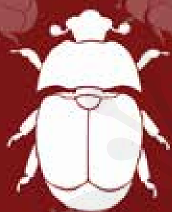


The Small Hive Beetle

The small hive beetle (SHB), *Aethina tumida*, belongs to the order Coleoptera and the Family Nitidulidae. The insects in this family are sometimes called “picnic beetles” or “sap beetles” and are often oval in shape and their antennae have enlarged tips. There many different kinds of Nitidulid beetles, some feed on plants, fruits, fungus, flower pollen, and a few species feed on insects. *Aethina tumida* is native to South Africa where it is known to attack hives of Apis mellifera scutellata. The beetle utilizes the hive products (pollen, honey, bee larvae, pupae, and adults) to complete its reproductive cycle, however, it’s considered only a minor pest because it targets weaker colonies. Consequently, in South Africa, the small hive beetle is no more threatening than wax moths are to Hawaii’s bee colonies.

The arrival of the beetle to North America in 1996, where it attacks the European Honeybee *Apis mellifera*, has had a much larger impact, especially in subtropical areas such as Florida and Louisiana, and more recently in Hawaii. In this chapter we discuss the life cycle of the beetle, notes on identification, management and control suggestions, all based on observations conducted in Hawaii, and suited to application in tropical countries.

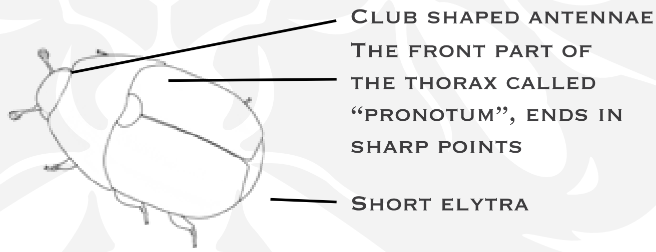
Life Cycle

Life Cycle in Detail

1 - The invasion of the colony by adult beetles

Insects, and beetles in particular, are known to use chemicals as a form of communication. These chemicals include pheromones, which may signal the presence of the opposite sex or may recruit individuals to a particular site where food is available, the so called “aggregation pheromones.” Many Nitidulid beetles are known for their ability to detect the scent of their food resources, including plants, fruits, and carrion, and in many cases they are strongly attracted to the scent of decomposing and fermenting substrates (Hood, 2011). In the case of A. tumida, the adults are known to able to orient themselves and fly towards feral hives, apiaries, and locations where raw honey is being processed. The beetles probably follow chemical trails that are produced by the bees themselves; their products (wax, pollen, and honey) and possibly they also follow pheromones produced by adult beetles (Suazo et at, 2003; Hood, 2011).

The adults measure approximately 5mm long and 3 mm wide (Hood, 2011) and can be reddish in coloration when young but soon turn dark brown to black. There a number of physical traits that can be used to identify these beetles, some of which are observable with the naked eye. The antennae of the small hive beetle are broader at the tip than the base, in what is often described as “club shaped antennae”. Although some other beetle species in this family have similar antennae shape, it is important to consider that in the SHB the relative length of the thin part of the antenna is about the same length as the broad flat part. In addition, the SHB thorax (the segment behind the head of the animal) ends in lateral sharp little points. Finally, the wing coverings typical of other beetles, called “elytra,” are somewhat shorter in length in SHB, leaving exposed the segments of the abdomen when the insect is viewed from above.



The invasion of honeybee colonies by SHB tends to occur at dusk, and possibly continues throughout the night. Invading beetles often contact worker bees as they enter the colony; based on our observations here on Hawaii, bees guarding the entrance exhibit variable degrees of aggression towards the intruding beetles, including brief chases and lunging movements towards the SHB. The beetles in response may simply stop and/or may exhibit a “turtling” behavior where they hide their legs and antennae under their bodies and lie close to the substrate, as a turtle would do when disturbed. This posture is an effective adaptive defense against adult bees because it makes stinging attacks or physical removal very difficult for the bees. Our observations suggest that although bees at the entrance of the hive may respond aggressively towards the intruding SHB, the majority of beetles successfully entered the hive within seconds of their arrival (Villalobos et al, in preparation).

It is important to keep in mind that Hawaii’s bees at the time of this publication were all 100% pure European stock, and no evidence of Africanized bees had been recorded. As the SHB expands its range south of the continental US, it will encounter bees of mixed origins with varying degrees of Africanization. Whether the more aggressive Africanized bees of Latin America may be able to better defend their colonies from attack remains undetermined, but prudently, the beekeepers in those areas are eagerly learning about this new apicultural pest.

