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Study on prevalence of small hive beetles on honey bee colony in Bako and Hollata apiaries

Rahel Abebe, Amsalu Bezabeh and Yacob Hailu Tolossa*
Addis Ababa University, College of Veterinary Medicine and Agriculture
P.O. Box 24, Bishoftu, Ethiopia
***Corresponding author:** *yacob.hailu@aau.edu.et*

Abstract

This study was conducted in Hollata modern bee research center and its branches including those found around Hollata and Bako to determine the prevalence of small hive beetle and to assess the level of infestation and comb damaged. A total of 280 honey bee colonies from Hollata bee research centers were collected and studied. The overall prevalence of small hive beetle in the research center was 58.8%, but there is difference in the prevalence of SHB between the sites from significantly higher overall prevalence ($p<0.05$) observed at Bako apiary (100%) to 45.6% in Hollata station and 0% around Hollata apiaries (Muger, Menagesha, Suba and Gole). This difference was statistically significant ($p<0.05$). Significantly higher prevalence was also observed in medium and weak bee colonies ($P=0.000$) as compared to strong ones, and level of infestation and extent of comb damage also coincides with the strength of the colonies. Our findings indicate that SHB is now an emerging threat to the country's production of honey and other hive products, thus call for more research work on the biology and impact of the pest on the health of bee colonies and honey production and productivity of the sector at large. An immediate professional intervention is required to prevent and control the pest from causing series damage on the honey production and limit its transmission as well as expansion in the country.

Keywords: Apiary, Bako, Honey bee, Hallata, Small Hive Beetle, Pest

Introduction

Ethiopia has the largest bee population in Africa with over 10 million bee colonies, out of which about 4.6 million are confined in hives and the remaining exist in the forest (CSA 2007). Currently, the available bee colonies in Ethiopia are grouped in to five different honey bee populations occupying ecologically different areas: *Apis mellifera jemenitica* in the northwest and eastern arid and semi-arid lowlands; *Apis mellifera scutellata* in the west, south and southwest humid midlands; *Apis mellifera bandasii*, in the central moist highlands; *Apis mellifera monticola* from the northern mountainous highlands; and *Apis mellifera woyi-gambella* in south western semi-arid to sub-humid lowland parts of the country (Amssalu *et al.,* 2004).

Ethiopia is the leader in both bee populations in Africa and in bee product business development (Aby, 2009). Each year the country produces a total 42,180,346kg of honey and 3200 tons of bee wax per year (CSA, 2007). It is first rank in Africa and tenth in world in honey and also the fourth largest beeswax producer after China, Mexico and Turkey (Aby, 2009).

Like any other animals honey bees are exposed to diseases like parasite, pests, bacteria and predators (Amssalu and Gezaahegn, 2001). Many organisms make their living home in the hive of honey bees. Some are parasites that directly harm the bees while, others utilize the bees hive only for shelter purpose without producing significant effect on the bee's lives or activity (Carbon, 1998a) but mostly they attack by honey pests. The effect of these pests loose bee life, damage and fed bee products (Thomas, 1998).

Among those organisms that have an association with honey bees is one of the pest which is small hive beetles (SHB) such as *Athena tumid Murray, Coleoptera: Nitidulidae.* SHB, which is originated from South Africa are now widely spread in different parts of country. SHB was first identified in united state in Florida by Thomas (1998) and are now found in states of United States and detected in Australia late (Fletcher and Cook, 2002). This pest is considered an important parasite in Nigeria and Uganda (Sanford, 2000b). In Africa the distribution of small hive beetle is primarily in the tropical and sub tropical region (Pettis and Shimanuki, 2000) and in Ethiopia was first detected in south part (Desalegn and Amssalu, 2001). SHB are native to sub-Saharan Africa where they are scavengers in colonies of African sub-species of honey bee (*Apis mellifers*). The bucketful reproduction of the beetle in its native range is often restricted to weak colonies or associated with after absconding events (Hepburn *et al*., 1998) because of behavioral resistance mechanisms of their honey bee hosts (Elzen *et al*., 2001) is associated with after absconding events. Absconding is frequent in African honey bee sub-species and can be triggered by parasite infestations (Hepburn and Radiof, 1998). In these causes, a variety of food stores, brood combs and freshly emerged bees, are often left behind by the absconding swarms thus, beetle are provided a range of diets in their native habitat, the reproductive effects of which are not yet known (Ellis *et al*., 2002).

