Small Hive Beetle Management in Mississippi

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CONTENTS

This bulletin was prepared to give information to the bee and honey industry.

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Introduction

Ever since the South Africa native small hive beetle (SHB) found its way to the United States, reports and complaints of its predation on honey bee colonies have abounded. The small hive beetle, *Aethina tumida*, adversely affects all aspects of beekeeping, including queen rearing, honey production and processing, and pollination operations. The purpose of this booklet is to objectively report on proper identification, the effects of this pest on beekeeping in Mississippi and how honey bee colonies can best be managed to reduce economic damage. There is no silver-bullet method of controlling small hive beetles, but a combination of management techniques and chemical treatments can be employed to the keep economic impact of SHB at acceptable levels in the apiary and the honey processing facility.

Where in the United States Do Small Hive Beetles Occur?

Small hive beetles were first discovered along the Eastern seaboard in 1996, and are believed to have arrived on a ship from South Africa, hitchhiking in a swarm of bees or in empty honeycomb. A live specimen was recovered by a beekeeper in Charleston, South Carolina, but the specimen was not identified as a small hive beetle until a few years later. The first confirmation of an active infestation of SHB in a U.S. apiary occurred in Florida in 1998.

As a result of highly mobile migratory beekeeping operations in the U.S., small hive beetles have been found in every state but Alaska, and in several Canadian provinces. Recently they have invaded Hawaii, where they are considered a primary pest of honey bees year-round. However, due to the short seasons and colder climates of the northern U.S., population explosions are seldom seen and SHB are considered a secondary pest. In the southern climates, several generations of beetles are typically produced during the spring, summer and early fall. Large adult beetle populations are frequently seen in southern apiaries, and the beekeeper must be vigilant about colony maintenance to keep them from reproducing.

How Do Small Hive Beetles Cause Damage?

Small hive beetles are opportunistic scavengers, closely related to sap and pollen beetles. In honey bee colonies they feed on pollen, honey and occasionally brood. The damage associated with an SHB infestation is caused by the larval stage; adults have little negative impact on a colony besides distracting worker bees from their normal hive duties. Unfortunately, once a beekeeper notices larval damage, it is usually too late to expect a hive to recover. Larvae appear suddenly and in large numbers—typically hundreds to thousands—and immediately begin tunneling into comb. As the larvae feed, they distribute the yeast *Kodamaea ohmeri* in their feces, which ferments the pollen and honey, and creates a slimy mess on the surface of combs (Fig. 1). Honeybees are repelled from the areas of the comb being thus slimed; consequently, brood rearing ceases and the bee population declines rapidly. The event is termed a "slimeout." Bees may cluster outside the hive and even abscond, leaving the chore of cleaning up to the beekeeper. There are two tell-tale signs of an SHB larval infestation that are perceivable even before a damaged hive is opened: (1) a strong odor of rotting citrus, and (2) the appearance of honey running out of the front of the hive.

How Can Small Hive Beetles Be Located and Identified in a Hive?

Hive Inspections: Inspections for small hive beetles can be made on any warm day when the temperature exceeds 70ºF. The adults become active at this temperature and crawl about the hive and combs outside the bee cluster/brood area. If a hive has a significant infestation, beetles will be observed on the underside of the top cover when it is removed, or inside the inner cover. The adults seek out dark secluded areas; therefore, upon inspection remove the hive cover, smoke it heavily (beetles do not like smoke and will run or even fly away from it) and let the light penetrate into the hive as much as possible. Smoke each subsequent super or brood chamber and remove it after a few minutes. The beetles will easily be seen on the bottom board once it is exposed, and they can be exterminated in a bucket of soapy water. Since adults cause

Fig. 1. A "slimed" honey comb. This comb has been ruined by an infestation of small hive beetle larvae.

little to no direct damage to the colony, there is no determined economic injury level (EIL) based on adult numbers. The best strategy for control is to remove as many existing adults as possible from the colony to discourage reproduction. Unfortunately, when abundant larvae are detected in the hive, it is usually too late to act, as the hive has typically succumbed to the infestation. The most effective way to minimize the threat of SHB in your colonies is to keep the bee population strong. Assuming a hive has a queen and is strong enough to protect and cover all the combs in the hive with workers, SHB larvae will not appear, even if you see a significant number of adult beetles. Conversely, when a hive becomes queenless and demoralized the bees will not protect it and hive beetles will readily reproduce.