2 – Mating and egg-laying in the hive

The hive is rich in food resources for the SHB, including honey, pollen, bee larvae, pupae, and dead bees. The adult beetles mate inside the honeybee colony and when the conditions are suitable, the female beetle lays her eggs in the colony. It has been estimated that a single female beetle can lay 1000 to 2000 eggs throughout her lifetime (Cuthbertson et al. 2013, Schmolke 1974, Somerville, 2003). SHB eggs are slightly smaller in size than honeybee eggs, approximately 1.4 mm long (Hood 2011), but beekeepers can easily distinguish them due to the tendency of SHB females to lay eggs in clumps, often inside cracks of the frames or the body of the hive, or even in the honeycomb itself. By laying eggs in cracks or tight spaces the SHB interferes with the detection and removal or consumption of the eggs by the patrolling worker bees. Female SHB can also use their ovipositor to perforate the wall of a capped cell and lay eggs directly into the cell (Cuthbertson et al. 2013, Ellis 2004, Hood 2011), this behavior is another way that beetles reduce detection and mortality to their brood. Small hive beetle reproduction inside the hive often begins as a subtle attack, with discreet attempts at egg-laying by the females. If the colony is very small or weak, the bee population will not be able to control these attacks and an explosive reproductive pattern is then obvious. During the final stages of collapse, SHB eggs can be seen all over the comb, openly exposed on the brood frames.

Africanized bees have strong hygienic behavior tendencies; this includes a prompt removal, usually by consumption, of the SHB eggs from the hive. The European honeybee also exhibits this tendency but it seems they are comparatively less effective in the removal of the eggs. The patrolling, detection and removal of the SHB eggs is related to bee numbers, and certain areas of the hives, such as the brood frames, have a higher concentration of nurse bees. Consequently, although the best resources for the beetle would be the brood area, the first signs of egg-laying by female SHB are found in less actively patrolled frames, for example the end frames in the brood box, o the honey supers and inner cover.

The eggs of the SHB, much like those of the honeybee, are sensitive to desiccation, and if the relative humidity drops below 50%, there is a notable increase in mortality in the eggs of this insect (Cuthbertson et al. 2013, Somerville 2003, Stedman 2006). Honeybees are very efficient in their control of the hive's temperature and humidity, and the SHB use this ability to regulate the microenvironment for their own benefit and reproduction. Aspects relating to the importance of low humidity in the control of this insect will be addressed in more detail in the section of Management and Control.

The dynamic relationship between SHB and adult bee density can be hard to monitor and can change suddenly. A strong, densely populated colony may appear healthy in spite of large numbers of SHB adults. There may not be any sign of SHB eggs or larvae on the frames and the colony appears to be successfully containing the invasion. This type of situation is not uncommon but the apparent balance is temporary. A colony with a large unmanaged beetle population is under constant pressure to chase, deter, and remove any egg or larvae from the intruding beetles. The hives may also devote workers to building temporary prisons made out of wax and propolis to entrap the beetles. Even under the best of conditions the beetles may succeed at producing a few young here and there, and populations tend to persit, even in apiaries where colony losses due to SHB are kept at a minimum. The control of the SHB that is exerted by the bees can easily be altered by a decrease in bee population and/or by changes in hive structure (in particular adding boxes to the hive). Swarming events, high varroa mite loads, sudden changes in local weather (droughts, rainy periods) can alter the bee population rapidly and the SHB responds promptly to those changes. The result is that SHB can take control of a colony in a few weeks, sometimes a few days. Consequently, it is important to keep the beetle numbers as low as possible so that changes in bee population or hive management procedures do not trigger an explosive take over of the hive by the small hive beetle.

3 & 4 - Larval development inside the hive

The beetle larvae emerge from their eggs in about 2 to 3 days depending on the temperature (Hood, 2011, OIE). Larvae are cream colored and have distinctive paired rows of spines running the length of their backs. The larvae have 3 pairs of relatively long legs on the front of the body and a series of smaller knobby appendages on the medium and back of their body, which helps them move quickly over the honeycomb. The SHB larvae superficially resemble the wax moth larvae, but the wax moth larvae are softer bodied, do not have the rows of spines, and tend to leave a thread of silk as they move across the frames. In comparison, the SHB larvae leave behind a slimy-wet trail.

The diet of the SHB is similar to that of the adult beetles, although protein is a much-needed resource for development. SHB larvae are voracious eaters and they possess a type of yeast that ferments honey. This yeast, called Kodamea ohmeri, lives inside the digestive tract of the insect, and is excreted with the feces. As the yeast ferments and liquefies the honey, the area where the larvae and adults are feeding becomes noticeably "wet" in appearance. It is still unclear whether the fermentation that takes place may actually produce odor clues that contribute to the attraction of more SHB to the affected colony. The effect of the yeast is commonly called a "Slime Out" by beekeepers, and it is shorthand to describe the complete loss of a colony due to an explosive attack by SHB. A collapse colony will exhibit obvious signs including: a) the frames will be wet and shinny in appearance, b) the fermenting honey will liquefy and fall down the frame towards the bottom board of the hive, c) the hive will take on a characteristic rotten orange smell, d) the honeycomb structure will be destroyed as the SHB tunnel through the comb eating larvae, pupae and pollen.

