Comparative Resistance of Russian and Italian Honey Bees (Hymenoptera: Apidae) to Small Hive Beetles (Coleoptera: Nitidulidae)

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J. Econ. Entomol. 102(1): 13–19 (2009)

ABSTRACT To compare resistance to small hive beetles (Coleoptera: Nitidulidae) between Russian and commercial Italian honey bees (Hymenoptera: Apidae), the numbers of invading beetles, their population levels through time and small hive beetle reproduction inside the colonies were monitored. We found that the genotype of queens introduced into nucleus colonies had no immediate effect on small hive beetle invasion. However, the influence of honey bee stock on small hive beetle invasion was pronounced once test bees populated the hives. In colonies deliberately freed from small hive beetle during each observation period, the average number of invading beetles was higher in the Italian colonies (29 ± 5 beetles) than in the Russian honey bee colonies (16 ± 3 beetles). A similar trend was observed in colonies that were allowed to be freely colonized by beetles throughout the experimental period (Italian, 11.46 ± 1.35; Russian, 5.21 ± 0.66 beetles). A linear regression analysis showed no relationships between the number of beetles in the colonies and adult bee population ($r^2 = 0.1034$, $P = 0.297$), brood produced ($r^2 = 0.1488$, $P = 0.132$), or amount of pollen ($r^2 = 0.1036$, $P = 0.295$). There were more Italian colonies that supported small hive beetle reproduction than Russian colonies. Regardless of stock, the use of entrance reducers had a significant effect on the average number of small hive beetle (with reducer, 16 ± 3; without reducer, 27 ± 5 beetles). However, there was no effect on bee population (with reducer, 13.20 ± 0.71; without reducer, 14.60 ± 0.70 frames) or brood production (with reducer, 6.12 ± 0.30; without reducer, 6.44 ± 0.34 frames). Overall, Russian honey bees were more resistant to small hive beetle than Italian honey bees as indicated by fewer invading beetles, lower small hive beetle population through time, and lesser reproduction.

KEY WORDS *Aethina tumida*, small hive beetle, resistance, entrance reducer

The distribution of small hive beetle *Aethina tumida* Murray (Coleoptera: Nitidulidae) continues to expand. Originating from sub-Saharan Africa, small hive beetle has now been detected in >30 U.S. states (Neumann and Elzen 2004), Egypt (Mostafa and Williams 2002), Australia (Somerville 2003), and Canada (Clay 2006). This rapid spread of small hive beetle can be associated in part with its ability to invade colonies. Small hive beetle adults are active fliers (Elzen et al. 1999), and their body structure allows easy entry into colonies through cracks and crevices. Elzen et al. (1999) also showed that odors from hive products were more attractive to beetle invasion with the presence of adult bees. Olfactometric and wind tunnel studies confirmed that volatiles from adult honey bees are involved in host location by small hive beetles (Suazo et al. 2003). Further analyses of these volatiles revealed several components, including isopentyl acetate, an alarm pheromone constituent (Torto et al. 2005).

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African honey bees (*Apis mellifera scutellata* and *Apis mellifera capensis*) are known to deter population growth of small hive beetle due to a myriad of behavioral resistance mechanisms (Lundie 1940, Ellis et al. 2004, Neumann and Elzen 2004, Neumann and Härtel 2004). These two small hive beetle subspecies are known to remove small hive beetle eggs and larvae (Ellis et al. 2003, 2004; Neumann and Härtel 2004), and this behavior is thought to be a key element in their resistance to small hive beetle (Neumann and Härtel 2004). Africanized honey bee also are reported to use propolis in building "corrals" in which beetles are imprisoned, and to minimize the presence of cracks that can be used as invasion routes for beetles (Neumann et al. 2001). Africanized honey bee displays active aggression toward adult beetles (Lundie 1940, Elzen et al. 2001). However, aggression toward adult small hive beetle does not play a major role in the regulation of small hive beetle populations in Africanized honey bee colonies (Neumann and Elzen 2004).

