Foraging Behavior of Caged Honey Bees[1] in White Clover[2]

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ABSTRACT

Caged honey bees, *Apis mellifera* L., are often used to pollinate white clover, *Trifolium repens* L., particularly when a large number of controlled crosses are needed. A hive with openings on opposite sides was placed in one end of a screen cage so honey bees would be free to travel into or outside the cage. Clover clones with genetic leaf markings were used as indicator plants to determine if pollen was brought into the cage from outside sources. χ^2 analysis of the ratio of resulting progeny indicated that crosses were made only from pollen of the red leaf-marked clover.

White clover, *Trifolium repens* L., a desirable forage legume in the southern United States, is normally self incompatible. Controlled pollinations are made by hand when only a few seed are needed, but bees or other insects are used when large numbers are required. Honey bees, *Apis mellifora* L., are the most frequently used pollinators. One of the major problems encountered when using honey bees is maintaining strong active colonies under caged conditions.

Several researchers have studied foraging habits of caged honey bees. Boren et al. (1962), Nye (1962), and Weaver and Weihing (1960) found that feeding was required to maintain a healthy colony of caged bees. Nye (1962) stated that caged honey bees had a habit of "fighting the cage" during the 1st few days of confinement that never entirely disappeared. Bond and Fyfe (1968) found that in red clover, the number of bees working in cages was very small, usually not more than 6. Dunavan (1952) placed a honey bee colony in a cage such that hive entrances faced both outside and inside of the cage. The bees foraged freely on clover blossoms inside the cage and later reentered the hive. He did not determine whether there was movement of bees from outside to inside the cage.

Our objectives were to determine whether there would be any crossing between white clover outside and inside a bee cage if a hive was so placed that honey bees could forage either in the cage or in the field and to determine the viability of a caged honey bee colony that was not given additional food or water.

Materials and Methods.—A 16-mesh screen cage, 1.2×1.2×2.4 m, was placed over a single white clover clone for 34 days to prevent honey bees or other large insects from foraging on the clover flowers. This cage was used as a check to determine the amount of selfing which would occur naturally. Individual flower heads were tagged for later recovery and testing.

A 2nd cage, 2.4×2.4×3.6 m, was placed over clover from May 30–Sept. 5, 1977. A bee hive with openings on opposite sides was placed in one end of the cage so bees could travel through the hive and forage either inside or outside the cage. No supplemental food or water was provided. Bees found inside the cage were marked on the thorax with a drop of red fingernail polish for later identification. The marked bees were observed each day to determine how many ventured outside the cage and to determine if marked bees foraging outside ever reentered the cage.

A hive that also allowed bees to forage either inside or outside was placed in a 3rd cage (2.4× 2.4×4.9 m) that contained 2 white clover clones for 126 days. One clone had homozygous green leaf markings (V^gV^g) and the other clone had homozygous red leaf markings (V^rV^r) (Hovin and Gibson 1961). Flowers on the normal clone were tagged so they could later be identified. The seed from these flowers were planted in the greenhouse and grown to the 1st trifoliate leaf stage at which time they were checked for leaf marking color. χ^2 analysis was used to determine the frequency of crossing that occurred within the cage.

Results and Discussion.—Fifty-eight flowers containing 1926 florets were harvested from the clone in the 1st cage. The florets contained 43 seed or an avg of 0.022 seed/floret (Table 1). These seeds must have been produced by selfing since there were no other clover plants inside the cage.

When the hive was opened, several hundred bees entered the cage and promptly tried to escape through the corners. It took 2 wk for the colony to settle down to a normal activity, as Nye (1962) reported. Ninety-four bees found inside the cage were marked between June 16 and July 19, 1977. No red-marked bees were seen outside the cage during this time. On July 20, seventy-five bees were marked, and during the next few days, some of these bees were seen outside the cage. The bees foraging outside normally would make a foraging cycle every 45 min in the mornings, but by afternoon, foraging diminished and many of the marked bees were observed fanning the hive during the hot part of the afternoon. Marked bees inside the cage were never seen leaving the hive to forage outside on the same day. Very seldom did more than one red-marked bee forage inside the cage at a given time. Much of the foraging was done by unmarked bees, perhaps

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Table 1.—Floret and seed production from 3 tests and segregation ratio of progeny from normal clone in bee cage containing genetic red-leaf-marked clone.

Treatments	Florets	No. of seed	Seeds/floret	Leaf markings		χ^2
				Red	Green	
Test 1 (No bees)	1926	43	0.02	—	—	
Test 2 (Bees—no genetic leaf marker)	3841	4867	1.27	—	—	
Test 3 (Bees—red leaf marker)	2894	4248	1.44	1652*	44	1.23*

new foragers which had not established foraging patterns. Most of the new bees were not seen after they had been marked. Many were probably killed by incorrect marking. At the end of the test, the hive was opened and 28 marked bees were found inside. All combs were full of brood and honey.

One-hundred twenty-six seed heads with 2894 florets containing 4248 seed were harvested from the normal green-leaved clover clone (Table 1). Any crosses occurring in the cage to the normal clone would have heterozygous red leaf markings (V^rV^n). Crosses occurring between the normal clone and clover growing outside the cage would have normal markings (V^nV^n).

When the progeny were grown in the greenhouse until the 1st trifoliate leaf state a total of 1652 red-marked and 44 green-marked plants was noted. χ^2 analysis indicated that the crosses to the normal clone were from the red-marked clone inside the cage and not from pollen brought through the hive from outside sources.

The bees used in this test were never marked or otherwise disturbed. A few of the bees foraged inside the cage, but the majority foraged outside. These bees also may have been new foragers which had not become oriented with the surrounding area. When the hive was removed from the cage and opened, all combs were full of honey or brood, which indicated that the bees could be maintained in this manner.

Results of these tests indicated that honey bee colonies may be allowed to forage both inside and outside a cage without affecting the purity of lines in the cage. The use of larger cages might improve the pollination since more flowers would be available for food. If water were not readily available from an outside source, the addition of water inside the cage might attract more bees back into the cage and improve the frequency of pollination.

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