The SHB's yeast can also impact recently extracted honey if there are eggs or larvae on the frames. When SHB is present, we recommend that honey is extracted the same day or within 24 hourrs of removal from the hive to prevent the development of SHB larvae and the deposition of yeast on the frames. Once honey begins to ferment, it can't be sold or consumed, and adult bees will not clean the "slimed" frames if they are returned to the colony. If a honey harvest is lost due to SHB feeding, the wax foundation should be removed and the wooden or plastic frames need to de thoroughly washed using soapy water and a diluted solution of bleach (5 to 10%). Frames will need to be rinsed properly, and dried before returning the hive.

The destructive power of the SHB larvae is great, and they represent a much larger threat than the adult beetles, and to avoid having a large number of larvae, the control efforts should focus on the adult bees and interrupting their reproductive attempts in the hive. SHB larvae develop quickly (12-13 days) depending on access to food. At the end of the larval stage, they enter an "ambulatory" phase where they seek to crawl out of the hive to pupate in the soil.

5 – Pupation in the soil

Small hive beetle larvae exit the hive and migrate downwards towards the soil during the late afternoon (Stedman, 2006). The larvae can push themselves into the soil quickly (< I min), especially is the soil is soft and humid. If the soil conditions around the hive are inhospitable the larvae can traverse relatively great distances in their search for an adequate site for pupation. The larvae are quite resistant and can survive a number of days while they continue to search for a pupation site (Cuthbertson et al., 2010). Depending on the type of soil the larvae can dig downward to a depth of 10 to 20 cm deep (Cuthbertson et al., 2013; Pettis & Shimanuki, 2000). Multiple studies reveal that soil type plays only a small role on the pupation success of the SHB (Cuthbertson et al., 2013). In contrast, soil humidity seems to be a more important factor in determining pupation success, as very dry soils seem to limit the increase in SHB populations. Duration of the pupal stage is variable, reports range from 2 to 12 weeks depending on ambient temperatures and time of the year, but in warm tropical climates, such as in Hawaii, the pupal stage can be completed in 12 to 15 days (Wong & Villalobos, pers. obs).

The visual impact of a collapsing colony with thousands of SHB larvae feeding on the comb and subsequently dropping to the ground to pupate generates an understandable interest on control methods that can be applied directly to the soil and kill the larvae or the pupae. However, the ability of the larvae to migrate away from their original colony and the depth to which they can burrow makes application of pesticide solutions that drench the soil impractical and expensive. There is also interest in applying abrasive materials to the soil, for example diatomaceous earth, that can potentially damage the exoskeleton of insects and promote desiccation and death, but there are no data to support these treatments are effective. Before embarking on examining methods to reduce pupation success, it is perhaps more important to realize the best way to deal with the SHB is to concentrate on interfering with the reproductive cycle inside the colony. Preventing colony slime outs and eliminating the large number of larvae that will develop from each of those colonies, its more effective than attempting to kill them once the hive has collapsed.

6 - Adult phase

Recently emerged SHB are reddish in coloration and eventually change to their dark brown/almost black color. Sexual maturation occurs about a week after emergence (Ellis 2004), and the adults live approximately 4 to 6 months in the field. In 2012, deGuzman et al. showed that adult beetles were capable to survive up to a year if they were supplied protein in their diets. However, SHB can survive up to 176 solely on a diet honey, this is an important adaptation to survive inside a colony during periods of adverse climate (winter, excessive rain or drought) in which the colony has less protein (pollen, eggs, bee larvae) available for the beetles to consume.

SHB are known to drift between colonies, but there is very little information on why they beetles may switch from one colony to another.

Visual assessment of small hive beetle levels

Monitoring population levels of the SHB is very important as it helps the beekeeper determine the potential seasonality of their numbers, and helps understand increases of beetle numbers with respect to colony dynamics that increase the risk of take over and collapse due to SHB attack.

Colony inspections must be conducted in a systematic way to facilitate comparison across colonies in the same apiary, helping identify those colonies that seem more at risk at a particular site, but also systematic comparisons will help understand site differences that may be influence apiaries at ach location, for example windward versus leeward apiaries may experience very different rainfall patterns that can affect beetle numbers.

