

COMPARISON OF SPRING POLLEN COLLECTION BY HONEY BEE (*APIS MELLIFERA*) COLONIES OF BUCKFAST AND "CANADIAN" STOCKSDENNIS VAN ENGELSDORP¹ and GARD W. OTIS

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The amount and type of pollen collected during the period of apple bloom (25–31 May, 1995) were determined for honey bee colonies of Buckfast and Ontario stocks that had been matched on the basis of brood area. The Buckfast colonies collected 62% more pollen (approximately 18,770 more pollen foraging trips per colony per day) than the Ontario colonies. The proportion of apple pollen generally decreased with increased distance of the hives to the orchard. The results demonstrate that Buckfast bee colonies can effectively pollinate spring fruit crops in Ontario.

Introduction

The economic contribution of honey bees to the North American agrifood industry is large. In the USA, their contribution through pollination of crops is estimated to be approximately US\$14.6 billion per year (Morse and Calderone 2000). In Canada, the portion of crop value that results from honey bee pollination is approximately CAD\$500 million (= ~US\$320 million) annually (CAPA 1995). Under current agricultural practices, many crops require managed bee colonies to ensure sufficient numbers of foraging insects on crop inflorescences to obtain consistently high crop yields. For example, apples are almost completely reliant on insects for pollination (Free 1993). In the absence of honey bees, losses of 30–90% of the crop can occur (Southwick and Southwick 1992; CAPA 1995). For this reason most apple growers rent hives of honey bees during apple bloom to ensure adequate pollination.

Beekeepers have an obligation to provide growers with hives containing sufficient numbers of bees for pollination and fruit set (Hoopingarner and Waller 1992). Although many beekeepers regularly estimate populations of bees in hives (e.g., frames covered by bees, area of sealed brood), they rarely quantify the extent to which those bees forage on the desired crop (e.g., amount and type of pollen collected, numbers of bees working flowers). Because bee foraging activities, including pollen collection, vary extensively because of genetic differences (Nye and Mackensen 1968; Mackensen and Nye 1969; Free and Williams 1973; Hellmich et al. 1985; Robinson and Page 1989; Page and Fondrk 1995; Page et al. 1995), quantification of the amount of pollen collected from the crop being pollinated may be the best measure of the extent to which colonies are foraging on the desired crop.

In order to enhance the resistance of bees in Ontario to tracheal mites (*Acarapis woodi*), Buckfast bees have been imported recently from England and Denmark. Buckfast bees were developed by the late Brother Adam in Devon, UK. They constitute pedigreed crosses of several

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European and Middle Eastern honey bee races (Adam 1987a). Control over queen mating is achieved at isolated mating stations with selected drone lines. Due in part to intensive selection, Buckfast bee colonies are reported to be industrious, have small winter populations, increase populations rapidly in spring, have a low tendency to swarm, and produce large crops of honey (Adam 1987 a,b). Because these stocks were selected under European conditions, it was not known initially if they would perform effectively in Ontario. In particular, some beekeepers have questioned their value for commercial pollination of spring fruit crops because of their relatively small winter bee populations.

This study was undertaken to compare the foraging ability of Buckfast and typical Canadian colonies on apples and other plants flowering in late spring. As a result of the experimental design, we were able to compare pollen collection by colonies of two stocks of bees in three apiaries over the main period of apple bloom.

Methods

Two stocks of bees were compared in this study. The Buckfast bees were descended from breeder queens imported to Canada in 1994 from Keld Brandstrup, Denmark, who has continued selection of the stock he originally obtained from Buckfast Abbey, Devon, UK. Daughter queens reared from six imported breeder queens were mated in isolation on Thorah Island in Lake Simcoe, Ontario. The drones with which they mated were produced by 12 colonies headed by sister queens reared from a Buckfast queen imported from Buckfast Abbey in 1992. The Canadian stock represented a mixture of the bees being maintained by beekeepers in Ontario in 1995. The queens in these colonies, reared from several different mothers obtained from commercial beekeepers in Ontario, had been in hives at least 5 km from apiaries containing Buckfast colonies during the period in which they mated.

