

Differences in the number of sensilla coeloconica and sensilla ampullacea of segment 10 of the antennae of Africanized and Caucasian bees and of their F₁ hybrids

Antonio Carlos Stort and Osmar Malaspina

ABSTRACT

The numbers of sensilla coeloconica and sensilla ampullacea of segment 10 of the antennae of Caucasian and Africanized worker bees and of their hybrids were counted with the aid of a scanning electron microscope. Africanized bees have fewer sensilla than Caucasian bees and the continuous distribution obtained from the F₁ values suggests polygenic inheritance for the control of this trait. There are also indications that the hybrid Brazilian *Apis mellifera* studied here are close to typical African bees (*Apis mellifera scutellata*) in terms of number of sensilla.

INTRODUCTION

The Africanized bees which first originated in Brazil and which have already reached the United States have been extensively studied from different viewpoints. Several investigations have been published about the genetics of morphological structures. Among them are studies on head and thorax traits (Gonçalves, 1970), sting length (Stort and Chaud Netto, 1977), selection for increased frequency of the open sting trait (Soares, 1979), selection for reduction of venom gland size (Alves-Junior, 1987), analysis of abdominal segment coloration (Stort, 1976), analysis of number of setae of the discoid cell of the wings (Carvalho, 1982), analyses of structures of the buccal apparatus (Pignata, 1990), and analysis of morphometric differences between Africanized and European bees and their F₁ hybrids (Rinderer *et al.*, 1990).

Multidimensional discriminant analyses have also been used to determine the morphological evolutionary trend in Brazilian hybrid bees as compared to their typical African, Italian and German parental lines (Stort and Bueno, 1985) and to attempt to identify Africanized bees (Daly and Balling, 1978; Rinderer *et al.*, 1986).

The antennae of Africanized bees have been found to be smaller than those of Italian bees (Gonçalves, 1970; Stort, 1979). Different types of sensory receptors are located on the antennae, such as the sensilla placodea, sensilla trichodea, sensilla basiconica, sensilla campaniformia, sensilla coeloconica and sensilla ampullacea (Schenk, 1903), but only the number (Stort and Barelli, 1981) and area (Moraes, 1988) of these sensilla have been studied genetically in Africanized bees.

The objective of the present investigation was to determine the number of sensilla coeloconica and sensilla ampullacea on segment number 10 (the most

distal one) of the flagellum of the antennae of Africanized bees, of Caucasian bees and of the F_1 hybrids, produced by their controlled crosses. According to Kuwabara and Takeda (1956), the sensilla coeloconica and sensilla ampullacea may be hygroreceptor organs.

MATERIAL AND METHODS

Three colonies (C_1 , C_2 , C_{36}) of Caucasian bees (*Apis mellifera caucasica*), four colonies (A_1 , A_2 , A_3 , A_{76}) of Africanized bees and three colonies (An_1 , An_2 , An_3) of typical African bees (*Apis mellifera scutellata*) were used. Colony C_{36} of Caucasian bees and colony A_{76} of Africanized bees served as parental and 15 colonies of hybrid bees were produced. Eight of these were obtained from crosses between Caucasian queens and Africanized drones and seven were obtained from reciprocal crosses, i.e., Africanized queens with Caucasian drones (Table I). The crosses were made by instrumental insemination using one male per virgin female.

Table I - Mean \pm SD of the number of sensilla coeloconica/ampullacea of the Caucasian, Africanized, African, parental and F_1 colonies.