The most effective way to sample for beetles, even if you have a trap or poison bait for control, is to know where to look for live beetles, and to do this consistently. In strong colonies SHB tend to stay out of the way of the worker bees, and for that reason they avoid high bee traffic areas. Consequently, beetles can more frequently found on the underside of lid of the hive, on the honey boxes, or on the most external frames of the brood box. Most often the end frames of the brood box will contain honey and bits of pollen, and sampling the end frames at each end is a good way to assess what beetle densities. To obtain a more accurate count of the beetles, it is sometimes recommended that the inspector or beekeeper use an "aspirator" (manual or battery powered) to avoid recounting the beetles that are scurrying around the frame.

The following is the recommended sequence for visual assessment of beetle levels. This procedure is easiest with two people, but one person alone can certainly achieve it.

a) Take off the lid of the colony and quickly examine the underside, count beetles. If you use an inner cover, do the same for the inner cover, and put aside.

b) Remove the honey box and put it over the lid of the colony on the ground. The honeybox will be checked later, just before you are about to close the colony after inspection. The beetles that may be in the honeybox will avoid the light and congregate at the bottom of the honeybox or on the lid, and they can be recorded at the end.

c) Examine the brood box starting by the end frames (the most external right and left frames of the brood box). Each frame should be lifted out of the box and examined quickly on both sides. When plastic frames are employed, check the small holes on the edge of the frame, as the beetles tend to use these as hiding areas. Count or estimate the beetles and return the frame to to hive. Repeat with the frame on the other end of the brood box.

d) If the population of SHB seems high in the brood box, if there is evidence of beetle eggs or young larvae, or if the frames that contain honey in the brood box seem wet and shiny, continue the evaluation to determine if the colony is collapsing. Take out a brood frame or a pollen frame and inspect them carefully for SHB eggs or larvae. Pay special attention to those frames that appear wet and slippery. If there are concerns about the stability of the colony, consider reducing the space by removing boxes or even end frames, this manipulation concentrates the bees into a denser cluster, which provides more coverage of the frames, and helps protect the colony as a whole.

e) If the examination of the brood box did not reveal any problems, then the honey super that had been removed is then lifted off the ground. If there were beetles in the honey super they most likely moved away from the light and may be found walking on the lid where the box was resting. These beetles can be collected using the aspirator. Once the lid is clean, bang the honey super on the lid once more, to dislodge any other beetles. Quickly lift the super and place on top of the brood box. Examine the lid for any SHB that fell off the super.

Examining colonies is not detrimental to the bee's health and it does not result in higher number of SHB attacking the colony. Frequent assessments allow the beekeeper an opportunity to react to bee and/or beetle population changes. The best strategy against SHB is strong colonies where the bees densely cover the frames. By examining the colony a beekeeper can manipulate hive space, provide extra brood, replace a queen, clean or add more SHB traps, all of which contribute to a more effective control of the SHB.

Monitoring with Traps

There are a great variety of traps out there for the SHB. However, in this section, we'll talk about traps as a way to not only control their numbers but as a way to monitor the population of this important bee pest.

Traps that are used to control SHB can also be used to estimate beetle density. Certain types of traps use poison to kill the beetle, much in the same way traps used to control ant and roach population do. However, these traps do not provide an exact count of how many beetles visited the trap as the insects may eat the poison and die elsewhere.

There are a great number of trap that don't use poison as a killing agent, but rather, rely on mineral oil (cooking oil) to trap and drown the insect. These traps allow the accumulation of beetles inside the trap and allow you to gather more information regarding the beetle number present in your colonies. However, it is estimated that these traps capture about 1/3 of the beetles present in the entire colony.

The recent arrival of SHB to Oahu has allowed us to use oil traps to monitor the invasion in our research apiary. During this study period, oil traps were placed in every colony and adult beetle numbers were recorded. The results indicate that beetle density was low during the first few months (3-5% of the colonies were infested in the first three months and the rate of capture did not go above 3 beetles per week per hive). The second trimester, however, the frequency of captured beetles went up and as of 2014, three years after establishment on the island, the capture rate is 10-15 beetles per hive per week. There are peaks in these numbers during rainy seasons where the numbers can be as high as 100 beetles per hive per week.

The observation obtained in Hawaii suggest that the SHB can be detected early in an apiary using traps. Nevertheless, the SHB density and their reproduction rates can be influenced by weather conditions. For example, the introduction of the SHB to Oahu and their invasion of the research apiary happened during a summer season, which is a dry and productive time of the year. Data collected on Oahu since 2013 to 2016 suggest that as adult bee populations in the hive increase during the summer months, the SHB may have more difficulty succeeding at reproducing in the colony (J. Wong in preparation). Additionally, the drier weather may reduce the suitability of the soil for pupation. The winter period in Hawaii is usually the rainy period and a slight ambient temperature drop. This season is associated with an increase in beetle populations in Hawaii. Therefore, the increase in beetle capture during the second trimester in 2011 could have been influenced by the season. In conclusion, the traps for SHB can be used to help detect the presence of beetles and their population density within a hive. However, it is necessary to pay attention to the weather and honey bee colony conditions that favor the increase of their numbers. It is possible to obtain this information without introducing toxins to the hives.

