ANNUAL REPORT FOR PROJECT NUMBER 05-WH-01
YEAR 2005 (1ST YEAR)

Project Leader: Wm. Michael Hood
Location: Clemson University, SC
Mailing Address: Department of Entomology, Soils, and Plant Sciences, 305 Long Hall, Clemson University, Clemson, SC 29634
Phone: 864-656-0346 FAX: 864-656-0274 E-mail: mhood@clemson.edu

Project Title: **Trapping the Small Hive Beetle**

Problem and its Significance:

The American beekeeping industry was confronted in the late 1990s with a new exotic pest, the small hive beetle (SHB), *Aethina tumida* Murray. A native of Africa, the SHB was discovered in North America in Charleston County, South Carolina in 1996. The precise date and means of their entry into the USA are unknown, but mitochondrial DNA evidence suggests congruity with *A. tumida* populations in South Africa. In the nine years since their arrival, SHBs have proven themselves a serious pest of honey bees especially in the southeastern region of the USA.

As a member of the sap beetle family Nitidulidae, SHBs demonstrate an affinity for decaying plant material. SHBs are capable of reproducing on fruit – indeed, infested fruit is one of the suspected modes of their entry into this country – but oviposition rate, adult longevity, and net reproduction are significantly higher when they feed on bee hive products. The stereotyped pattern for their life history is for adults to enter bee hives and co-habit with bees, a feat accomplished in part by a syndrome of behavioral mimicry in which beetles dupe their hosts into feeding them trophallactically. Females lay eggs in various cracks and crevices throughout the hive. First-generation SHB larvae have been identified in South Carolina as early as April. Larvae proceed through all instars while feeding on bee hive products, then leave the hive to pupate in the soil. They rarely move beyond 90 cm of the hive entrance nor deeper than 20 cm from the surface. Adults remain in the soil for up to two days after eclosion. SHB overwinter as adults in the USA and they are found in the bee cluster where they find food and warmth. Four to five SHB generations are possible annually in the southeastern USA given favorable conditions(WMH).

Although the SHB is considered a minor pest of African honey bees *Apis mellifera scutellata* and *A. m. capensis*, it causes serious damage to European-derived *A. mellifera* in the USA. In a comparative study conducted in South Africa and Georgia, SHBs were shown to significantly reduce bee populations, brood area, and average flight activity in Georgia, but not South Africa. The beetles consume honey and pollen in the bee colony and eat unprotected bee brood and eggs. The activity of beetle larvae triggers fermentation of a colony's honey stores, rendering the honey unfit for consumption by bees or humans. Studies have shown that beetles pierce the cappings of bee brood and oviposit directly on the immature bee. Absconding, or nest abandonment by bees, is frequently the terminal outcome of beetle infestation.

SHB have been reported in thirty states and one Canadian province (Hood 2004). SHB have now been found in all southeastern states in the US and are now a region-wide pest. Some states have had beetles for only 1-2 yr and the pest has yet to become a management problem. The most serious damage has occurred in warmer regions of the country in Florida, Georgia and South Carolina, but SHBs overwinter successfully in Minnesota. Beetles spread mainly by movement of beetle-infested bee colonies, empty beekeeping equipment, package bees or other beetle-infested material. Therefore, SHB spread to Western regions of the USA is imminent, particularly in regions where migratory beekeepers move colonies for pollination rental.

By the late 1990s, field trials by USDA and university scientists had led to approved chemical treatments for SHB. Gard Star® (40% permethrin AI), a soil insecticide, is approved for soil treatment around hives and targets larvae as they enter the soil to pupate. An in-hive pesticide, Check Mite+® (10% coumaphos AI, an **organophosphate**), is registered under an emergency use label in many states. This product is subject to renewal annually and there exist the regulatory loss of this product for just cause. SHBs sometimes are a problem in honey processing facilities.

Hood and Miller (2003) have investigated the effectiveness of an in-hive trap. Various materials, alcohol, beer, ethylene glycol, mineral oil, honey, and cider vinegar were examined for their attraction and lethality to SHB. A series of field and laboratory experiments over 2 years tested these materials as control agents when placed in a plastic box (152 x 80 x 25mm) with vents in the top to allow SHB entry but exclude bee entry (Fig. 1). The trap was mounted to the base of a hive frame and placed inside the hive. Cider vinegar showed the highest counts of dead SHB in colonies, but low lethality in lab tests. Mineral oil showed high SHB lethality in lab tests, but resulted in comparatively low beetle trap kill in colonies. A problem in this study was the ability of beetles to exit the traps. Although the study implicated cider vinegar as an effective attractant, more work is needed to improve the efficiency of the trap design.