Beetle Identification: Small hive beetles belong to the insect order Coleoptera and the family Nitidulidae (sap beetles). Their scientific name is *Aethina tumida* Murray. Small hive beetles have a 4-stage life cycle consisting of egg, larva, pupa and adult. The metamorphosis from egg to adult can be completed in as little as 4-6 weeks; consequently there may be as many as 6 consecutive generations per year in ideal climates. Each stage can best be described as follows:

Adults: Newly emerged adults are light reddish-brown in color, but darken to nearly black as their exoskeletons harden over the next 24-48 hours. Females are about 5.7 mm (1/4 in.), while the males are slightly shorter on average, about 5.5 mm; both are ovoid in shape when viewed from above. They are almost indistinguishable from each other to the untrained eye. Mature size can vary significantly in a natural environment (Fig. 2) and is directly related to the nutrition they received during the larval stage. Adults have club-shaped antennae and their bodies are covered in fine, golden hairs which make them slippery to handle.

Larvae: Small hive beetle larvae are often confused with wax worms—the hive-dwelling larvae of the greater wax moth, *Galleria mellonella*, and the lesser wax moth, *Achroia grisella*. There are several physical characteristics that can be used to distinguish between the two pests if you have good eyes or a hand lens. SHB have relatively small, flat heads compared to wax worms, which have bulbous head capsules. The beetle larvae have numerous protuberances on their bodies and rows of

Fig. 2. Adult small hive beetles. Males (left) are typically smaller than females (center and right). Their sizes can vary considerably due to the level of nutrition tehy receive during the larval stage.

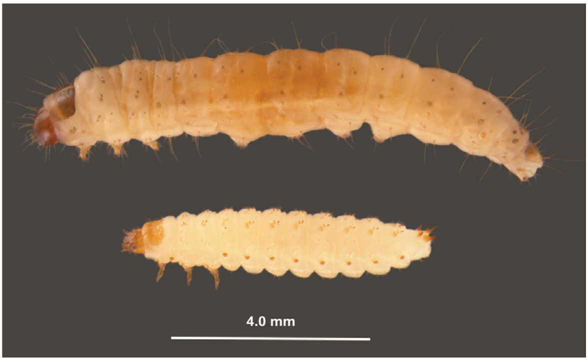

Fig. 3. Larval pests of the bee hive. Wax worm larva (top) and small hive beelte larva (bottom) may be confused by the beekeeper. Both species take advantage of weakened colonies, and both may be found infesting the same hives.

small spines along their backs, while the wax worm is sparsely covered with long hairs. SHB have six legs located near the head, while wax moths have eight prolegs along their body, in addition to the six legs near the head. The abdominal segmentation is much more pronounced in hive beetle larvae. Perhaps the most obvious distinguishing characteristic is the webbing produced by tunneling wax worms. Hive beetle larvae do not spin webs or make cocoons in the combs as wax worms do. There is also an enormous size difference in the mature larvae of both species. Prior to pupation, SHB larvae may reach lengths of 9.5 mm (3/8") and diameters of 1.6 mm (1/16"), while wax worms may grow to be over 20 mm long (7/8") and 6.5 mm (1/4") across. The size of the mature larvae of both species can vary depending on environmental factors such as nutrition and temperature.

Eggs: Small hive beetle eggs are approximately 1.4 mm long and 0.26 mm wide, looking very similar to honey bee eggs in shape and color, but smaller in size. They are deposited in clusters in dark protected areas of the hive. Sometimes female SHB will chew a hole in capped brood and deposit eggs into a brood cell. Eggs are rarely noticed during hive inspections and are therefore not used to diagnose infestations.

Pupae: This is the only life stage that does not occur in the hive. The pupae may be found by digging in the soil surrounding a hive that has been slimed out. They typically occur in the first 6 inches of soil, depending on the soil type and moisture content. By rule of thumb, the drier the soil, the deeper you have to dig to find them. Pupae tend not to cluster together, but are somewhat randomly dispersed throughout the soil. They are whitish-tan, with clearly distinguishable eyes, mouthparts and appendages (Fig. 4). They measure 4.5 to 6 mm in length.

Fig. 4. Small hive beetle pupa. Larvae exit the hive and complete the pupal stage of development in the soil.

Important Biological Aspects of Small Hive Beetles

The key to managing small hive beetles, as with any pest, is to find a way to interrupt their reproductive cycle. Every stage of development is susceptible to some management practice, whether cultural or chemical. All of the known effective strategies will be discussed in this booklet.

