The Effects of Habitat Type, ApilifeVAR™, and Screened Bottom Boards on Small Hive Beetle (*Aethina tumida*) Entry into Honey Bee (*Apis mellifera*) Colonies

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Abstract

In this study we investigated how habitat type (open field vs. shaded area), Apilife VAR™, and screened bottom boards affect small hive beetle (*Aethina tumida*) entry into honey bee (*Apis mellifera*) colonies in late summer and fall. Data on ending number of beetles and number of deep frames of bees, pollen, honey and total brood were collected on day 27 for both of two trials. Bottom screens failed to repel beetles, although their use did not lead to greater beetle populations in test colonies. Bottom board type did not affect any of the colony strength parameters except honey in trial 2 (more honey in colonies with conventional wooden bottom boards than screened ones). The use of Apilife VAR did not affect beetle entry or any of the colony strength parameters. Habitat type did not affect any of the measured parameters except honey (more honey in colonies in the open than shaded area). The data suggest that small hive beetles disperse within an apiary, at least initially, without regard to habitat, presence of ApilifeVAR, or screened bottom boards.

Introduction

Small hive beetle (*Aethina tumida*) adults feed and reproduce in honey bee (*Apis mellifera*) colonies (Lundie 1940, Schmolke 1974) in Africa, the United States, and Australia. How beetles locate a host colony remains unclear. Odors from various hive products (bees, brood, honey, and pollen) and bee volatiles are attractive to adult beetles (Elzen et al. 1999, Suazo et al. 2003, Torto et al. 2005). Management practices used by beekeepers may encourage beetle entry into colonies. For example, the use of grease patties (made of vegetable shortening and sugar) for the delivery of antibiotics and control of tracheal mites (Elzen et al. 2002) has been correlated with increased beetle numbers in treated colonies.

Using screened bottom boards (Pettis and Shimanuki 1999) and Apilife VAR™ for varroa mite (*Varroa destructor*) control may affect beetle entry. Bottom screens are traversable by beetle adults (Ellis et al. 2002), giving them a greater surface area through which to access colonies. ApilifeVAR is an aromatic product. Because beetles use olfactory stimuli to locate colonies, it is unclear how ApilifeVAR will affect a beetle's host seeking endeavors. Finally, some nitidulid beetles exhibit habitat preference (open field vs. forested areas, Blackmer and Phelan 1995), suggesting that small hive beetles may do the same. For these reasons, we investigated how habitat type (open field vs. shaded area), ApilifeVAR, and screened bottom boards affect beetle entry into honey bee colonies.

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Materials and Methods

Trial 1

Experiments for trial 1 were conducted August 2004 in Colquitt County, Georgia, USA. Twenty-four, four-frame nucleus colonies were used for the study. All colonies were established as queenless splits from full-sized Langstroth colonies in Oconee County, Georgia and allowed to requeen themselves prior to the study. For trial 1, six colonies each were allotted one of four treatments: (1) conventional wood bottom board, (2) screened bottom board, (3) conventional wood bottom board with ApilifeVAR, and (4) screened bottom board with ApilifeVAR. Colonies treated with ApilifeVAR received new acaracide treatment every 9-10 days per label instructions.

All colonies were made beetle-free by collecting adult beetles from the hive (lid, bottom, side walls, frames, etc.) using a mouth aspirator. Once free of beetles, the colonies were moved to Colquitt County and placed in a queen-mating apiary where 400+ small mating nucleus colonies each having >10 beetles were present. Data on ending number of beetles (determined by aspirating and counting) and number of deep frames of bees, pollen, honey, and total brood (Skinner et al. 2001) were collected on day 27 of our study. All collected beetles were killed, making the colonies beetle-free for use in the second trial.

Trial 2

The day trial 1 concluded, all experimental colonies were returned to Oconee County, Georgia where approximately 85 full-

Table 1: The effect of bottom board type (conventional wood or screened) on the number of adult small hive beetles within a colony and on colony strength parameters. Data are mean ± std. error (n). Columnar data followed by the same letter are not different at $\alpha \leq 0.05$.

Trial 1					
bottom board	no. beetles	no. bees	cm² brood	cm² pollen	cm² honey
conventional wood	78 ± 19 (11)a	5110 ± 321 (12)a	3292 ± 200 (12)a	199 ± 21 (12)a	2116 ± 197 (12)a
screened	60 ± 7 (12)a	5939 ± 308 (12)a	3658 ± 152 (12)a	276 ± 29 (12)a	1853 ± 214 (12)a
Trial 2					
bottom board	no. beetles	no. bees	cm² brood	cm² pollen	cm² honey
conventional wood	19 ± 2 (12)a	6675 ± 376 (12)a	2759 ± 186 (11)a	557 ± 86 (12)a	1515 ± 241 (12)a
screened	16 ± 2 (12)a	7452 ± 365 (12)a	1913 ± 189 (12)a	294 ± 64 (12)a	1204 ± 240 (12)b

size Langstroth colonies, each having >15 beetles, were present. The experimental colonies were randomly placed in either an open field (no trees) or a forested area that was heavily shaded to yield six colonies each for the following four treatments: (1) conventional wooden bottom board and open field, (2) screened bottom board and open field, (3) wooden bottom board and shaded area, and (4) screened bottom board and shaded area. Both test apiaries (shaded and field) in trial 2 were located an equal distance from the non-experimental colonies. Data were collected as before for trial 1.