SHB can be a destructive pest of honey bee colonies causing damage to comb, stored honey and pollen if a beetle infestation is sufficiently heavy, they may cause bees to abandon their hive (Morse and Caldron, 2000). The beetles can also be a pest of stored combs of honey (in the comb a waiting extraction). Beetle larvae may tunnel through comb of honey, feeding and defecation, causing discoloration and fermentation of the honey (Ellis, 2004).

Different soil types might affect various aspect beetle pupation biology. Absence of beetles in certain geographical areas due to the physical and chemical nature of soils and environmental conditions generally associated with extracting facilities such as high temperature and humidity provide optimal condition for beetle development (Ellis et al, 2004). In Ethiopia very limited works are ongoing to investigate the biology, prevalence and impact of this **newly** emerging pest on honey bees colony and productivity at large. Studies have not so far also conducted on prevalence of small hive beetle in Hollata and Bako apiaries. Therefore, the main objectives of this study were [1] To study prevalence of SHB in Bak , Hollata and its surrounding apiaries [2] To assess the level of infestation and comb damaged by beetles.

Materials and Methods

Study areas

The study was conducted from October 2011 to Aril 2012 in Hollata bee research center which include Hollata bee research center itself as a main station in Hollata and other apiaries in the highlands such as Muger, Menagesha, Suba, Gole and in lowland at Bako.

Hollata bee research center

Hollata is Located in the West Shoa zone of Oromiya Region about 23 Km from West of Addis Ababa. The study area is situated at latitude of $9^0 3'$N and longitude of $38^0 30'$E. The altitude of the area is 2400mm above sea level with a relative humidity of 50.4% and mean annual rainfall of 1060mm.The rainy season covers June-September and short rainy season from February to April. Mean monthly maximum and minimum temperature are 23.3^0c and 4.6^0c respectively, with 13.95^0c of average temperature. The soil type of the area is vertisoil.

Bako apiary

Situated in Bako agricultural research centre which is found in west Shoa zone of Oromia region. Apiary area lies between $09^0 6'$N latitude and 37^0E longitude at an attitude 1650 m above sea level and located about 258 km west of Addis Ababa on the main road to Nekemet. Bako has a hot humid climate and received mean annual rainfall of about 1219 mm. The rainy period covers April-October. Mean monthly

maximum and minimum temperature are 28^0c and 14^0c respectively, with 21^0c of average temperature and sandy loam soil type.

Study population (Honey bee colony)

A total of 280 honey bee colonies from Hollata, Bako, Muger, Menagesha, Suba and Gole apiaries were included in this study. The honey bees species that were found in the study area are all *Apis mellifera bandonsii* (Amsallu *et a.l*, 2004). Being research center the bee hives used in the studied honey bee colonies were of modern type such as Zander and Langstroth.

Study method

All the honey bee colonies found in the study area or apiaries were purposively examined for presence of small hive beetle and the prevalence was compared with the considered factors.

The presence of small hive beetle was examined by opening of each hives and internally each frame inspected and external inspection included weather adult and larvae of SHB present or absent. When opening a hive containing beetles, they can be seen running across the combs to find places to hide themselves. Adults may also be detected under top covers or on the bottom boards. If the infestation is heavy, both adults and masses of larvae may be seen on the combs and bottom board. Status of combs also determined if Damage or not by the pests and could be characterized as severely damaged if the beetle damaged the comb greater than 4 combs, moderate damaged if the comb damaged one or half up to 3 and non damaged comb. Status of bees was assessed as strong, medium or weak.

Data Analysis

Data obtained in the study was stored in Microsoft (MS)-Excel spreadsheet program and subjected to SPSS version15.0 (Spiegel,1988) software for chi square (x^2) statistical analysis for possible significant difference between prevalence among apiary (ecology), statues of bees and other risk factors.

