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# COLONY DEFENCE OF TWO HONEYBEE TYPES AND THEIR HYBRID 1. NATURALLY MATED QUEENS



ANITA M. COLLINS, THOMAS E. RINDERER, AND KENNETH W. TUCKER

*USDA, ARS, Honey-Bee Breeding, Genetics and Physiology Laboratory, Baton Rouge, Louisiana 70820, USA*

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## Summary

Honeybee colonies of Africanized and European (Italian) types, and hybrids between the two (Italian × Africanized), were assayed for eleven measures of colony defensive behaviour. The Africanized colonies were significantly more defensive than the European ones. The hybrids were intermediate to the parental types in terms of seconds to respond to a sting target, total stings delivered, number of bees around the colony entrance prior to testing (0 s), and number of bees in the air at 60 s and 90 s. The hybrids were similar to the European parent in terms of seconds to respond to alarm pheromone, number of responding bees around the colony entrance at 30 s, 60 s and 90 s, and the number of bees in the air at 0 s and 30 s.

## Introduction

The importation of representatives of the fierce *Apis mellifera scutellata* subspecies to Brazil in 1957 (Kerr, 1967) stimulated interest in the defensive behaviour of honeybees. This bee type, currently spreading throughout the Americas (Michener, 1975), is most likely the result of hybridization of *A. m. scutellata* with various European subspecies previously in Brazil, and is referred to as the Africanized bee. A number of studies (Stort, 1975*a*, *b*, *c*, 1976, 1980) have been done to compare the defensive behaviour of the Africanized type with the European, and to discover the mode of inheritance. This information is important because a major approach to ameliorating the effects of excessively defensive Africanized bees is genetic. However, the studies mentioned used only a single colony of each type, representing only one of the possible hybrids. This study attempts to broaden the biological base from which such genetic analysis is made.

## Materials and Methods

The study was conducted in 1981 in one apiary approximately 55 km SW of Acarigua, Portuguesa, Venezuela (9°3'N, 69°12'W, 250 m above sea level). The area is tropical, dry forest and savanna, with some parts under cultivation. Thirty large colonies of equivalent size were moved into the apiary, including 6 colonies of each bee type reported on here: (a) Africanized, colonies with African-like behaviour; (b) European, Italian (*A. m. ligustica*); and (c) the hybrid, Italian × Africanized.

This area had had a noticeable Africanized honeybee population for 5 years (G. Vogel, personal communications). The most African-like colonies were chosen from all Africanized ones available, based on small body size of workers, dark colour, high levels of defensiveness and excessive running on the combs, all attributes readily judged by an experienced beekeeper. Choices were made on this basis because at this time there were no morphometric procedures available for use in the field. The Italian queens had been imported from the USA and the hybrids were produced by rearing queens from the parental European stock and allowing them to mate naturally in an Africanized area with no known European colonies.

The colonies were assayed using a standardized test of colony defensive behaviour (Collins & Kubasek, 1982) on 6 days (13, 14 and 17 February; 16, 17 and 18 March; 1981) in the latter part of the dry season. Nectar availability at these times was low. The measurements made on each colony were: (1) the number of seconds until a colony responded to an alarm pheromone, isopentyl acetate (in medicinal paraffin 1 : 100, v/v), which was sprayed on the entrance to begin the test; (2) the number of seconds until the first bees were seen on two blue suede sting targets (5 × 5 cm) mechanically waved in front of the entrance for 30 s beginning 60 s after the pheromone spray; (3) the total number of stings in both targets; and (4–11) the number of bees counted in photographs of the area around the colony entrance (ENT), or the airspace

(AIR) in front of the colony, which were taken prior to the test (0 s), 30 s after the test began, at 60 s (30 s after a physical jolt to the colony), and at 90 s (after 30 s of access to moving targets).

The data were treated by a log transformation and analysed using a Least Squares analysis of variance (SAS, 1982). Linear contrasts between bee types were made using Student's *t*-test.

## Results

The least squares means and standard errors for the eleven measures of colony defence are listed in Table 1 by bee type. The Africanized type was consistently more defensive (faster responses, more stings, more bees responding), than the European type. Also, these colonies showed more activity prior to testing (0 s). The hybrids were more similar to the European parental type in terms of seconds to respond to the pheromone, number of bees at the entrance at 30 s, 60 s and 90 s, and number of bees in the air at 0s and 30 s. They were intermediate (either significantly different or not significantly different from *both* types) for the other 5 characters measured.

If the numbers of bees responding are expressed as percentages of the number of bees responding during the previous test segment, the Europeans show a greater percentage response to the initial cue, the alarm pheromone (IPA). The Africanized showed their greatest response to the physical jolt and the moving targets; the hybrid, to the physical jolt. The greater importance of alarm pheromone in regulating colony defence in European honeybees was also reported by Collins et al. (1989). The more important stimulus for the Africanized bees is the moving target and pheromones associated with it.