Life Cycle: Female beetles deposit clusters of eggs in cracks and crevices along the edges of frames and in capped brood. Eggs hatch in 24-48 hours and the larvae feed for the first 7 days on honey, pollen and bee brood and eggs. Larvae molt their exoskeletons as they grow, reaching maturity in about 10 days. This fourth "instar" is the only non-feeding larval stage. At this time they become attracted to light and migrate out of the hive and into the surrounding soil. They typically burrow 4-6 inches into the ground, or to where the moisture level is suitable for pupation. The pupal stage lasts 3-4 weeks, and adults will often emerge from the soil following a soaking rain. Males have been observed to emerge a day or two earlier than females, but the sex ratio of any given generation of beetles tends to be 1:1.

One complete life cycle (Fig. 5) takes 40 to 54 days, from the time an egg is oviposited until the mature female lays the next generation of eggs. The number of SHB generations produced in a year increases toward the south across the state. Four to five generations can result in exhausting populations by late October in the deep south. There is much speculation about whether soil type limits successful SHB pupation in certain parts of the state. The beetle's native African soil is predominately sandy loam. Unfortunately, SHB larvae are excellent burrowers, and they do quite well in Mississippi clay as long as the soil is not fully saturated with water. Too much water, or too little, will prevent larvae from pupating successfully.

Host-Finding: Small hive beetles are very mobile, flying from hive to hive, and between apiaries in search of suitable places to reproduce. They are strong fliers for their small size, and are known to travel several miles on the wing. Newly-emerged adults fly before and just after sundown during the hot summer months, locating host colonies by orienting to the volatile hive odors.

Research shows that adult small hive beetles are highly attracted to a component of honey bee alarm pheromone, isoamyl acetate, and that they use this compound as an orientation cue. Isoamyl acetate is emitted by honey bee colonies under two conditions: when the colony is queenless or under other distress, or when the colony is already infested with SHB. In the latter case, the resident beetles have inoculated pollen and honey with *K. ohmeri* yeast, which produces isoamyl acetate as a fermentation by-product. In odor choice assays, fermented pollen dough is significantly preferred by SHB over alarmed worker bees, which is why yeast-inoculated pollen dough is a suitable bait for adult beetle monitoring traps in apiaries (Fig. 6).