Data Analysis

The number of adult beetles present in colonies at the end of each trial was analyzed by ANOVA with treatment (ApilifeVAR present or not) and bottom board type (conventional wood or screened) as main effects in trial 1 (with bottom board type×treatment as test error term) and location (open field or shaded area) and bottom board type as main effects in trial 2 (with location×bottom board type as test error term). The effects of beginning colony strength parameters (number of adult bees, and total amount of brood, pollen, and honey – taken at the end of trial 1) on the number of adult beetles per colony in trial 2 were analyzed with regression analyses testing for linear, quadratic, and cubic effects. All analyses were conducted using SAS (1992). Differences were accepted at $\alpha \leq 0.05$.

Results and Discussion

Bottom board type did not affect beetle entry in either trial 1 ($F = 5.9$; df = 1, 19; $P = 0.25$) or trial 2 ($F = 0.9$; df = 1, 20; $P = 0.53$). Although bottom screens failed to repel beetles, their use did not lead to greater beetle populations in test colonies (Table 1). This is a positive finding because it has been speculated that bottom screens may facilitate beetle entry (hives with bottom screens have more entrance sites into the colony). Earlier work has shown that in one of two test apiaries, colonies with bottom screens did not have more beetles than colonies with conventional bottom boards; in a second test apiary colonies with bottom screens had statistically fewer beetles than colonies with convenational bottom boards (Ellis et al. 2003). In the present study, colonies with bottom screens in both trials had numerically fewer beetles, but the decrease was not significantly different (Table 1).

Table 2: The effect of ApilifeVAR or no treatment (control) on the number of adult small hive beetles within a colony and on colony strength parameters (trial 1). Data are mean ± std. error (n). Columnar data followed by the same letter are not different at $\alpha \leq 0.05$.

treatment	no. beetles	no. bees	cm² brood	cm² pollen	cm² honey
Control	73 ± 9 (11)a	5379 ± 400 (12)a	3376 ± 212 (12)a	236 ± 23 (12)a	2054 ± 225 (12)a
ApilifeVAR	64 ± 17 (12)a	5669 ± 256 (12)a	3574 ± 149 (12)a	239 ± 33 (12)a	1915 ± 191 (12)a

Table 3: The effect of location (open field or shaded area) on the number of adult small hive beetles within a colony and on colony strength parameters (trial 2). Data are mean ± std. error (n). Columnar data followed by the same letter are not different at $\alpha \leq 0.05$.

location	no. beetles	no. bees	cm² brood	cm² pollen	cm² honey
Open field	18 ± 2 (12)a	7245 ± 489 (12)a	2384 ± 277 (11)a	535 ± 93 (12)a	1611 ± 243 (12)a
Shaded area	17 ± 2 (12)a	6882 ± 238 (12)a	2256 ± 176 (12)a	316 ± 63 (12)a	1107 ± 222 (12)b

Bottom board type did not affect the number of bees, cm² pollen, or cm² brood in either trial ($0.06 \leq P \leq 0.48$) or cm² honey in trial 1 whereas it did affect cm² honey in trial 2 ($F = 289$; df = 1, 20; $P = 0.04$). In trial 2, colonies with conventional bottom boards had more honey that those with screened ones (Table 1). Others have shown positive effects of bottom screens on adult bee populations and overall brood area (Pettis and Shimanuki 1999; Ellis et al. 2001, 2003; Harbo and Harris 2005). Although not significant in the present study, our trends suggest the same (Table 1).

The use of Apilife VAR did not significantly affect beetle entry ($F = 1.8$; df = 1, 19; $P = 0.41$) or any of the colony strength parameters ($0.53 \leq P \leq 0.70$) (Table 2). There were no significant interactions between bottom board type and ApilifeVAR ($0.32 \leq P \leq 0.85$) for any of the measured parameters. Our data suggest that using ApilifeVAR to control varroa does not entice or impede beetle entry.

Blackmer and Phelan (1995) provided evidence that some nitidulid beetles prefer wooded habitats, while others prefer agricultural ones (open fields). The data presented in this study show no general trend for small hive beetles. Habitat type (field/shaded area) did not significantly affect beetle entry ($F = 0.1$; df = 1, 20; $P = 0.80$) or the number of bees, cm² pollen, or cm² brood ($0.23 \leq P \leq 0.75$), whereas it did affect cm² honey ($F = 762$; df = 1, 20; $P = 0.02$). Colonies in the open field had more stored honey than colonies in the shaded area (Table 3). There were no significant interactions between bottom board type and habitat ($0.21 \leq P \leq 0.96$). Although habitat did not affect beetle attraction to colonies, it may affect a colony's propensity to suffer beetle-associated damage. For example, beetles pupate best in moist soils (Ellis et al. 2004). Inasmuch as habitat affects soil moisture (sunny fields vs. shady forests), it may also affect the ability of beetles to pupate. Therefore, our data only suggest that beetle attraction to colonies is unaffected by habitat, not a beetle's ability to damage or destroy a colony.

We attempted to correlate the number of adult beetles to beginning hive strength parameters (number of adult bees and cm² brood, pollen, and honey) for the second trial to test if beetles ran-

domly distribute throughout an apiary or if they cue into certain colonies based on any of the above parameters. We did not find significant linear, quadratic, or cubic correlations between the number of beetles in a colony and any strength parameter ($P \geq 0.05$).

The data from this study collectively suggest that small hive beetles disperse within an apiary without regard for colony differences in bee population, brood, pollen, or honey. However, this may be true only when beetles first arrive in an apiary. Multiple seasons, different locations, varying weather conditions, and varying local beetle pressures may have yielded different results for our study. Nonetheless, our data failed to show a relationship between the number of adult beetles in a hive and bottom board type, use of ApilifeVAR, hive location, or any of four colony strength parameters. We hope our results encourage others to explore the effects of habitat on beetle attraction to colonies.

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