THE NATURAL NEST AND NEST DENSITY OF THE AFRICANIZED HONEY BEE (HYMENOPTERA, APIDAE) NEAR TAPACHULA, CHIAPAS, MEXICO

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Abstract

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Natural nests of the Africanized honey bee near Tapachula, Chiapas, Mexico, were examined during March and April 1988, approximately 18 months after initial colonization. Most were in hollow trees, but open nests and nests in arboreal termite nests occurred. All nests were less than 6 months old and most less than 2 months. The modal cavity volume was 10–20 L. No brood diseases were seen. Colony density was estimated to be about six per square kilometre, higher than the density of man-kept hives.

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Résumé

Les nids naturels des abeilles africanisées près de Tapachula, Chiapas, Mexique, ont été étudiés pendant les mois de mars et d'avril, 1988, approximativement 18 mois à partir de la colonisation initiale. La plupart se trouvaient dans les arbres creux, mais des nids ouverts et aussi dans des nids de termites aux arbres ont été constatés. Tous les nids ont été âgés de moins de 6 mois, mais la majeure partie a été âgée de moins de 2 mois. La valeur de la modalité d'une cavité a été entre 10 à 20 L. Aucune maladie de couvée n'a été en évidence. La densité des colonies a été évaluée à six par kilometre carré, ou plus élevée que celle des ruches exploitées par les apiculteurs.

Introduction

Occupation of a favorable nest site is important for nesting animals. In the honey bee (*Apis mellifera* L.) characteristics of the nest site can affect winter survival (Seeley 1985), reproduction (Morales-Soto 1986), and disease (Ratnieks and Nowakowski 1989). The characteristics of feral nest sites of honey bees indicate the choices made by swarms from among potential nest sites. Nest dissections can provide additional ecological information, such as colony age, disease, reproductive status, and population.

Comparisons of natural nests of European *A. mellifera* in temperate New York State (Seeley and Morse 1976) and *A. mellifera scutellata* Lepeletier 1836 in the Okavanga River delta of Botswana (Schneider and Blyther 1988) show differences in factors such as colony population, cavity volume, and nest substrate. This study describes natural Africanized honey bee nests near Tapachula, Chiapas, Mexico and is the first extensive data set on Africanized bee nest sites (Seeley 1988). In addition to their comparative value, these data are relevant to the control of the Africanized bee (Rinderer et al. 1987), such as the design and placement of bait hives for trapping swarms. Nest density is also examined. This is important, as the abundance of Africanized bees affects the feasibility of various control measures, such as trapping swarms with bait hives and enhancing mating to European drones by maintaining European queens in beekeeper-managed hives as the drone source.

Materials and Methods

Study Area, Race of Bees Studied. Nests were studied near Tapachula, Chiapas, Mexico (lat. 15°N, altitude 50–250 m) from 13 March to 7 April 1988. This area has a tropical