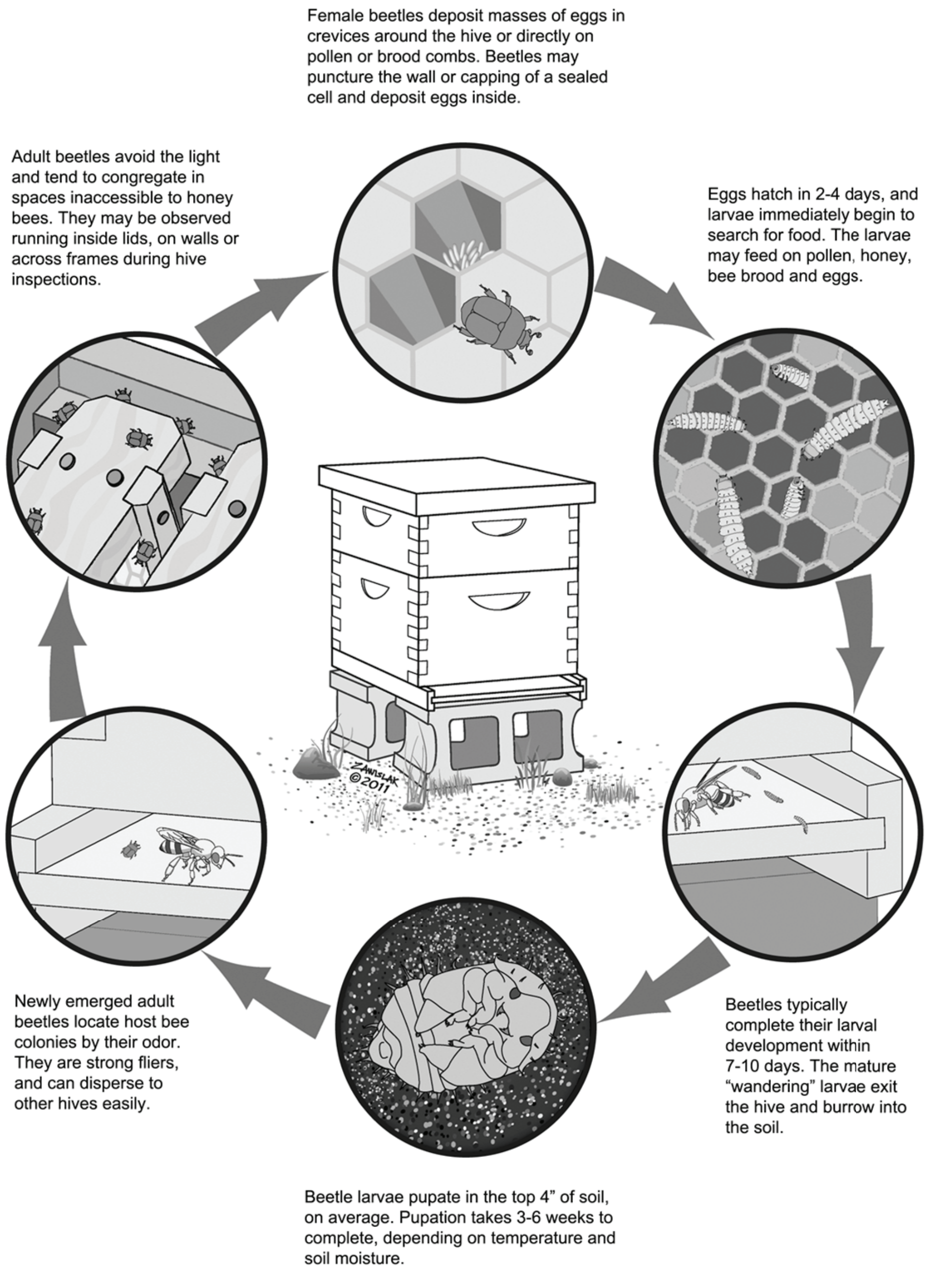

Fig. 5. The life Cycle of the Small Hive Beetle. Beetles must move inside and outside of the bee hive to complete development. Controlling adult beetle populations within hives can usually prevent large numbers of beetle larvae from hatching, which do the most economic damage.

Fig. 6. Hive Beetle Pipe trap. These traps, baited with yeast-innoculated pollen dough, can be used to monitor migrating adult beetles in an apiary.

Small hive beetles seek out areas of low activity in the hive until they are ready to lay eggs. When not ovipositing in the brood chamber, they are found in the honey supers or on pollen frames, where they often go unnoticed by bees. Honey bees occasionally herd the beetles into confinement areas, which may be empty cells, burr comb or a corner of the hive. There, the beetles are physically guarded and often entombed in igloo-shaped "corrals" made of wax and propolis. Imprisonment does not mean death, however. Beetles can survive in captivity for weeks by way of a behavioral adaptation that allows them to receive food from their captors. The beetle touches the mandibles of a honey bee with its antennae, signaling the bee to regurgitate the contents of her honey crop as if she were feeding another bee. Usually, the "duping" only secures a few feedings from each guard bee before the bee realizes her mistake and refuses to give the service.

Reproduction and Dispersal: Small hive beetles are brilliant at the task of producing progeny. In the laboratory, males mate multiple times with any number of females, and appear to "replenish their stores" within minutes, as long as they have access to food and water. Females can lay 1,000 eggs in their lifetimes, and possibly as many as 2,000 under optimum conditions.

Little is known about SHB mating behavior in the wild, but once a female has been mated and has taken a meal, she is ready to oviposit her first clutch of eggs. More often than not, however, she is forced to wait. The mechanism or cue that signals female SHB to begin oviposition in the hive is unknown. There have been recorded accounts of cryptic low-level reproduction of hive beetles in healthy colonies, but there can also be hundreds of presumably mated females inhabiting a hive, and no visible larvae. Eggs are difficult to see, and one can not assume they are or are not present. The egg is the most fragile life stage of the hive beetle, and egg mortality via desiccation or destruction by bees is likely one of the limiting factors to SHB reproduction in a strong colony. Humidity levels during the first days after oviposition can determine whether or not eggs remain viable. Honey bees maintain an average relative humidity of 40% in the hive, and approximately 90% in the brood area. Relative humidity at levels below 50% causes desiccation of beetle eggs, which suggests that eggs laid in brood comb have a greater chance of survival than those laid in the hive periphery. As mentioned earlier, brood comb is the most highly-guarded area of the hive, and strong colonies may not permit beetle oviposition in this favorable environment for beetle development.

Eggs hatch in about two days, and the tiny larvae immediately begin feeding on the nearest resource. Young larvae are cannibalistic in the laboratory, but this has not been observed in natural settings. Once larvae reach maturity (10-16 days in nature, 7-10 days in the lab), they enter a “wandering” phase, during which they crawl out of the hive to pupate in the soil. The wandering phase is characterized by larvae becoming strongly attracted to light, particularly ultraviolet, and moving toward a light source. It is believed that they use ambient light cues to orient to the nearest hive exit—typically, the front opening. Larvae are seldom seen leaving the hive, but they probably choose the cool morning or evening hours during the summer months to execute this transition.