Management and Control of the Small Hive Beetle

This section will provide recommendations for the management and control of the SHB, with emphasis on methods to control their numbers without insecticides. These strategies are based on the observations and practices used by the University of Hawaii Honeybee Project. Any references to commercial products, such as SHB traps, methods to control Varroa mite, or chemical insecticides, does not indicate a preference or lobbying for those specific products, but rather a shorthand for describing our procedure. Similarly, any fail to mention a trademark brand or productive does not indicate discrimination. In summary, the products mentioned in this section by name are presented as examples, not product endorsements.

The defensive role of worker bees

Probably the most difficult aspect to accept is that the best defense against the small hive beetle is simply having a strong and healthy hive. While this beetle did not evolve with Apis mellifera, the European honey bee, the natural behavior of surveillance, defense, and cleaning the workers in the hive exhibit helps control this intruder.

The small hive beetle locates and invades hives in the evening and night. Although occasionally the SHB is intercepted by the guard bees in the entrance, the opposition from bees is not sufficient to prevent the entry of adult beetles (Nikaido & Villalobos, pers com). The SHB exoskeleton is too hard for the bee to sting, but the vigilant and defensive behavior of bees, which includes short chases and sometimes even the creation of propolis "jails" in the corners of the boxes, helps prevent beetles from multiplying. The dynamics of the interaction between the SHB and bees will be discussed at the end of this document, after covering the different styles of traps available. However, it is worth noting that traps only work with the help of bees, and no trap provides complete protection in weak hives. The bees's defensive behavior is the engine that drives the capture of beetles in traps.

Traps for Controlling Small Hive Beetle within a Hive

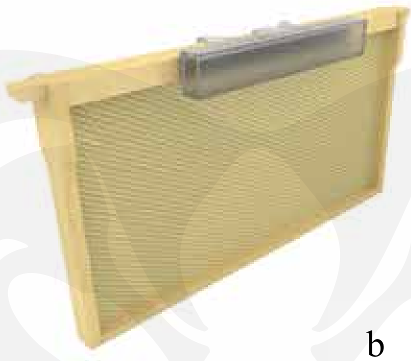
Traps used for controlling SHB numbers can be divided into two groups which depend of where they are placed:
1 - Traps that are placed inside the hive, also known as in-hive traps. These traps are placed within the brood chamber or honey supers.

2 - Traps that are placed directly on the floor of the hive or under the hive using a screened bottom board with metal mesh.

Most of the traps that are placed inside the hive have a "container" cavity filled with oil in order to drown the beetles. These traps work due to the behavior of the workers which intercept and chase the beetles. The behavioral interference of the bees forces the SHB to look for hiding places. The traps have narrow openings, allowing only the beetle to enter, and protecting the bees from also falling into the oil. In the absence of traps the bee behavior results in the beetles accumulating on the edge of the outer frames and top areas of the colony. The traps in conjucntion with the bee vigilance provide an alternative and deadly refuge for beetles.

Examples of oil traps inside the hive "Cutt's Beetle Blasters", "AJ's Beetle Eater", "BeetleJail", and the "Hood" trap. The first three traps are placed hanging between two frames. These traps have a row of holes or small slits where the beetle can enter. The Hood trap is placed at the base of a wooden frame without honeycomb, and like the other two can be filled with cooking oil. Traps hanging from the frames are, in our opinion, easier to remove when it is time to clean or replace them. Hood trap, in comparison, requires the remove the whole frame, additionally, this trap leaves a large opening in the frame, which can promote the breeding of drones. Drones, if not collected and exterminated before emerging, can cause an increase in the population of the Varroa.

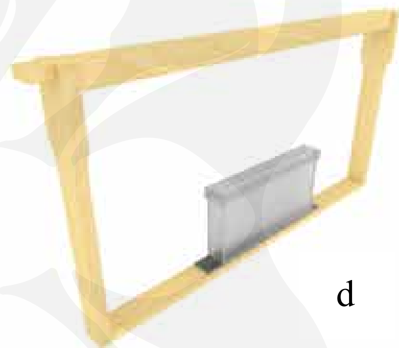

a


b


c

The traps known as Beetle Blaster (a) and AJ Beetle Eater (c) rest on two frames, while the one known as the Beetle Jail (b) hangs only one.