Results

Table 1: Prevalence of small hive beetle based on agro-ecology

Factor	No of colony examined	Result		Level infestation	
Agro-ecology		Negative	Positive	Highly infested	Moderately infested
Low land	112	0 (.0%)	112 (100%)	105(93.8%)	7(6.3%)
High land	168	121 (72.0%)	47(28%)	0 (.0%)	47(28.0%)
Total	280	121 (43.2%)	159 (56.8%)	105 (37.5%)	54(19.3%)

Chi-square = 254.6 P-value = 0.000 (<0.05)

Table 2: Prevalence of small hive beetle in different sites under Hollata apiary center

Factor	No of colony examined	Result		Level of infestation	
Site		Positive	Negative	Highly infested	Moderately infested
Bako	112	112 (100%)	0(0.0%)	105 (93.8%)	7(6.3%)
Around Hollata [Muger, enagesha, Suba and Gole]	65	0 (0%)	65 (100%)	0 (0%)	0 (0%)
Hollata	103	47(45.6)	56 (54.4%)	0(0.0%)	47(45.6%)
Total	280	159 (56.8%)	121(43.2%)	105 (37.5%)	54 (19.3%)

Chi-square =316.8 P-value =0.000 (<0.05)

A total of 280 honey bee colonies were examined as shown in Table1, all the honey bee colonies examined in the low land were positive to small hive beetle, thus the prevalence of small hive beetles in low land was 112 (100%) among these 105 (93.8%) were highly infested and the rest of 7 (6.2%) were moderately infested. On the contrary out of 168 colonies examined in the highland 47 were found positive and the prevalence of SHB in highland area is (28%), among these colonies 0(0%) and 47(28%) are severely and moderately infested, respectively, that means all infested colonies were moderately infested. Over all prevalence of SHB in the two agro ecological areas was 159 (56.8%) among these 105 (37.5%) and 54 (19.5%) were severely and moderately infested, respectively, out of 280 examined bee colonies. The prevalence of SHB was found to be significantly higher (p=0.000) in low land compared to highland areas.

Out of 112 honey bee colonies examined from Bako apiary all of them were found to be positive and the prevalence is 112 (100%), among which 105 (93.8%) and the rest 7 (6.2%) bee colonies were severely and moderately infested, respectively, with SHB. Out of 103 honey bee colonies examined in Hollata apiary (main station) 47 were found positive and the prevalence of SHB was 45.6%, among these all of them were moderately infested. In the other sub sites of Hollta apiary centers which are found around Hollata all the 65 honey bee colonies examined were negative to small hive beetle (Table 2). The differences in prevalence observed the three apiaries was statistically highly significant (p<0.000).

Table 3: Prevalence of small hive beetle based on bee colony status

Factor	No of colony examined	Result		Level of infestation	
Bee status		Positive	Negative	Highly infested	Moderately infested
Strong	100	47 (47%)	53(53.0%)	43(43.0%)	4(4.0%)
Medium	76	51 (67.1%)	25(32.9%)	30(39.5%)	21(27.6%)
Weak	104	61 (58.7)	43(41.3%)	32(30.8%)	29(27.9%)
Total	280	159 (56.8%)	121(43.2%)	105(37.5%)	54(19.3%)

Chi-square 25.1 P-value = 0.000 (<0.05)