Adult beetles, freshly emerged from the soil, are also strongly attracted to UV light, and they use visual cues in addition to odor cues to orient to a host hive. Research indicates that flying beetles are attracted to certain colors more than others: white and a several shades of pink and fuchsia are the most attractive to adult SHB. This knowledge should perhaps be taken into consideration when painting hive boxes. The most probable source of adult SHB is a permanent apiary that has experienced a slimeout at some point in time. If hives are not relocated after a slimeout, emerging adults will infest the available colonies. Adult beetles are also capable of flying several miles and may migrate from one apiary into another in which SHB control measures may not be in place. Therefore, a constant vigil must take place to survey for SHB migration into a new apiary, especially in the spring and early summer.

Due to the tendency of adult SHB to spread between hives and apiaries, the spread of brood diseases, such as American foulbrood and European foulbrood, is of concern. Scientists have confirmed that hive beetle adults and larvae can acquire spores of the American foulbrood pathogen (*Paenibacillus larvae*) from an infected hive and transmit them to a non-infected hive. The spores are retained in larval SHB through pupation and into adulthood, which means that emerging adults have to potential to spread AFB both between and among apiaries.

Cleaning Up Damaged Combs

As previously mentioned, the bees leave the slimeout to the beekeeper for cleaning. Fortunately, damaged combs can usually be reclaimed and reused. To rid the combs of larvae and beetles, submerge frames in a bucket of warm detergent water and agitate them vigorously. Next, take a garden pressure hose and wash them thoroughly, leaving them outside to dry. (NOTE: Direct sun can melt beeswax combs, so play close attention to the temperature and place frames in partial sun if temperatures exceed 85ºF.) Do not place the frames back in hives for at least a few days. All eggs may not have been destroyed in the washing process, and larvae may still emerge.

Once combs are clean and dry, they may be placed in a strong colony for the bees to begin restoring them to usable condition. After bees have cleaned the combs, they can be safely reused for either brood production and honey storage. Please note that washing the combs in the above manner will not get rid of the SHB yeast. However, bee activity will restore healthy microflora to combs, which will keep yeast growth in check. Wax moths will not attack the combs as long as they are exposed to sunshine.

Preventing Small Hive Beetle Damage in the Apiary

Integrated Pest Management (IPM) is a layered system of pest management consisting of monitoring, preventing and controlling pest outbreaks. Chemical insecticide usage is limited, but not prohibited, in IPM practices. A successful IPM program requires intimate knowledge of the pest species and its host, and it must be flexible to account for changes in environmental conditions. Beekeepers and researchers have developed an arsenal of management techniques to help keep hive beetle populations under control in southern states. These practices include maintaining strong and healthy colonies, keeping bees with hygienic behaviors, locating hives in full sunshine, trapping adult beetles, moving hives after larval outbreaks, judicious feeding of protein supplements, and appropriate chemical treatments.

Hive management to ensure a strong and healthy hive is the most important cultural practice. To a beekeeper, a strong colony must contain a young, healthy queen with sufficient workers to cover and protect all combs in the hive, whether they are empty or filled with honey, pollen or brood. A healthy colony has parasites and diseases in check, particularly varroa mites, tracheal mites, American & European foulbrood and nosema. Requeening with superior bee stock can sometimes help reduce problems with viruses and pathogenic micro-organisms, especially if a "hygienic" queen is installed. Colonies should not be under nutritional stress, but have plenty of both pollen and honey. Supplemental feeding may be necessary. Some commercially available food supplements contain essential oils and natural ingredients that are claimed to boost health and vigor. However, protein supplements and pollen patties, if fed improperly or at the wrong time of year, can prove detrimental to a colony with a small hive beetle infestation. Pollen patties are particular magnets for gravid female beetles and larvae.

In Mississippi, pollen patties should only be fed early in the season (February-March), or late in the season when outside temperatures remain below 70ºF. If pollen patties must be fed during warmer months, they should be administered in smaller portions. No more than a ½ lb. patty should be fed at one time to any colony. For every 5 frames of bees, use no more than a ¼ lb. patty. Bees should be able to consume the entire patty in 2 days or less. If beetle larvae are ever observed on a protein patty, it should be removed and disposed of immediately, before the feeding beetles have a chance to mature (Fig. 7). An alternative is to feed a dry powder supplement, either inside the hive or outside in an open tray protected from precipitation.