Fig. 1 shows colony differences for 4 of the 11 characters where they were significant: speed of response to pheromone, total stings, and numbers of bees (ENT and AIR) at 90 s. There was intercolony variation in all 3 populations ($P < 0{\cdot}01$).

TABLE 1. Least squares means (± SE) for 11 measures of colony defensive behaviour by two types of honeybees (Africanized and European) and their hybrid.
Values in parentheses for number of bees are counts expressed as a percentage of the previous values.

| *Bee type* | *Africanized* | *Italian queen × Africanized drones* | *Italian* |
|---|---|---|---|
| Seconds to respond to: | | | |
| pheromone | 3·6 ± 0·7*a** | 9·0 ± 0·7*b* | 8·8 ± 0·7*b* |
| target | 0·8 ± 1·0*a* | 2·1 ± 1·0*ab* | 4·7 ± 1·0*b* |
| Total stings: | 143·1 ± 2·5*a* | 71·0 ± 2·6*b* | 39·2 ± 2·5*c* |
| Number of bees (ENT) at: | | | |
| 0 s | 52·0 ± 3·7*a* | 29·5 ± 4·0*b* | 8·9 ± 3·7*c* |
| 30 s | 61·9 ± 3·1*a* (119%) | 32·1 ± 3·3*b* (109%) | 24·7 ± 3·1*b* (277%) |
| 60 s | 91·2 ± 3·1*a* (147%) | 45·7 ± 3·2*b* (142%) | 39·0 ± 3·1*b* (158%) |
| 90 s | 137·2 ± 22·8*a* (150%) | 52·4 ± 24·3*b* (114%) | 47·4 ± 22·9*b* (121%) |
| Number of bees (AIR) at: | | | |
| 0 s | 21·3 ± 12·6*a* | 11·1 ± 13·4*b* | 7·9 ± 13·0*b* |
| 30 s | 26·8 ± 6·4*a* (126%) | 14·1 ± 6·8*b* (127%) | 10·3 ± 6·6*b* (130%) |
| 60 s | 23·6 ± 10·5*a* (88%) | 15·3 ± 11·1*ab* (108%) | 9·0 ± 10·8*b* (87%) |
| 90 s | 118·9 ± 3·6*a* (504%) | 48·9 ± 3·9*b* (320%) | 25·2 ± 3·8*c* (280%) |

* Means within rows with different letters are significantly different at $P < 0{\cdot}01$.
AIR, bees in the air; ENT, bees at the hive entrance.

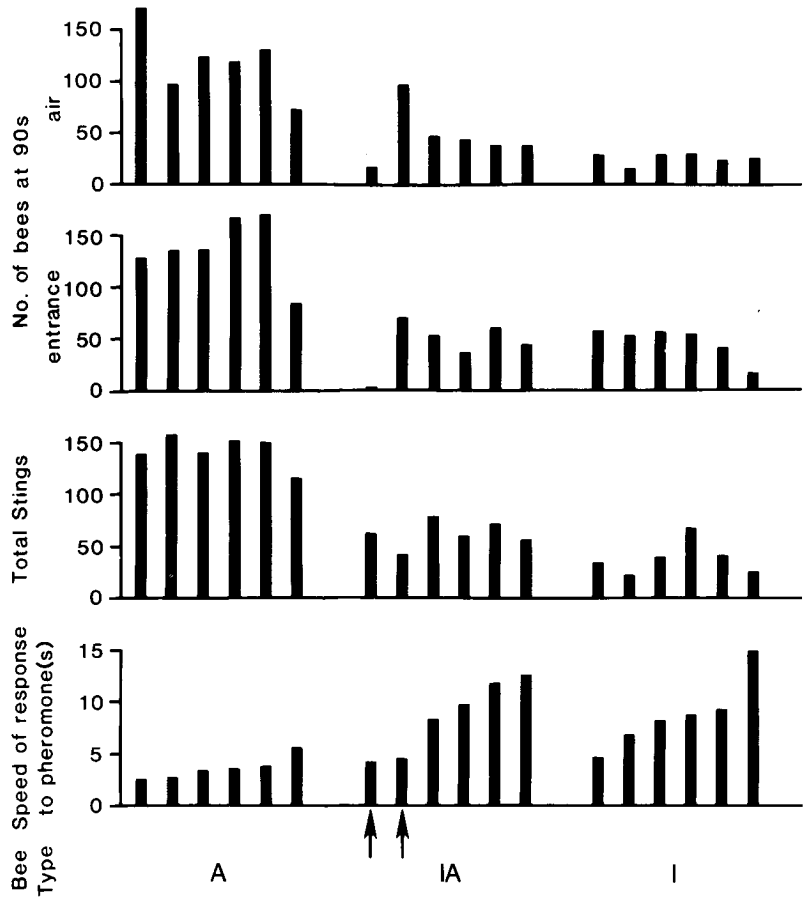


FIG. 1 Individual colony means ($n$ = 6) within bee type for 4 measures of colony defensive behaviour. A, Africanized; IA, Italian × Africanized; I, Italian. Arrows indicate hybrid colonies showing independent segregation of some of the characters.