Once developed, an efficient in-hive trap could be used to exploit a vulnerable stage in the SHB life cycle. Hood and Miller (2003) reported finding only SHB adults in bee colonies and no beetle life stages in the soil in Georgia and South Carolina during winter. Thus the SHB takes a 3-4 month interruption in its life cycle during the cooler months in most regions of southeastern USA. An efficient SHB adult trap placed in an infested bee colony in late winter could thus impede buildup of an incipient beetle population. A trap could be placed in bee colonies during other times of the year when SHB invasion pressure is shown to be high. The successful development of an effective SHB trap will offer beekeepers an integrated management tool which can be used even during nectar flows without fear of hive product contamination.

References:

Hood, W.M., G.A. Miller. 2003. Trapping small hive beetles (Coleoptera: Nitidulidae) inside colonies of honey bees (Hymenoptera: Apidae). American Bee Journal 143(5): 405-409.

Hood, W.M. 2004. The Small Hive Beetle, *Aethina tumida*: A Review. Bee World 85 (3): 51-59.

Objectives: 2005

The long term goals for this project are to develop a small hive beetle (SHB) trap that is convenient, economical, and efficient. The trap should reduce the SHB population to a low level to preclude the need for chemical treatment. The trap should be a user-friendly device which can be fastened to the bottom bar of a beehive frame and inserted in the place of a normal frame or be incorporated as a modified bottom board with trap attached underneath. A beekeeper should be able to use the trap at any time of year without fear of hive product contamination.

1. Finalize development of an effective in-hive SHB trap.

2. Field test two SHB traps to compare efficiency during one season

Plans and Procedures: 2005

Objective 1: Finalize development of an effective in-hive SHB trap.

During winter and spring 2005, a SHB one-way trapping device will be further developed for use inside bee colonies. The engineering objective is a device that provides beetle entry, prohibits their escape, and tightly contains liquid attractants such as cider vinegar. Based on earlier SHB trapping work, this research will concentrate on cider vinegar as an attractant, but other compounds may be tested. Trap prototypes will be lab pre-tested for their ability to trap and retain SHB. Precision Plastics, Inc., Clover, South Carolina, has been retained as possible manufacturer of a plastic resin trap. The jar/modified bottom board trap can be assembled from locally available beekeeping equipment.

Accomplishment 2005

A one-way small hive beetle trap, commercially known as the "Hood Small Hive Beetle Trap," was successfully developed and is currently distributed and sold by Brushy Mountain Bee Farm, Moravian Falls, North Carolina 28654. (2006 Catalog of Beekeeper's Supplies, Ph. 1800-233-7929, E-mail: sales@brushymountainbeefarm.com, website: www.brushymountainbeefarm.com.)