These resistance mechanisms observed in Africanized honey bee are not frequent in European honey bee colonies (Ellis et al. 2004). Behavioral resistance to small hive beetles is not pronounced in the European honey bees studied by Elzen et al. (2001) and Ellis et al. (2004). However, Russian honey bees were reported to be more intense than Italian honey bees in the removal of live beetles (de Guzman et al. 2006). In the same study, Russian colonies had lower colony mortality. Ellis et al. (2004) reported that Cape honey bees and an unknown stock of European honey bee removed 67 and 57% of small hive beetle-infested brood, respectively. However, de Guzman et al. (2008) found Russian and Italian stocks both removed ≈85% of small hive beetle-infested brood.

Small hive beetles can kill colonies (Sanford 1998, Elzen et al. 1999). Although weak colonies succumb to small hive beetles more easily than strong colonies, strong colonies can still be overwhelmed (Wenning 2001). Typically, serious damage to combs is caused by hundreds to thousands of small hive beetle larvae (Lundie 1940). However, small hive beetle adults also can reproduce in the colonies at low levels without noticeable damage to honey bee combs (Spiewok and Neumann 2006). Whether reproduction inside the colonies varies among honey bee genotypes has yet to be established.

At present, small hive beetle populations are being managed using chemicals due to the lack of other known effective controls (Ellis and Delaplane 2007). Several approaches have been tested including the use of modified hive entrances such as polyvinyl chloride (PVC) pipes (Hood 2004). Reducing hive entrances by using PVC pipes resulted in a decrease in the number of small hive beetle in the colonies. However, the efficacy of this technique was inconsistent. Also, these entrances had negative effects on brood production, water drainage, and bottom board debris (Ellis et al. 2003, Hood 2004).

A wooden entrance reducer placed in the entrance of the hive is a common hive part used to reduce robbing by other honey bees and invasion by several colony pests such as mice and wasps. However, its usefulness in inhibiting small hive beetle invasion has not been investigated. Our earlier studies showed that Russian honey bees had some levels of resistance to small hive beetle as indicated by their ability to remove live beetles from observation hives (de Guzman et al. 2006). This study was conducted to compare Russian and commercial Italian honey bees for their resistance to small hive beetles by 1) assessing the number of invading beetles in colonies regularly freed from small hive beetle, 2) monitoring population development in colonies not devoid of beetles, and 3) evaluating small hive beetle reproduction in the colonies.

Materials and Methods

Invasion of Colonies Deliberately Freed from Small Hive Beetles. Forty 1.4-kg packages were made on 25 April 2005 by using the large package technique (Harbo and Hoopingarner 1997). Packages were installed in Langstroth hives (17 cm) containing five combs (two honey and three empty frames) that were stored previously in a freezer for a few months. Colonies were held in a cooler (7.5°C) after being stocked with worker bees and moved to a temporary apiary location at dusk. The following day, 20 colonies received Italian queens, which were purchased from a queen breeder in California who advertises Italian queens, and 20 received Russian queens from the Russian honey bee breeding program (http://russian-breeder.org). One week after queen installation, all colonies were examined for queen acceptance and for the presence of beetles. During this time, beetles were counted as described by de Guzman et al. (2006), with some modifications. In brief, frames were individually examined for the presence of small hive beetles. During examination, inspected frames were placed in a separate hive body. Hive covers and bottom boards also were inspected. When colonies had more than one hive body, each hive body was separated and provided with a bottom board and a cover to prevent beetles from escaping. The beetles were not removed from the colonies. Thereafter, small hive beetle were counted and removed from the colonies during each observation helping to ensure that small hive beetle present in the colonies at subsequent observations were new inhabitants. The numbers of beetles in the colonies were counted to determine whether queen type has an immediate effect on the invasion of small hive beetle in newly installed packages. Colonies were then relocated to an apiary that had been unoccupied by bees during the previous month to assure the absence of beetles. According to de Guzman and Frake (2007), at higher temperatures it takes ≈2 wk for larvae (wandering phase) to emerge as adults from the soil. Colony placement within the apiary was randomized within an irregular pattern. Examination of colonies was conducted for 2 mo. At the last inspection the colonies contained only the progeny of the installed queens (test bees). The numbers of frames occupied by adult bees and brood were estimated on 25 May 2005 and 30 June 2005. The first and second cycles of brood were expected to begin emerging on these examination dates.