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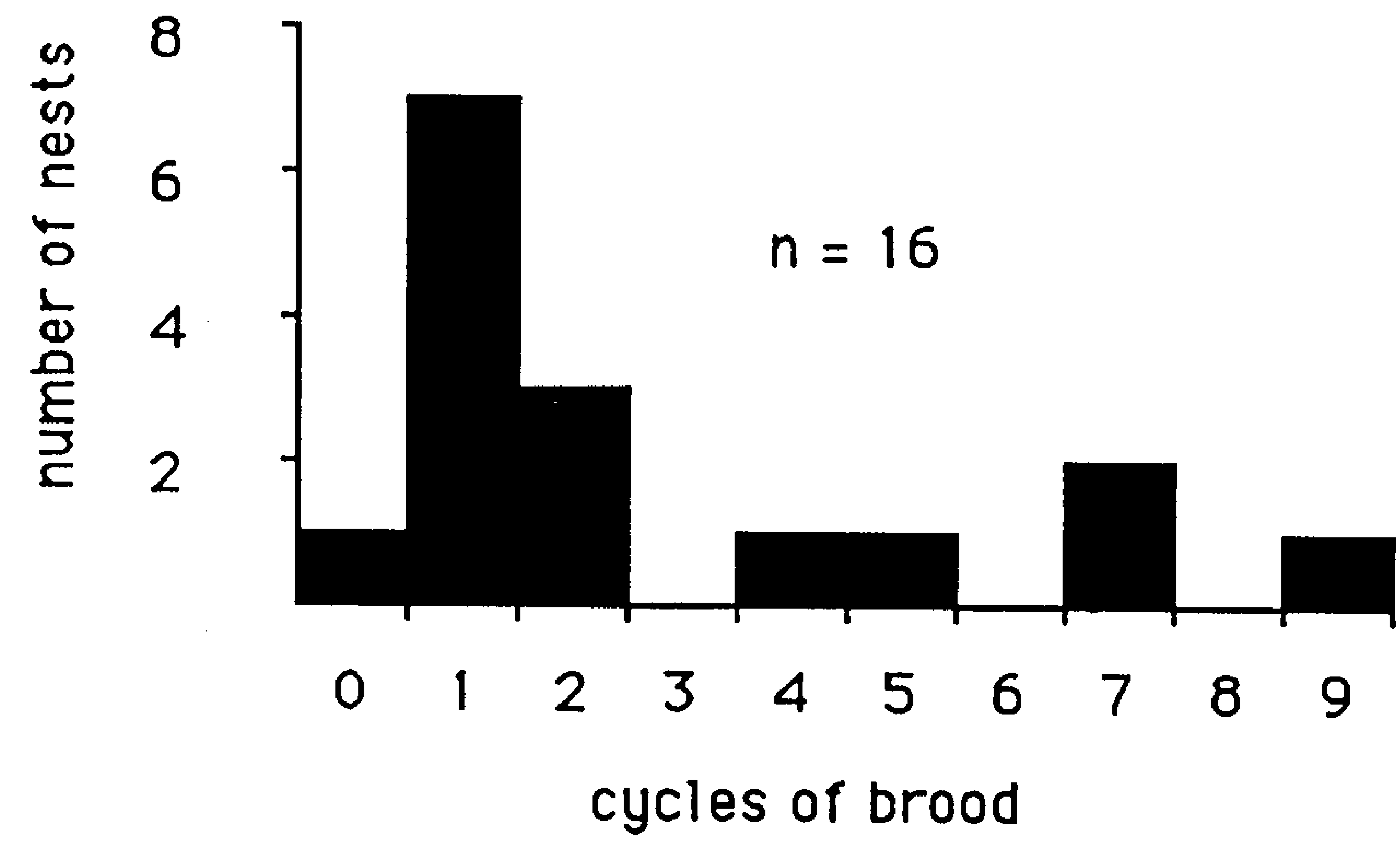

FIG. 1. Age of colonies in brood cycles. Each cycle equals approximately 3 weeks.

climate, with a dry season from November to April. Nests were surveyed in three main areas, representative of the typical land use: (*a*) San Roque, ca. 5 km WSW of Tapachula, an area of banana and cacao plantation, arable land, and waste land; (*b*) Rio Florido, ca. 8 km SW of Tapachula, an area of cacao plantation, woodland, and arable land; (*c*) Huixtla Rd., ca. 15 km WNW of Tapachula, an area of cattle ranching with some woodland and arable land. Trees and water were abundant at all sites.

Africanized bee swarms first colonized here in late 1986 (Fierro et al. 1988). Since mid-1987, 98–100% of all swarms captured here have been identified as Africanized (Fierro et al. 1988) using the fast FABIS (Sylvester and Rinderer 1987) morphometric method on worker wing and femur, or mitochondrial DNA (Smith et al. 1989; Hall and Muralidharan 1989). Samples of 10 worker bees from 15 of the natural nests in this study were analyzed by fast FABIS. Of these, 14 were identified as Africanized and one was intermediate between Africanized and European.

Finding Nests, Density of Nests. Most nests were found by questioning local residents. At San Roque an area of 2.1 km^2 was also searched on foot. It is likely that almost all natural nests in San Roque were found because only one new nest was reported in the second half of the study period, despite a substantial reward offered for each nest. The other two areas were not surveyed as thoroughly. These densities may be underestimated, but are useful in showing that the colony density at San Roque applies generally.

Nest Collection, and Measurement. Of the 30 nests found, 18 were dissected. Most were collected at sunset after the bees had stopped flying. When the nest could not be removed, the combs and bees were taken after killing the bees (in three cases the number of adult bees was not recorded). Adult bees, and capped brood cells, were counted individually. Comb area was estimated with a 2 by 2 cm grid. Honey stores were weighed, not including the small amount of honey in the brood area. Nest age was estimated from the maximum number of meconium layers in nine worker brood cells from the darkest area of comb. Larval bees defecate after spinning the cocoon, so that an alternating series of cocoons and fecal masses builds up in a cell with repeated brood rearing. Cavity volumes were measured either by filling with known volumes of sand, or by measurement. The proportion of the cavity occupied by combs was estimated by eye.