On 22 May 1995, 12 Buckfast and 15 "Canadian" colonies were randomly selected from the Hillside apiary and home apiary of the University of Guelph. Sealed brood area was estimated in each colony by removing the frames, shaking the bees off, and placing a grid divided into six equal rectangles ($10.6 \text{ cm} \times 14.4 \text{ cm} = 152.6 \text{ cm}^2$) over the side of the combs facing the examiner. The percentage of sealed worker brood in each section of the grid was multiplied by the area of the section (156.2 cm^2), doubled to approximate the area on both sides of the comb, and summed over all combs to estimate the sealed brood area of the colony. Brood areas between the two stocks were compared using a *t*-test in the Proc GLM function of SAS (SAS[®], SAS Institute Inc., Box 8000, Cary, NC).

Eighteen colonies (9 Buckfast, 9 Canadian; 6 in the home apiary, 12 in the Hillside apiary) were selected for further study on the basis of these brood area estimates. The selected colonies were divided into three groups of six colonies (3 Buckfast and 3 Canadian per group). Within each group the colonies had similar (within 5%) sealed brood estimates. Two colonies (1 Buckfast, 1 Canadian) within each group were located at the home apiary. On the night of 22 May 1995, the 12 selected colonies in the Hillside apiary were redistributed equally to two University of Guelph apple orchards, the Stone Road Orchard (approximately 500 m from the home apiary) and the Cambridge Research Station Orchard (approximately 15 km west of the other two apiaries). With this design we established equal numbers of colonies of both stocks matched for sealed brood area in each of the three study apiaries. The colonies at the Stone Road Orchard were distributed 20–30 m apart around the perimeter of the orchard. At the Cambridge Orchard, the colonies were placed 3 m apart, approximately 200 m from the nearest edge of the orchard.

The following day, OAC pollen traps were placed on all study colonies. Pollen was trapped and removed on 25, 26, 27, 30, and 31 May, which corresponded to the main period of apple bloom in 1995. Pollen traps were not emptied on 28 and 29 May because of rainy weather. After collection,

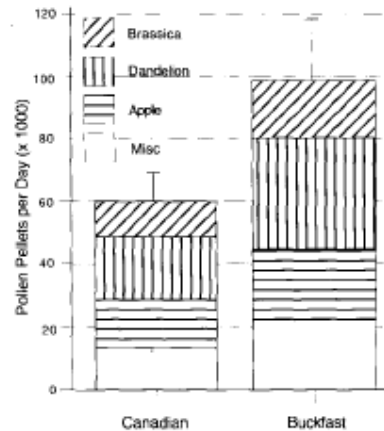


FIGURE 1. Amounts and types of pollen collected by Buckfast and Canadian honey bee colonies, 25–31 May, 1995, near Guelph, Ontario. Error bar represents the standard error of the mean for pollen of all floral types.

pollen pellets from each hive were dried in paper bags for three days at 35°C, cleaned by removing bee parts and chalkbrood mummies, and weighed. For each pollen sample representing a hive on a particular date, a subsample of pollen pellets (roughly 5 g) was removed, weighed, and sorted by colour. The number of pollen pellets of each type was counted in each subsample. The pollen pellets of the four colour groups were identified by comparison of pollen grains from representative pellets to a reference pollen collection as well as colour comparison to the figures in Hodges (1984) that depict the colour of pollen from various plant species. The four pollen types we recognized were: apple and crabapple (*Malus* spp.), mustards (*Brassica* spp.), dandelion (*Taraxacum officinale*), and other species. For each colony on each date, the total number of pollen pellets of each type was estimated by dividing the number of pellets of that type in the subsample by the weight of the subsample, and multiplying by the total weight of pollen collected on that date. Summing the estimates for the number of pollen pellets of the four floral types provided an estimate of the total number of pollen pellets collected per day. Using the GLM procedure of SAS, pollen was analysed by pollen type and total pollen collected using a split plot repeated measure analysis of variance, where date was the repeated measure and both line and apiary were fixed values. In all cases, least square means and their standard errors are presented.