The Hood trap (d) is screwed in at the base of frame.


d

There are two types of traps that are placed on the floor of the hive. Some consist of small plastic boxes (approximately 10 by 10 cm) with openings of an adequate size for the beetle, but not for bees. Within these boxes is a poison, with or without food, for the beetles (e) Beekeepers also improvise and use other flat boxes, including cd cases to create "home made" posion traps. Another type of traps that are commonly placed "under" the hive incorporate the use of a screened botttom board and a large plastic tin, or metal tub filled with oil under the hive (f).


e


f

Detailed Trap Use for the Small Hive Beetle

This section will explain in detail the installation of traps within the hive and will highlight the pros and cons of each type.

1 - Oil Traps within the Hive

These traps should be placed in areas where the bees tend to corral the beeltes. In an strong colony these are areas which are far from the colony's brood, usually the side frames and the top of the hive. Consequently, traps should not be placed on the center of the brood area but rather in the periphery of the brood, on the outermost frames of the honey super of the brood box itself (Fig. 1 and Fig. 2). If possible, there should be two traps per colony, since sometimes the catch count is higher on one side of the box than the other.

The deadly agent for the SHB in these traps is not poison, but oil; fallen beetles will simply drown in it. The oil used is just cooking oil. It is important to note that the compartment traps must not be filled more than one third of the way (Fig 3). If the traps that are too full of oil it can prove to be difficult to remove due to the danger of tilting the traps and spilling oil on the bees and the colony. These oil spills suffocate the bees and damage the honeycomb. A low oil amount helps prevent spills and facilitates inspection and removal of traps.

fig. 1

fig. 2

fig. 3

A practical suggestion which can help prevent spills is to slightly lift the frame edge of one of the frames that the trap is resting on (Fig. 4). This way, you can grab the trap with both hands and lift upward without tilting. Holding a trap by only one end may result in spilling the oil. Also, trying to pry the trap out with your hive tool may cause the plastic to break (Fig 5). Some bees tend to use propolis or wax to seal the holes on the oil traps. Obviously, when this happens beetles cannot enter the trap. It is easy to remove these blockages using a thin twig to push them open again. This is additional evidence that hives require attention and it should not be assumed that all is well in unsupervised boxes. It should also be noted that if the beetle population is very high, the drowned bodies of the beetles will accumulate. If the trap is not checked, the large number of dead beetles may rise higher than the oil level. When this happens, the new beetles that fall in will not drown because of the lack of contact with the oil. This situation does not occur very often, but it is important to understand what can happen if the traps are not checked frequently. In the apiary at the University of Hawaii colonies are checked once a week; this is because data is collected on a schedule. This monitoring frequency is ideal but it might not be realistic for a beekeper with many hives. However, we strongly recommend that beekeepers check on their colonies every two weeks, especially during periods of high beetle populations or colony instability, for example a new queen, or swarming season. This does not mean thata beekeeper should be replace traps on a bi-weekly schedule, it simply means that beekeepers should monitor if the holes are still open, there is enough oil, that the traps are not full of beetles, and especially that the colony is healthy and has not lost its queen.

fig. 4

Oil traps are plastic and some are designed to be disposable and others to be more durable. It is possible however, to extend the use of “disposable” traps if washed and refilled. Many beekeepers in Hawaii remove their traps, empty out oil and dead beetles, give them a mild washing with liquid soap, and then wash them in clean water to avoid damage to the hive. This method greatly reduces the costs of beetle management. The only problem with this technique is that the plastic is delicate and attention must payed that the trap has no cracks and is leaking oil within beehive. To test the trap’s integrity simply pour some water and hold briefly over a sink or tub. Damaged traps should be discarded.

There are many advantages of using in-hive oil traps including altenrative placement within the hive (on the honey supers or the brood box), they can be easily examined, and easily replaced. The Hood trap is a little more problematic because once it is mounted on a deep frame, it cannot go up in a honey super due to the frame size difference.

fig. 5

2 - Bottom Board Oil Traps

Bottom board oil traps are placed under the hive (Fig. F). To use them, a screened bottom board is required. The principle is the same as the in-hive oil traps. The mesh is large enough to allow the passage of the beetles, but not the bees. Beetles fall into trap and drown. The trap known as West Beetle trap is an example of this type of trap.

In Hawaii, in areas where the population of SHB is very high, beekeepers use this type of commercial trap or have created homemade ones, sometimes in combination with in-hive traps. One drawback of using this type of trap is that if the need to modify the or replace the floor of the hive and that means an extra expense. Another problem is that the hive has to be on a flat area so that a beekeeper can remove the trap as if it were a drawer in a desk. If the hive is on uneven ground, the trap does not slide easily, and it is possible that abrupt movements during the removal of the trap can lead to splashed oil whithin the hive which can damage the bees and brood. The advantages of this trap however, is its volume; they can be left for a long time without replacing the oil. Some beekeepers use water with a few drops of liquid soap, but the water usually evaporates very quickly compared to oil.

