers may have difficulties in obtaining them in the desired quantities; also, mated queens are more expensive.

Successful artificial replacement of queens mainly depends on the acceptance of the introduced queens. When Africanized virgin queens are introduced, the rate of acceptance ranges from 50 to 80% (Teixeira, 1993; Medina, 1993). Some factors should be kept in mind when introducing virgin queens. Young queens with a high body weight are better accepted by recipient colonies compared to old queens of low body weight (Szabo, 1977; Taranov, 1977; Mantilla and Gonçalves, 1987).

Killing of introduced queens by attacking workers in recipient colonies is the main cause of queen loss after introduction. Mantilla (1986) noted that the loss of introduced queens is higher than 50%, with the condition of the recipient colony having an important effect on success. It is more difficult for colonies of laying workers to accept the new queen.

Since the periodical replacement of queens is important to enhance productivity in apiculture and since the introduction of virgin queens is the process most frequently used, despite the high rate of failure, it is necessary to learn more about the factors that influence this activity. We assessed the influence of genetic origin of virgin queens on their acceptance as replacement queens.

MATERIAL AND METHODS

The queens used in the present study were produced in the queen rearing sector of the Beekeeping Research and Extension Center - Epagri/Cepea in Florianópolis, Santa Catarina,

and the introduction of virgin queens was performed in the experimental apiary of the Department of Natural Sciences of the Regional University of Blumenau.

To obtain the queens to be used in the experiments for the assessment of virgin queen acceptance, 15 mother queens were produced from honey bee colonies belonging to beekeepers in the Blumenau region, State of Santa Catarina (Brazil). However, four mother queens were lost during the study, and therefore the acceptance of virgin queens was measured only for the remaining 11 mother queens.

The queens (mothers and their daughters) were produced by the simple transfer method, using larvae aged 12 to 24 h. The queen cells were transferred to small glass bottles, within two days before emergence. These were maintained in an incubator at 34°C, until they emerged as adults. Virgin daughter queens were introduced into queenless standard Langstroth four-frame nucleus colonies from three to five days after emergence, during 12 different periods in 2001 and 2002. In each of these periods, a daughter queen from each queen mother was introduced into a nucleus, selected at random among 30 available ones. These nucleus mating colonies contained four combs covered with adult bees. The nuclei were orphaned 24 h before introduction of the virgin queen. The queens were placed in standard screened wooden queen cages, and were confined in these cages within the queenless nucleus colonies for 48 h after introduction. They were then released from the cages.

Twenty-four hours after the queens were released from the cage, they were considered accepted if they were found when the nuclei were inspected. When the queen was not found during this inspection and no new queen cells were present in the colony, a new inspection was performed after 24 h.

To determine the effect of queen mother on the acceptance of virgin queens, the data were analyzed by the chi-square homogeneity test (χ^2), with the level of significance set at 5%.

RESULTS AND DISCUSSION

The percentage of virgin queen acceptance was determined in each of the 12 periods (Table 1). The mean number (\pm SD) of accepted queens per introduction step was 5.3 ± 1.5 ($N = 132$).

Table 1. Acceptance of virgin queens introduced into Africanized honey bee colonies from March 2001 to May 2002 ($N = 11$ queens introduced each month).

	Introduction period											
	2001								2002			
	Mar.	Apr.	May	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	May
# Accepted	7	6	4	3	5	5	5	9	4	5	6	5

The acceptance of virgin or mated queens by the recipient colonies depends, among other factors, on environmental conditions. In the southern region of Brazil the winter is characterized by a low natural supply of food and because of that no queens were introduced in June

and July 2001. Although no queens were introduced during critical months in terms of food flow, high variability was still observed during the rest of the year. In the fourth period, in August 2001, only three of the 12 introduced queens were accepted. However, in February 2002, 10 of the 12 introduced queens were accepted. Although the entry of food into the hive was not measured, it is known that the feeding conditions inside the hive are a strong factor affecting queen acceptance. Thus, the variability observed in the results of the various introduction steps may have been due to the influence of different food flows during the study.

The virgin queen acceptance results were compared among the progenies of the mother queens (Table 2). The mean (\pm SD) number of virgin queen acceptance per mother queen was 6.0 ± 1.7 (range: 4 to 9). There was significant variation in the percentage virgin queen acceptance among the progenies of the different queens ($\chi^2 = 4.2$; $P < 0.05$).

Table 2. Number of virgin queens introduced into colonies of Africanized honey bees that were accepted, daughters of 11 different mother queens (N = 12 daughter queens per mother queen).

	Mother queen										
	1	2	3	4	5	6	7	8	9	10	11
# Accepted	4	7	4	5	5	6	8	5	4	8	9

Although Medina (1993) obtained 80% acceptance when he introduced virgin queens in the Ribeirão Preto region, in the State of São Paulo, the other studies conducted in the same region and in regions with other climatic conditions obtained a low rate of success for virgin queen acceptance; most of the time it was lower than 50% (Teixeira, 1993). The rate of virgin queen acceptance that we obtained was similar to the rates reported for Africanized bees in various regions of Brazil.

Since the queens were all introduced under similar conditions, in the same group of nucleus colonies, the variation in the virgin queen acceptance rate is apparently due to the origin of the queen, that is, the queen mother. These differences apparently have a genetic component.

In the production of queens, various characteristics are usually considered. The queen should have certain characteristics that will be transmitted to her worker daughters in order to increase the yield of bee products, since she is the mother of all the workers. Thus, a queen producer usually selects his mother queens by considering characteristics, such as low tendency to swarm, high hygienic behavior, and high honey, pollen, royal jelly, and propolis production. Since apiculture also depends on the successful acceptance of queens when the beekeeper periodically replaces them, it is important that he should select queens that are daughters of queens that have been selected for acceptance of their daughter queens.

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