During the 30 June 2005 inspection, entrance reducers (entrance width, 2.2 cm; height, 1.3 cm) were installed in nine Italian and 10 Russian colonies. Nine colonies of each stock did not receive entrance reducers and served as experimental controls (entrance width = 37 cm, height = 3.8 cm). Six observations were made between July 2005 and September 2006. For each colony, individual frames, hive cover and bottom board were visually examined for the presence of small hive beetle (de Guzman et al. 2006). All beetles were counted and collected during each observation. The number of frames of adult bees was estimated based on the technique of estimating cluster size described by Nasr et al. (1990). However, only the tops of frames covered by bees were counted. Brood area was also measured (Rogers et al. 1983) and converted to numbers of brood frames. The same technique was used in measuring pollen availability in the hives, which was estimated only in February 2005.

Small Hive Beetle Population Development. Thirty-six colonies were established in April 2007 by using the tower technique. This technique involved equally dividing a strong colony, that is, the numbers of frames of brood, honey, and adult bees. From each parent colony, either two or four division colonies were made that were stacked on top of each other overnight to allow equal distribution of bees, small hive beetle and mites among the divisions. Each division colony consisted of about four brood frames, two honey frames and four empty frames (14.6 cm in height). Thereafter, each division was provided with a bottom board and a hive cover. All colonies were relocated into a holding site and allowed to settle overnight before queen introduction. To ensure uniformity for both stocks, half of the colony divisions (i.e., one or two) derived from each parent colony received either Italian or Russian queen(s). All Italian queens were purchased from the same queen breeder as in the 2005 experiment, and the Russian queens were obtained from the Russian honey bee breeding program. When colonies turned over their populations (≈2 mo), they were moved to a permanent location that did not have honey bee colonies during the previous month. Colonies were randomly placed within the apiary. Populations of small hive beetle were monitored by visually examining individual frames, hive covers, and bottom boards (de Guzman et al. 2006). Beetles were not removed from the colonies at any time. Three observations were conducted. Brood area and amount of pollen (Rogers et al. 1983) and adult bee population (Burgett and Burikam 1985) also were estimated and then converted to numbers of frames.

Small Hive Beetle Reproduction. To compare the attractiveness of both stocks to small hive beetle, reproduction was monitored in the 2007 colonies only. In June and July 2007, bottom board varroa traps with screen (8 mesh) on top were used to collect immature stages of small hive beetle that dropped from the colonies. In August 2007, each colony was provided with double bottom boards; a screen bottom board on top of a solid bottom board with the entrance facing the back of the colony (to facilitate the installation or removal of trays that served as traps). No entrance reducer was provided. Each tray (a cafeteria style) was fitted with a white paper smeared with petroleum jelly. Trapping of immature small hive beetle was conducted for three to four consecutive days every month from June to October 2007. In addition, matured small hive beetle larvae (wandering phase) that were leaving the hives to pupate in the soil were monitored by providing a trap in front of each hive entrance. Traps were made of rain gutters (length, 45.72 cm; width, 10.80 cm) installed on 5 June 2007. Both ends were closed with end caps and covered with gutter covers having 1-cm-diameter holes. Gutter covers were held in place using rubber bands. Each trap contained potting soil (≈1.6 kg) that was sterilized in an oven at 260°C for 30 min. Thereafter, gutters were examined every 2 wk from 17 June to 20 October 2007.