Colony number	Mean \pm SD	Type of colony
C_1	40.600 \pm 2.675	Caucasian
C_2	41.400 \pm 5.985	Caucasian
A_1	30.700 \pm 5.034	Africanized
A_2	32.300 \pm 4.372	Africanized
A_3	31.700 \pm 2.149	Africanized
An_1	28.600 \pm 2.547	African
An_2	27.800 \pm 3.735	African
An_3	29.500 \pm 3.203	African
C_{36}	44.150 \pm 2.720	Caucasian parental
A_{76}	31.800 \pm 4.188	Africanized parental
94	37.000 \pm 5.182	F_1 - F/Cauc. x M/Afric.
75	35.533 \pm 5.780	F_1 - F/Cauc. x M/Afric.
69	34.933 \pm 4.559	F_1 - F/Cauc. x M/Afric.
27	38.533 \pm 4.324	F_1 - F/Cauc. x M/Afric.
116	37.133 \pm 4.172	F_1 - F/Cauc. x M/Afric.
98	36.933 \pm 3.474	F_1 - F/Cauc. x M/Afric.
93	40.200 \pm 7.022	F_1 - F/Cauc. x M/Afric.
123	42.400 \pm 3.582	F_1 - F/Cauc. x M/Afric.
80	38.600 \pm 4.808	F_1 - F/Afric. x M/Cauc.
115	36.667 \pm 4.685	F_1 - F/Afric. x M/Cauc.
32	39.600 \pm 4.171	F_1 - F/Afric. x M/Cauc.
130	36.867 \pm 3.482	F_1 - F/Afric. x M/Cauc.
117	32.267 \pm 3.173	F_1 - F/Afric. x M/Cauc.
56	39.533 \pm 4.373	F_1 - F/Afric. x M/Cauc.
118	36.733 \pm 4.200	F_1 - F/Afric. x M/Cauc.

SD = Standard deviation; F = female; M = male.

Samples of 15 adult workers were taken from each colony, anesthetized, killed in an ether chamber, and fixed in Karnovsky fluid for 6 h. The antennae were then separated and submitted to ultrasound to remove dirt particles.

After drying, each antenna was glued to a metal support, covered with a thin layer of gold in a model S150-B Sputter apparatus (Edwards) and segment number 10 was examined with a model T330-A Jeol scanning electron microscope (Institute of Chemistry, UNESP, Araraquara). The region containing the set of sensilla coeloconica and sensilla ampullacea was photographed and the number of sensilla was counted on the photograph (Figure 1).

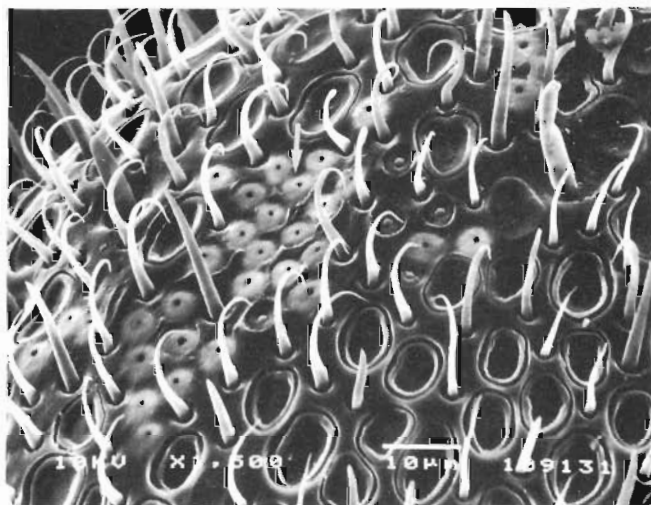


Figure 1 - Sensilla coeloconica/ampullacea (arrow) of segment number 10 of the antennae of Africanized worker bee.

The data obtained for the sample from the two parental types were compared by the nonparametric Mann-Whitney test. The distribution obtained for the data referring to the various F_1 samples was compared with theoretical normal distribution values by the chi-square test.

RESULTS AND DISCUSSION

The results obtained are presented in Table I. Comparison of the data for the C_{36} and A_{76} parental colonies gave a T value = 5.877, significant at the 5% level, indicating that the two populations are statistically different.