Fig 7. Hive beetle larvae in a pollen patty. When feeding supplemental protein, give a colony no more than they can consume in two days. If larvae are observed on the patty, immediately dispose of it.

Comb culling and rotation improves the overall health of the colony, which in turn enhances the ability of the colony to better deal with populations on their own. By doing so, infective stages of *Nosema* spp., American foulbrood, European foulbrood and other diseases are reduced in the hive. Also, pesticide residues are eliminated from the hive. Old combs should be culled and replaced with new foundation/combs every 3-5 years, even though combs may remain usable for more than 10 years.

The placement of hives in full sunshine can discourage invasion by host-seeking adult small hive beetles. Most of the serious problems with small hive beetles occur where hives are placed in heavily shaded areas. A full-sun location will help prevent small hive beetle attacks and even reduce effects of varroa mites. Scientists do not have a good explanation for the latter phenomenon, but it is likely to be associated with relative humidity and temperatures within the hive.

Soil type affects the ability of small hive beetles to pupate and overwinter in the ground. Larvae emerging from the hive in the fall will pupate and emerge from the ground the following spring. In apiaries with heavy clay soils, the larvae are unable to burrow deep enough to escape a winter freeze. Soil moisture is also much greater in heavy soils, which tend to collect and hold water. Too much moisture is as detrimental to pupating SHB as too little moisture. Small hive beetle problems are predictably worse in apiaries with more porous soil types.

Trapping adult small hive beetles is an effective means of preventing a buildup of adults within the hive. Numerous types of insecticide-free traps are available for purchase through bee supply catalogs. If the beekeeping budget is tight, homemade versions of many of these traps can be easily constructed using readily-available materials. Traps are either external (affixed to the outside of the hive) or internal (placed within the hive). Multiple types of traps can be used simultaneously for more effective beetle removal. Most of these traps require a food-safe liquid killing agent, such as vegetable oil, which is held in a reservoir. Beetles fall into the reservoir while attempting to find refuge from honey bees, or they are lured in with a food bait such as rotted fruit or apple cider vinegar. Bottom board traps are the most popular external trap styles. They are designed to replace a standard bottom board, and feature a removable tray

Fig 8. Installing a bottom board hive beetle trap. A tray filled with a killing agent (such as oil or a detergent solution) replaces the regular bottom board. Adult small hive beetles, seeking refuge from the bees, fall into the tray and drown. Hives must be kept extremely level for these types of traps to be effective. Bottom traps also help to eliminate varroa mites that may fall from the bees, as with standard screen bottom boards. The collection tray can be temporarily replaced with a sticky board to monitor varroa mite levels.

which is filled with killing agent (Fig. 8). Bee hives must be placed on a level surface when implementing bottom board traps. Internal hive traps fit within, on top of, or between frames. They tend to be less expensive, but have a much smaller capacity for beetles and need to be serviced more frequently.

Biological control of small hive beetles has been investigated, but so far has demonstrated little promise. Two nematodes (*Steinernema* and *Heterorhabditis* spp.) have been found to attack larvae and pupae in the soil. Some strains are commercially available to consumers. There are also some naturally occurring entomopathogenic fungi (*Metarhizum* spp.) which kill the larval stage. The bacterium-derived *B.t.* toxin—widely used on field crop pests and in home gardens—has not proven effective against SHB adults. Fire ants will prey upon wandering larvae that have exited a hive but probably do little to control infestations.

Finally, choosing bees that are bred for low tolerance to pests goes a long way to prevent beetle invasion. While there are no truly SHB-resistant strains of European bees, hygienic bees can reduce SHB pressure indirectly by limiting varroa and tracheal mites in the colony. Some colonies show a greater inclination to imprison beetles than others. Breeders could increase this trait by rearing queens from such colonies.

Managing Established Small Hive Beetle Populations

Once small hive beetles become established in an apiary, there is no single "best" method for managing their population growth. The most important thing is to keep the adult numbers at sufficiently low levels in hives so that the bees are not overwhelmed. There are currently three main control strategies available to beekeepers:

IPM, as described previously, should be implemented in whole, and is the most demanding from a financial and managerial standpoint. However, if followed properly, an IPM program will reduce the use of chemicals in the apiary and within the hives, and result in an overall healthier beekeeping system.

Trapping adult SHB should be an ongoing practice once SHB have been detected in the apiary. Traps should be removed or deactivated in late fall, but must be reinstalled once bees begin foraging in the spring. Trapping is especially effective as a prophylactic beetle management strategy.