Data Analyses. Because the honey bee populations of the nucleus colonies used in 2005 were not from the

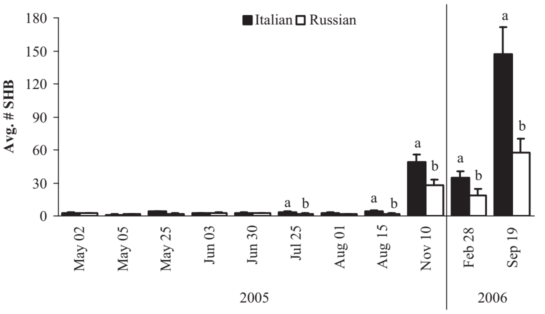

Fig. 1. Average number (mean ± SE) of small hive beetles in Italian and Russian honey bee colonies. No difference between the two stocks was detected from 2 May to 30 June 2005. Entrance reducers were installed on 30 June. For each date, bars with different letters are significantly different ($P < 0.05$).

test queens, data on the number of beetles and bee population for the first 2 mo of observation were analyzed separately. Data on the number of beetles in the nucleus colonies were analyzed using Proc Mixed with stock and sampling period as fixed effects. When no interaction was found, the Wilcoxon two-sample test was used to determine overall date and stock differences. Data on adult bee population and brood production were analyzed using the Wilcoxon two-sample test. Data on the number of small hive beetle from months when test bees populated the hives were analyzed using Proc Mixed with stock, sampling period, and reducer type modeled as fixed effects. Because an interaction between stock and sampling period was detected, stocks were compared for each sampling period using the Wilcoxon two-sample test. The amount of pollen was also compared using Proc Mixed with stock and reducer type modeled as fixed effects.

In 2007, data on the number of beetles, adult bee population, brood area, number pollen cells, and the number of trapped beetles were analyzed using Proc Mixed with stock and sampling period as fixed effects. Because no interaction between stock and sampling date was found for any of these parameters, nonparametric analyses were conducted. A Wilcoxon two-sample test was used to compare the two honey bee stocks and a Kruskal–Wallis test was used to determine overall sampling date differences (SAS version 8.2, SAS Institute 2001).

Results

Small Hive Beetle Invasion. Analysis of variance (ANOVA) revealed no interaction between stock and observation period for the number of small hive beetle in the colonies. The Wilcoxon two-sample test showed that the genotype of queen introduced in newly installed packages had no immediate effect ($W = 10038$, $P = 0.395$ on the number of beetles in the colonies [May–June 2005]) (Fig. 1). Overall, the number of small hive beetle in the colonies was low, with 3 ± 0.3 (mean ± SE) and 2 ± 0.2 beetles in the nucleus

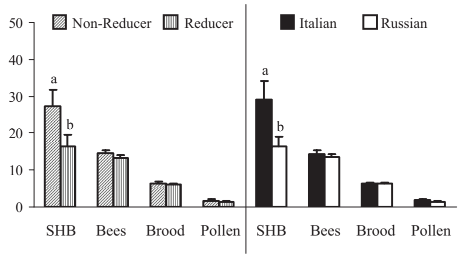

Fig. 2. Average numbers (mean ± SE) of small hive beetles, frames of bees, brood and pollen in colonies with and without entrance reducers regardless of stock, and in colonies of Italian and Russian honey bees regardless of the presence of entrance reducers in 2005–2006. For each variable, bars with different letters are significantly different ($P < 0.05$) and bars with no letters are not significantly different ($P > 0.05$).

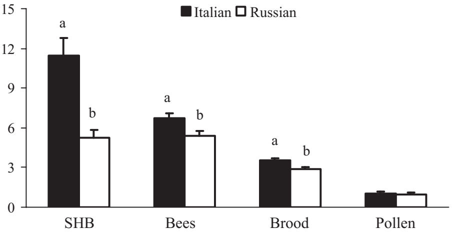

Fig. 3. Average numbers (mean ± SE) of small hive beetles, frames of bees, and brood and pollen in Italian and Russian honey bee colonies in 2007. For each variable, bars with different letters are significantly different ($P < 0.05$) and bars with no letters are not significantly different ($P > 0.05$).

colonies with Italian and Russian queens, respectively. Likewise, no stock differences were detected with regard to the number of frames of adult bees (W = 1639, $P = 0.114$) or the number of brood frames (W = 3424, $P = 0.994$) during this time. The Italian nucleus colonies had an average of 10.66 ± 0.90 frames of bees and 5.95 ± 0.34 frames of brood, whereas the Russian colonies had 8.88 ± 0.67 and 5.66 ± 0.31 frames of bees and brood, respectively.