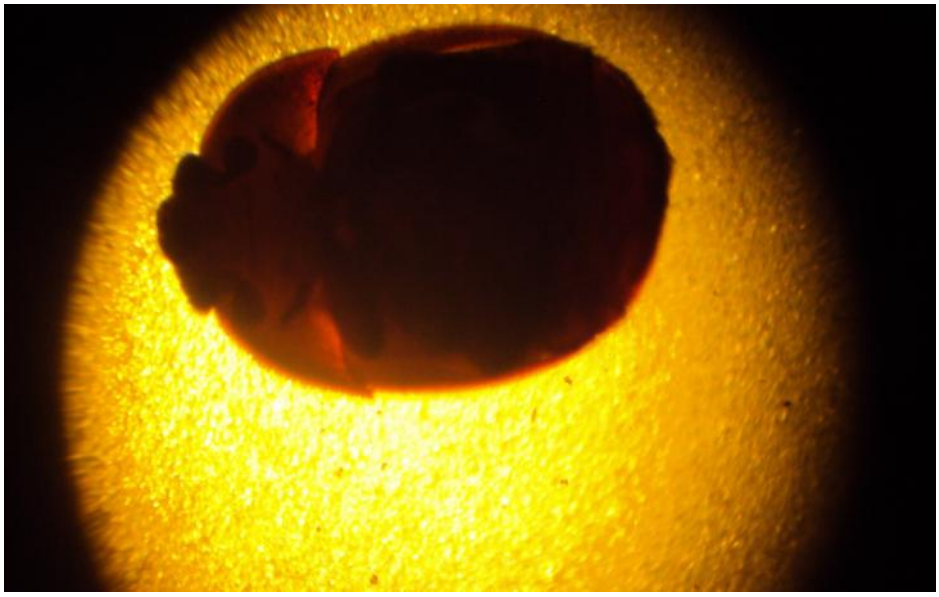
Table 4: Comb damaged and level infestation of SHB based on bee colony status

Factor	No of colony examined	Comb damaged		Chi-square P-value
Bee colony status		Sever damage	Moderate damage	
Strong	47	11 (23.4%)	36 (76.6)	***9.857***
Medium	51	19 (37.7)	32(62.3)	*0.043 (<0.05)*
Weak	61	17(27.8)	44(72.2)	
Infestation status				
Highly infested	105 (66.0%)	44 (41.9%)	61(58.1%)	**319.8**
Moderately infested	54 (34%)	3 (5.6%)	51 (94.4%)	0.000 (<0.05)
Total	159 (100%)	47(29.6)	112 (70.4)	

The prevalence of SHB compared with bee colony status was shown in Table 3. A total of 100 strong, 76 medium and 104 week bee colonies were examined and the prevalence of SHB in strong bee colonies was 47(47%) among which 43(43%) were highly infested and 4(4%) moderately infested. The prevalence of SHB in colonies with medium strength was 51(67.1%), among these 30(39.5%) were highly infested and 21(27.6 %) were moderately infested. The prevalence SHB in weak bee colonies was 61(58.7%), among these 32(30.8%) and 29(27.9%) were highly and moderately infested, respectively. This difference was statistically significant (p<0.000).

As shown in Table 4 the level of comb damaged was compared with bee colony status and infestation. There were 47 infested strong bee colonies among these 11(23.4%) and 36 (76.6%) were severely and moderately damaged respectively. Out of the 51 infested medium honey bee colonies 19 (37.7%) were with severe comb damage and 32 (62.3%) were with moderate comb damage and also out of 61 infested weak bee colonies 17(27.8%) were with severe comb damage and 44 (72.2%) were with moderate comb damaged. Of the overall 159 infested bee colonies, 47(29.6%) were with severe comb damage while the rest 112 (70.4%) were with moderate comb damage. Generally of the 105 (66.0%) highly infested bee colonies, 44 (41.9%) were with severe comb damage and 61(58.1%) were with moderate comb damage. Among the 54(34%) moderately infested bee colonies 3(5.6%) have severe comb damage and 51(94.4%) have moderate comb damage and over all of infestation level was 47(29.6%) and 112 (70.4%) were with severe and moderate comb damage, respectively, out of 159 infested bee colonies. The difference in the level of comb damage with the bee colony status and infestation status is statistically highly significant ($p<0.05$).

Photographs of different developmental stages of SHB



Photograph of adult small hive beetle under sterio-microscope (Sourse: Rahel, 2012)

Photograph of pupal stage of small hive beetle under sterio-microscope (dorsal view)