3 - Poison Traps

These traps are usually plastic cases that are loaded with beetle poison and are placed on the floor of the hive. There are commercial traps known as “Beetle Barn” that can be purchased online. These traps have narrow entrances and are small and tough; the beetles will use them for hiding and come into contact with poison (Fig. e). Some beekeepers in the US have also developed traps modifying plastic CD cases.

Regardless of which type of kit is used, beekeepers should consult with the government about which pesticides are approved for use within the hive. One of the biggest problems would be the contamination of the hive if the chemical spread out of the trap. This has been reported when the ambient temperature is very high and/or traps are filled with by rain water. Consequently you should not take lightly the introduction of pesticides, especially if the producer produces organic honey. Some beekeepers have developed boric acid mixtures (see the manual published in Mexico SAGARPA) instead of using synthetic insecticides as coumaphos, but even materials as boric acid must be introduced carefully.

Summary

Regardless if the traps use poison or oil, traps should still be checked frequently as the entrances can be sealed by bees and dead insects can accumulate inside the trap. The traps should also be refilled with new pesticide if it has been consumed. Poison traps do not provide data density as oil traps, that is, the beekeeper cannot have an idea if SHB density is falling or rising, since the beetles may die out of the trap and sometimes are removed by the bees. However, these traps are easy to use and do not require modifications of the hive. Traps with poison, or oil, constitue a tool to SHB management but are not a magic bullet. The beetle is unlikely to enter the traps if there is no pressure from the bees. In Hawaii, we have had the opportunity to observe colonies with 2 or 3 traps on the floor of the hive but nevertheless the colony was consumed by larvae of the SHB. It is crucial to keep the colonies strong and do frequent inspections to detect problems in the hive and make modifications to the hive space (number of boxes) to reflect the bee numbers, especially if the bee population has declined.

Management of the Apiary

Apiary Cleanliness

Apiary cleanliness includes reducing the availability of food for the SHB. Waste created by honey harvesting should be removed immediately because the beetle is opportunistic and will use materials left behind for feeding and breeding.

If it gets to the point that a hive is about to collapse because of the SHB, it is important to get rid of the combs to prevent the larvae from reaching the ground and pupating in the area of the apiary. One of the simplest ways without chemical contaminants to kill the larvae is dipping frames and honeycombs inside a container with soap and water. Once the larvae and adults have died, wash and dry the frames and pick up any organic waste, including comb with pollen and dead larvae to prevent adult beetles from feeding in the apiary.

In Hawaii, some beekeepers attempted, unsuccessfully, to use black plastic bags to hold the contaminated combs and left them in the sun in order to kill the larvae. This practice was not effective because adults and larvae are very tough. Furthermore, SHB can break the bags with their mandibles and reach the soil, so we recommended to either freeze or drown the contaminated comb. Beekeepers and famers with animals such as chickens, may be tempted to offer honeycombs with larvae to the birds, but SHB larvae penetrates the soil very quickly, so while the chickens successfully eat some of the larvae, most manages to escape and pupate in the soil. If you would like to “recycle” the bee larvae and bee pupae as food for chickens, freeze the combs first and then thaw it and offer it to the animals.

Honey Harvesting

Honey harvesting is complicated by the presence of the small hive beetle. Honey supers that are to be harvested should be taken directly to the area where the honeycomb is to be removed. It is recommended to extract that same day to prevent beetles from laying eggs on the comb, or to prevent eggs that are already on the comb from hatching into newly emerged larvae that would invade the frames. SHB eggs are very small and are usually hidden in crevices, so it is not feasible to make a visual inspection of the increases.

If honey comb is left alone for more than one day, it is very likely that SHB larvae will begin to feed there. Larvae deposit a yeast species (whose scientific name is Kodamea ohmeri) that causes the fermentation of honey. This yeast is the one that produces the impression of moisture on a frame when a hive is being taken over by the SHB. Fermentation ruins honey harvest and can be avoided if honeycomb is extracted the same day of harvest.

During honey extraction, organic waste is generated for the SHB. Waste includes materials such as wax cappings and pieces of pollen comb. It is recommended to melt the wax, and store waste in a plastic jar with a secure lid. In Hawaii, there were many problems in the “extraction houses” due to the accumulation of adults and larvae of the SHB. These problems can be completely avoided if you plan well and use good harvest cans with lids that prevent infestation by the SHB. Beekeepers in Hawaii, after a learning period, have learned the urgency of harvesting and extracting honey in one day or freezing frames that can’t be extracted inmediately.