After 3 mo or when all colonies were composed of only test bees, a significant interaction between honey bee stock and observation period was detected (F = 9.77, df = 5, $P < 0.0001$). Italian colonies consistently showed significantly higher numbers of beetles throughout the experimental period (July 2005–September 2006) (Fig. 1), except in August 2005 when the lowest overall population of small hive beetle was observed. Colonies with entrance reducers (16 ± 3 beetles) had significantly fewer beetles ($P = 0.037$) than colonies without entrance reducers (27 ± 5 beetles).

There was no interaction among entrance reducers, stock and sampling date for the numbers of frames of bees ($F = 0.57$, df = 5, $P = 0.726$), or brood ($F = 0.81$ df = 5, $P = 0.545$). The presence of entrance reducers did not affect bee ($F = 1.99$, df = 1, $P = 0.161$) and brood production ($F = 0.06$, df = 1, $P = 0.808$) or pollen availability ($F = 1.41$, df = 1, $P = 0.246$). Overall, the two stocks had similar numbers of frames of adult bees ($F = 0.19$, df = 1, $P = 0.663$), frames of brood ($F = 0.07$, df = 1, $P = 0.799$), and available pollen ($F = 1.19$, df = 1, $P = 0.286$) (Fig. 2).

Small Hive Beetle Population Development. Overall, Italian honey bee colonies significantly (W = 1700.5, $P = 0.0004$) supported more beetles than the Russian honey colonies (Fig. 3). The highest number of beetles was observed in October 2007 (12.73 ± 1.93 beetles) and lowest numbers were observed in June (7.14 ± 1.18) and August 2007 (6.31 ± 0.99 beetles) ($\chi^2 = 9.30$, $P = 0.0096$).

Analyses of colony parameters showed that Italian colonies were more populous (frames of adult bees: W = 1862, $P = 0.011$; frames of brood: W = 1841, $P = 0.007$) than the Russian honey bees (Fig. 3). However, both stocks had similar amounts of pollen present in the colonies (W = 2241, $P = 0.916$) (Fig. 3). Overall, adult bee population was highest in August (7.51 ± 0.50 frames) and October 2007 (6.10 ± 0.33 frames) and lowest in June 2007 (4.95 ± 0.54 frames) (χ^2 = 13.16, $P = 0.001$). A linear regression analysis showed no relationships among the number of beetles in the colonies and adult bee population ($r^2 = 0.1034$, P = 0.297), brood produced ($r^2 = 0.1488$, $P = 0.132$), and amount of pollen ($r^2 = 0.1036$, $P = 0.295$).

Small Hive Beetle Reproduction. Analysis revealed no stock by date interaction ($F = 1.41$, df = 4, P = 0.234) and no stock effect ($F = 0.96$, df = 1, $P = 0.328$) on the number of eggs/larvae found on the bottom board traps. However, the number of beetles differed among sampling dates ($F = 67.01$, df = 5, $P < 0.0001$). The highest number of eggs/larvae was observed in June 2007 (32.60 ± 4.24 beetles) followed by July (11.36 ± 3.04). The lowest counts were observed in August (0.53 ± 0.29), September (1.43 ± 1.01), and October (0.38 ± 0.20 beetles). In September, two Italian colonies collapsed (with a handful of bees) due to high levels of varroa infestation; thus, trap counts (colony 420, 248 larvae and colony 412, 118 larvae) for these colonies were excluded from the analyses.