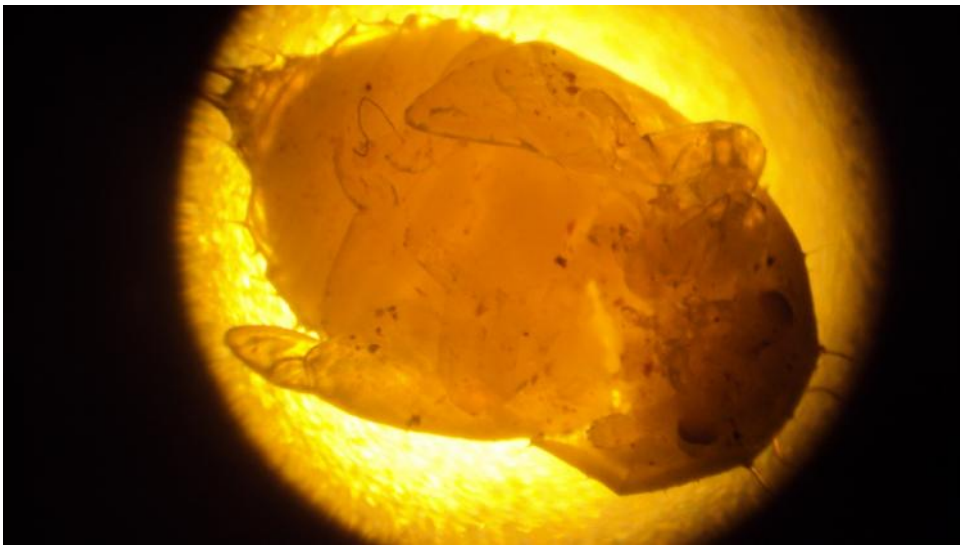


Figure 3: Photograph of pupal stage of small hive beetle under sterio-microscope (ventral view)

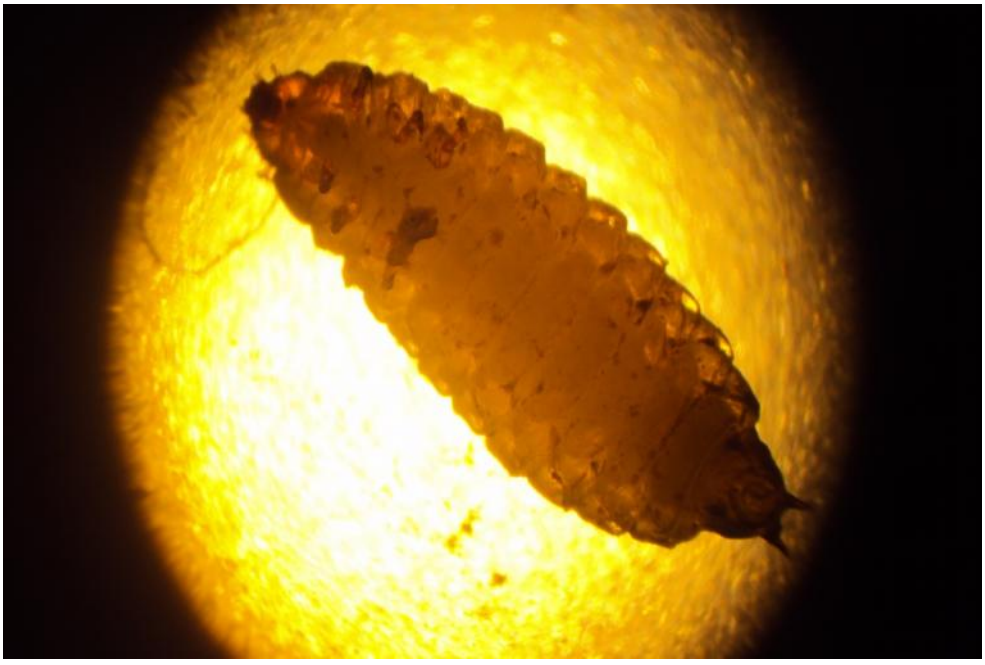


Figure 4: Photograph of larval stage of small hive beetle under sterio-microscope (ventral view)

Discussion

Prevalence of small hive beetle in the current study was 58.8%; this indicates the occurrence of the pest in the study area in particular and in the country in general. This finding considers with (Desalegn and Amssalu, 2001) who studied prevalence in small holder bee keepers, reported 10% prevalence of SHB in south and south west Ethiopia that is for the first time in the country. In this study only honey bee colonies found in the research center in modern apiary form were considered, so when once infection occurs transmission will be high which could increase the prevalence.