Colony Reduction

The interaction of bees versus beetles that occurs within the hive is probably the best defense out there against SHB. Strong hives where bees completely cover the frames tend to have fewer problems with beetles. In comparison, small colonies are at major risk of SHB attacks especially if the beekeeper places them in boxes too large for the number of bees present. In these cases, some frames are not being used immediately by the bees or are not being watched by many workers, creating the ideal conditions for SHB breeding to occur.

To avoid this problem you can reduce the colony space. New colonies or new nukes can be put in brood boxes of normal size, but instead of filling the box with frames that bees cannot cover, only fill the box with enough frames that the bees can cover. The frames are placed in the center of the box, leaving the sides empty where more frames would go (Fig. 6). The colony will be visited next week to assess its condition and if you notice that the bees are building comb on the underside of the hive lid, then add a frame where the building is happening (comb that was built under the cover is removed). This process of gradually adding frames works well because it works with the bees to fill up the new hive. During this process, if the nuke produce a queen by itself, you should pay close attention that the new queen is successful. This can be confirmed by reviewing the hive to see if the workers are developing cells for breeding queens, and then by verifying that the queen emerged from her cell. If the process fails, it is likely that the beetles will take advantage of the situation. At the University of Hawaii apiaries, we noticed an increase in SHB in hives that are having problems with their queens (Wong, Nikaido, & Villalobos, article in preparation), which is why it is recommended that a new hive is checked for a laying queen. If the workers fail to breed a new queen, then it is suggested that a frame containing eggs is given to the workers to give them another chance. Preferably, however, introducing a new queen altogether works best as it shortens the time period that it takes to raise a new queen.

Hive reduction periods and swarms period in certain areas coincide with periods of flowering and rain. Wet weather in turn, appears to be related to an increase in beetle density. This situation is inevitable in certain geographical regions; monitoring by the beekeeper and the strategic management of nukes and new hives can reduce problems in apiaries, even in humid areas.

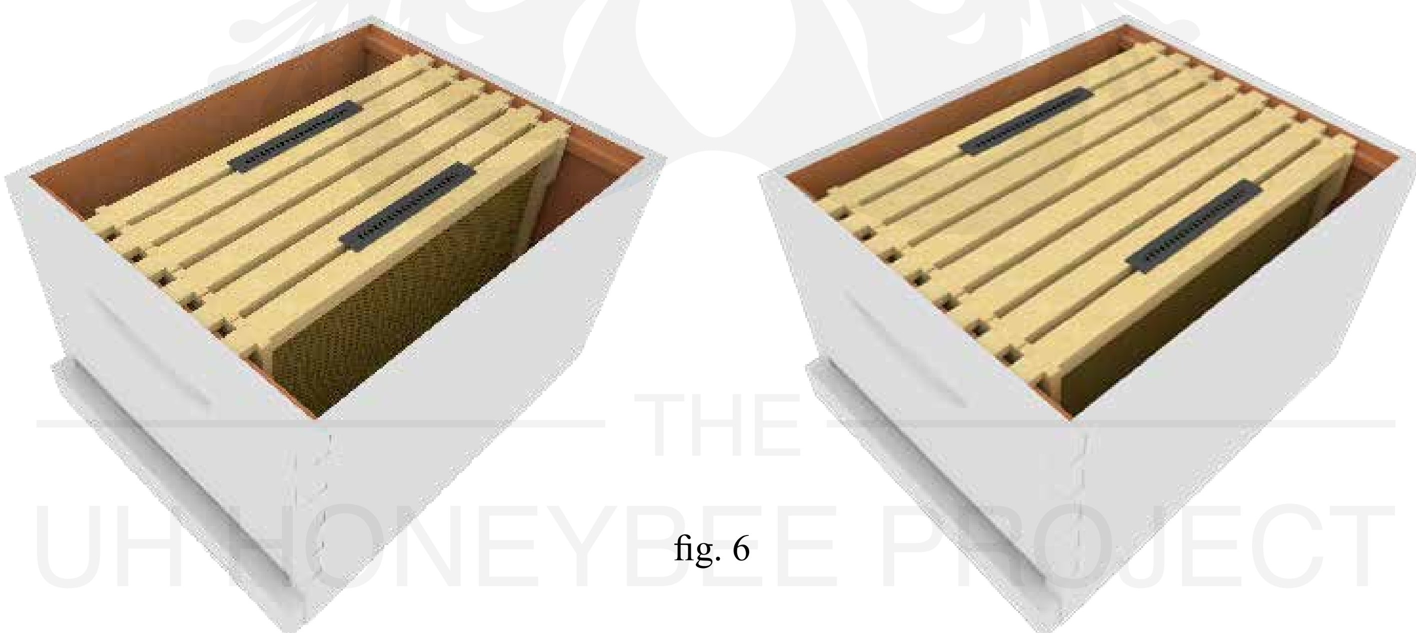


fig. 6

THE

UH HONEYBEE PROJECT