On 3 June, after the apple bloom and pollen collection had ceased, the brood areas of the 18 study colonies were estimated again and compared statistically using a *t*-test as described above.

Results

The Buckfast colonies collected an average of 1.6 times more pollen pellets than the Canadian colonies (Fig. 1; $p = 0.001$). The estimated numbers of pollen pellets of each floral type collected by the Buckfast colonies were also proportionately greater, but not significantly greater ($p > 0.05$ for each of the four pollen categories).

The total number of pollen pellets collected per day differed among apiaries (Cambridge Orchard: $86,800 \pm 15,920$; Stone Road Orchard: $82,700 \pm 27,130$; Home Apiary: $75,000 \pm 15,380$; $p = 0.002$). An LSD test detected a significant difference between the Cambridge Orchard and the

Home Apiary only ($p < 0.05$). A comparison of the number of pollen pellets collected per day of each of the four floral types detected no differences among apiaries ($P > 0.05$ for each ANOVA). Interestingly, the proportion of *Malus* spp. pollen declined with increasing distance to the orchard (26.9% adjacent to the orchard, 23.4% at 200 m from the orchard (Cambridge Research Station), 22.0% at 500 m from the orchard (Home apiary)).

No difference in estimated sealed brood area was found between the randomly chosen Buckfast and Canadian colonies on 22 May before apple pollination began (Buckfast: 1620 ± 166 cm², $n = 12$; Canadian: 1730 ± 149 cm², $n = 15$; $t = 0.493$, $p = 0.56$). The estimated sealed brood areas of the 18 experimental colonies had increased considerably by 3 June, but were still approximately equal (Buckfast: 2270 ± 198 cm², $n = 9$; Canadian: 2340 ± 177 cm², $n = 9$; $t = 0.264$; $p = 0.85$).

Discussion

In this study, Buckfast honey bee colonies collected 62% more pollen than colonies of Ontario honey bee stock that had been matched for strength (sealed brood area). Because a bee collects two pollen pellets on a foraging trip, we estimate that bees in each Buckfast colony made 18,770 more pollen foraging trips per day than bees in a typical colony of Canadian bee stock. In developing the Buckfast stock, Brother Adam used, among other traits, "industry of the bees" and the amount of pollen stored in combs as selection criteria (Adam 1987a). Pollen hoarding, identified by breeding bees with larger amounts of pollen stored in combs, is now known to have a genetic basis (Hellmich et al. 1985; Calderone and Page 1988; Page and Fondrk 1995). Our results suggest that Brother Adam's selection regime for Buckfast bees inadvertently resulted in colonies that exhibit enhanced pollen hoarding behaviour.

Colonies at the Cambridge Orchard collected more pollen, a difference that could have been a result of lower competition from nearby bee hives. Unfortunately, the presence of numerous additional colonies at the home apiary, located only 500 m from the Stone Road Orchard, prevented us from assessing the effect of proximity to the orchard on the pollen foraging by the colonies. It seemed that proximity to the orchard increased the proportion of apple pollen collected, as has been reported for other crops (Ribbands 1951, 1952; Free and Williams 1974).

Our most significant conclusion is that Buckfast bee colonies are equal to or better at foraging for apple pollen and presumably at pollinating apples and other spring fruit crops, than the general bee stock that has been managed by Ontario beekeepers in the past. This is encouraging given our other positive observations that Buckfast bees in general have good resistance to tracheal mites (Danka et al. 1995; Lin et al. 1996; Nasr et al. in press), are gentle, have a very low tendency to swarm, are good honey producers, and are winter hardy (van Engelsdorp 1995; P.G. Kelly, pers. comm.). Although we did not find differences between the two stocks in colony strength (brood area) either before or after the apple bloom period, further evaluations of colony size (e.g., brood area, number of worker bees, and/or cluster size) would be useful to confirm the greater pollen foraging of Buckfast bees that we observed. Additional genetic combinations (i.e., sets of sister queens mated to a single drone line) of Buckfast bees should be evaluated in light of the fact that genetic combinations of Buckfast bees can differ in many characteristics (van Engelsdorp 1995).

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