Only a few of the entrance traps were found infested with beetles through time and thus, available data were insufficient to form conclusive results. Nevertheless, more traps from Italian colonies were found infested than those from Russian colonies. In June 2007, traps from six Italian colonies (three colonies with one beetle, one with two beetles, one with four beetles, and one with eight beetles) and two Russian colonies (one beetle each) were found infested. In July 2007, only three traps from Italian colonies had beetles (two with one beetle and one with four beetles). Only one trap from an Italian colony had eight beetles in August 2007. For September and October 2007, no beetles were detected in any trap. It is interesting to note that more beetles were found in the trap of one colony that had been queenless and broodless (with little pollen) since June 2007; 13 beetles were recorded in July and 44 beetles in August when the colony only had a handful of bees left.

Discussion

Our results showed that Russian honey bees were more resistant to small hive beetle than the commercial Italian bees. Despite the ability of small hive beetle to fly, the comingling of both stocks in our apiary, and the randomized placement of colonies within our apiary, Russian honey bee colonies supported low numbers of invading small hive beetle in colonies that were deliberately freed from small hive beetle during each observation. Similarly, established Russian colonies where small hive beetle were allowed to freely colonize (without entrance reducers and beetles were not removed at any time) maintained low populations of beetles throughout the experimental period. The low numbers of small hive beetle in Russian colonies may be the result of the bees' active aggression toward invading adult beetles. Russian honey bees have been observed to remove live beetles from observation hives, an activity that was not observed in commercial Italian bees (de Guzman et al. 2006).

In the 2005–2006 experiment, small hive beetle populations were generally low during the first 4 mo of observations. However, the small hive beetle population increased in November 2005 with the highest number observed in September 2006, 17 mo after queen installation. This increase in November and September may be due to an increase in small hive beetle populations in surrounding apiaries. There are ≈13 apiaries located within a 4.8 km radius of the test apiary, all of which are known to be infested with small hive beetle and thus were potential sources of infestation. One of these apiaries was highly infested with small hive beetle, for example, a colony may have ≈500 or more beetles just under the inner cover alone. This increase is likely due to a drop in temperature, which lessened the number of guard bees at the hive entrance. The average temperature during the week of observation in November 2006 was ≈21.59°C, which was higher than the temperature recorded in February (12.72°C). The decrease in February 2006 was probably due to natural mortality, inactivity due to cold weather or the lack of reproduction during the winter, as observed by Pettis and Shimanuki (2000). In the 2007 experiment, small hive beetle infestation was generally low despite using the same apiary. Nevertheless, the highest infestation also was observed in the fall. This increase in number in the fall may be due to the availability of invading beetles that just emerged from the soil during this time.

Although the genotype of queens introduced into nucleus colonies did not have an immediate effect on small hive beetle invasion, resistance to small hive beetle invasion was expressed when colonies were fully established and adult test bees populated the hives. Despite starting from homogenous populations for both experiments (from a large package in 2005 and colony divisions from the same parent colonies in 2007), our colonies supported differential populations of small hive beetle. Our results consistently showed that colonies that received Russian queens had fewer small hive beetles on average than their Italian counterparts. This observation suggests that differences in behavior or differences in volatiles from adult bees of the two stocks may have played a role in the invasion process. It has been shown that odors from hive products were more attractive to beetle invasion with the presence of adult bees (Elzen et al. 1999). Using olfactometric and wind tunnel bioassays, volatiles from living worker bees were confirmed to attract small hive beetle (Suazo et al. 2003). In our study, both stocks had similar adult honey bee and brood populations in 2005–2006. However, in 2007 Russian colonies were smaller than the Italian colonies. Thus, attraction may be due to the differential quantity or quality of volatiles produced in the hives by the two stocks. Torto et al. (2005) identified eight major components of volatiles collected from adult worker honey bees. It is possible that the amounts or proportions of these components in the two stocks are different. Also, it has been shown that the cuticular hydrocarbon profiles of honey bees previously infested with varroa mites are different from those of uninfested honey bees (Salvy et al. 2001). In both experiments, the Italian bees had higher varroa infestations (2005–2006, 4.74%; 2007, 11.34 ± 1.45%) in the brood than the Russian bees (2005–2006, 2.70%; 2007, 7.22 ± 1.37, corroborating earlier reports (Rinderer et al. 2001, de Guzman et al. 2007). Perhaps differential levels of varroa caused colony odor differences that contributed to fewer small hive beetle in Russian colonies. Freshly collected pollen also is known to attract beetles (Suazo et al. 2003). We observed that the amounts of pollen available in the hives were similar in both stocks in February 2006 as well as in June to October 2007, and we found no influence on the number of beetles in the colonies. Although weaker colonies are known to be more susceptible to small hive beetle infestation than stronger colonies, Russian colonies had fewer number of small hive beetle despite being less populous in 2007. Furthermore, colonies used in our 2007 study were generally smaller than those in 2005. Yet, there were fewer beetles observed in 2007 than in 2005–2006. Perhaps, weather factors particularly temperature and relative humidity may have contributed to this difference.

