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THE EFFECT OF EMPTY COMB ON THE PROPORTION OF FORAGING HONEYBEES COLLECTING NECTAR[1]

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Summary

The influence of adding empty combs to colonies on the proportions of foraging honeybees returning to hives with nectar, pollen, pollen and nectar, or water, and of unsuccessful foragers was examined. Increased amounts of empty comb resulted in an increase in the proportion of nectar foragers, a decrease in the proportion of pollen foragers and a decrease in the proportion of foragers for both nectar and pollen. The proportions of bees collecting water, and of unsuccessful foragers perhaps decreased slightly.

Introduction

Empty comb in the nests of colonies of honeybees (*Apis mellifera* L.) influences several aspects of honeybee hoarding and nectar harvesting behaviour (Rinderer & Baxter, 1978; Rinderer & Baxter, 1979; Rinderer, 1982*a*; 1982*b*; 1983). Generally, increased amounts of empty comb result in increased nectar harvesting intensity and efficiency for individual bees. Additionally, certain evidence (Rinderer, 1982*a*) suggests that colonies stimulated by additional empty comb have a greater proportion of nectar-foraging bees. This study was designed to test that hypothesis further.

Materials and Methods

Four field colonies of honeybees with open-mated queens and nearly equal populations of bees in Langstroth hives were selected for the experiment. The size of each hive was adjusted to 2 chambers and combs were changed, as little as necessary, in such a way that those in each lower chamber were all full, or nearly full, of brood, pollen, nectar or honey and those in each upper chamber were all empty, or nearly so. Each colony thus had 1·14 m^2 of empty comb surface area (CSA). Foraging bees were sampled at 2-h intervals between 8.30 and 14.30 h for 2 days. Each colony was then given 5 additional chambers filled with empty combs, and so had a total of 6·84 m^2 of empty CSA, and foraging bees were again sampled for 2 days. Colonies were studied one at a time throughout June and July. Nectar-flow conditions were poor during the period; field colonies generally stored little or no additional honey.

For each sample, the hive entrance was closed to eliminate the possibility of collecting outgoing bees. Samples of at least 10 incoming bees were then taken with an insect net. The bees were transferred to plastic bags and stored on ice till they were examined. Colonies were not sampled during periods of orientation flights.

Examination consisted of identifying bees as nectar foragers, pollen foragers, pollen and nectar foragers, water foragers, or unsuccessful foragers. The contents of the honey sac were expelled, (Gary & Lorenzen, 1976) measured with a micropipette, and examined with a refractometer. Bees carrying more than 5 µl of liquid having more than 10% sugar were considered to be carrying nectar. Bees with at least a trace of pollen packed into their corbiculae were considered to be carrying pollen.

Chi-squared analyses were conducted on the numbers of bees occurring in various categories of foragers for the 2 treatments of CSA. Pooled data χ^2s, sums of individual replicate χ^2s, and heterogeneity χ^2s were then calculated to evaluate changes in specific forager categories more closely (Snedecor & Cochran, 1967).

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Results and Discussion

An overall proportional shift occurred ($P<0{\cdot}03$) among the forager types between treatments (Table 1). Comparisons of numbers of bees in specific forager categories to bees in all other forager categories showed that the proportion of nectar foragers increased ($P<0{\cdot}01$) under increased amounts of empty CSA. Replicates were not significantly inconsistent with these changes since no heterogeneity χ^2 was significant.

The relative proportions of nectar foragers, pollen foragers, and foragers for both nectar and pollen are probably regulated by a large number of interacting stimuli. This study supports the hypothesis that stimuli from empty CSA lead bees to prefer collecting nectar to one or more of the other substances and thus have an important role in forager regulation.

Another major role is played by the brood. Erickson et al. (1973) reported that increasing the amount of brood in a colony resulted in a proportional increase in pollen foragers. Stimuli from empty comb and stimuli from brood may dominate the regulatory system controlling the relative proportions of foragers collecting pollen, nectar, and both pollen and nectar.

TABLE 1. Numbers of foragers in 5 forager categories for 2 amounts of comb surface area and χ^2s evaluating differences. General differences between treatments are evaluated by the overall χ^2. Changes in specific categories are evaluated separately as changes in that category compared with changes in all other categories taken collectively. Heterogeneity χ^2s test consistency between replicates and are derived from the differences between the sums of χ^2s for replicates and the χ^2s for pooled data.

Forager category	*CSA/(M²)*			*χ² of comparisons*		
	1·14	*6·84*	*Type*	*Value*	*df*	*P*
Nectar	77	102	pooled (P)	7·05	1	0·01
			sum (S)	9·26	4	0·06
			heterogeneity (H)	2·21	3	0·53
Pollen	130	108	P	1·11	1	0·29
			S	4·85	4	0·30
			H	3·74	3	0·29
Nectar and pollen	46	29	P	3·04	1	0·09
			S	4·67	4	0·32
			H	1·63	3	0·65
Water	23	28	P	0·96	1	0·41
			S	3·82	4	0·43
			H	2·86	3	0·41
Unsuccessful	155	135	P	0·15	1	0·70
			S	5·39	4	0·25
			H	5·24	3	0·16
Total	431	402	overall	11·19	4	0·03

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