Mean data for the F_1 hybrids were distributed between the values for the parental lines (Figure 2), indicating that the inheritance of this trait is complex. Comparison of the data distribution with theoretical

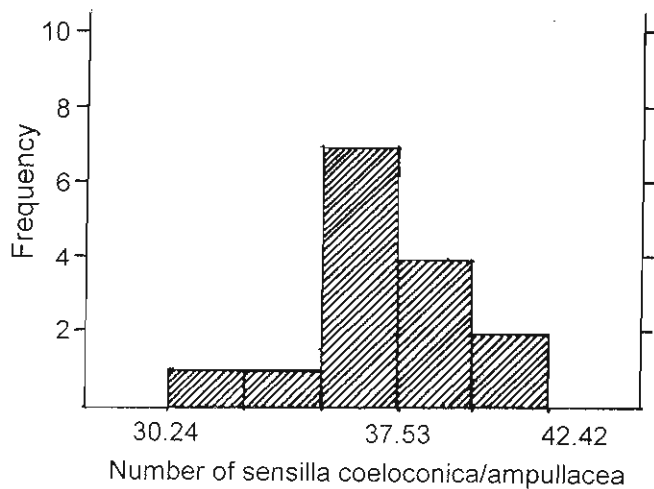


Figure 2 - Histogram of the frequency distribution of the mean number of sensilla coeloconica/ampullacea of segment number 10 of antennae of 15 F₁ descendant colonies (single drone matings) of a cross between Caucasian and Africanized bees. The mean is 37.53 and the class interval corresponds to the standard deviation value = 2.43.

values of the normal distribution showed that distribution was normal ($\chi^2 = 5.80$, nonsignificant), suggesting that this trait is controlled by polygenes, as is also the case for the control of the number of sensilla placodea (Stort and Barelli, 1981).

The data obtained for the number of sensilla coeloconica and sensilla ampullacea also agreed with those obtained for several other morphometric traits which have been studied comparatively in populations of Africanized and European bees and in their hybrids, i.e., in most cases the number is larger in European bees and genetic control occurs through several genes (Gonçalves, 1970; Stort, 1979).

The number of sensilla coeloconica and sensilla ampullacea of the set of segment 10 of the antennae of Africanized worker bees studied here was very close to the number obtained for typical African worker bees (*Apis mellifera scutellata*) originating from the same site in Pretoria (Kosmos Apiary) from which the queens that gave origin to the swarms that escaped in Brazil were obtained and considerably lower than the mean found for Caucasian colonies (Table I).

Thus, with respect to number of sensilla coeloconica and sensilla ampullacea, there are indications that Brazilian hybrid *Apis mellifera* bees tend towards the African ancestor, as also observed for several other morphometric traits studied by Stort and Bueno (1985).

The mean value (37.117) obtained from seven F₁ colonies resulting from crosses between Africanized queens and Caucasian males and the mean value (37.747) obtained from samples of all eight F₁ resulting from crosses between Caucasian queens and African-

ized males indicate that in general the F₁ generations obtained from the two types of crosses did not differ. Thus, there is no component of the cytoplasm type influencing this type of inheritance, contrary to what was found for food gathering behavior (Malaspina, 1982).

ACKNOWLEDGMENTS

The authors wish to thank Drs. José Arana Varela and Mario Cilense, Departamento de Físico-Química, Instituto de Química de Araraquara, UNESP, for permitting the use of scanning electron microscope and for their help during operation of the equipment.

This research was supported by CNPq and FAPESP. Publication supported by FAPESP.

RESUMO

Com o auxílio de um microscópio eletrônico de varredura foi contado o número de sensilla coeloconica e ampullacea do segmento 10 das antenas de amostras de operárias caucasianas, africanizadas e de híbridos provenientes dos seus cruzamentos. Os dados mostraram que as abelhas africanizadas possuem menor quantidade dessas sensilla do que as caucasianas e a distribuição contínua obtida a partir dos valores dos F₁ sugere herança poligênica para o controle desse caráter. Foi mostrado também que em relação ao caráter considerado há indicações de que as abelhas *Apis mellifera* híbridas do Brasil estudadas nesse trabalho são próximas das africanas típicas (*Apis mellifera scutellata*).