Table 1. The density of natural colonies of honey bees

Location	Habitat	Nest sites (in order of importance)	Area, km²	Nests/km²
Russia[a]*	Temperate forests	Hollow trees	10.4	0.96
			88	0.57
			10	0.30
			72.5	0.17
		Four forests combined	180.9	0.41
New York[b]	Temperate mixed forest	Hollow trees	16.4	0.5
New York[c]	Urban/suburban	Buildings, hollow trees	4.8	2.3
Santa Cruz Island[d]	Arid island	Small rock caves	230	0.25
Arizona[e]	Semi-desert canyon	Small rock caves	3.1	2.9–5.1†
Panama Canal[f]	Various	Buildings, hollow trees, open	50	4.7–7.1‡
Botswana[g]	Semi-desert	Hollow trees, termite nests	6	7.8
Brazil[h]	Small isolated woodlands		1.8	4.5§
Chiapas[i]	Agricultural land	Hollow trees, termite nests, open		
		San Roque	2.1	6.2
		Huixtla Rd.	ca. 1	5
		Rio Florido	ca. 1	9

*a, Galton 1971; b, Visscher and Seeley 1982; c, Morse et al. 1990; d, Wenner 1989; e, Taber 1979; f, Boreham and Roubik 1987; g, Schneider and Blyther 1988; h, W.E. Kerr, personal communication; i, this study.
†Range of 5 years studied; some colonies were not discovered until the last year of the study.
‡Range of number of colonies destroyed per year for 4 years; not an actual density.
§W.E. Kerr (personal communication) located eight colonies in 15 small woodlands in Goias and Matto Grosso. Kerr (1971) reports the density only within woodlands in which colonies were found, leading to the unrepresentatively high figure of 108 colonies per square kilometre.

Results and Discussion

Nest Sites. The 30 nests were located in hollow trees (18), arboreal termite nests (*Nasutitermes*) (six), not in cavities (four), or in manmade cavities (two). At Rio Florido five of nine nests were in termite nests, two of which had also built combs under the termite nest. Of the exposed nests, three were under tree branches and one under a fallen trunk. In Botswana (Schneider and Blyther 1988) half the natural nests were in termite nests and only one of 51 was exposed. In New York only one of 41 was exposed (Seeley and Morse 1976). In Panama, the majority of nests were in or on manmade sites, 13% were in tree hollows, and 11% on vegetation (Boreham and Roubik 1987). In Tanzania African honey bees construct nests in "any available cavity" (Smith 1953).

Colony Ages. Figure 1 shows the ages of 16 of the 18 colonies dissected. Of these, 11 had two or fewer brood cycles. This corresponds to about 2 months, given 3 weeks per cycle (Winston 1987), plus 1 week for building the first combs. The oldest colony was 9 cycles old, about 6 months. The absence of older colonies may be due to frequent absconding (Winston et al. 1983).

Colony Status, Pests, and Diseases. Status was determined for 20 colonies. Fourteen were alive and neither recently nor imminently swarming nor absconding, judging by the presence of worker brood of all ages and no queen cells. Two colonies had recently swarmed. One colony was in the process of absconding as evidenced by the presence of the queen, eggs, and emerging adults, but no larvae in uncapped cells (Winston et al. 1979). It subsequently absconded after being removed to the laboratory garden. However, the distinctive brood characteristics of absconding were apparent on the day after relocation, making it seem unlikely that relocation caused absconding. Two colonies were queenless with laying workers, as evidenced by the absence of the queen and multiple eggs in cells. One of these colonies had built an exposed nest in a tree that was later cut down, destroying the nest and leaving a few combs plus bees on the ground. Finally, one colony had been destroyed recently by humans.

In two colonies there was evidence for damage by ants. One was a laying worker colony. In the other, which was not dissected and was located high in a tree, live bees with damaged wings were falling from the nest entrance. During the dissection of 16 nests, areas containing brood were examined for macroscopic symptoms of the brood diseases chalkbrood, American foulbrood, European foulbrood, and sacbrood (see Bailey 1981), but none was seen.

Public Health. Bees from one nest, in the base of a tree beside a busy pathway at Rio Florido, were stinging people. Local people burnt out this nest. Several other colonies were nesting low down in tree stumps beside roads or paths, and two were in gardens at heights of 5 and 6 m. In general, these feral nests caused little nuisance to people. This was probably because (*a*) most were not in the immediate vicinity of houses or roads, or were high up; (*b*) local people knew where low nests were, and avoided them; and (*c*) most colonies were not particularly defensive, probably because they had low populations.