Chemical insecticide should be limited as much as is practical in the apiary and hives. Many pesticides have a tendency to bind to beeswax, and are sequestered in the combs, pollen stores and even in honey. Repeated use of pesticides eventually decreases their overall effectiveness by promoting resistance within the pest population.

There are exceptional circumstances in which chemical insecticides may be needed to control SHB. Migratory beekeepers with hundreds to thousands of colonies sometimes depend on chemical control to reduce beetles quickly before their hives are shipped out for pollination. Most small-scale or hobbyist beekeepers can avoid insecticide use altogether. There are a limited number of pesticides registered for use against small hive beetles, so the brand names of such products will be given. Labels for all products must be followed closely. **Never use unapproved chemicals that are not specifically registered for use in bee hives!** Products containing fipronil (roach bait) are highly toxic to bees and are moderately toxic to humans.

For in-hive use, Bayer Checkmite+ Bee Mite Strip® is the only legally registered product for SHB control. It contains the organophosphate insecticide coumaphos, and is to be used in conjunction with some kind of apparatus that prevents bees from directly contacting the product. Most beekeepers construct their own apparatus from a piece of corrugated plastic or cardboard, to which they staple a piece of the coumaphos strip. If the corrugation is only on one side of the material, the coumaphos strip should be attached to that side. The apparatus is placed, insecticide strip down, on the bottom board of the hive. Small hive beetles come in contact with the chemical on the strips when they seek cover under the corrugated material.

Checkmite+ strips were originally registered to control varroa mites when hung between the brood frames during the spring and summer. Now, there are several strains of coumaphos-resistant mites, and this product is used less frequently for varroa control. It must be noted that coumaphos is very persistent in beeswax, and can disrupt egg-production in queens. Its use must be judicious for hive beetle control.

Only one product, Gardstar® 40% EC, is approved to control small hive beetles outside of the hive. This product is a soil drench containing the insecticide permethrin. It is a neurotoxin with activity similar to DDT, and is highly toxic to honey bees. The material is mixed with water as directed and sprinkled directly onto the ground around the hives for a radius of several feet. The product works on larvae migrating out of the hive and into the soil to pupate. One treatment will last several weeks. It is important to know that hive beetles will not start reproducing until late spring and treatments should not occur until the weather is warm enough to allow a reproductive cycle to complete. That may be as late as mid-May in northern Mississippi or early to mid-March in southern Mississippi. However, if hives had extensive beetle infestations in the fall, a soil treatment could be appropriate in the early spring. Soil drenches work best in a small, permanent apiary with stationary hives.

Researchers are continuing to explore other bee-safe chemical treatments that are effective in combating small hive beetles. With only these two products available, and their effectiveness questionable, beekeepers should still rely primarily on IPM and trapping programs.

Protecting Honey Combs and Stored Supers During Processing

Comb protection during honey processing is a matter of egg control. It is very difficult to screen frames for beetle eggs, and even adults may go unnoticed when you are in a hurry to remove honey supers. When supers are first taken off, the majority of adults can be knocked off of individual frames with a sharp rap against the hive body. Be sure to check open honey cells for stragglers. Eggs can be deposited overnight by beetles brought inside with the combs or by beetles attracted from outside. Beetle eggs hidden in honeycombs will hatch rapidly in the warmth of the honey house. Precautions include reducing the relative humidity to 50% or lower in the room where the honey is held for uncapping and extraction. This will cause any existing eggs to desiccate. A safe rule of thumb is to make sure all combs are extracted within 48 hours of being removed from the hive.

Prior to extraction, keep supers under a bright light that penetrates between the combs when supers are stacked crisscrossed. Once they have been extracted, immediately place the frames back on strong hives for cleaning or set them outside in the sun to allow nearby colonies of bees to clean out any remaining honey. If combs are not to be used again that season, they should either be frozen or fumigated with an approved chemical such as aluminium phosphide (Phostoxin®) or para-dichlorobenzene (Para-Moth®), and wrapped in a protective material (trash bags work well if used in several layers). Beekeepers with access to a deep freezer can place the frames back in a honey super, wrap the unit in a trash bag, and freeze for a minimum of 72 hours. This will kill any remaining eggs in the frames and supers. It is advisable to keep the frames wrapped in trash bags after removing them from the freezer to prevent wax moth infestation or hive beetle reinfestation. If storing drawn out frames, keep them as cool and dry as possible to prevent molding. A dehumidifier is a practical investment for the honey house.