## Discussion

As previously (Collins et al., 1982), the Africanized bee type was considerably more defensive than the European type. The important information to be gained from this study is the manner in which the characters were expressed in the hybrid and what this indicates about their mode of inheritance. There seems to be a widespread misunderstanding that African characters are dominant and therefore all Africanized bees (the hybrids of *A. m. scutellata* and European subspecies) show extreme defensiveness. The populations of bees in South America that can be referred to as Africanized are really quite variable in this respect and other characters (personal observation and unpublished data). They are the result of continued interbreeding between individuals carrying genes of both European and African descent and can include all possible genetic segregations of the two original extremes. This means that some colonies are very European-like, some very African-like, and many behave somewhere between the two extremes.

The Africanized colonies used in this study were deliberately chosen for their African-like phenotype, to represent one parental type. The hybrids produced were matings of European queens with feral Africanized drones and represent the $F_1$ genotype. The corresponding

phenotype was intermediate to the parental types for some characters and similar to the less defensive parent for others. Therefore, a possible genetic explanation for the inheritance of the first character group would be a simple additive system, for the second group, a single gene with the gentle, Italian phenotype showing dominance. One of the traits, seconds to respond to alarm pheromone, was segregating independently of the number of stings and number of bees responding, which indicates that for at least some traits, the controlling genes are different.

Hybrids of only one European subspecies with Africanized drones are reported here. There are indications from our own experience, and reports from others, that the other European subspecies may combine differently with the Africanized one. Beekeepers attempting to maintain desirable bees in Africanized areas would be well advised to evaluate different stocks, as some could be more successfully used in a scheme of reproductive isolation and selection as proposed by Hellmich et al. (1988).

This study used naturally mated queens, which would have mated with 1–20 drones (Taber, 1958; Koeniger, 1986) and produced colonies of mixed genotypes. Since the measures made of colony defence were a composite of the behaviour of all defenders from the colony, the colony means were the average of all genotypes in the colony. Results from more genetically defined matings, using queens instrumentally inseminated with a single drone to produce colonies of genetically similar workers, are necessary to understand the inheritance of this behaviour pattern more clearly.

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## References

COLLINS, A. M.; KUBASEK, K. J. (1982) Field test of honey bee (Hymenoptera : Apidae) colony defensive behaviour. *Ann. ent. Soc. Am.* 75 : 383–387

COLLINS, A. M.; RINDERER, T. E.; DALY, H. V.; HARBO, J. R.; PESANTE, D. (1989) Alarm pheromone production by two honeybee, *Apis mellifera*, types. *J. chem. Ecol.* 15 : 1747–1756

COLLINS, A. M.; RINDERER, T. E.; HARBO, J. R.; BOLTEN, A. B. (1982) Colony defense by Africanized and European honey bees. *Science* 218 : 72–74

HELLMICH II, R. L.; COLLINS, A. M.; DANKA, R. G.; RINDERER, T. E. (1988) Influencing matings of European honey bee queens in areas with Africanized honey bees (Hymenoptera: Apidae). *J. econ. Ent.* 81 : 796–799

KERR, W. E. (1967) The history of the introduction of African bees to Brazil. *S. Afr. Bee J.* Mar/Apr : 3–5

KOENIGER, G. (1986) Reproduction and mating behaviour *from* Honeybee Genetics and Breeding. *ed.* T. E. Rinderer. *New York : Academic Press, Inc.*

MICHENER, C. D. (1975) The Brazilian bee problem. *A. Rev. Ent.* 20 : 399–416

SAS (1982)Statistical analysis system user's guide : statistics. *Cary, North Carolina : SAS Institute, Inc.*

STORT, A. C. (1975*a*) Genetic study of aggressiveness of two subspecies of *Apis mellifera* in Brazil. 2. Time at which the first sting reached a leather ball. *J. apic. Res.* 14 : 171–175

——(1975*b*) Genetic study of aggressiveness of two subspecies of *Apis mellifera* in Brazil. IV. Number of stings in the gloves of the observer. *Behav. Genet.* 5 : 269–274

——(1975*c*) Genetic study of aggressiveness of two subspecies of *Apis mellifera* in Brazil. V. Number of stings in the leather ball. *J. Kans. ent. Soc.* 48 : 381–387

——(1976) Genetic study of aggressiveness of two subspecies of *Apis mellifera* in Brazil. III. Time taken for the colony to become aggressive. *Ciênc. Cult., S Paulo* 28 : 1182–1185

——(1980) Genetic study of aggressiveness of two subspecies of *Apis mellifera* in Brazil. VI. Observer persecution behaviour. *Revta brasil. Genet.* 3 : 285–294

TABER, S. (1958) Concerning the number of times queen bees mate. *J. econ. Ent.* 51 : 786–789