Colony Density. Colony density at the San Roque site was 6.2 feral colonies per square kilometre, and nine and five per square kilometre at Rio Florido and Huixtla Rd. Data on feral colony density are reviewed in Table 1. The colony density reported in this study is similar to Botswana and Panama (Schneider and Blyther 1988; Boreham and Roubik 1987) and cerrado (savannah) regions in Goias and Mato Grosso, Brazil (W.E. Kerr; pers. comm.). High densities occur in the east African savannah, particularly during the flowering season of nectar-bearing trees (Smith 1953). Colony densities are higher in tropical than temperate areas, and are at their lowest in temperate forests (Visscher and Seeley 1982; Galton 1971), and Santa Cruz island, California (Wenner 1989). Temperate forests have abundant nest sites (Galton 1971), so this difference must reflect other factors such as food availability.

Feral colonies outnumber managed colonies in coastal Chiapas. Fierro et al. (1988) estimated that there were 28 000 managed colonies there (=2 per square kilometre), but more around Tapachula. This alone indicates the difficulty in genetic control of mating by maintaining European queens in managed hives as a source of European drones. This is ameliorated by the typically larger colony population of managed colonies, and the few drones in the feral colonies (see below). However, as the feral colonies were recently established this may not reflect their potential for producing drones.

During and prior to this study a swarm monitoring program was being carried out (Fierro et al. 1988). Several thousand bait hives were set up in groups of two or three at 200- to 300-m intervals along roads near Tapachula, and caught up to 143 swarms per month (Moffett et al. 1987; Fierro et al. 1988). One line of bait hives was situated 2–3 km east of San Roque and Rio Florido. The high density of feral nests indicates that an extensive trapping program would be needed to trap a majority of swarms. The effectiveness of swarm trapping also may be limited by long distance swarm movement of Africanized swarms (Ratnieks 1991) and their broad nest site acceptability.

Nest Site Properties. The nest cavity volumes recorded in this study and other studies (Seeley and Morse 1976; Schneider and Blyther 1988) are shown in Figure 2*a*. Chiapas cavities are significantly smaller than those in New York ($P=0.0004$, Mann Whitney *U*-test) but not significantly different from those in Okavanga ($P=0.61$). Acceptance of small cavities (12 L) by Africanized bees has also been reported by Taylor and Otis (1978). However, bait hive experiments (Rinderer et al. 1981, 1982) indicate that Africanized bees in Venezuela select larger cavities (i.e. 20 L rather than 10 L, and above 40 L rather than below 40 L) given a choice. European bees select 40-L cavities in preference to 10- or 100-L ones (Seeley 1977). At present, the data are insufficient to determine whether the observed differences in cavity volume among studies reflect differences in cavity availability or acceptability.

FIG. 2. Comparisons of cavity volumes (*a*), entrance areas (*b*), and nest or entrance height (*c*) for natural nests in Chiapas, New York State (Seeley and Morse 1976), and Okavanga, Botswana (Schneider and Blyther 1988).

Table 2. Adult bee and brood populations, comb areas

	Workers			Drones		
	Mean	SD	*n*	Mean	SD	*n*
Comb area (cm^2)	1897	1148	18	120	265	18
Adult bees	6882	4442	15	10	30	15
Capped brood cells	5252	3039	18	65	152	18

Entrance areas for cavity nests (the total area of all entrances to the cavity, whether or not they were being used) show a bimodal distribution (Fig. 2*b*). Five out of 16 of the nests had combined entrance areas greater than the maximum recorded in New York, although the distributions are not different (Mann-Whitney *U*-test, $P = 0.17$). More exposed nests occurred (four of 30) than in New York (one of 39) (Seeley and Morse 1976). Nest height data (Fig. 2*c*) show that a range of heights were acceptable, as in New York (Seeley and Morse 1976).

Population, Brood, Comb, Stores. Table 2 lists the mean adult bee and capped brood populations, and comb area. Mean adult bee populations were similar for this study and for Okavanga (6900 versus 6500) (Schneider and Blyther 1988), but lower than New York during summer (15 000) (Seeley and Morse 1976). The number and proportion of drones in the Chiapas colonies is also very low in comparison with colonies in New York. On average only 0.15% adult bees and 1.2% of capped brood were drones, and only 5.9% of comb was drone-sized, compared with 4.8%, 17.6%, and 17% for New York (Seeley and Morse 1976).

The low production of drones may reflect the young age of colonies. Swarm-founded colonies of European race honey bees in British Columia do not produce drone comb during the first month following establishment (Lee and Winston 1985). In addition, drone production, colony population, swarming, and absconding could have been affected by foraging conditions. Local beekeepers were commenting that this season, normally a period of nectar abundance, was a poor one. Honey stores in the dissected colonies ranged from 0 to 2 kg (mean 0.46 kg, SD 0.56 kg, $n = 18$), although Africanized bees frequently store little honey (Winston et al. 1983).

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