Significantly higher prevalence of the SHB in low land (Bako) apiary (100%) than high land Hollata apiary (28%) was observed in this study. The probable reason could be due to favorable climatic condition, soil type (sandy loam soil) and presence of fruits, to complete its life cycle, thus Bako will better full fill the requirement of the SHB biology. In addition the beekeepers transfer combs from one hives to other to strengthen weak colonies unknowingly during which the infestation spreads. Even if the climatic condition and other requirements were not conducive 28% prevalence in Hollata indicates the ability of the pest to survive in the high land.

This is in agreement with Amssalu and Desalegn (2001) who demonstrated that they beetles can survive in just about any kind of soil and extreme winter conditions which disprove the previous believed that SHBs could survive only in sandy soil and warm climates. Hollata apiary was previously free of this pest and the current occurrence could be as result of transfer of bee hives from Bako to Hollata and improper disposal of this pest brought from Bako for research purpose to Hollata main apiary station. That is way those high land found in and around Hollata apiaries are completely free of the pest because have no contact with the positive hives or SHB. Somerville (2003) said the main way of transmission of SHB is via the movement of bees, infested equipments and queens from areas having beetles to areas free of beetles dropped drastically.

In addition the level of infestation is significantly higher in Bako (highly infested) where as those positive bee colonies of Hollata are moderately infested. This could be due to the climatic effect and stage of infestation. The prevalence was also higher in medium and weak bee colonies than strong ones but the infestation level is higher in strong colonies. In this study sampling was after harvesting period and in most cases honey is not harvested from weak colonies, thus higher infestation in the strong colonies could be due to stress as result of harvesting and attraction of these pest by honey facilitate its transmission and quick multiplication in strong colonies. This finding is in agreement with Keller and Tarpy (1998) who explained higher attraction of this pest to colonies with honey and stress during harvesting that facilitate higher infestation of strong colonies.

On the contrary the strong honey bee colonies infested with SHB have mostly moderate damage (76.6%); this shows strong bee colonies better defend against the beetle to protect themselves which reduce comb damage, when compared to medium and weak colonies. Highly infested colonies are not all suffered for heavy comb damaged because it depend on the status of bee colonies, if the bee colonies is strong, have hygienic and aggressive behavior, thus the infestation will have moderate comb damage. Whereas if bees are medium, weak, and less clean and have less aggressive behavior, the comb damage is severe. This finding coincides with Neumann *et al*., (2001) who explained the defense of strong honey bee colonies against SHB. Accordingly African honey bees confine beetles to crakes and crevices (where the beetles naturally hide) throughout the colony. Incarcerated beetles lack access to the combs because worker bees continuously guard the entrance of such areas and prevent many attempted escapes of beetles.

Conclusion and Recommendations

Beekeeping has been and still plays a significant role in the national economy of the country as well as for the subsistence smallholder farmers. The contribution of bees and hive products, though difficult to assess, is probably one of the most important small-scale income generating activities for hundred thousands of farmer beekeepers. Currently honey bee production is getting higher attention in the agricultural sector. Improving the production system and adopting different technologies to advance productivity from this sector is ongoing in different research centers like Hollata apiary. However according to the current finding SHB, *Athina tumida murray*, was identified in the Hollata apiary and its sub sites causing series damage to the apiary. SHB is a destructive pest of honey bee colonies causing damaged to comb, store honey brood and pollen that result in decreasing the strength of bee colonies, consequently reduce

productivity of infested colonies. If the large numbers of SHB is present in the hive, can result the queen bee stopping laying eggs and colonies absconding from the hive, that affect not only bee products but also bee population. Thus this alarms the emergency of additional danger to this slowly developing honey production sector in the country.

According to the above conclusive remarks the following recommendations were forwarded:

- Appropriate treatment and control methods must be introduced in the infested areas and prevention has to be practiced to limit its transmission and distribution to outside the research center
- Care must be taken during transfer of hives from infested area to beetle free areas
- Stored honey supers, hive equipment, broken frame, unclean extracting and other attractive factors should be avoid from apiary
- Be aware that suppering colonies, making splits, exchanging combs, or use of Porter bee escapes can spread the beetles or provide room for beetles to become established away from the cluster of protective bees.
- Detailed investigations should be conducted in different parts of the country for presence of SHB infestation

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