REFERENCES

- Alves-Junior, V.V. (1987). Estudo do tamanho da glândula ácida em operárias de *Apis mellifera* descendentes de rainhas cruzadas com um zangão. Master's thesis, Instituto de Biociências, UNESP, Rio Claro, SP.
- Carvalho, M.A.S. (1982). Morfometria comparada em zangões e análise do número de cerdas das asas de operárias de *Apis mellifera*. Master's thesis, Instituto de Biociências, UNESP, Rio Claro, SP.
- Daly, H.V. and Balling, S.S. (1978). Identification of Africanized honey bees in the western hemisphere by discriminant analysis. *J. Kansas Ent. Soc.* 51: 857-869.
- Gonçalves, L.S. (1970). Análise genética do cruzamento entre *Apis mellifera ligustica* e *Apis mellifera adansonii*. Escolha e análise genética de caracteres morfológicos da cabeça e do tórax. Doctoral thesis, Faculdade de Medicina, USP, Ribeirão Preto.
- Kuwabara, M. and Takeda, K. (1956). On the hygroreceptor of the honey bee *Apis mellifera*. *Physiol. Ecol.* 7: 1-6.
- Malaspina, O. (1982). Análise do comportamento de coleta de alimento e morfometria em abelhas africanizadas, cauca-

- sianas e em descendentes dos seus cruzamentos. Doctoral thesis, Instituto de Biociências, UNESP, Rio Claro, SP.
- Moraes, M.M.B.** (1988). Estudo morfológico e genético das antenas de abelhas da família Apidae (Hymenoptera, Apoidea). Doctoral thesis, Instituto de Biociências, UNESP, Rio Claro, SP.
- Pignata, M.I.B.** (1990). Análise genética e morfológica do aparelho bucal de algumas espécies de abelhas da família Apidae. Master's thesis, Instituto de Biociências, UNESP, Rio Claro, SP.
- Rinderer, T.E., Sylvester, H.A., Browen, M.A., Villa, J.D., Pesante, D. and Collins, A.M.** (1986). Field and simplified techniques for identifying Africanized and European honey bees. *Apidologie* 17: 33-48.
- Rinderer, T.E., Daly, H.V., Sylvester, H.A., Lancaster, V.A., Collins, A.M., Buco, S.M., Hellmich, R.L. and Danka, R.G.** (1990). Morphometric differences among Africanized and European honey bees and their F₁ hybrids (Hymenoptera: Apidae). *Ann. Entomol. Soc. Am.* 83: 346-351.
- Schenk, O.** (1903). Die antennalen hautsinnesorgane einiger Lepidopteren und Hymenopteren mit berchsichtigung der sexuellen unters chide. *Zool. Ialviv.* 17: 537-618.
- Soares, A.E.E.** (1979). Estudo do caráter "ferrão aberto" em *Apis mellifera* L. (Hymenoptera, Apoidea). Doctoral thesis, Faculdade de Medicina de Ribeirão Preto, USP, Ribeirão Preto, SP.
- Stort, A.C.** (1976). Análise da coloração abdominal em três linhagens puras e em híbridadas de *Apis mellifera*. Anais do 4º Congresso Brasileiro de Apicultura (Gonçalves, L.S., ed.). Curitiba, PR, pp. 155-166.
- Stort, A.C.** (1979). Estudo genético de caracteres morfológicos e suas relações com o comportamento de defesa de abelhas do gênero *Apis*. Livre Docência thesis, Instituto de Biociências, UNESP, Rio Claro, SP.
- Stort, A.C. and Barelli, N.** (1981). Genetic study of olfactory structures in the antennae of two *Apis mellifera* subspecies. *J. Kansas Entomol. Soc.* 54: 352-358.
- Stort, A.C. and Bueno, O.C.** (1985). Are *Apis mellifera* bees morphologically Africanized in Brazil? *Rev. Bras. Biol.* 45: 393-397.
- Stort, A.C. and Chaud-Netto, J.** (1977). Study of the size of sting and comparison with the aggressive behavior in Africanized and Italian bees. *Cienc. Cult.* 30: 332-335.

(Received August 28, 1996)