Sanitation in the honey house is essential to reducing beetle problems. Beeswax cappings should be rendered immediately or otherwise properly stored to prevent damage from larvae. Old combs needing to be rendered should not be left lying around. The honey house floor should be constructed in such a way as to allow easy cleaning and pressure washing. Even if no larvae are observed during honey extraction, they can suddenly appear within a day or two after the operation. If larvae are observed in the honey house, all is not lost. Wandering larvae are easily managed in an enclosure. They can be trapped, collected and destroyed using a full-spectrum light bulb placed over a pan of soapy water. Provide a ramp or two for the larvae to crawl up, otherwise they will circle the base of the pan.

Queen Rearing Strategies to Reduce Beetle Problems

Queen rearing involves a more advanced form of bee management, and all precautions and preventive management strategies mentioned previously still apply. However, because queen rearing entails the use of poorly-populated mating colonies and requires intense management and feeding of hives, SHB control is more challenging. Most commercial bee breeders, especially in the southern U.S., have discontinued using small mating nucleus colonies because of SHB problems later in the season. However, some report that they can still operate "baby nucs" earlier in the year with fewer SHB problems. Many queen producers are switching to heavier populated standard frame nuc hives for late season matings.

Sugar syrup should be fed sparingly to mating nucs. If inboard feeders are used, they should be filled to only ⅓ or ½ their capacity; this is about as much syrup as the bees will consume in a few days. Overfeeding may result in excess syrup, which can ferment and attract beetles. There are some available products containing essential oils and other ingredients, such as Honey-B-Healthy®, which claim that their use inhibits fermentation of sugar syrup and stimulates bees to consume it more quickly. The use of chemical pest treatments in mating nucs, starters, and cell builders should be avoided at all costs. Some pesticide products have been documented to adversely affect queen fecundity. Others can cause drone sterility. The verdict is still out on several more.

Precautions for Making Late-Season Splits in Beetle-Infested Areas

Making colony splits in Mississippi during June, July and August is risky, so certain precautions should be taken. Splits in the summer months should be made stronger (more bees). Place only enough honey combs in the split that the bees can cover and protect. The basic formula for a split colony is: 2 honey frames + 2-3 brood frames + 2-5 empty drawn foundation (depending on whether you are making an 8 or 10 frame colony). Empty drawn combs are needed in the center so the bees can expand the brood nest quickly. Undrawn foundation should only be used if a nectar flow is heavy or if feeding sugar syrup is ongoing.

A honey-bound split is not a very good one, and beetles can quickly overcome the bees, especially if the workers do not accept a queen or a queen cell fails. When a hive has become queen-less, the nest bees become less meticulous about their housekeeping and beetle eggs have a much greater chance of survival.

An Anecdote: Too many combs of brood, pollen and honey can present a problem when making splits. In one case, observed by one of the authors, a split was inspected on a Saturday to see if the queen cell had hatched properly. At that time, the colony had no signs of SHB larvae, and only a few adult beetles were present. The colony contained 5 frames of honey and 3 frames of brood. The following Monday, the split was slimed out. Resident bees (2-3 lbs.) had swarmed to a nearby bush and hundreds of SHB larvae were crawling about the hive. The swarm, which contained a virgin queen, was collected, moved to another location and given new combs with less honey to protect. Fortunately, due to the beekeeper's immediate action, the colony recovered. The split had been made around July 1st and was from one of about 30 that were slimed out. This anecdote illustrates the challenge of making splits late in the season, but they can be made successfully, using plenty of bees and a minimum brood and honeycombs.

Fig. 9. Making splits. Dividing existing colonies can be an effective way to increase bee stocks, but the beekeeper risks creating colonies that are potentially too weak to withstand heavy SHB infestations.

Do Not's in SHB Management

Do not feed protein substitute or pollen patties except in small portions, and only during the early spring. They are magnets for gravid beetles to start laying eggs.

Do not leave combs of honey and pollen lying unprotected, in or out of the bee yard, nor in the honey house.

Do not allow colonies to remain queenless any longer than is absolutely necessary.

Do not leave hives open any longer than necessary during inspection or manipulation.

Do not place hives in intense shade. Full sunshine is ideal.

Do not leave dead outs in the bee yard. Hives with declining bee populations should be dealt with before they die. Combining them with other hives, requeen, or use other means to nurse them back to a strong population.

Do not remove more honey from hives than can be extracted within 48 hours.

Do not add drawn combs to hives until they have enough bees to cover them and keep SHB from escaping to them.

Do not feed excessive amounts of sugar syrup in feeders where SHB can have access to it; only small portions that the bees can consume in a few days. Remove fermented syrup—it is attractive to adult SHB.

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