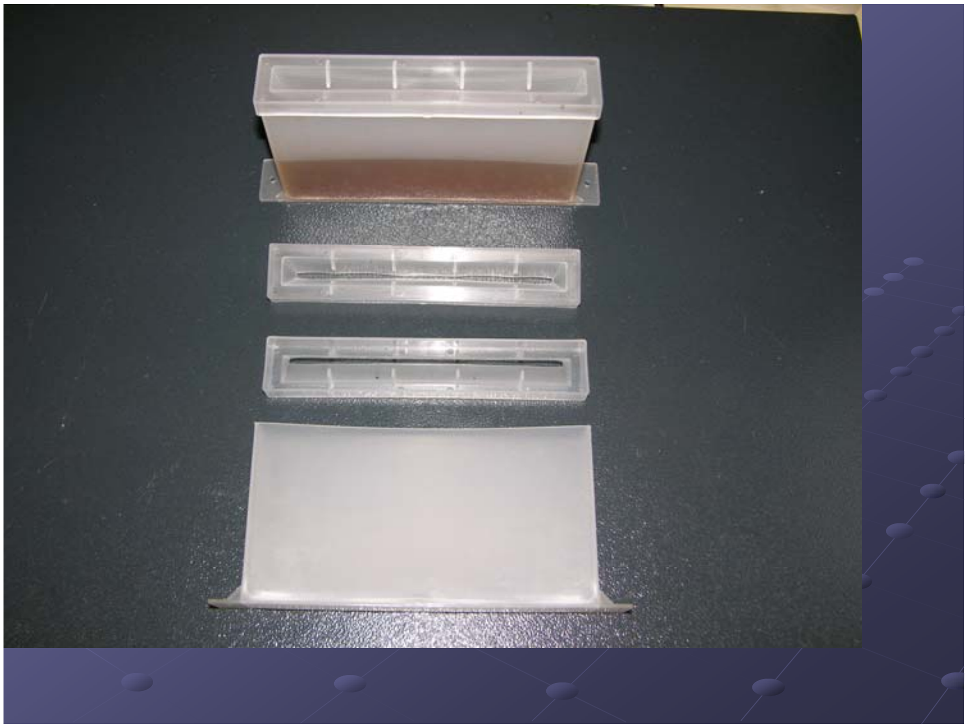

Figure 1. Hood Small Hive Beetle Trap

Objective 2. Field test two SHB traps to compare efficiency during one season.

During spring, summer and fall 2005, a field test will be conducted in coastal South Carolina to compare trapping efficiency. A beekeeper cooperator who is located in the coastal area of the state will provide research apiary locations for this project. SHB have been problematic in these locations and natural infestation is expected. Twenty-four bee colonies will be established in early April with 2-lb package bees apparently free of SHB. Field tests will be conducted comparing the efficacy of the two traps to colonies with no traps. Twelve new honey bee colonies will be established in each test apiary using package bees (2 lb., approximately 7,000 bees each) with new queens in early April 2005. The colonies will be housed in 10-frame Langstroth hives and managed as normal for honey production. Within 6-8 weeks following colony establishment, four colonies will be randomly selected in each test apiary to receive one of the three treatments (one of the two selected traps or no trap as control. Test colonies will be monitored at treatment placement and at 3-4 week intervals to determine honey bee and beetle densities. Beetle density will be determined by removing five frames from each test colony hive body and counting beetles on the three exposed interior hive sides and the hive bottom. Beetles collected from traps will be counted and emptied and new cider vinegar replaced. Bee population density will be compared by measuring the number of capped cells of bee brood in each colony by placement of a scribed 25cm² piece of Plexiglas over each side of colony brood frames and counting the number of squares of capped brood.

Accomplishment 2005

Field tests were conducted as described above beginning on 29-30 March 2005 and the last data were collected on 9 November 2005. Colonies were serviced at 3-week intervals. The numbers of dead SHB adults counted in the two trap types were not significantly different and the amount of capped bee brood did not vary by treatment during the trial period. However, there was a significant decrease in number of SHB surveyed in the Hood SHB trapped colonies when compared to the number SHB counted in control treatment colonies over the 5 months trapping period which suggests a higher control efficiency. All test colonies survived the trial period except one control treatment colony. The Hood SHB trap proved to be more user friendly since no hive modifications were necessary.

Table 1. – Least square means ± SE (n) of dead small hive beetles (SHB) counted in two treatment traps, amount of capped bee brood by treatment, and colony SHB populations sampled. Data in columns followed by the same letter are not different at the α ≤ 0.05 level.

Treatment	Dead SHB	Capped Bee Brood ($25cm^2$)	Colony SHB Population Surveyed
Hood SHB Trap	8.75 ± 3.70 (8)a	98.85 ± 5.68 (8)a	.98 ± .86 (8)a
Jar/Hive Bottom SHB Trap	15.40 ± 3.70 (8)a	101.86 ± 5.73 (8)a	1.60 ± .86 (8)ab
Control (No Trap)	---	88.04 ± 6.40 (7)a	3.81 ± .98 (7)b

NOTE: A manuscript of the results of accomplishment 2 has been accepted for publication in The American Bee Journal (51 S. 2nd Street, Hamilton, IL. 62341, ph. 217-847-3324) – Apicultural Research Section and is scheduled to be published in the August or September 2006 issue. Contact Editor Joe M. Graham for reprints (email: ABJ@dadant.com, Website: www.dadant.com.)