Spiewok and Neumann (2006) reported the presence of a cryptic low-level reproduction of beetles in the colonies. In this study, we also observed low-level reproduction as evidenced by the presence of larvae (1–50) on the bottom board debris of three Italian colonies in 2005. These colonies did not show symptoms or damage typical of small hive beetle infestation. All three colonies were queen right but were generally weak (2–4 frames of bees) and had entrance reducers. The entrance reducers may have prevented the bees from cleaning the bottom board or perhaps these colonies were genetically less able to maintain debris-free hives. None of the Russian colonies had larvae on their bottom board. This observation suggests that Russian bees were more hygienic than the Italian bees used in this study, which agrees with the findings of de Guzman et al. (2008).

In this study, trapping of immature beetles inside the hives also indicated the occurrence of low-level small hive beetle reproduction. However, the high number of trapped eggs/larvae in June and July 2007 may be due to adult beetles laying eggs inside the traps. We used varroa traps with screen tops during these months, whereas cafeteria trays in between a solid bottom board and a screen bottom board were used in August to October 2007. Although trapped eggs/larvae can also be a result of bees' hygienic behavior, it is less likely that the Italian bees were more hygienic than the Russian bees. It is probable that small hive beetle reproduction was lesser in the Russian colonies than in the Italian colonies. This observation was suggested by the number of traps that collected wandering phase larvae, which are known to leave the hive to pupate in the soil (Lundie 1940). We only found two traps with one beetle each among the Russian colonies compared with 11 traps from Italian colonies having a total of 32 beetles from June to October 2007. Less reproduction in the Russian colonies may result from the bees' aggressive behavior toward adult beetles (de Guzman et al. 2006). The absence of beetles in any trap in September and October also may be indicative of no small hive beetle reproduction during the fall when temperatures started to drop.

Modified hive entrances help regulate beetles invading colonies. This was shown by Ellis et al. (2003) who reported a decrease in the number of small hive beetle when using PVC entrance reducers. We found similar results when using wooden entrance reducers. Colonies with entrance reducers installed had fewer small hive beetles than those without entrance reducers. However, we found that wooden entrance reducers did not affect brood and bee production, in contrast with the findings of Ellis et al. (2003) who found negative effects of PVC pipe entrances on amounts of adult worker bees and brood. Also, colonies with open entrances or 3.8-cm pipe entrances had more frames of pollen than those with 1.9 cm entrances (Ellis et al. 2003). We did not detect differences between colonies with or without entrance reducers in the amount of stored pollen.

Our results showed that Russian honey bees are more resistant to small hive beetle invasion or less attractive to small hive beetle infestation than Italian bees as indicated by their low numbers despite the absence of entrance reducers, and less reproduction inside the colonies. Russian honey bees are known for their resistance to varroa and tracheal mites. Resistance to small hive beetle is an added value of this mite-resistant stock.

Acknowledgments

We thank G. Delatte, T. Stelzer, J. Wales and R. Spencer, for their technical assistance. This research was completed in cooperation with the Louisiana Agricultural Experiment Station.

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Received 20 June 2008; accepted 21 August 2008.